Yasemin K. Özkan
Editor

Complete Denture Prosthodontics

Treatment and Problem Solving

Springer

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Contents

Part I Tooth Arrangement and Try-in

1 Anterior Tooth Selection and Arrangement 3
Buket Evren and Yasemin K. Özkan

2 Posterior Tooth Selection and Arrangement 31
Buket Evren and Yasemin K. Özkan

3 Evaluation of Try-In Stage 69
Yasemin K. Özkan, Yılmaz Umut Aslan, and Buket Evren

4 The Remounting Process: Adjustment of Dentures on the Articulator and in Mouth 105
Zeliha Şanıvar, Şükrü Can Akmansoy, Seda Keban, and Yasemin K. Özkan

Part II Post Insertion Problems

5 Post Insertion Problems in Complete Dentures 145
Yasemin K. Özkan

6 Long-Term Problems with Complete Dentures 197
Yasemin K. Özkan

Part III Stress-Reducing Materials for Complete Dentures

7 Tissue Conditioner Materials. 213
Erkut Kahramanoğlu and Yasemin K. Özkan

8 Clinical Applications of Soft Lining Materials 223
Ceren Küçük and Yasemin K. Özkan

Part IV Different Techniques for Problem Cases

9 Single Complete Dentures 243
Coşkun Yıldız and Yasemin K. Özkan

10 Duplicate (Copy) Dentures. 271
Yasemin K. Özkan, Yılmaz Umut Aslan, and Ender Kazazoğlu

11 Managing the Edentulous Dry Mouth: Reservoir Complete Denture 281
Yasemin K. Özkan

Part I

Tooth Arrangement and Try-in

1 Anterior Tooth Selection and Arrangement

Buket Evren and Yasemin K. Özkan

1.1 Anterior Tooth Selection and Arrangement

In order to construct esthetic dentures, in spite of a lot of guidance, there are still many questions regarding the esthetics of anterior portion of complete dentures. This guidance includes esthetic arrangements, subjective experiences, physiological theories, anatomical-morphological differences, and statistical comparisons. The dentist should obey the precise rules for each specific case while considering the general status and expectations of the patient. In this chapter, some general principles are explained about anterior tooth selection and tooth arrangement.

Tooth arrangement in complete dentures should fulfill the requirements of Gerber (1979):

- Complete dentures should restore the facial expression individually and naturally.
- Complete dentures should preserve the remaining tissues and structures of the system.
- Complete dentures should provide sufficient mastication function and proper phonation.

The facial expression of a person is composed of several dynamic and static components. Anterior teeth have direct effects on facial expression, facial ratios (vertical height), and extraoral appearance of the patients and at the same time support the soft tissues of the face. Although hard and soft tissues guide edentulous oral cavity, they do not give sufficient information about the location and shape of the lost teeth. Some artistic skill is also needed to have a satisfying restoration.

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The photographs of the natural teeth of the patients or the previous dentures can be asked for tooth arrangements. If the materials are not enough or absent, clinically proven anterior tooth arrangement rules should be applied.

Some of the rules among the embryogenetic principles of Gerber (1960) are based on the concept of developmental physiology. The principles of Gerber indicate that facial structure should be reflected by the maxillary anterior teeth. Even though the morphometric principles lying under these rules are scientifically undefined, considering this can provide a satisfying esthetics of the complete dentures.

If facial asymmetry or deformity is present, both anterior and posterior teeth are arranged not considering the general rules but considering the patient. The aim is to arrange the teeth as close as possible and to ensure that the visibility of facial deformity is minimal.

1.1.1 Patient Evaluation: For Whom the Prosthesis Is Constructed?

The first and the most important factor that should be considered in anterior tooth selection and arrangement is for whom the prosthesis is constructed. Only after this factor is understood can the size, shape, color, and material of the teeth be evaluated. By considering all these factors, we can achieve the natural and satisfying appearance that we try to have.

One of the best ways to have patient satisfaction is to include the patient in teeth selection and arrangement stages. How can we achieve this? If the patient is already a denture user, he should be asked about the things he likes and dislikes about his dentures. What kinds of alterations does he want? In order to have sufficient time to think about the subject seriously, the dentist should begin asking these questions in the first appointment. If it would be the first complete dentures he will wear, probably some natural teeth will be extracted. These remaining teeth can be useful for the new dentures. Perhaps there are some spaces, grooves, and prominences on the remaining teeth which the patient wishes to

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have on the new dentures. It may be beneficial to have an impression of the teeth before extraction. Old photographs showing the position of anterior teeth of the patient are also helpful. Our aim is to have as much information as possible to have a denture with a natural appearance and to be acceptable by the patient.

Nevertheless, we do not want to show the sample teeth to the patient and we do not want him/her to make his own choice. To see the variations will confuse him/her. The first opportunity for the patient to see the teeth arrangement will be after the teeth are arranged on the wax rims and approved by the dentist. Selection of the anterior teeth should always be performed together with the patient and the dentist. Dentists' concerns are important as much as the patients' wishes and thoughts. Because of their experience, dentists have a large influence on their patients. Therefore, according to some authorities, trying to affect the patients should be prevented. Compared to the other stages of the treatment, it is important to maintain a sincere relationship during the decision stage. Studies show that patients, who were allowed to make choices on esthetic properties of their prostheses, showed faster adaptation to their prostheses. Also, many studies indicated that satisfying patients on esthetical terms shortens the adaptation time for their new prostheses.

Ideas from relatives (family members and friends) should also be considered together with the patients' own choice. Evaluating teeth samples on patients makes selecting anterior teeth easier and also allows choosing the morphology and shade of teeth.

The sample table does not provide a three-dimensional view. Therefore, sample models are used for teeth arrangement to provide the three-dimensional view for both dentists and patients. Patients, who are incompatible during anterior teeth arrangement, blame their dentist afterward because of the esthetical outcomes and usually cause problems about their prostheses.

1.1.2 Tooth Selection

Tooth selection stage is very important to determine the appearance of the patient. Each patient has a different good appearance concept but it is necessary to provide a standard. Good appearance is classified into three different types. This can be beneficial to please the willing patients.

1.1.2.1 Natural Appearance

For natural appearance, the dentist, with his dental anatomy experience and knowledge of aging process effect, decides the most suitable denture. The denture is the product of his experience. Depending on the patients' age, he reflects the wear and discoloration of teeth. With his own experience and the use of qualified materials, he forms a copy of life. The patient who fits this appearance is sophisticated, intelligent, and conscious.

1.1.2.2 Ideal Appearance

Most of the patients are not aware of the good points of natural appearance, and they want their teeth to reflect the ideal appearance in magazines and advertisements. These kinds of prosthesis could be fabricated with teeth in each shape, form, and color harmonious with the characteristics of the patient. The arrangements that usually please this group of patients give better results in patients with young characteristic features and normal intermaxillary relationship.

Problems arise when there are differences in the intermaxillary relationship. Although it does not fit the patient's own esthetic criteria, the essential tooth arrangement is established for the stability of the prosthesis. If a patient with a Class III intermaxillary relationship wants to have a normal inclination with his anterior maxillary and mandibular teeth, he will accept an unstable prosthesis, and a patient with a Class II relationship will observe that to have a normal relationship, the mandibular incisors will be repositioned (Fig. 1.1a, b).

The patients who adopt the ideal appearance only think about the general appearance; they are not interested in the details. These kinds of patients can be in different ages but mostly they are easily satisfied. Usually, they are worried about the harmony between the color, size, and relationship of the teeth and their own characteristics. On the other hand, they talk about their doubts at the try-in stage if their opinion is asked.

1.1.2.3 Preferred Appearance

Many studies indicate that most of the patients are not aware of the slight differences in dental anatomy unless their attention is attracted. The patients usually want to have properly aligned tooth arrangements as the orthodontists obtained or they want to have small white teeth. For some of these types of patients, the shape, color, and size of teeth are not important, but the teeth should provide the soft tissue support and therefore be placed in a proper position. These kinds of patients emphasize their wishes when they first visit the dental office. How wishes will suitably meet with tissue tolerance should be explained by the dentist. The other part of this group is biased about how their teeth will be arranged in reality. They spent most of their time providing the accurate shape, color, and intermaxillary relationship of teeth, but a fully harmonious treatment is not important. The patients in this group can be easily defined. Either their old dentures are apparently inaccurate (golden teeth or unnatural diastemas) or they exhibit their own wishes in details when selecting teeth.

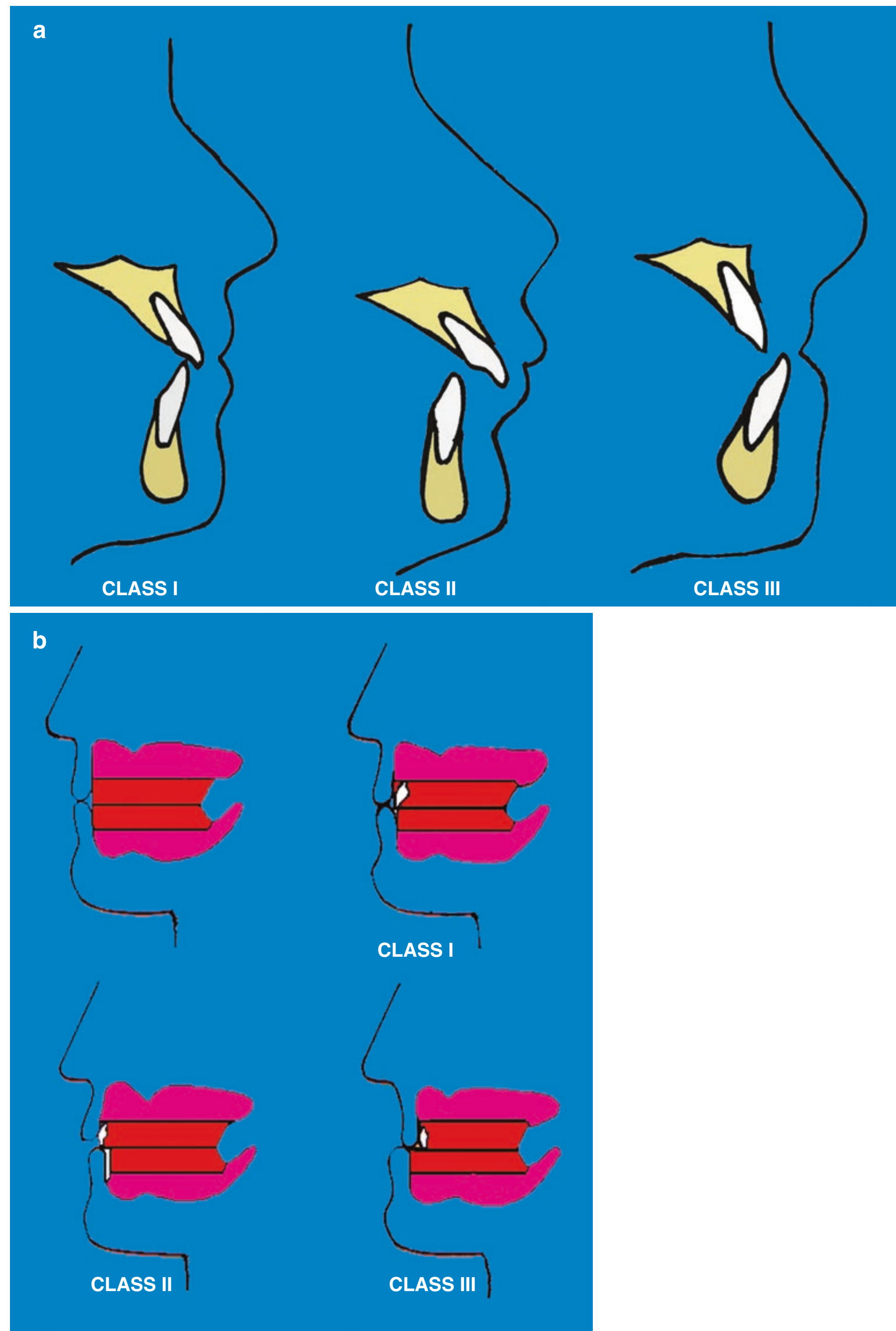


Fig. 1.1 (**a**, **b**) The position of incisor teeth in Class 1, Class 2, and Class 3 patients

For these kinds of patient's, tooth selection is usually simple and little problem is observed. If any problem occurs, it is difficult to diagnose, and the depressed displeasure of the patient cannot be expressed until he wears the denture. Even, some patients do not want to be definite about their complaints, as they do not want to be known as anxious about their appearance. Therefore, they define their displeasure on other features of denture design.

In order to avoid problems, the dentist should be ready for the situations that he does not have any authority and if possible he should be in direct relation with the patient during decision. The aim of this kind of approach is to

have the best results. Furthermore, the dentist should have some materials such as models and pages from magazines. The photographs of the previous successful patient can also be useful. The dentist should explain the reasons of the applications, and in a short time, he should determine the best appearance that the patient is satisfied. Another useful strategy is to ask the opinions of the relatives of the patients. Many elderly patients come to the office with their children who give them physical and psychological support. Both the patients and their children are satisfied with the shape and arrangement of the teeth, and they are persuaded that the aim of our demands is to have the best possible results. It is difficult to satisfy patients as they become older.

1.1.3 Topographic and Functional Adjustments in Anterior Teeth Arrangement

If functional demands are met, the location of artificial teeth in complete dentures should be in the same place that the natural dentition was in the past. During the arrangement of artificial teeth, the upper and lower anterior teeth should not have any contact in centric relation. A distance of 1 mm achieves "slight freedom" during protrusive movement before contact with the upper teeth. Anterior teeth are generally located with a maximum incisal guidance angle of 15 degrees (Fig. 1.2). The proper vertical and horizontal overlaps of maxillary and mandibular teeth should be obtained necessarily. Another criterion for the topographical placement of anterior teeth is to provide proper space for the soft tissue profile of the face and the tongue as indicated by Sir Wilfred Fish (1936)

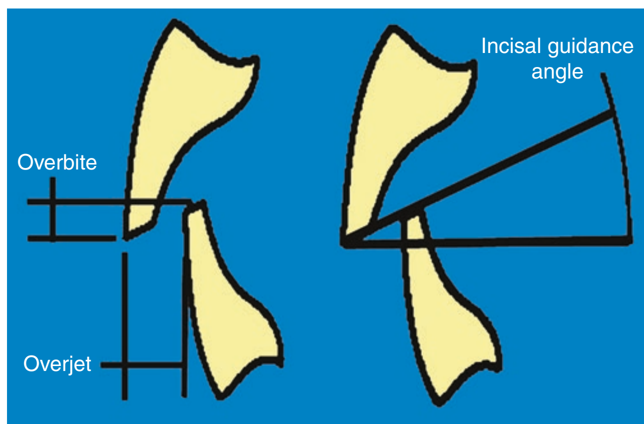


Fig. 1.2 Maximum incisal guidance angle is generally 15 ° in the ideal arrangement of anterior teeth

1.1.4 Anterior Tooth Selection

There are four main subjects in anterior tooth selection:

1. *Tooth size*
2. *Tooth shape*
3. *Tooth color*
4. *Tooth material*

1.1.4.1 Tooth Size

If the patient did not explain any tooth size, selection of teeth according to the size of the patient is the easiest approach. A pair of compasses can be used to measure the width of all anterior artificial teeth. In the west European population, the sum of the mean width of maxillary anterior six teeth is 46 mm. In order to provide harmony, for a medium-sized male patient, the width of anterior teeth should be 46 mm; for a large-sized male, it should be 48 mm; and for a small-sized male, it should be 44 mm.

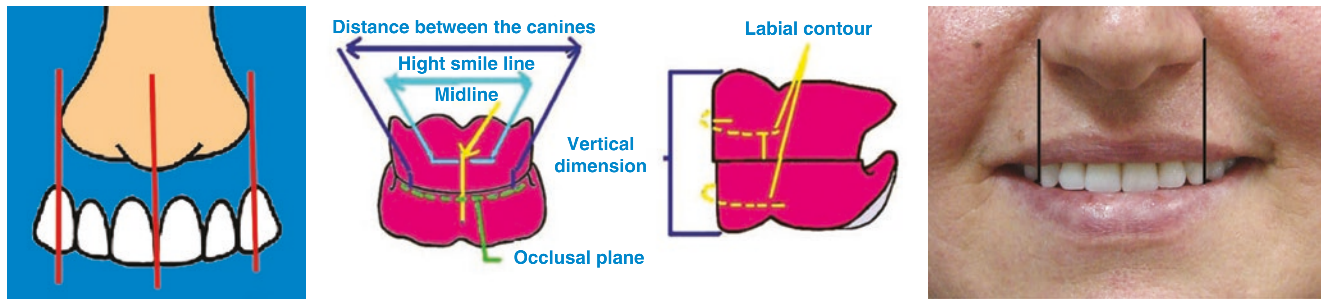
Although there is no evidence that the teeth of females are smaller than the teeth of males, the mean size of women teeth is less, and to have harmony, during teeth selection, 2 mm less teeth size can be chosen in each size (large, medium, small). When this system is used, the patient can think that the selected teeth are large for him. To confirm the selection, comparisons can be made by preparing models with natural dentition.

Another method for anterior teeth selection is to mark the corners of the mouth on wax rims. By measuring the distance between the corners of the mouth on wax rims, the overall width of six anterior teeth can be achieved. Some anatomical measurements for teeth selection are as follows:

1. The vertical lines drawn from the edges of the nose passes from the midline of the canine surfaces (Figs. 1.3–1.5).
2. The sum of the mesiodistal width of the first central incisors is equal to the width of the philtrum (Figs. 1.4 and 1.6).
3. The distance between the commissures of the mouth on wax rims is equal to the overall width of anterior teeth (Figs. 1.7 and 1.8).
4. The sum of the mesiodistal width of the anterior teeth is close to 1/3 of the distance between zygomas (Fig. 1.9).
5. The mesiodistal width of one central incisor is equal to 1/16 of the distance between zygomas (Fig. 1.10).

Alternatively, by measuring the distance between the ala of the nose, the distance between the midlines of the canines can be predicted.

The size of teeth is also related to the size of the dental arch and the interarch distance. The easiest method to determine the teeth size is determining on the stone model. These



Figs. 1.3–1.5 The vertical lines drawn from the edges of the ala of the nose pass from the midline of the canine surfaces

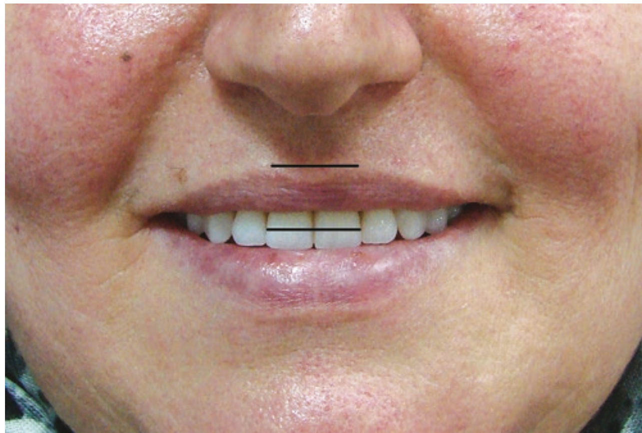


Fig. 1.6 The sum of the mesiodistal width of the first central incisors is equal to the width of the philtrum

models are classified as large, medium-large, medium-small, and small. Anterior teeth are also classified similarly due to the shape of the stone model. Trying different forms of teeth on the edge of wax rims can give the dentist an idea about the height of teeth he will use. For the best esthetic results, the highest teeth suitable for the edentulous space should be chosen.

The size of each tooth is also important besides the total width of six anterior teeth. There are two sizes that should be taken into consideration: (1) mesiodistal width and (2) incisogingival height.

Mesiodistal Width

The total width of maxillary six anterior teeth can be achieved by dividing the largest width between zygomas into 3.3. The rule of House and Loop that divides the distance between zygomas into 16 is the starting point to find the width of maxillary anterior teeth. Lateral incisors are nearly 2 mm, while canines are 1 mm narrower than the central incisors. The total width of six anterior teeth can be obtained by this formula. 1/12 of the distance between the zygomas (face width), 1/20 of the distance between hairy skin and the jaw (face height), and 1/4 of the distance between palatine papilla and fovea palatina are used for the selection of central incisors. Therefore, it can be easily measured by a pair of compasses on the model. The dentist can improve his own system with a little effort.

Golden proportion can be used for maxillary central and lateral incisors. When it is viewed from the front side, it is believed that the most suitable width is obtained when the central and lateral incisors are in golden proportion (approximately 5:3). The most suitable width of canine should be in the same descending golden proportion in accordance with the lateral incisors.

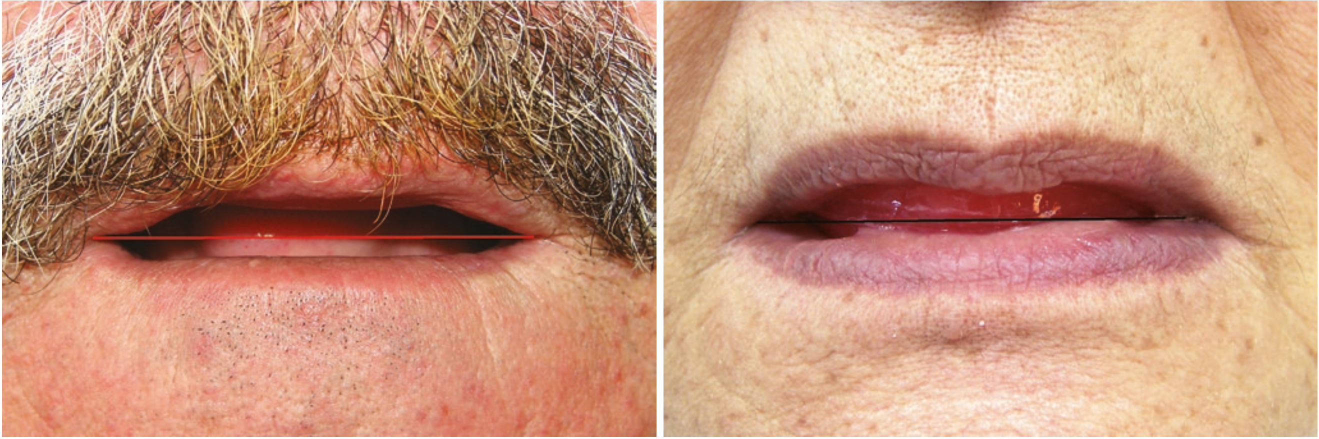
To be in harmony with the maxillary incisors, producers make the lower incisors narrower than the natural incisors. If there is no special explanation, the technician generally prefers to choose small incisors. The ratio between the width of maxillary central incisors and the width of mandibular central incisors should be 1:0.6, or the sum of the width of mandibular four incisors should be 2.4 times of the sum of the width of the maxillary four incisors. Esthetic problems arising from narrow mandibular incisors are avoided by informing the technician about teeth harmonious with these ratios.

Incisogingival Length

Wax rims are used for marking the height of the smile line. The patient is asked to smile, and a horizontal line is drawn on the wax rims at the point where the lip reaches. This is beneficial in determining the height of teeth. As a common guide, when the patient smiles, upper lip stays close to the gingival cervical part of the teeth (Figs. 1.3 and 1.11a, b).

House and Loop suggested using the facial measurements for the selection of maxillary central incisors. Measuring the distance between the hair border and gnation and dividing the number by 16 will give the height of the maxillary central incisors. Mostly, the maxillary teeth are not visible when the patient smiles, but the wax rims can be a starting point for teeth selection.

Companies producing denture teeth arrange the size of the mandibular teeth according to the size of the maxillary incisors. Therefore, when the anterior teeth are selected, the



Figs. 1.7 and 1.8 By measuring the distance between the corners of the mouth on wax rims, the overall width of anterior teeth can be achieved

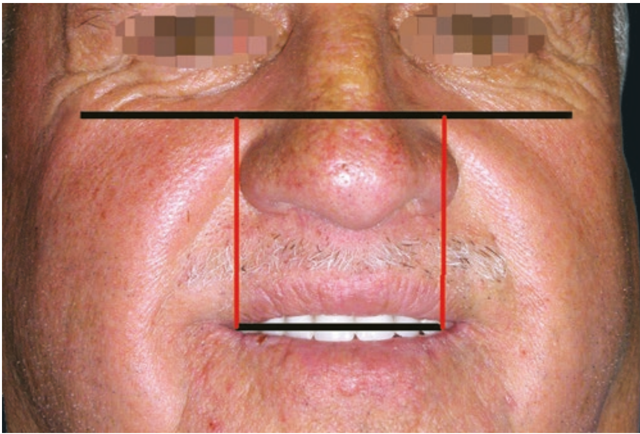


Fig. 1.9 The sum of the mesiodistal width of the anterior teeth is close to 1/3 of the distance between zygomas

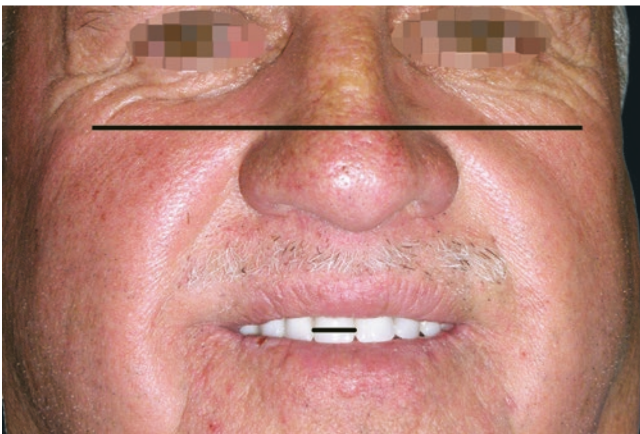
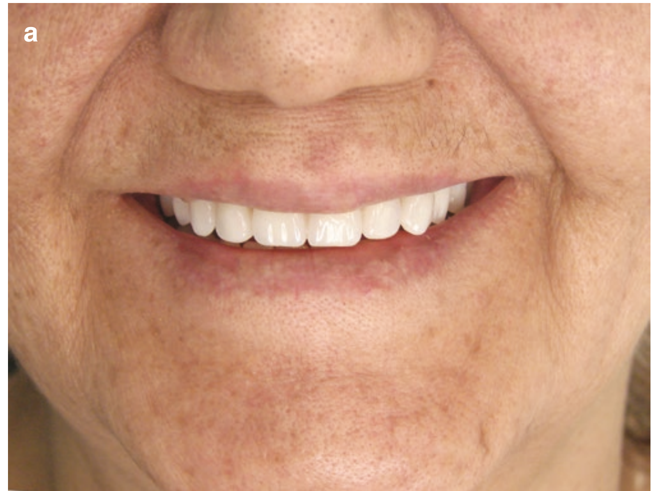


Fig. 1.10 The mesiodistal width of one central incisor is equal to 1/16 of the distance between zygomas



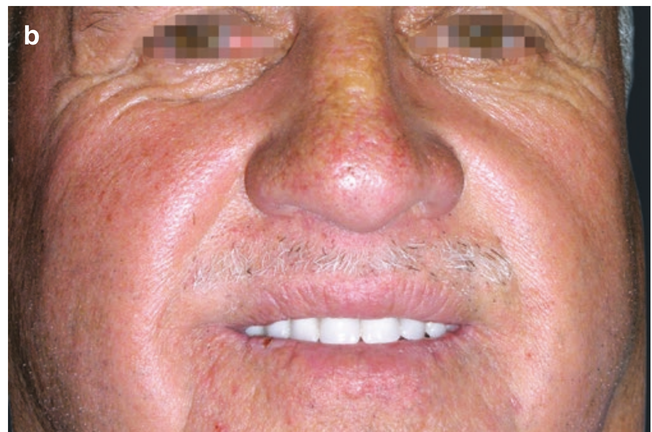


Fig. 1.11 (**a**, **b**) When the patient smiles, the upper lip is closer to the cervical parts of the teeth

most suitable lower anterior teeth size can be selected from the tooth list.

1.1.4.2 Tooth Shape

The Selection of Shape

Many kinds of teeth are available in the market, and each manufacturer uses different shape classifications. Generally, many teeth are designed with previously determined clinical crown length and width ratio. Specific shapes are obtained due to short, medium, or long crown length and narrow, medium, and large crown width. Teeth are also classified as flat or curved according to the shape of their labial surfaces (Fig. 1.12a–f).

Facial views of the patients are classified as square, tapered, and oval and their modifications as square-tapered, square-oval, and tapered-oval. This classification is the starting point of the correct tooth selection; however, other factors as femininity and masculinity should be taken into account. Oval teeth are feminine and square teeth are masculine, as the curved labial surface is more feminine and flat labial surface is more masculine. If the patient is male and has a square-tapered facial form, then square-tapered and flat labial surface teeth should be chosen (Fig. 1.13).

Determining the teeth shape by proportioning the distance between zygomas with the width of the forehead and the lower third of the face is accepted generally. When the width

Fig. 1.12 (**a**–**f**) There are many different types of artificial teeth in the market. (**a**) Different types of shade guides manufactured by different companies, (**b**) square-shaped teeth, (**c**) narrow-type teeth, (**d**) oval-formed teeth, (**e**, **f**) flat- and convex-shaped teeth

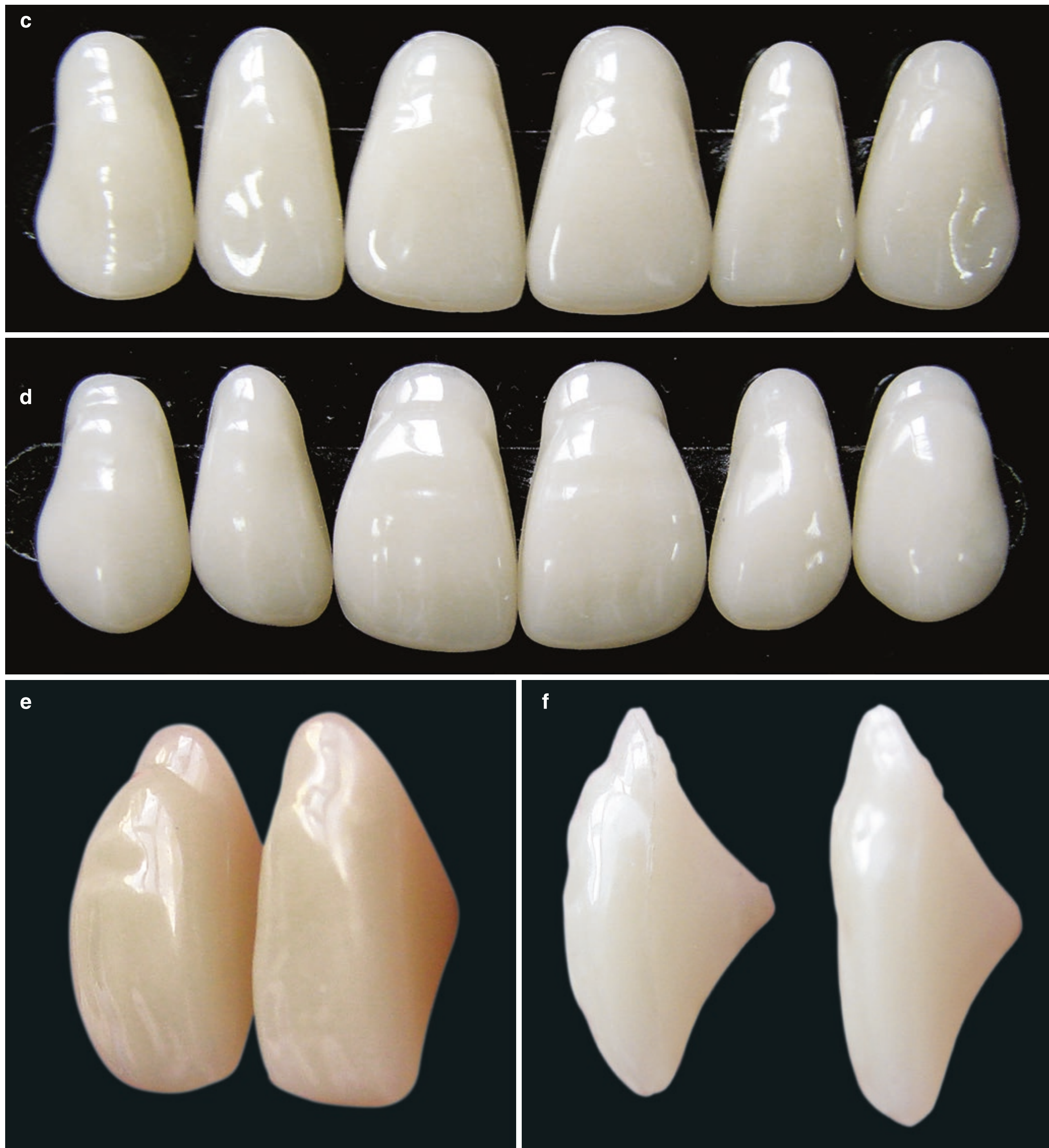


Fig. 1.12 (continued)

of the forehead of the patients are wider than the distance between the zygomas, square-shaped teeth (Fig. 1.12b) are preferred, and when the patients have wider upper lip, tapering teeth are preferred.

A correlation can be set between the shape of the upper jaw and the shape of the teeth. When the upper jaw is in V-shape and narrow, tapering type of teeth would fit best for space (Fig. 1.14a, b). Similarly, by placing six anterior teeth between canines helps to place the teeth easier when square-shaped teeth are used for patients with square-shaped jaws (Fig. 1.15a, b).

The convexity of the labial surfaces of the incisors is related to the convexity of the patient's face. The general facial harmony of the patient who has a convex profile can be

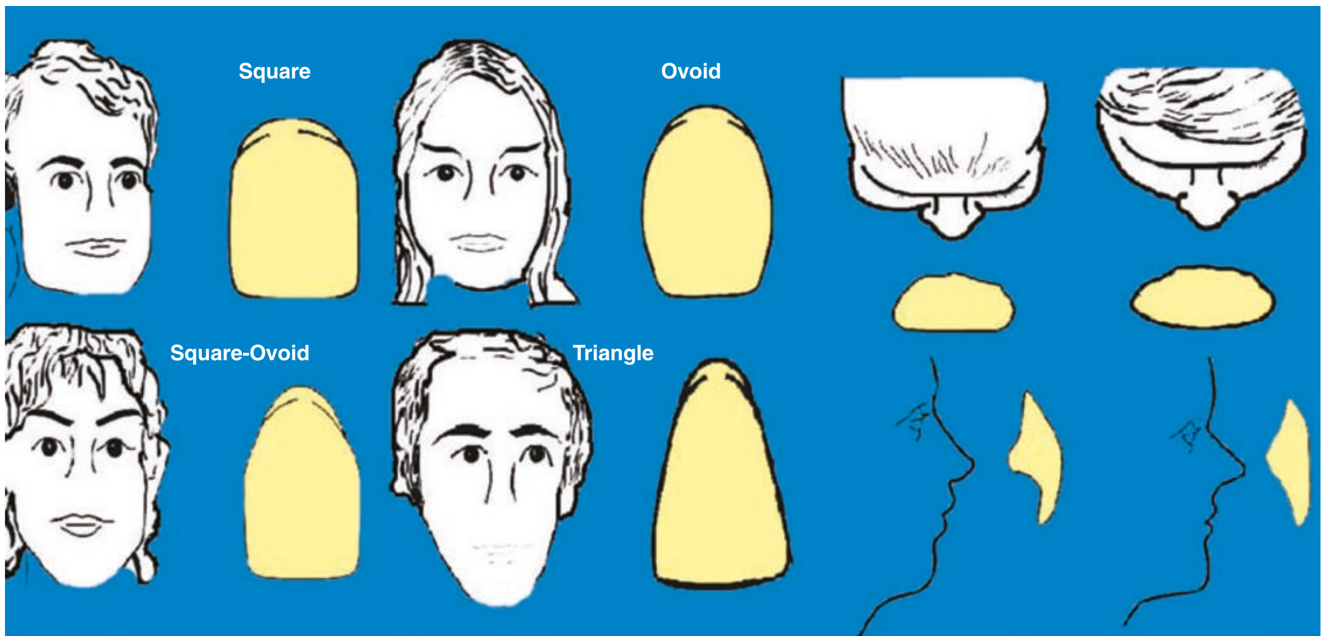


Fig. 1.13 Classification of facial shapes

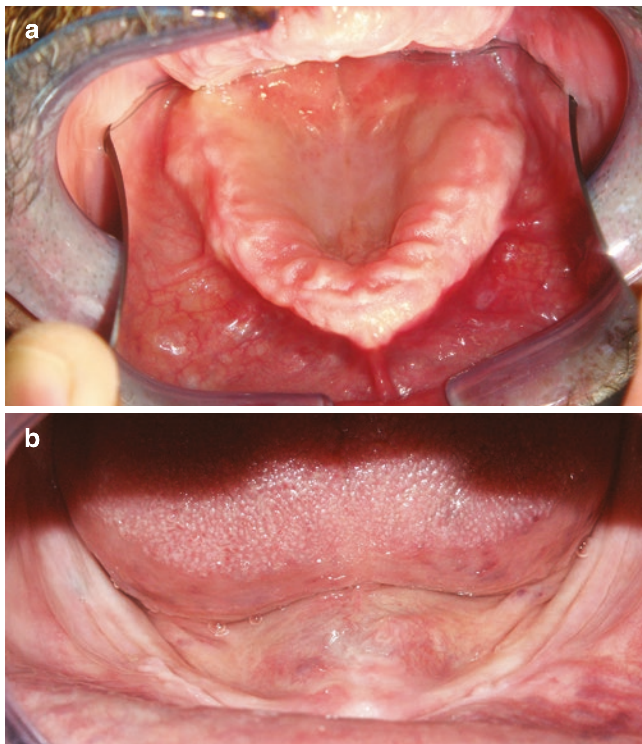


Fig. 1.14 (**a**, **b**) Triangular-shaped ridges in the upper and lower arches

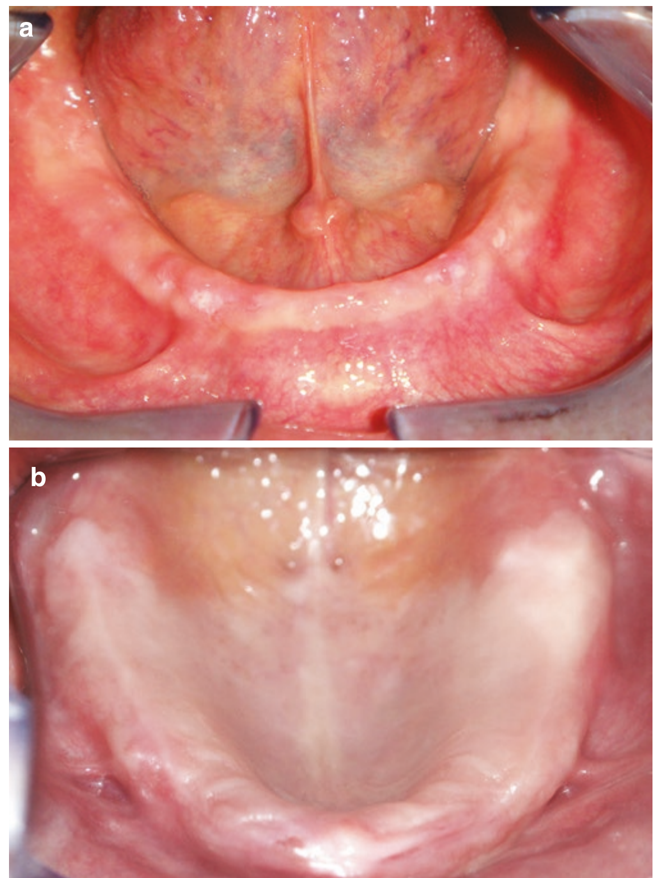


Fig. 1.15 (**a**, **b**) Square-shaped ridges in the upper and lower arches

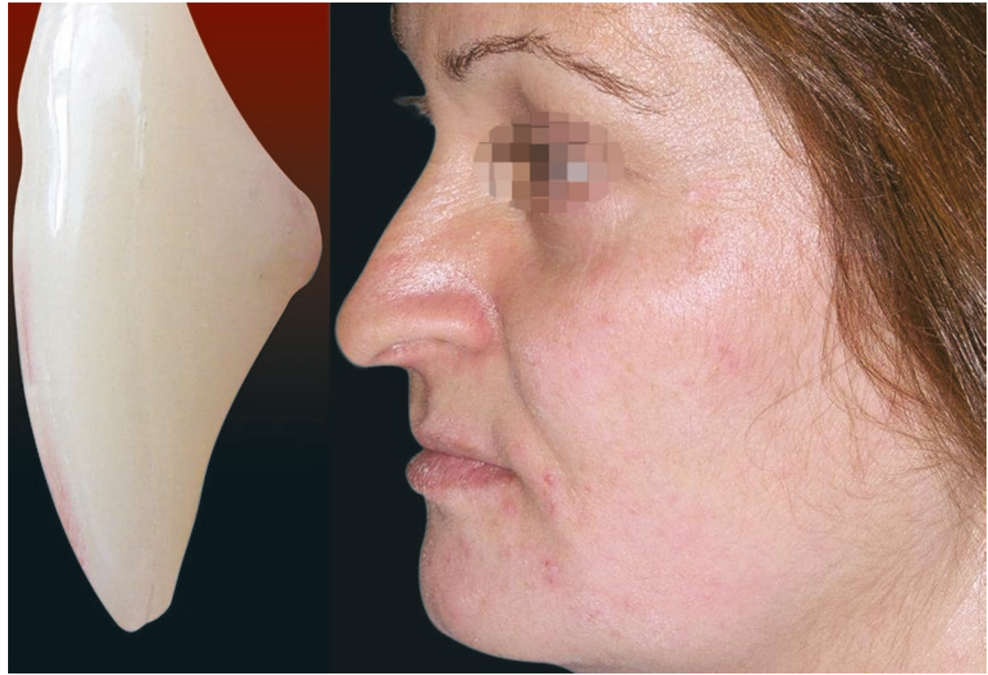


Fig. 1.16 The convexity of labial surfaces of incisors is related with the overall convexity of the face of the patient

completed with convex teeth (Figs. 1.13 and 1.16). To complete this type of facial harmony, it is suggested to use the golden proportion for selecting teeth size, and at the same time, it can also be used for the selection of teeth shape. The most suitable height-width ratio is 5:3 for anterior teeth. While convex teeth are used for the patients who have a convex profile, flat teeth are used for the patients who have a flat profile.

Another method to choose the teeth shape was suggested in the 1950s by Frush and Fisher. The use of square teeth was suggested for the male patients who have square-cornered physical form. Since women have curved and round features, round- and curved-shaped teeth were suggested for this group of patients. Therefore, the dentist was advised to select the teeth according to the patient's gender. Even though there is no definite correlation between gender and the teeth shape, harmonious results can be obtained using this method (Fig. 1.17a, b).

Attrition is another important factor for determining the tooth shape. If the elder patients that we have treated with complete dentures had their own teeth, attrition would be observed. The dentist should convince the patient to have attrition on the denture teeth to have realistic results. Grinding 1–2 mm from the incisal edges of the incisors is sufficient. While adjusting the maxillary teeth, it is important to form straight lines, but angled surfaces should be created during articulation of the edges of the mandibular incisors. In order to create attrition-like surfaces, incisors can be grinded by the dentist, and then the technician can adjust it. Many dentists prefer not to make any modifications during the try-in stage and direct the technician to bring anterior teeth to occlusion with the same method. When setting up the incisal edge, the inclination of the adjustment as if passing upward from buccal to lingual should be taken into consideration.

At the same time, it is important to inform the technician about the other signs of aging (overeruption and root exposure) as the attrition signs are reported. Although it is possible to create this appearance at the try-in stage by removing the wax from the margin of the selected tooth, if the alveolar bone is protruding, it may cause problems.

Even though it is addressed that it would be necessary to imitate the root surface exposure, the technician limits the potential of creating a realistic effect in teeth arrangement by changing the cervical margins of the incisors to place the teeth in a limited area (Fig. 1.18a, b).

For the selection of teeth shape, the dentist uses the methods that are proven to provide a beautiful appearance and have practical benefits. In this case, generally it is best to select square-/oval-shaped teeth. The arrangement of these teeth is easy, modifications are possible at the contact points, obtaining functional occlusion is easy, and these arrangements can be performed without changing the general shape. Square teeth have long contact points, and even when incisal edges are grinded to imitate attrition, the contact point is sufficient for the papilla acting as gingiva which fills wide interproximal areas because if the papilla reaches the incisal edges, a bad appearance will occur. If the root surface appearance is imitated, square-shaped teeth are important; otherwise artificial increase in the clinical crown height will form deep interproximal spaces, and in

that situation, the appearance and the hygiene will be disturbed.

Square/oval teeth are recommended in researches regarding teeth selection, and these teeth can be selected for all patients. The selections are performed according to the choices of the patients and dentists. All the groups in the study selected the teeth among different shapes, and it is concluded that square or oval teeth are selected other than tapering formed teeth; however, the female patients chose round-shaped teeth. The common thought of male observers is that rounded teeth in female patients are the esthetic complement.

Tooth Form

In determining the shape and form of anterior teeth, it is suitable to select anterior teeth that are in harmony with the shape of the face. From the lateral view, the shape of the face is defined when parts of the face, such as the forehead, zygomatic arch, and mandibular angle, are considered altogether.

The face of a human being can have four main shapes, (1) square formation, (2) tapering square formation, (3) tapering formation, and (4) oval formation, or some variations of these (Fig. 1.17a, b). The shape of the upper central incisor, when turned upside down, should look like the shape of the face. For example, a person with a square-shaped face looks the best with the square-formed upper anterior teeth.

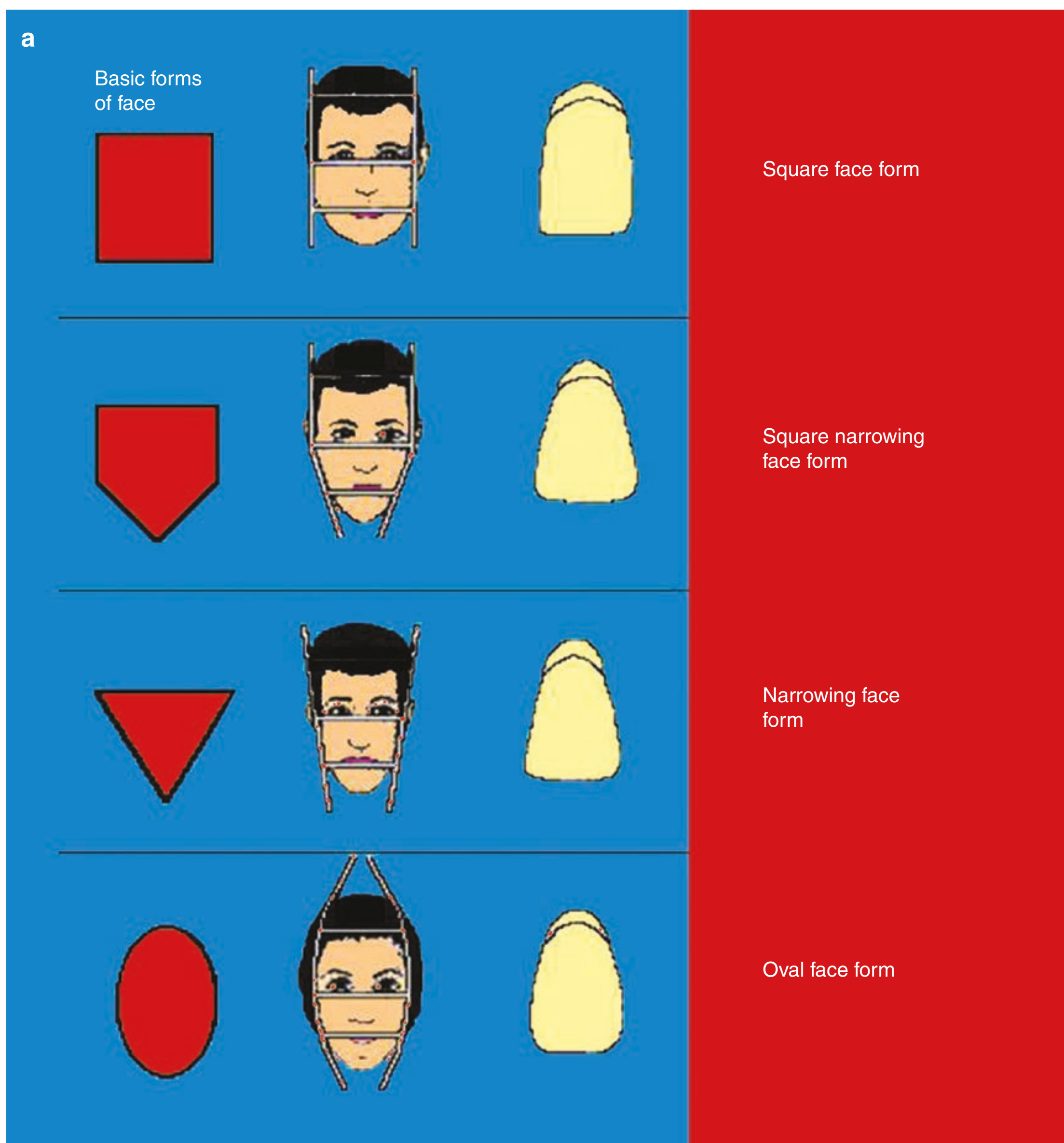


Fig. 1.17 (**a**) Basic forms of the face and teeth. (**b**) Modified forms of the face and teeth

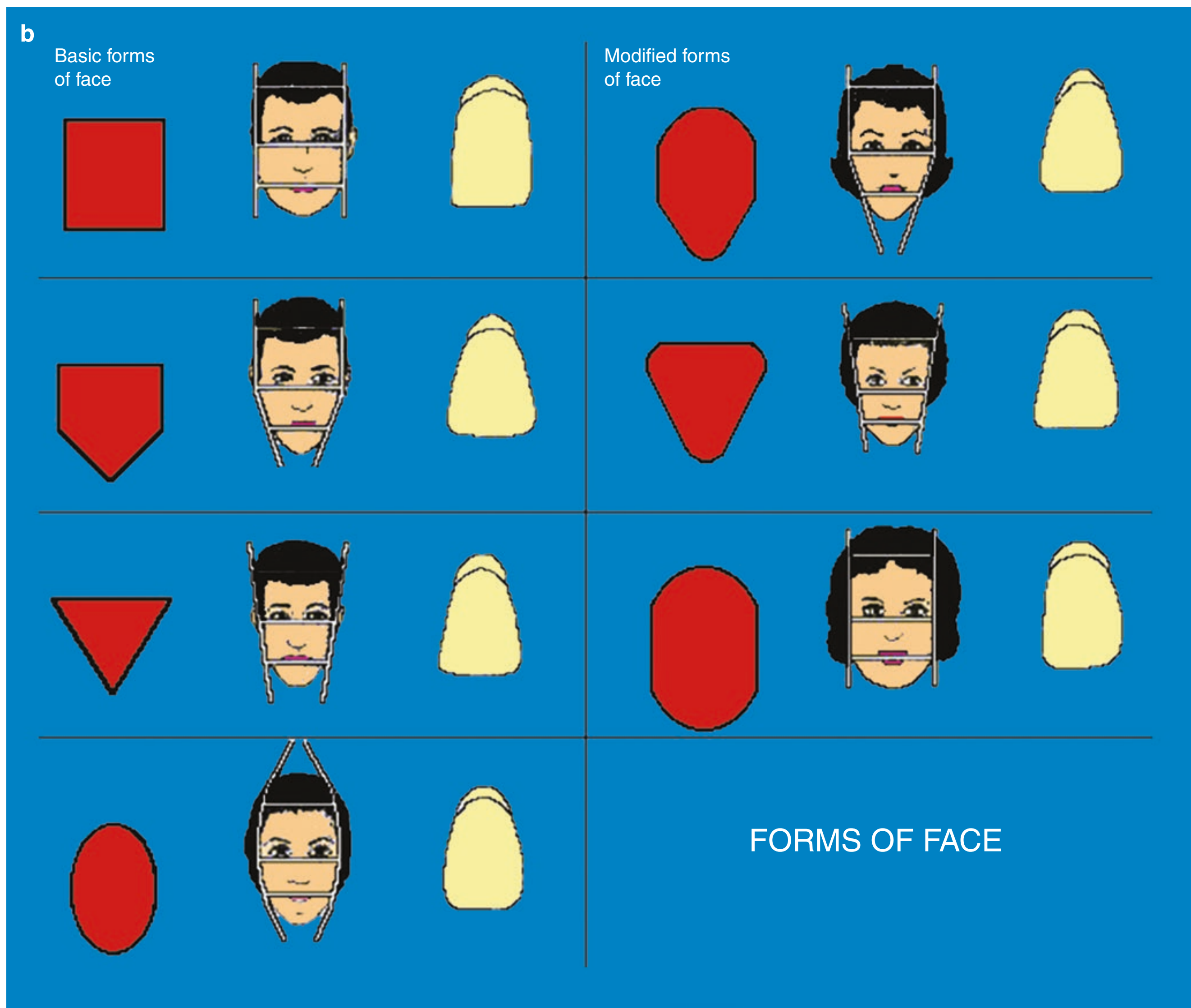


Fig. 1.17 (continued)

This method of teeth selection is known as geometric theory. Most of the production companies produce their tooth selection systems as per these face shapes. However, the shape of the upper central incisors of patients with natural teeth is not always the opposite of the shape of the face. Wright found out that 60.7% of the individuals have natural upper central incisors that are not the reverse of the face shape. Bell, on the other hand, has analyzed the upper central incisors of 31 individuals whose natural teeth are esthetically acceptable. There has been no correlation found between the shape of incisors and the form of the faces. Nevertheless, since oval-formed teeth are not always seen in patients with an oval-shaped face, when considered artistically, this kind of approach makes sense. When all the natural teeth of a patient are lost, the shape and form of his/her face can be a valuable indicator. Moreover, as orthodontists do, there are situations in which a natural arrangement can be altered. Therefore, teeth that are in harmony with the face shape could attain natural and satisfactory appearance.

Tooth Inclination

A single tooth can have both mesiodistal and incisogingival inclinations. These inclinations of selected teeth can complete the profile inclinations of the face. Manufacturers produce F (flat) or C (curved) tooth forms according to their labial surfaces.

It is a good idea to select anterior teeth slightly larger than required to reshape for cosmetic purposes. The main concept here is that there is a possibility for every tooth to be modified into a desired form individually for each patient. Selection of very small anterior teeth is also a common mistake. Present denture teeth may be considered as a starting

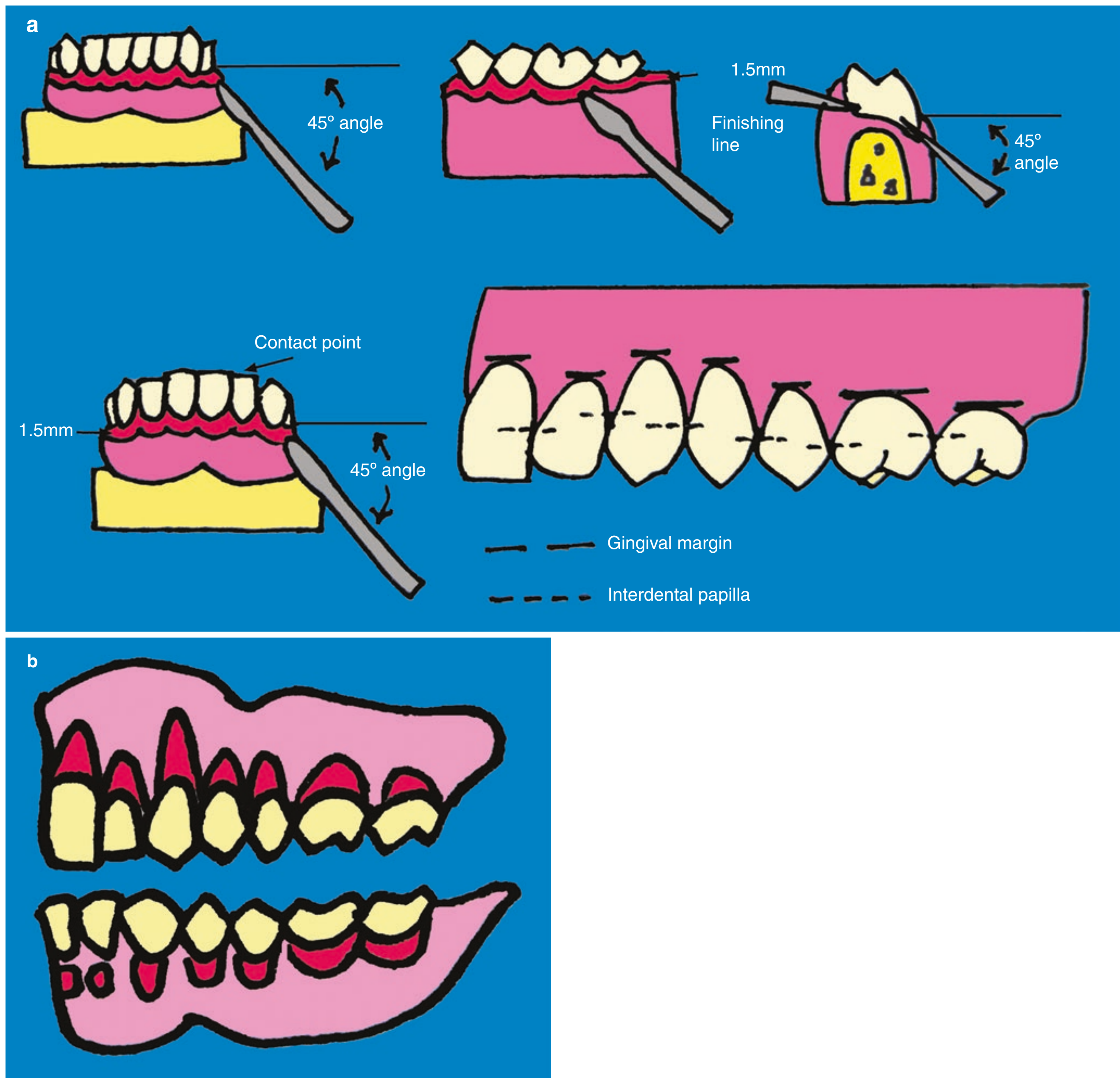


Fig. 1.18 (**a**) Gingival wax-up (**b**) Denture wax-up with root forms

point. In order to obtain more natural and more personal appearance for the patient, dentists should consider it as their responsibility to reshape each tooth.

1.1.4.3 Tooth Color

During anterior tooth color selection, age and skin color are the determinant factors. Older patients have darker teeth. If the patients have too many pigments on their eyes, hair, and skin, selected teeth should also be pigmented. After the dentist suggests the correct color, they select the color together with the patient. Dentists should suggest two or three proper colors for the patient. If the entire shade guide is shown to the patients, they will select the whitest color, and it will be difficult to persuade them for the correct color (Fig. 1.19).

Dentists are generally exposed to three kinds of problems:

1. It may be problematic to select the most suitable color for the patient.

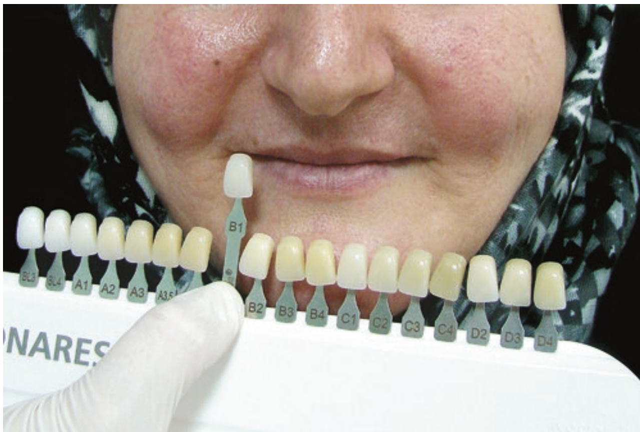


Fig. 1.19 During teeth selection with the shade guide, the patient generally prefers light colors

Fig. 1.20 Examination of the anterior teeth with a mirror

2. It may be problematic to make the patient agree with your choice.
3. It may be problematic to be sure that the selected color provides all the detailed features regarding the patient's requirements.

If possible, color selection must be performed under natural light. It is ideal to make the selection facing a window that points north. This is not always possible; some places are lightened totally by artificial light. In the absence of natural light, light devices that produce light similar to daylight must be selected. Many manufacturers provide a large selection of color, but since it is not important to obtain a harmony with the color of natural and artificial teeth, it is easier to select the color in complete dentures. First, the color that best matches the patient's skin color is selected. Yellow colors for dark-skinned patients and gray colors for elder patients are the best selections. After determining the proper color tone, maxillary anterior six teeth are placed while the patient is holding a little mirror to examine the artificial teeth (Fig. 1.20).

Another problem is the disagreement of patients and dentists regarding the color of the teeth. For dentists, it is hard to imagine selecting a color that looks unnaturally white. That is why we want the patients to make the same choices as ours. It is good for the case if the patient has knowledge of dental esthetics. If the new complete dentures are genuinely satisfactory for them, and they show off to their friends, should we upset them by insisting that our choices are correct? If we act too harshly to convince these patients, we may have to face a reverse reflex. If the patient agrees unwillingly during the try-in stage, it will result in dissatisfaction. It is best to give the patients what they want.

Main Guidelines for Tooth Color Selection

Three features of color that must be considered are:

- Hue is the feature that allows red, yellow, and blue and such classification of colors.
- Value is the lightness or darkness of a color.
- Chroma is the saturation of a color.

Hue, value, and chroma are generally terms related to color; therefore, they are important during teeth selection. Hue is basically the color of an object.

Today, yellow is the most dominant shade in most of the shade guides. Other colors have a smaller part. As the color lightens or becomes closer to white, value increases. As people become older, the teeth tend to become darker, or their value decreases. Chroma is the amount of hue in color. Since yellow is a dominant hue, chroma means the amount of yellow in each tooth.

It is important to use teeth with different colors, other than just one color. Many different colors may be used on a single tooth in order to obtain a more natural and more satisfactory appearance.

When choosing colors for complete dentures, patients should not be allowed to look at the shade guide and select whatever they want. Instead, considering that 8% of the male population is color-blind, a female assistant may help with these selections, especially for partial dentures. Even though there are no scientific formulas for edentulous patients, the following guidelines can be used:

1. Every manufacturer produces different shade guides, and it is wise to use different shade guides during color selection.
2. As people become older, teeth lose their brightness or their value decreases. They become more yellow and gray.
3. As a rule, the darker the skin color of the patient, the lower the value of the teeth that is selected.
4. Because of relative closeness and amount of skin, the most important factor to be evaluated is the color of the skin other than the color of the hair and eye. The shade guide is held near the lips and close to the skin. It may be

a useful test to look by slightly narrowing the eyes. The color that disappears first is the one closest to the patient's skin color.
5. Success may be achieved by choosing anterior teeth with different colors. This may create depth and naturalness illusion. A more natural look is obtained by choosing a lighter shade for lateral incisors than canines and central incisors. Canines generally have a darker color than central incisors.
6. When choosing color for mandibular anterior teeth, the same color selected for maxillary teeth may be used. For a Class III (prognathic) patient, mandibular anterior teeth with less brightness and value will not look as pronounced as lighter-shaded teeth. Conversely, for a Class II (retrognathic) patient, lighter-shaded teeth may be used in order to make teeth look more anteriorly positioned than they normally would be.

1.1.4.4 Tooth Material

Preference between the acrylic and porcelain teeth is done according to their price, appearance, mechanical strength, and the basis of bonding to denture base. Acrylic is always more advantageous than porcelain in price. If porcelain is preferred, it is more expensive than acrylic. Although the best acrylic teeth have a very good appearance and are fabricated with two colors of acrylic including enamel and dentin by the dough method, the most beautiful view is obtained in porcelain. A very good appearance can be achieved by adding fine details and different colors to porcelain veneer crowns. These features can also be added to acrylic teeth after production, but acrylic is sensitive to abrasion, and such modifications are not guaranteed to be permanent.

Acrylic and porcelain have different mechanical properties. The main problem of acrylic teeth is the weak frictional resistance. By the development of cross-linked resins, the resistance of acrylic teeth increased. Although resistance to abrasion is increased, acrylic teeth cannot be compared to porcelains. On the other hand, although porcelain is resistant to abrasion, it is brittle. While acrylic teeth have impact resistance, porcelains can be broken by an impact. Fractures include the posterior teeth.

Physical problems and abrasion resistance of porcelains can create disadvantages and cause problems. After 5 years of use, renewing 32% of maxillary dentures and 42% of mandibular dentures, and controlling the patients once a year to observe the previous soft tissue changes, is recommended.

Full porcelain teeth suggest that there is no need for correction, encouraging the patients to remain without any change in the supporting tissues. The lifetime of faulty prostheses is extremely extended. When acrylic teeth are used, abrasions can be observed clearly, and the patients are aware of the need to renew the denture before soft tissue damage occurs.

Although acrylic teeth aren't stiff like porcelains, abrasion of acrylics can be beneficial in some ways. It is necessary to adjust the occlusal and incisal surfaces when occlusion is rehabilitated. Also, when technical and clinical problems arise or to create a natural appearance in a single appointment, acrylic teeth can be adjusted. Post adjustment of acrylic teeth is an important advantage.

Another advantage of acrylic teeth is the connection with the denture base. When the teeth and the denture base are made from acrylic resins, and the bonding surfaces are clean, chemical bonding is possible. Chemical bonding to porcelain is impossible, and retention is provided with pins and holes. Even if the mechanical support is sufficient for retention, failure of adhesion between the porcelains and acrylic denture base can cause notch formation, and this region may be a source of weakness, and then a serious crack growth can occur. Failure of adhesion of teeth may lead to the fracture of denture base in use.

Selection of tooth material, porcelain or acrylic resin, mostly depends on the choice of the physician. There is no clear evidence regarding superiority between esthetics and effectiveness of the materials as well as the tissue response. The following suggestions help us in our selections. Acrylic resins are mostly used in immediate dentures because of their ease in insertions and occlusal adjustments. Acrylic teeth may be used in the presence of natural teeth or gold restorations in the opposing arch. If porcelain teeth are used, after grinding of porcelains for occlusal adjustment, abrasions can be seen on the opposing natural dentition or gold restoration. If the patients are satisfied with their dentures, changing the denture material is unnecessary. If the distance between the arches is limited, acrylic teeth are preferred since they are easily grinded and provide sufficient length esthetically even after grinding. If the patient complains about the sound coming from the denture, acrylic teeth decrease it.

The Main Points of the Tooth Material Selection

Following materials can be used for the selection of anterior teeth:

1. Conventional acrylic resin
2. Acrylic resin that has interpenetrating polymer network (IPN)
3. Composite resin
4. Porcelain

The type of teeth that will be used depends on esthetics, wear resistance and hardness, the sound generated by contact of the teeth, ease of placement and fabrication, repairability, and bonding to denture base. The advantages and disadvantages of each material should be carefully evaluated considering the personal preferences and objectives.

Conventional Acrylic Resin

Novel acrylic resin teeth are more superior than the first produced acrylic resin teeth due to the developments in their

chemical structure and fabrication. First produced acrylic resin teeth had a bad reputation due to their rapid wearing and discolorations. The newly produced resins are cross-linked, denser, and more abrasion resistant than the first produced teeth. Acrylic resin teeth can be grinded to fit into small spaces without affecting the bonding resistance to the acrylic resin denture base material. Occlusal and facial surfaces of teeth can be easily polished. The teeth also can be easily trimmed for esthetic purposes. During the function, acrylic resin teeth do not emit too much noise when contacted. Nevertheless, the acrylic resin teeth can wear over time and can be exposed to abrasion due to improper brushing and cleaning.

Acrylic Resins that Have Interpenetrating Polymer Network (IPN)

This material is a filler-free copolymer, which has interpenetrating polymer network with a high degree of cross-linkage. The relationship between the four-component materials is idealized with computer studies, and these materials are combined with interpenetrating polymer network with complex manufacturing processes. Before the formation of the second polymer layer, when the first polymer is cross-linked to a three-dimensional network and the second polymer occurred as a three-dimensional and cross-linked network, IPN material emerges. IPN teeth can be abraded, and since they are made from acrylic resin, their connection to the denture base is good. Due to their polymer structures, IPN material is harder and more resistant to abrasion, heat, and discoloration than conventional resins. Using IPN teeth instead of conventional cross-linked acrylic resin teeth does not have any disadvantages. IPN teeth are prepared and used like conventional acrylic resin teeth (e.g., Portrait IPN, Bioform IPN, Bioblend IPN (Dentsply)).

Composite Resin Teeth

The development of dental composite materials led to extraordinarily successful results. By the improvements of the material such as filler technologies, development of new monomers for the matrix and new layering techniques, esthetic qualities are enhenced. This material is not based on PMMA polymers; instead it is composed of a urethane dimethacrylate-based cross-linking agent, which is reinforced with inorganic microfillers. The inorganic pyrogenic silica fillers considerably increase the hardness and rigidity of the material compared with PMMA-based materials. This material is used for SR Orthosit teeth (Ivoclar Vivadent). The SR Phonares NHC and SR Phonares II (Ivoclar Vivadent) teeth consist of NHC material, which is a composite consisting of a urethane dimethacrylate matrix with inorganic fillers, isofillers (prepolymer), and PMMA clusters embedded in the structure.

Porcelain Teeth

Porcelain is the material which has the highest abrasion resistance among the materials used in the fabrication of denture teeth. It is also the most resistant material for discoloration. Making more sound than acrylic teeth when in contact is the disadvantage of porcelains in patients with parafunction or neuromuscular coordination problem. When there is insufficient distance between the arches, retention pins are available on porcelain anterior teeth. Use of pins for the mechanical connection to acrylic resin base material is another disadvantage of porcelain teeth. Also, small disintegrations or fractures may occur in porcelain teeth (e.g., ACE (Shofu)).

1.1.5 Final Tooth Selection

To assist the selection of teeth, manufacturers presented shape and shade guides. The reported criteria and outlines help for the tooth selection. By keeping in mind all the information, the physician should approach patients using his creativity and imagination. Most importantly, a few that can have a good appearance in the patient's mouth can be selected by looking at the patients existing dentures. Depending on the patients' consent, the final decision will not be given until the try-in stage. The dentist should not only depend on the discussed criteria for tooth selection. If patient intervention is not desirable during anterior teeth selection, patients should not be encouraged to choose the teeth with the physician. The patient will look at the manufacturer's shade guide with uneducated eyes and without predicting how it will look like in the mouth. If the dentist looks at the shade guide together with the patient, patients will tend to choose a very light color. For the physician, it is quite difficult to select the color and shape of teeth without being confused by the patient.

After teeth are properly arranged on denture base, the patient will see his/her teeth in a relationship with his/her face and mouth. At this stage, it is beneficial to make a gingival wax-up around the neck of the teeth for creating a natural appearance.

1.1.6 Arrangement of Anterior Teeth

Proper tooth arrangement in the anterior region is important to provide the desired esthetics and to make the patients accept their new dentures easily. Also, patient education is very important. As an acceptable attrition is possible during the use of old dentures, patients should be aware of the changes that may occur in their appearance. Lip support will be lost in time and new dentures will provide the lip support again. Using photographs will be helpful. If this is

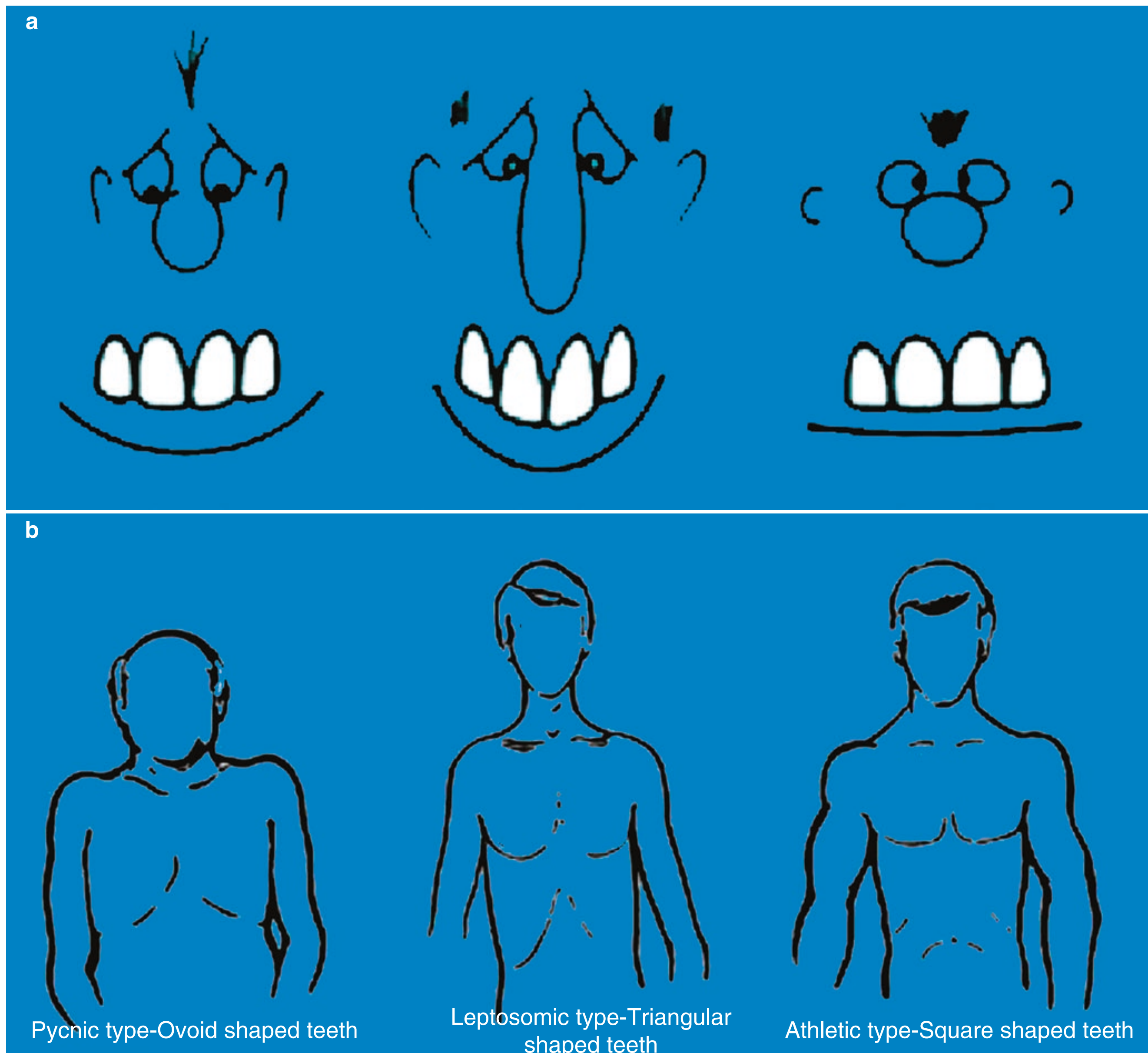


Fig. 1.21 (**a**) According to Gysi, the shape and arrangement of the teeth should be in harmony with the face (**b**) There is a relation between the shape of the incisors and the body types

not possible, dimensions of teeth, the presence of anterior diastema, or the prominence of anterior teeth is enquired of the patient. If there is diastema, smaller size teeth are preferred. When there is a prominence, greater teeth are preferred. Presence of diastema prevents the anterior teeth to appear as a block. Diastema between central incisors gives the appearance of masculinity, while diastema between the lateral incisors and canines gives feminine images. Prominences on the anterior teeth are perfect to ensure the naturalness. For the masculine images, arranging central incisors more prominent than laterals and, for the feminine images, arranging lateral incisors more prominent than central is the most accepted method.

According to Gysi, shape and arrangement of teeth must be compatible with the face (Fig. 1.21a). According to Kretschmer, the shape of incisors is related to the body (Fig. 1.21b). In addition, the maxillary alveolar ridge can be a guide for the dentist to determine the tooth shape.

1.1.6.1 Arrangement of Maxillary Anterior Teeth

The first maxillary incisors are placed approximately 1cm front of the incisive papilla. The placement of these teeth

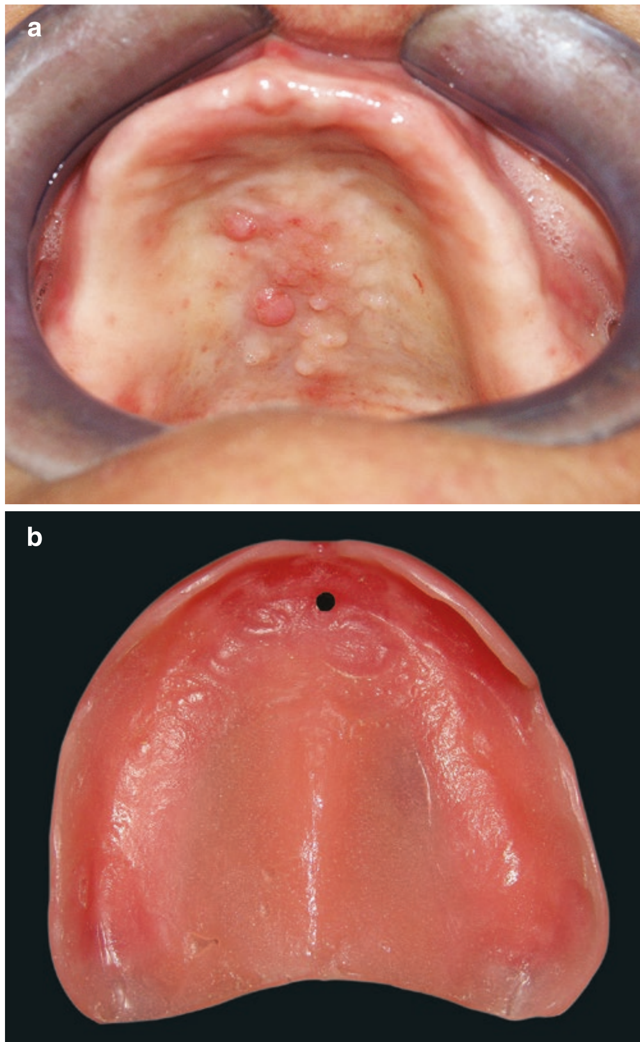


Fig. 1.22 (**a**) The view of incisive papilla inside the mouth, (**b**) the view of incisive papilla inside the denture

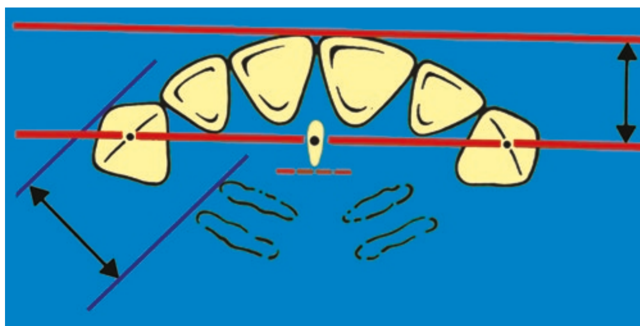


Fig. 1.23 The upper first incisors are placed approximately 1 cm anteriorly from the incisive papilla

must support the upper lip, and they must be visible (a few millimeters) in the rest position (Figs. 1.22 and 1.23). The first maxillary incisors should be placed symmetrically in the midline. Their long axes are usually parallel to the midline. However, a small inclination up to 5° can also be given. There is a curve in the labiolingual direction according to the alveolar arch. The second maxillary incisors can be arranged with an inclination of 10° as per midline. Generally, the level of incisal edges of the second incisors is higher than the first incisors. The position of these teeth must be in harmony with the shape of the arch. The maxillary canine teeth are the corner teeth of the mouth, and their location is very important. The long axes of the canines must be parallel to the vertical axis of the face, and cervical area should be placed more labially than the incisal edge (Figs. 1.24a–e and 1.25a, b).

Disto-labial half of the canines should be compatible with the mesiolabial half of the first premolars, while mesiolabial half of the canines should be compatible with the second incisor teeth (Fig. 1.26). The incisal edges of the canines should be in the same level with the first incisors or a little above. The incisal edges of the upper incisors must be perpendicular to the vertical axis of the face.

1.1.6.2 Golden Ratio

1.618/1 is the golden ratio, and it is the proportion between the long and short edges of the teeth. There is a golden ratio between the mesiodistal width of the central and lateral incisors.

The shape of the nose should be taken into consideration in the selection and arrangement of teeth. Generally, a curved teeth arrangement is preferred in patients with a curved nose, while wider teeth arrangement should be preferred in individuals with a wider nose (Fig. 1.27a). According to Gerber, when determining the position of anterior teeth, the correct view is obtained by placing the teeth according to the shape of nose (Fig. 1.27b).

Anterior teeth must support the lips. Therefore, in edentulous patients whose teeth were lost formerly, if the artificial teeth were placed on the top of the alveolar crest, the teeth would be located on the inner part of the crest as a result of the resorption. Thus, it should be kept in mind that the teeth should support the lips and the teeth should be arranged taking these features into consideration (Figs. 1.28 and 1.29).

Smile line should also be controlled while arranging the teeth. During smiling, incisal edges of the maxillary incisors should be parallel to the lower lip (Fig. 1.30). Incisal edges of the maxillary first incisors should be visible approximately 3 mm in young women and 2 mm in young men and should be at the same level for the middle-aged patients. It may be higher than this level in elderly patients. Nevertheless, it is not always possible to apply these rules. The physician can do some modifications according to the requests of the patients. Most of the patients want to have larger and more visible maxillary teeth during smiling.

Fig. 1.24 and 1.25 (**a**–**e**) The arrangement of upper anterior teeth. (**a**) The relation with the midline, (**b**) the relation with the occlusal plane, (**c**, **d**) the profile view, (**e**) the view from palatal surface. The arrangement of the upper anterior teeth. The relation of teeth with occlusal plane and midline. (**a**) Frontal drawing (**b**) Profile drawing

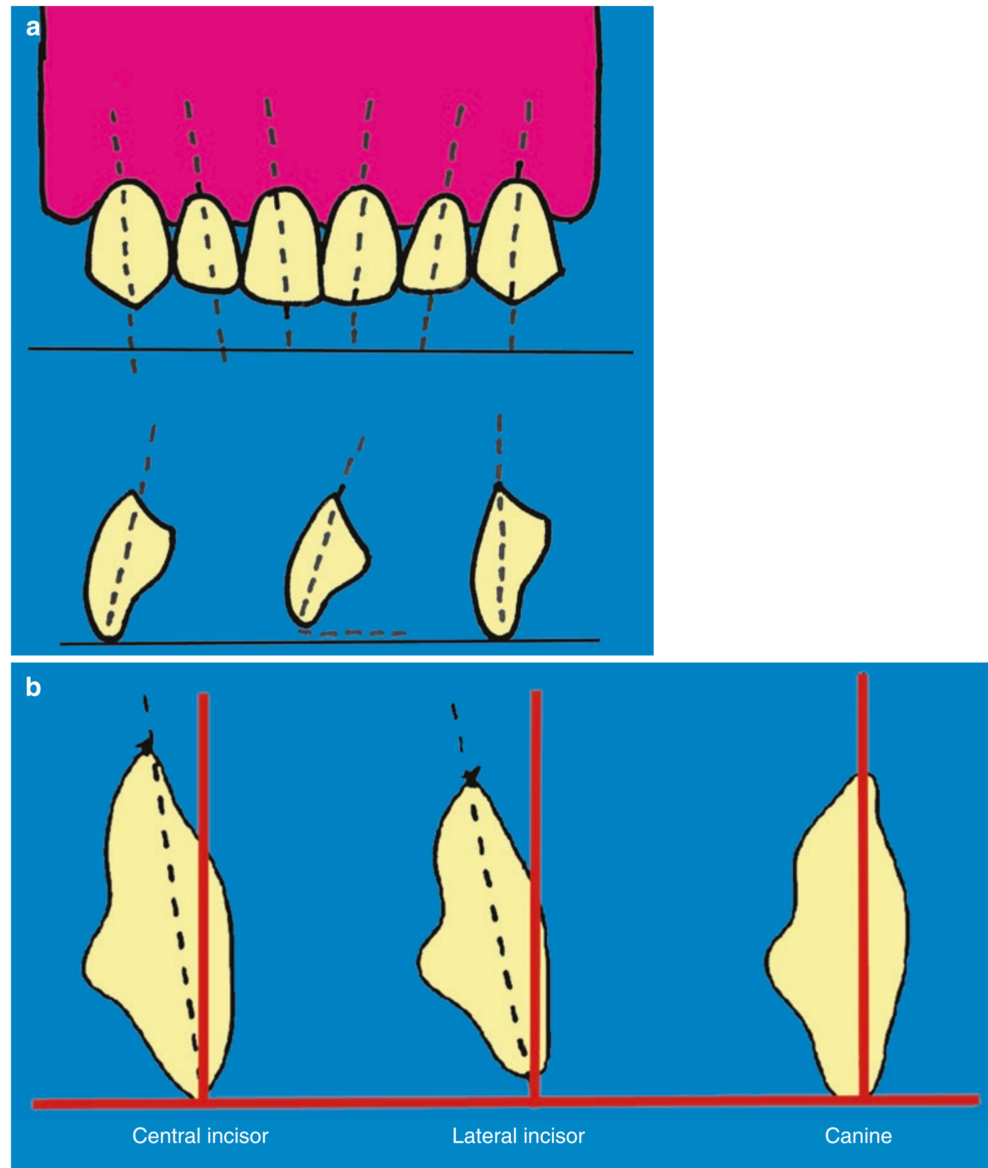
1.1.6.3 Arrangement of Mandibular Anterior Teeth

After determining the shapes of maxillary anterior teeth, proper mandibular anterior teeth are selected. Most of the manufacturers produce mandibular anterior teeth harmonious with the maxillary anterior teeth.

The long axis of the mandibular anterior teeth should be parallel to the midline. Usually, the long axis of the lower canines is not parallel to the midline, and they are placed with a slight inclination (Figs. 1.30 and 1.31a–c).

The arrangement of the teeth must be symmetrical in both left and right side of the jaw, and the amount of individual

Fig. 1.24 and 1.25 (continued)



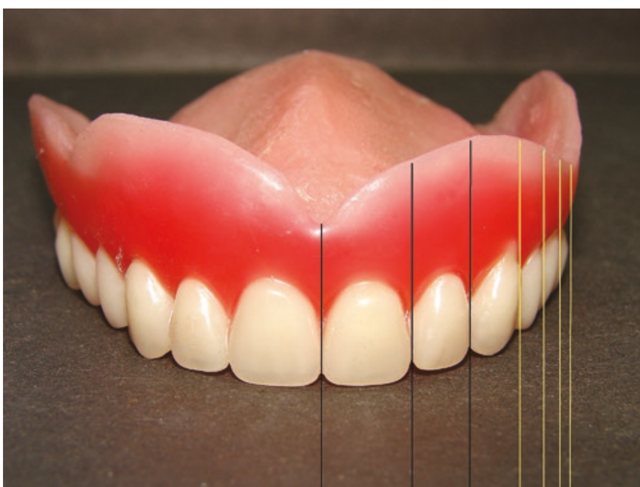


Fig. 1.26 The disto-labial half of the canines should be placed in harmony with the mesiolabial half of the first premolar, while the mesiolabial half should be in harmony with the second incisors

rotation and inclination of teeth must be similar on both sides (Fig. 1.32d, e). However, some modifications can be performed during teeth arrangement after having the consent of the patient. The incisal edges of the mandibular incisors should be on the same level. 2–3 mm overjet must be provided, and the amount of overbite should be zero.

The relationship between the mandibular anterior incisors and the lips should be evaluated. The teeth should be aligned contacting the lower lip. The position of the lower lip is affected by the anatomy of orbicularis oris muscle, which is supported by the upper anterior teeth (Figs. 1.33 and 1.34a, b).

Since natural mandibular anterior teeth mostly don't have symmetry, some irregularities can be performed in the arrangement of teeth. Because mandibular anterior teeth are less visible, esthetics may be compromised. However, the use of photographs is also helpful. Uninformed patients think that maxillary and mandibular teeth are in contact. When arrang-

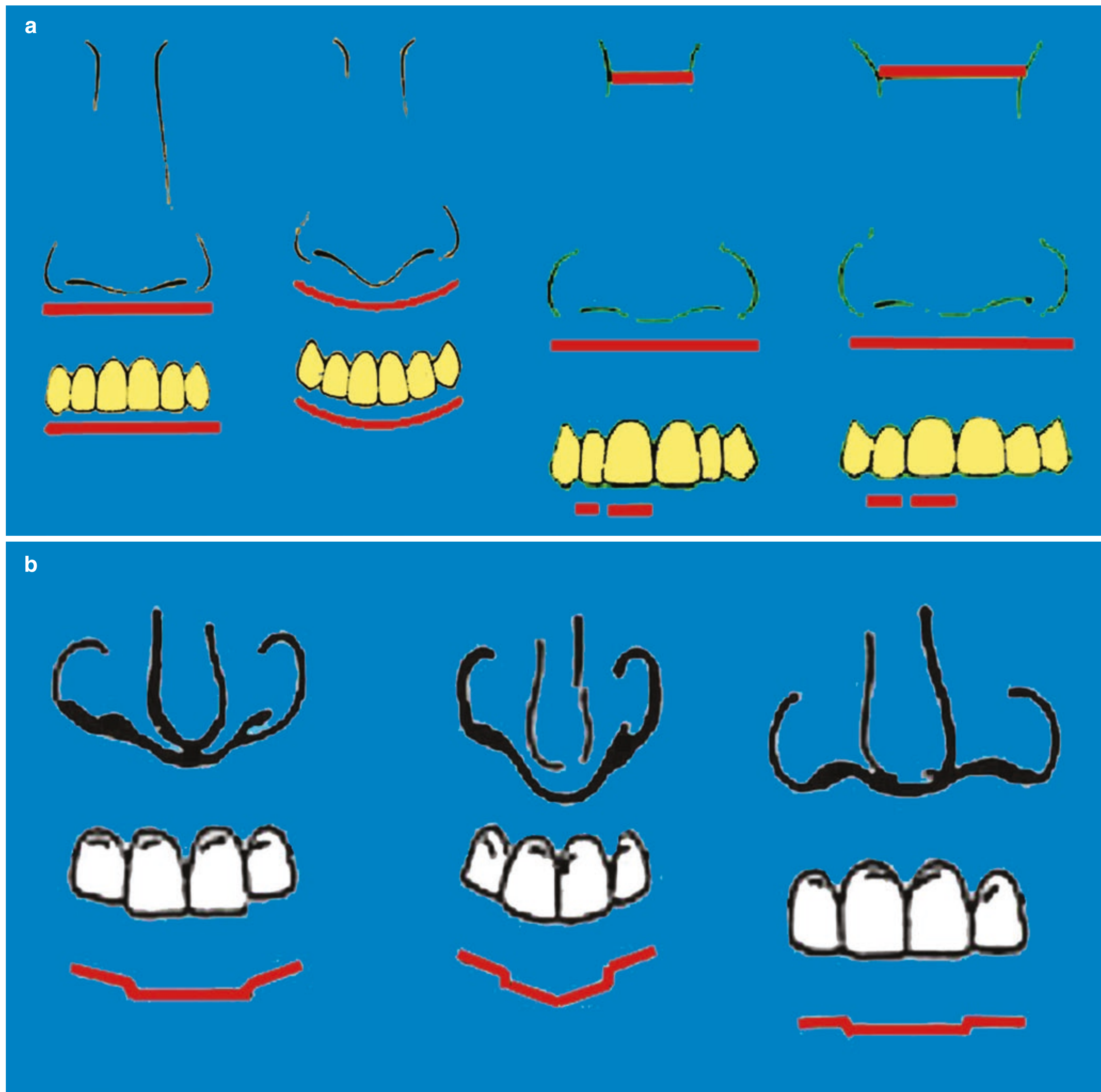
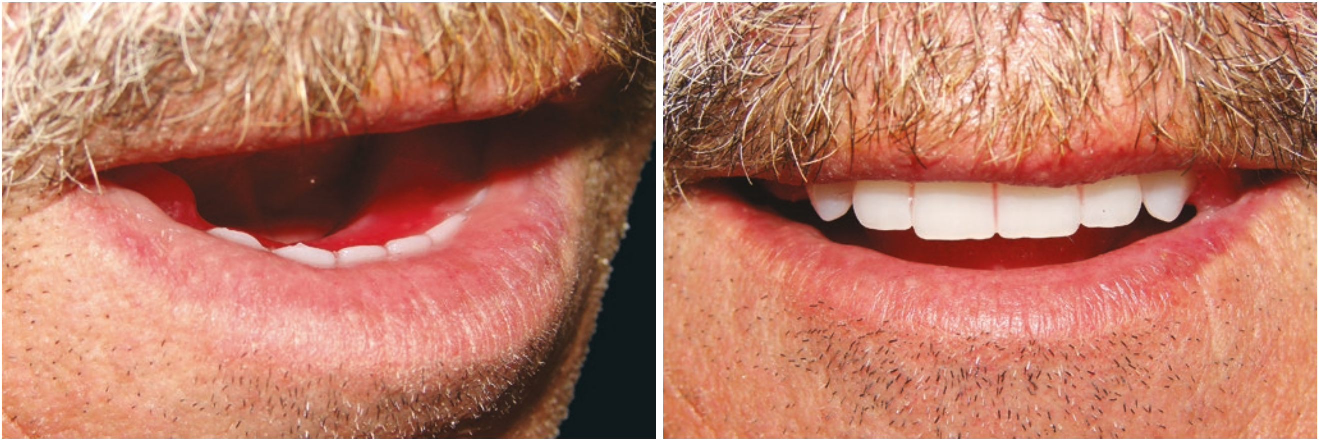


Fig. 1.27 (**a**, **b**) The alignment of anterior teeth in relation with the shape of the nose

ing the horizontal and vertical overlap, giving information to the patient will prevent the patient's disapproval.

After the anterior teeth are selected, the arrangement is a very difficult stage in order to avoid an artificial appearance. It is important to arrange anterior teeth beside the patient for both the patient and the physician. While the physicians take an opportunity to check the position of anterior teeth before the arrangement of posterior teeth, the patients observe that the dentures are custom made for them; however, if the time is limited, anterior teeth can be arranged by the physician or the technician before the try-in stage. Since maxillary wax rims are removed to determine the centric relation control points, the physician should arrange at least two upper and lower central incisors chairside. This will provide the required information to the physician or the technician to finish the anterior teeth arrangement. Midline of the face should be marked on the upper denture base and transferred to the stone model.

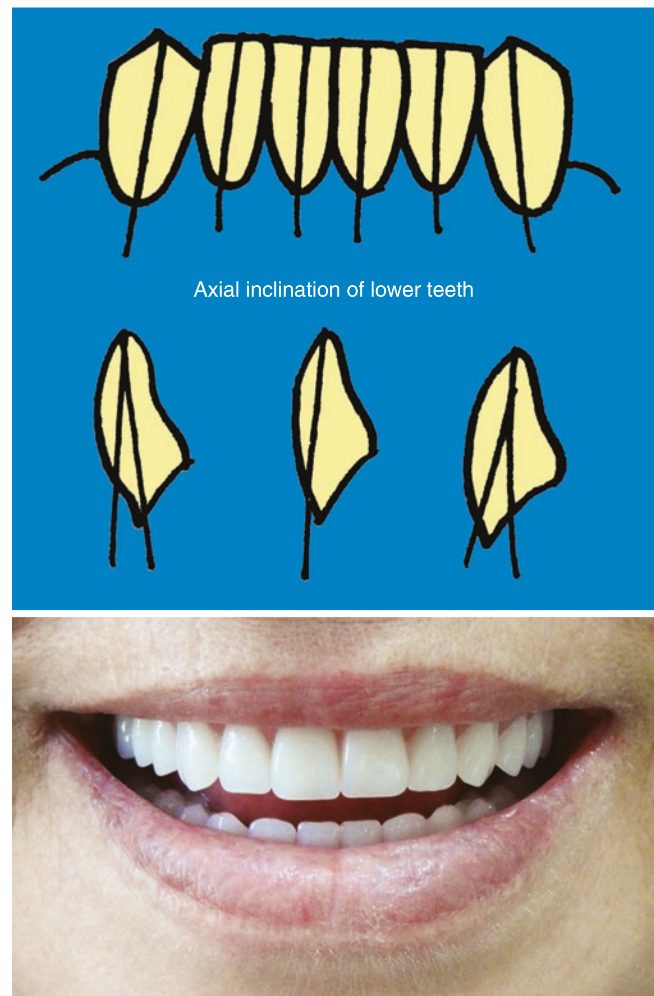
For an attractive appearance in young women, the best way to ensure harmony is the arrangement of maxillary incisors parallel to the lower lip when smiling. Application of this arrangement in elderly patients makes a negative effect, and if this



Figs. 1.28 and 1.29 The upper and lower lip support during teeth arrangement

technique is also applied to men, a feminine appearance will occur. By placing the central incisors more prominent than lateral incisors, a masculine image can be created. The appearance will be better when there is wear facets on the incisal edges. This effect can be increased related to decreased overjet or edge-to-edge occlusion. Clearly, it is easier to achieve this effect in patients with Class III jaw relation. Another way to emphasize masculine or feminine teeth arrangement (can be used with the teeth arrangement above) is modifying the angle of canine. Placing the tip of the canines lingually will create feminine appearance, while placing the tip of the canines buccally, a masculine appearance will occur. If physicians approach is not careful enough, making a diastema will cause problems. In general, the diastema is arranged between the central incisors. Making a narrower diastema at the incisal edge than the cervical margin should be avoided; otherwise fibrous foods will stick in this space, and it will be displeasing to remove them. Self-cleaning of this area can be achieved by arranging a wider diastema at the incisal edge. Diastema comes to a realistic state with angling and abrading of teeth.

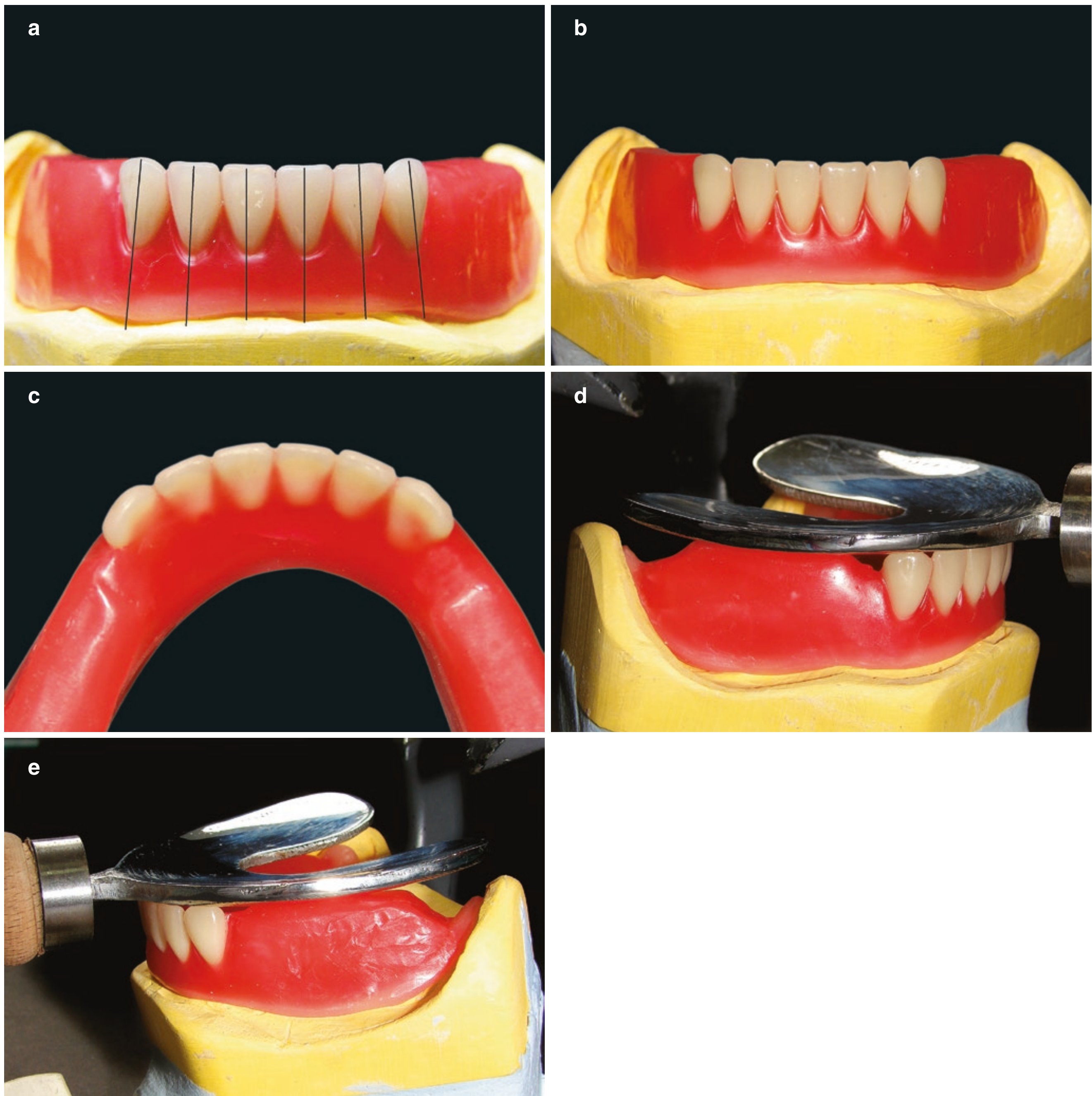
Unlike diastema, crowding should be approached more carefully. It is a simple irregularity when considered, but it causes difficulties. This is because the lingual surfaces are in contact with the tongue and may cause discomfort. The most accepted crowding is applied to mandibular incisors and gives a realistic image. By inclining the lateral incisors lingually, crowding is easily formed, so, in order to have a more realistic affect, incisors that are inclined lingually are slightly extended.



Figs. 1.30–1.32 The incisal edges of the upper anterior teeth should be parallel to the lower lip during smiling. The arrangement of anterior teeth in relation with the midline. (**a**) The arrangement of anterior teeth in relation with the midline. (**b**, **c**) The buccal and lingual view of lower anterior teeth. (**d**, **e**) The teeth should be symmetrical in both right and left sides, and the amount of rotation and inclination should be the same on both sides

1.1.7 Vertical and Horizontal Distance Between Anterior Teeth (Overlap)

The amount of vertical and horizontal distance between the anterior teeth is determined with esthetic, function, and phonetics. A little amount of both maxillary and mandibular

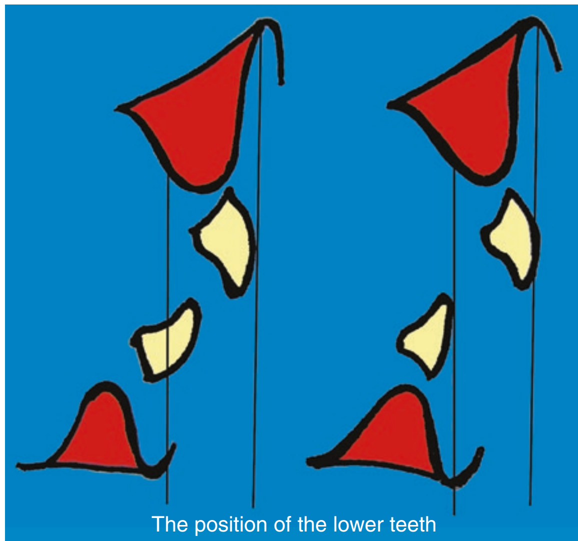


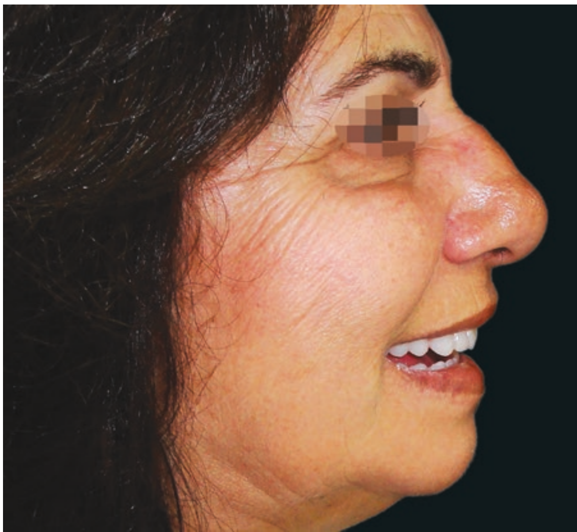
Figs. 1.30–1.32 (continued)

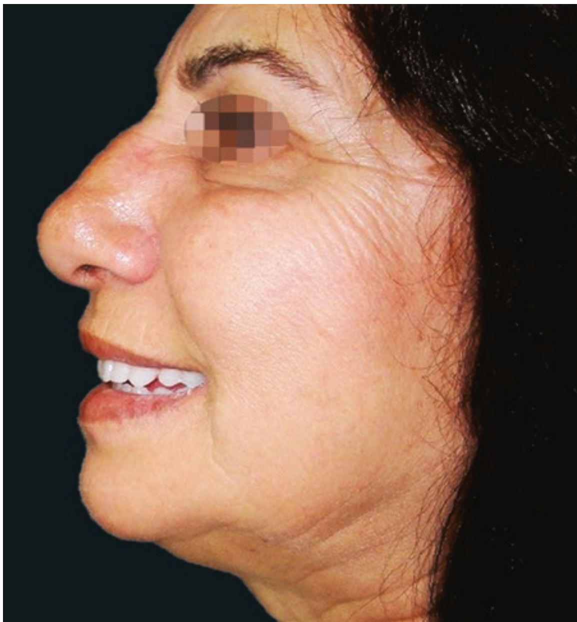
teeth will be visible in the vertical dimension of occlusion, during rest position or function (laughing, speaking). In complete dentures, the appearance amount of the maxillary and mandibular teeth must be considered firstly in the determination of vertical relation. The final assessment of the appearance amount of the teeth is done during the try-in appointment. After the esthetical arrangement of teeth, their position is evaluated phonetically. The degree of vertical and horizontal distance affects the amount of incisal guidance (Fig. 1.35). For balanced occlusion, if vertical distance is increased and horizontal distance is decreased, posterior tubercle height should be steep. As a result of increasing the vertical distance between the teeth, they will be much more visible.

1.1.8 Esthetic Arrangement of Anterior Teeth

The arrangement of teeth should be performed according to patient's cosmetic needs. The reason for this is the appear-







Figs. 1.33 and 1.34 The position of the lower lip should be in harmony with the orbicularis oris muscle which is supported by the maxillary anterior teeth

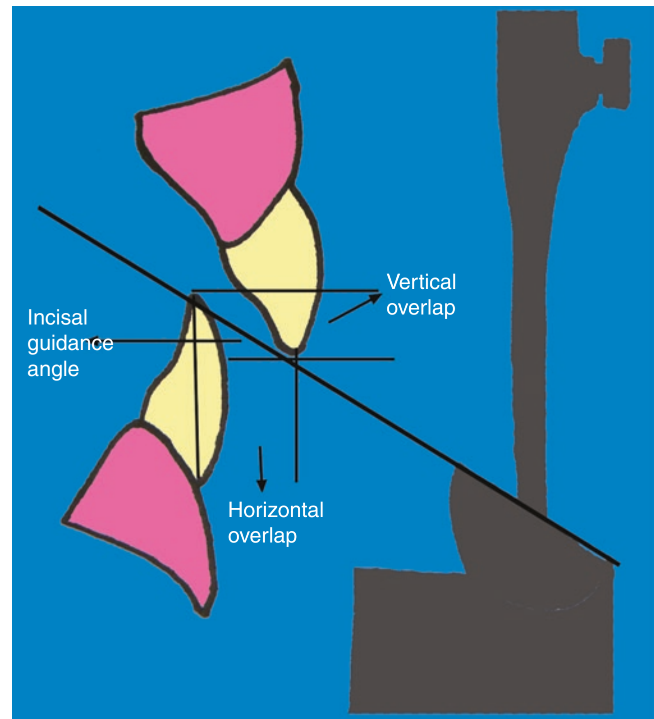


Fig. 1.35 The degree of the horizontal and vertical distance between the teeth affects the amount of incisal guidance

ance need of teeth as if they belong to the patient. The time spent on the arrangement of anterior teeth is usually more than the time spent on other stages of denture fabrication. This is because this procedure is not only a simple technique; it is also an art. Frush and Fisher indicated the criteria for anterior teeth arrangement depending on the patient's age, gender, and personality. Although these criteria are not certain, they help for improving the patient's cosmetic appearance. Below, the techniques necessary to arrange the teeth in accordance with age, gender, and personality are discussed. Contributing techniques are also given, to be descriptive.

1.1.8.1 Age

When the teeth are in the function or rest position, the visible part of upper and lower teeth give an idea about the age of the patient. When the lips are slightly opened, 3 mm of the central incisors are visible at the age of 30, while with increased age they are invisible by the age of 60 (Fig. 1.36a). It is the opposite with the mandibular incisors; at the age of 30, 0.5 mm of these teeth are visible, while 3 mm are visible at the age of 60.

Some patients who will be treated with complete dentures have excessively abraded natural teeth or dentures. They usually have decreased vertical dimension, and their teeth are less visible or invisible during speaking or laughing or in the rest position. When making a new denture for such patients, the visible portion of the teeth is concerned with the

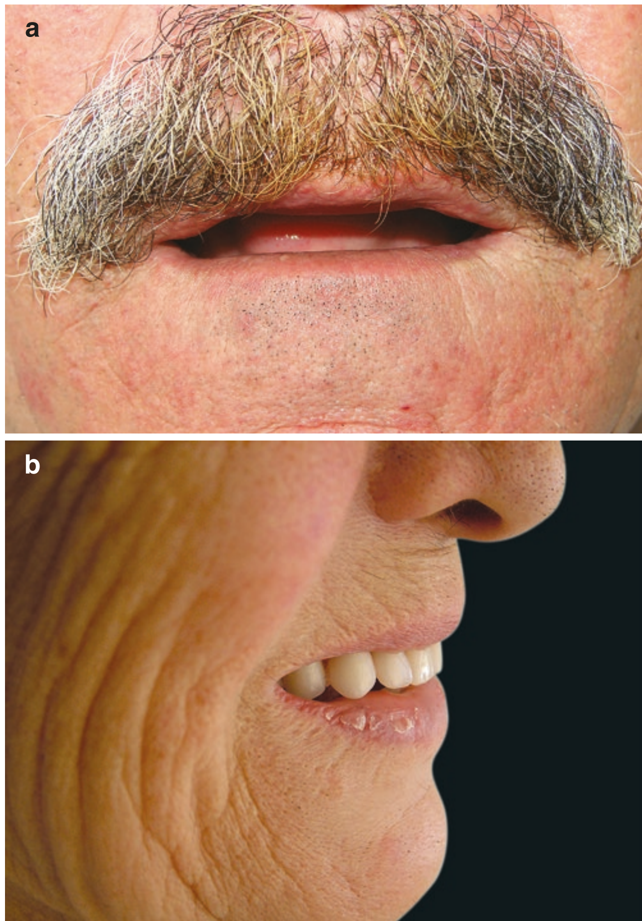


Fig. 1.36 (**a**) The appearance amount of anterior teeth decreases by the increasing age. (**b**) The increase of the appearance amount of anterior teeth according to the demands of the patient

vertical dimension. If vertical dimension is increased, teeth will be much more visible. Before accepting the vertical dimension, patients should be informed about esthetic changes, and the approval of their relatives and friends should also be considered. In elderly patients, it would be quite inappropriate to have the same proportion of the teeth visible as that of a 30 years old patient. On the other hand, some elderly patients may desire younger look, and they think that with the visible teeth they have a younger appearance (Fig. 1.36b).

Frush and Fisher reported that the severity of advanced aged could be successfully reflected to the denture with careful teeth selection. The appearance of anterior teeth can be converted from young to an elder individual by changing the long axis of the teeth, making diastema and abrading incisal edges of the teeth. For the middle-aged patients, an arrangement of teeth may be between both teeth arrangement styles. The matrix between the teeth is equally important. In young individuals, interdental papilla is pointed and seems tightly adapted to the teeth. With advancing age, as a result of gingival recession around some of the teeth, papillae are shortened and blunted and became edematous and flat. Many patient's natural teeth are abraded with advanced age, and this abrasion can be simulated by grinding the incisal edges of the teeth. Also, notches can be made on the incisal edges. Interproximal areas near the gingival line may also be abraded to simulate aging. The wax matrix around the artificial teeth can be modified to give them square or oval shape and to change the visibility of teeth. Wax matrix can also be changed to be harmonious with the patients' age. The labial surface of anterior teeth can be roughened to remove the surface glaze. Thus, the "value" of teeth decreases and the esthetic changes for the better.

1.1.8.2 Gender

All of the artificial teeth must have feminine properties for an anterior teeth arrangement with feminine features. These teeth have softer anatomic features. Incisal edges draw a curve that indicates soft appearance. Furthermore, the position of anterior teeth can exhibit the femininity. The slight cervical bevel of the central incisor, anterior mesial rotation of lateral incisors with the prominence of cervical part of canine provides more feminine arrangement. A more masculine appearance can be achieved with cubic and square-formed teeth. The incisal edges of six anterior teeth are almost straight with a slight bevel. In order to create a more masculine appearance, central incisors must be arranged in a straight line. Lateral incisors are rotated inward while canines are perpendicular cervicoincisally.

Masculine characteristics are provided by:

- Creating flat labial surfaces mesiodistally and incisogingivally
- Large arch form; arranging the central incisors with slightly inward rotation at mesial side
- Arranging canines more prominent with their incisal edges located outwardly
- Sharper mesioincisal and distoincisal angles
- Arranging the edge of lateral and central incisors at the same level
- Preparing large lateral incisors

Feminine characteristics are provided by:

- Preparing curved labial surfaces mesiodistally and incisogingivally
- Curved arch form; arranging the central incisors with inward rotation at distoincisal edge
- Tilting incisal edges of canines palatally
- Rounded mesioincisal and distoincisal angles
- Arranging the incisal edges of lateral incisors above the central incisors and canines
- Preparing narrow lateral incisors

1.1.8.3 Personality

In order to arrange the position and shape of the teeth according to their personalities, the patients should be known. Our purpose is to state the personality of this special patient. Frush and Fisher used a *personality spectrum*, which is arranged from sensitive to medium to vigorous. Sensitive people are fragile and delicate, while strong people are unkind and aggressive. While a small section of the population has a sensitive personality, a larger section of the population has a vigorous personality, but most of the population has personality degree somewhere in the middle with a propensity toward either the sensitive or vigorous group. Each tooth is important when defining personality. Also, the wax matrix is extremely important to specify personality because this part controls the cervical 1/3 of the tooth contour. When making arrangements according to personality, central incisors play the most dominant role, followed by canines and lastly lateral incisors. Although we are talking about anterior teeth selection, premolars also play an important role in providing a natural appearance. Alterations in the color of artificial teeth contribute to the final denture success as well as their long axis in arrangements.

1.1.9 Protrusive Records

Protrusive relations can be recorded when determining centric relation, and it can be recorded before posterior teeth arrangement in anterior try-in appointment to detect the condylar path angle. Detection of horizontal condylar path angles will be important when choosing the posterior teeth, which is going to be explained in the next chapter. Protrusive relations were recorded in an early stage for well-arranged posterior teeth and for being in harmony with jaw movements. Following steps are followed:

1. Maxillary and mandibular denture bases are placed in the mouth. The patient is told to move his/her jaw 3–4 mm anteriorly from centric relation position. It is necessary to give a hand mirror to the patient in order to help for watching jaw movements.
2. A layer of wax is melted and doubled up. Double-layered wax is adapted to the mandibular posterior teeth area bilaterally (to determine the right records, blocked posterior monoplane teeth can be arranged at this appointment). Because of Christensen phenomenon, at least two layers of wax are needed. Due to the downward movement of condyles, posterior teeth are separated forming a gap between them.
3. Wax is heated with a torch or another device and is placed into the mouth. Mandibular denture base is stabilized with index finger, and the patient is directed to move his/her jaw to the desired position. Records are removed from the mouth and both of the denture bases are rinsed with cold water.
4. Mandibular denture base is placed on the stone model that is attached to the articulator, and using adhesive wax, adaptation of wax rims to each other is ensured. Maxillary denture base is not placed on the stone model.
5. Condylar lock and centric mechanism are loosened on the articulator, and the maxillary base is fitted to the model in the articulator as much as it can be. The condylar mechanism is turned in varying degrees until stone model fits the maxillary denture base precisely.
6. Obtained condylar path angle values are written on the maxillary stone model to be used in the future.

For edentulous patients, the time spent on selecting and arranging the anterior teeth is much more than the time spent for taking the impression and recording maxillomandibular relations. The reason for this is that the most important factor in the anterior teeth selection and arrangement is art, not science.

After using various guides to select proper size, shape, and color, if there is not any other guidance, some average values may be useful for the initial teeth arrangement. This initial arrangement must be modified individually for the patient; however, even for the most artistic physician, scientific principles are required for arranging the teeth, which is the most difficult stage of the denture construction.

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2 Posterior Tooth Selection and Arrangement

Buket Evren and Yasemin K. Özkan

2.1 Posterior Tooth Selection and Arrangement

A knowledge and understanding of a number of physical and biological factors directly related to the patient are required to appropriately select artificial teeth to rehabilitate the occlusion. The goals for this section of therapy are to construct complete dentures that (1) function well, (2) allow the patient to speak normally, (3) are esthetically pleasing, and (4) will not abuse the tissues over residual crest. The clinicians are the best person to gather, correlate, and evaluate the biomechanical information so that the artificial teeth selected will meet the individual needs of the patient. The selection and arrangement of artificial teeth is a relatively simple non-time-consuming procedure, but it requires the development of experience and confidence

Three terms or phases must be explained to discuss the rehabilitation of the edentulous patient.

The first one is the philosophy of occlusion. Many dentists develop their own philosophy from their experience in treating their patients. A dentist's philosophy is formulated according to the response to the following question: What must be done to restore the patient's jaw according to the functional relation?

The philosophy of occlusion consists of:

1. The adjustment of the relation between the centric relation and the centric occlusion
2. The absence of premature occlusal contacts during eccentric movements
3. There being enough tooth form and cusp height to permit grinding
4. The fabrication of esthetically pleasing dentures

The *second term is the occlusion concept.* In the literature, the occlusion concept is expressed as balanced and unbalanced occlusion. Balanced occlusion is the occlusion of teeth when the occlusal surfaces are in harmony in the centric and eccentric position. Unbalanced concept defines the maximum surface contact between the cusps in the centric occlusion position without considering the contact relations of the teeth in eccentric position.

The final term is the occlusal plane. Occlusal plane expresses the shape and form of teeth (e.g., teeth with or without cusp) preferred to establish the desired occlusal concept.

2.2 Posterior Tooth Selection

The size and occlusal surfaces of the artificial posterior teeth can vary according to the manufacturer and can be fabricated from different materials such as porcelain, acrylic, or metal. The form and the occlusal surfaces of the artificial teeth are designed to imitate natural teeth. The resorption of the alveolar ridge, tongue, cheek, and lip tonus of the patient and tooth extraction can alter the space available to place artificial teeth.

Each natural tooth as its located in its own periodontal membrane is evaluated as a single structure (Fig. 2.1a, b), any load on the artificial teeth effects the entire denture (Figs. 2.2a and 2.3).

For the examination of artificial teeth, occlusal surfaces, buccolingual width, mesiodistal dimension, material, and occluso-gingival height should be evaluated (Fig. 2.4a–c).

Condylar inclination, incisal guidance, the curve of Spee, and the angulation of the occlusal plane are also important factors during the selection of posterior teeth form.

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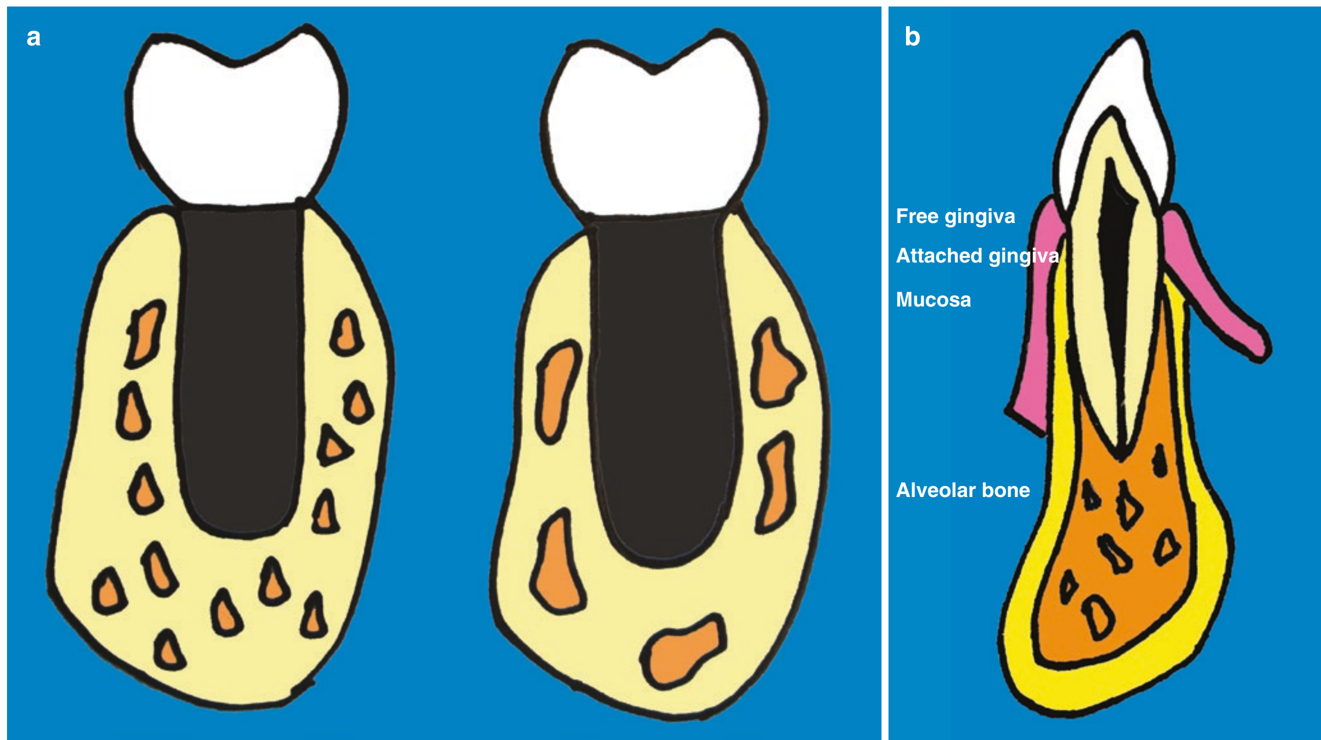


Fig. 2.1 (**a**, **b**) Each natural tooth, as it's located in its own periodontal membrane, is evaluated as a single structure

2.2.1 Occlusal Surface

Appropriate form of the artificial teeth should be selected for a successful denture. Artificial teeth that imitate natural teeth are called anatomic teeth (Figs. 2.2b and 2.4a–c). It is easy to imitate the attrition on the occlusal surface of the artificial teeth (Fig. 2.2c, d). Different types of artificial teeth are designed to increase the chewing ability and to adapt jaw movement principles, but some occlusal designs, called *mechanic* occlusal form, are designed only for chewing or grinding. None of the posterior artificial teeth forms can be used without any occlusal modification on dentures.

Manufacturers of artificial teeth produce artificial teeth in three basic forms: anatomic (40°), semi-anatomic (30°, 10°), and non-anatomic (0°) (Fig. 2.5). The anatomic form can be used for the balanced occlusion and in a single denture construction versus natural dentition. They are more esthetic (especially in the premolar region). Anatomic artificial teeth have several advantages, as they are more esthetic with their natural appearance. The chewing ability and ease to construct balanced occlusion are the other advantages of artificial teeth. Non-anatomic teeth (0°) are used in patients with Class II and Class III jaw relation and/or with excessive alveolar bone resorption in order to decrease the horizontal forces that effect denture stability. Esthetic is not adequate as they have no cusp inclination (Fig. 2.6). To permit closure of the jaws over a broad contact area and to allow construction of dentures with a simple technique are the advantages of the non-anatomic teeth form.

2.2.2 Width

The posterior natural dentition is in balance between the pressures of the tongue in the lingual direction and the cheeks in the facial direction (Fig. 2.7). Artificial posterior teeth also should be arranged in a same manner, in neutral zone (Fig. 2.8). After tooth extraction, if the patient does not wear a denture immediately, the neutral zone will be reduced due to the elongation of the cheeks and lips. The width of the alveolar ridge is also reduced by the alveolar bone resorption. The occlusal width of the artificial teeth should be chosen convenient with the width of the alveolar ridge; otherwise stability of occlusion will be disturbed.

This situation explains that the occlusal form of the artificial teeth should be narrower than the natural teeth. Artificial teeth with narrow occlusal table limit the amount of food compressed between them during chewing and allow patients to chew food in small pieces. Besides that, the chewing ability of the artificial teeth with narrow occlusal table is better than the artificial teeth with wide occlusal table due to the increased pressure on the unit area. Also the load that is

tolerated by denture bearing area is one eight or ten of the load, which is tolerated by the periodontal membrane of the natural tooth, so it is preferable to select artificial teeth with narrow occlusal tables.

2.2.3 Dimension

The selection of posterior artificial teeth dimension should be done in regard to the distance between the distal side of the lower canine and mesial side of the retromolar pad (Fig. 2.9a–c). If the artificial teeth are selected with inadequate dimensions, teeth cannot provide adequate guidance during mastication, and foods are accumulated into the cheeks. On the other hand, if a molar tooth is placed on the retromolar area or on the tuberosity areas, the contacts of the teeth in these areas reduce the denture stability.

- The selection of the posterior teeth can be made by determining the space between the apex of the retromolar pad and the distal of the lower canine (Ex: 29, 30 mm).
- Posterior teeth, at least, can be approximately in the same cervico-incisal length with anterior teeth.
- The selection is affected by the interocclusal distance (S, small; M, middle; L, large). If there is a limited distance, smaller teeth should be selected.
- The buccolingual dimension of the artificial teeth can affect the tongue area. If there is not enough space, smaller teeth should be selected.

2.2.4 Materials

The wearing of natural teeth depends on mastication forces and the abrasive qualities of food. After the delivery of the denture to the patient, in the first week, occlusal adjustment is needed to eliminate premature contacts or small mistakes. The adjustments made on the occlusal surfaces of the tooth provide a harmony over time between the occlusal surfaces. The mandible moves forward and upward when the alveolar ridge resorption occurs, and the new position of the denture is less harmful to the mandible when the artificial teeth adapt. One of the materials used in the selection of the artificial teeth is porcelain, which is more resistant to wear, and the other material is acrylic, which has a pronounced tendency to wear. The porcelain teeth of patients with a high chewing capacity can wear after a long period. With the recent developments in dental materials, composite teeth that have medium wear resistance have been introduced. In the case of rapid alveolar ridge resorption, the adaptation of porcelain teeth occurs very slowly. At the end of the first year, after being exposed to an abrasive diet or strong chewing movements, a marked loss of material and contour may occur in acrylic teeth. Acrylic teeth can be selected for patients with a slight chewing ability and porcelain teeth for those with a strong chewing ability. The patient's old denture should be examined, or the degree of chewing ability should be revised with the palpation of the masseter muscle when the patient's teeth are in occlusion.

The occlusal contour loss of acrylic teeth due to wear of both jaws is one of its disadvantages. In some conditions, one jaw is arranged with porcelain teeth and the other with acrylic teeth. Wear occurring after the adjustment or polishing procedures will be the same with those of acrylic teeth. The arrangement of acrylic teeth is easy; therefore acrylic

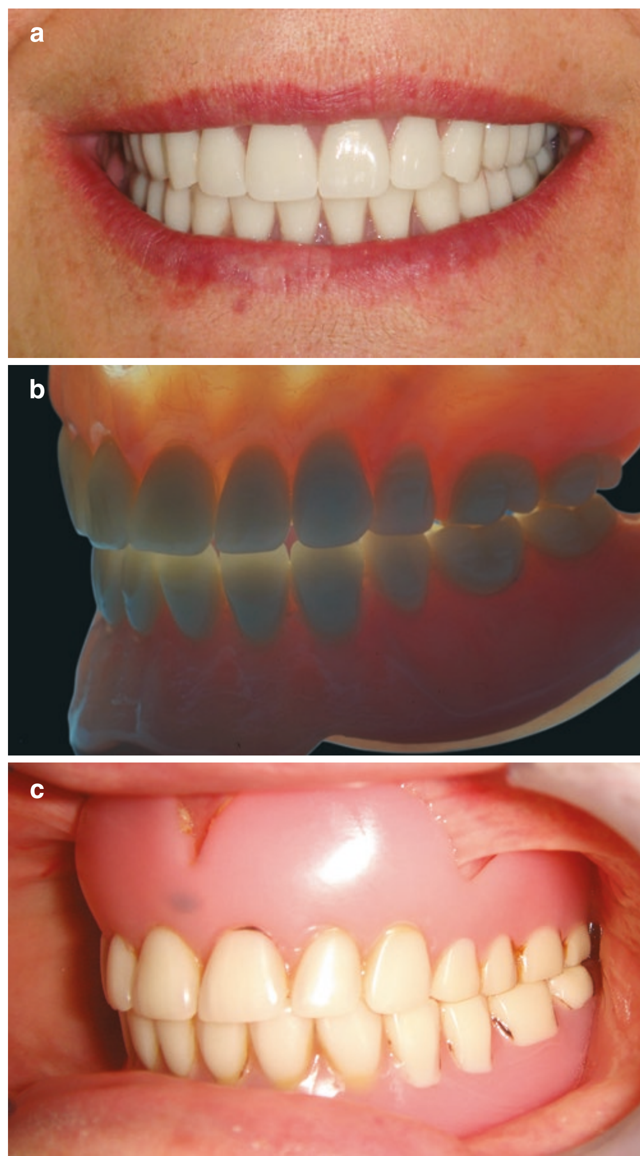
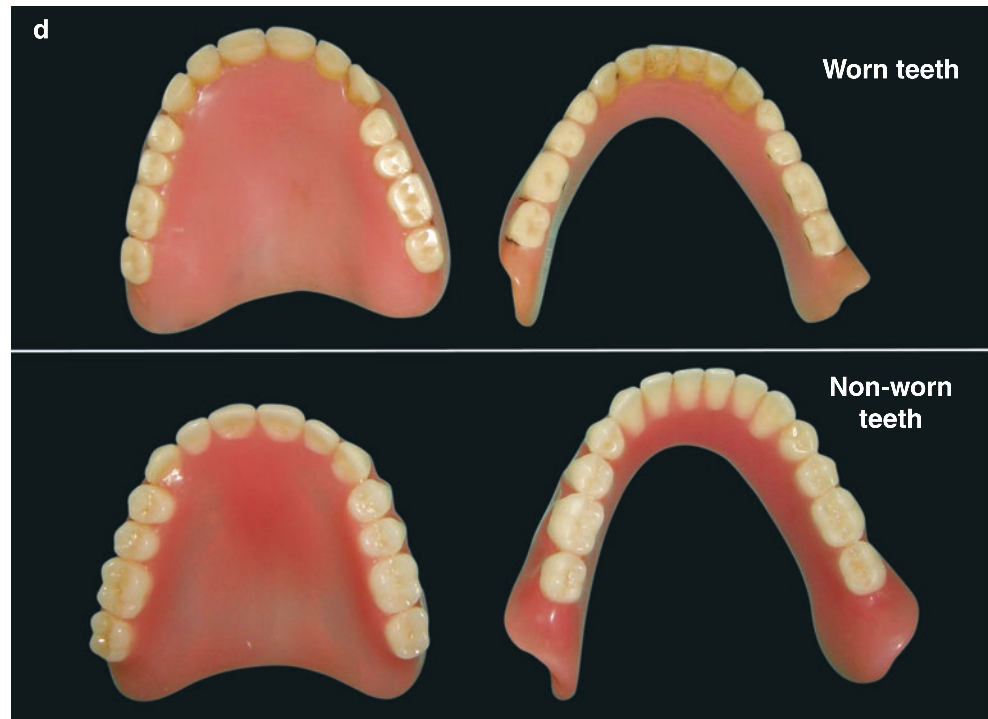


Fig. 2.2 (**a**) Artificial teeth do not have periodontal ligaments, so when forces are applied, denture is affected. (**b**) Artificial teeth are known as anatomic teeth, as they imitate natural teeth. (**c**, **d**) The surface of teeth used in dentures is worn out when used by the patient

Fig. 2.2 (continued)



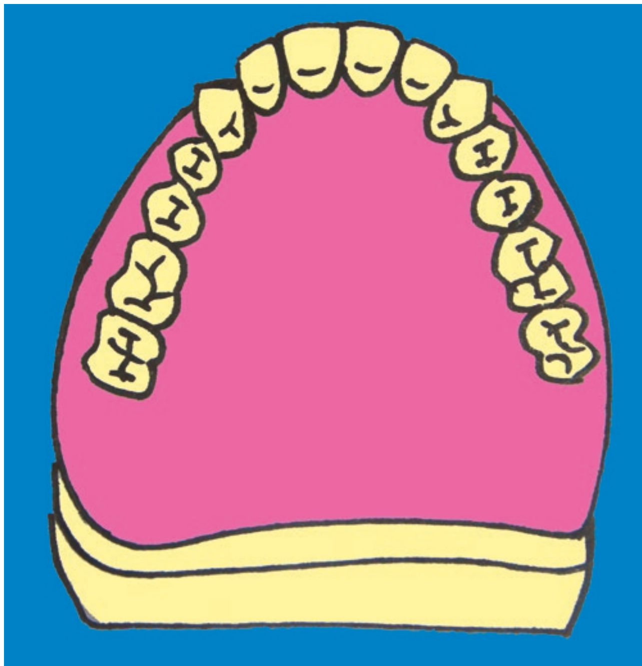


Fig. 2.3 Artificial teeth do not have periodontal ligaments, so when forces are applied, denture is affected

teeth are used in general. As there is chemical retention between acrylic teeth and the denture base materials, the mechanical retention is not necessary. There will be no problem relating to chemical retention with tooth grinding of artificial teeth during their placement; however, there is a controversy regarding porcelain teeth since mechanical retention is risked by grinding.

2.2.5 Height

The size of the artificial teeth must be arranged according to the canine tooth, otherwise, there will be an anesthetics appearance when patient smiles. The contour and the height of the artificial tooth are protected when the interocclusal distance is narrow.

2.3 Patient-Related Factors Affecting Posterior Tooth Selection

The physical condition and parafunction of the patient, occlusion of the previous denture, and the shape and relations of the crests should be considered during posterior tooth selection.

2.3.1 Muscle Control

The clinician has the chance to access the muscle control of the patient during recording and transferring the jaw relations. If difficulties are encountered during these procedures,

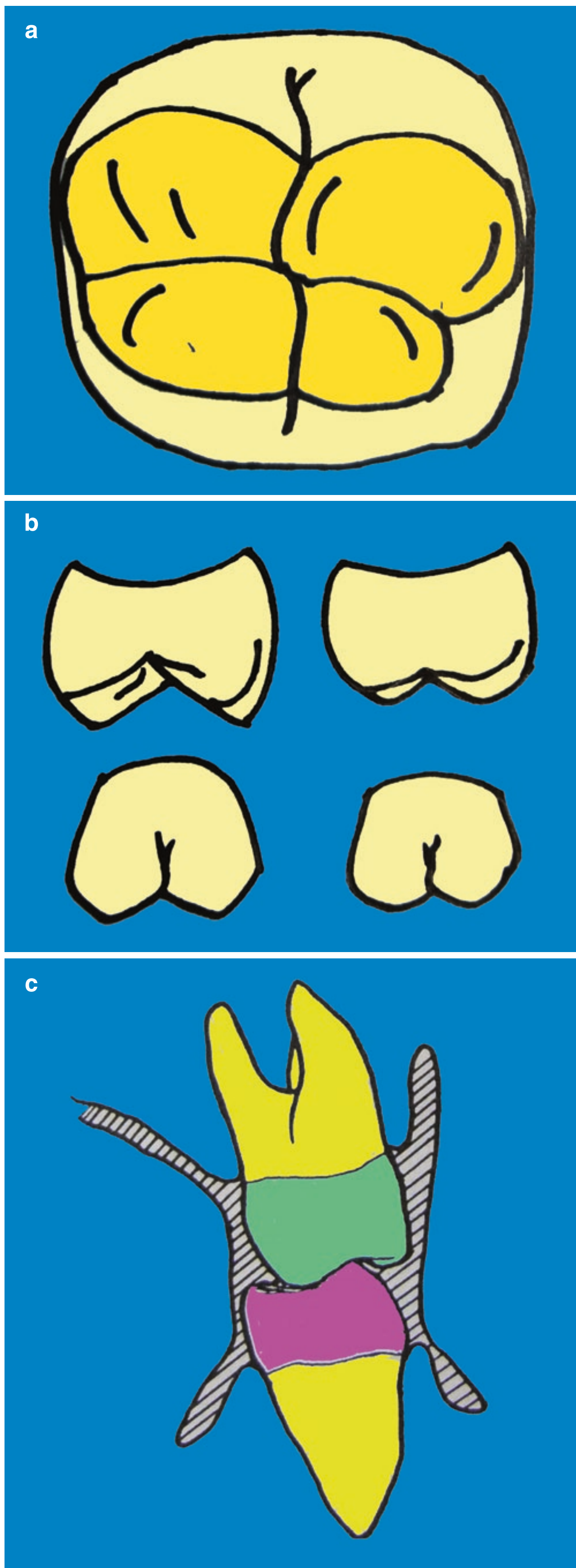


Fig. 2.4 (**a–c**) Artificial teeth are known as anatomic teeth, as they imitate natural teeth

the anatomic or semi-anatomic posterior tooth form is indicated. If muscle control is still questioned and the clinician has difficulty in conforming the different jaw relation records, zero-angled posterior teeth or maxillary semi-anatomic or anatomic teeth combined with zero-angled mandibular teeth should be chosen. The coordination and muscle adaptation ability of young patients are quite good. Their esthetic expectations are higher. Therefore, it is suitable to choose anatomic (cusped) teeth. The coordination ability of elderly patients, their esthetic expectations, and adaptation capacity are less, and they need more help. If the teeth of the existing denture are cusped, then cusped teeth are used, but if they are not cusped, shallow cusped teeth are selected.

Patients between 70 and 80 years old display a decrease in their neuromuscular control. In such situations, non-anatomic posterior teeth may be preferred because these teeth provide occlusal freedom during movements without locking the teeth in any occlusal position. On the contrary, there are many patients whose chronological age is not similar to their biological age (e.g., a 70-year-old patient whose appearance and functions are like a 50-year-old individual). The use of anatomical teeth for such cases may not cause a problem, and other criteria can be achieved. Conversely, a 50-year-old patient with Parkinson disease may have seriously lost his/her neuromuscular control, and non-anatomical teeth can be indicated.

2.3.2 Jaw Relations

Anatomical and non-anatomical teeth have the same basic strength; it is easier to provide esthetics with these teeth, and they achieve proper cusp height to improve a balanced occlusal concept. Nevertheless, cusped teeth are designed and produced to provide occlusion between Class I molar relation and normal mediolateral relation. If the patient has a Class I skeletal relation, cusped teeth can be grinded and arranged to provide balanced occlusion. However, every patient does not have a skeletal relation that allows for improving a classical Class I molar relation.

Patients who have a Class II jaw relation usually move their mandible habitual centric occlusion position. The amount of anterior movement may vary each time the mouth is closed. The use of anatomical and non-anatomical teeth does not allow for anterior movement as they do with free sliding movement. Cusp interferences may occur in the forward and forward-lateral position of the mandible.

For this skeletal Class II patient, a suitable tooth form and the occlusal plane should be selected to obtain movement freedom at centric occlusion and anterior position when the jaws are in centric relation. Skeletal Class III patients have problems that prevent the use of an anatomic or semi-anatomic tooth shape during the selection and arrangement of the tooth (Fig. 2.10a–d).

Non-anatomic teeth selection is suitable for the neuromuscular problem patients for whom the recording of

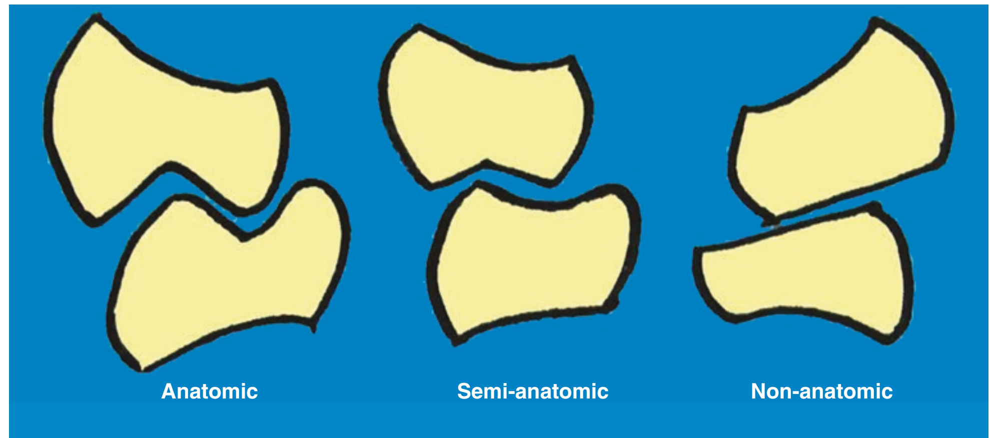


Fig. 2.5 Anatomic, semi-anatomic, and non-anatomic teeth forms

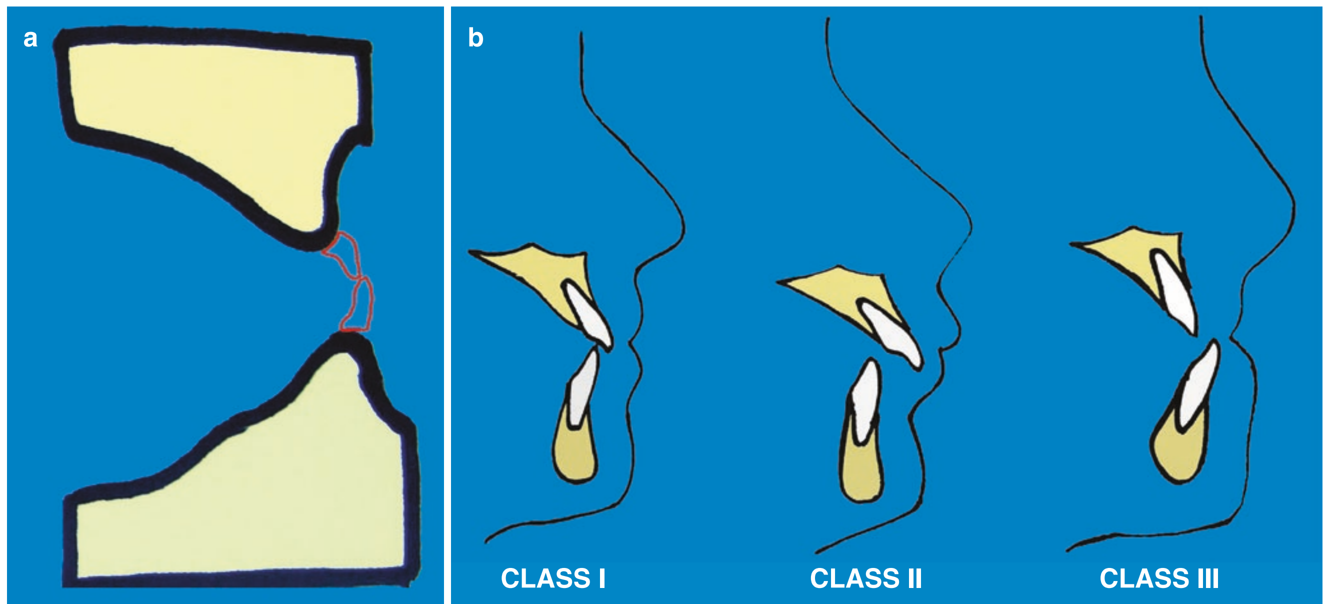


Fig. 2.6 (**a**, **b**) Non-anatomic teeth forms can be used in crossbite and Class III cases

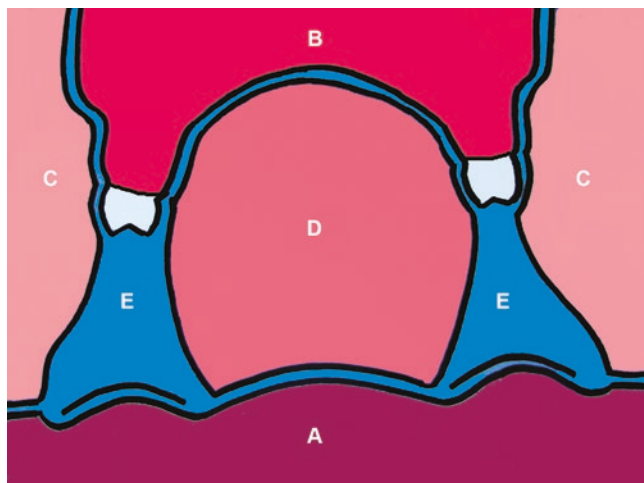


Fig. 2.7 Posterior natural dentition is in balance between pressure of the tongue in lingual direction and cheeks in facial direction

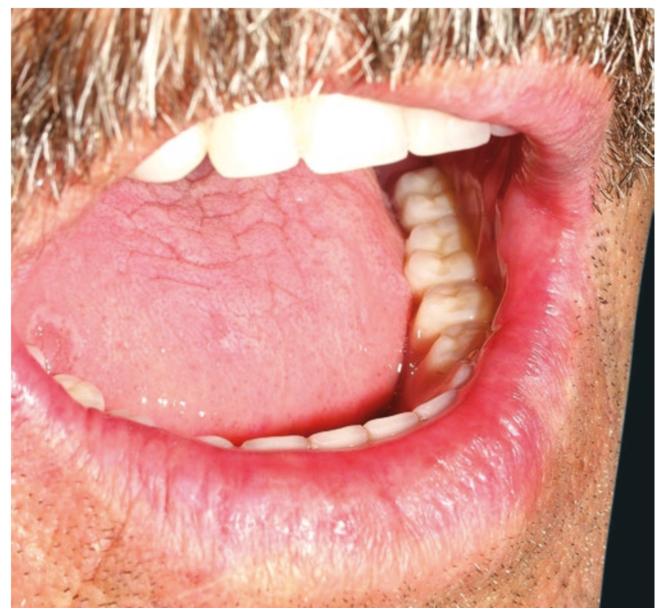


Fig. 2.8 Artificial posterior teeth also should be arranged in a same manner, in neutral zone

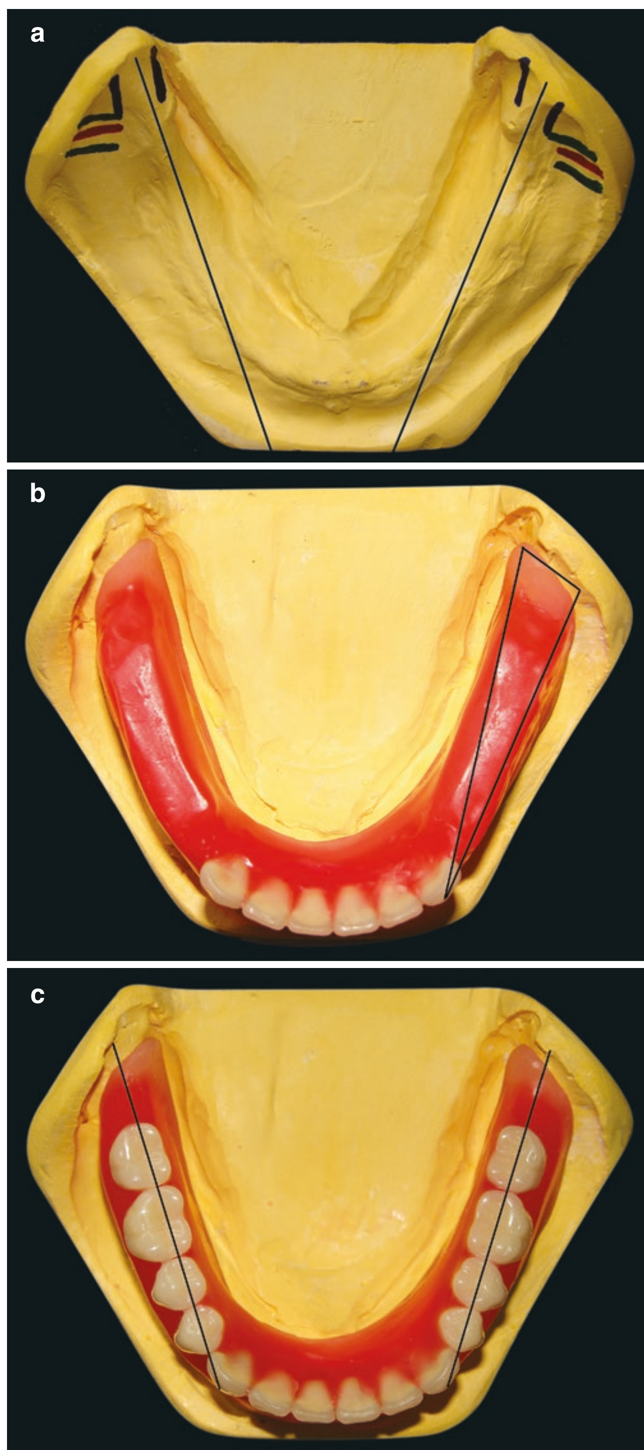


Fig. 2.9 (**a**–**c**) Selection of posterior artificial teeth should allow for distance between distal side of lower canine and mesial side of retromolar pad

centric relation is difficult. The immediate denture wearers, patients having bad or changed neuromuscular control, use an occlusal plane which permits modifications; however, the use of 0° and non-anatomic teeth in two arches is limited.

2.3.3 Chewing Efficiency and Esthetics

Patients usually establish a relationship with the chewing ability and the existence of tooth cusp; but this is not quite right; the chewing ability is affected by many factors, which are reported earlier [in this book]. When esthetics is considered, the posterior teeth are ignored; however, the posterior area is a quite important area for esthetics.

The *buccal corridor* which starts from the first premolar on the maxillary denture is important for the smile of the patient, which increases and gives a natural appearance when the teeth are arranged in a suitable form, width, and dimension (Fig. 2.11a–d).

To increase the denture' esthetics, artificial teeth which imitate natural dentition of the patients should be selected. If the patient's esthetic worries are high, especially teeth with angled cusps should be selected in the premolar area instead of zero degree teeth. Teeth with buccal cusps establish a reliable, natural, and pleasant appearance.

2.3.4 Distance Between the Arches

The distance between the arches affects the selection of the crown's length or the occlusal-cervical length. The manufacturer produces the teeth as small, medium, and large. The distance between the arches is recorded after the models were attached to the articulators and usually longer teeth seem more esthetics.

2.3.5 Wear Amount of Previous Denture

Most of the information about the patient can be obtained from his/her old denture (Fig. 2.2c, d). The wear of the teeth should be controlled regarding occlusal harmony, comfort, and effectiveness. The factors that affect posterior tooth selection are shown in Table 2.1.

2.4 Selection of the Number of Posterior Teeth

Studies about chewing ability show that the chewing performance takes place especially at the second premolar and the first molar areas, but not at the most posterior area. Because of this, artificial teeth should not be placed behind the area between the premolars and retromolar pad (Fig. 2.12a, b).

The number of teeth that will be used to develop the occlusal design is affected by the existing place. The first and second molar teeth have the best chewing surface. Usually, the exclusion of the first premolar is better because this tooth has a narrow occlusal surface for chewing food and appears like a modified canine.

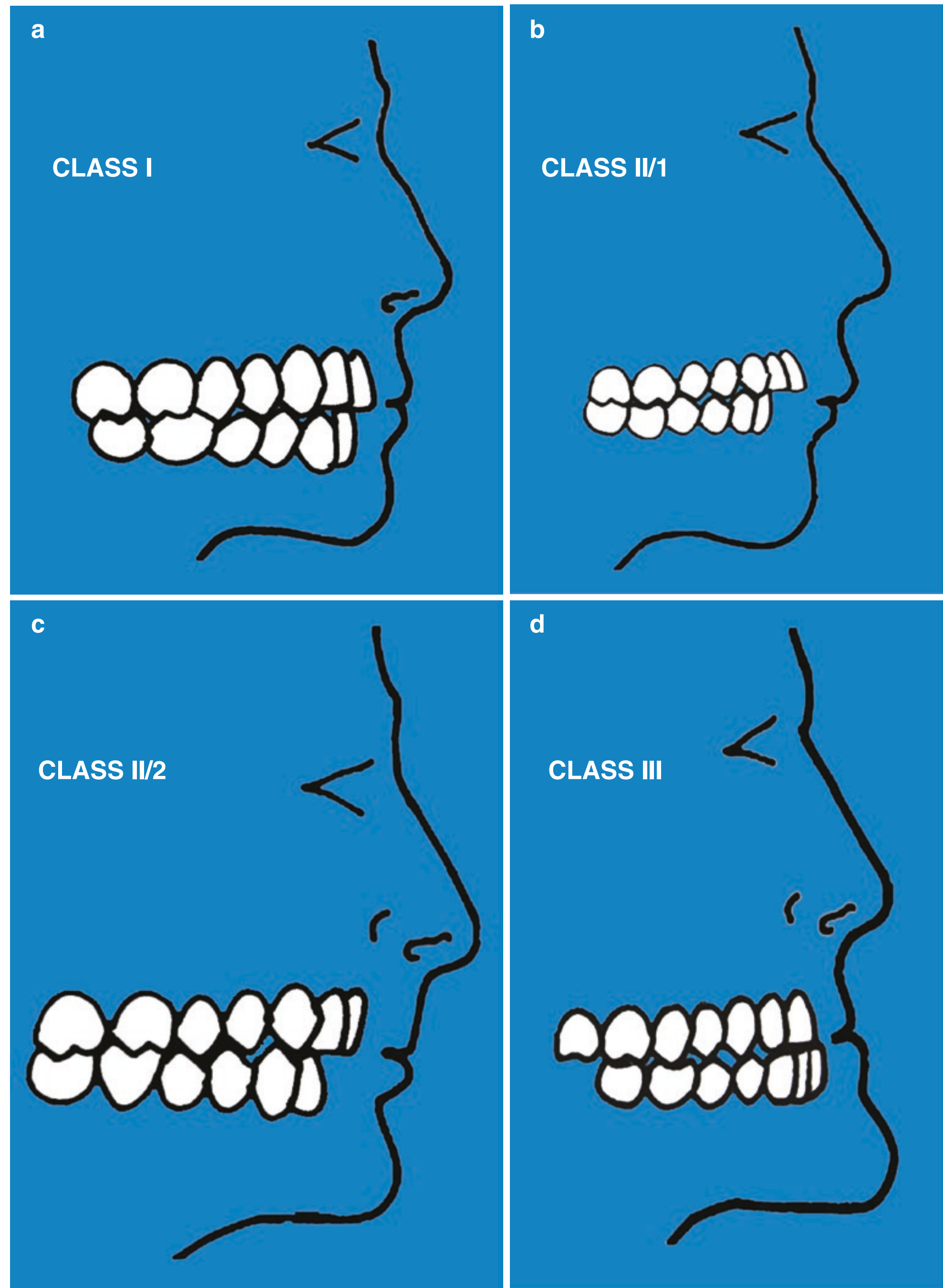


Fig. 2.10 (**a–d**) Class I, II, and III jaw relations

2.5 The Selection of Occlusal Concept

In the selection of the occlusal plane, the harmony of the dentures during function should be compatible with the oral tissues, and the patient satisfaction should be considered. The denture wearer shows differences in age, physical ability, oral tissues anatomy, jaw relation, previous denture experience, and parafunctional habits. As explained previously, different researchers have developed different occlusal concepts (i.e., balanced occlusion, monoplane occlusion, lingualized occlusion).

Usually, there are some features in denture wearer patients during tooth arrangement: good function, safety for oral tissues, being acceptable for the patient, and the control of the neuromuscular system. None of the occlusal planes show all the features together; the use area of each occlusal plane concept is different. The aim of each occlusal plane concept is to increase the denture stability while controlling eccentric tooth movements and minimizing the horizontal stress.

Kapur, in his study related to occlusal models and tooth arrangement, stated that different variation and occlusal con-

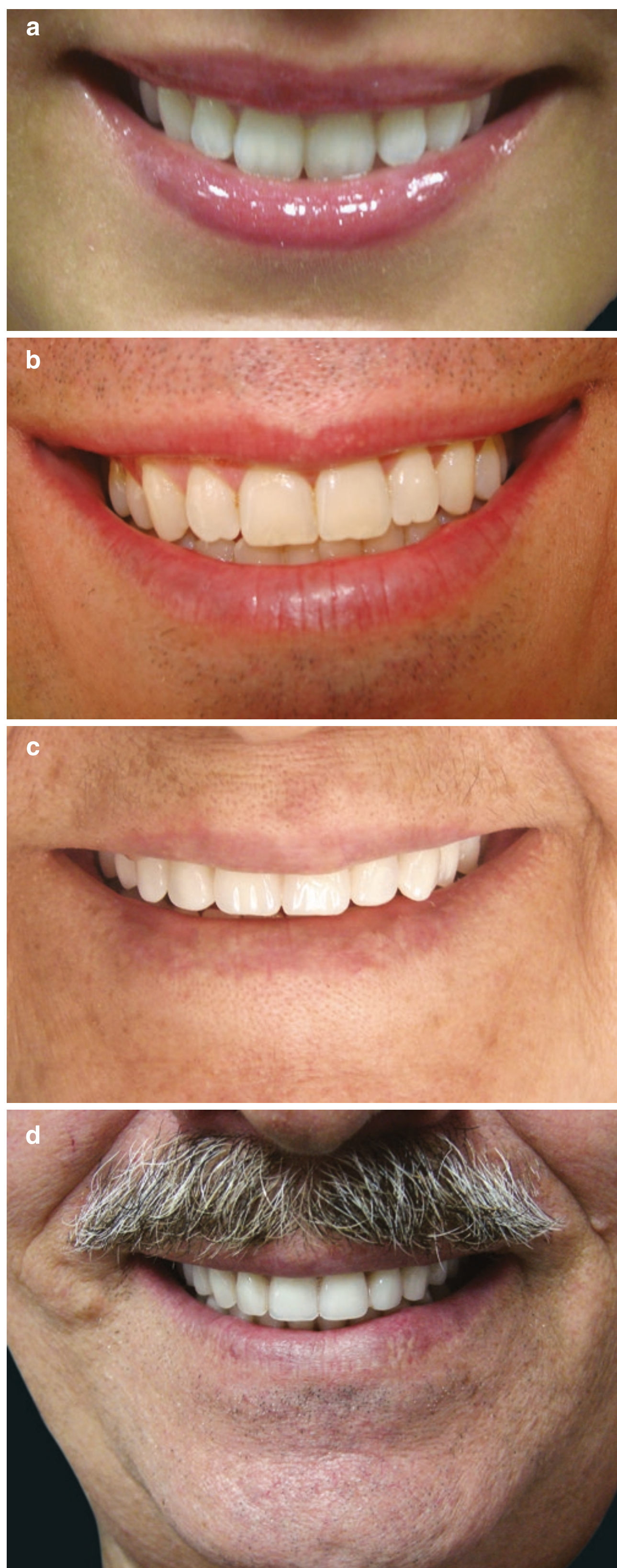


Fig. 2.11 (**a**, **b**) Appearance of buccal corridor in natural dentition. (**c**, **d**) The buccal corridor accomplished by the complete dentures

tact times are observed during swallowing, chewing, natural tooth movements, sleeping, and awakening.

The studies show that the lateral pressure that occurs during movement of the denture base related to the occlusal contact is potentially destructive. Occlusal contacts directly cause the movement and deformation of denture base, and therefore even if the clinical studies do not prove, they should be considered as potential etiological factors that injure soft and hard tissues.

A question that has been discussed for years is "Should the denture have balanced occlusion or not?" Nevertheless, as a general view, the stability and retention of the complete denture are affected by parafunctional habits, such as bruxism or lateral premature contacts; the balanced occlusion is preferred particularly for difficult cases.

Although the scientific evidence is weak in supporting the occlusal concept, Brewer (1963) reports that the teeth contact is less during chewing (10 min) than without chewing out (swallowing, parafunctional habits) (2–4 h). This observation indicates the need for balanced occlusion especially in cases of parafunction. The teeth of a balanced denture provide stabilization in full arches, while applying balanced pressure during the parafunctional jaw movements. It is not forgotten that 2–4 h pass with parafunction and 10 min with function per day and the occlusal concept selection should be done according to the patient's features as previously considered.

In this section tooth arrangements in three concepts will be described.

2.5.1 Balanced Occlusion

For the concept of balance, there must be a contact of upper buccal cusps with lower lingual cusps in the working side and upper lingual cusps with lower buccal cusps in the non-working side. In working side, the mandibular jaw moves toward the cheeks; the condyle of the working side is stable in the socket and better supported. In balanced side, the mandible moves toward the tongue; the balanced condyle moves to orbiting position. It moves more in space, and it has more tendencies to injury or damage (Fig. 2.13a–c). The posterior teeth must be in contact when the anterior teeth are in the edge-to-edge position (Fig. 2.13d). To obtain balanced occlusion, some relations must be established such as condylar guidance, incisal guidance, occlusal plane, compensating curve, and cusp height. To establish the balanced occlusion, the dentist should have information about the condylar guidance, incisal guidance, occlusal plane, compensating curve, and the cusp height (Fig. 2.14).

Table 2.1 Patient-related factors affecting posterior tooth selection

Patient-related factors	Tooth form			
	Anatomic	Semi-anatomic	Rational (0 degrees)	Combined. Upper jaw anatomic/lower jaw rational
Neuromuscular control	Patient provides muscle control	Patient provides muscle control	Suitable for muscle control	Suitable for patients with weak muscle control
Anteroposterior jaw relation	Class I: easy to modify Classes II, III: teeth can be modified but need too much occlusal modification	Class I: easy to modify Classes II, III: teeth can be modified but need too much occlusal modification	Classes I, II, III: easy to modify	Classes I, II, III: easy to modify
Mediolateral jaw relation	It is difficult to arrange the teeth in cross-bite	It is difficult to arrange the teeth in cross-bite	It is easy to arrange the teeth in cross-bite	It is easy to arrange the teeth in cross-bite
Esthetics	Satisfactory esthetics	Satisfactory esthetics	Flat maxillary teeth affect the esthetics	Maxillary teeth with cusps Satisfactory esthetics
Occlusal concept	Balanced/non-balanced	Balanced/non-balanced	Only non-balanced	Balanced/non-balanced

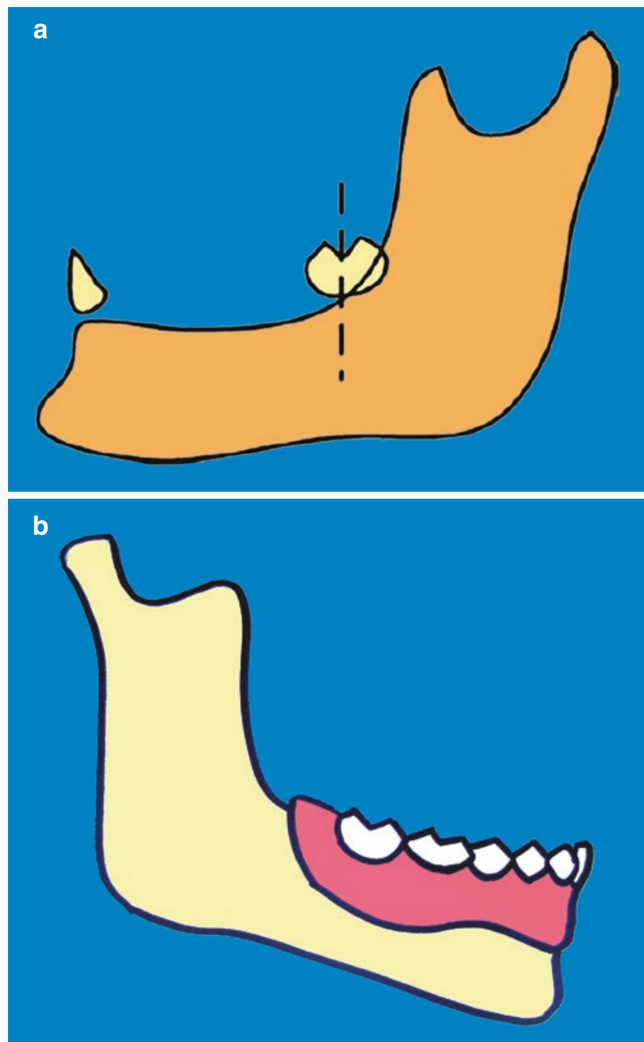


Fig. 2.12 (**a**) This area is situated between the distal of mandibular premolar and retromolar pad area. Artificial teeth should not to be arranged at the posterior of this area. (**b**) Correct arrangement

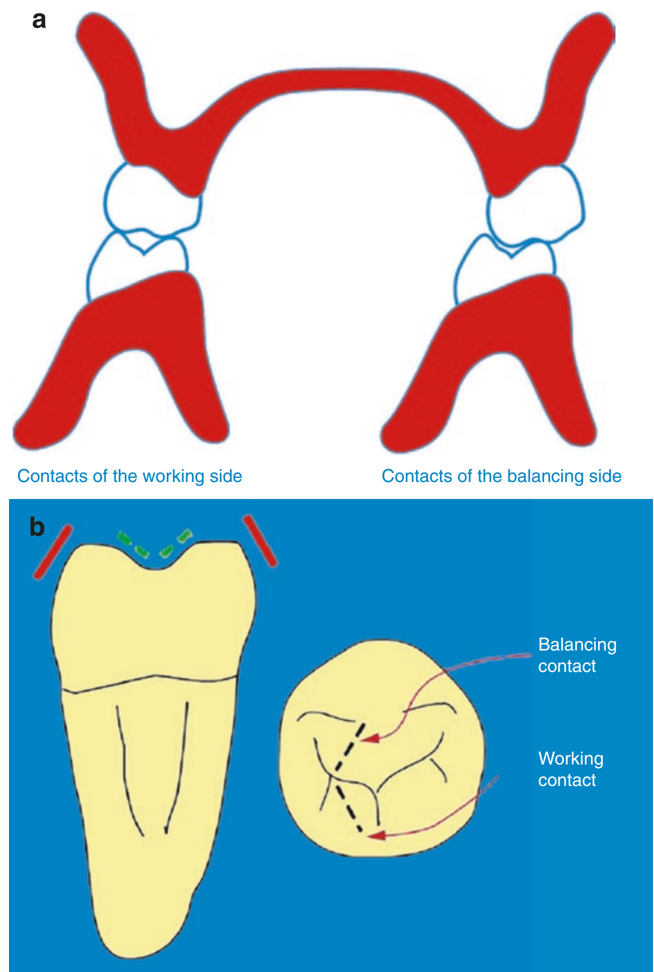


Fig. 2.13 (**a**, **b**) The working and balancing side contacts, (**c**) the working and balancing side condyle and teeth movements, (**d**) Anterior guidance and protrusive movement

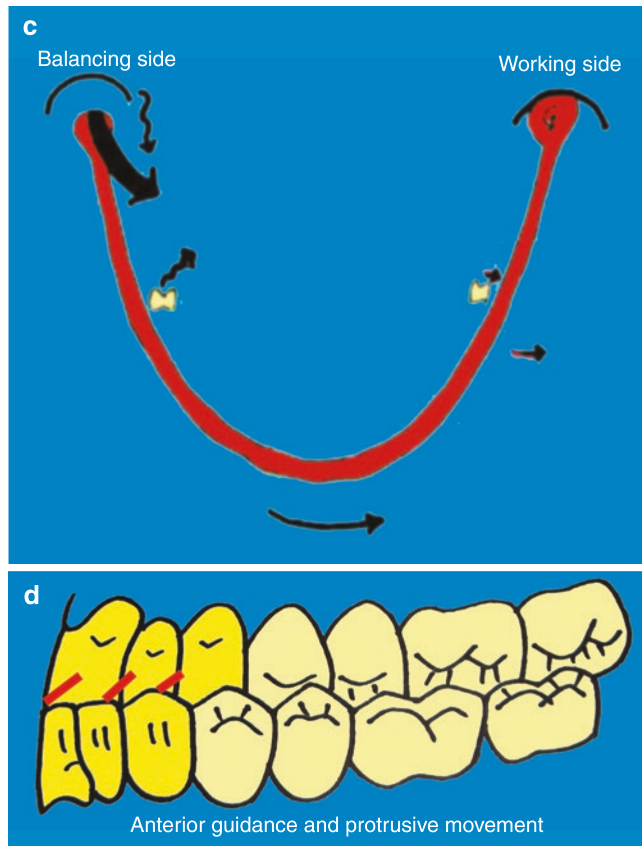


Fig. 2.13 (continued)

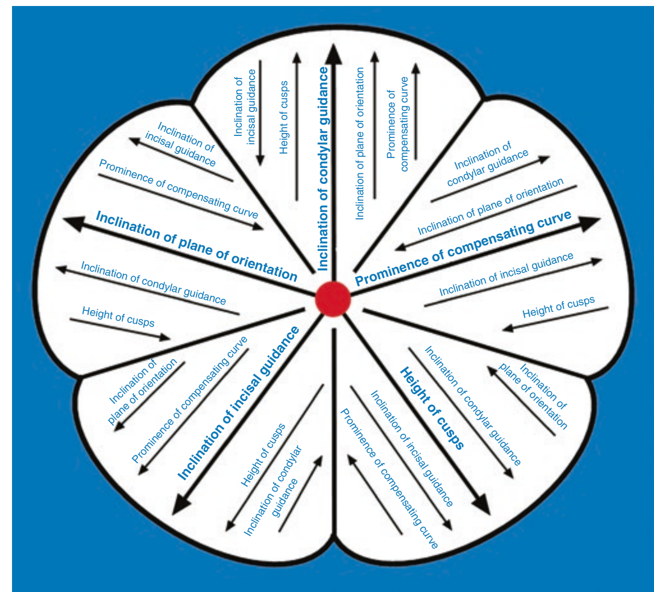


Fig. 2.14 Factors that affect balanced occlusion

2.5.2 Factors That Affect Articulation

2.5.2.1 Condylar Guidance

Condylar guidance as reported previously can change from 0° to 60°. Articulation adjustments can be obtained with patient's protrusive biting records and are not under the dentist control. If the horizontal condylar measurements vary from 0° to 20°, it's called low grade, from 20° to 30° called medium grade, and 30° and more called a high grade. If the horizontal condylar measurements are high, the use of anatomic or semi-anatomic or the combination of both is optional. In this case, zero degree teeth cannot be used because it is difficult to obtain bilateral balanced occlusion with these teeth. As a rule, with high condylar guidance, high cup inclination is needed.

2.5.2.2 Incisal Guidance

Horizontal incisal guidance defined as the effect of the upper and lower anterior teeth' contacts during the movement of the mandible (Fig. 2.15a). The clinician must try to obtain the smallest horizontal incisal guidance angle (Fig. 2.15b). If the angle is over 10°, anterior teeth should be modified until a smaller angle is obtained.

Anatomic teeth have cusps heights and inclinations that are unavailable in non-anatomic teeth. If the condylar path and the incisal guidance, the border control factors, are at a high level (especially incisal guidance due to its proximity to the posterior teeth), the anatomic tooth should be used to obtain balance. There are different anatomic teeth that have different cup height and inclinations, and to establish the mechanic aim, one of these should be selected. If the incisal guidance is approximately less than 10°, anatomic teeth also can be used. Figure 2.16 shows the effect of the inclination of the incisal guidance and inclination of the condylar path on the cup height.

2.5.2.3 Occlusal Plane

The occlusal plane is obtained during the determination of the vertical dimension and centric jaw relation. It is a temporary relation that is modified with mediolateral and anteroposterior compensating curves (Figs. 2.17 and 2.18).

2.5.2.4 Compensating Curve

A certain degree of compensation is required to arrange the bilateral balanced occlusion. First of all is the anteroposterior compensating curve (Spee). In dentate subjects there is usually a small wear ratio, and, if there is no bruxism, the form of the incisal teeth will not change for life. In dentate subjects, when the mandible moves forward and the condyle moves toward the anterior slope, the anterior segment of the mandible is fixed in mandibular teeth guidance which contacts the lingual surface of maxillary incisor, and the premolars and molars teeth are not in contact (Fig. 2.19a). But this situation is not desirable for complete dentures (Fig. 2.19b). To obtain balanced occlusion, in the protrusive movement of the jaw when the anterior teeth are in contact, the posterior teeth should also be in contact (Fig. 2.20). The posterior contact is important for the stabilization of the complete denture.

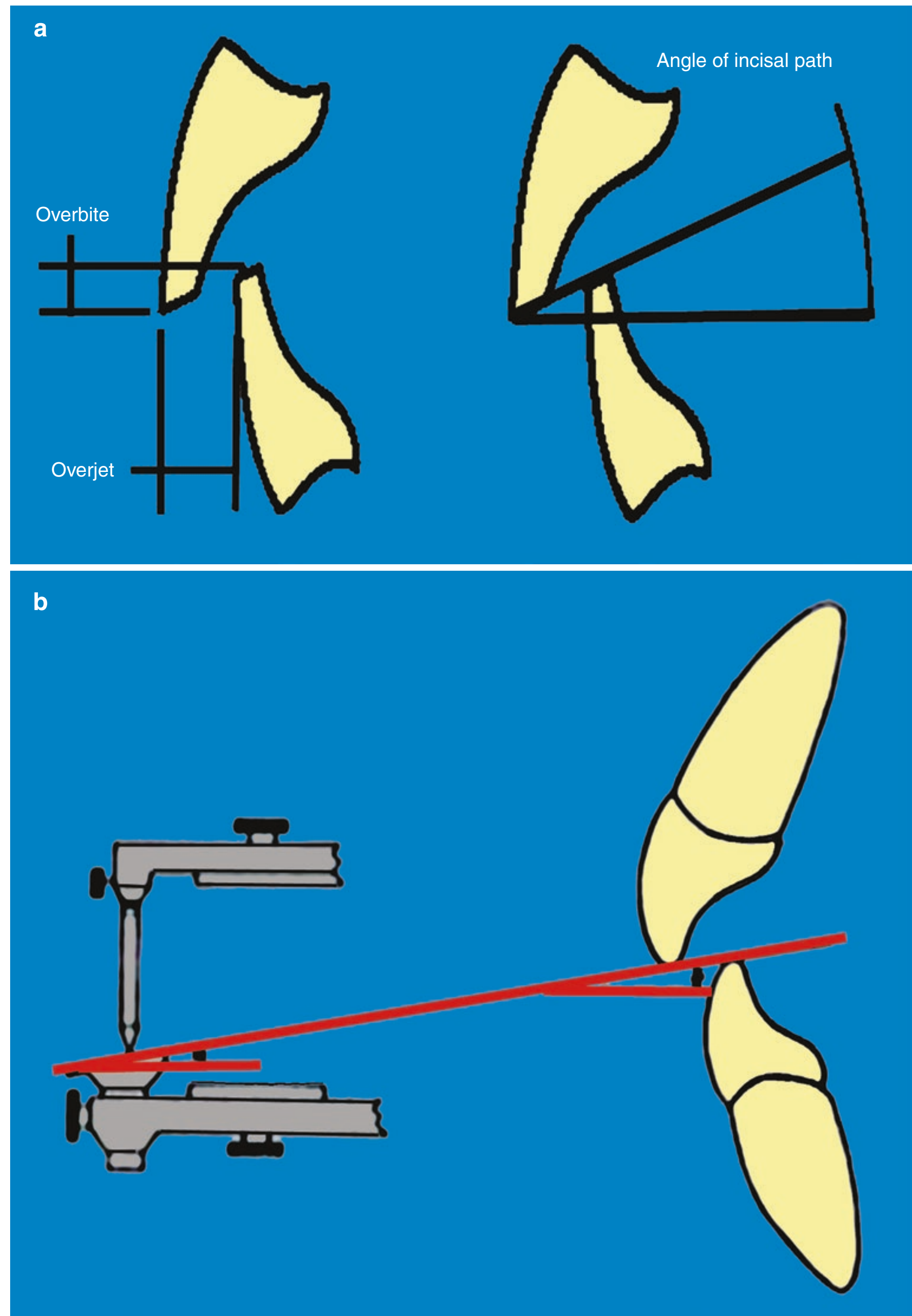


Fig. 2.15 (**a**) Horizontal incisal guidance is defined as the effect of the upper and lower anterior teeth contacts on movement of the mandible (**b**) The clinician must try to obtain the smallest horizontal incisal guidance angle

Accordingly, the anteroposterior compensating curve provides support for the denture, and in protrusive movement, it provides contact between premolar and molar teeth (Fig. 2.18). With the curve of Spee, arc-shaped occlusion is obtained. Spee defined this as a mandibular sliding path (Fig. 2.21). The curve of Spee starts from the tip of the canine and continues to the anterior border of the ramus touching the buccal tubercles of the posterior teeth (Fig. 2.22). In ideal Spee of the curve, this arch is drawn as continuing through the condyle. The curvature of the arch is a circle with a mean diameter of 10.16 cm.

2.5.2.5 The Curve of Wilson

The curve of Wilson is the transversal compensation curve (lateral compensation). The curve of Wilson reaches the frontal (transversal) and contact to the cusp tips of the

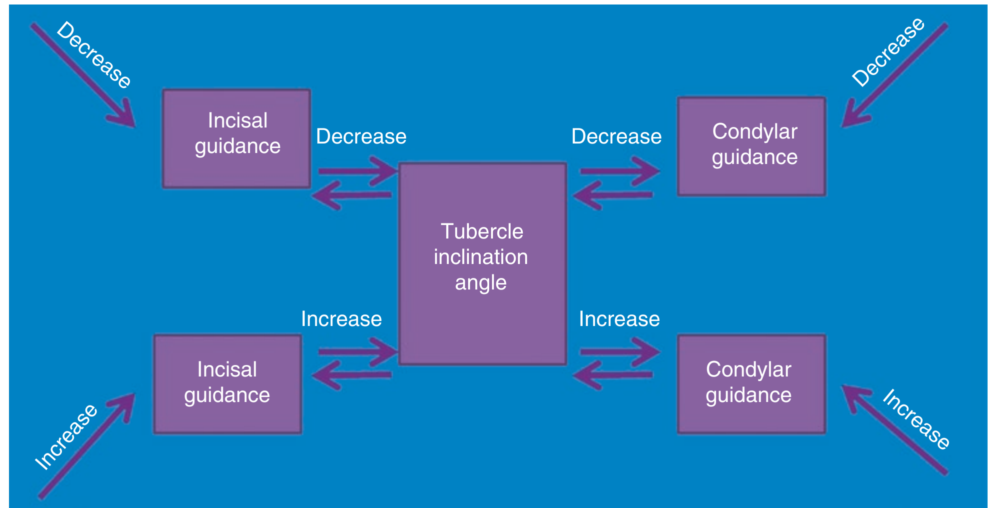
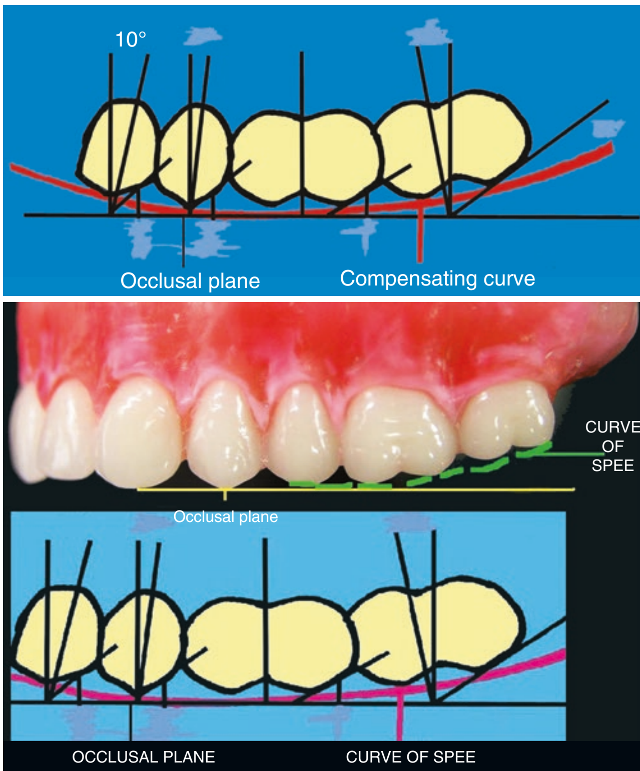


Fig. 2.16 Effect of inclination of incisal guidance and inclination of condylar path on cusp height



Figs. 2.17 and 2.18 Temporary relation which is modified with mediolateral and anteroposterior compensating curves

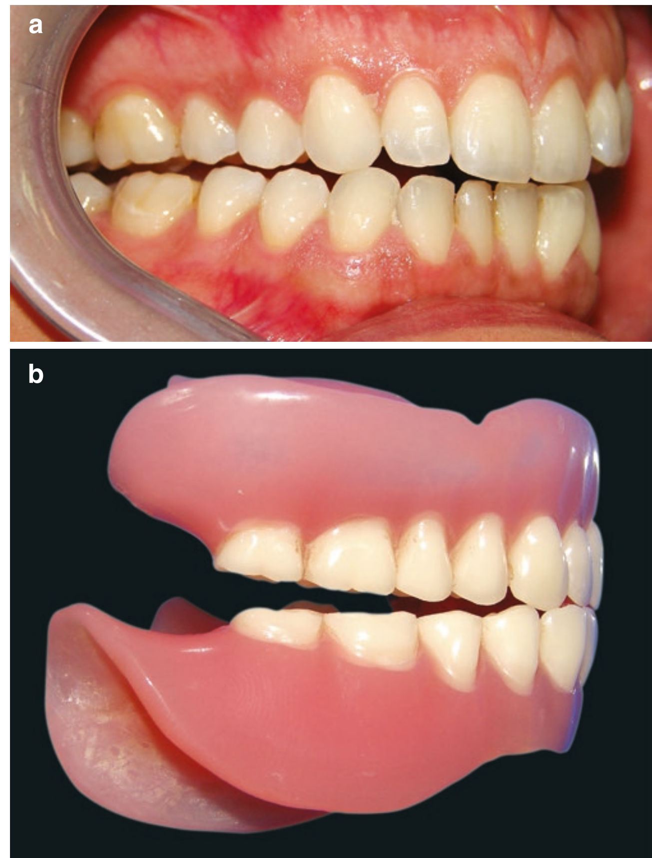


Fig. 2.19 (**a**) In natural dentition, when there is contact between the anterior teeth, the molar teeth do not make contact during protrusive movements (**b**) This situation is not desirable for complete dentures

posterior teeth. The curve of Wilson occurs with the same lingual inclination of right and left mandibular molar teeth and with the antagonist maxillary buccal inclination (Figs. 2.23a–c and 2.24). As the mandible moves laterally and the translated condyle moves down and forward the denture should maintain bilateral contact. When the movement is observed coronally, the buccal inclination of the lower buccal cusp should be in contact with the lingual inclination of the upper buccal cusp in the rotated side, and the lingual inclination of lower buccal cusp should be in contact with the buccal cusp of the upper lingual cusp, in the translated side. This is impossible with the anatomic condyle position and occlusal plane in humans. Constant degree cusps are used to obtain this relation

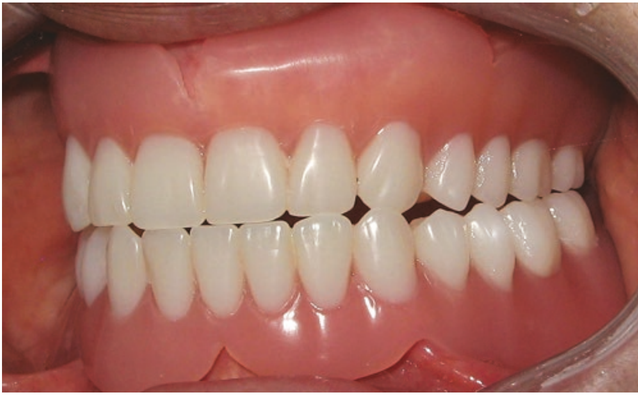


Fig. 2.20 To obtain balanced occlusion, in protrusive movement of the jaw when the anterior teeth are in contact, the posterior teeth also should be in contact

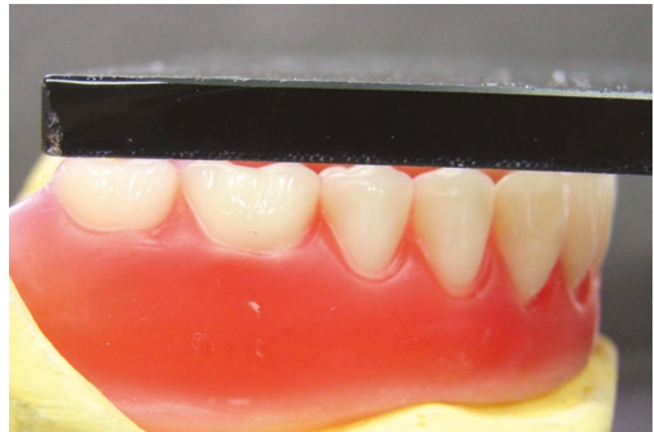


Fig. 2.22 The curve of Spee starts from the tip of the canine and continues to the anterior border of the ramus, touching the buccal tubercles of the posterior teeth

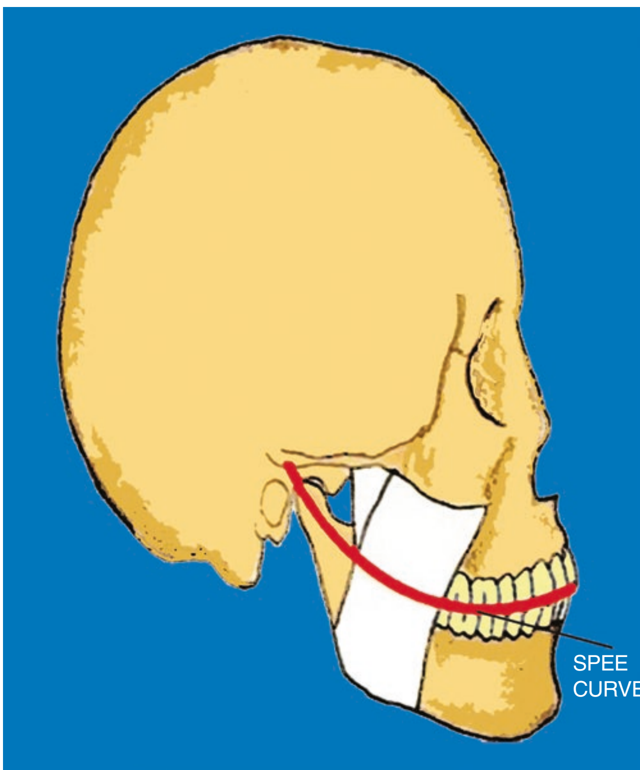


Fig. 2.21 With the curve of Spee, arch-shaped occlusion is obtained

and meanwhile, during the translation movement, the tip of the upper teeth are arranged buccally to permit occlusal contact bilaterally. Thus, the lingual inclination angle of the buccal cusps decrease artificially, and the buccal inclination angle of the lingual cusps is increased. The inclination degree is needed to modify the angle, and it changes in anteroposterior position because of the convexity of the downward inclination. Anterior teeth inclination is decreased because of the reduction of the effect of translated downward movement of the condyle. With the properly arranged curve of Wilson, the teeth contacts of the non-working side will increase. The lingual inclination of the lower posterior teeth places the lingual cusps lower than the buccal (Fig. 2.23a–c).

This design provides easy access to the occlusal table. When the tongue places the food to the occlusal surface, due to the long buccal cusps, the backward movement of food is prevented. The compensating curves (Spee and Wilson) are needed for the bilateral occlusal support, and also, the inclination that is given to the artificial teeth is similar to the inclination of the natural dentition. Therefore, it's possible to construct a stable and natural looking denture.

The condition of Spee and Wilson curves of the artificial teeth depends on the angle of the condylar and incisal guidance and also the height of the cusp inclination.

2.5.2.6 The Cusp Angle

To balance the articulation factors, sometimes the high cusp angles are determined with different angulations; therefore, mechanic bilateral balanced occlusion is obtained (Fig. 2.25). During creating occlusion philosophy, the dentist arranges the relation between incisal guidance, condylar guidance, compensating curve, and plane of occlusion, which affect the inclination of cusp angle for articulator. For some cases, high cusp angles are required, whereas for the others low cusp angles are suitable. The dentist should not use the same type artificial teeth for each treated patient because unique teeth are not enough to obtain balanced articulation.

In articulator, at the posterior area, the guidance equality of glenoid fossa is provided by the condylar guidance planes (Fig. 2.26a, b), and in the anterior area, the guidance equality of the upper incisors lingual surfaces is provided by the incisal guidance planes (Fig. 2.26c). The angle, which is formed by the orientation plane, is called condylar and incisal guidance angle. In adjustable articulators, although the condylar guidance angle can be according to the patient, there is no

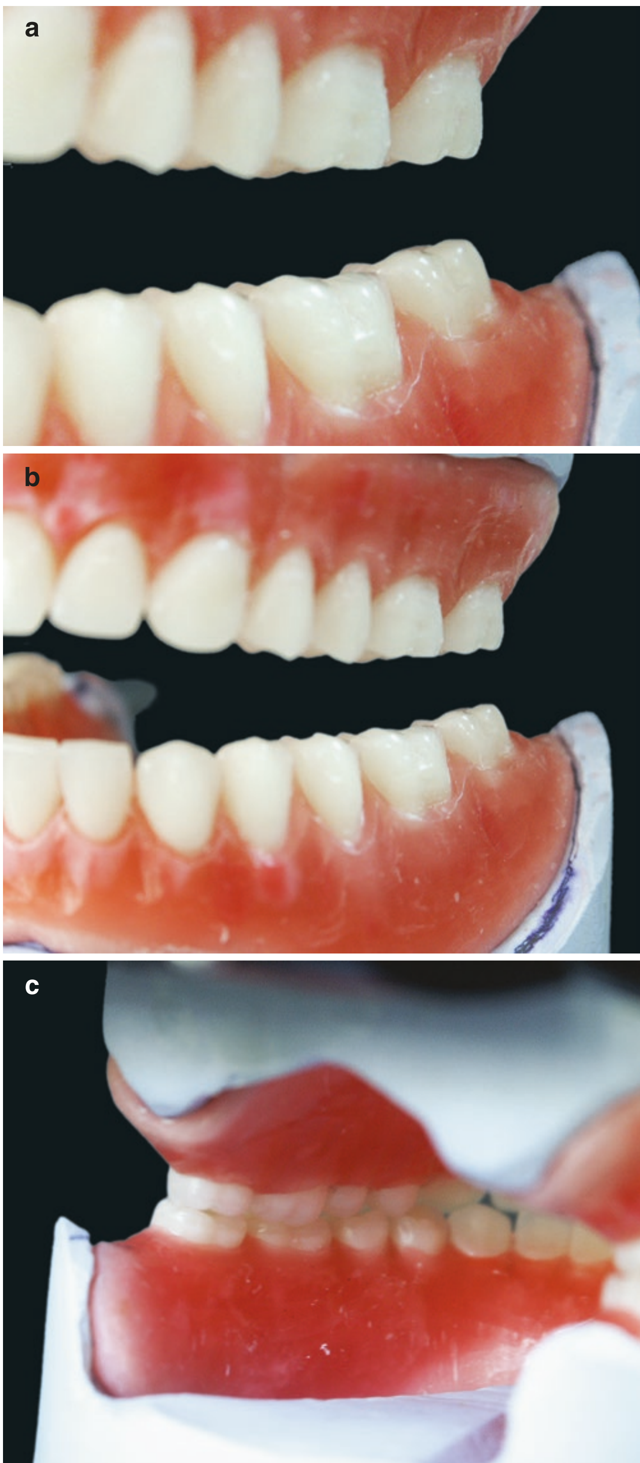


Fig. 2.23 (**a**–**c**) Lingual inclination of lower posterior teeth places lingual cusps lower than buccal cusps. Tips of posterior teeth cusps should be in contact with curve of Wilson

limitation for the incisal guidance. Many authorities have suggested to adjust 10° incisal guidance angle to obtain good appearance and easy tooth arrangement. When the cusped posterior teeth are arranged in normal buccolingual relation,

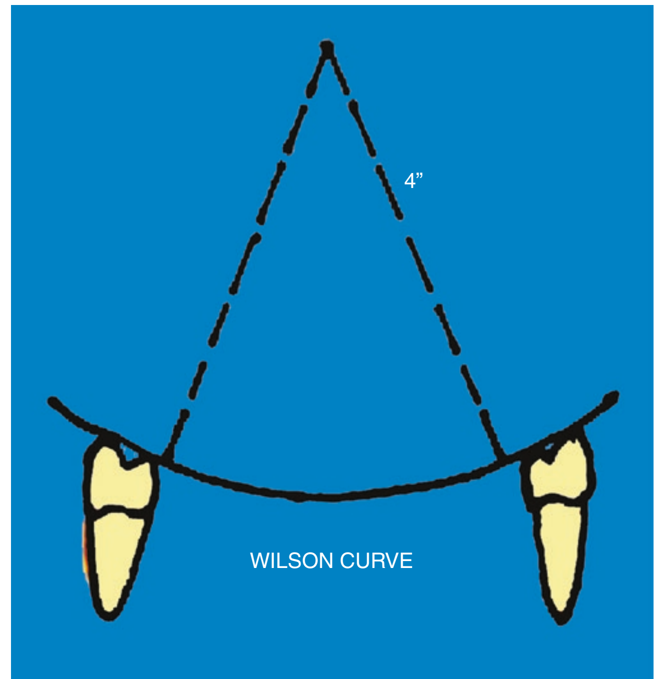


Fig. 2.24 Lingual inclination of lower posterior teeth places lingual cusps lower than buccal cusps. Tips of posterior teeth cusps should be in contact with curve of Wilson

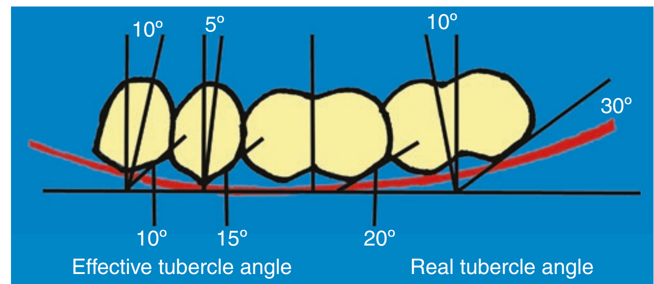


Fig. 2.25 Cusp angles can differ according to the teeth

in protrusive movement, to support the distal surface of the upper cusps with the mesiolingual inclination of the lower teeth by making contact, the working cusp angle should approach the incisal guidance angle in size. If the teeth are arranged posteriorly, to approach to the condylar guidance, the angle must be increased.

2.5.3 Balanced Occlusion with Anatomic Teeth

After the try-in stage of the anterior teeth, further information is obtained to arrange more objective and more suitable posterior teeth (Fig. 2.27a, b). Protrusive registration is made to obtain information so that the condylar inclination is adjusted to the articulator. Using the esthetic and phonetic guidance, after the arrangement of anterior teeth, the incisal

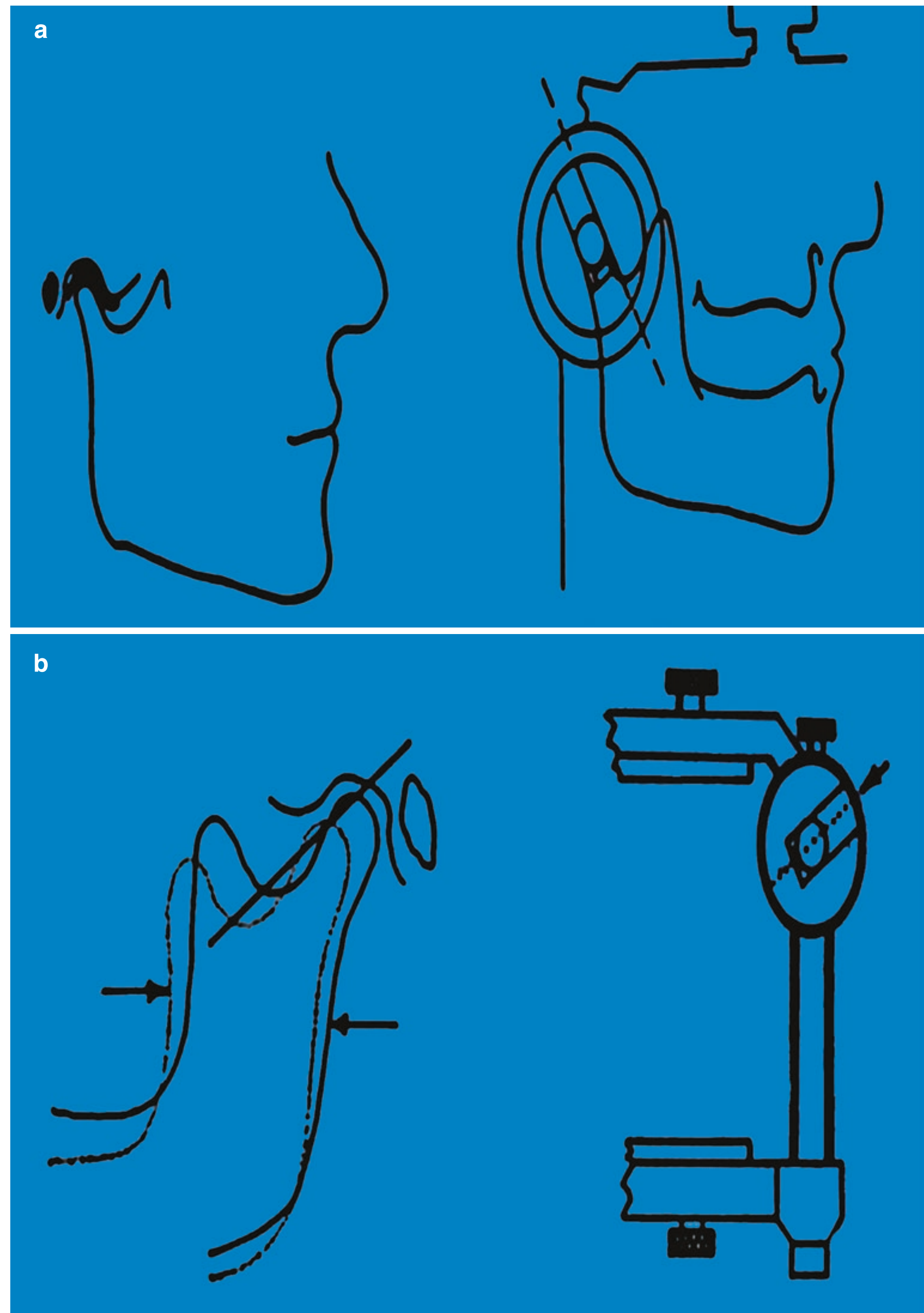
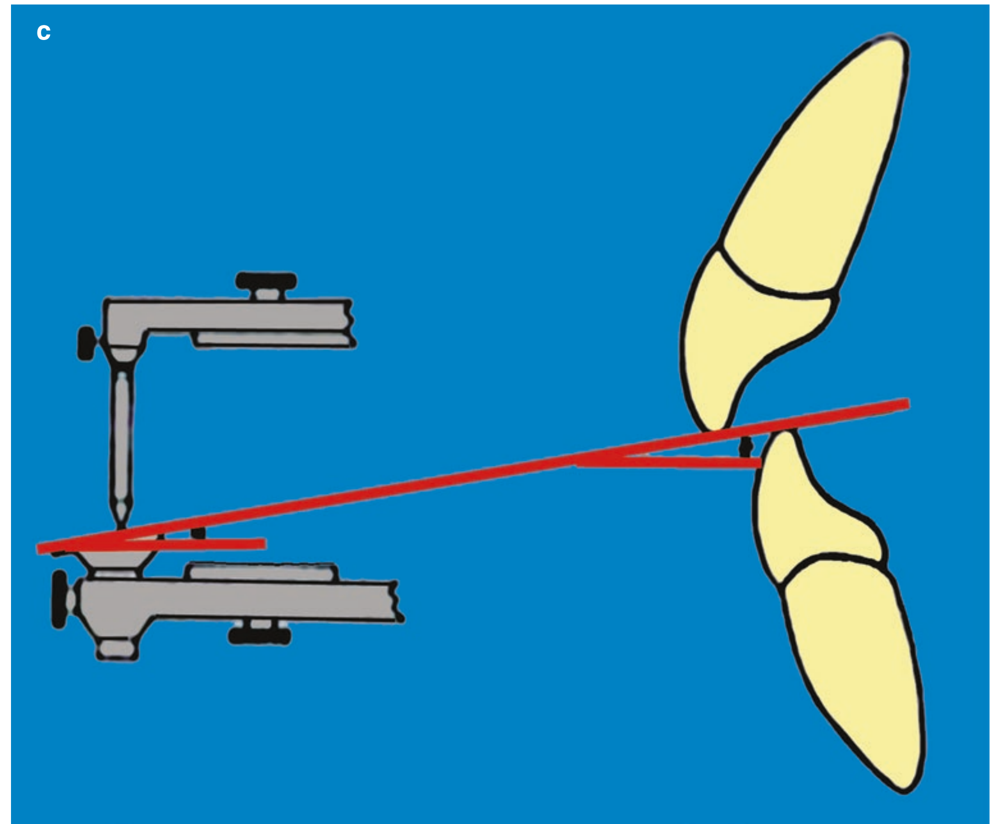


Fig. 2.26 (**a**, **b**) In articulator, at the posterior area, the guidance equality of glenoid fossa is provided by the condylar guidance planes. (**c**) In the anterior area, guidance equality of upper incisors lingual surfaces is provided by incisal guidance planes

guidance is obtained. And according to this, the incisor guidance plane of the articulator is adjusted. After the adjustment of the incisal table, the incisor guidance's pin remains in all the eccentric movements. The incisal guidance and the condylar inclination are the border control factors affecting the cusp height (Fig. 2.28).

The factors that increase the formation of balanced occlusion are the plane of occlusion, the curve of compensation (Curve of Spee) and the height and inclination of the cusps. All the five factors are called as Hanau's articulation laws. After the arrangement of anterior teeth according to the esthetics and phonetics, the vertical and horizontal overlap

Fig. 2.26 (continued)



can be arranged (Figs. 2.29 and 2.30). The incisal guidance will be more when the vertical overlap is highest and horizontal overlap is smallest, therefore, to construct a balanced occlusion the cusp heights can be increased (Figs. 2.31, 2.32). The smallest cusp height is needed when the vertical overlap is smallest, and the horizontal overlap is highest (Fig. 2.33).

The condylar inclination according to the plane of occlusion affects the angle or height of the needed artificial teeth to construct balanced through the posterior. For example, 40° instead of 15°'s condylar inclination needs posterior teeth with highest cusp angle and height.

In the articulator, the first molar is placed between the border control factors (incisal guidance and condylar inclination). It is approximately in equal distance to each one (Figs. 2.34 and 2.35). Therefore, the needed cusps height can be thought as a mathematical or mechanical factor to provide balance in lateral and protrusive movements. For example, when the incisal guidance is 10°, and condylar guidance is 20°, to provide balance the cusp height should be 20° at the first molar area because the first molar is half of the border control factors mechanically (10° + 30° = 40° ÷ 2 = 20°). This condition solves mathematically or mechanically how the posterior teeth should be placed to obtain balanced occlusion. This condition is not the same inside the mouth. The condyle-first molar distance is longer than the first molar-incisal guidance distance because there is no incisal pin and the anterior teeth provide the guidance (Fig. 2.36).

The incisal guides in the mouth are the teeth, not the pin, and these teeth are closer to the first molar then the condylar guidance. Therefore, the incisal guidance in the mouth plays a major role during the arrangement of the posterior teeth occlusion in eccentric movements when compared with condylar guidance. Also, the alveolar ridge form should be considered during the use of posterior teeth. Generally, the tooth arrangement is related to the smooth alveolar ridge form. The angle of the alveolar ridge should be in relation to the angle of the anatomic teeth (Fig. 2.37). In the case of resorbed alveolar ridge form, the non-anatomic teeth should be used (Fig. 2.38).

The patient may cause the wear of artificial teeth over the years (Fig. 2.39). To correct the situation, which is in the patient tissues tolerance, lateral forces should be decreased, and so, the harmony will be constructed between the effectiveness of the cusps and the stability of the non-anatomic teeth. This procedure is based on subjective causes, and it is not a scientific evaluation.

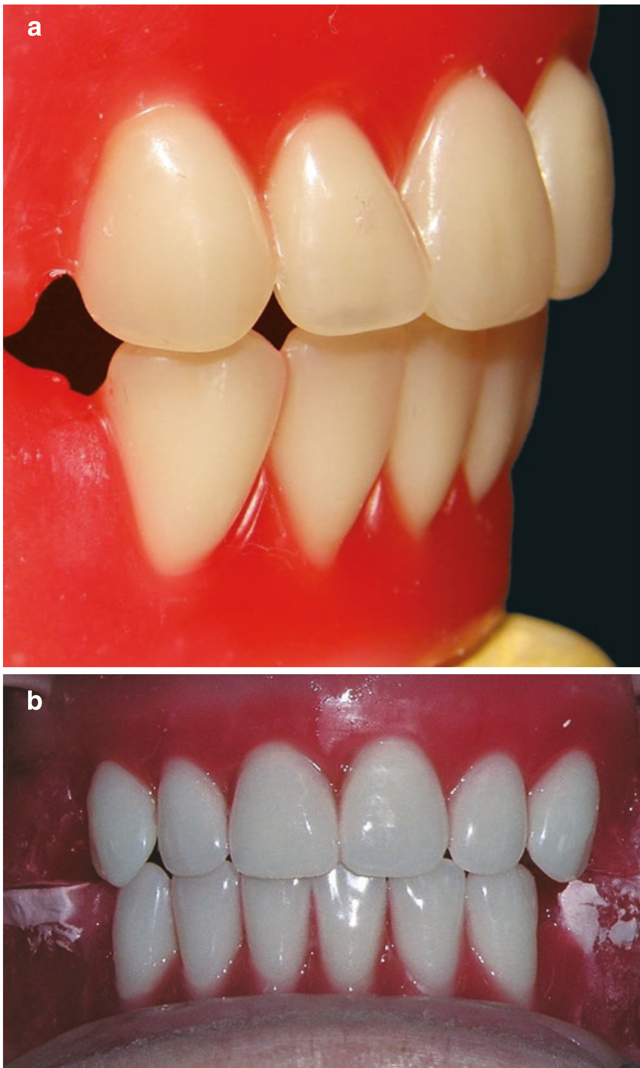
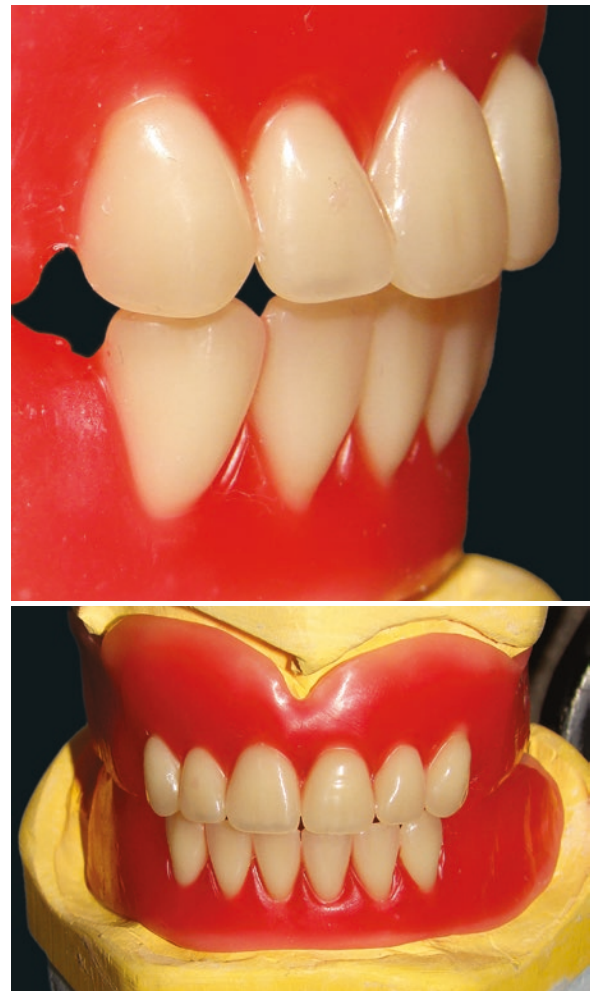


Fig. 2.27 (a, b) Try-in stage of the anterior teeth



Figs. 2.29 and 2.30 After arranging the anterior teeth, the vertical and horizontal overlap amounts can be arranged according to esthetics and phonetics

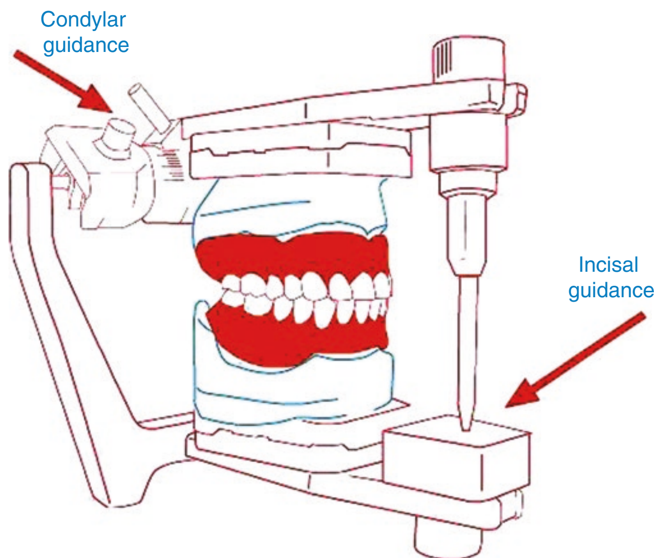


Fig. 2.28 Incisal guidance and condylar inclination are border control factors affecting cusp height

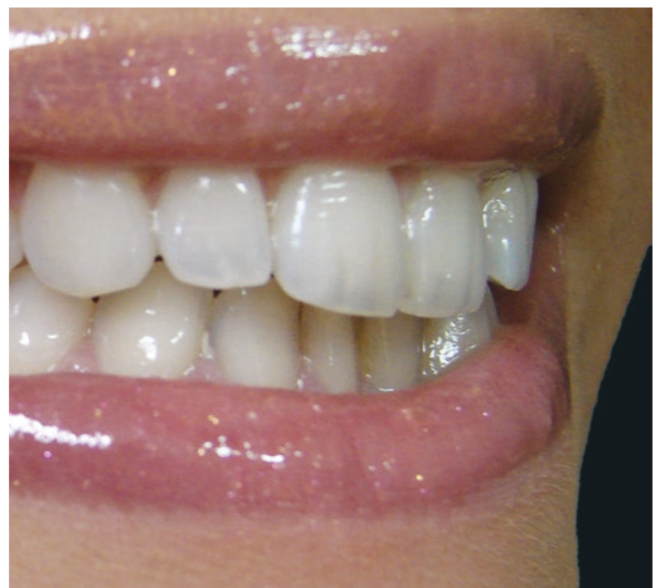


Fig. 2.31 Incisal guidance will be more when the vertical overlap is highest and horizontal overlap is smallest

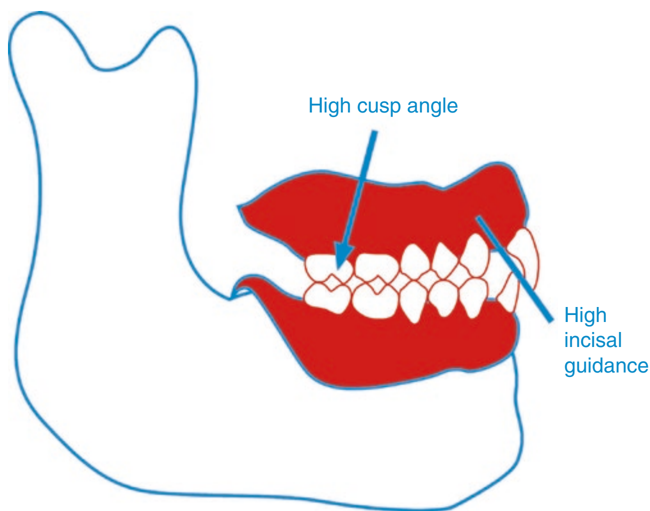


Fig. 2.32 Incisal guidance will be greater when the vertical overlap is highest and the horizontal overlap is smallest; therefore, to construct a balanced occlusion, the cusp heights should be increased

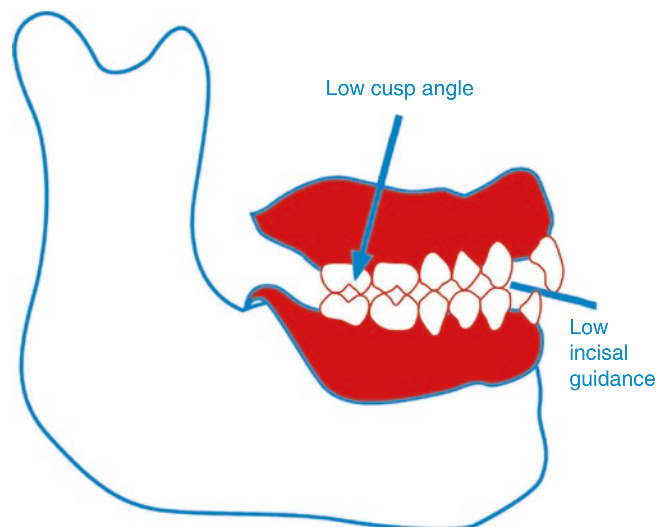
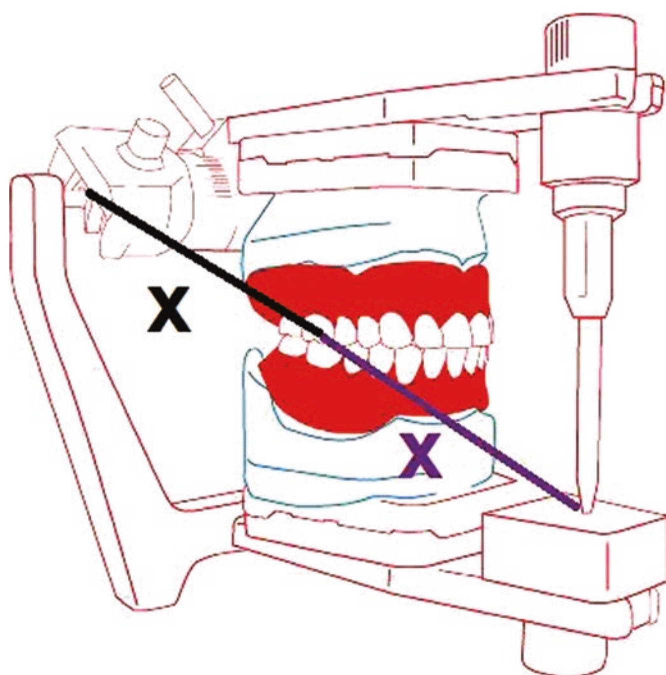
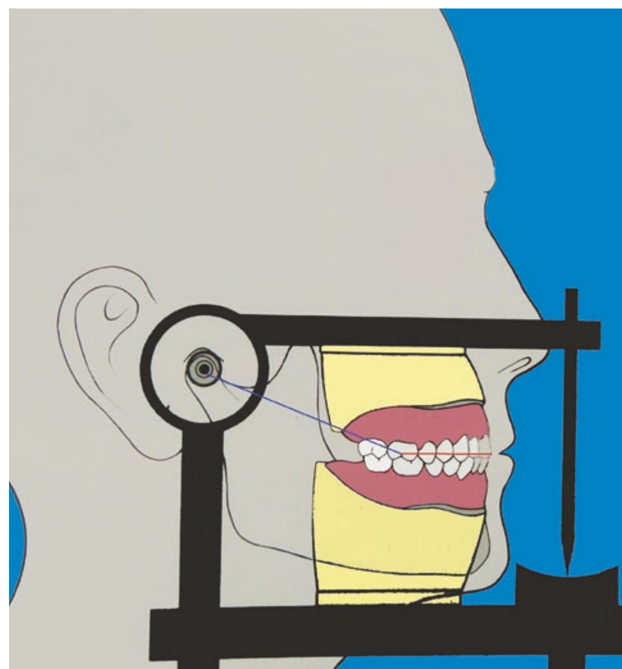


Fig. 2.33 The smallest height of cusps is needed when the vertical overlap is smallest and the horizontal overlap is highest





Figs. 2.34 and 2.35 In the articulator, the first molar is placed between the border control factors (incisal guidance and condylar inclination). It is approximately equal distance to each one

2.5.3.1 The Plane of Occlusion and Shape of the Arch

The suitable occlusal plane is determined by (1) esthetics, (2) occlusal function (as a Hanau rule), and (3) intraoral functional factors.

Esthetics is important because the posterior teeth are not visible if they are too high or too low. For example, when the upper posterior teeth are too low, the denture looks as if it is moving downward in the mouth (Fig. 2.40a, b). The occlusal plane should be leveled from one side of the arch to the other (Fig. 2.41a, b). If the teeth are high on one side of the arch, an unaesthetic appearance will occur (Fig. 2.42). To balance the occlusion, the plane of occlusion is important in increasing the posterior cusps height. As noted earlier, the plane of

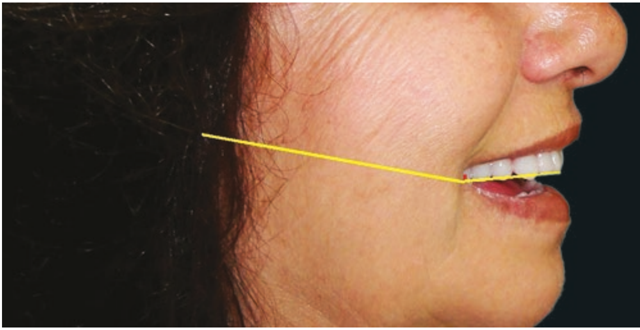


Fig. 2.36 Condyle-first molar distance is longer than first molar-incisal guidance distance because there is no incisal pin and anterior teeth provide guidance

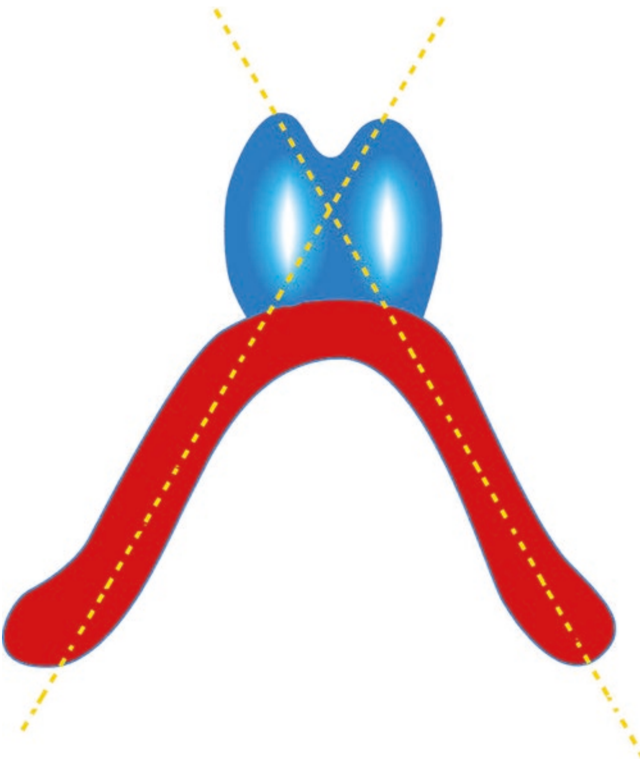


Fig. 2.37 Tooth arrangement is related to alveolar ridge form. The angle of the alveolar ridge should be in relation with the angle of the anatomic teeth

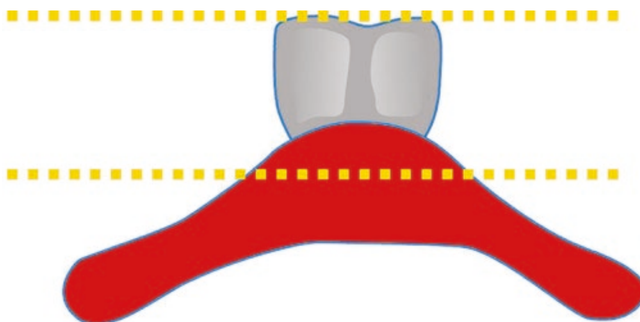


Fig. 2.38 In cases of resorbed alveolar ridge form, non-anatomic teeth should be used

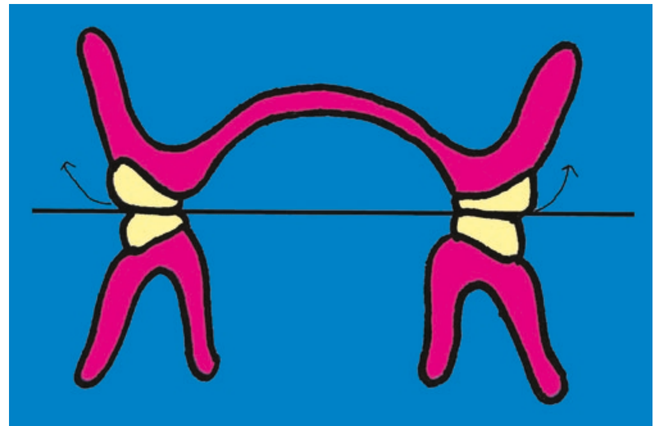


Fig. 2.39 Wearing of artificial teeth over time

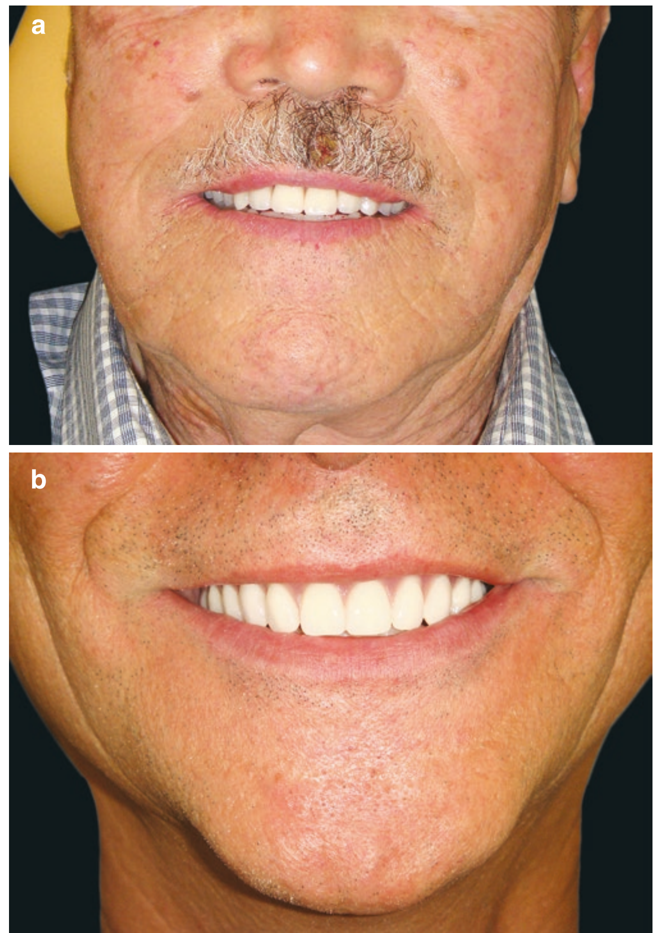


Fig. 2.40 (**a**, **b**) When the upper posterior teeth are too low, they do not have an esthetic appearance

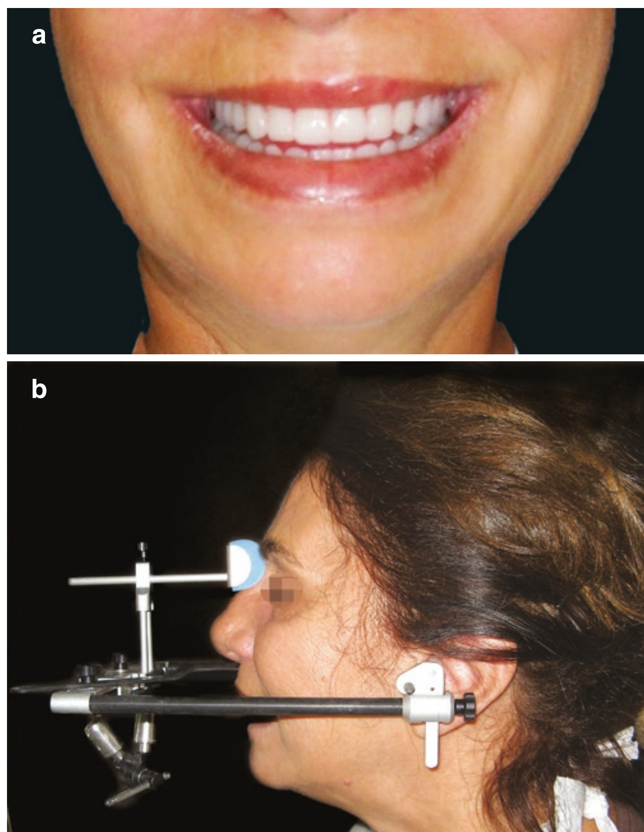


Fig. 2.41 (**a**, **b**) Esthetics is achieved when the occlusal plane is leveled equally with the other side of the arch

occlusion is one of the rules of Hanau. The primer relation of the occlusal plane is cheeks and tongue. The plane should be in a suitable position, so that, the tongue should move the food in a suitable position around the occlusal plane (Fig. 2.43). If the occlusal plane is so high, it will be difficult for the tongue to reverse the foods on the plane, so it will be difficult to chew.

The teeth should not be placed toward the lingual side to avoid interfacing with the tongue. This situation cause to decrease denture stability and make the patient uncomfortable. The arrangement of the lingual cusps in a triangular area as shown in Figs. 2.44a, b, and 2.45 provides good guidance. The mobility of the denture according to the tissue resilience is an important factor that effects the posterior teeth arrangement.

In many complete denture patients, the arrangement of the posterior teeth should be made in a cusp-fossa relation. In normal complete denture cases, the upper palatinal cusps are in contact with the antagonist mandibular teeth central fossa. This situation is not applicable to the premolar area where the buccal cusps of the mandibular premolar are in relation with the mesial of its upper antagonist (Figs. 2.46a, b, and 2.47).

Chewing efficiency and suitable occlusal balance are provided by at least three couple of antagonists on both sides of the jaw. To obtain balanced articulation, anterior teeth should have 1 mm distance before the contact in protrusive and lateral movements. The premature contacts of these teeth in lateral and protrusive movements cause excess loading of the alveolar residual ridge and therefore loss of stabilization.

2.6 Anatomic Tooth Arrangement in the Class I Relation

If the alveolar residual ridge is in suitable form and the maxillo-mandibular relation is normal, two premolars and two molar teeth are arranged in normal occlusion in each quadrant (Figs. 2.46 and 2.48). The maxillo-mandibular relation is evaluated as good, when the two arches are parallel to each other in sagittal and frontal horizontal planes and when the angle between the line which joint the upper and lower alveolar residual ridge and the occlusal plane is more than 80° (Fig. 2.49).

2.6.1 Anatomic Tooth Arrangement to Obtain Balanced Occlusion

To arrange the posterior teeth, it will be useful to draw some areas on the model for guidance. These areas are the tip of the alveolar residual ridge (posterior teeth are set on the alveolar residual ridge), retromolar pad, the two thirds of the height of the retromolar pad, and the incisor edge of the lower central incisor (Fig. 2.50a, b).

A few rules should be taken in consideration to arrange posterior teeth. These are:

1. The lingual part of the lower teeth should be set inside the two lines which elongate from the mesial of the lower canine toward both sides of the retromolar pad (Fig. 2.44a; Fig. 2.45).
2. The occlusal plane of the lower jaw should be located on the two thirds of the height of the retromolar pad (Fig. 2.50b).
3. The teeth should not be set on the inclination of the lower alveolar ridge or retromolar pad; otherwise, the mandibular denture will slide forward (Fig. 2.12a, b).
4. The central fossa of the teeth should be located on the tip of the alveolar ridge (Fig. 2.26b).
5. The long axis of the teeth is positioned perpendicular to the occlusal plane.
6. The marginal edge of the adjacent teeth should be on the same level.
7. The buccal and lingual cusps should be in contact with the occlusal plane.

Fig. 2.42 If the tooth arrangement is high in one side of the arch, it should be corrected

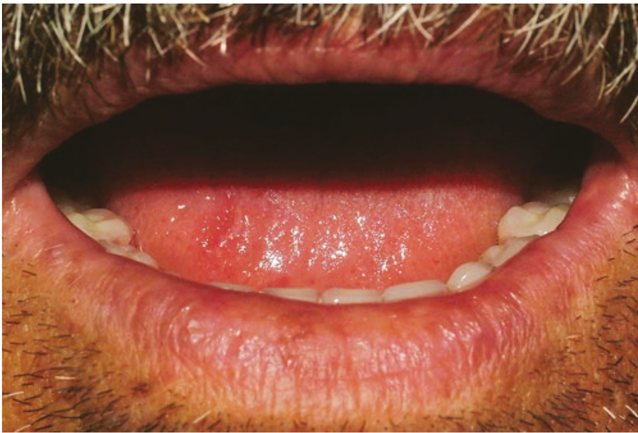


Fig. 2.43 Proper position of occlusal plane

8. The Wilson and Spee curves should be adjusted to obtain balance.
9. The maximum intercuspal position should be obtained with the antagonist teeth.

Different books make different comments about the posterior teeth arrangement. As a result, the important to note how the teeth are arranged, not the sequence of the tooth arrangement, and the criteria that are reported should be applied for all the teeth arrangements. In this section, there is a description showing how the teeth should be arranged in a simple manner. This is a classical arrangement and the dentist can modify this arrangement by angulating the cusps inclinations.

The Arrangement of the Upper Posterior Teeth (Fig. 2.46a, b)

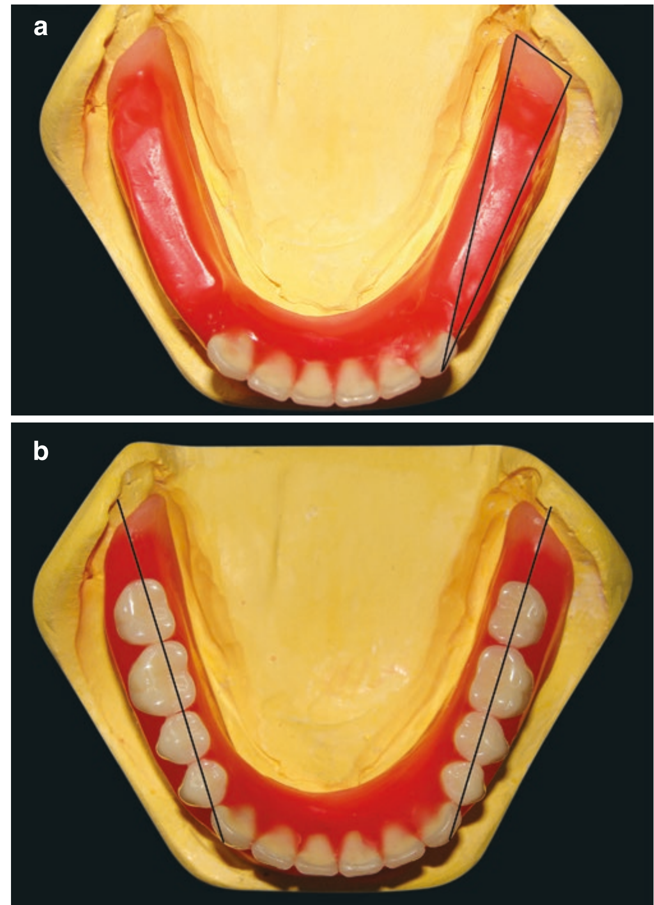


Fig. 2.44 (**a**, **b**) Arrangement of lingual cusps in triangular area

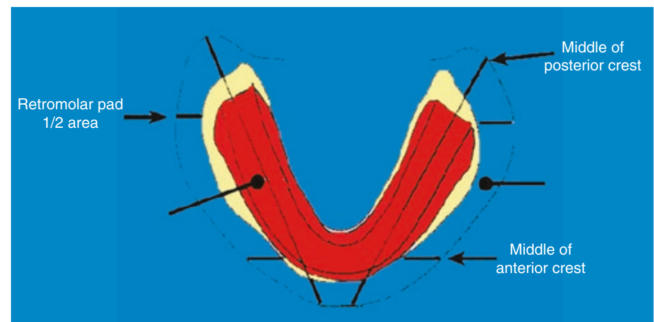


Fig. 2.45 Arrangement of lingual cusps in triangular area

2.6.1.1 Upper Premolar

(a) Premolars are set perpendicular to the occlusal plane.
(b) When the buccal cusps of the upper first premolar are in contact with the occlusal plane, the lingual cusps are approximately 0.5 mm above the occlusal plane.
(c) Buccal cusps of the first premolar are set at the embrasure of the mandibular first and second premolar (Fig. 2.51a).

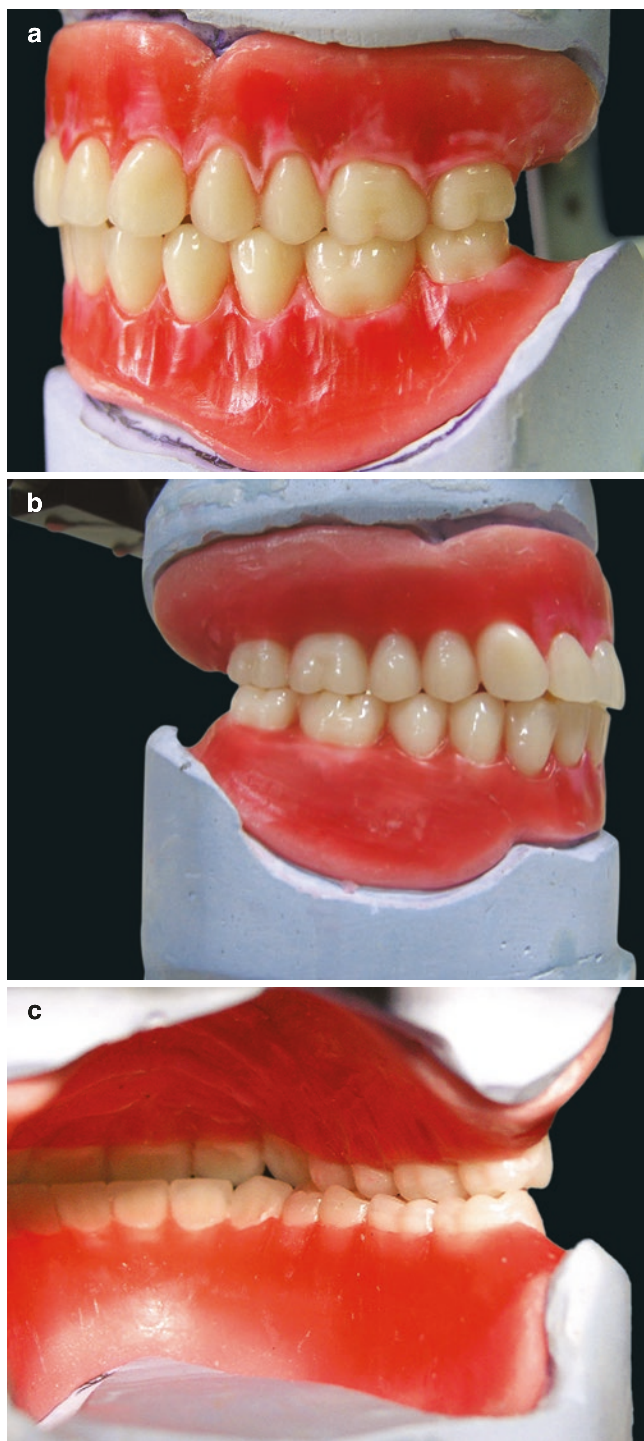


Fig. 2.46 (**a**, **b**) Arrangement of posterior teeth according to tubercle-fossa relations

(d) Buccal and lingual cusps of the upper second premolars are in contact with the occlusal plane; the lingual cusps of the upper first and second premolar should be on the tip of the residual alveolar ridge (Fig. 2.51b).

(e) Palatinal functional cusps of the upper premolar are in contact with the antagonist tooth's marginal edges.

2.6.1.2 Upper Molars

The inclination of the upper molars toward the mesial and slightly to the lingual forms an upward inclination of 6 degrees, the mesiolingual cusp of the upper first molar is in contact with the occlusal plane and lingual cusps are located on the lower alveolar residual ridge, and mesiobuccal cusps of the upper first molar are set in the buccal sulcus of the lower first molar and its mesiolingual cusps set at the central fossa of the lower first molar. Neither of the upper second molar cusps is in contact with the occlusal plane. While the buccal cusps of the upper teeth form a slight inclination, its lingual cusps are similar; however, they form an inclination that is located 0.5 mm lower. Using a plane, the contact of the canine, premolars, and mesiobuccal cusp of the upper first molar with this plane is checked. The distobuccal cusp of the upper first molar is not in contact. While controlling the buccal inclination of the upper posterior teeth, the four cusps of the upper molars are in contact, but the premolars are not.

2.6.2 Arrangement of Mandibular Teeth

To begin with, the lower molar tooth is set in centric occlusion, the mesiobuccal cusp of the upper first molar is set in the buccal sulcus of the lower lingual cusp, and the mesiolingual cusps of the lower first molar are set at the central fossa of the upper first molar. The functional disto-palatinal cusp is in contact with the marginal edge of its antagonist tooth, and when looking from the buccal side, the mesiobuccal cusp of the upper first molar makes a pointed contact toward the mesiobuccal fossa of the antagonist tooth. The lower second molar is set. The mesiobuccal cusp of the upper second molar is set to the buccal sulcus of the lower second molar (Fig. 2.52a, b). The functional mesio-palatinal cusp is in contact with the central fossa of the lower second molar. The functional disto-palatinal cusp is in contact with the marginal edge of its antagonist tooth. The lower second premolar is set. The tip of the cusp is set at the embrasure of the upper first and second premolar. The functional cusps of the lower teeth are in contact with the marginal edge of the upper premolar; the last tooth is to be set is the lower first premolar. It is set to the embrasure of upper canine and first premolar. The lower premolars follow the canine's curvature (Fig. 2.46a, b).

When looking from the occlusal side, the central fossa of the lower posterior teeth should be located on the alveolar residual ridge. The lingual border of the posterior tooth arrangement is called as the line of Pound (Pound's line is

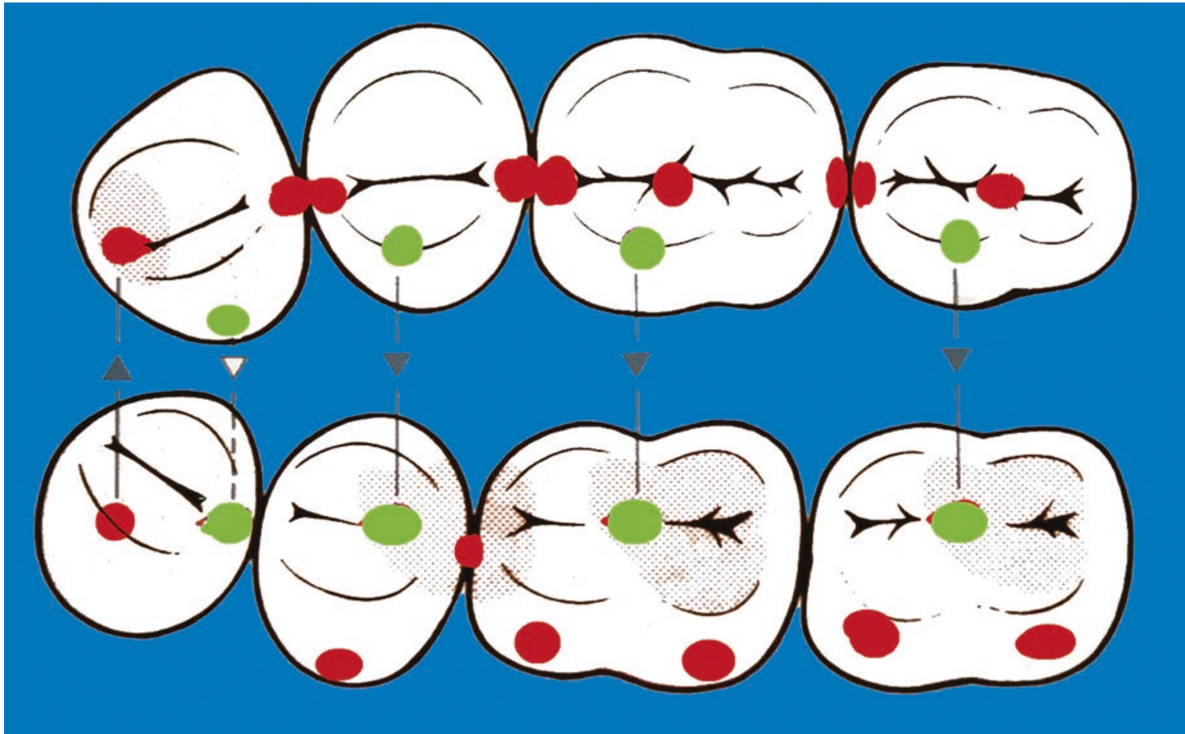


Fig. 2.47 Arrangement of posterior teeth according to tubercle-fossa relations

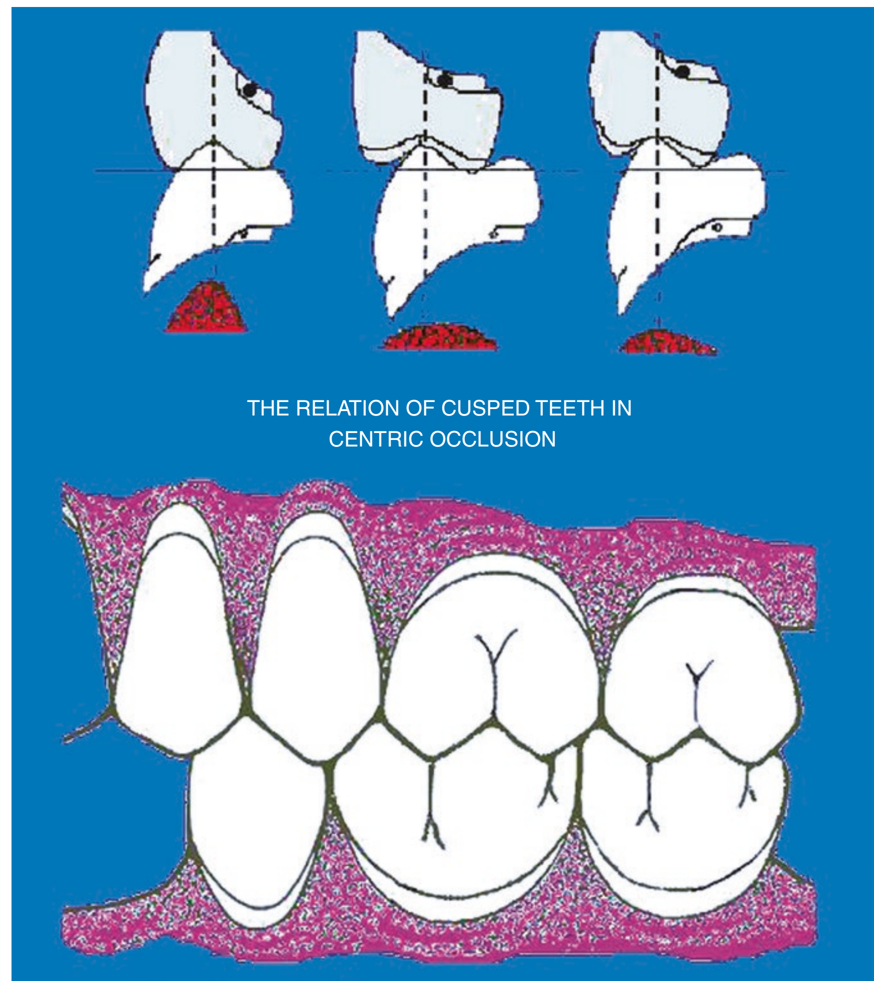


Fig. 2.48 If the alveolar residual ridge is of a suitable form and the maxillo-mandibular relation is normal, two premolars and two molar teeth can be arranged in normal occlusion in each quadrant

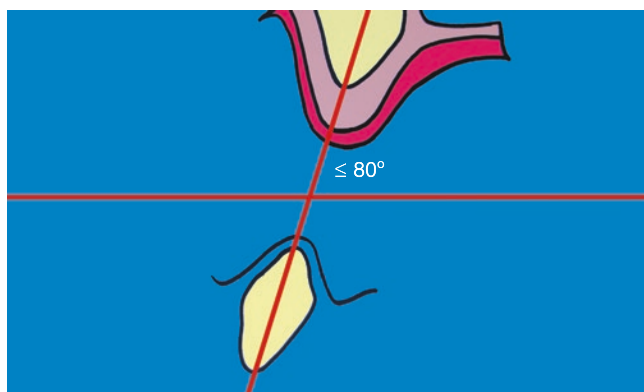


Fig. 2.49 The maxillo-mandibular relation is evaluated as good when the two arches are parallel to each other in sagittal and frontal horizontal planes and when the angle between the line that joins the upper and lower alveolar residual ridge and the occlusal plane is more than 80°

called to be the one that forms the triangle between the mesial edge of the lower canine and the lingual border of the same side) (Figs. 2.44a, b, 2.46, and 2.53). It shows the tooth arrangement in normal occlusion.

2.7 Crossbite Occlusion

The crossbite tooth arrangement is indicated when there is a suitable alveolar ridge contour and parallel alveolar ridge in the sagittal plane, but when there is no harmony between upper and lower alveolar ridges in the horizontal plane (Fig. 2.54).

In crossbite, a normal arrangement should be done because first premolars are not affected. Lower second premolar is set with vestibular tilting; the two distal fossae are grinded to contact with the antagonist buccal and lingual cusps. In the molar area, lower lingual and upper buccal cusps function as supporting cusps. The palatal cusps of the upper posterior teeth are set lower than the buccal cusps and provide the occlusal surface to be tilted lingually. Contrary to Monson arrangement, the crossbite arrangement provides more effective chewing by following the habitual path in lateral movements (Figs. 2.55, 2.56, 2.57, 2.58, 2.59, 2.60, and 2.61).

2.8 Tooth Arrangement According to Lingualized Occlusion

The lingual cusps of the upper teeth move in all directions freely. Therefore, this occlusion has the advantages of both anatomic and non-anatomic teeth. The patient, as the anatomic teeth, is not locked in centric position. The centric contacts that are formed at the palatinal cusp of the upper teeth are formed at the central fossa of the lower teeth. The

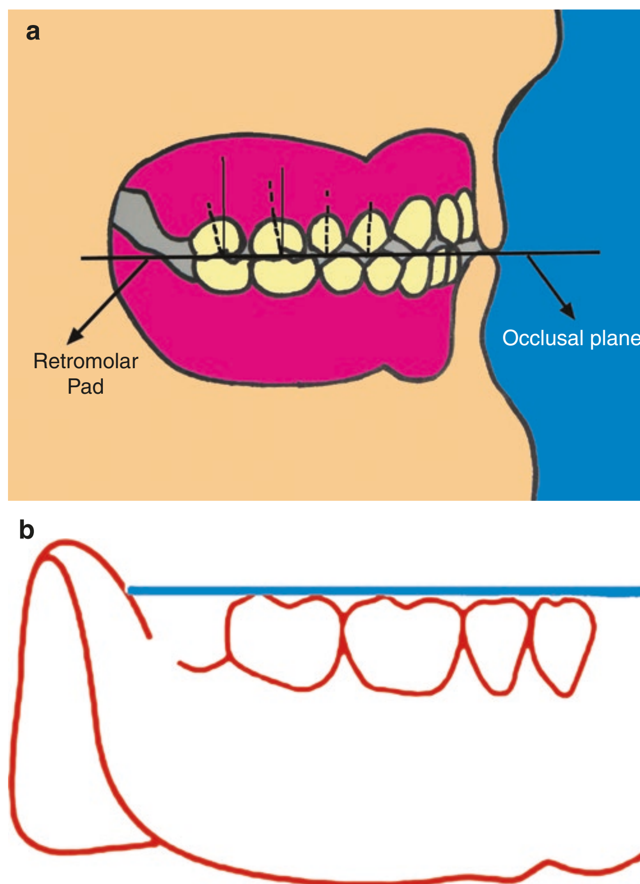


Fig. 2.50 (**a**, **b**) Relationship between occlusal plane and retromolar pad

buccal cusps should be out of contact (Fig. 2.62). Therefore, teeth contribute to the support of the cheeks (Fig. 2.62). It is possible to make 1:2 tooth arrangement according to the occlusal position and anterior teeth arrangement.

2.8.1 Posterior Tooth Arrangement: Mandibular Jaw

The posterior teeth are arranged with the help of the tooth arrangement table. The first step is to locate the tooth arrangement table by adjusting, the height of the retromolar third pad in the posterior side and, the height of the distal inclination of lower canine in the anterior side. The specialty of this tooth arrangement is that the buccal cusps are not in contact with occlusal table (Fig. 2.63).

The central fossae of the lower teeth are located on the tip of the alveolar residual ridge. When looking from the lingual side, lower posterior teeth should not pass to the Pound's line. When looking from the buccal side, the vertical axes of the posterior teeth should be perpendicular to the tooth arrangement table.

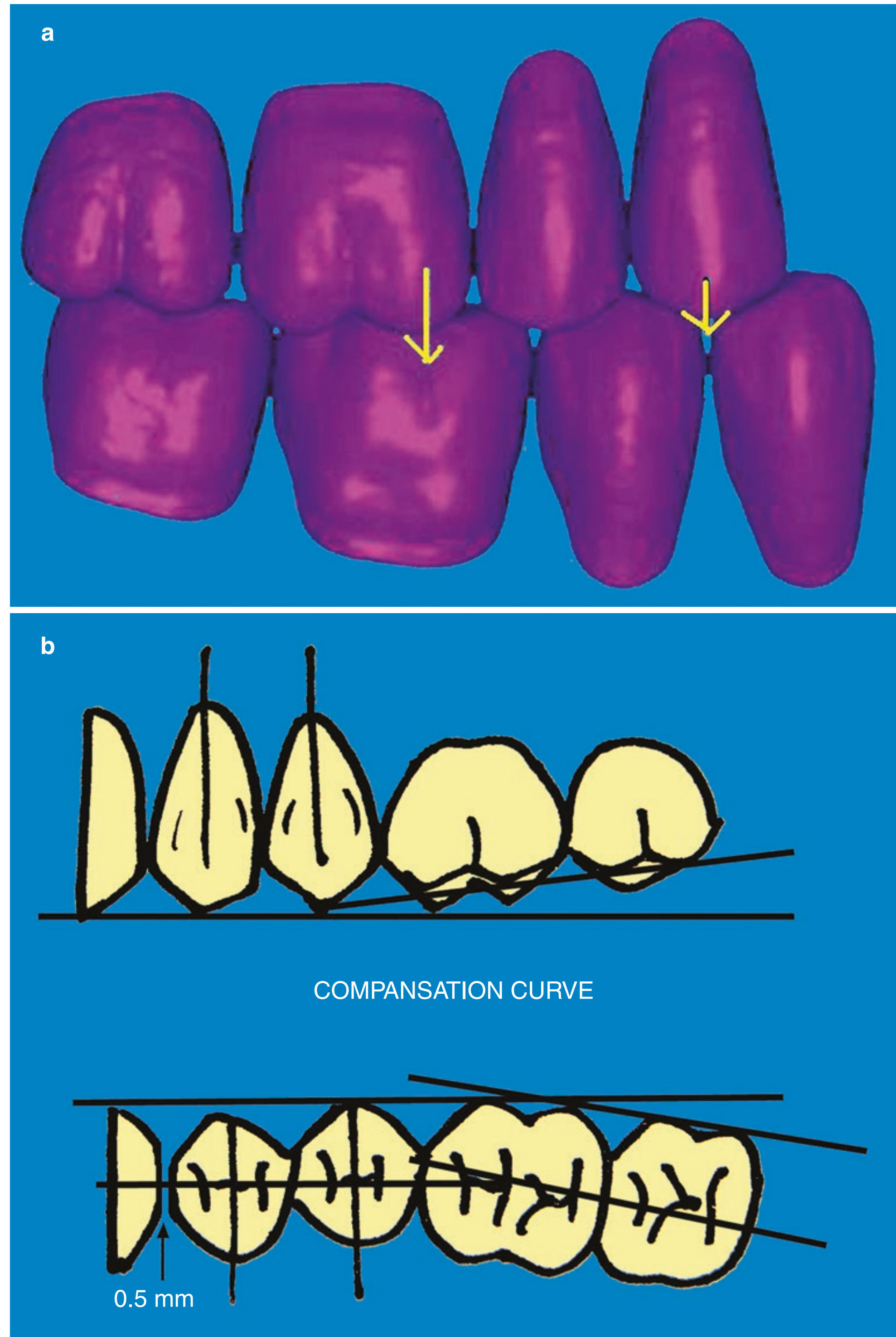


Fig. 2.51 (**a**) The buccal cusps of the first premolar are set at the embrasure of the mandibular first and second premolar. (**b**) The relationship of upper and lower teeth with the occlusal plane

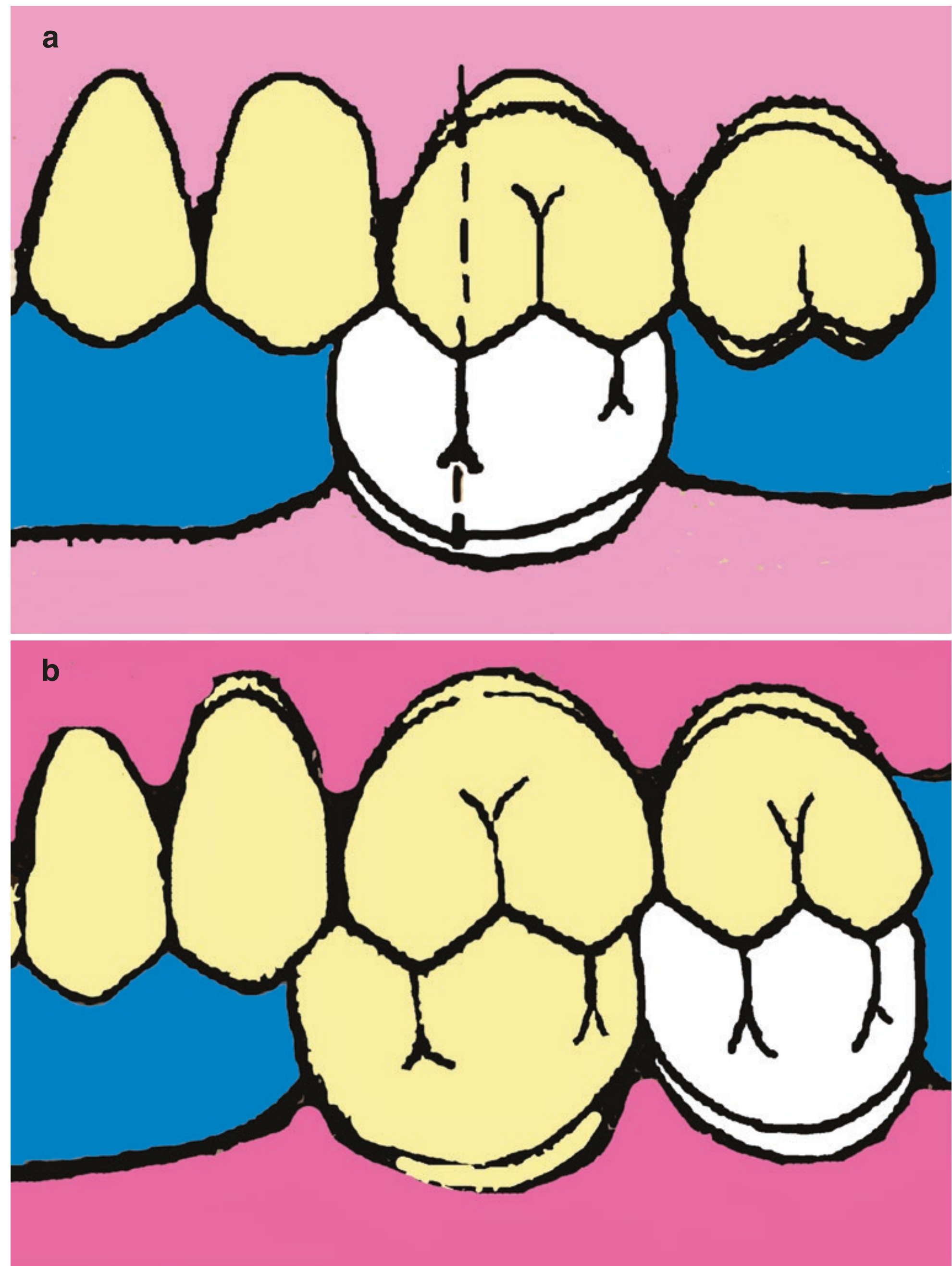


Fig. 2.52 (**a**, **b**) Arrangement of lower molars

2.8.2 Posterior Tooth Arrangement: Maxillary Jaw

To obtain optimum cusp relation, the upper teeth are set with lower teeth in a one-to-one tooth relationship (Fig. 2.64).

2.8.2.1 First Premolar

The buccal cusps of the lower first premolar should be in contact with the central fossa of the upper first premolar to obtain esthetic transition from canines and to help the formation of the buccal corridor.

2.8.2.2 Second Premolar

The palatinal cusp of upper premolar is in contact with the fossa of the lower premolar.

2.8.2.3 First Molar

Usually, the lower first molar is located in the lowest part of the alveolar ridge. The lingual cusps of the upper molar form the static chewing center.

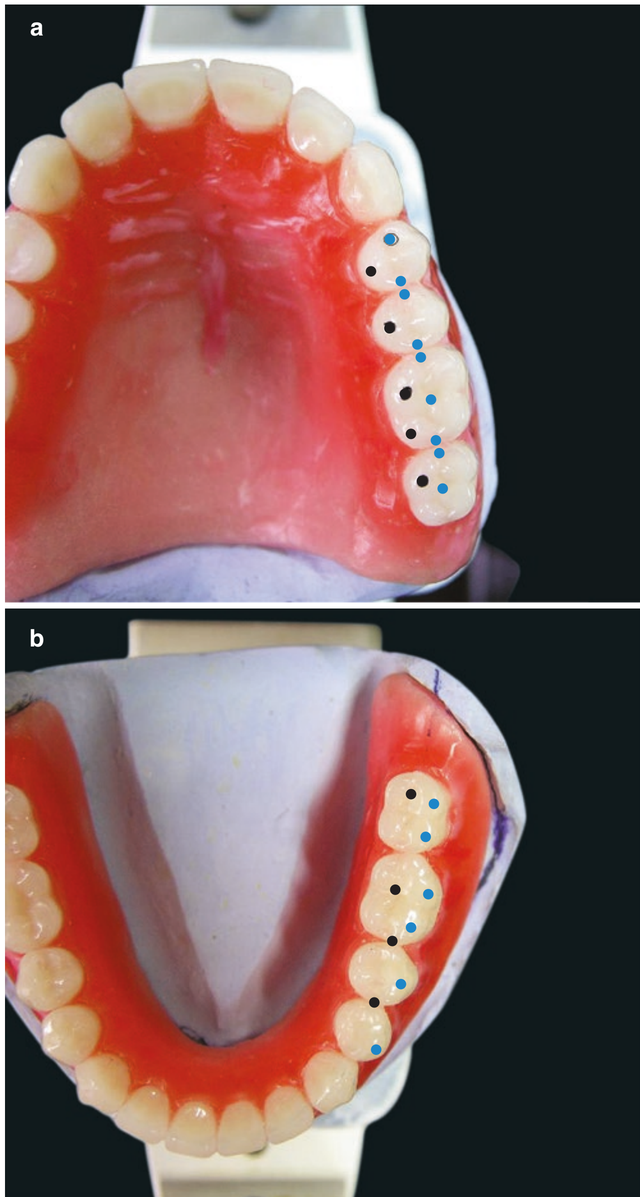


Fig. 2.53 (a, b) Upper and lower tooth centric occlusion contacts

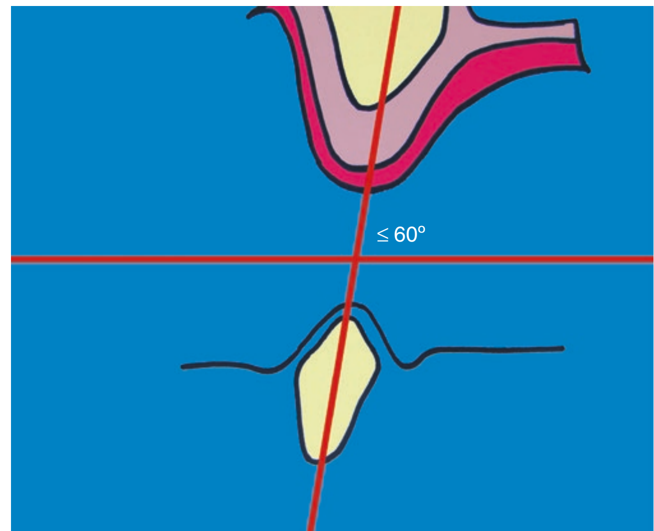
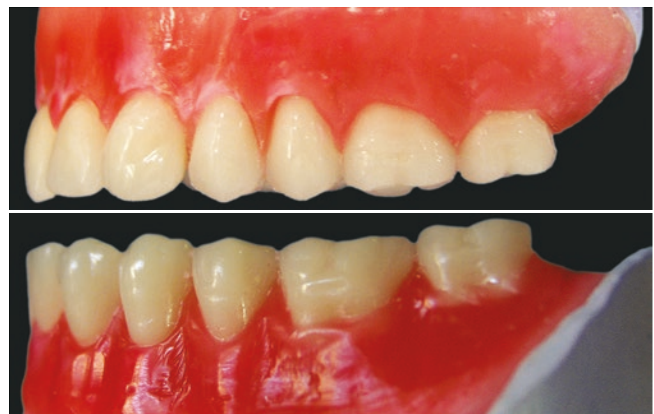


Fig. 2.54 Crossbite tooth arrangement is indicated when there is no harmony between the upper and lower alveolar ridges in the horizontal plane



Figs. 2.55 and 2.56 Harmonious appearance of upper and lower jaws

2.8.2.4 Second Molar

The inclination of the buccal cusps of the tooth is lying according to the Monson line (Figs. 2.65, 2.66, 2.67, 2.68, 2.69, 2.70, 2.71, and 2.72).

2.9 The Sphere of Monson and Reversed Occlusion

In the occlusal scheme of the curve of Monson or the reversed curve (anti-Monson), the cusp-fossa relation is the same with the normal occlusal arrangement. To compensate the abnormal alveolar ridge cases, sometimes the occlusal surface of the teeth can be tilted, and the normal arrangement can be modified. When the upper jaw is smaller than the lower jaw, it is preferable to arrange the teeth in Monson curve in order not to narrow the tongue cavity. In these cases, to form occlusal surface tilted lingually with Monson curve (concave), a more stable denture base during chewing is provided (Figs. 2.73, 2.74, and 2.75).

If the alveolar residual ridge is placed lingually and the area under the denture base is inclined on the vestibular side, the occlusal inclination should be prepared reverse (convex) (Figs. 2.76, 2.77, and 2.78).

During the non-functional movements, it is desired to provide bilateral balance in Monson sphere and cross inclination because the balancing or working cusp inclinations are prepared very shallow. Only, the vertical chewing strokes are possible.

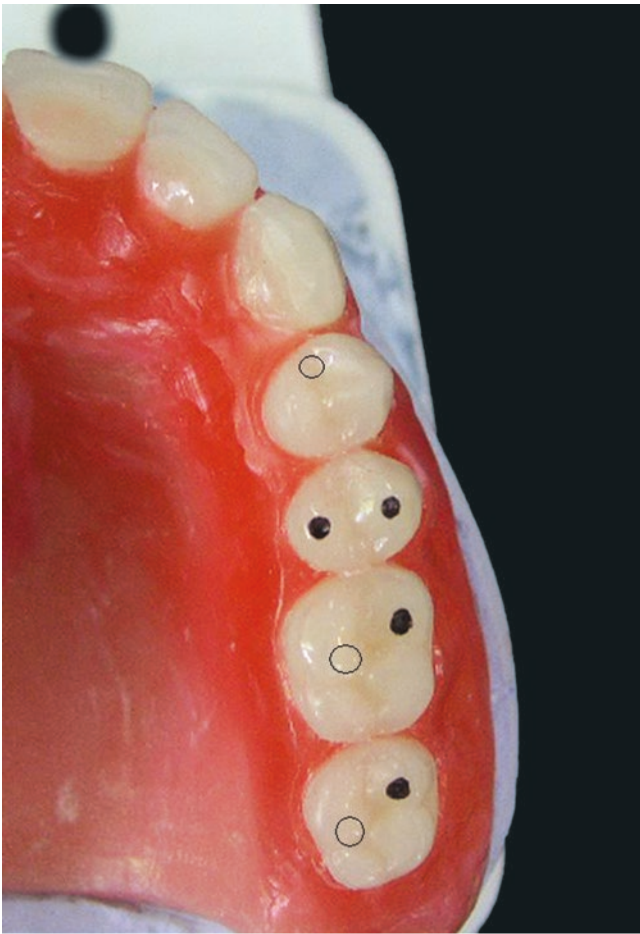


Fig. 2.57 Mesial fossa of first premolar is directly on crest line (normal position). Molars are arranged according to crossbite

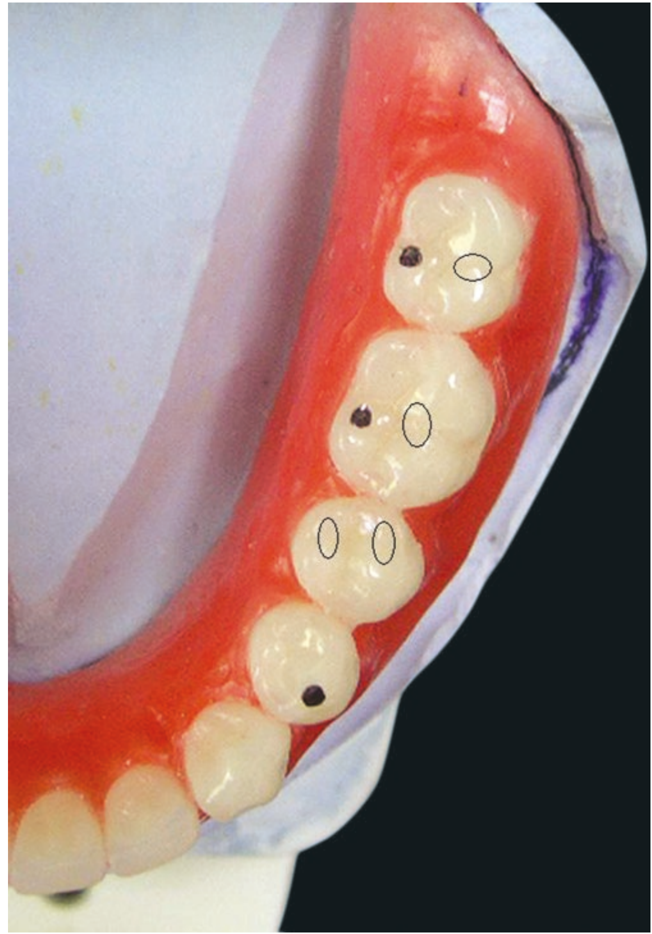


Fig. 2.58 Occlusal appearance of mandibular posterior teeth: Buccal cusp tip of mandibular first premolar is placed directly on the crestal line (normal position). An additional fossa is prepared on the second premolar (transitional position). Lingual cusps of the molars are the functional cusps (crossbite position)

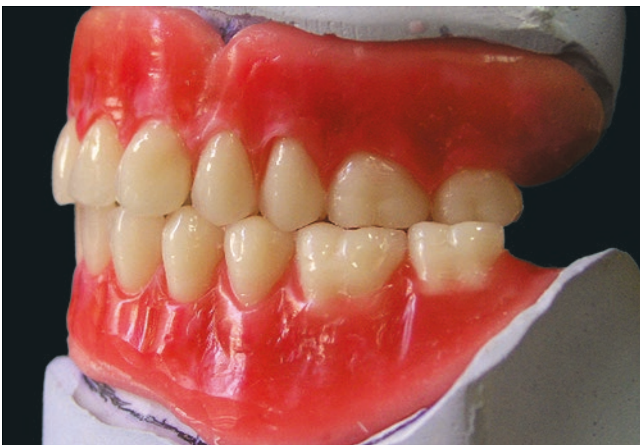


Fig. 2.59 Facial appearance of crossbite occlusion

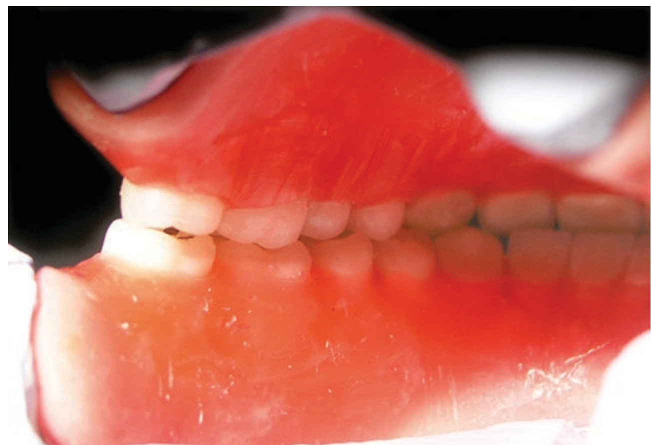


Fig. 2.60 Lingual view of tubercle-fossa relations. The first premolar is in the normal position, while the second premolar is in transition and the molars are in the reverse position

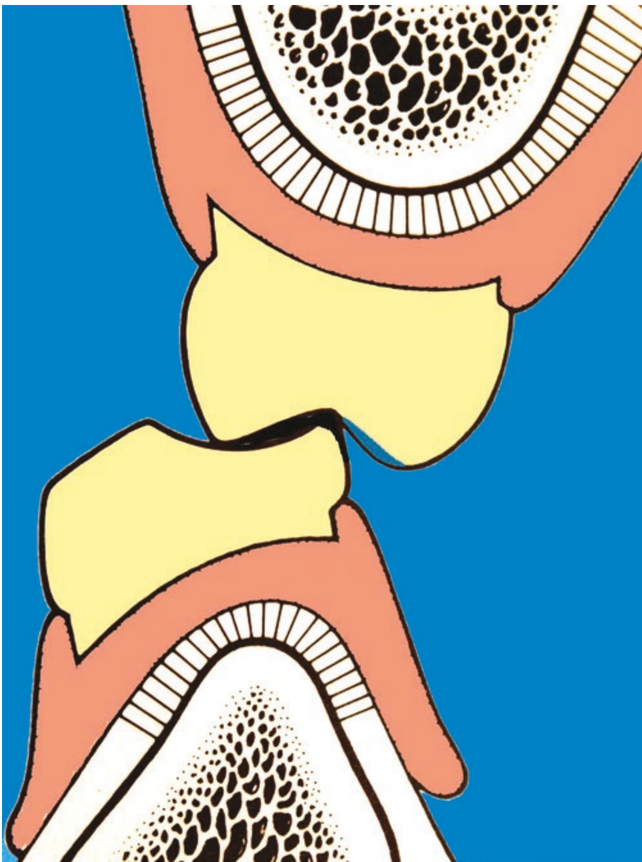


Fig. 2.61 Crossbite's schematic drawing

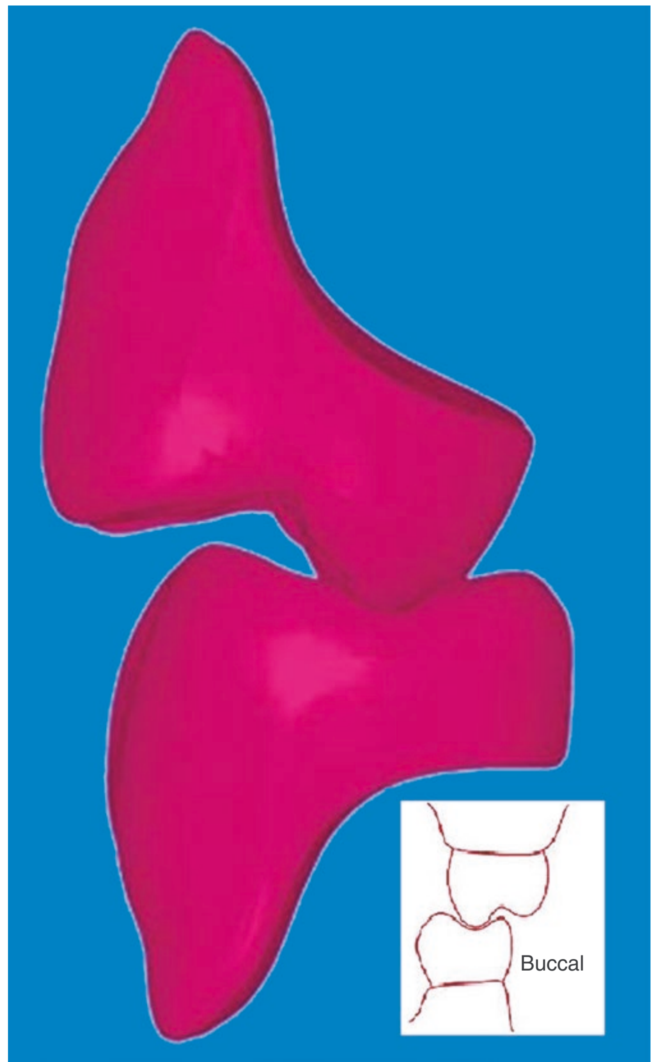


Fig. 2.62 The centric contacts which are formed at the palatinal cusp of the upper teeth are formed at the central fossa of lower teeth

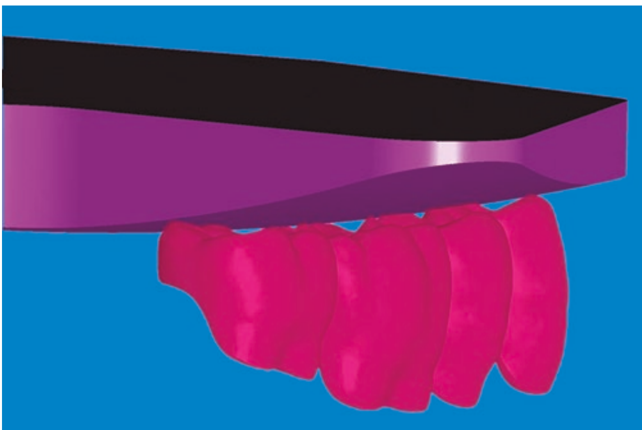


Fig. 2.63 The characteristic of lingualized occlusion is that the buccal cusps are not in contact with the occlusal table

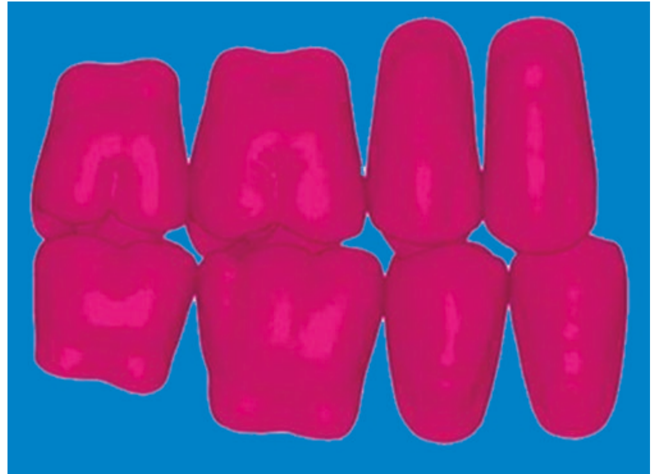
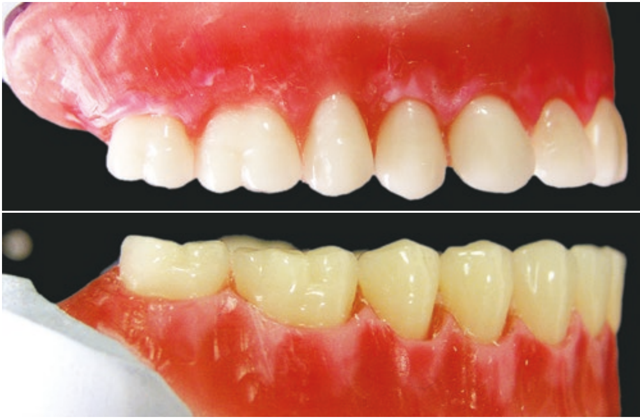


Fig. 2.64 To obtain optimum cusp relation, the upper teeth are arranged in a one-to-one tooth relation with the lower teeth



Figs. 2.65 and 2.66 Harmonious appearance of maxillary and mandibular teeth

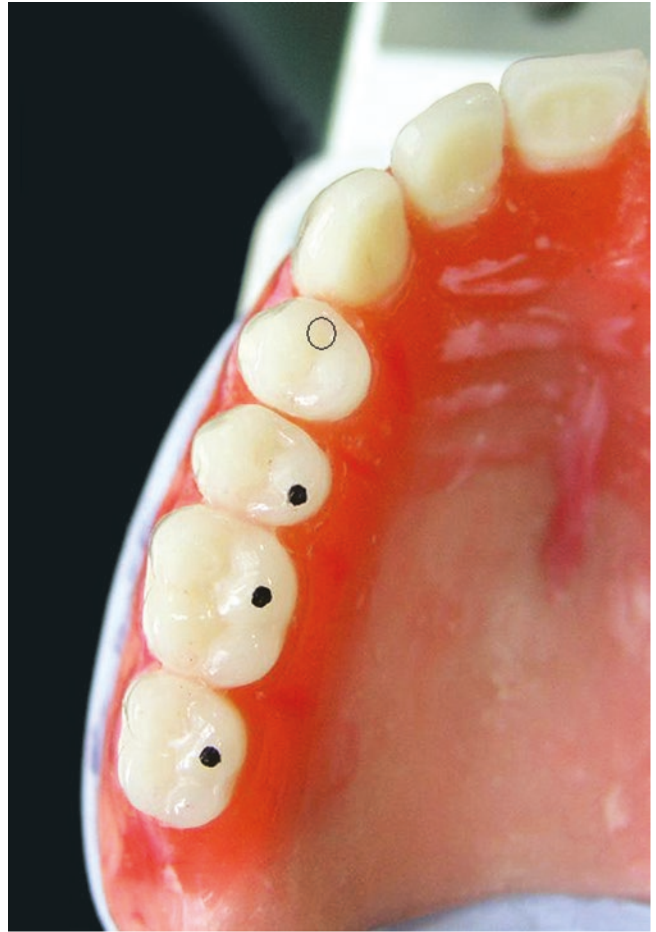


Fig. 2.68 The appearance of the maxillary teeth. Mesial fossa of the first premolar and palatal cusps (black spots) of the other posterior teeth are placed on the top or lingual of the crest as in the construction of a complete denture

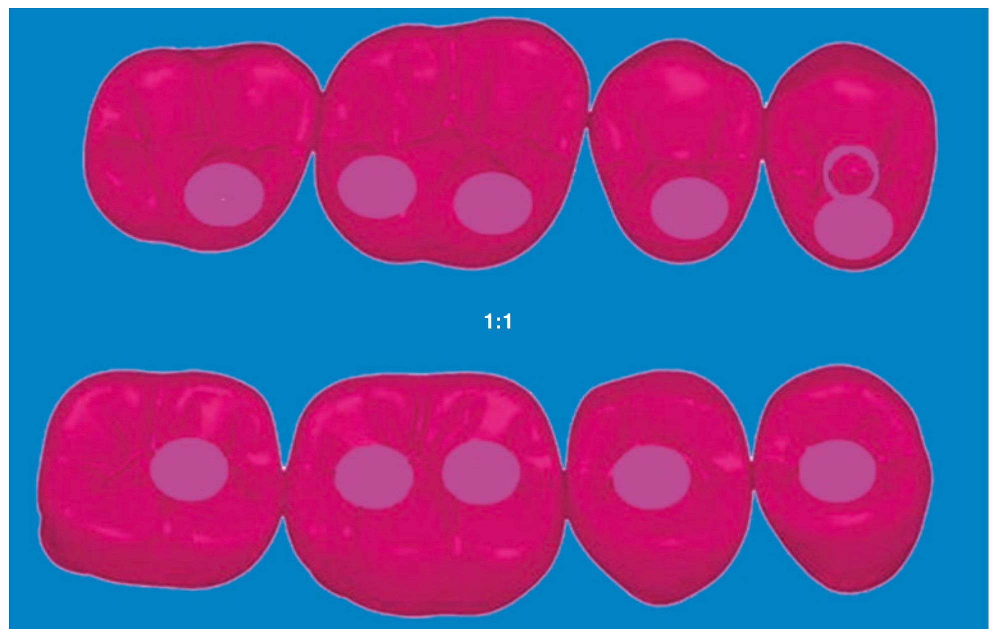


Fig. 2.67 Centric occlusal contacts of lower and upper teeth

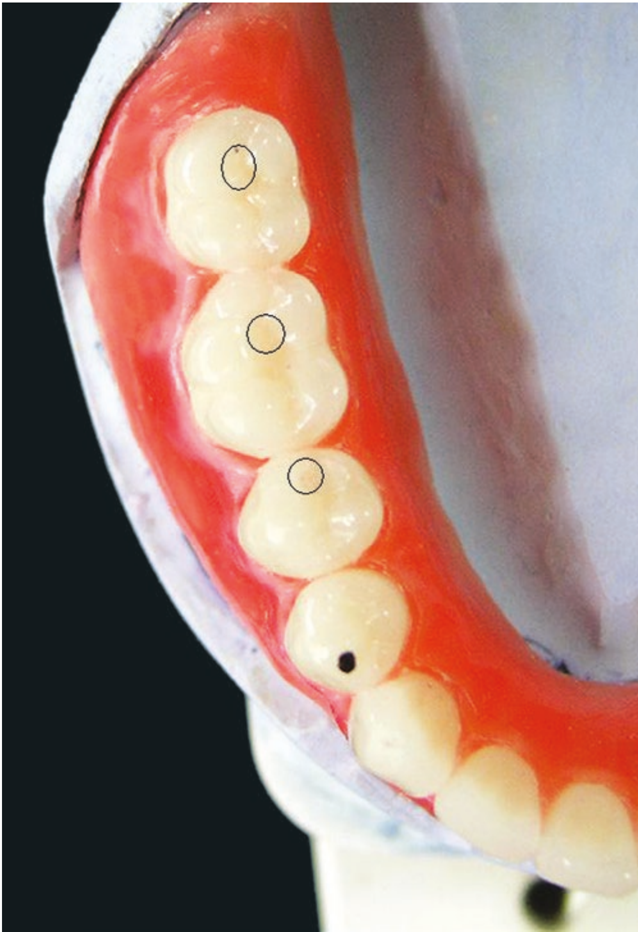


Fig. 2.69 The appearance of the mandibular teeth. Buccal cusp tips of the first premolar teeth are placed on the top of the crest. Fossa of the other posterior teeth shows a significant lingual placement

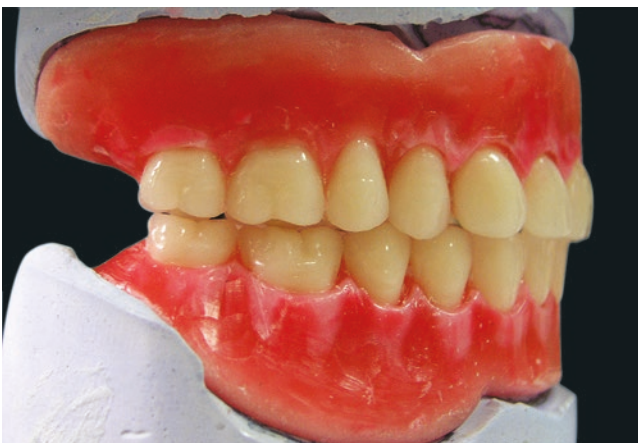


Fig. 2.70 Facial view of the teeth in occlusion. Maxillary second premolars and maxillary second molars are out of occlusion

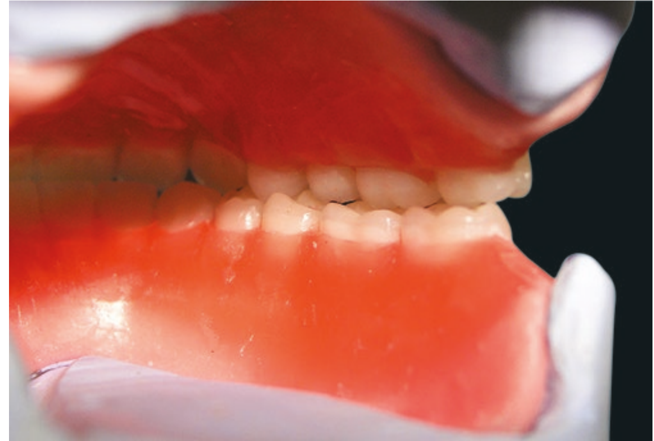


Fig. 2.71 Lingual view of cusp-fossa relationship

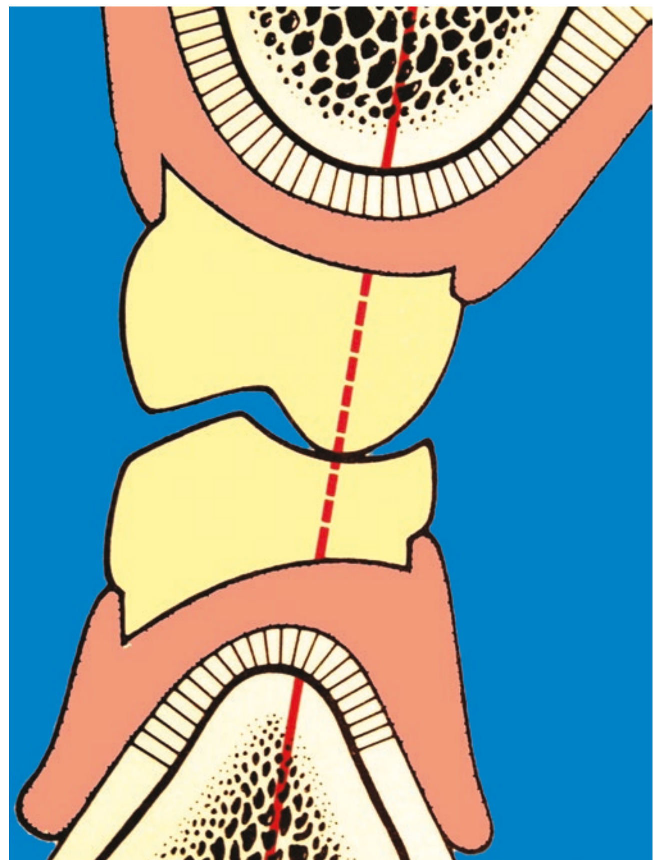


Fig. 2.72 Prominent lingual cusp-fossa relationship

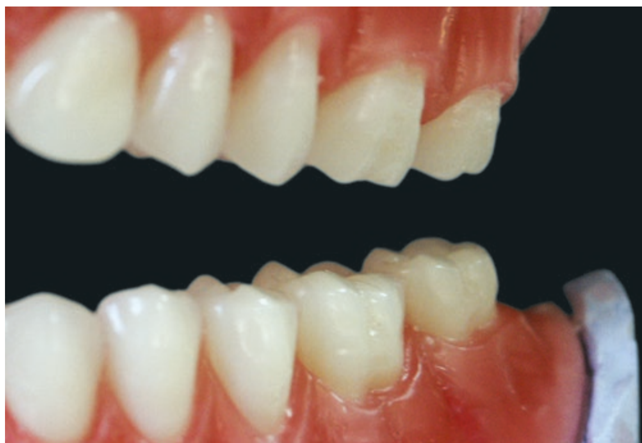


Fig. 2.73 Monson curve. If the maxilla is smaller than the mandibula, the tooth arrangement should be on the Monson curve

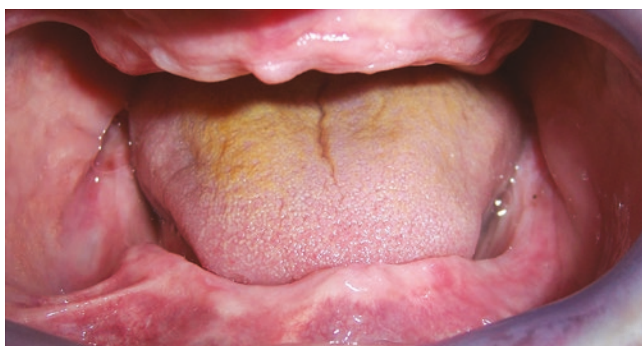


Fig. 2.74 Jaw relations with wide lower jaw arch. If the teeth are arranged in a crossbite relation, the tongue space will be narrower; therefore, a saucer-shaped occlusal plane is prepared (Monson curve)

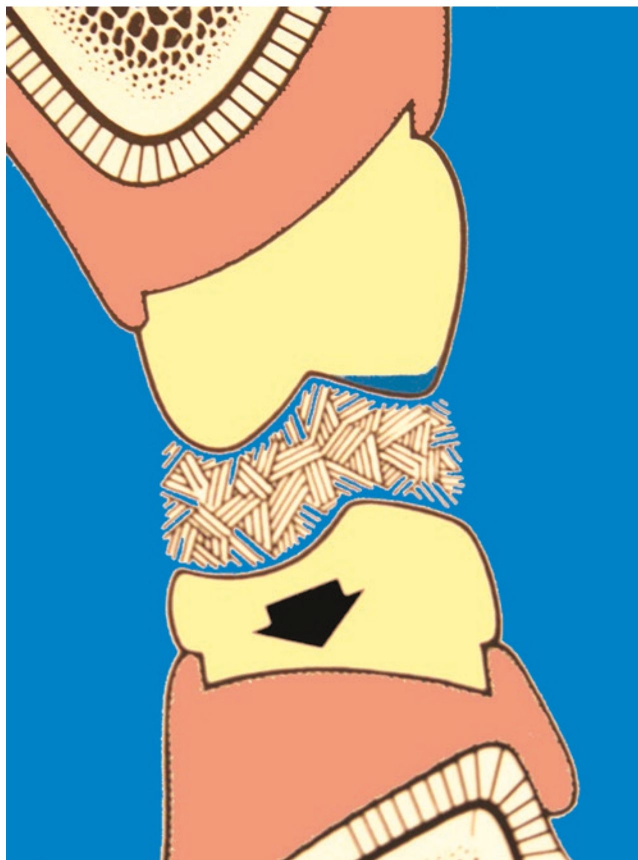


Fig. 2.75 Components of mastication forces that affect occlusal surfaces provide stabilization of the denture bases

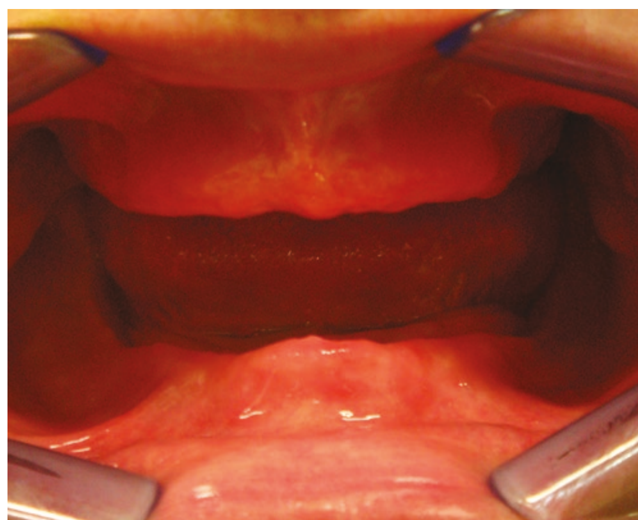


Fig. 2.76 Reverse occlusal curve. If the crest is localized lingually, occlusal surfaces of the lower posterior teeth should be inclined lingually to provide stability. This is only relevant when the patient has vertical chewing forces

2.10 The Arrangement for the Shortened Mandibular Dental Arch

The mandibular alveolar ridge may not be long enough length to place two premolars and two molars for each quadrant for providing stabile occlusion.

If the mandibula is shorter than normal and the ramus begins to rise more anteriorly than normal, the chewing forces that are coming on the molar cause a forward sliding movement on the loaded side. This is proven by the pressure area that occurs at the lingual side of the other canine.

In many cases, removing the lower second molar prevents the forward sliding movement. Otherwise, removing the first

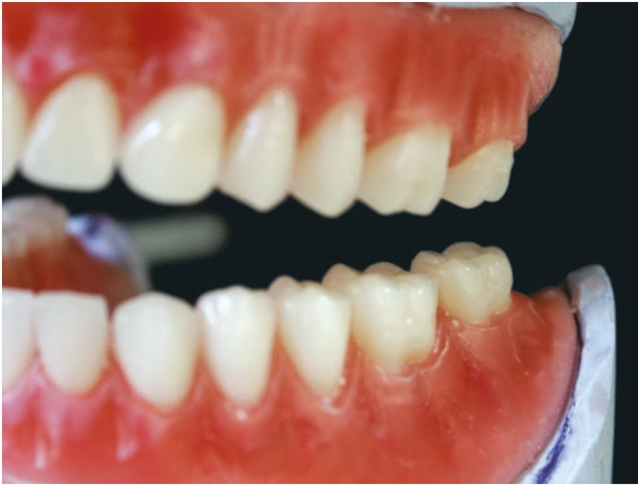
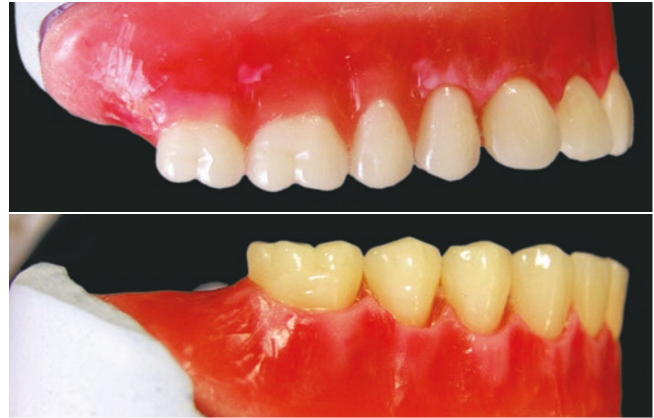


Fig. 2.77 Interarch relationship of the narrow mandibular arch. By preparing a reverse curve of Monson, the chewing forces are provided vertically



Figs. 2.79 and 2.80 Harmonious arrangement of upper and lower teeth. The mandibular arch is shorter than normal. A lower second molar is placed where the first molar would be

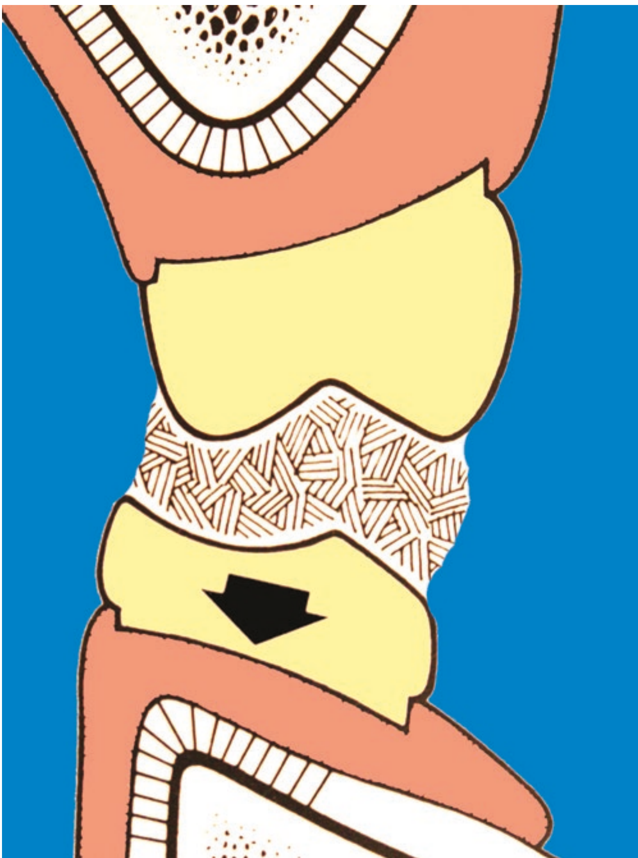


Fig. 2.78 Chewing forces affect the occlusal surfaces to help the stabilization of the denture base

molar and placing the second molar should be a second choice. The upper arrangements are not changed thinking that there is enough space. The maxillary second molar forms a rest for the tongue to obtain upper denture stabilization. Shortened dental arch should be used with cross-arch arrangement, concave or convex occlusal curve with modification of lingualized occlusion.

If there is still a forward sliding movement in the lower denture, in spite of the shortened dental arch, the teeth arrangement can be changed to provide that the patient is able to make chewing in chewing center. This situation is provided by placing the second molar to the second premolar area and forming the Spee curve by placing the antagonist first premolar to the distal of the second molar (Figs. 2.79, 2.80, 2.81, 2.82, 2.83, and 2.84).

2.11 Non-anatomic Tooth Arrangement

The non-anatomic tooth can be arranged as:

1. Increasing the occlusal plane to obtain balance (or giving inclination)
2. Single plane concept which invalidates all the balances
3. Straight occlusal plane with balanced inclination (or single plane)

The philosophy and the technique of each arrangement show variety, and this variety is related to different things.

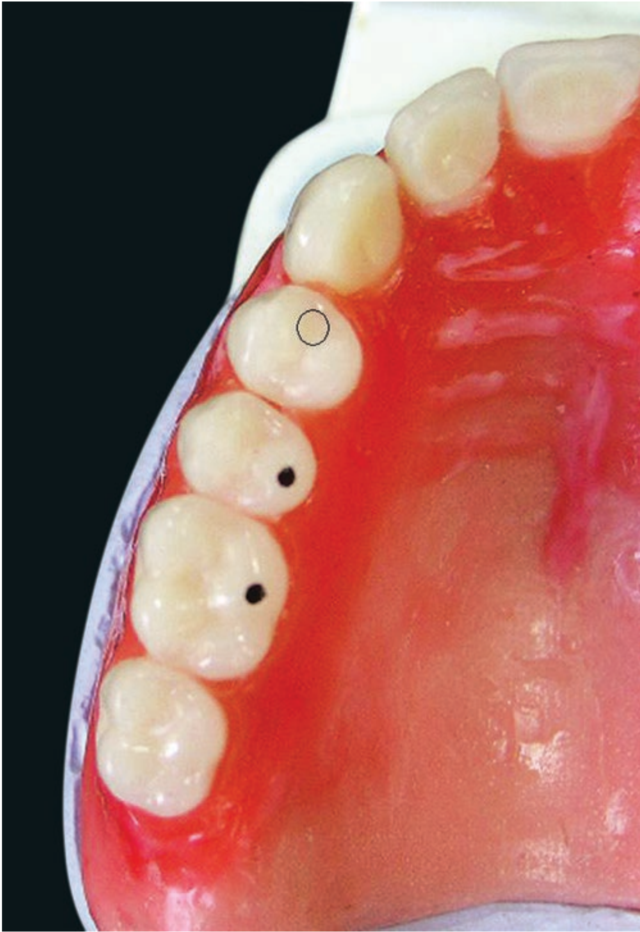


Fig. 2.81 View of upper teeth. The mesial fossa of the first premolar and the palatinal cusps of the second premolar and first molar should be on the alveolar crest or on the lingual side. The second molar has no antagonist

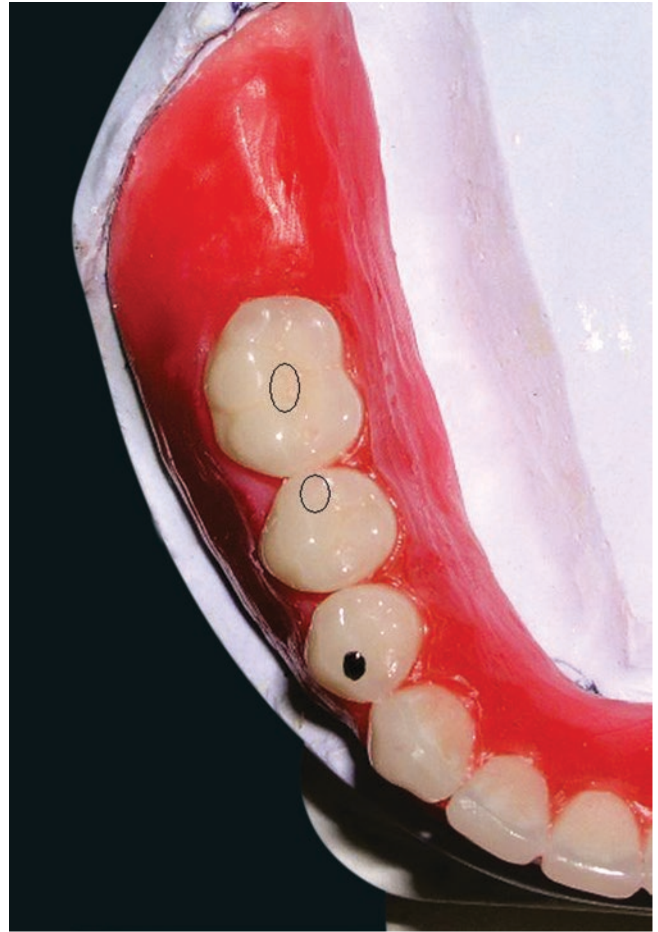


Fig. 2.83 View of lower teeth. The buccal cusp tip of the first premolar and the fossa of the second premolar and the second molar are placed over the crest. The first molar is removed intentionally

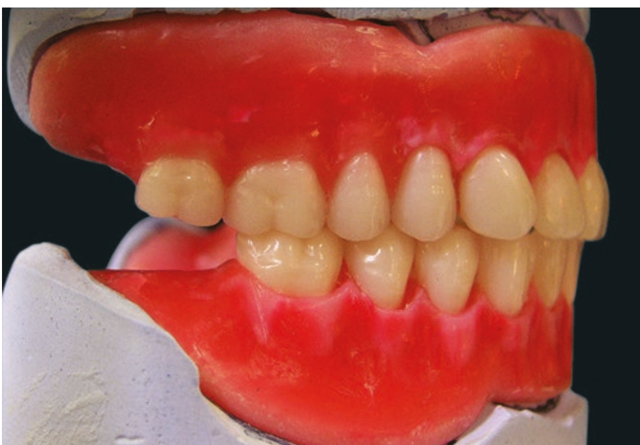


Fig. 2.82 View of shortened dental arch. Maxillary second molar aids the stabilizing effect of the tongue. It does not have an occlusal function

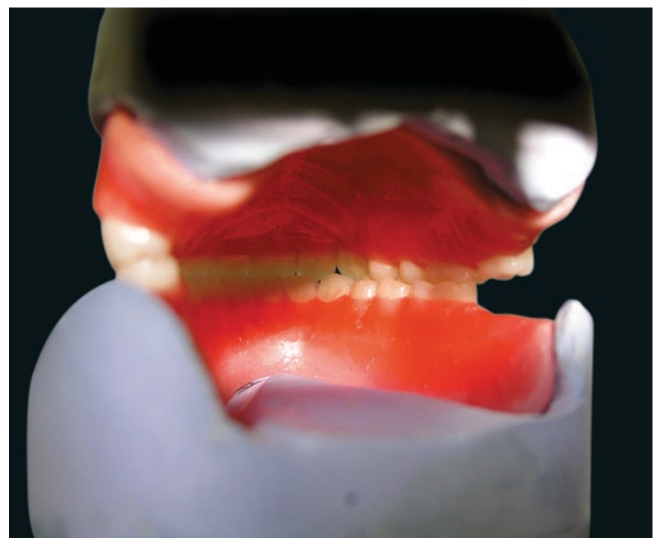


Fig. 2.84 Tubercle-fossa relationship from lingual view: The tubercle-fossa relationship is normal without the maxillary second molar

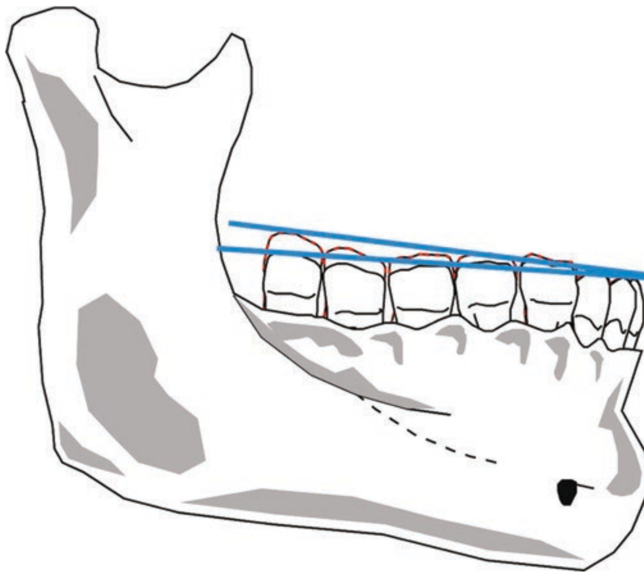


Fig. 2.85 To help maintain protrusive balance, the occlusal plane is increased posteriorly

2.11.1 Increasing the Occlusal Plane to Obtain Balance (or Increasing Inclination)

In this situation, Hanau rules are used to obtain balance in occlusion or desired working occlusion. If there is a disharmony between the patient's centric relation and centric occlusion (or neuromuscular position), the patient can close his mouth in centric occlusion routinely. If the centric relation is recorded at the highest point of the mandibular denture, the patient could not have maximum intercuspal position distance in centric occlusion position because this is forward than the centric relation position. Therefore, to provide maximum occlusion in centric occlusion position, a protrusive balance in occlusal plane should be prepared. The incisal guidance, occlusal plane and the height and inclination of the teeth should be adjusted (Fig. 2.85).

2.11.2 Single Plane Concept That Invalidates All Balances

The teeth are arranged with the single plane concept, so that they are situated in a single plane which is parallel to the floor. Teeth are arranged and transferred to the articulator without Hanau rules.

There is no using occlusal plane, and the teeth are arranged without having a cusp height. Without having these factors, there is no way of achieving balance in irregular movements.

Fig. 2.86 The balance ramp is maintained by the extreme inclination of the first and second molars. Balance is provided from the most distal area of the ramp

2.11.3 Straight Occlusal Plane with Balance Ramp (or Single Plane)

In this occlusal plane, the balance is obtained by the arrangement of height and angle of the first and second molars. This is obtained by the above inclination of the distal of the molar tooth than the other posterior teeth's occlusal plane. When the patient moves toward the protrusive or the working position, the tilted molar makes contact, and the balance is obtained as the technique suggested (Fig. 2.86).

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3 Evaluation of Try-In Stage

Yasemin K. Özkan, Yılmaz Umut Aslan, and Buket Evren

3.1 Evaluation of Try-In Stage

The final try-in stage is when the denture is tested by the dentist and patient and the necessary connections are done. In this phase, the failure to make changes and an adequate review could increase the problems that might emerge after the delivery of the dentures to the patient and may even make it necessary to remake the dentures. The try-in of complete dentures is an extremely important session in both lab and clinical sessions, and as this is the last session to determine and correct the patient's problems, the dentist should be very considerate and empathetic at this try-in stage.

The patient must have mirror in his/her hand, and the dentures should not be finished until confirmation has been received from the patient and his/her relatives during the try-in stage. If the dentist senses hesitation regarding the patient's decision, he should change what has not been approved either at that session or a later one, and a new try-in should be made.

The dentist should not make any decision without first placing the denture in the patient's mouth for the trial of the denture, which has come from laboratory and is on the articulator. This is because the appearance of the denture can be completely different from the intraoral appearance. This idea should be acknowledged as a rule, and even the patient should not be permitted to control the denture in his/her hands or suggest any ideas.

3.1.1 Examination of the Dentures on the Main Models

It is necessary to make an evaluation on the articulator before trying out the dentures in the patient's mouth (Fig. 3.1a, b). It is advisable to provide perfect harmony of the denture bases with the models and obtain a similar degree of harmony in the mouth too. It is also desirable that the bases' adaptation must be perfect before controlling the occlusion or having any idea about the appearance of the dentures. When examining the model, the clinician should pay attention some issues as follows:

Do the denture flanges extend until the buccal and labial flange areas?

Are residual crest ridgelines and mastication stable area marked correctly? (Fig. 3.2a, b).

3.1.1.1 The Position of the Teeth on the Articulator

The relations of cusp-fossa, the harmonious arrangement of the teeth in the arch, the status of the curve of Spee, and the convenience of the anterior horizontal and vertical overlap should be controlled during the examination on the articulator. In the try-in stage, it is convenient to make this process on the articulator because there is no possibility to view the teeth from the lingual side and to detect the teeth relations (Fig. 3.3a, b). As mentioned previously, the tooth arrangement can be done at neutral occlusion, lingualized occlusion and cross bite, in keeping with the patient's crest.

The cusp-fossa relationship should be examined by inspecting the lingual view of the denture on the articulator because it is not possible to evaluate the lingual appearance of the denture intraorally during the controls. In this examination at the maximum intercuspidation, the contact of the palatal cusps with the opposite teeth's fossa in centric relation must be provided (Fig. 3.4a, b).

3.1.1.2 The Examination of Occlusal Balance in Left and Right Lateral Movement

On the working side (left), the palatal cusps contact to the opposite fossa's lingual inclination. On balancing side (right), at a time when mastication is not being done, care must be taken to have balancing contacts for the upper denture stabilization (Figs. 3.5a–d, 3.6a–c). In cases where there is no contact on the balancing side, an attempt should be

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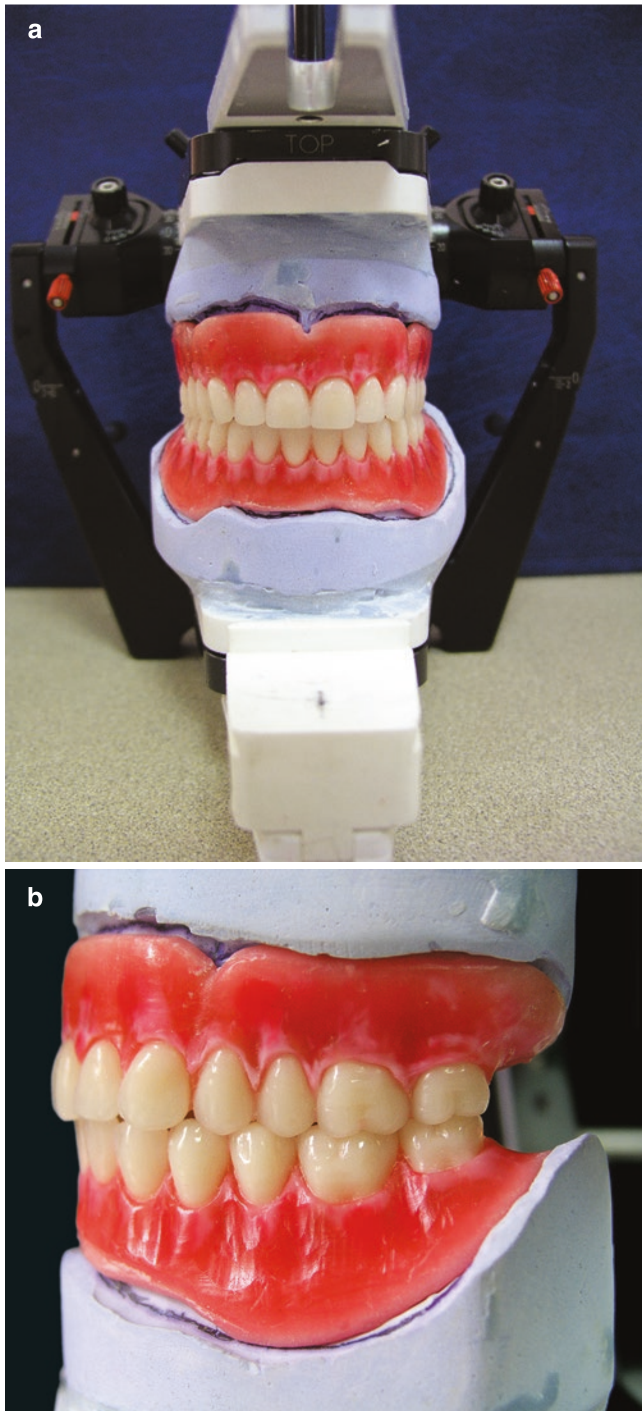


Fig. 3.1 (**a**, **b**) View of the teeth arrangement in centric relation (front and profile view)

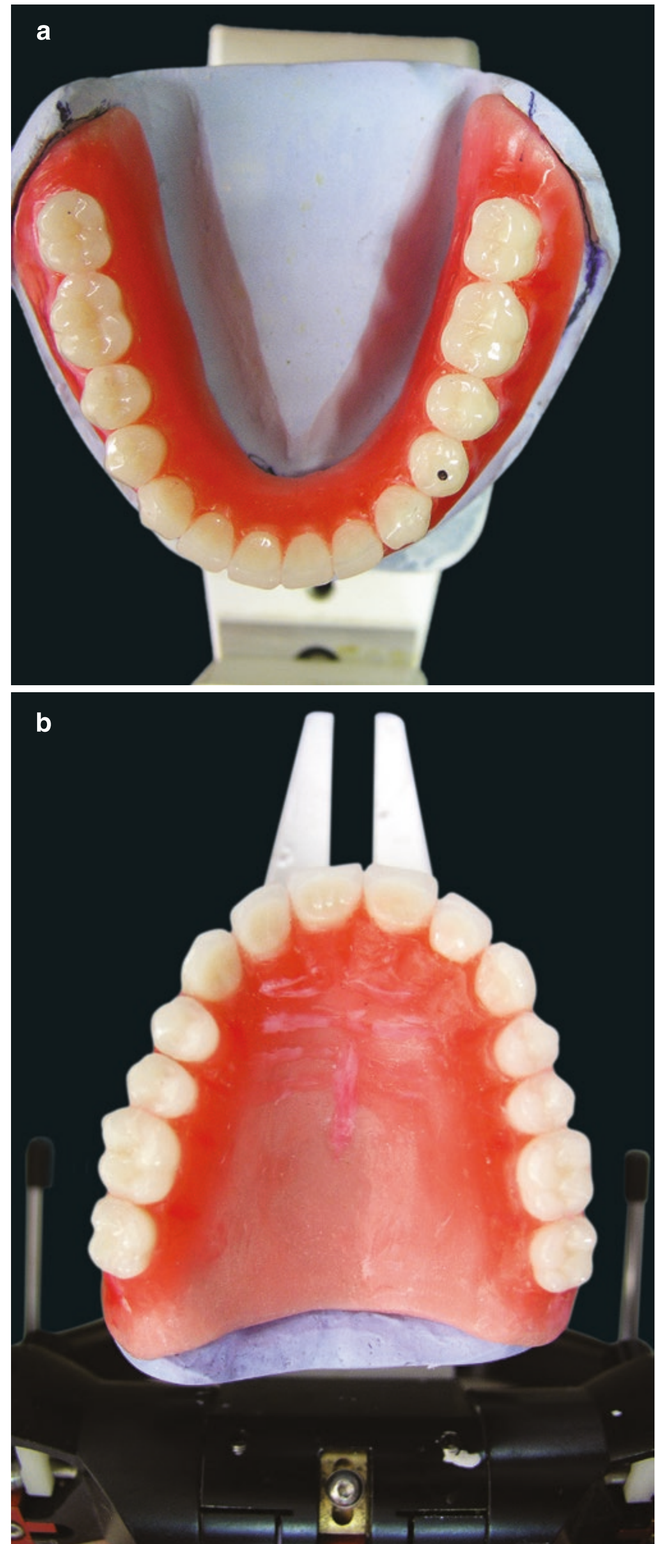


Fig. 3.2 (**a**, **b**) Evaluation of the lower and upper denture borders on the model (checking that the buccal cusp tip of first premolar and fossae of other posterior teeth are on the crest line)

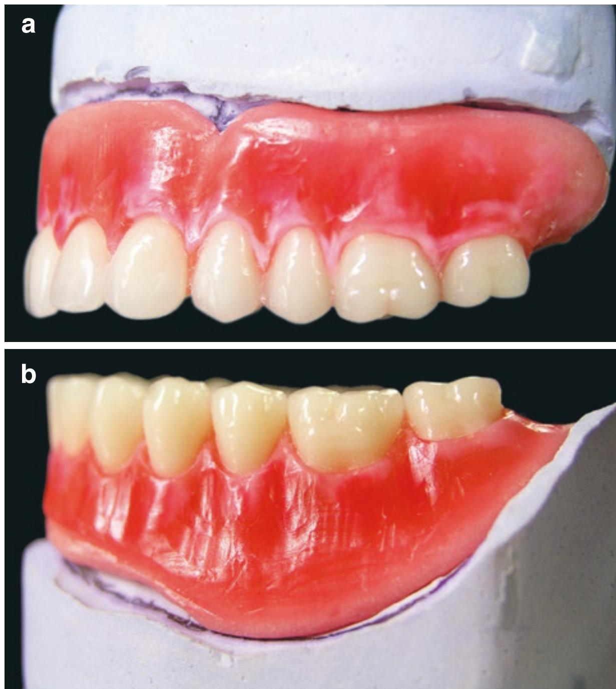


Fig. 3.3 (**a**, **b**) Control of the Spee and Monson curve

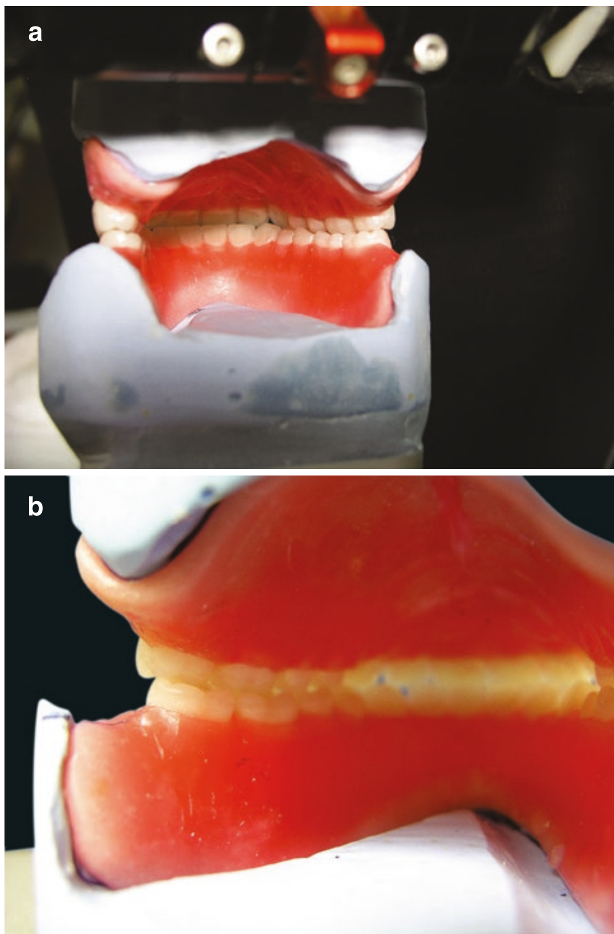


Fig. 3.4 (**a**, **b**) View of the right and left sides of the dentition on the models in centric relation (lingual view)

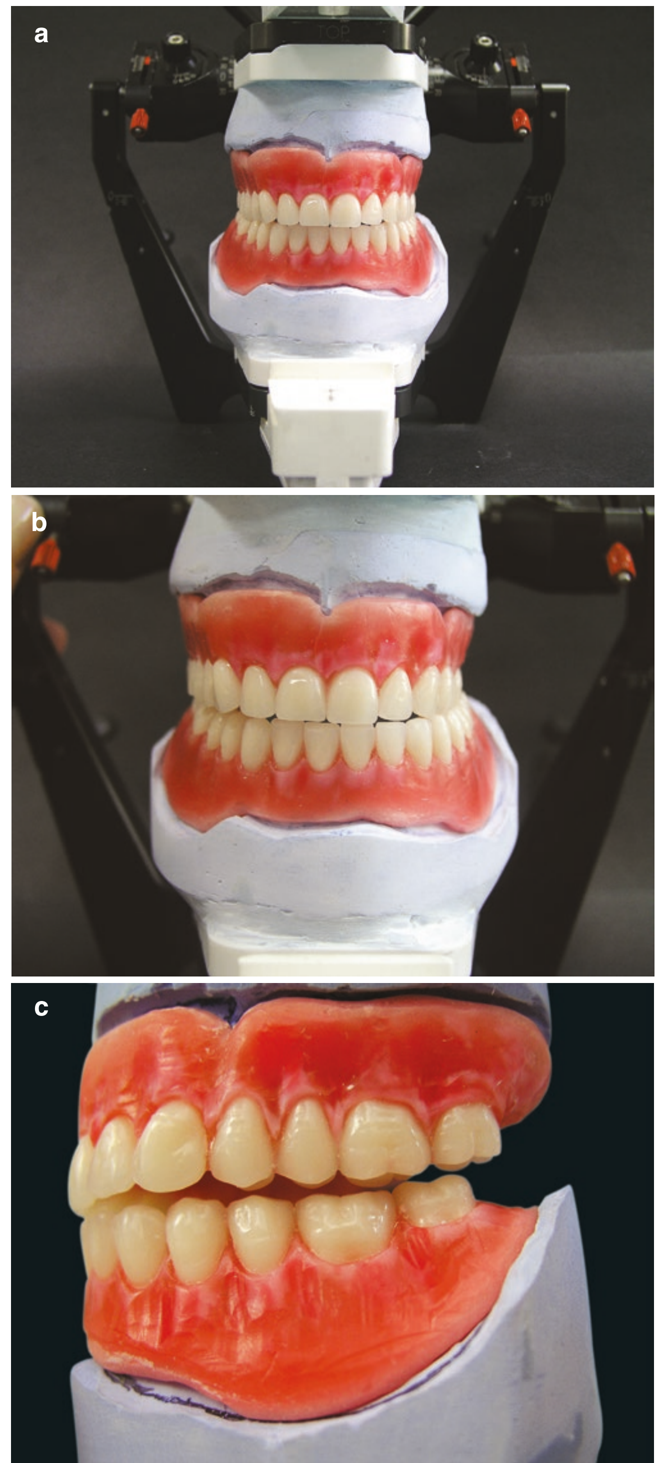


Fig. 3.5 (**a**) Position of centric relation. (**b**) Left lateral movement. (**c**) The lack of balancing side contact in the left lateral movement. (**d**) Providing balancing contacts

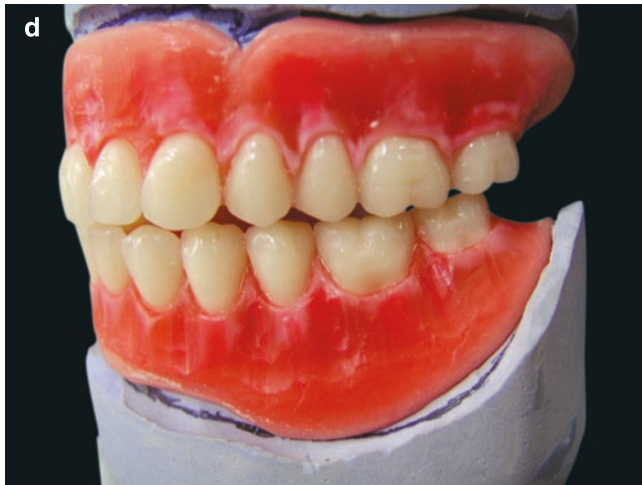


Fig. 3.5 (continued)

made to provide contacts by grinding, and if it is not possible with grinding, the tooth arrangement should be adjusted. The same is valid for the right mandibular movement.

3.1.1.3 The Examination of Occlusal Balance in Protrusive Movement

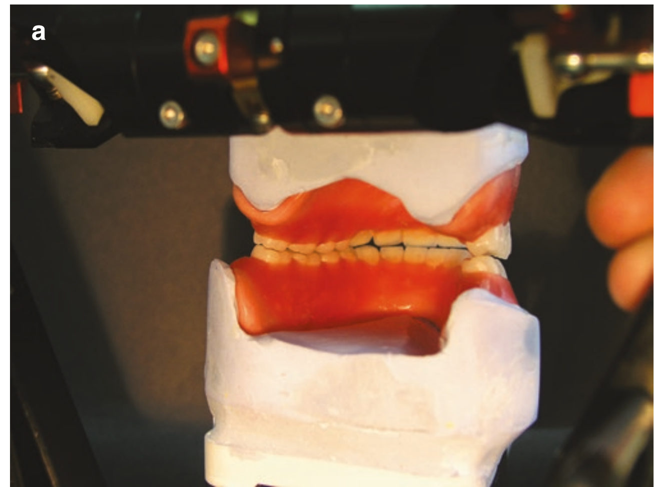
For the evaluation of protrusive movements, the anteroposterior curve and cusp angles of the denture's teeth should be in harmony with the condylar guidance and anterior overbite. At the status of the contact at the anterior teeth, contact of the posterior teeth is also necessary for the evaluation of the protrusive relation. The posterior disclusion with natural teeth is not a preferred situation for edentulous individuals. There must be simultaneous contact on all teeth to provide balance (Fig. 3.7a–f).

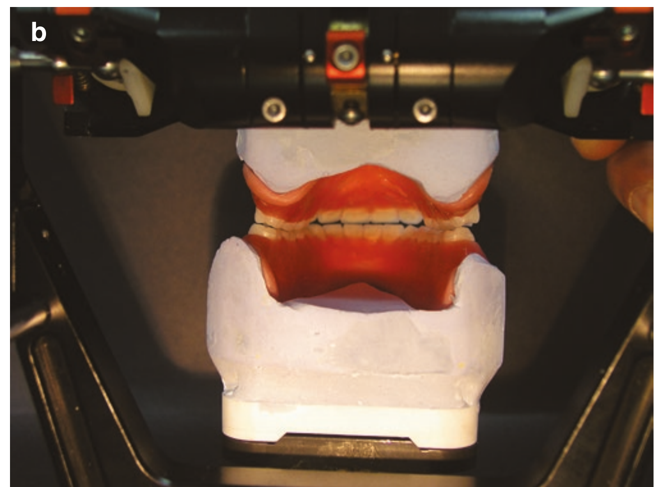
After finishing the examination of the tooth arrangement, it is time for the trial in the mouth.

3.1.2 Intraoral Examination of the Trial Denture

During the try-in stage, if the denture base retention is not good, there will be difficulties in occlusion control. In addition, patients can have difficulty in appreciating the aesthetics because of the denture mobility. If the denture flanges are not too short, sufficient retention can be provided with denture adhesive, but if the retention of the baseplates is inadequate, this situation must be corrected before finishing the dentures (Fig. 3.8a).

Especially during warm weather, it is not advisable to leave the dentures in the mouth for more than a few minutes. Due to the thermoplastic characteristics of the wax, the teeth could move. During the try-in stage, it is necessary to cool the baseplates and again position them onto the models.





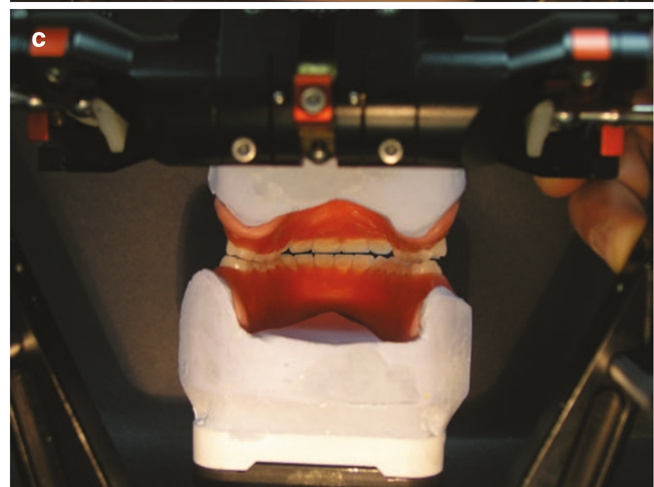


Fig. 3.6 (**a**–**c**) The view from the lingual side of the working and balancing side contacts in the left lateral movement

3.1.2.1 Controlling Flanges of the Base

The extensions of the denture flanges are controlled (Fig. 3.8b). The control of the flanges is carried out by moving the lips slightly sideways, with the direct examination of the buccal and labial sulci and evaluation of the relation of

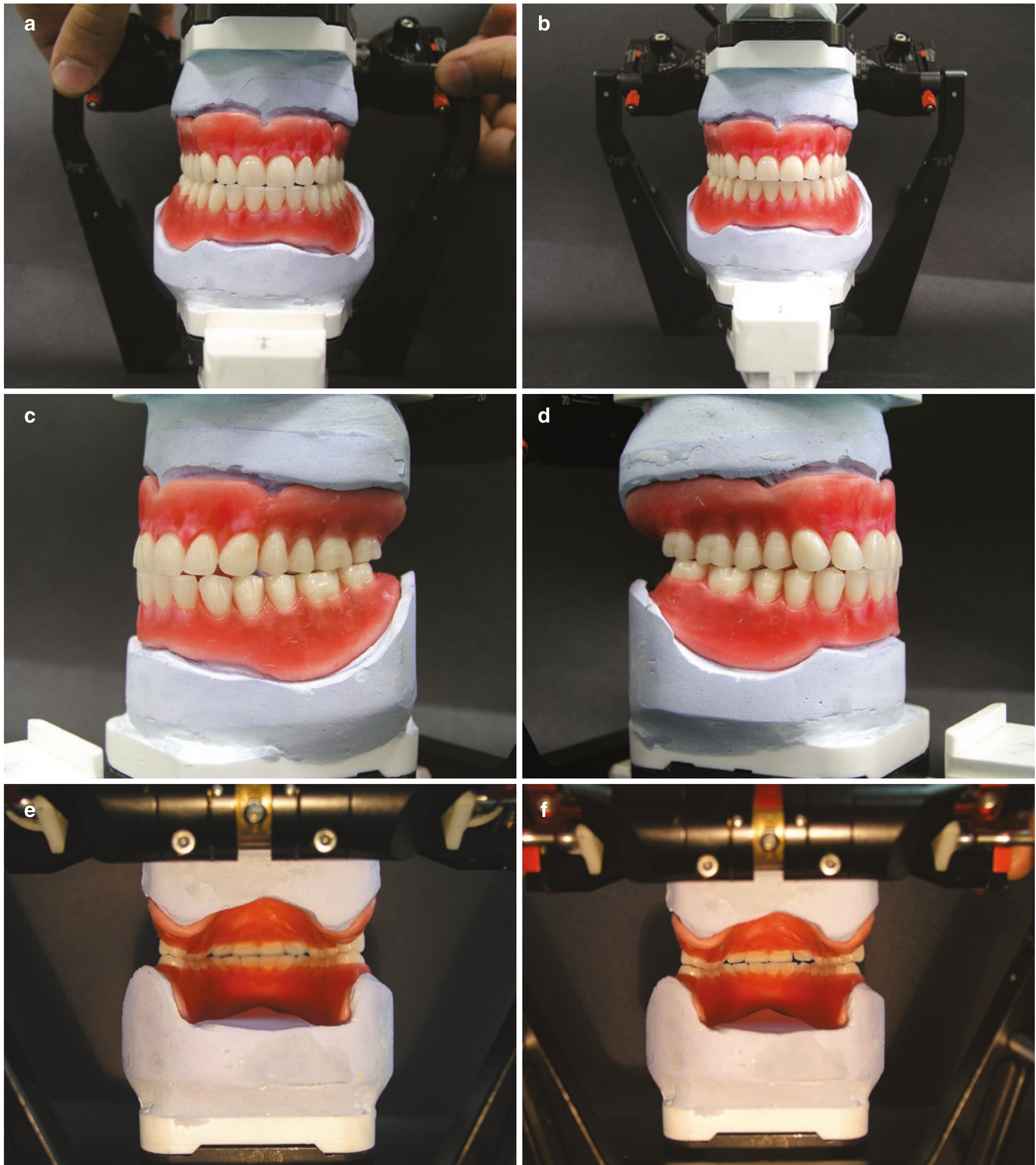


Fig. 3.7 (**a**) Full contact between anterior and posterior teeth in the protrusive movement (front view). (**b**) Transition from protrusive movement to centric relation. (**c**, **d**) Full contact between anterior and posterior teeth in the protrusive movement (profile view). (**e**, **f**) The view from the lingual

sulci with the denture. If there are doubts about the length, temporary wax is added, and the extension is intraorally controlled. If this addition is sufficient, then a new impression should be taken that contains this region. Frenum regions must be controlled, and as previously described the openings in this area should be arranged (Fig. 3.8b, c).

Overextension of the flanges arises due to the denture's movement away from the basal tissues. The lower denture

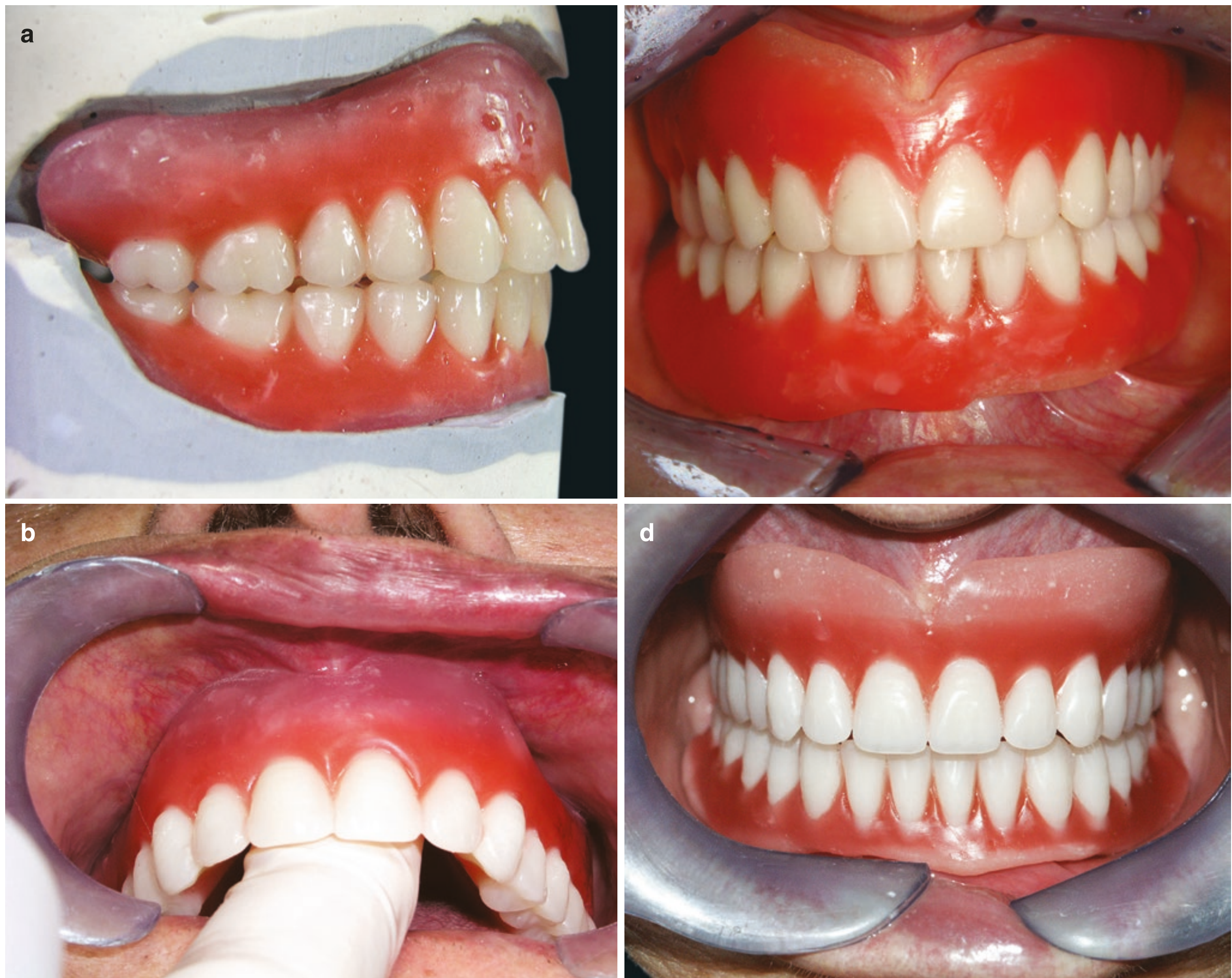


Fig. 3.8 (**a**) Checking the borders of the baseplate on the articulator. (**b**) Checking in the mouth. (**c**, **d**) Checking of frenum in the mouth

moves upward after it is placed in the lower jaw, while the upper denture drops by itself. When trying a denture that has good retentivity, any slight overextensions may not be apparent. The restriction of the motion ability of the frenula can be seen directly by an examination of the labial frenulum. Excessive shortening of these areas must be avoided; otherwise air intake between the denture and the tissues will occur. During the function to control the overextended flanges, finger pressure is applied to the occlusal surfaces of the posterior teeth, and with the other hand, the lips and cheeks are pulled slightly outward and toward the denture to imitate the movements made during the talking and mastication. Severe manipulation of the soft tissues must be avoided because it will reveal less sulcular depth than observed during normal function.

Extensions at the lingual side are controlled by telling the patient to move his/her tongue. The movement of the dentures when the tongue is extended over the lips depends on the genioglossus muscles and extensions in the posterior lingual areas (Fig. 3.9a, b). However, due to the muscles in the sulcular area, care should be taken when determining the difference between the upward pressure and the tongue's direct pressure on the lingual surface of the denture.

Therefore, the tongue's degree of egression should be limited to the one described. The lateral movement of the tongue toward the cheeks shows the overextension areas in the mylohyoid and sublingual gland areas on the opposite side, while swallowing shows the distolingual extension areas and pushes the palatoglossal arch forward.

The posterior border of the palate is controlled by the vibration line, and the area is palpated to ensure that postdam pressure is applied to the soft tissues and not the hard, bony region.

3.1.2.2 Vertical Dimension Control (VDR/VDO)

The dentist should control both the occlusal (VDO) and rest vertical dimension (VDR) and also observe the sufficiency of the freeway space. If the vertical dimension is determined incorrectly, new arrangements should be made in the centric relation, and the vertical dimension should be determined again. To avoid this fault, it is better to arrange the lower and upper anterior teeth and make a trial; thus, the vertical dimension fault can be determined initially.

The degree of visibility of the upper and lower denture teeth is also an important factor for providing the correct ver-

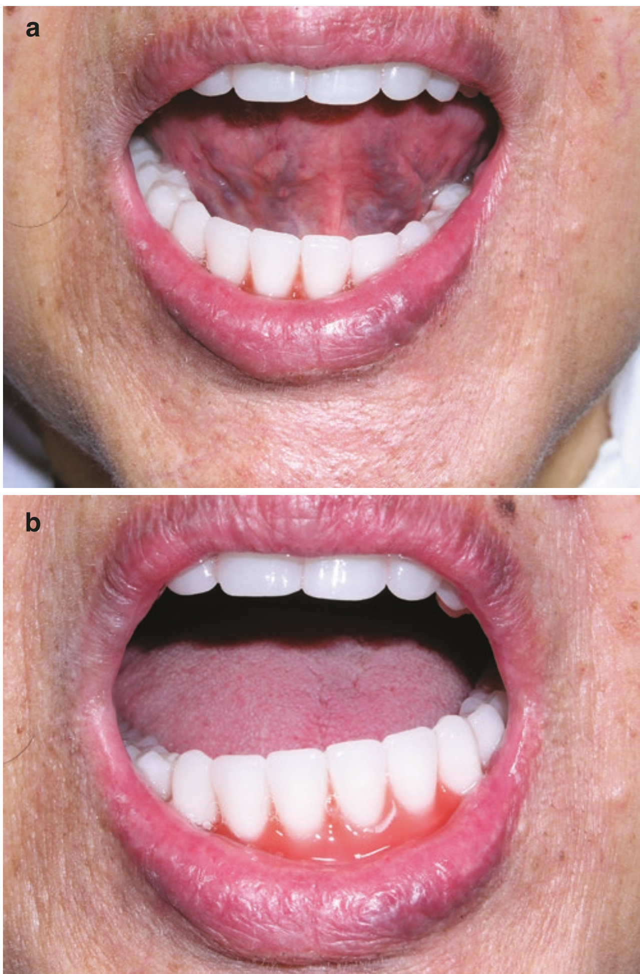


Fig. 3.9 (**a**, **b**) The movement of the lower denture due to the pressure of the baseplate on the genioglossus muscle and posterolingual area

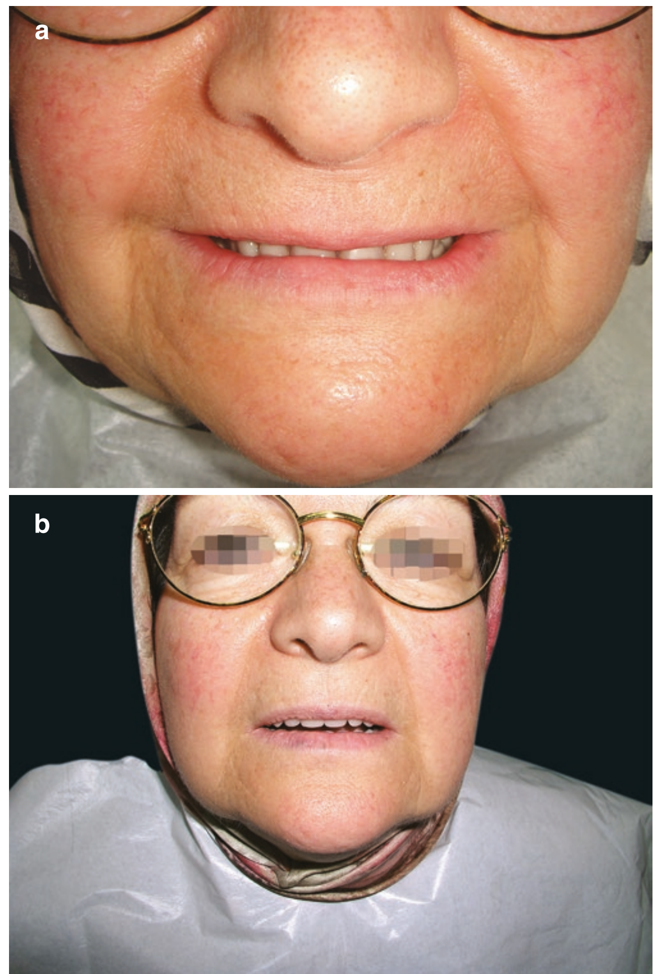


Fig. 3.11 (**a**) Determination of low vertical dimension. (**b**) Bringing the vertical dimension to normal level

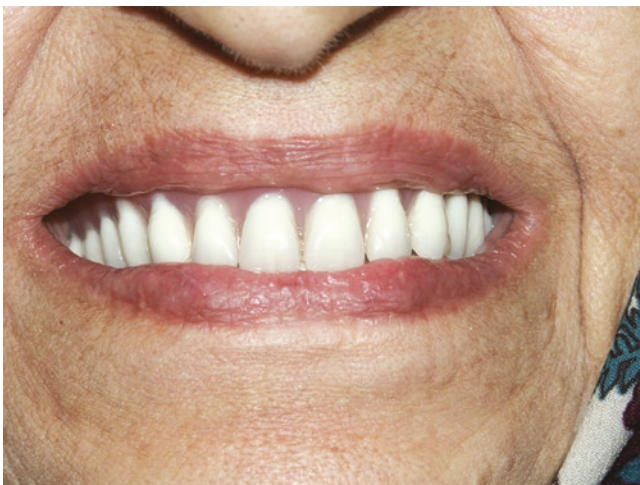


Fig. 3.10 Determination of high vertical dimension

tical dimension of the occlusion. Aesthetics should not be ignored when determining the vertical dimension.

The position of the teeth should be checked when the patient is talking and laughing or when he/she in the rest position. The higher the vertical dimension, the more visible the maxillary and mandibular teeth will be because the position of the teeth will be changed to close the interocclusal space (Fig. 3.10). The opposite situation is also true; the lower the vertical dimension of occlusion, the less visible the teeth will be (Fig. 3.11a). Increasing the vertical dimension is achieved by placing wax between the teeth. In order to reduce the vertical dimension, all teeth must be removed from the lower denture, and a wax rim must be prepared away from the upper teeth occlusion for recording the new jaw relations. If the lower anterior teeth remain in their place, the forward movement of the mandible will prevent the recording of the jaw relations in the correct position and prevent closure when the occlusal height is reduced and the mandible moves forward. However, when there is a moderate horizontal-incisal overlap or the required closure angle is less, it is advantageous to leave the incisors where they are, because reduction on the height can be measured easily due to the relation with the upper incisors. When adjusting the vertical dimension, the correct teeth arrangement should be obtained together with aesthetics (Fig. 3.11b).

Aesthetic problems that are encountered during the fabrication of a new denture appear due to the patient's vertical dimension. For example, crest resorption is increased in a patient with occlusally worn teeth. As a result of this, for a patient in the rest position, the teeth will not be extremely visible during laughing and speaking because of the bone loss and attrition of the teeth. While making a new denture for this patient, we should increase the vertical dimension by considering these criteria. Due to the increase in the patient's vertical dimension, the teeth will be more visible, and the facial appearance will be differentiated. This aesthetic alteration may not be accepted by the patient or the patient's family or relatives. Frequently, vertical space can be reduced to supply the patient's aesthetic needs. As a result, it would be incorrect to benefit from only one or two criteria for the determination of the patient's vertical dimension. The vertical dimension is not a value that can be measured exactly, numerically. Clinical criteria and clinical evaluations should be taken into account.

Freeway space will reduce when the vertical dimension is established high, muscle tonus will increase, and a tough expression will occur in the patient's appearance. The mandibular crest's anterior region will meet more labially with the upper jaw when the vertical dimension is low, and the tip of the chin will approach to the nose tip when the teeth are in the occlusion. The lips will look thinner, and wrinkles will appear on the upper lip area.

3.1.2.3 Vertical Dimension Control with the Phonetic Tests

After the teeth arrangement, phonetic tests are the most efficient method for controlling the vertical dimension that was previously adjusted. So long as the phonetic tests are not applied, the vertical dimension should not be considered correct.

Baseplates are used for testing speech. The better the fit and the contours of the bases, the more accurate is the speech obtained. The patients are asked to count loudly from 60 to 70 while controlling the contact of the teeth. The sound of the letter "s," which the patients make while counting from 60 to 70, should be taken into account. When pronouncing the letters "s" and "e," the teeth are usually very close to each other, but they do not make contact. It is very easy to pronounce these numbers, and during the quick repetition of them, it can be controlled without a change in the occlusal vertical dimension and palatal sealing. In most cases, when the patients are pronouncing the sound of the letter "s," by sliding the teeth forward and downward, lower anterior teeth get as close as 0.5–1 mm to the upper anterior teeth, or even contact each other. During this approach of the anterior teeth, the teeth and the space between them controls the airflow, and it helps to pronounce the "s" sound without making a whistling sound (Fig. 3.12). During this test, if it is understood that there is a space wider than 0.5–1 mm, the vertical dimension should be increased, or the position of the anterior teeth should be changed. If the teeth are in contact, it will be decided that there isn't sufficient interocclusal space during speaking, and it will be essential to decrease the vertical dimension.

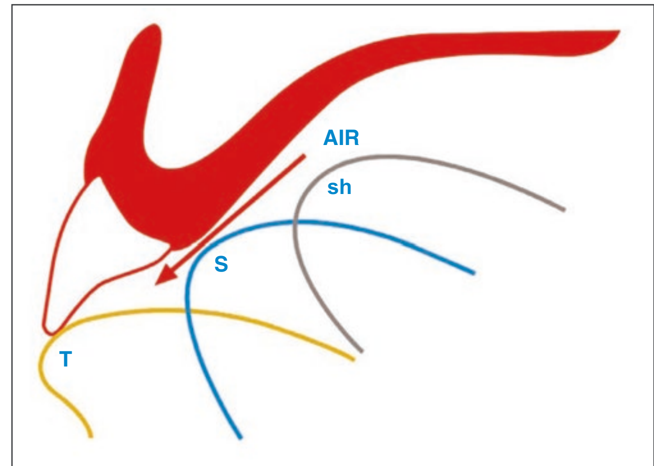


Fig. 3.12 During the pronunciation of the "s, t, and sh" letters, the position of the tongue with the upper denture

Other phonetic tests that are important in determining the occlusal vertical dimension are:

1. By making the patient pronounce "s, s, s, s" sounds quickly, the anterior and posterior teeth are examined. Perhaps the best method would be to observe the patient during a normal conversation. The patient may also read from a magazine or a book (see Fig. 3.12).
2. Vertical and horizontal overlap of anterior teeth can be tested by asking the patient say the word "jury," "jerry." If there is insufficient distance, the lower teeth will collide with the upper teeth.
3. The dentist should be sure that the tongue covers the interocclusal distance by the forward motion, by asking the patient say words beginning with "D" such as driver, dentist, or dirt (Fig. 3.13).
4. By making the patient repeat "m" letter quickly, the dentist can be sure that the lower jaw stays stable and only the lips move. During this test, the word "Mississippi" or "Emma" can be used.

3.1.2.4 Evaluating the Occlusal Plane

Especially when the patient smiles, it is revealed that the occlusal plane is the most effective factor of the denture appearance (Fig. 3.14a, b). The occlusal plane is created by arranging the lower teeth rising posteriorly onto the retromolar pad (Fig. 3.15). The height of the last tooth on the lower denture should be the half or 2/3 of the retromolar pad

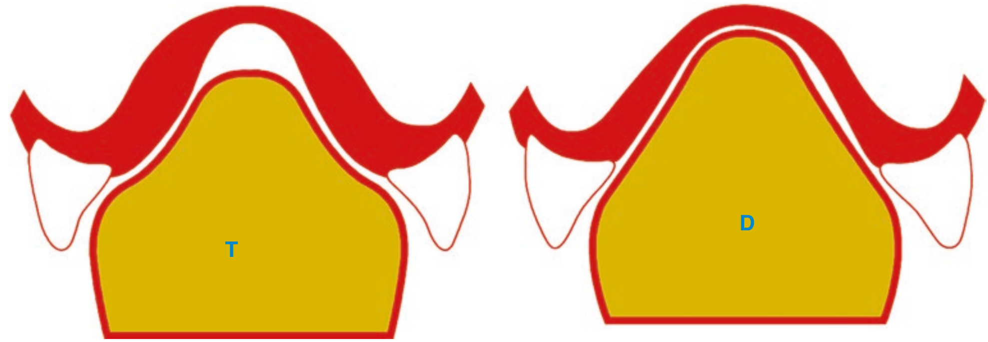


Fig. 3.13 During the pronunciation of the "t and d" letters, the position of the tongue with the upper denture

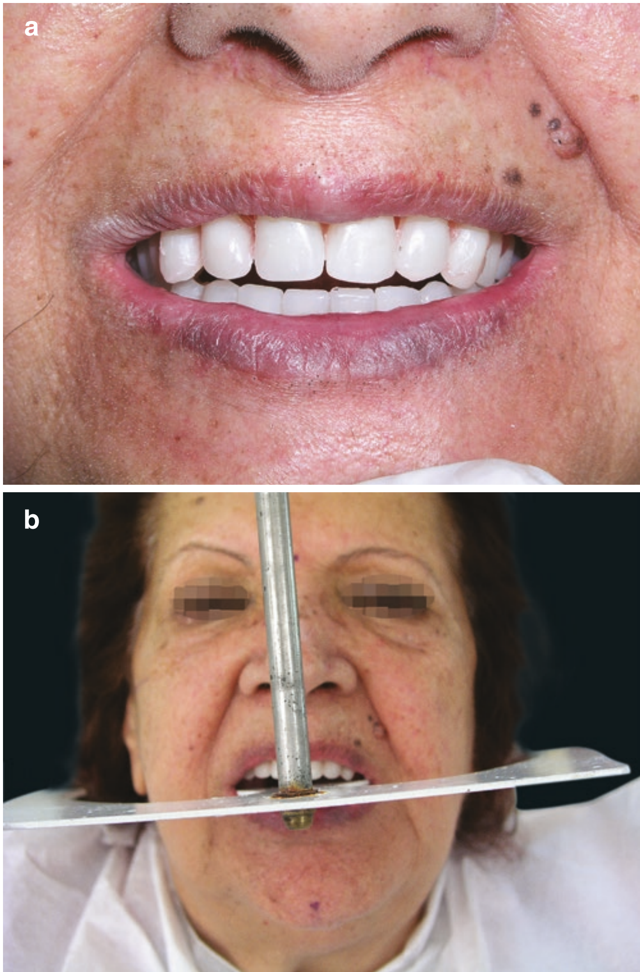


Fig. 3.14 (**a**) Determination of high occlusal plane in the anterior area. (**b**) Asymmetric occlusal plane

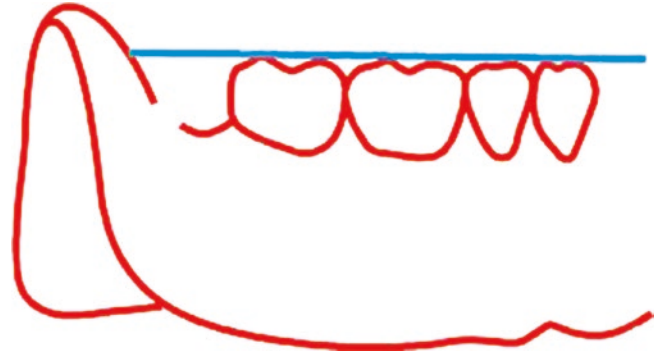


Fig. 3.15 Relation between occlusal plane and retromolar pad

height. When the maxillary posterior teeth are too low, the dentures seem like they are falling out of the mouth. The occlusal plane should be leveled from one side of the arch to the other. If the teeth are high on one side of the arch, an unaesthetic appearance can result, so the occlusal plane should be at the same level on both sides of the arch (Figs. 3.16–3.18).

For stability, the tongue must be placed directly over the occlusal surfaces of the lower posterior teeth; in this way it can apply a small amount of pressure downward. If the posterior teeth are placed over the tongue, the denture becomes less stable during tongue movements (Fig. 3.19). When the lower denture's stability is weak, it may be necessary to take the occlusal plane down to improve the tongue control of the denture. Occlusal plane inclination is also important for balancing the occlusion in increasing the tubercle height of the posterior teeth. Occlusal plane is one of Hanau's Laws. The cheeks and the tongue are the main relations of the occlusal plane. The plane should be at a proper level so that the tongue can properly move food around the occlusal plane. If the occlusal plane is too high, it can be difficult for the tongue to push food onto the plane and consequently chewing the food becomes difficult.

It is important to prevent the tongue from becoming jammed by arranging the teeth far from the lingual. This can cause instability of the mandibular denture, and it bothers the patient. Placing the lingual cusps of the lower posterior teeth on the triangular region between the mesial surface of canine and retromolar pad's buccal and lingual surfaces creates a good guidance (Fig. 3.20).

Whatever methods are used in the creation of the occlusal plane, a final control is required to check the compatibility of the occlusal plane for the benefit of the patient's cosmetic enhancement. The patient should be observed while smiling, talking, and in the rest position.

Figs. 3.16–3.18 (**a**, **b**) Detecting occlusal plane properly by using the Fox Ruler (The occlusal plane is parallel to the Frankfurt and Camper planes)

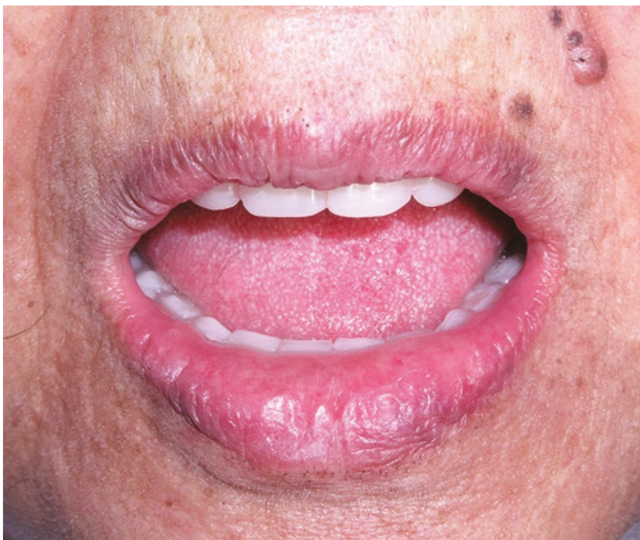


Fig. 3.19 Tongue should be placed over the lower posterior teeth for stability

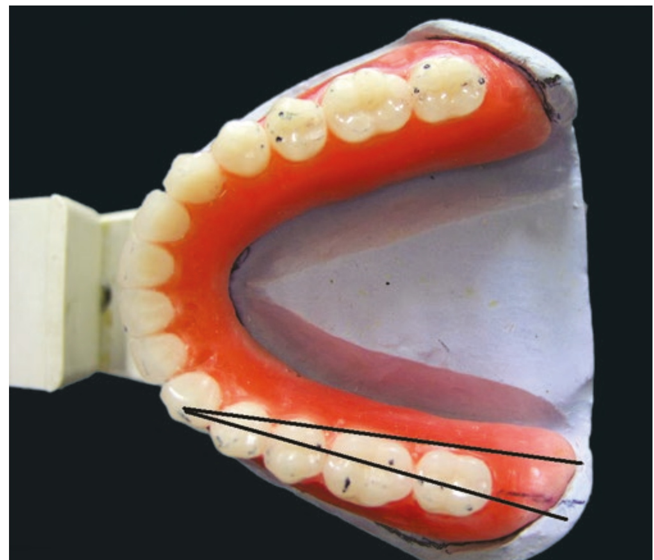


Fig. 3.20 Placing the lower posterior teeth on the lingual triangular area

3.1.2.5 Appearance of the Lips

In dentate individuals lip support is provided by internal factors (Fig. 3.21). These are the anterior teeth and the surrounding bone (Fig. 3.22). In the anterior maxilla, buccal bone loss and reduction of the crest height occur with the extraction of anterior teeth.

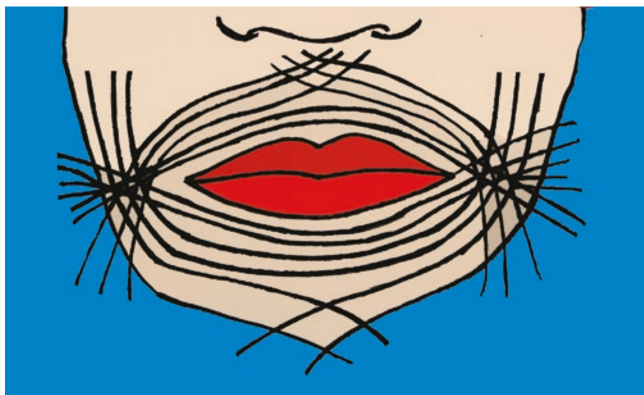


Fig. 3.21 The appearance of the muscles forming the lip

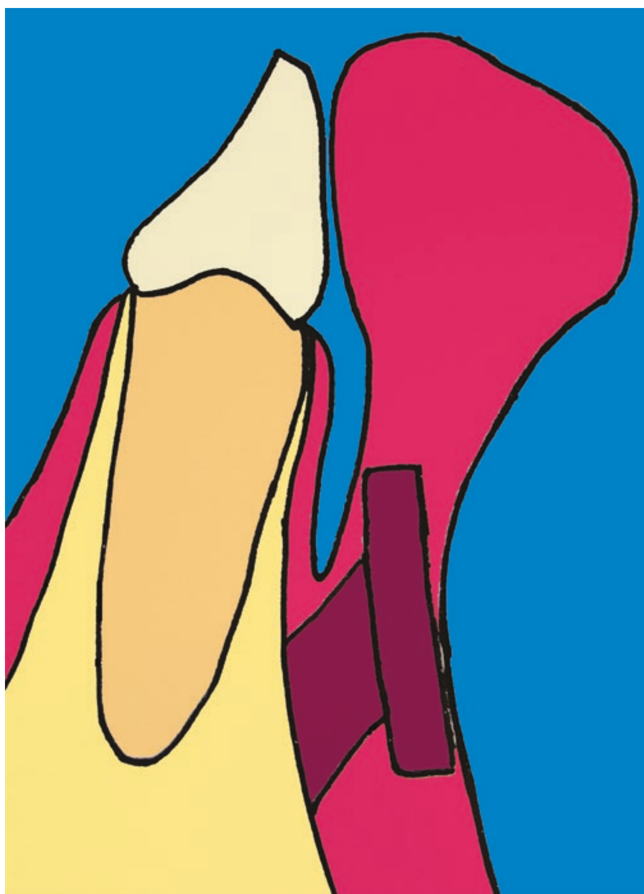


Fig. 3.22 The muscles, teeth, and underlying bone position provide the position of the lip

Following the extraction of the anterior teeth, if the teeth were to be placed on the alveolar crest, in reality, the teeth would be arranged inside the crest due to crest resorption. In such a situation, lip support would not be adequate and phonetic problems would occur, depending on the space between the teeth and lips (Fig. 3.23a, b). If the labial flange thickens to change this situation, reverse profile will occur together with the oval and collapsed profile (Fig. 3.24a, b). In the maxillary area, resorption is oriented upward and backward, and the crest ridge is also shaped backward. The dentures should be of such a design to support the natural anatomy around the teeth, in order to provide physiological lip support (Fig. 3.25). Therefore, it should not be forgotten that the teeth will support the lips in teeth arrangement and this should be considered during the try-in stage. With biometric measurements, the incisive papilla is approximately 8–10 mm away from the upper incisor teeth (Fig. 3.26).

3.1.2.6 Appearance of the Lips in Rest Position

Upper lip length increases with age and following teeth extraction. The upper incisors would be at the same level or at a higher level than the upper lip (Figs. 3.27 and 3.28). In order to decide whether the position of the teeth is correct, the position of the lips should principally be examined from two aspects, as laterally and frontally. When the denture is inserted into the mouth, the philtrum of the lip should protect its slight hollowness, the philtrum edges should be prominent, and the lips should be flattened slightly toward the commissures. This flattening should be terminated in the nasolabial groove. The nasolabial groove shouldn't change its form and must be prominent, separating the lips and cheeks (Fig. 3.29a–d). Incisal one-third of the lower incisors should contact the inner surface of lower lip, and the outer surface of all the incisors should create a round curve.

3.1.2.7 The Appearance of the Lips During Movement

When the lips are separated, the incisal edge of the upper first incisors should be observed, and when lips move upward, the second incisors incisal edges and the tip of the canines should be in view (Fig. 3.30a, b). During normal conversation, the lips should be able to move without disrupting their natural shapes. When the upper lip rises, as when laughing and smiling, the amount of the vestibule surfaces of the teeth that is visible depends on the height and movement capacity of the lips. To control the appearance of the teeth, the dentist should sit directly opposite the patient, and take note that the central vertical axis of the face is passing exactly from the center of the lower and upper arch, and at the same time, he should control each central incisor's long axis. It is very important to detect the center line correctly (Fig. 3.31a, b). Any mistake could result in the patient's mouth appearing to slope to one side. The desired

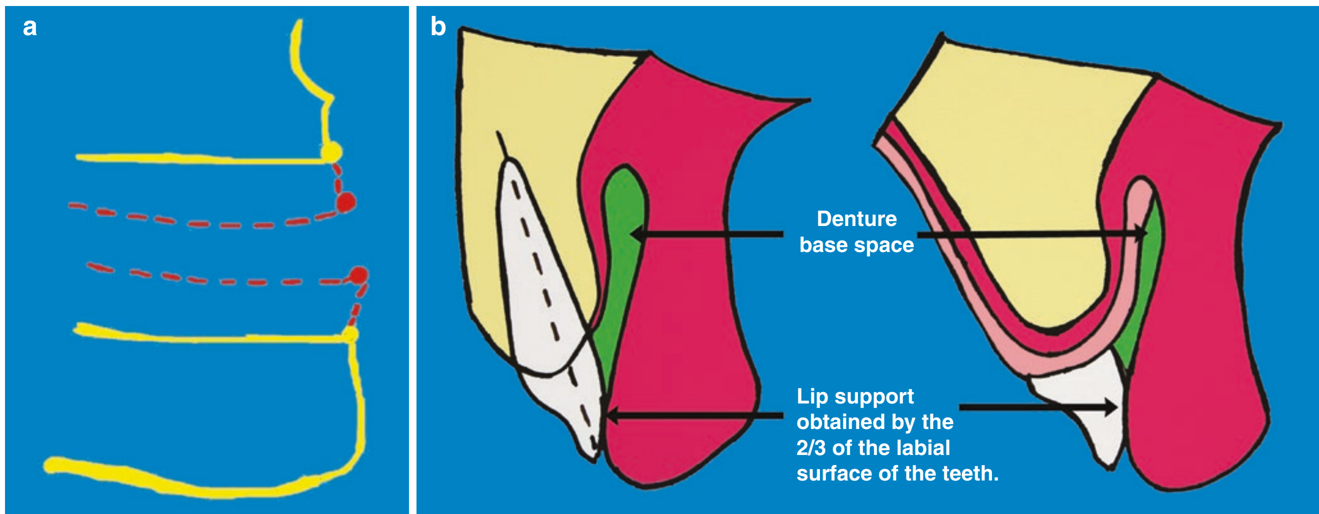


Fig. 3.23 (**a**) After tooth extraction, to provide lip support, the anterior teeth have to be in front of the alveolar crest. (**b**) Ensuring correct lip support with the baseplate and teeth

position is that the midline should pass exactly between the central incisors in the upper and lower jaws.

While checking the position of the anterior teeth, whether the central incisors can be seen at first glance in the middle of the dental arch should be considered. The size of the central teeth should be controlled on the basis of the philtrum and the mesiodistal size of the anterior teeth should also be examined, again by drawing perpendicular lines from the nose wings (Fig. 3.32a, b). The teeth size ratios should be pleasing, and each tooth should be of the correct size. The labial surfaces of teeth should be neither too flat nor too convex (Fig. 3.33a, b). It could be helpful to make use of the patient's profile when determining the convexity of the teeth (Fig. 3.33c).

Excessive lip support will occur if the dentures are too thick or the anterior teeth are placed too labially (Fig. 3.34a–d). Symptoms of this include the lips looking stretched, lines around the lips, the philtrum being eliminated, and the mentolabial, nasolabial, and labiomarginal sulci appearing insignificant.

To ensure aesthetics for cases with prominent crests, an adjusted teeth arrangement can be recommended, but this condition can adversely affect the retention of the dentures. It can also increase the risk of denture fracture (Fig. 3.34e–g).

If there is insufficient support of the lips, the area around the mouth contour is in a state of continuous collapse. The size of the vermillion border is shorter. Fallings have occurred in the corners of the mouth. The nasolabial, mentolabial, and labiomarginal sulci become evident, and the philtrum is eliminated (Fig. 3.35).

Watts and Mc Gregor (1986) reported that the average sagittal angle between the columella and the lips should be 90 degrees (Fig. 3.36). The arrangement in the anterior region can also be controlled by using this biometric measurement.

In edentulous individuals, the upper lip usually has a flattened appearance from the profile view (Fig. 3.37).

The inclination of the anterior teeth causes the lips to be extremely forward or backward. In some patients, the upper anterior teeth may be inclined lingually or labially, according to the frontal plane. The inclination of anterior teeth should be parallel to the profile line of the face. The inclinations of the anterior teeth are more prominent from the profile view. Small interincisal angles show a more convex profile (Figs. 3.38 and 3.39).

For prognathic patients, due to the protrusion of the mandibular incisors, the maxillary incisors' incisal edges are further than the cervical edges. If the prognathism is severe, tooth contact is almost impossible in the incisor area. This is because with such cases, the maxillary incisors have to be positioned too labially and too much leverage force would occur. At the same time, the position of the teeth will cause too much tension under the upper lip (Fig. 3.39). The relation between the lower and the upper crests in the anteroposterior position for the maxillary and mandibular teeth should be also taken into consideration (Fig. 3.40). Unlike natural dentition, in cases of normal orthognathy, the anterior teeth should not be in contact with each other in centric relation; there must be a distance of at least 1 mm. The angle that is created by the union of the vertical and horizontal overlap should not be greater than 15° (Figs. 3.41a, b, and 3.42). One of the mistakes, which is made at this stage, is to create a standard vertical and horizontal overlap without considering the crest's relation.

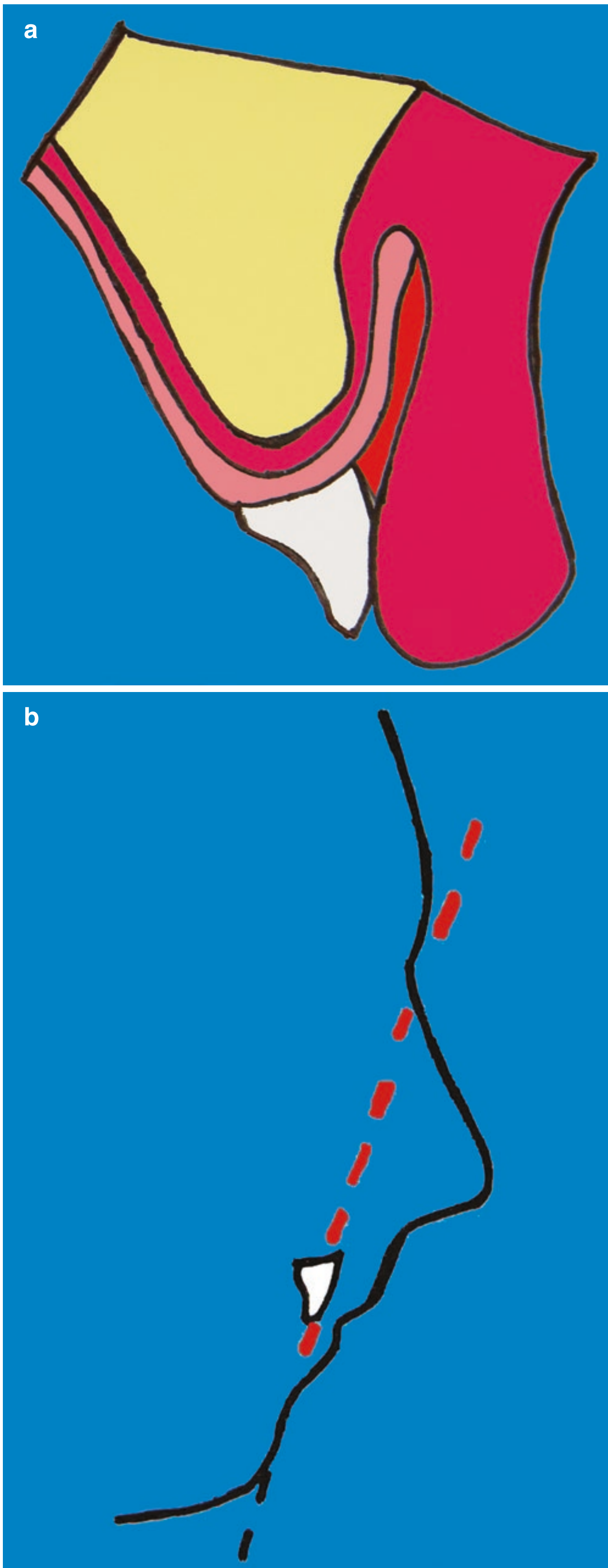


Fig. 3.24 (**a**, **b**) After the labial flange of the denture is thickened, a sunken and a collapsed and oval profile occurs

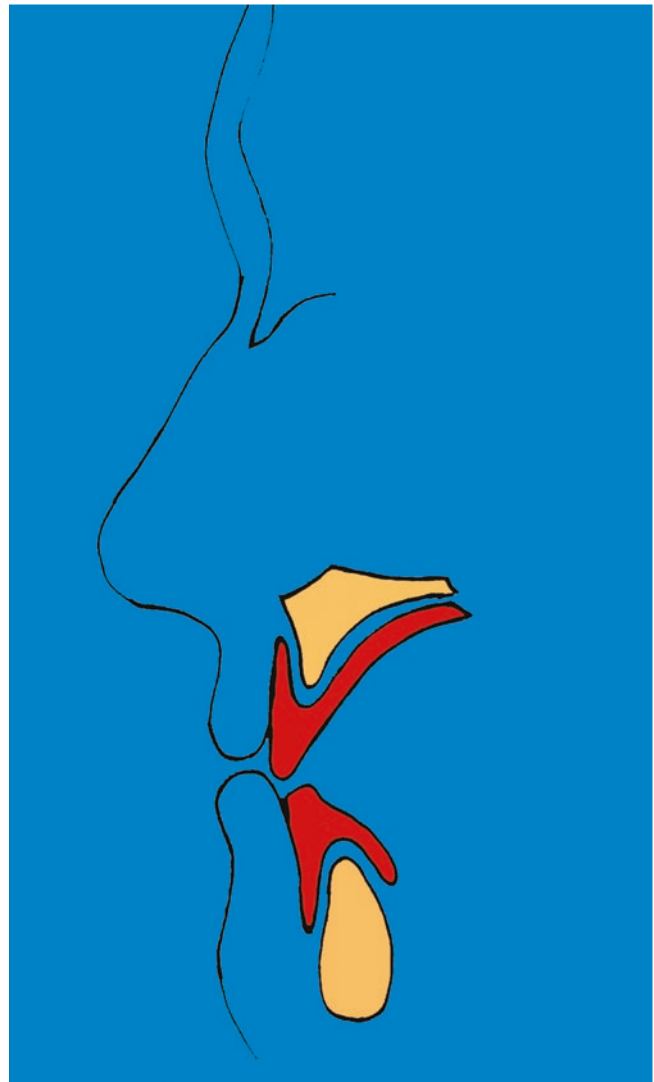


Fig. 3.25 Lips properly supported by the denture

3.1.2.8 Checking the Smile Line

The smile line is one of the most important factors of aesthetics. In the smiling position, the lower lip creates a nice curve known as smile line. This curve can be used as a guide for the upper anterior teeth arrangement. When the patient smiles, a nice expression occurs if the upper teeth's incisal edges follow the lower lip line. The incisal edges of upper incisor teeth should be parallel to the lower lip, also when smiling. If this adaptation is not provided or a reverse contour occurs, the line created by the lower lip when smiling will not be harmonious with the incisal edges of the teeth, and this situation will create a disagreeable appearance. A reverse contour will usually give the appearance of an artificial denture. The vertical position of the upper canine is effective in the formation of the smile line. The smile line will be more parallel to the lower lip if the incisal edges of the canines are positioned slightly shorter than the incisors (Fig. 3.43a–f).

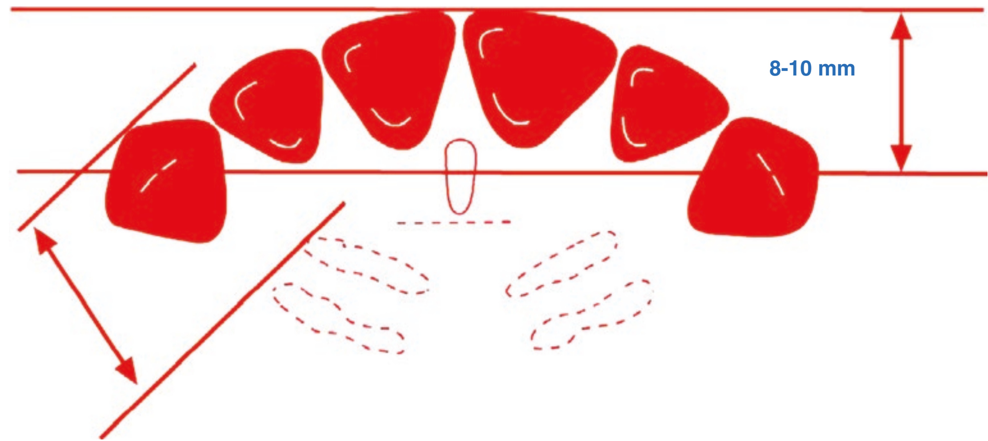
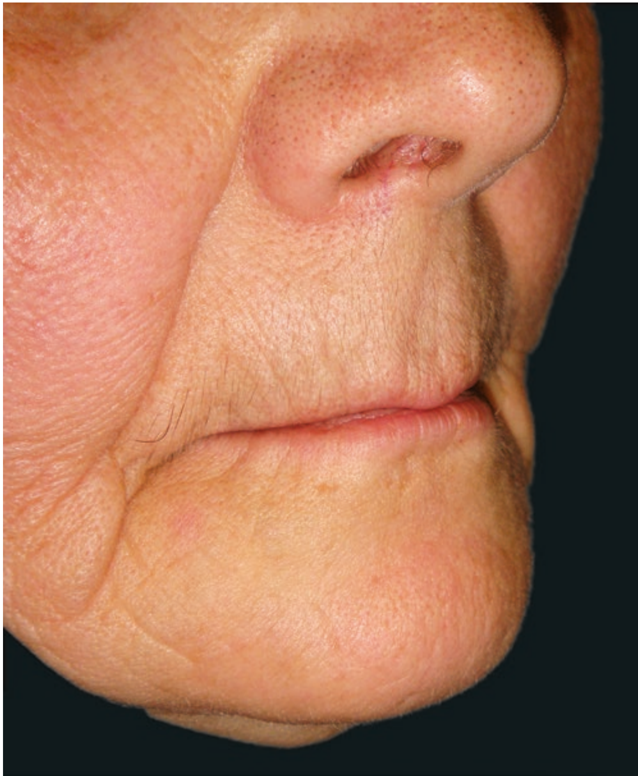


Fig. 3.26 Relationship between the upper anterior teeth and incisive papilla



Figs. 3.27 and 3.28 After the extraction of teeth and with increasing age, the length of the upper lip increases

The majority of patients desire larger and more visible upper anterior teeth during smiling (Fig. 3.44a–c). The vertical orientation of the lower anterior teeth is a better guide than the upper teeth. When the mouth is slightly opened, the incisal tip of the natural mandibular canine and buccal cusp of the first premolar are positioned at the commissures at the level of the lower lip (Fig. 3.45). It should be taken into account that the vertical positions of teeth are not formed correctly if the artificial anterior teeth are positioned below or over this level. If the lower teeth are over the lip level at the commissures, either the anterior teeth have an excessive overlap, the occlusion plane level is high, or the vertical dimension is high (Fig. 3.46). If the lower teeth are below the lip line, then the reverse is in question. If the shape of the smile line reversed, the aesthetics will be disrupted, and there will be an artificial appearance (Fig. 3.47a–e).

Some modifications can be made during teeth arrangement to enhance the natural appearance of the denture. The most important factor is to prevent a block view of the teeth and to provide the appearance of each tooth looking separate. For this purpose, diastemas can be made. A more feminine look can be created by lapping the upper central incisors over the lateral incisors. Slight asymmetry can be performed on the left and right sides. It will be more natural when the incisal edges of the lateral incisors are positioned higher than the central incisors and canines. If one central incisor is positioned more labially or lingually than the other central incisor, or the two central incisors are rotated mesially and positioned anteriorly, a more natural appearance will be observed. Abrading the incisal edges of the incisors will give the impression of occlusally worn teeth. It will give more natural appearance if one or two of the lateral incisors are positioned more lingually or slightly longer than the neighboring teeth and the mesial surfaces of the canines are placed on the distal surface of the lateral incisors (Fig. 3.48a–d).

3.1.2.9 Determination of the Buccal Corridor

The shape and position of the dental arch determine the buccal corridor. It is the space between the buccal surfaces of upper teeth and commissures when the patient smiles (Fig. 3.49). Unless a buccal corridor is created, the appearance of too many teeth will occur in the teeth arrangement. If the posterior teeth are arranged by creating a larger arch form

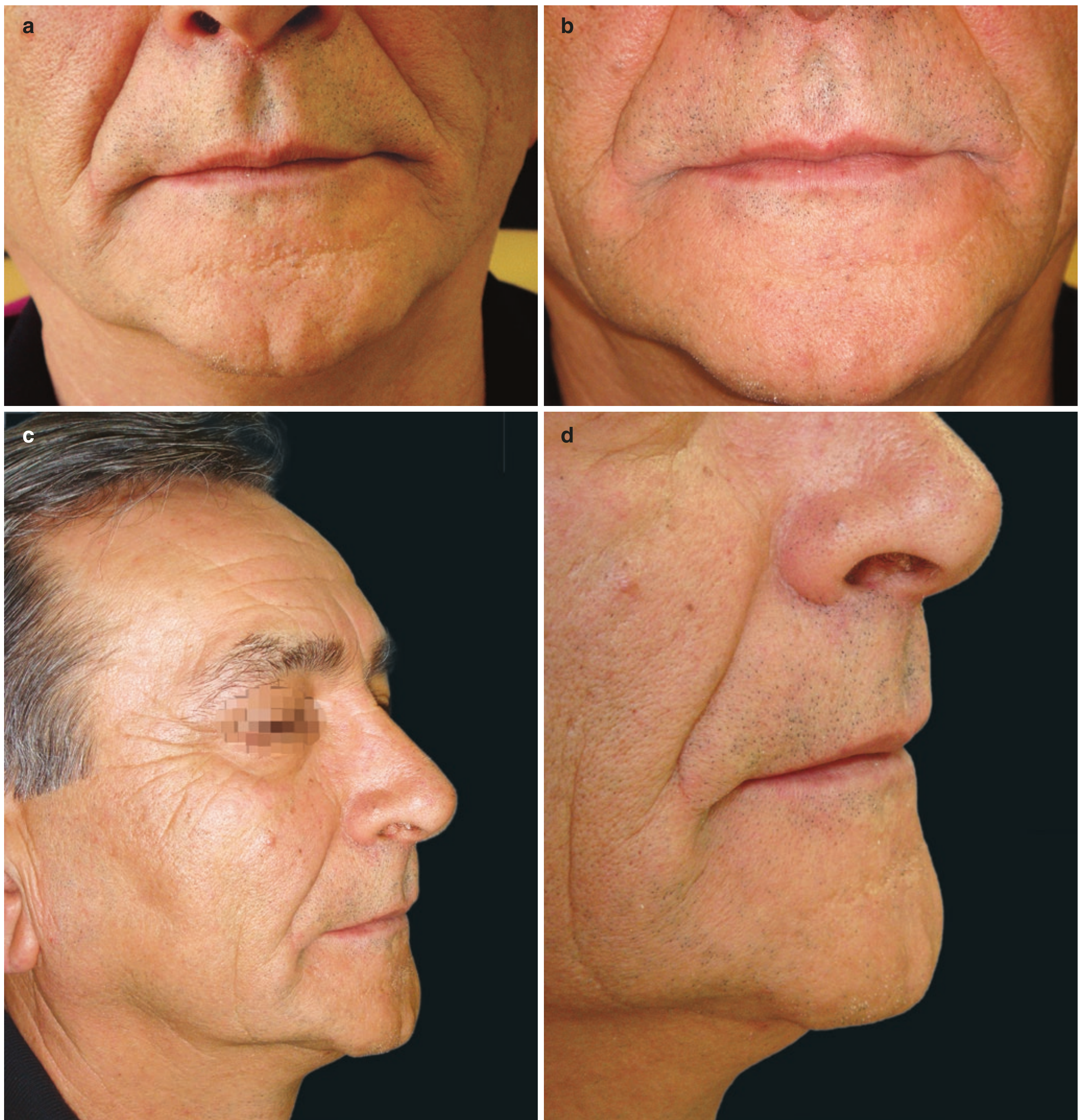


Fig. 3.29 (**a**, **b**) Frontal view of the nasolabial sulcus, philtrum, and lips. (**a**) Before the denture. (**b**) After the denture. (**c**) Lateral view of the nasolabial sulcus before the denture. (**d**) Lateral view of the nasolabial sulcus after the denture

than normal and support is not properly provided, the lips will not move and as a result the buccal corridor is reduced (Fig. 3.50).

3.1.2.10 The Relationship Between the Face and Teeth

There should be a comparison made between the color of the face and the teeth. The teeth should be checked to ensure the color of the teeth is warm and correct. The dentist must take care to confirm that the teeth will not look lighter by arranging the teeth buccally out of the arch, or will not appear darker by arranging them palatinally. When the upper and lower lips are in contact, the inclination of the cheeks and the shape and direction of the eyebrows should be considered. When the lips are not in contact, the harmony between the rotation amount of the central incisors and the vertical and horizontal shape of the eyebrows should be considered. The rotation amount of the second premolars and likewise the canines

Fig. 3.30 View of the upper incisor teeth (**a**) When the lips are spaced. (**b**) with slight smile

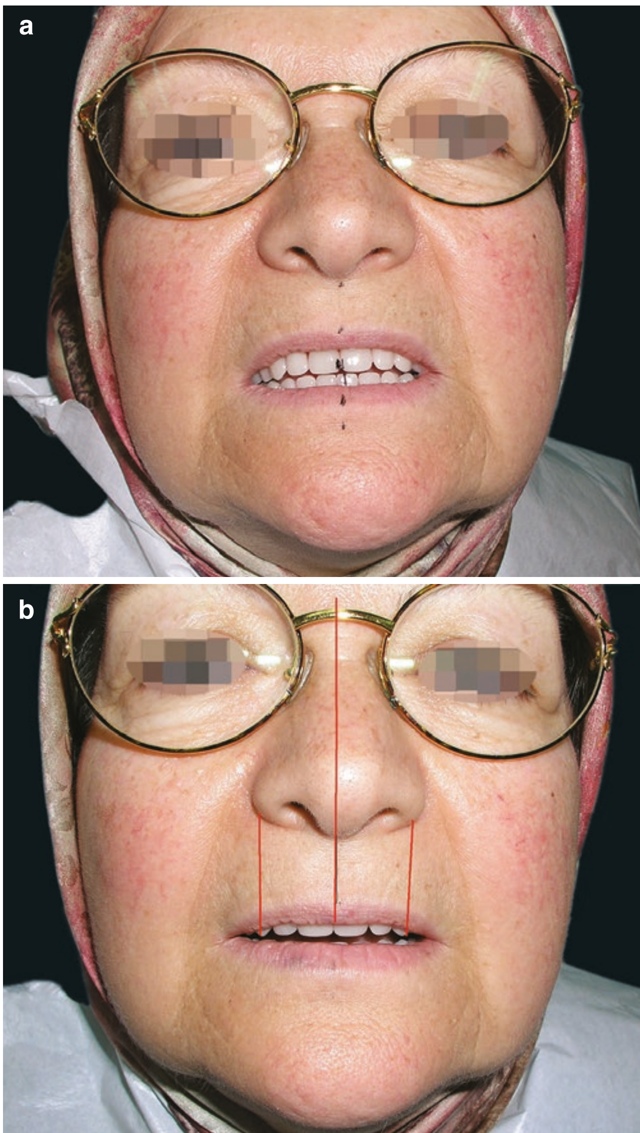


Fig. 3.31 (**a**, **b**) Checking the midline

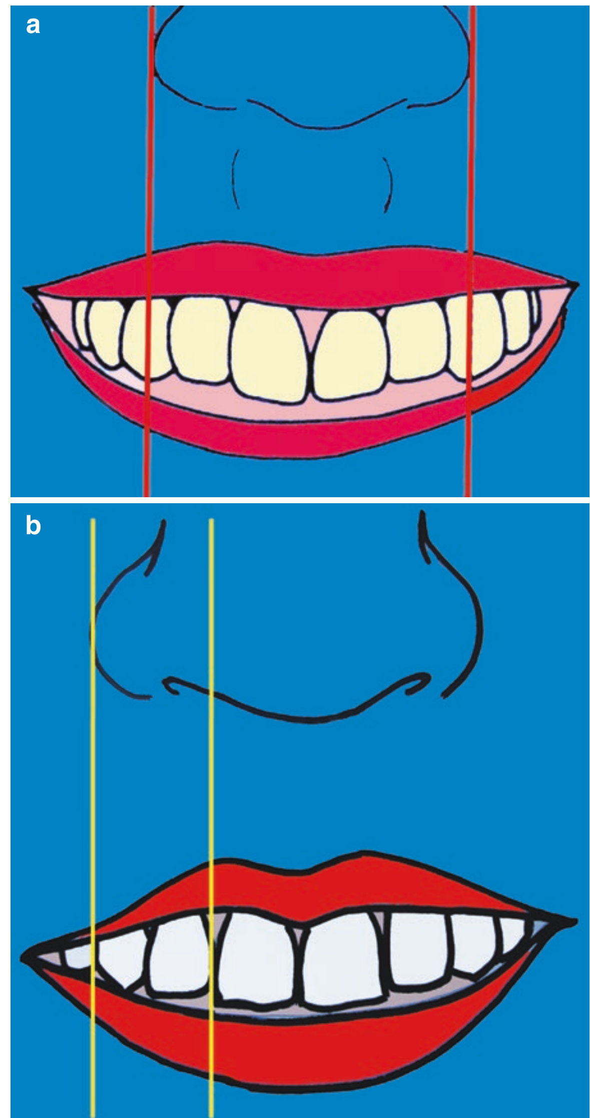


Fig. 3.32 (**a**, **b**) Relationship between upper anterior teeth, philtrum, and nose wings

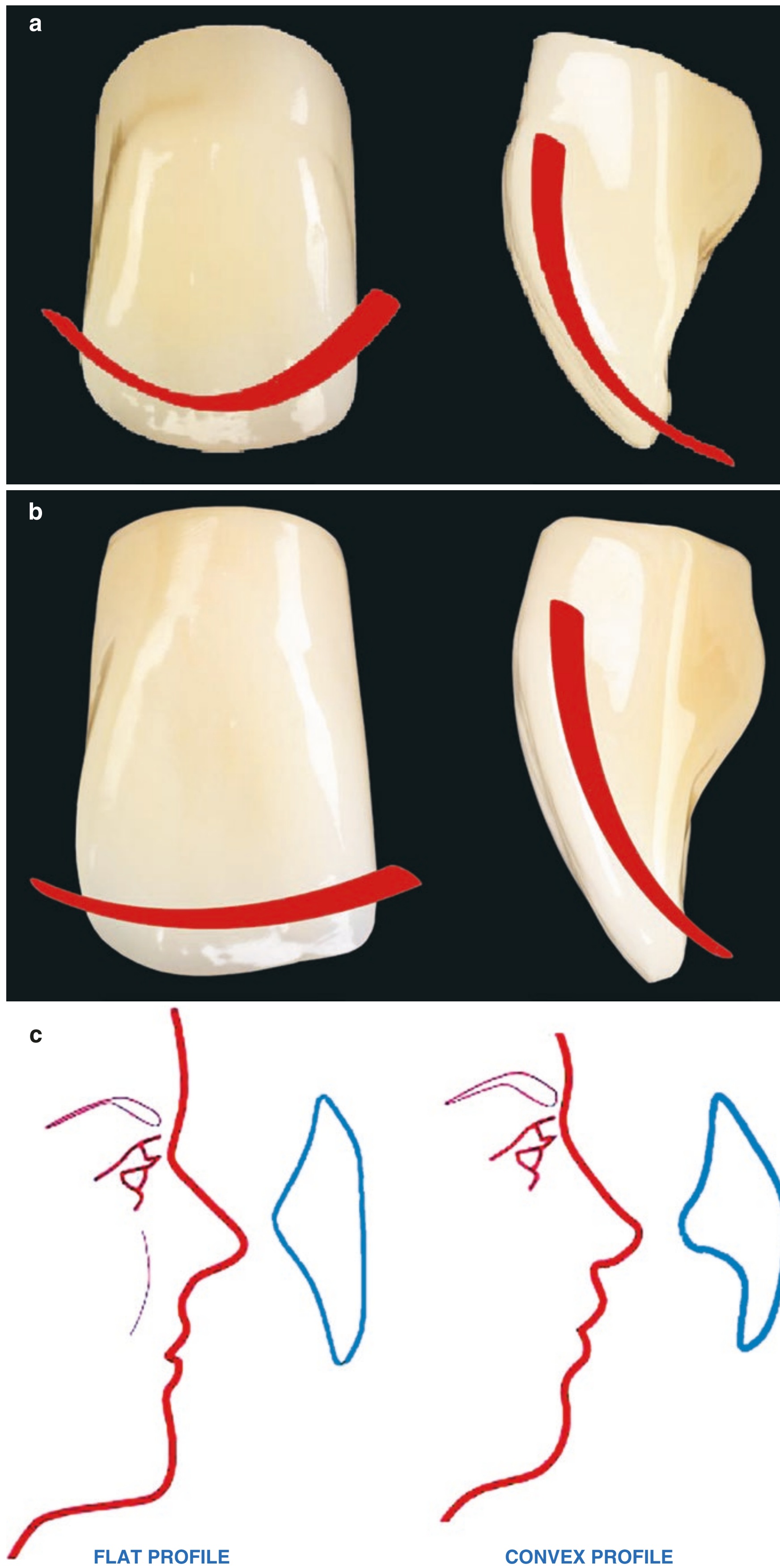


Fig. 3.33 (**a**, **b**) Convex labial surfaces of the teeth. (**c**) Relationship between face profile and convex labial surface of teeth

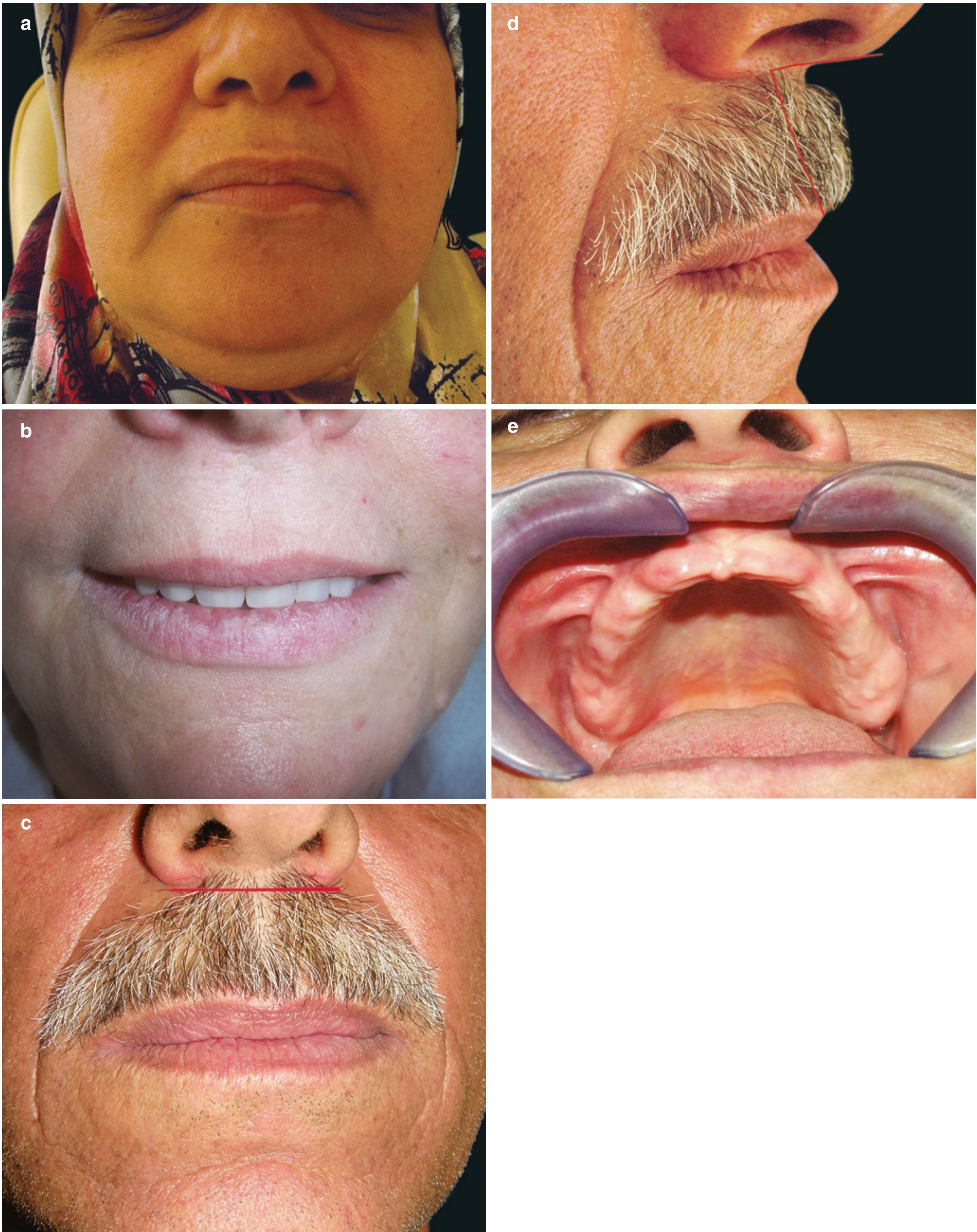


Fig. 3.34 (**a**–**d**) Aesthetic failure in the upper lip due to the thick labial flanges or anterior arrangement of the teeth (**e**) Excessive prominent crest. (**f**) View of the case on the model. (**g**) Adjusted anterior teeth arrangement

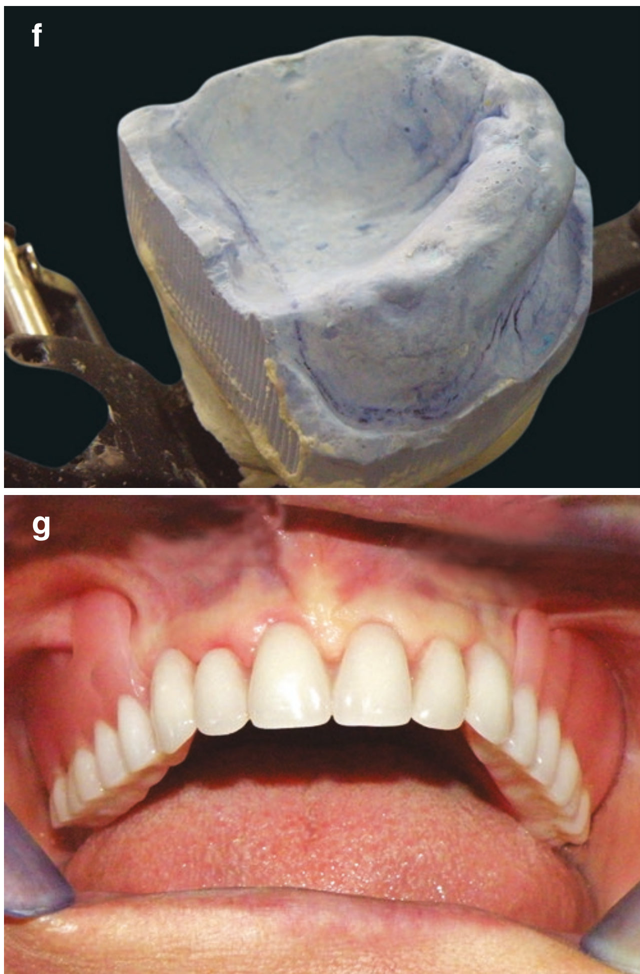


Fig. 3.34 (continued)

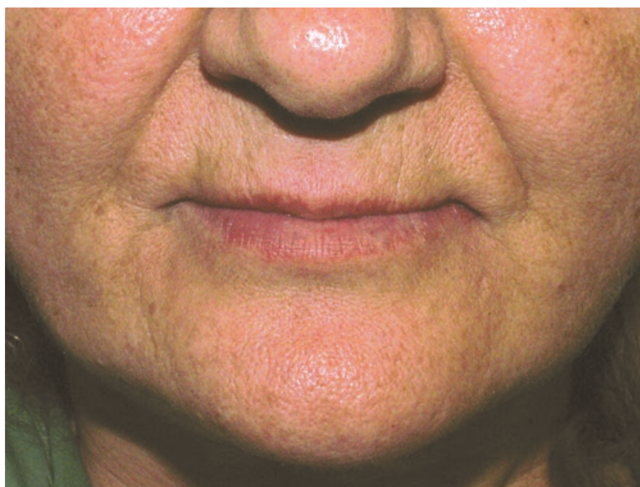


Fig. 3.35 The view of the tissue around the mouth as a result of insufficient lip support

should be considered to ascertain whether it is compatible with the inclination of the cheeks. Furthermore, compatibility between the wax-up on the cervical part of the teeth and the rotation and inclination of the teeth should be checked.

3.1.3 Problems Arising About Anterior Teeth During Try-In

3.1.3.1 Raised Appearance of the Upper Lip

If anterior teeth are arranged too labially and the natural arch shape was prepared too wide and forward, then the labial axis inclinations are arranged incorrectly (first incisor teeth should be arranged 8 mm ahead of the incisive papilla). When the anterior polished labial flange has been prepared too thick, the upper lip appears raised (Fig. 3.51a, b).

3.1.3.2 Collapsed Appearance of the Upper Lip

If upper anterior teeth are arranged too palatinally and close to the crest and besides this the patient's alveolar arch is too narrow and the vertical dimension is not sufficient, the upper lip will collapse inside (Fig. 3.52a–d). The incisive papilla may be used as a guide, and the teeth should be arranged 6–8 mm ahead of the incisive papilla.

3.1.3.3 Presence of Excessive Overbite

In such cases, it may be useful to increase the overjet or slightly enhance the vertical dimension. Excessive overbite generally is an undesirable situation for complete dentures. To reduce this, the labial incisal edges of the lower teeth and the palatinal incisal edges of upper teeth should be slightly abraded (Fig. 3.53).

3.1.3.4 Excessive Appearance of Anterior Teeth

In these cases, the occlusal plane is raised and overjet is reduced. The arch shape is narrowed and the vertical dimension is decreased a little. The teeth are arranged close to the crest.

3.1.4 Control of Posterior Teeth

3.1.4.1 Harmony Between Teeth Arrangement and Arches

If the line passing through the center line of the upper and lower crest is 80° or more, then the residual crests are in the proper position for posterior teeth arrangement (Fig. 3.54a).

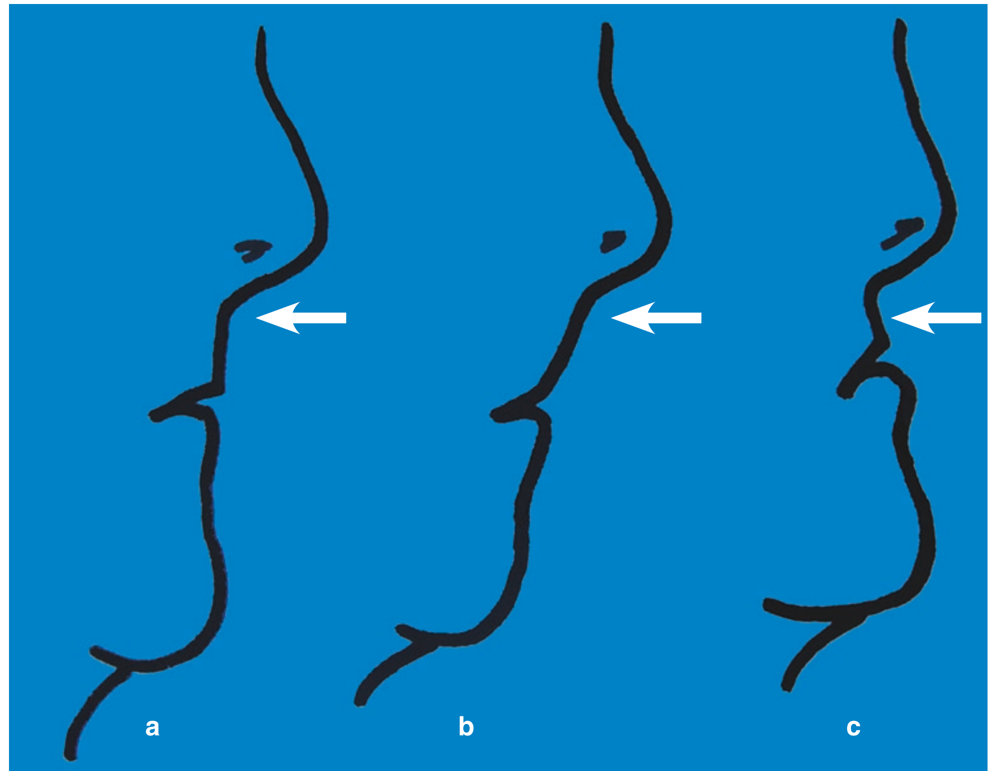


Fig. 3.36 The average of sagittal angle between the lips and columella is 90 degree in the normal class 1 relation. (**a**) Class 1. (**b**) Class 2. (**c**) Class 3

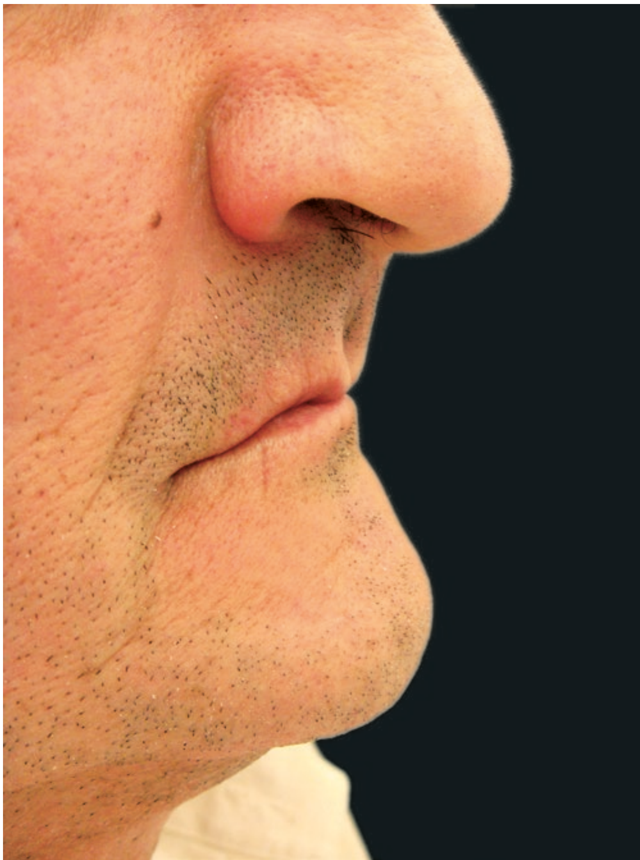


Fig. 3.37 The appearance of the upper lip of the profile (usually like a straight line)

An angle of less than 80° requires cross-bite or reverse occlusion for posterior teeth. This clinical condition shows that the lower crest is wider than the upper crest in the frontal and sagittal planes (Fig. 3.54b).

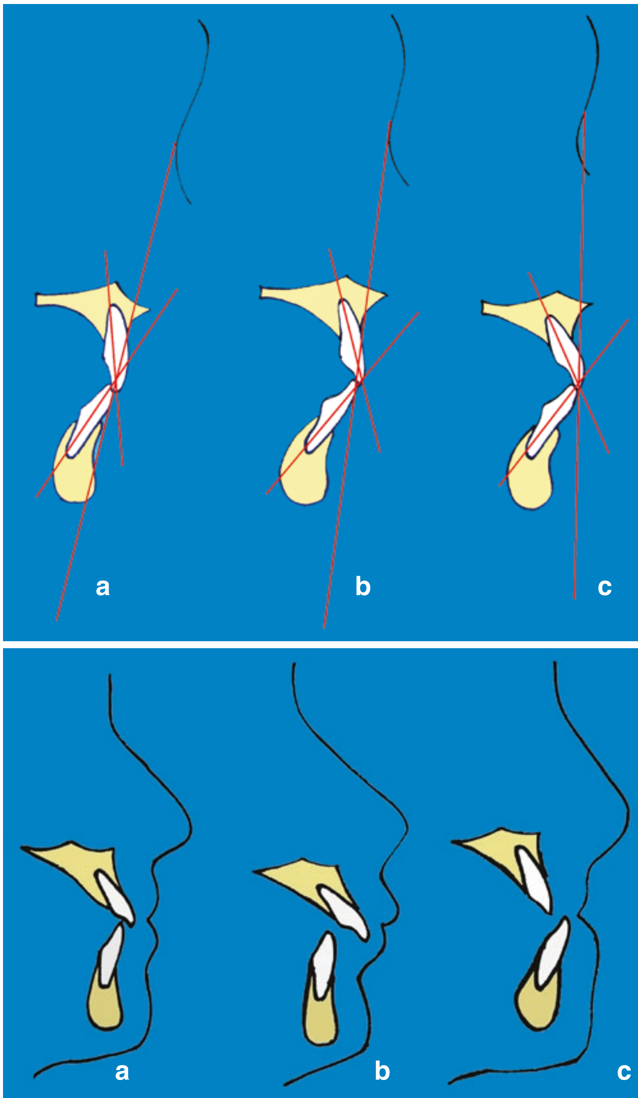
Centric occlusion should be evaluated. According to the tongue position, the occlusal plane, tooth/cheek relation and denture stability when under force should be considered. The contact of the cheeks should be evaluated. The posterior teeth should be arranged in the balance of muscles between the cheek and the tongue (Figs. 3.55 and 3.56). If cheek contact is missing, the bolus escapes to the patient's vestibular region when chewing (Figs. 3.57 and 3.58). Also, the denture moves with the slightest movement of the tongue (Fig. 3.59).

3.1.4.2 Positions of the Teeth According to Tongue

The arrangement of the teeth to the lingual side causes a decrease in tongue area (Fig. 3.60). The required area for the tongue should not be reduced and the dorsal side of the tongue should be on the same level or lower than the occlusal plane (Fig. 3.61).

3.1.4.3 Width and Position of Posterior Teeth

Pressure from the cheek and tongue affect the stability of the lower denture. The posterior teeth should be of such a size and position that they are placed in the neutral pressure area between these two structures (Fig. 3.62a, b). The overflow of teeth to the tongue space causes the tongue to cover a large



Figs. 3.38 and 3.39 The relationship between the slope of the anterior teeth and lips. (**a**) Class 1 relation. (**b**) Class 2 relation. (**c**) Class 3 relation

part of the occlusal surfaces of the posterior teeth. Normally, only 1–2 mm of lingual sides of these teeth can be covered by the tongue (Fig. 3.63). If coverage by the tongue is greater than this, either the teeth can be placed buccally, or the lingual surfaces can be grinded to reduce the width of the teeth. As an alternative, narrower teeth may be chosen.

3.1.4.4 Control of Centric Relation (CR) and Centric Occlusion (CO)

While asking that the patient closes the lower jaw in the terminal hinge axis position, the sliding of the lower baseplate should be considered. Many dentists are confused by this situation. If it is necessary, the closure should be controlled by holding the lower baseplate on both sides. If there is a mistake in the centric relation, the procedure is to remove the lower molars, place a higher level of wax on this region, and record a new centric relation. In such cases, the try-in stage should be repeated at another appointment. When the patient brings his/her lower jaw into the CR position, normal relations and maximal contact should be between the lower and upper jaws; that is, the CO should be normal. Any deviation pertaining to this issue may be caused by either incorrect centric relation, the slipping of the lower baseplate, or inaccuracy of the arrangement. All these things should be taken into consideration, and the correct tubercle fossa relation should be provided in the occlusion (Fig. 3.64a–d). When the flanges of both dentures are correct and the dentures are stable, the patient is asked to close his/her teeth gently. If everything is correct, the relation of the teeth resembles the relation on the articulator; however, equal posterior teeth contact does not mean that the occlusion is recorded correctly.

The second major phase is the evaluation of the CO position, which is obtained with the patient's closure. This situation is an occlusion position that is obtained without controlling the patient's mandible. In the meantime, it is important that the patient is sitting on the dentist's chair, and

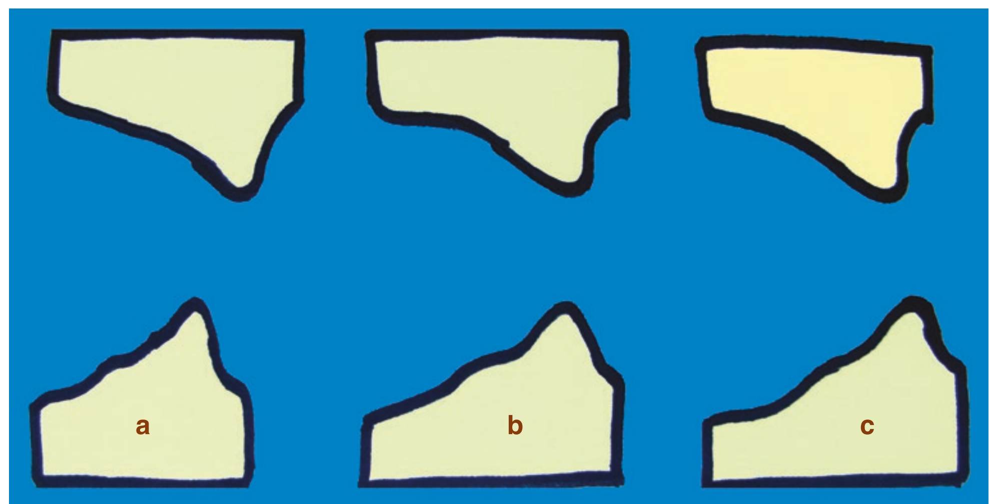


Fig. 3.40 When assessing the position of the upper teeth, the relation between the upper and lower crests should be evaluated. (**a**) Class 1 relation. (**b**) Class 2 relation. (**c**) Class 3 relation

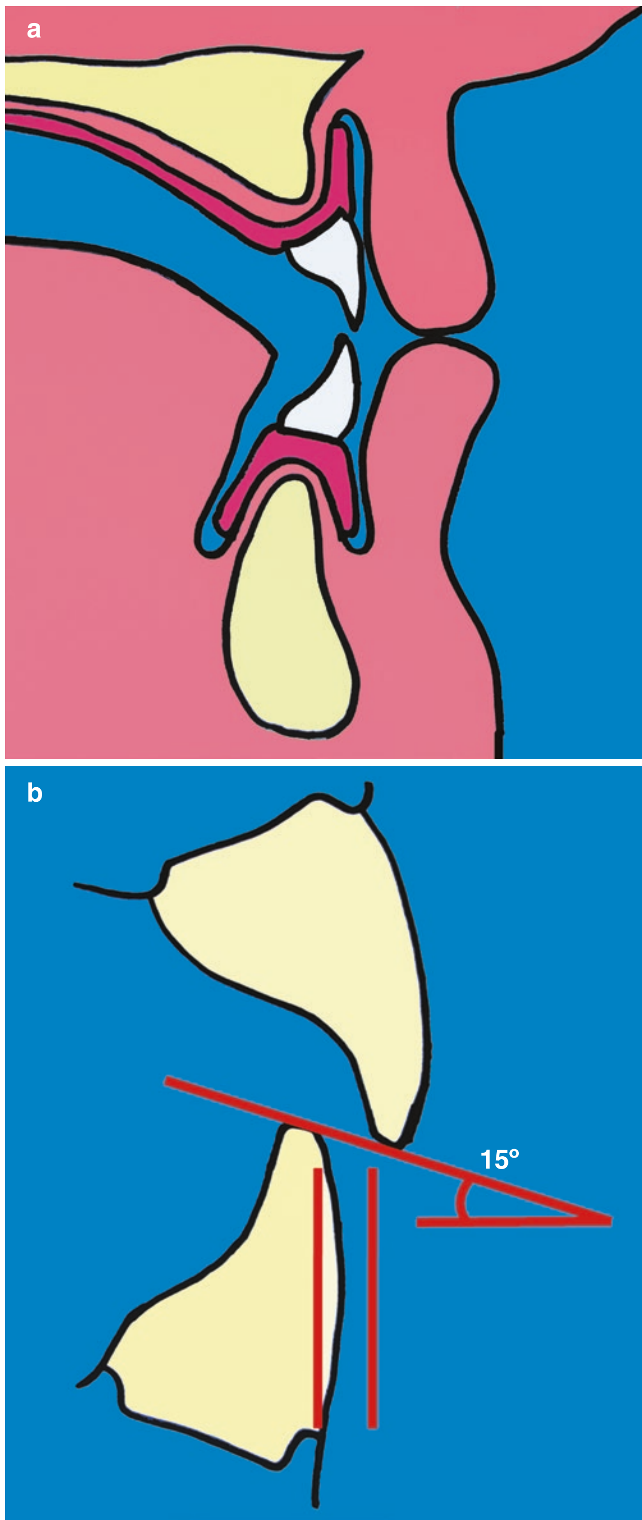


Fig. 3.41 (**a**, **b**) The angle formed by the combination of vertical and horizontal overlap in the upper and lower teeth should not be greater than 15 degrees

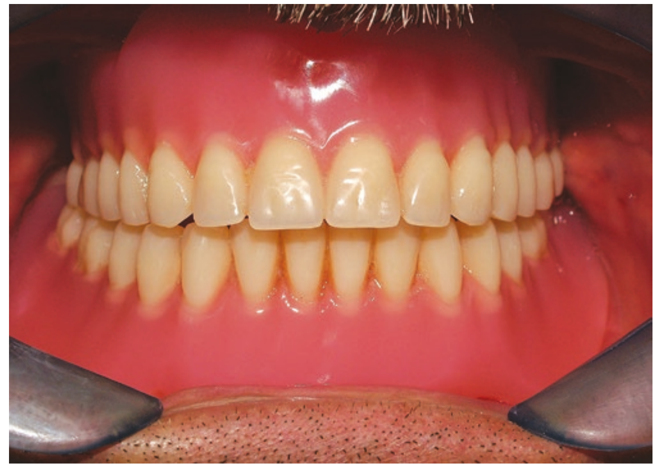


Fig. 3.42 Vertical and horizontal relationships in the upper and lower teeth

his/her head is upright and supported by the seat head. It must be ensured that the patient provides bilateral tooth contact during the first contact of the teeth, while he/she is performing opening and closing movements. The accuracy of the occlusion is controlled when the patient closes his/her mouth habitually. If there is any mistake, it will be more appropriate to correct it at this stage, before finishing.

If there is a mistake in the centric occlusion position and occlusal contacts, the following should be applied:

1. The balance of the dentures can be arranged on the articulator for the maximum intercuspidation in CR and CO. Therefore, the record of the protrusive relation is important. By determining the condylar inclination path, the protrusive balance is provided in the transition from centric relation position to centric occlusion position.
2. When the difference between the centric relation position and centric occlusion position is too much (more than 3 mm), it may be necessary to attach the dentures to the articulator in centric occlusion position. After having the CO record, the models are again taken onto another articulator with a key and the old articular key and CR record must be saved. Both articulator records will be used in obtaining the occlusal schema. To provide maximum intercuspidation, CO articulation is used and to provide a balanced tooth contact in CR position, centric relation models are used.
3. Determining the difference between CR and CO is important, in terms of determining the difference between the patient's familiar teeth arrangement and the new teeth arrangement that the dentist will create.

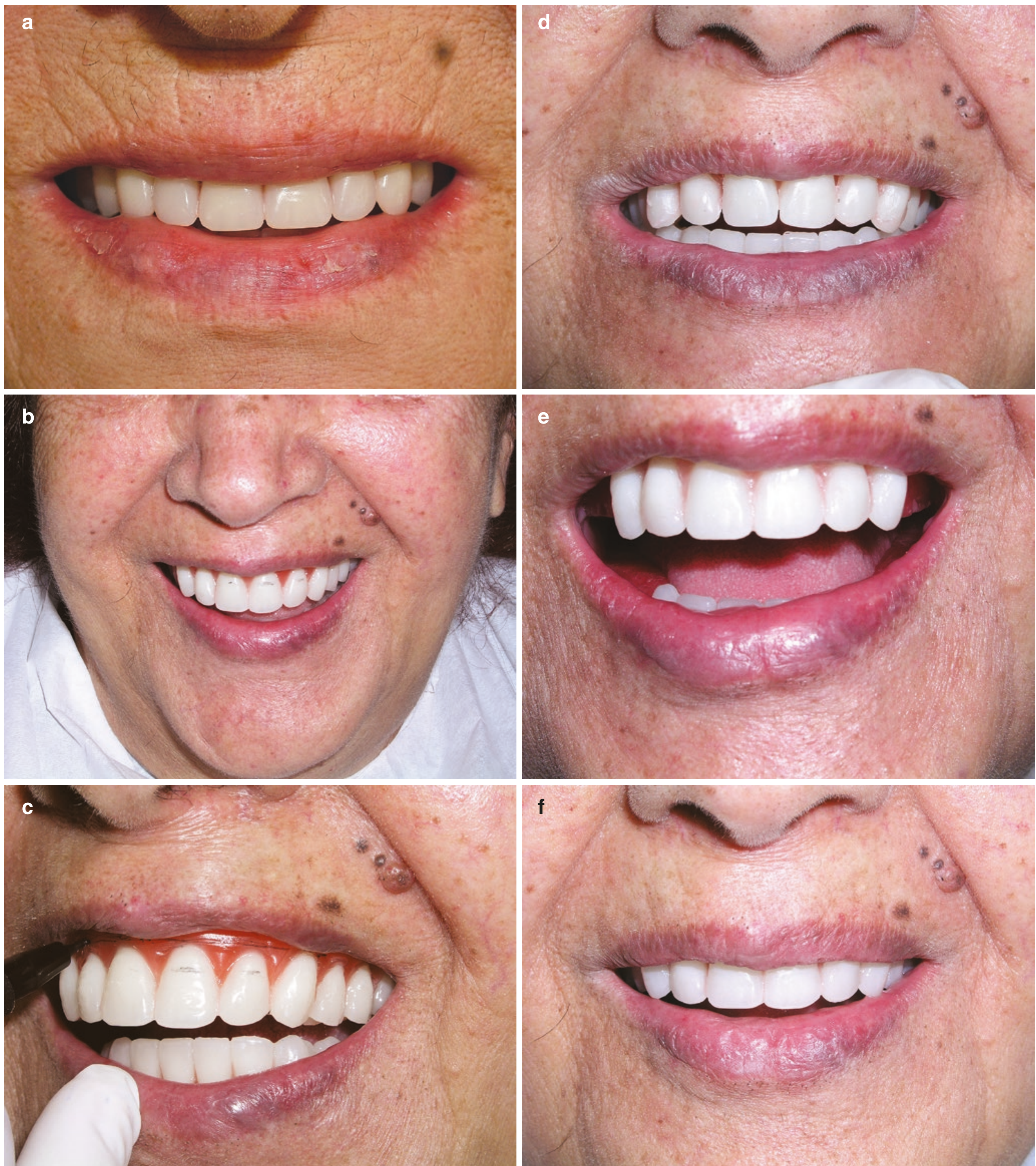


Fig. 3.43 (**a**) Determining the aesthetic of the smile line. (**b**–**e**) Making the necessary controls to provide an aesthetic smile line. (**f**) Proper smile line achieved as a result of controls

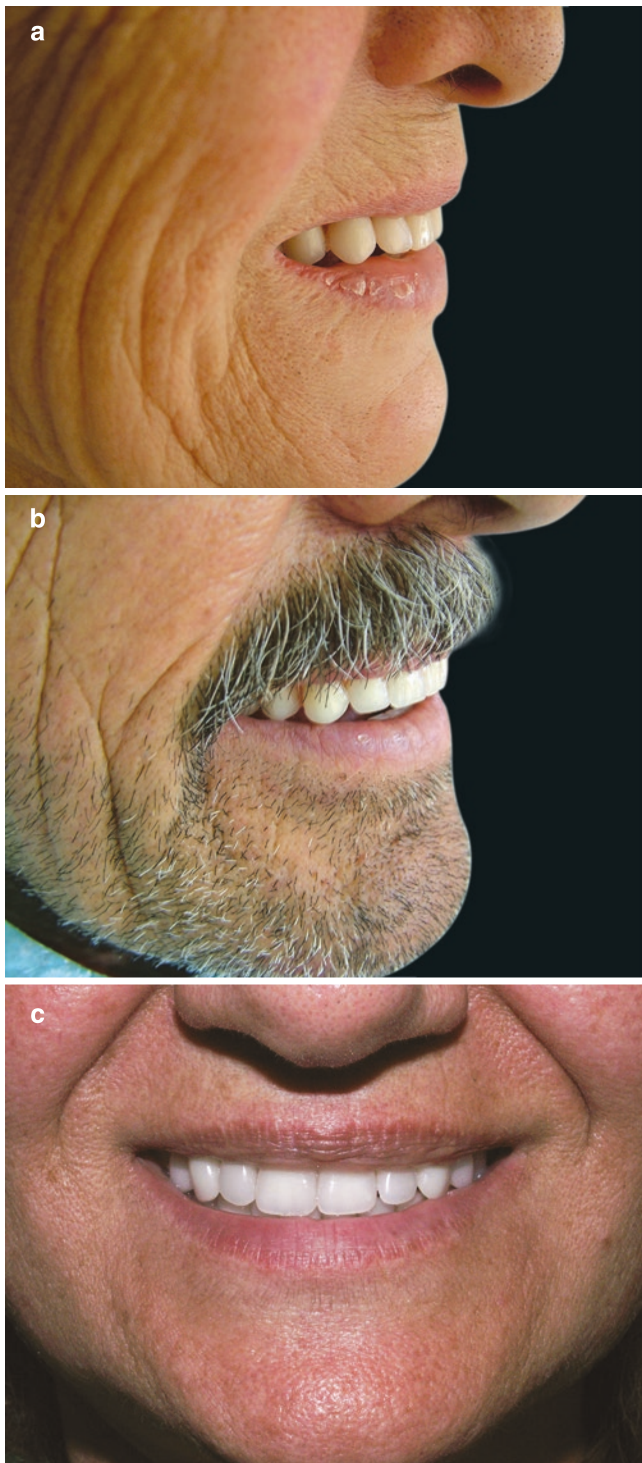


Fig. 3.44 (**a**–**c**) Smile line, arranged according to the requests of the old patients (the quantity of teeth appearance is more)

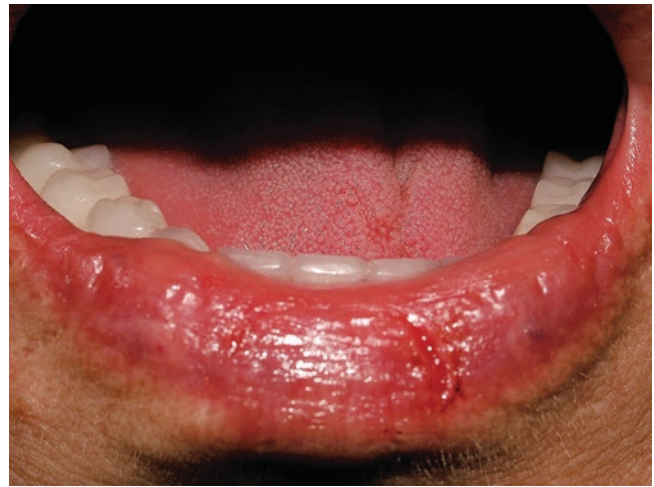


Fig. 3.45 The relationship between the lower lip and the lower anterior teeth

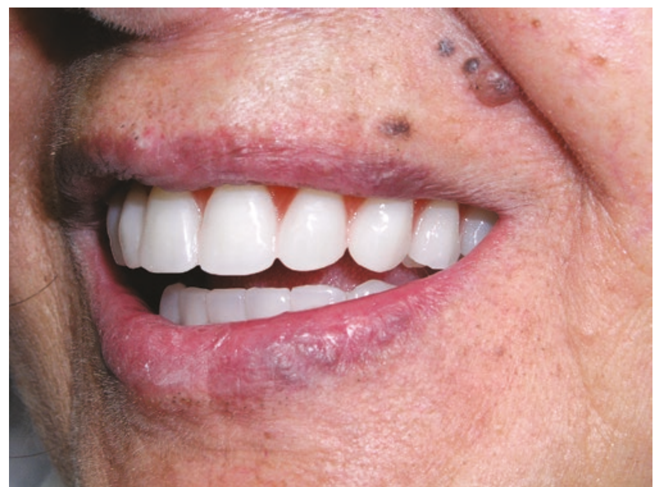


Fig. 3.46 Arrangement of lower anterior teeth higher than the lower lip level

3.1.5 Problems Arising During the Determination of the Occlusion

3.1.5.1 The Space Between the Posterior Teeth

A space is created between the denture and basal tissues in situations when the lower denture rises for occlusion with the upper teeth. This problem commonly occurs in the lower posterior region. When trying to place a spatula between the posterior teeth, if there is a space, the denture will be out of occlusion and sit on the basal tissues. The same situation occurs if the denture is finished without correcting the mistake. Excessive abrasion from the teeth can occur; as a result of this, vertical dimension may decrease, and chewing efficacy of the teeth may be reduced (Fig. 3.65a–c).

However, the amount of force applied for separating the teeth should be minimum, and during controlling, the occlusal contact should be preserved. If more force is applied, the patient will feel pain, and to eliminate the pressure, the jaws should be slightly separated from each other. If there is too much mobile tissue on the alveolar crest, the excessive force will result in the lapse of the denture to the tissues, and a virtual occlusion error will be observed.

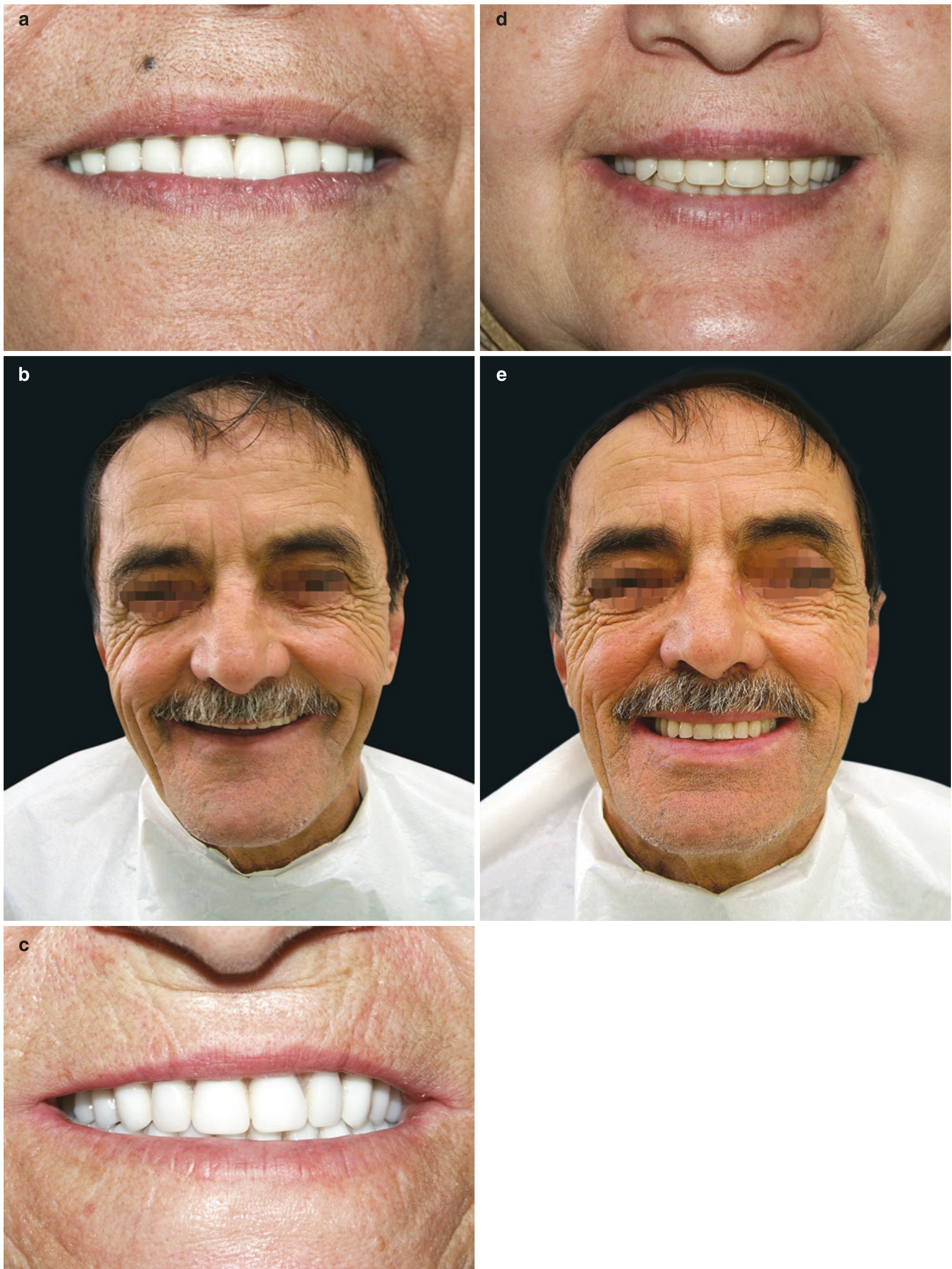


Fig. 3.47 (**a**–**c**) Aesthetics is disturbed when smile line cannot be adjusted, and facial expression is adversely effected. (**d**, **e**) Providing harmony for the smile line

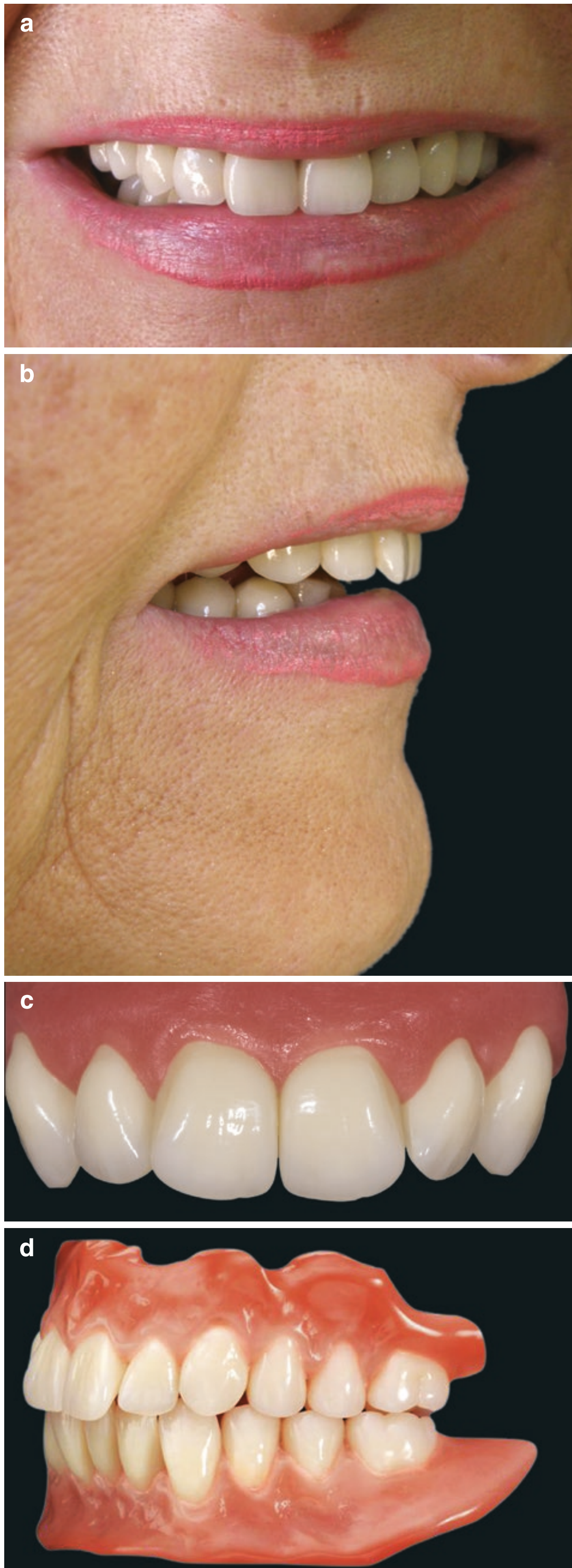


Fig. 3.48 (**a**–**d**) To improve the natural appearance of denture, modifications can be made during teeth arrangement

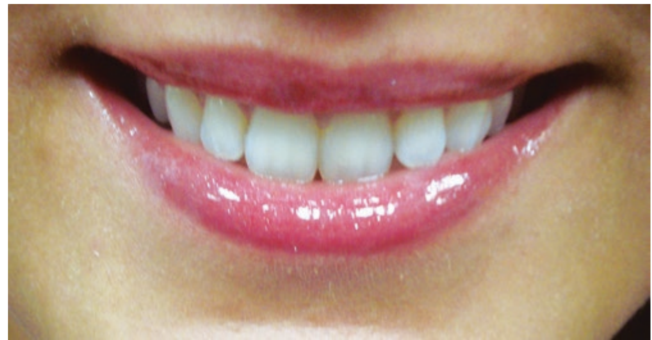


Fig. 3.49 Buccal corridor formed between the corners of the mouth and the buccal surfaces of the upper teeth increases aesthetic in a positive manner

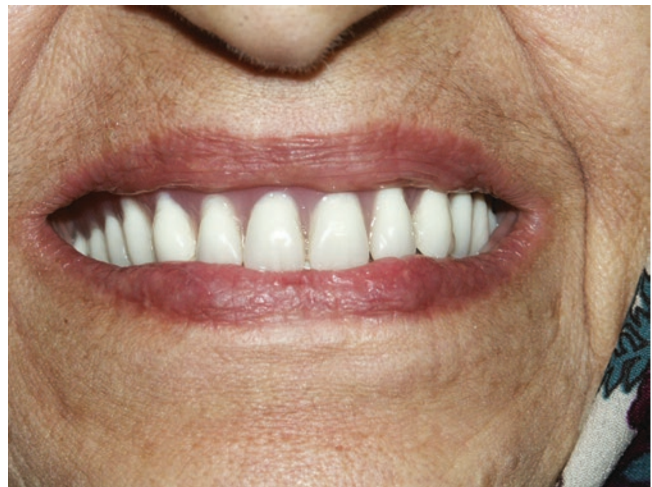


Fig. 3.50 Failure to create the buccal corridor

This occlusion insufficiency on the posterior teeth can arise from a similar movement of the record block while recording the occlusion. Unless slight pressure is applied bilaterally in the premolar region, the base of the record block cannot make contact with the tissues. As a consequence, the distance determined between the wax rims and crests is smaller than it should be, and therefore, although the posterior teeth are in occlusion on the articulator, they are separate from each other in the mouth. This type of error is related to the clinic. To fix this, wax plates of the proper thickness are placed on each side, and the correct distance between the crests can be recorded. The teeth are neither moved, nor they are raised to make an occlusion. This is a time-consuming and inaccurate method. After recording the correct occlusion, the technician will put the models on the articulator again and arrange the occlusion. Usually the upper record block is placed correctly, and thus the upper occlusal plane is correct for such patients.

In some cases, a lack of contact on the posterior teeth can occur due to the increase of the distance in the anterior region

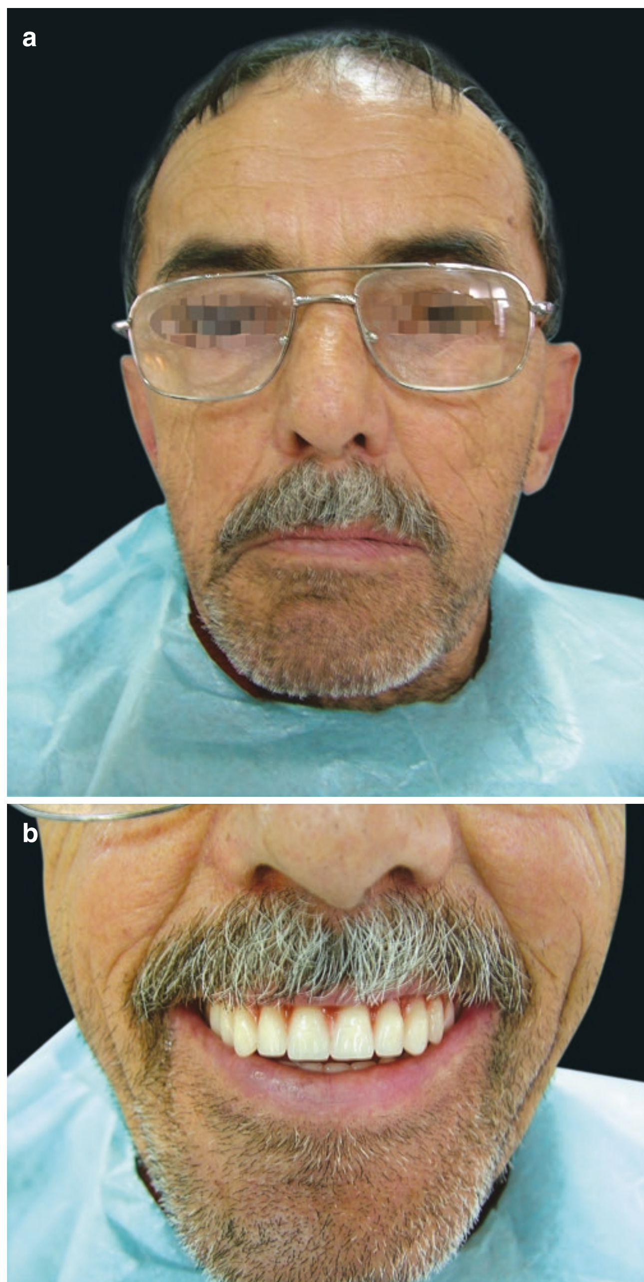


Fig. 3.51 (**a**, **b**) Arranging the upper teeth anteriorly causes the upper lip to be seen over contoured

that separates the models. This can happen while attaching the models to the articulator, but it is not a common mistake.

3.1.5.2 The Space Between the Anterior Teeth

The second widely observed occlusal error occurs either with the reduction of the vertical incisal overlap, which exists on the articulator, or with an evident gap between anterior teeth. In such a situation, occlusal height is increased, and the patient is not able to close his/her lips comfortably. In order to avoid this type of error, the distance between the models on the posterior region should be greater than the distance between the same regions in the mouth (Fig. 3.66).

Clinically, a small increase on the posterior region can occur by the compression of the tissues that covers the crests. If more pressure is applied while the wax rims are in contact, it can be increased 1–2 mm due to the soft tissue amount that can move to the space between the crests. This mobility will not be observed on the surface contours of the plaster models. For this reason, they remain separate from each other in this area, and primarily, when the patient brings the teeth to occlusion, the posterior teeth are first to contact each other. This type of occlusal error occurs as double sided. If hard wax is placed to one side of the jaw and soft wax placed to another side, tissues under the hard wax are compressed, and a high level of wax rim is provided in this region. Similar faults also occur because of the reduction of stress of a partially softened great piece of wax. If the occlusion is obtained using the squash bite technique (biting with pressure) and the wax has been left in a warm place for 1–2 days, the distortion which occurs due to the stress distribution inside the wax increases the height of the wax rims and the distance between the models. This can occur during the determination of occlusion or by correcting the mistake in the previous try-in stage.

The mistakes that arise by the premature contact of the molar teeth may be also due to a technical error in the laboratory. The lower and upper contacts of the models behind the denture bearing area do not allow the record blocks to fit correctly to the base and thus increase the distance between the crests.

Alternatively, if the adaptation of record block to the model is not sufficient, a similar mistake may occur by preventing the correct fit of the base to the model. The wax trial base will adapt itself partially to the mouth's shape, and when again placed to the inaccurate model, a weak adaptation will be observed. After all, if the real source of the mistake could not be detected, the distance between the crests will continue to appear more.

To correct the occlusion, the position of the upper teeth is controlled. If it is satisfactory, the lower posterior teeth are removed, and instead, a wax rim is placed at similar height. If the wax is added until it contacts the upper teeth, an accurate occlusal height record can be obtained by softening the surface later on.

3.1.5.3 Control of the Protrusive and Lateral Balances

The dentist should control the protrusive and lateral balances and observe whether or not the balance type which is hoped to obtain is provided. Balance can be provided consciously for cases where the teeth are arranged on a semi adjustable articulator, records are taken from the jaws, and during the

Fig. 3.52 (**a**, **b**) Arranging the upper anterior teeth more palatinally causes a collapsed upper lip. (**c**, **d**) Achieving lip support by the correct arrangement of teeth

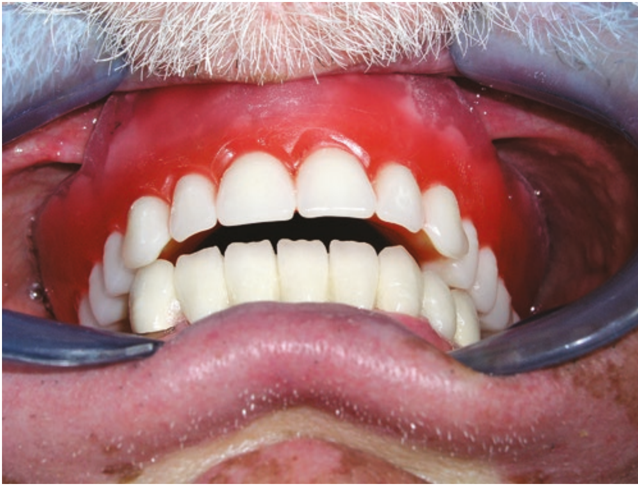


Fig. 3.53 Excessive deep bite

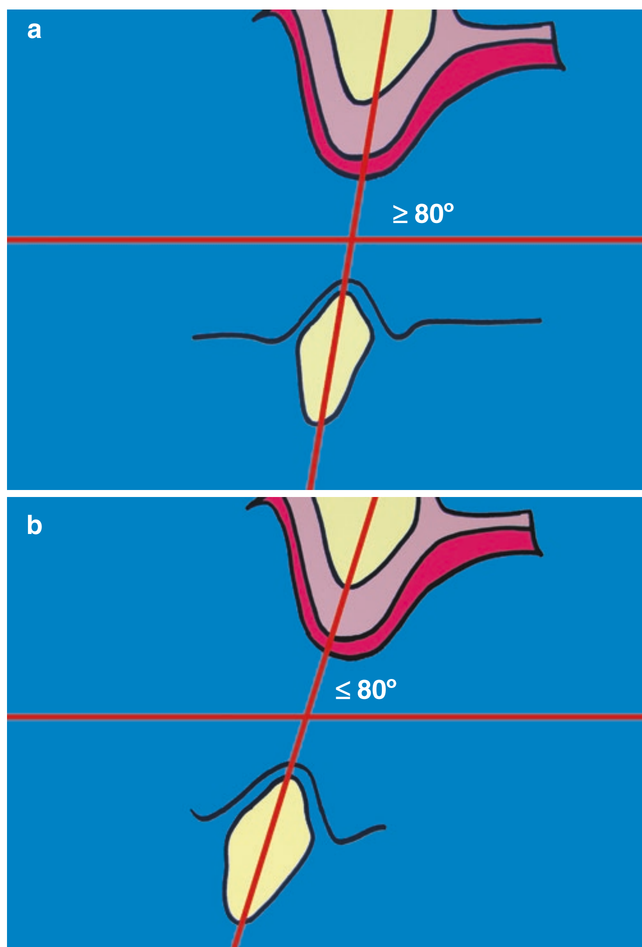


Fig. 3.54 (**a**) The line passing through the center line of the upper and lower crest is 80 degree. (**b**) The line passing through the center line of the upper and lower crest is lower than 80 degree

try-in stage, this situation can be proved. However, when the teeth are arranged on a simple hinge articulator, providing the balance is by change.

While teeth are arranged on this type of appliances, to provide an acceptable balance, the curve of Spee should be increased in cases with too much overbite. But despite everything, it should not be forgotten that the dentist will have to make too many concessions about the aesthetics or the anterior teeth and surface morphology of the molars to provide balance after finishing the dentures.

Small balancing mistakes are not important during the try-in stage. These can easily be removed later on with abrasion. During the try-in stage, the teeth can displace when controlling the balance contacts.

During lateral movements, when there is contact on the working side, contacts on the balancing side should be provided (Fig. 3.67a, b). Bilateral contact is desired for complete dentures. The reasons for this are the prevention of tubercle interferences during eating and speaking and providing denture stability.

It is also necessary to take care that when there is contact in the anterior teeth during protrusive movement, the posterior teeth should also have contact.

3.1.6 Problems Related with Posterior Teeth During the Try-In Stage

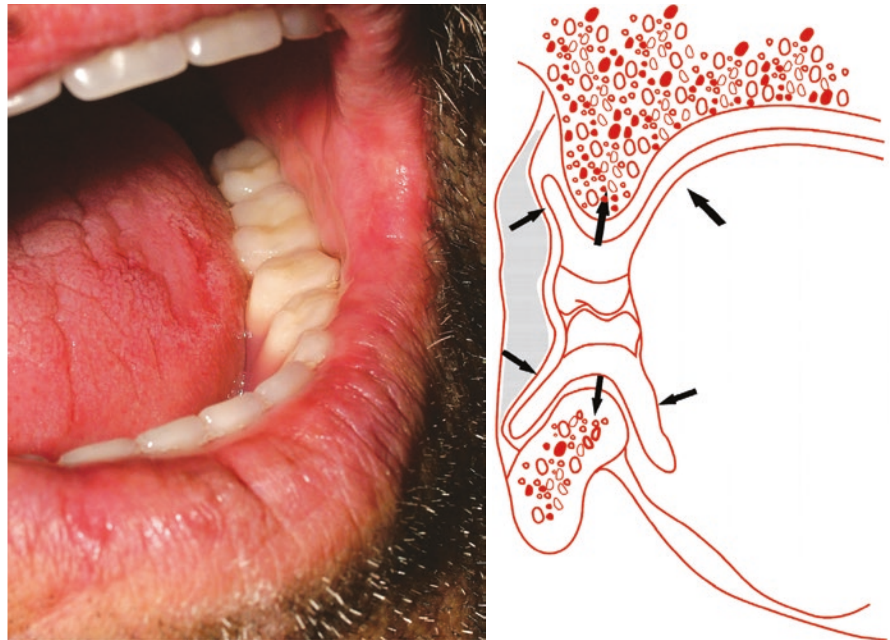
1. Too Much Visibility of Molar Teeth (Fig. 3.68)
   In cases where occlusal plane is determined high, the molar teeth are very visible. For the solution of this situation, the arch shape is narrowed, and the vertical dimension is slightly reduced. The first premolars are placed exactly on the crest. Wider anterior teeth are used.
2. Too Much Visibility of the Baseplate (Fig. 3.69)
   The occlusion plane will need to be elevated and if necessary long teeth are selected.

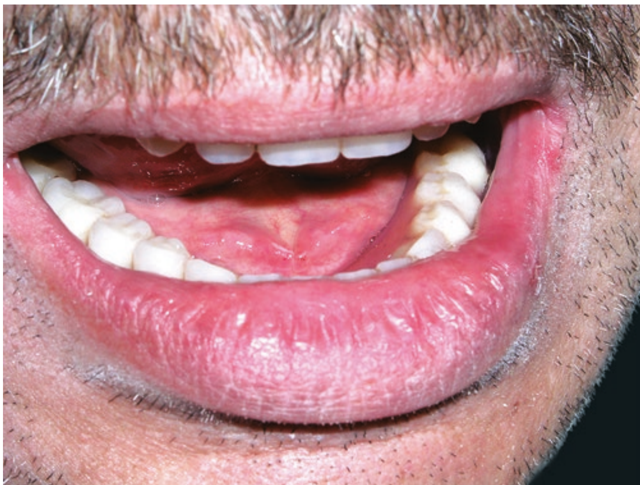
3.1.7 Patient Satisfaction

Hearing the thoughts of the patients' relatives is an important session. The patient is asked to look himself/herself in front of a pier glass instead of a hand mirror. Thus, with the help of pier glass, they will find an opportunity to examine their whole face instead of just a part of it and consider the dentures as a part of their face and body.

During the evaluation of the dentures, two types of patients are experienced. One group of patients runs to the mirror and starts to examine their teeth, including the lips, as soon as the dentures are inserted. Another group of patients comes close to the mirror very carefully and almost never looks at their teeth.

Figs. 3.55 and 3.56 The posterior teeth should be in balance with the cheek and tongue muscles (Neutral area)





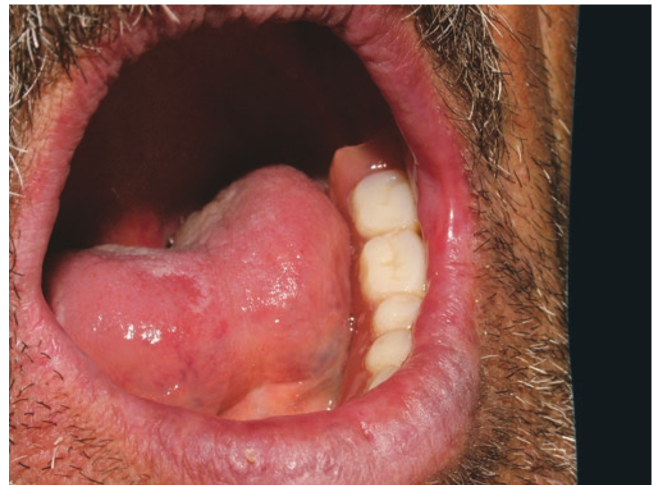
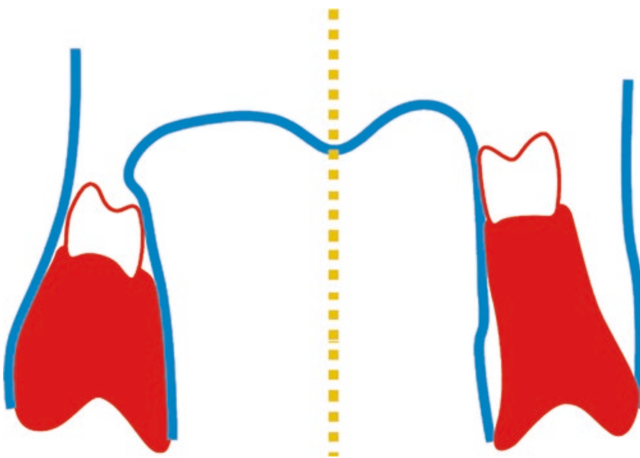


Fig. 3.59 The movement of the denture is unavoidable, when the neutral area is not achieved



Figs. 3.57 and 3.58 As a result of the lack of cheek contact, food is stuck in the gap

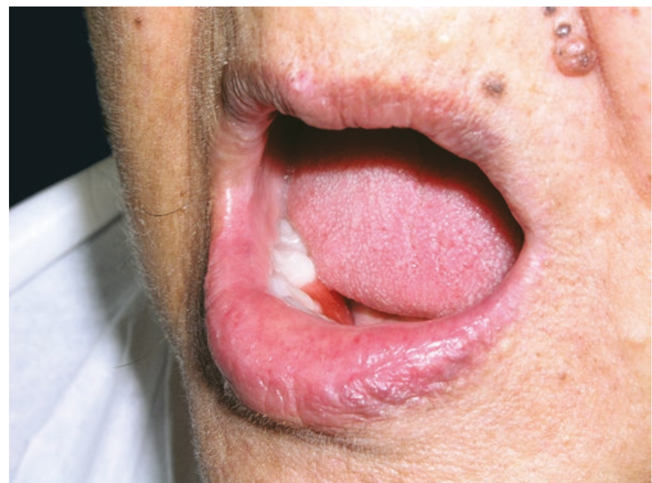


Fig. 3.60 Placing the teeth more lingually narrows the space for the tongue

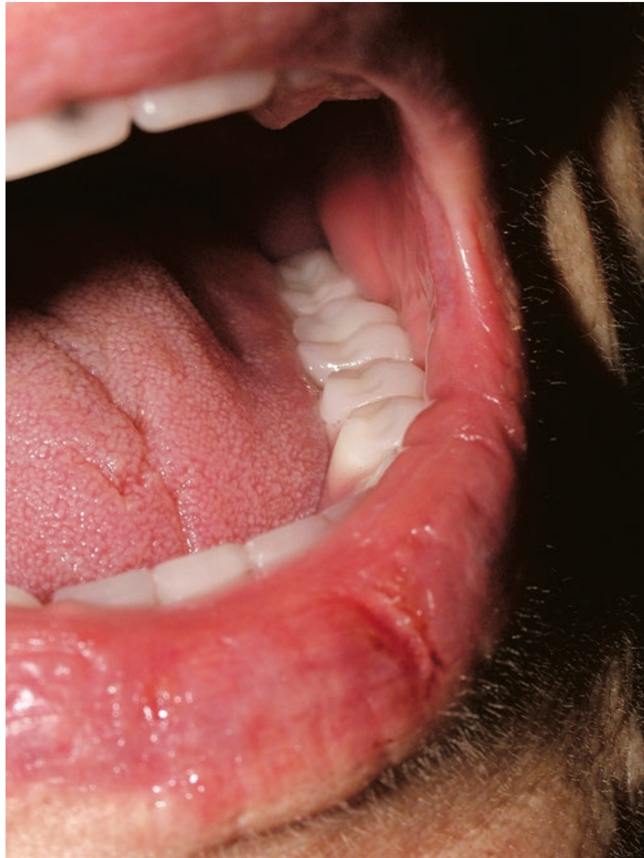


Fig. 3.61 Teeth arranged in harmony with the cheek and tongue

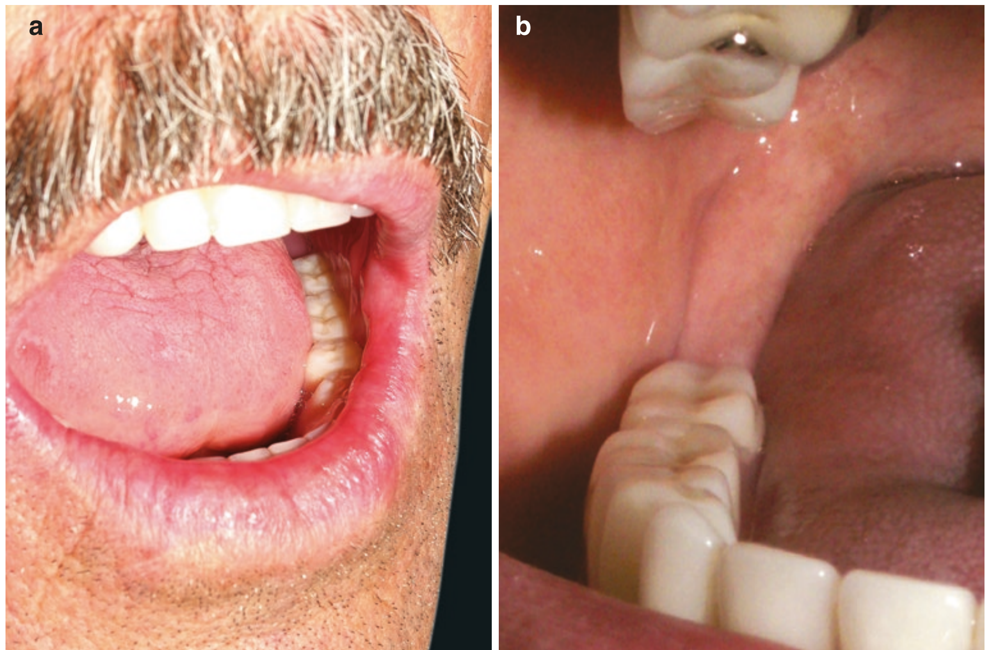


Fig. 3.62 (**a**) Balance between cheek and tongue pressure. (**b**) The lack of balance between cheek and tongue pressure

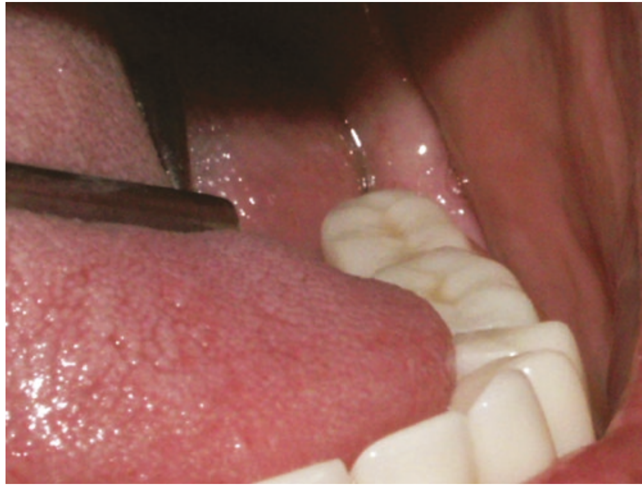
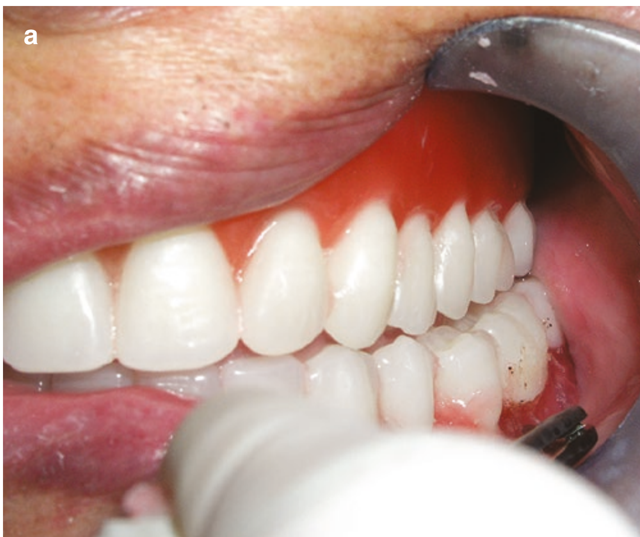
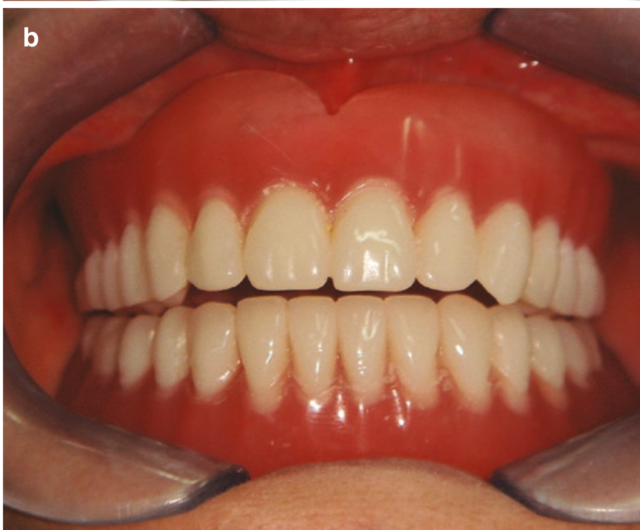


Fig. 3.63 The tongue can cover the posterior teeth by up to 1–2 mm

Fig. 3.64 (**a**) Correct relationship between the cusp and fossa in centric relation. (**b**, **c**) Lack of full contact in centric relation. (**d**) Full contact in centric relation





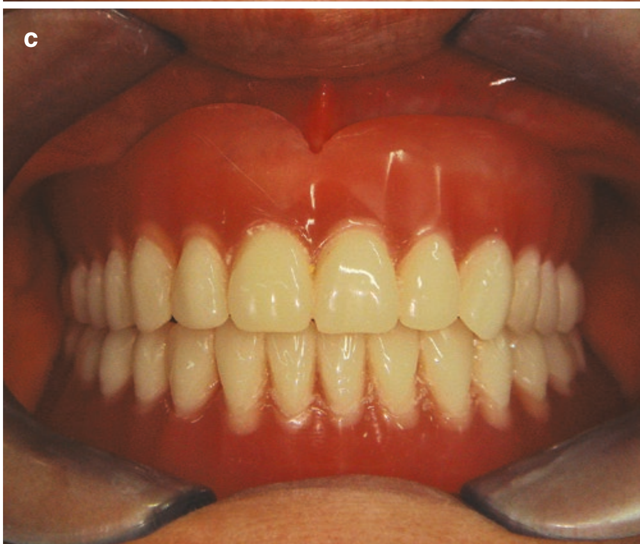
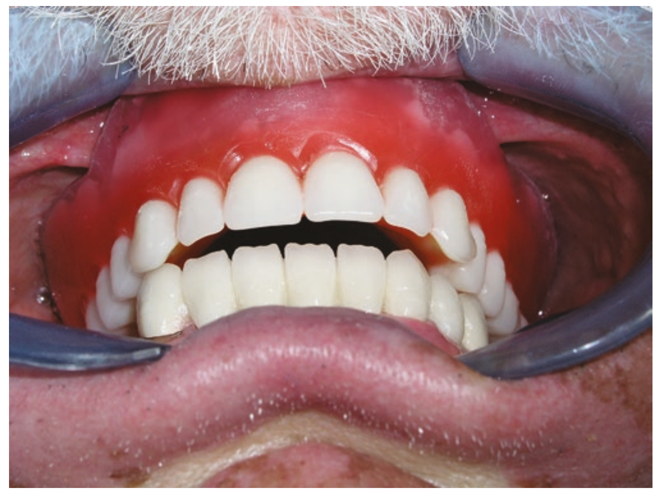
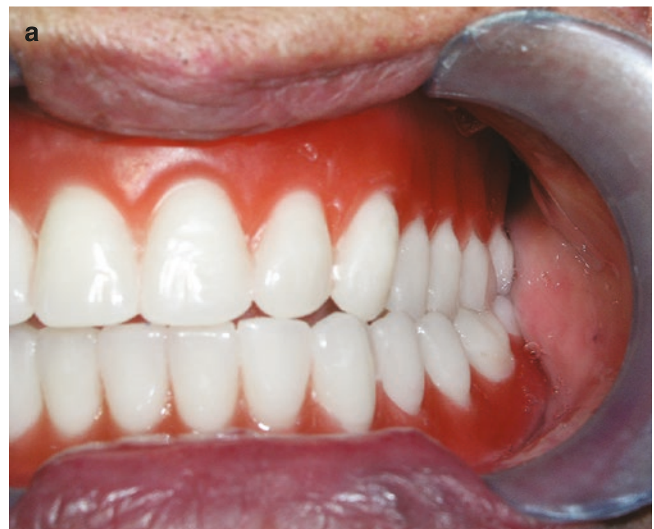


Fig. 3.65 (**a**, **b**) The space between the posterior teeth in centric relation. (**c**) Providing simultaneous contacts in centric relation



Figs. 3.66 The space between the anterior teeth in centric relation



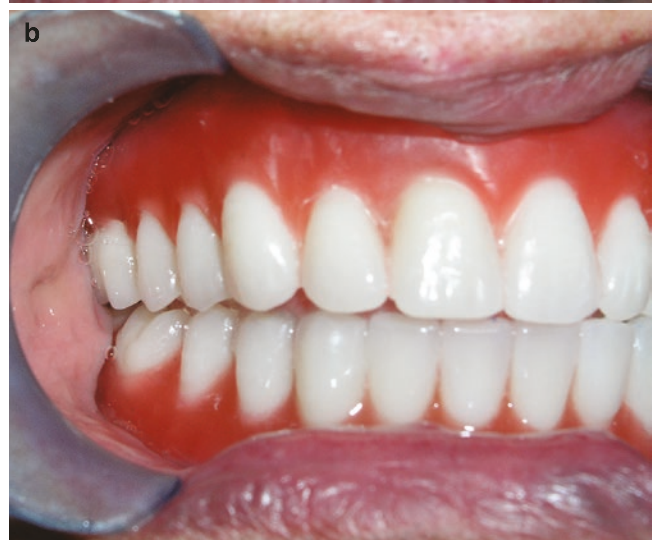
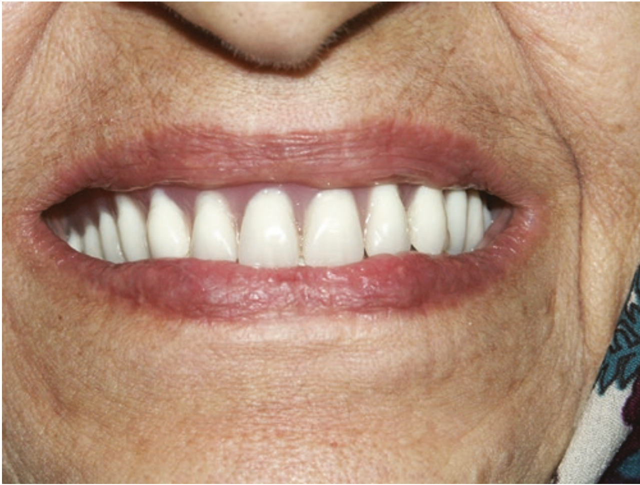


Fig. 3.67 (**a**, **b**) Checking the working and balancing side contacts during lateral movements



Figs. 3.68 Exessive appearance of molar teeth

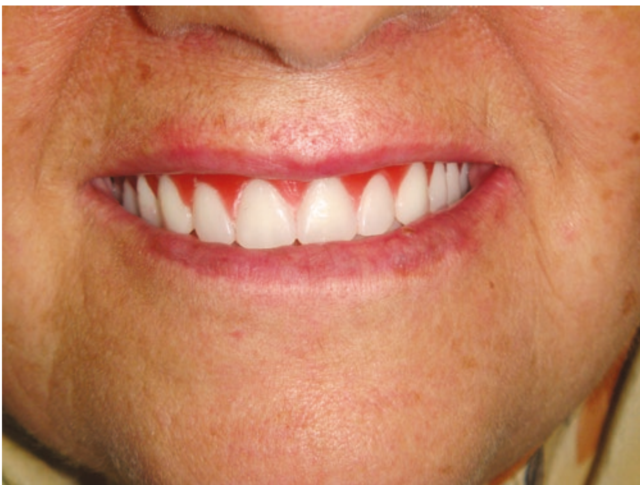


Fig. 3.69 The excessive appearance of the baseplate

The first type of the patients is *analytical and obsessive*. While the dentist persuades them to stop looking the mirror, these types of patients must be told to look at themselves from the perspective of other people.

In the second type of patient group, there are *adaptable* patients, but it is more accurate to say that they behave in a way that is dignified. Before the acceptance of the patient, it is necessary to ask the patient to look his/her teeth carefully. During the try-in stage, following the confirmation, it will not be correct to be surprised if the patient finds the dentures unaesthetic after their insertion (perhaps due to a relative or a friend's idea). For both patient groups, during try-in stage, the patients could be asked for their relatives' and friends' ideas by delivering the dentures with wax-up.

It is necessary to tell the patient not to eat or drink with the dentures only in the mouth for 10–15 min and even give him/her written instructions. Also, the patient is asked to bring the recommendations written by their relatives.

In the second try-in session, after the desired changes are completed and patient satisfaction is provided, the dentures are sent to the laboratory for finishing. Thus, the patient also would feel himself/herself to be responsible for the aesthetic evaluation after the dentures are finished.

Due to these reasons, which an attempt has been made to explain, during the teeth arrangement, the dentist or the technician should try to consider the dentures as the patient sees them. Therefore, the dentist should make a habit of analyzing and looking from left to right.

There are two practical ways to gain this habit:

1. The models are removed from the articulator, rotated so the labial surfaces of the teeth are distant and the dentures are observed from above and the back (in front of a mirror).
2. During the last try-in session, the dentures are observed in the mirror from the back of the patient. In such a situation, the dentist sees the dentures as the patient sees.

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4 The Remounting Process: Adjustment of Dentures on the Articulator and in Mouth

Zeliha Şanıvar, Şükrü Can Akmansoy, Seda Keban, and Yasemin K. Özkan

4.1 The Remounting Process: The Adjustment of Dentures on the Articulator and in the Mouth

If the patient has a high level of tolerance and patience, it is possible to make the adjustments and finishing procedures for the dentures at the same appointment. Due to various reasons, some patients do not attend the subsequent session and use the denture even if it irritates. Also, sometimes patients who cannot use the new denture, decide that they will not adopt them and try to use their old dentures, or prefer not to use any denture at all.

During the adjustment of the complete dentures, it is possible that the patient comes back a few times and asks for various changes to be made. There could be problems; for example, the denture could create feelings, such as it is mobile, the biting process can appear to be not good, the gingiva can be sensitive to touch, and the teeth may not appear correct. These problems that occur after placing the denture in the mouth can be minimized with denture treatment, according to the rules and patient education, to make the denture harmonious. It is important to know how to fix these visible problems after denture delivery.

The issues that need to be controlled during the application of the finished dentures are as follows:

4.1.1 Adaptation of Denture Bases

Why is adaptation of the denture base needed?
Denture bases require adjustments due to,

(a) Failure of acrylic resin polymerization
(b) Mistakes while taking the impression
(c) Alterations of soft tissue
(d) Bone alterations

4.1.1.1 Failure of Acrylic Resin Polymerization

Most current material for denture base is polymethyl methacrylate (PMMA). It is generally called acrylic resin. After the polymerization, polishing process, and a water bath lasting 1 day, there may be 0.4–0.5 mm linear shrinkage for heat polymerizing resin and 0.2–0.3 mm linear shrinkage in self-setting acrylic resin at room temperature. Up to 6–7% volumetrically shrinkage can be observed during polymerization. During the deflasking of the dentures, problems may occur. Most dimensional changes can be minimalized with the right procedures; however, on the other hand, uncontrolled deflasking process and polishing in high speed can cause extreme heat and increase the disintegration rate. Water absorption takes place after placement into the mouth; this also increases the volume of the denture. After placing the denture, it reaches dimensional stability in 2–3 weeks by showing dimensional change of approximately 0.2 mm.

Today, although current resins are not exactly perfect materials, they are used routinely, and their dimensional changes are within clinically acceptable limits. Nevertheless, changes in the dimensional stability often increase due to inaccurate polymerization and polishing processes.

4.1.1.2 Mistakes While Taking the Impression

Impressions of the complete dentures are taken from the soft tissues; therefore, it is impossible to take a perfect impression. Nowadays, the impression compounds that are used are well advanced and almost in line with the criteria determined by American Dental Association (ADA). Therefore, the main problem is not the impression material but the difficulty of the process itself, which deals with soft tissues. Generally, minor adjustments are required because the impressions are the record of one moment, and the patient's jaw movements cannot be duplicated exactly.

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4.1.1.3 Alterations of Soft Tissue

Oral mucosa cannot be expressed as a supporting tissue. Oral mucosa is a covering tissue that protects bone, provides nutrition and expels tissue residue. Other functions can be specified as the detection of touch, tasting, etc. Oral mucosa and the underlying bone provide protection against occlusal forces when the teeth are lost. These forces for the natural teeth are around 7–10.5 kg/cm^2, but in edentulous patients, this decreases to 1.75 kg/cm^2. The forces in edentulous patients are still in significant amounts because even if the mastication process is 30–40 min per day, during swallowing the number of times the mouth is shut is in the region of 1500, and furthermore para-functional (grinding and clenching) occlusal contacts are usually heavy and frequent.

Histologically, the oral mucosa and submucosa consist mostly of cells (actually liquid packages), intercellular liquid, blood vessels, glands, and loose connective tissue and fibers. Soft tissues are connected either tightly to the bone (in hard palate and well-built protrusion) or loosely to the bone (in loose tissues and adjacent tissues to the denture border areas). The mucosa may be thin in geriatric patients or may be very thick in younger patients. The thickness and elasticity of the mucosa varies individually. It is almost impossible to record all the elevations and depressions of mucosa instable situation. Generally, "selective pressure impression" or "modified mucostatic impression" is preferred instead of the unpressurized impression technique. Oral mucosa cannot retain the same contours for a long time; the cellular elements and liquids tend to change on a daily or sometimes hourly basis, according to normal physiological or pathological processes. Rapid changes are usually observed in patients who have health problems, such as high or low blood pressure, diabetes, kidney diseases, thyroid or parathyroid dysfunctions, postmenopause, age anniversary syndrome, etc. A couple of days after wearing the upper jaw denture, which has great retention, considerable loosening occurs. The main reason is alterations occurring in the soft tissues rather than the minor changes occurring in the acrylic resin. The alterations occurring in soft tissues can be minimized. Removing the dentures, or using soft lining materials, can heal the soft tissue that is irritated, inflamed, or deformed. As it is especially difficult to diagnose macroscopically, the resolution of the edema is a difficult problem, so before taking the impression, the best solution is to suggest a diet that does not allow a liquid intake, with minimum coffee and tea and forbidding alcohol.

4.1.1.4 Bone Alterations

Bone is an elastic structure and alterations in this structure may occur less and take a longer time or may occur in a short time. Many dentists observe that the dentures placed into the mouth with good adaptation loosen after a few weeks. This usually happens after placing the denture immediately because the alterations in soft and hard tissues take place at the recovery stage. This event is natural for all denture patients and is associated with fluctuations in speed. In diseases such as diabetes and thyroid and parathyroid dysfunctions that reduce the body's resistance, hard tissue changes occur faster. For a dentist, the best thing to do is to adjust the denture again, taking control of this pathological event, or by consulting with a physical doctor with regard to the patient's illnesses. The requirement of close contacts between the denture and the tissues is an illusion actually. The most reliable factor for providing retention is the atmospheric pressure and adaptation of the flanges. In addition, anatomical structures contacted with the borders of the dentures arise from muscles, frenulum, and membranous connections; these structures are not usually changing much and cause tension on the bone that tend to form new bone, not only protecting the bone.

The remounting of the denture starts after finishing the process of the acrylic reaction. It can be divided into four phases: two are laboratory phases and the other two are clinical phases, with patient contribution. A technician in the laboratory can address the first phase. These stages should be followed carefully and adjustments should be made.

The basic procedures are as follows:

1. The first occlusal adjustments are made in the laboratory immediately after flasking.
2. Evaluation and adjustment of the tissue surface in patient's mouth.
3. Complete dentures are attached to the articulator using the interocclusal records and occlusal adjustments are made.
4. Occlusion is controlled in the patient's mouth.

Incompatibilities in the occlusion are caused by:

1. Faulty recording of the jaw relations
2. Mistakes occurring in jaw relationship while mounting in the articulator
3. Problems in the adaptation of the baseplates

4. Careless examination of the tooth arrangement at the try-in stage
5. Alterations occurring during the polymerization stage
6. Excessive heat occurring at the polishing stage

Acrylic resin undergoes shrinkage during polymerization and after the polymerization in the cooling process because it has a high degree of thermal expansion coefficient. Frequently, the occlusion can be different when placed into the mouth. Most painful regions are caused by occlusal mistakes, so the occlusion must be corrected on the first day when it is delivered. Delaying the adjustment for next session may cause malocclusion, which damages soft tissue.

A denture that is not fitting well to the tissues fits with replacement when occlusion is provided, and in this case, it can be considered that the occlusion is true. However, a denture that seats properly on tissues, due to providing the wrong occlusion, replaces and may corrupt the stabilization. Therefore, before occlusal control, adaptation and retention of the baseplate should be reviewed to understand if destabilization is a cause or a factor.

Even if the dentures that have recently been delivered to the patient show a great adaptation to the tissues, the morphology of the tissues underneath the denture may have changed during the flasking stage or before the final impression.

4.1.2 The First Occlusal Adjustments (in the Laboratory)

4.1.2.1 Adjustment Following Acrylic Resin Polymerization

Remounting is conducted for decreasing the vertical dimension to normal, by removal of dentures from the flask without breaking, following completion of polymerization and attaching the models to the articulator. The aim is to increase the occlusal premature contacts related to the dimensional alterations in acrylic while decreasing the vertical dimension. In order to perform these procedures, the main models are removed from the flask without breaking and again attached to the articulator, of which the records are intact. It is usually seen that the incisal rod is elevated a little from the tray. Abrasion should be made until the rod again has contact with the tray and the upper and lower teeth have contact with each other. Abrasion is performed from the fossae without touching the cusps. Only if this is insufficient, should the cusps also be abraded a little. Nevertheless, the first choice should always be to abrade from the fossae.

Following removal from the flask, the dentures are attached to the articulator, without separating them from the models (Fig. 4.1a–c). Minor mistakes that can occur during flasking and polymerization may be observed in this stage.

The factors that must be controlled after removing the dentures from the flask are explained below:

1. *Controlling the Vertical Occlusal Dimension*

   Dimensional changes that occur during polymerization usually occur as a result of minor irregularities that can cause an increase in the occlusal vertical dimension, even though a little shrinkage that occurs during polymerization may affect the occlusal contacts. Therefore, by performing the first occlusal adjustment, a good cusp-fossae relation can be provided.
2. *Premature Centric Contacts*

   When polymerization shrinkage causes slide in the original cusp-fossae relation, the premature contacts should be eliminated to ensure proper relation. Occlusion is corrected with diamond bur. Upper palatinal cusps and lower buccal cusps are not grinded because they are functional cusps in complete dentures.

Adjustment of the centric contacts: Correct cusp-fossae relations are determined with the articulation paper. The original vertical dimension is adjusted in the position that incisal pin is in the center of the incisal plate. After ensuring all the centric contacts, eccentric movements are balanced. Also, without premature occlusal contacts, a smooth transition is ensured during protrusive and retrieve movements. Occlusal surfaces are polished again. The dentures are then separated from the stone model. The denture flanges are grinded down and adjusted and then sent to the dentist for adjustment in the mouth (Fig. 4.1d, e).

4.1.3 Evaluation and Adjustment of the Tissue Surface in Patient's Mouth

4.1.3.1 Preliminary Adjustment of the Denture Base

First of all, the grinding process should be addressed after the pressure areas have been determined. Irritation areas originate from occlusal failures, excessive function, and systemic problems. The unnecessary grinding of the denture base may increase these problems. An indelible pencil should not be used at the adjustment stage because it may be poor in

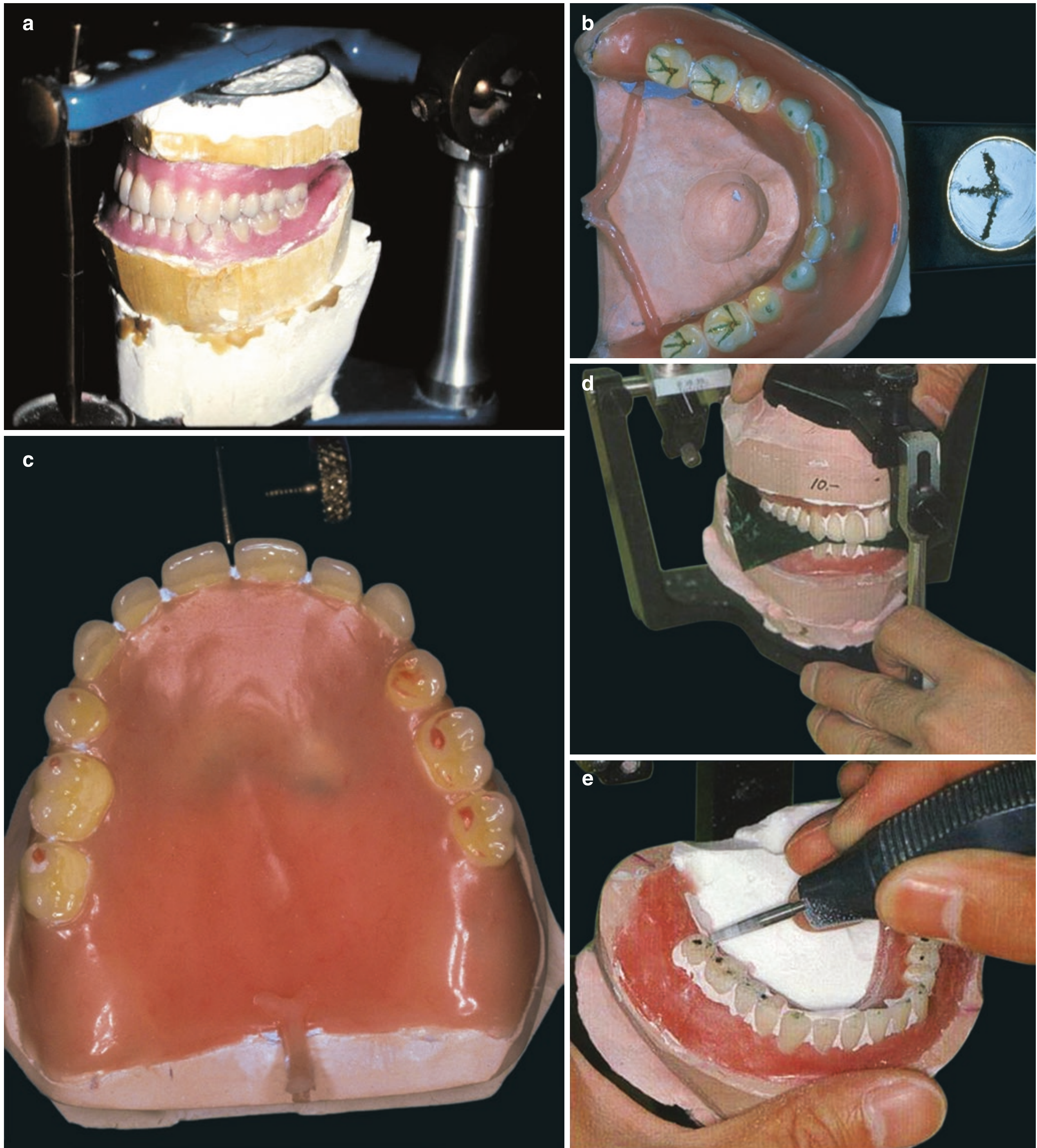


Fig. 4.1 (**a**) Dentures are attached to the articulator following removal from flask without separating from the main models. (**b**) Lower denture. (**c**) Upper denture. (**d**) Placing the articulating paper in centric occlusion. (**e**) Grinding process

Fig. 4.2 Pressure indicating paste

recording, and it is not possible to evaluate the required amount of grinding from denture base material. Primarily, the tissue surface of the dentures must be controlled. Any roughness on the denture may cause pain. All flanges are required to be polished and smooth.

4.1.3.2 Adjustment of the Tissue Surface

The internal surfaces of the dentures are controlled by finger whether there is any roughness or not. Insertion path of the denture must be evaluated. If there are any undercut-on crests, it can cause pain and irritation during insertion and removal of the denture. Pressure areas at the inner side are determined using pressure indicating paste (Fig. 4.2). During the application of the pressure indicating paste, the inner surface of the denture should be dried, and a thin layer of pressure indicating paste is applied to the inner surface. The denture is placed in the mouth softly; as, if any resistance occurs during this procedure, it should be removed and examined again (Fig. 4.3a). Then, the denture is removed from the mouth and checked. The areas without pressure indicating paste are the pressure areas (Fig. 4.3b). On these areas pressure indicating paste is applied again, thereby the grinding is done and the denture is again placed in the mouth (Fig. 4.3c). This process is repeated in both dentures until they fit passively. Following this stage, patient is told to close his/her mouth slightly, after placing cotton rolls on the posterior areas (Fig. 4.4a). If the patient feels pain on this position, the pressure indicating paste is applied again, following the removal of the denture, and cotton rolls are placed again. The exposed surfaces are again grinded. This process is continued until the patient feels no pain. At this stage, by placing the cotton rolls, if he/she is fine the patient is kept waiting in this position for 10 min. This process helps the soft tissues to assume a better form because of the distortion that originated from the earlier denture, which did not fit sufficiently well. The patient should not be allowed to close his/her mouth

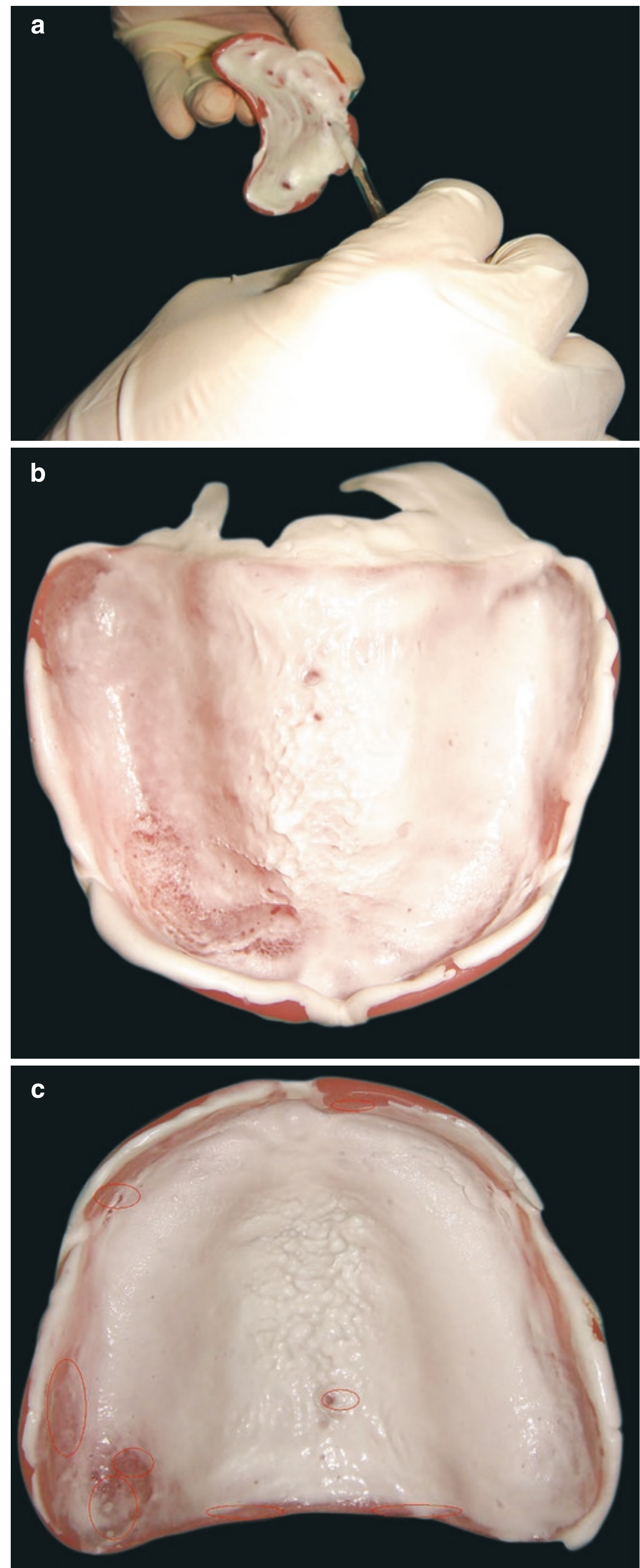


Fig. 4.3 (**a**) Application of pressure indicating paste to the inner surface of the denture. (**b**) Pressure area in upper right tuber region. (**c**) Grinding the areas where the paste is exposed. Pressure area in the upper right tuber region

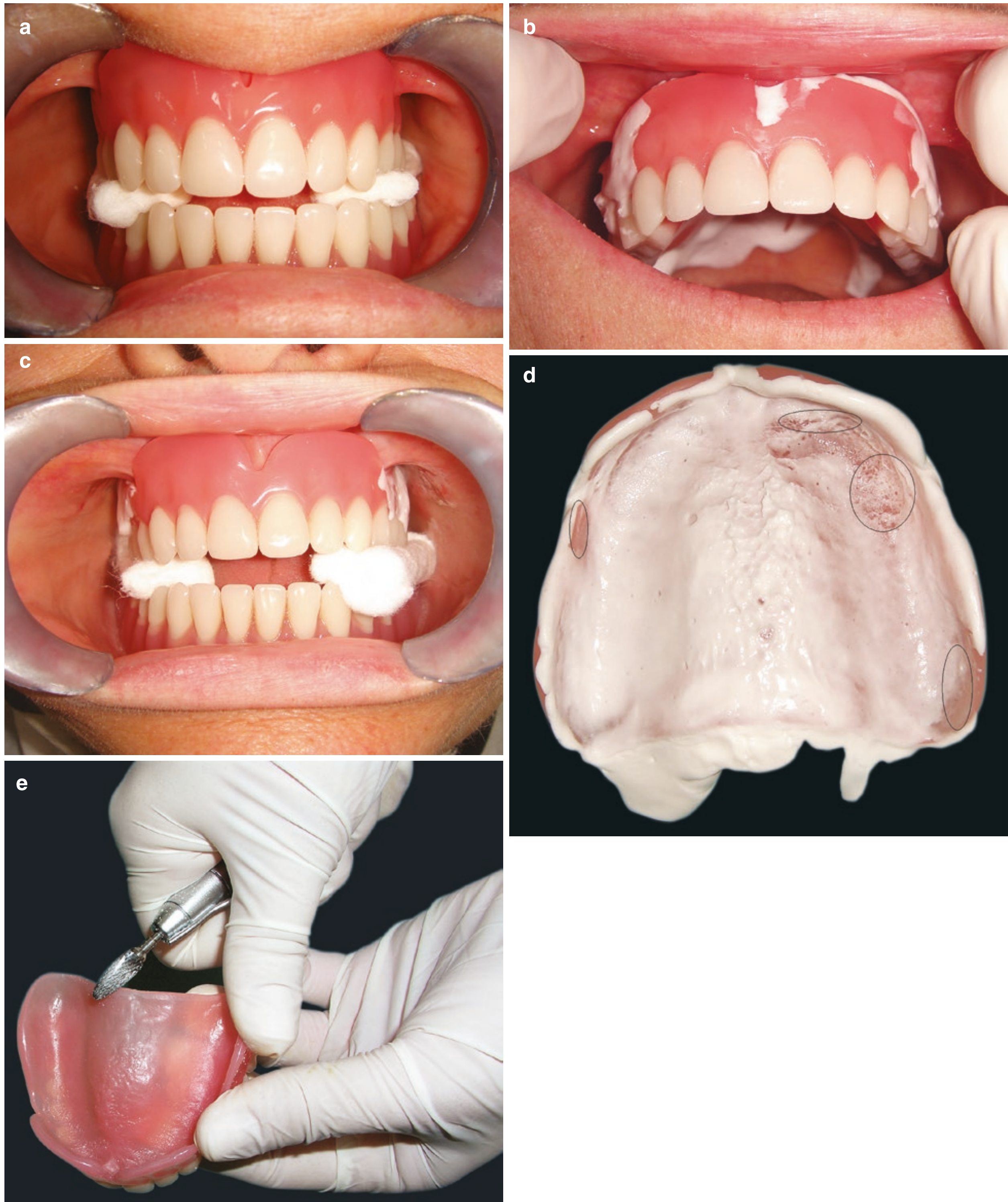


Fig. 4.4 (**a**) Closing the patient's mouth by placing cotton rolls in the posterior region. (**b**) Application of pressure indicating paste to upper denture. (**c**) Closing the patient's mouth. (**d**) Determination of the exposed surface with pressure indicative paste. (**e**) Grinding the defined areas

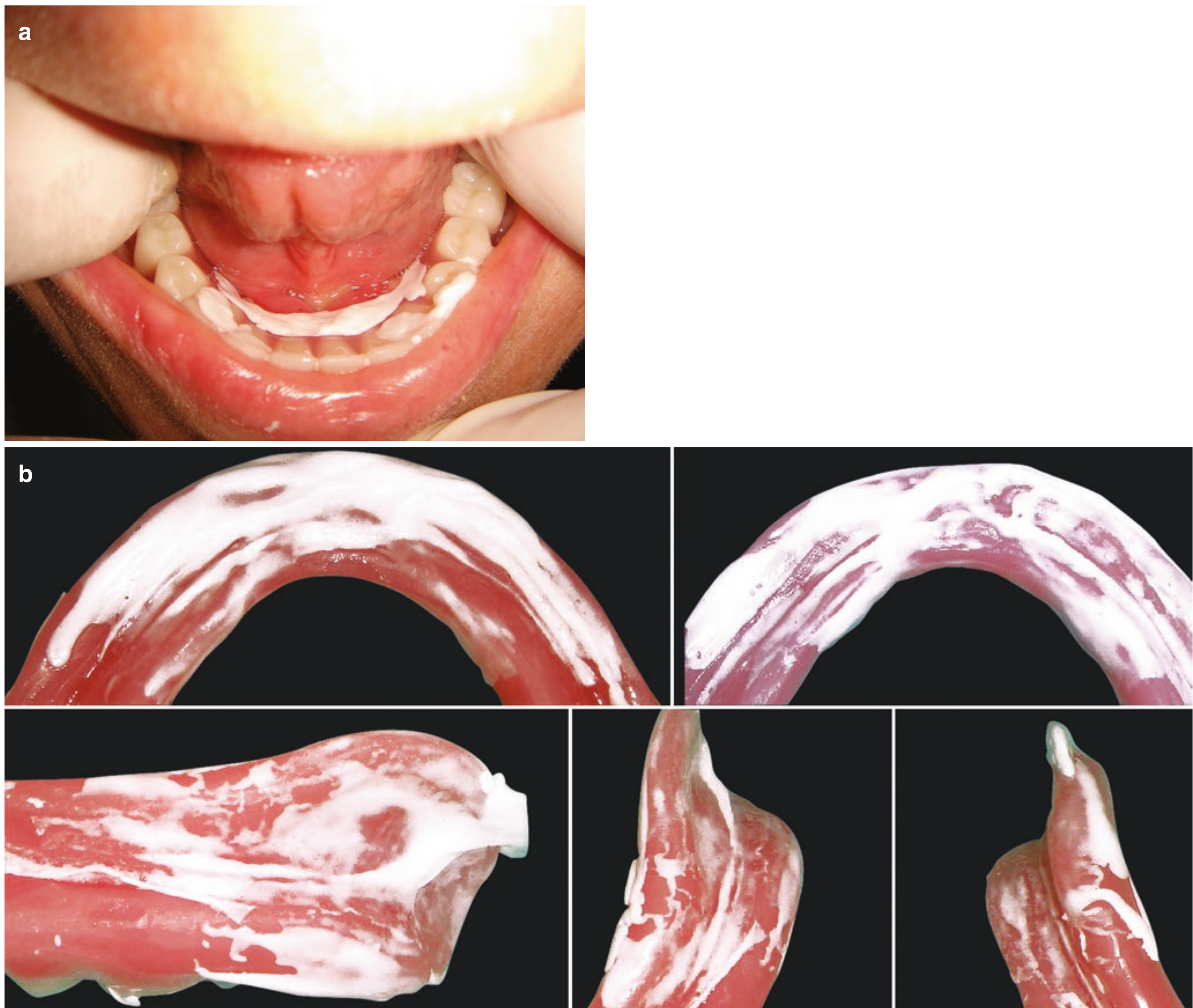


Fig. 4.5 (**a**) Application of pressure indicating paste to lower denture. (**b**) Pressure areas are detected in lower denture

while the dentures are in because the soft tissues could be deformed by the occlusal premature contacts. After 10 min, one of the dentures, usually the upper denture, is removed and again coated with pressure indicating paste (Fig. 4.4b) and cotton rolls are placed again, but this time the patient is told to bite more firmly (Fig. 4.4c). The pain points, which are described by the patient, are determined and grinded again (Fig. 4.4d). Each time it is necessary to clean the inner surface of the denture (Fig. 4.4e) and apply a thin layer of pressure indicating paste.

The same procedures are repeated on the lower denture. A thin layer of paste is applied to the denture bases, and more pressure is applied on the first molar area of the denture (Fig. 4.5a). The denture is removed carefully and evaluated (Fig. 4.5b). The lower denture is always exposed to more tissue replacement and shows more pressure areas than the upper denture. These areas are adjusted conservatively.

4.1.3.3 Adjustment of the Upper Denture

Pressure fields in the upper denture are the:

1. Median palatine raphe
2. Incisive papillae
3. Distal flange area
4. Zygomatic area
5. Vibrating line
6. Frenum areas (Fig. 4.6a)

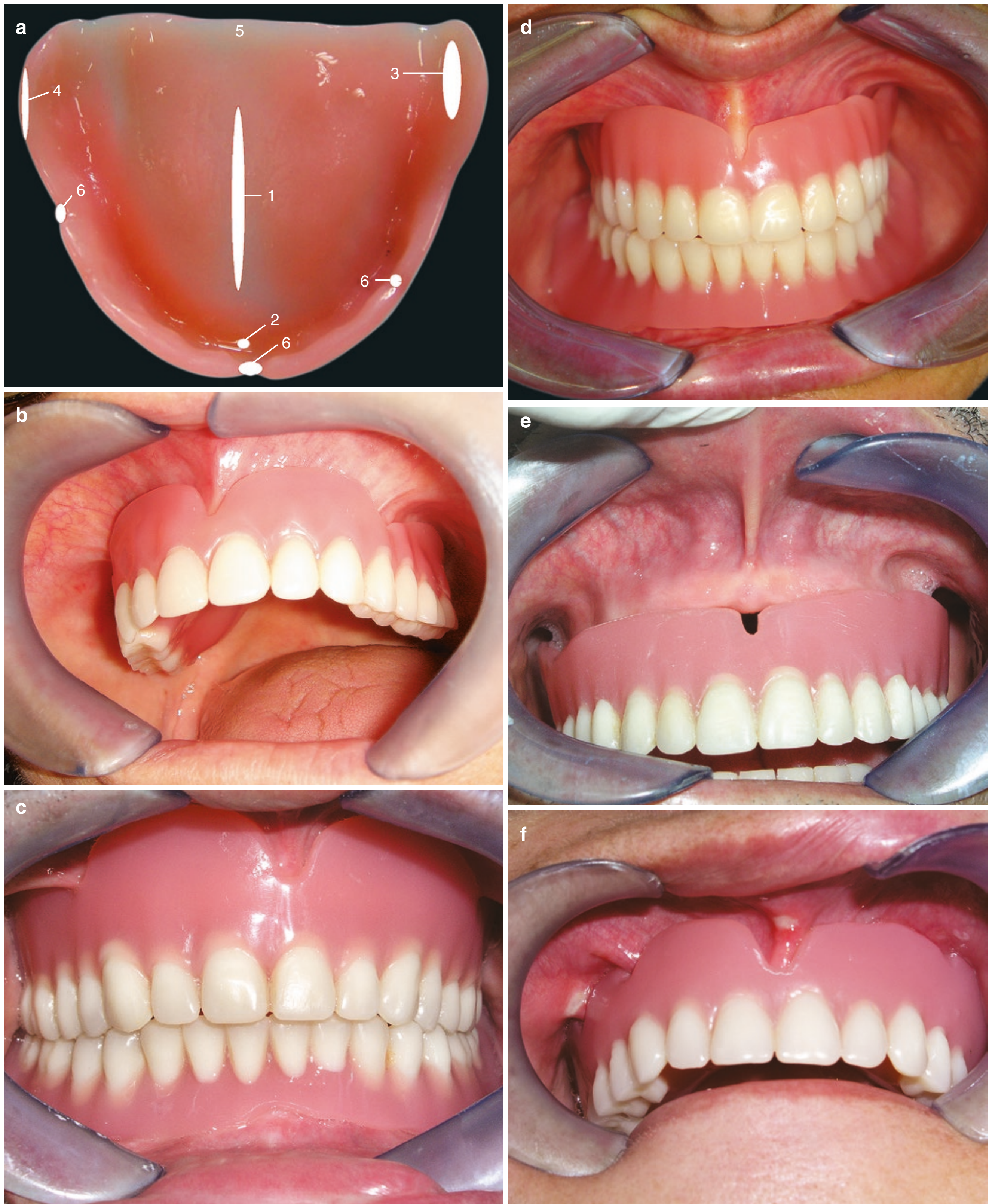


Fig. 4.6 (**a**) Areas that need to be adjusted in the upper denture. (**b**) Preparing narrow frenal area. (**c**) Enough opening for frenulum. (**d**) Preparing faulty frenal area (**e**) The movement of the denture due to insufficient opening. (**f**) Irritation caused by insufficient opening. (**g**, **h**) Irritation caused by extended labial flange

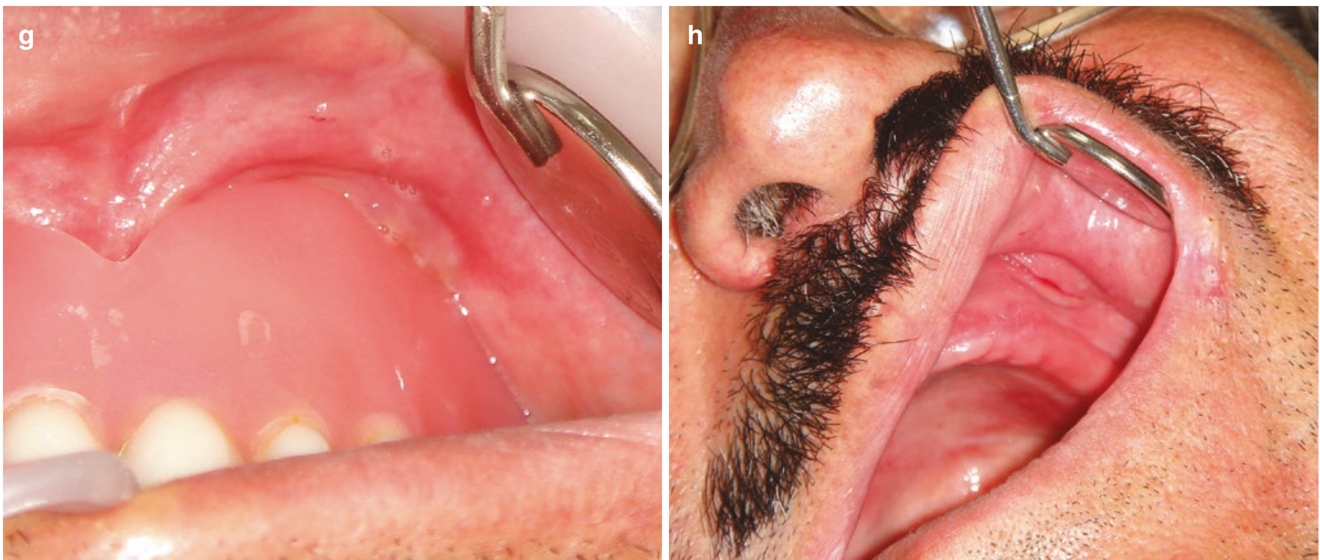


Fig. 4.6 (continued)

Frenum

The frenulum cannot be controlled easily while taking the impression, so they may become red and irritated. The opening on which the lip frenulum is located should not be too narrow and shallow (Fig. 4.6b). The frenulum must turn around the denture like a cable turning around a cylinder (Fig. 4.6c). Insufficient opening of the labial frenulum causes movement of the denture and irritation (Fig. 4.6d–f). Labial margins should be shortened without inhibiting patient's lip movements; otherwise denture irritation occurs in these areas, and retention of the denture is disrupted (Fig. 4.6g h).

Controlling the Buccal Frenum Area

When the patient's mouth is opened, buccal frenulum is pulled backward and downward (Fig. 4.7a). Thus, the denture is assisted to fit the area where the borders are in their accurate place rather than the replacement of the denture. The buccal frenulum area must be relieved wider than the labial frenulum; insufficient reliving may cause irritation and displacing of the denture (Fig. 4.7b, c).

Median Palatine Raphe

This area beneath the denture should be relieved if the raphe is too prominent. The amount of the relief is determined on the model after taking the impression (Fig. 4.8a–c); otherwise, after a period papillary hyperplasia may occur, due to the excessive relief (Fig. 4.8d, e).

Incisive Papilla

Incisive papilla is useful for making a slight relief at this area. When the papilla is too prominent, irritation may occur in this area after using the denture.

Tuber Areas

For the tuber protuberances, it is important to be in precise length and height. However, this area is usually prepared wide. This situation causes the coronoid process to contact this area when the patient opens his/her mouth. Patients may complain of pain at the distobuccal area, due to excessive retention of the dentures. If the retention is not sufficient, there will be overpressure on the coronoid process area, and

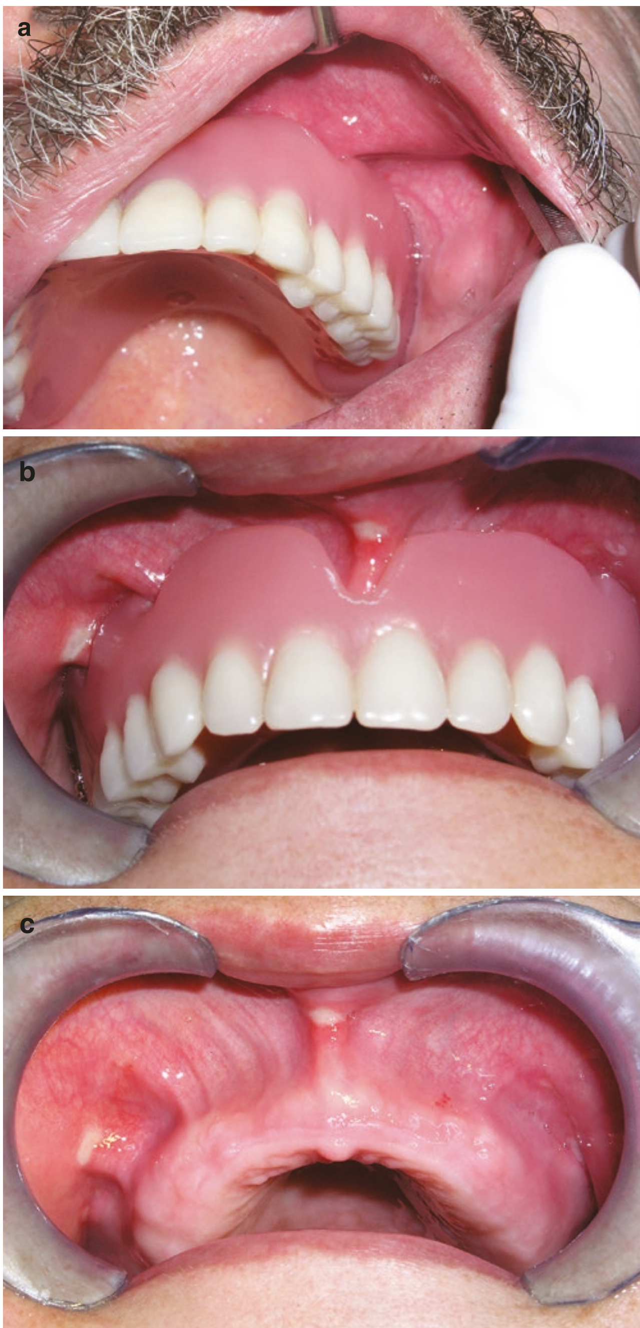


Fig. 4.7 (**a**) Control of buccal frenum. (**b**) Insufficient buccal frenum opening. (**c**) Irritation caused by insufficient opening

the patient will complain about the falling of the denture. The easiest way to evaluate the width of the tuber area is to apply pressure indicating paste and then to give the patient instructions to open his/her mouth and move their mandible to the right and left sides (Fig. 4.9a–d). There will be irritation areas if this region is not adjusted and shortened (Fig. 4.9e, f).

Zygomatic Arch Area

If the crests are full (not flat), there will usually not be a problem for the patient in the zygomatic arch region. The mucosa on the zygomatic arch area is thinner than the other parts of the peripheral tissues. During chewing, if the patient complains of pain in this region, pressure indicating paste will be applied. The clinician will give directions to the patient to chew on the first molars when cotton rolls are in these areas (Fig. 4.10a, b). Relief can be applied if the mucosa is thin. The margins of the zygomatic area should be thinner than the paratuber area (Fig. 4.10c).

Vibrating Line

Clinician should be careful when doing changes in this area because of the hermetic seal of the denture. The safest way for this region is to put a thin layer of pressure indicating paste and ask the patient to swallow and close and open his/her mouth for several times. Excessive pressure areas will be determined, and corrections will be made (Fig. 4.11a–c). If the changes are not made, there will be irritation areas (Fig. 4.11d, e).

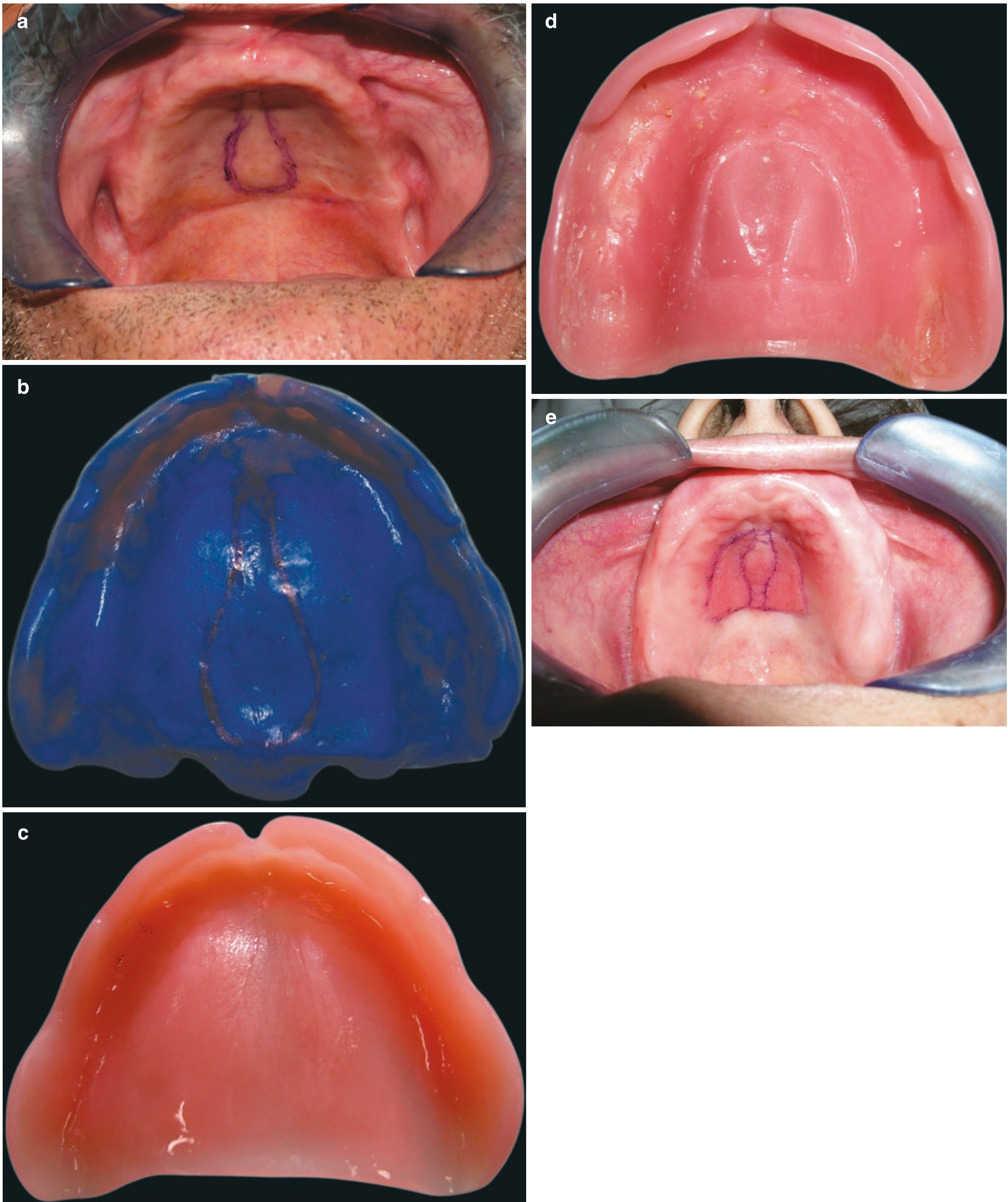


Fig. 4.8 (**a**) Marking prominent median palatine raphe in the mouth. (**b**) Determination of this area on the impression. (**c**) Proper relief. (**d**) Excessive relief. (**e**) Papillary hyperplasia caused by excessive relief in the mouth

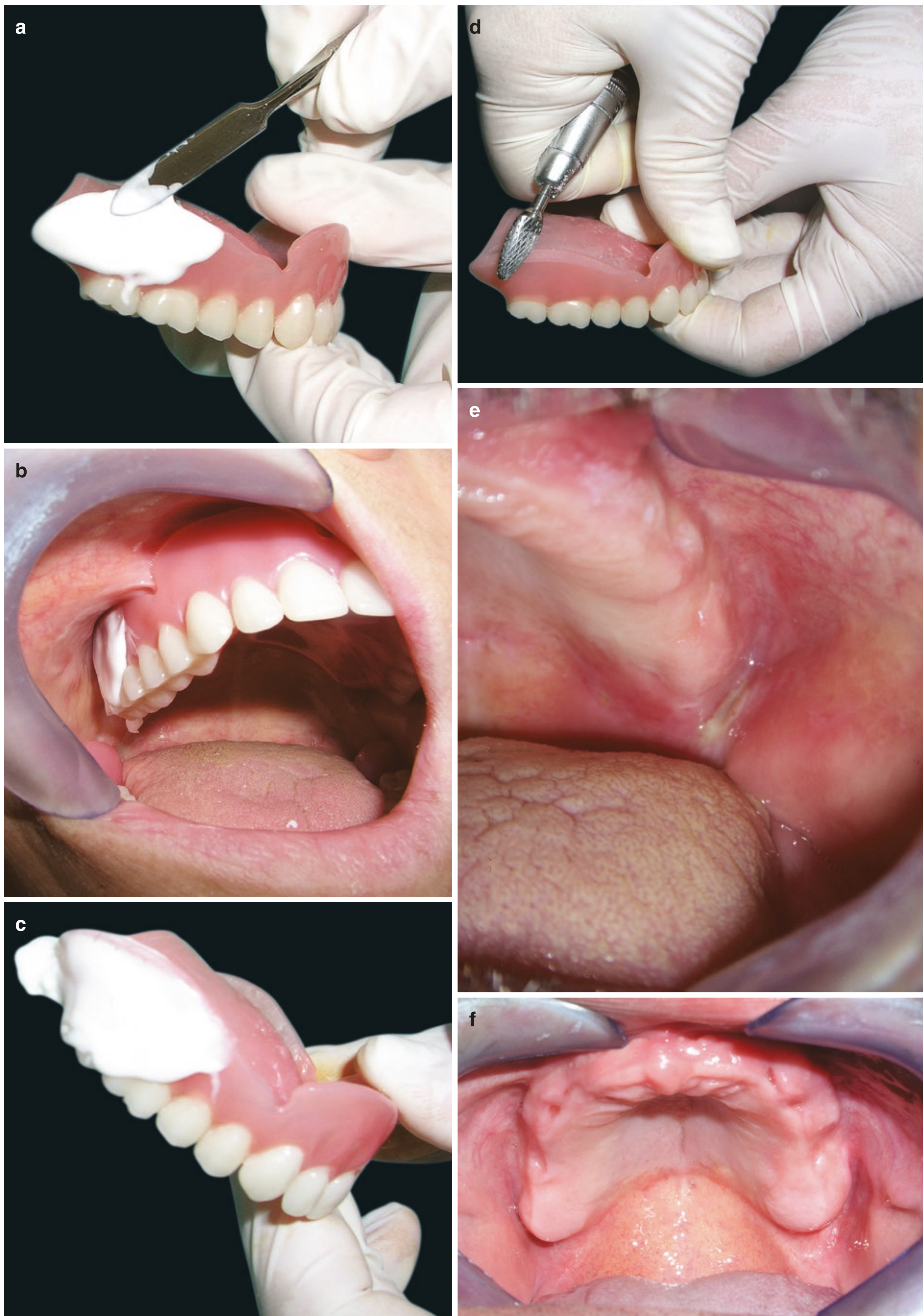


Fig. 4.9 (**a**) Application of pressure indicating paste to tuber area. (**b**) Opening the patient's mouth and performing movements. (**c**) Determination of flange thickness. (**d**) Arrangement of denture flanges. (**e**, **f**) Irritation areas on the paratuber area

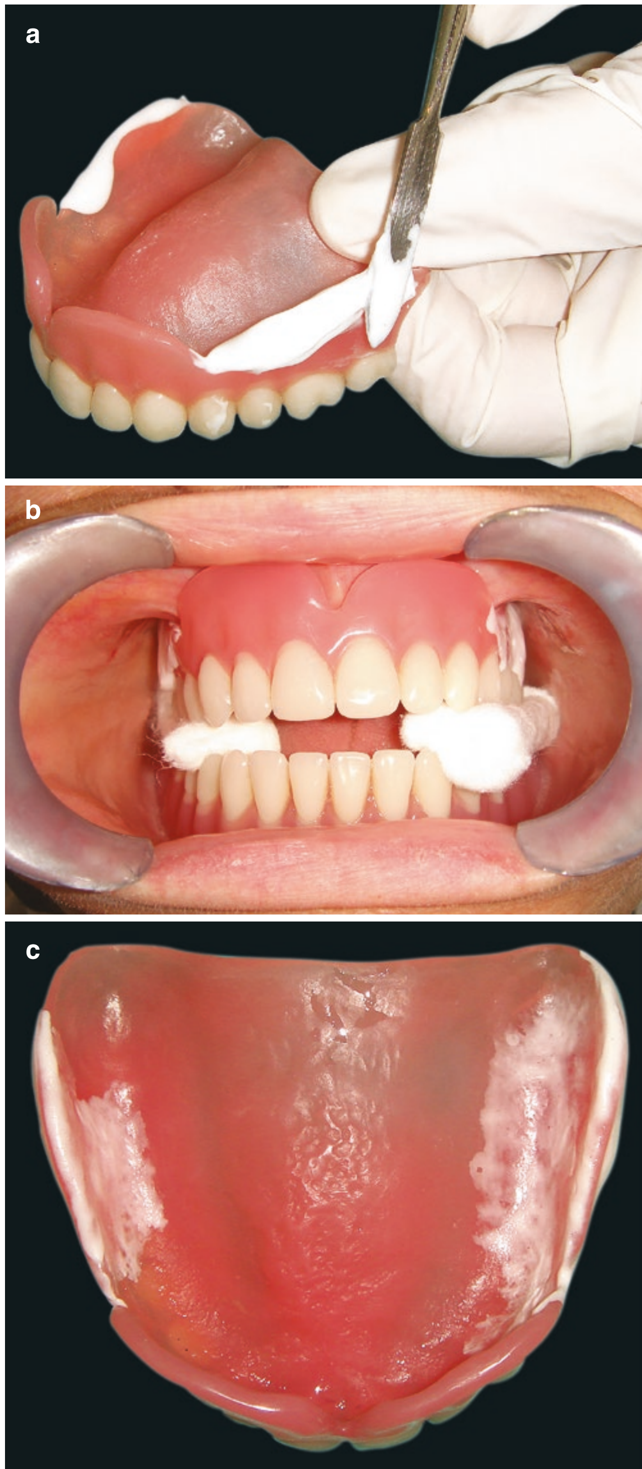


Fig. 4.10 (**a**) Application of pressure indicating paste to zygomatic area. (**b**) Biting on cotton rolls. (**c**) Arrangement of excess areas

4.1.3.4 Arrangement of Upper Denture

Complaints about a loose upper denture are mainly regarding inadequate posterior border lines or an inadequate posterior palatal seal. The hamular notch and the vibrating line can be determined using a marker pen. The position of the hamular notch can be misleading because they are positioned distally to the tubers. The best way to determine the extensions of posterior borders and the peripheral seal is by giving directions to the patient to bite on two wax rolls in the molar regions. For this procedure, slightly more than 2 mm length on the distal part of the posterior border and a 1 mm length of the postdam region are required. Retention will be improved with this seal. This wax can also be used for the master impression and can be turned into the hard resin. If the posterior borders are too short and the wax's length is more than 3 mm, the modeling procedure should be performed with impression compound.

Methods for making arrangements on the posterior border of the denture:

1. Determine the hamular notch and the vibrating line.
2. Occlusal plane wax is placed on the posterior border of the denture as a roll.
3. After insertion of the denture, the clinician gives directions to the patient like swallowing and rinsing the mouth.
4. Then the clinician evaluates the denture, and after that excessive wax parts are arranged with the wax instrument according to the palatal seal border.

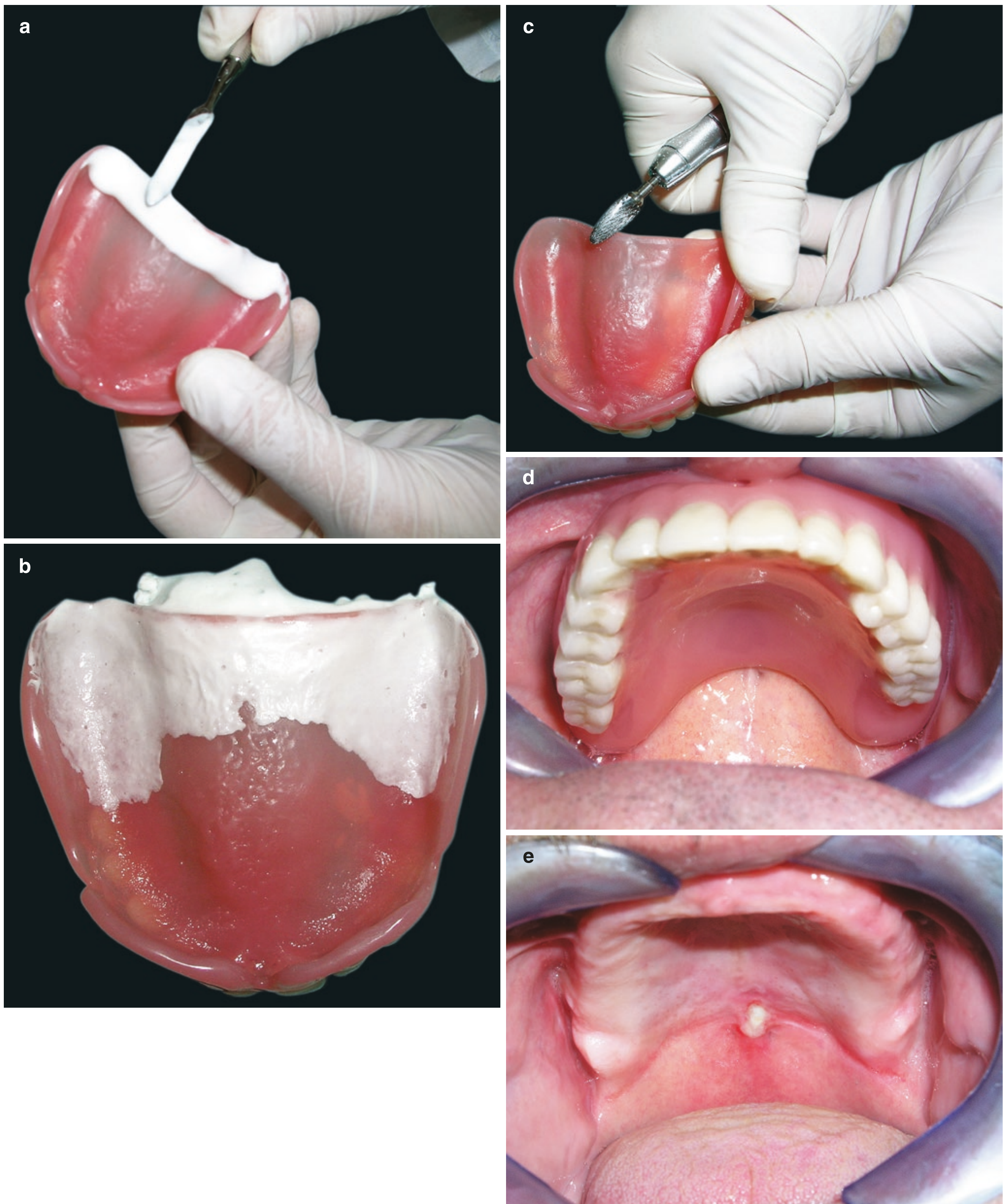


Fig. 4.11 (**a**) Application of pressure indicating paste to the vibrating line. (**b**) Determination of pressure areas. (**c**) Arrangement of the pressure areas. (**d**) Preparation of overextended and sharp vibration area. (**e**) Irritation area

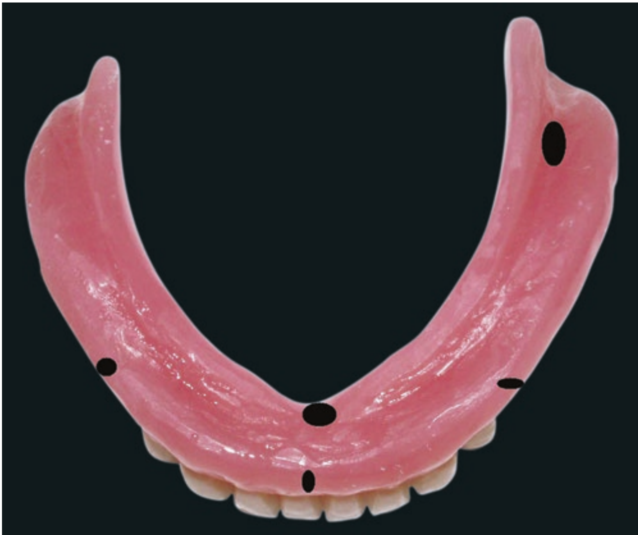


Fig. 4.12 Areas that need to be adjusted in the lower denture

4.1.3.5 Adjustment of the Lower Denture

Pressure relieving areas for the lower denture (Fig. 4.12):

1. Frenum area and flanges
2. Genial tubercle area
3. Mylohyoid ridge area

Labial Frenum and Labial Flanges

The clinician should not create wide relief on this frenum due to the vertical movements of the labial frenum. It should be prepared as narrow and as extended as far as possible without limiting the movements, as this causes irritation (Fig. 4.13a, b).

If the crest is optimal, the labial flanges should have a thickness of 1–2 mm. Flanges thicker than that level will be uncomfortable for the patient (Fig. 4.14). Thicker flanges are better support for the lips and cheeks and a better hermetic seal if the crest is flat; however, irritation will occur if the flanges are not adjusted properly.

Buccal Frenum and Flanges

If the denture is moving during the mouth opening, the buccal frenum region is narrow and shallow. The buccal frenum should be relieved as wide as necessary (Fig. 4.14). The shortness and length of the flanges must be determined.

The thickness of the flanges should be approximately 2 mm. If the crest is flat, the flanges should be thicker to obtain support. Food impaction will be seen if the denture is not prepared with a convex shape (Figs. 4.15 and 4.16). Loosening will be seen if the flanges are overextended. In the

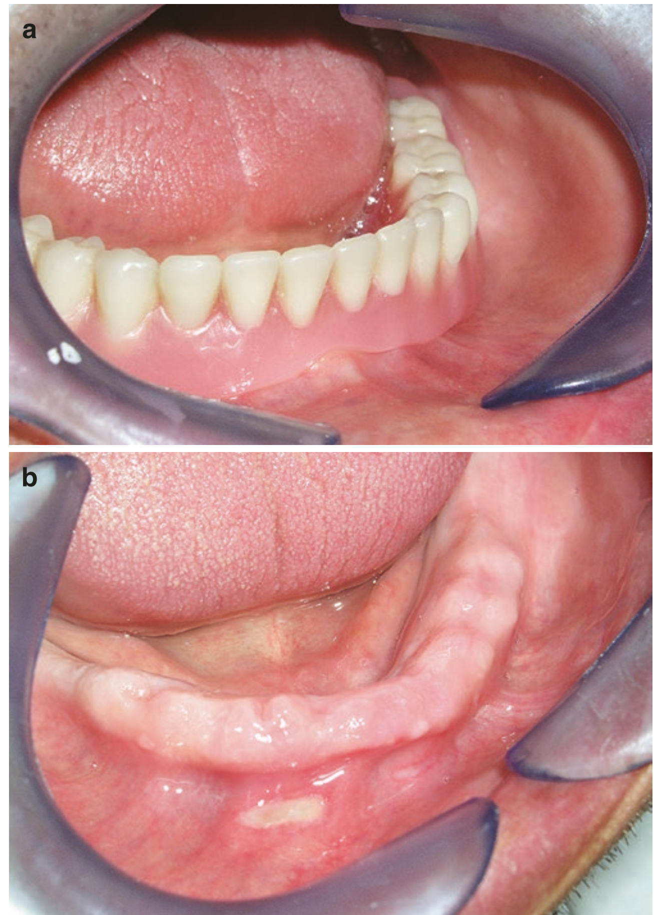


Fig. 4.13 (**a**) Insufficient labial frenum opening. (**b**) Irritation caused by insufficient opening

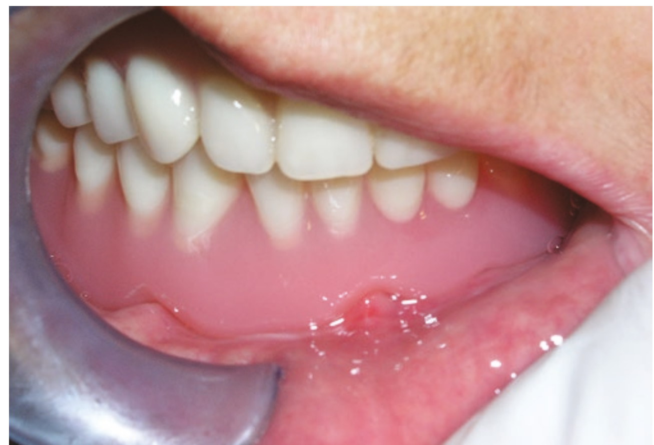
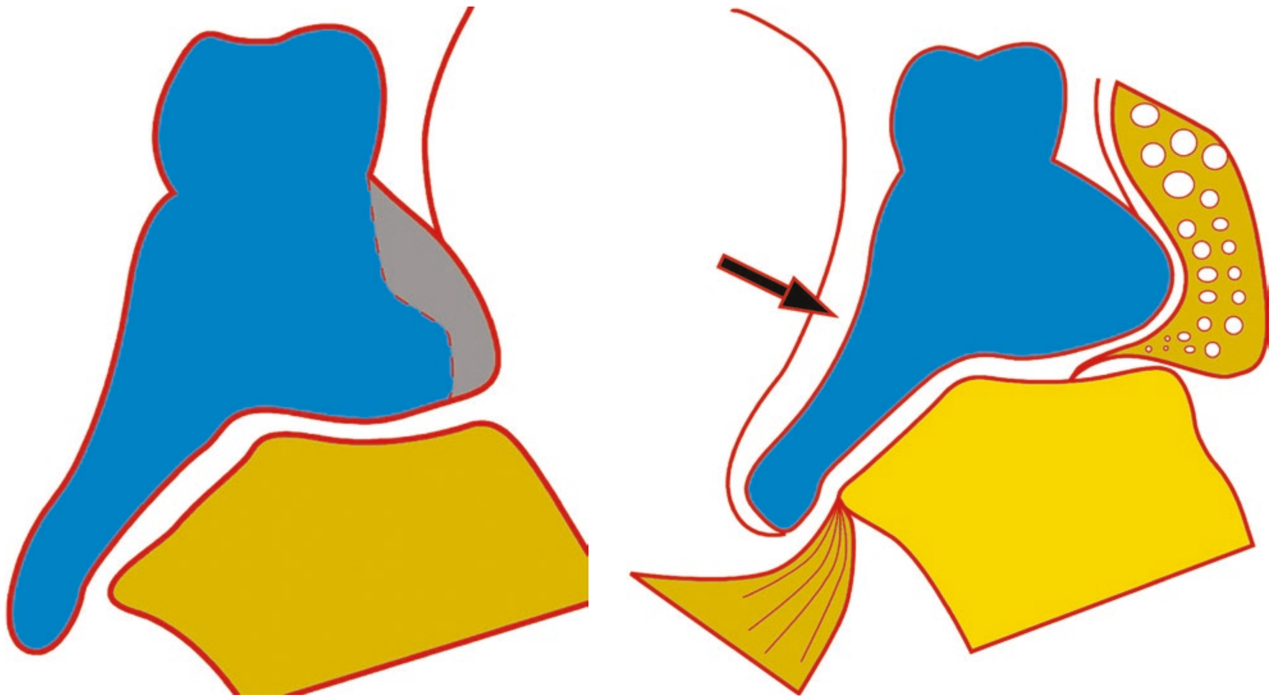


Fig. 4.14 Extended labial flange and insufficient buccal frenum opening



Figs. 4.15 and 4.16 Over-thickened denture flanges

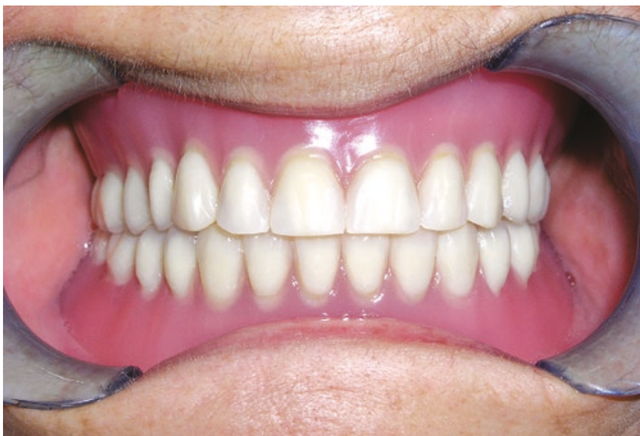


Fig. 4.17 The preparation of the back masseteric area to be narrow towards the retromolar area

masseter muscle region over the buccal vestibule area, flange reliefs should be made correctly; otherwise it will cause pain. For these reasons, this region should be arranged anatomically and narrowed toward the retromolar pad (Fig. 4.17).

Retromolar Pad Area

A thin pressure indicating paste (PIP) is applied, and then the pressure areas determined are relieved (Fig. 4.18a–c).

Buccal Shelf Area

The buccal shelf is an important region for supporting the denture. So, the corrections should be performed by PIP and visual examination. Clinicians should be more conservative over this region (Fig. 4.18d). The impression of this area should be mucostatic against irritation.

Mylohyoid Ridge Area

When the residual crest is flat, the mylohyoid ridge region is mostly sharp and distinct. PIP is applied to the inner side of the denture, the denture is inserted, and the clinician moves the denture strongly from one side to the other. Pressure will appear at the mylohyoid ridge, if there is any. This process will be performed over and over until no sign of pressure is seen. Corrections at this area could be made a little more because it is impossible to obtain any support from a sharp ridge, and the peripheral seal will not be affected. After corrections, polishing should be performed (Fig. 4.19a–d). The mylohyoid flanges can be prepared 4–6 mm longer (Fig. 4.20). Relief should be made if the activation of the muscle is severe, and the flanges should not be shortened (Fig. 4.21). The patient will be complaining of pain if the flanges are shortened. Corrections should be made accordingly; otherwise, movement of the lower denture can be seen. The mylohyoid region should be concave and harmonious with the tongue (Fig. 4.22).

Lingual Flanges

Due to the peripheral seal, all the lingual flanges are critically important and must be arranged carefully. While taking the impression and finishing the denture, the clinician should be careful due to the lingual frenum-tongue connection, and if the area is not adjusted properly, pain and movement will

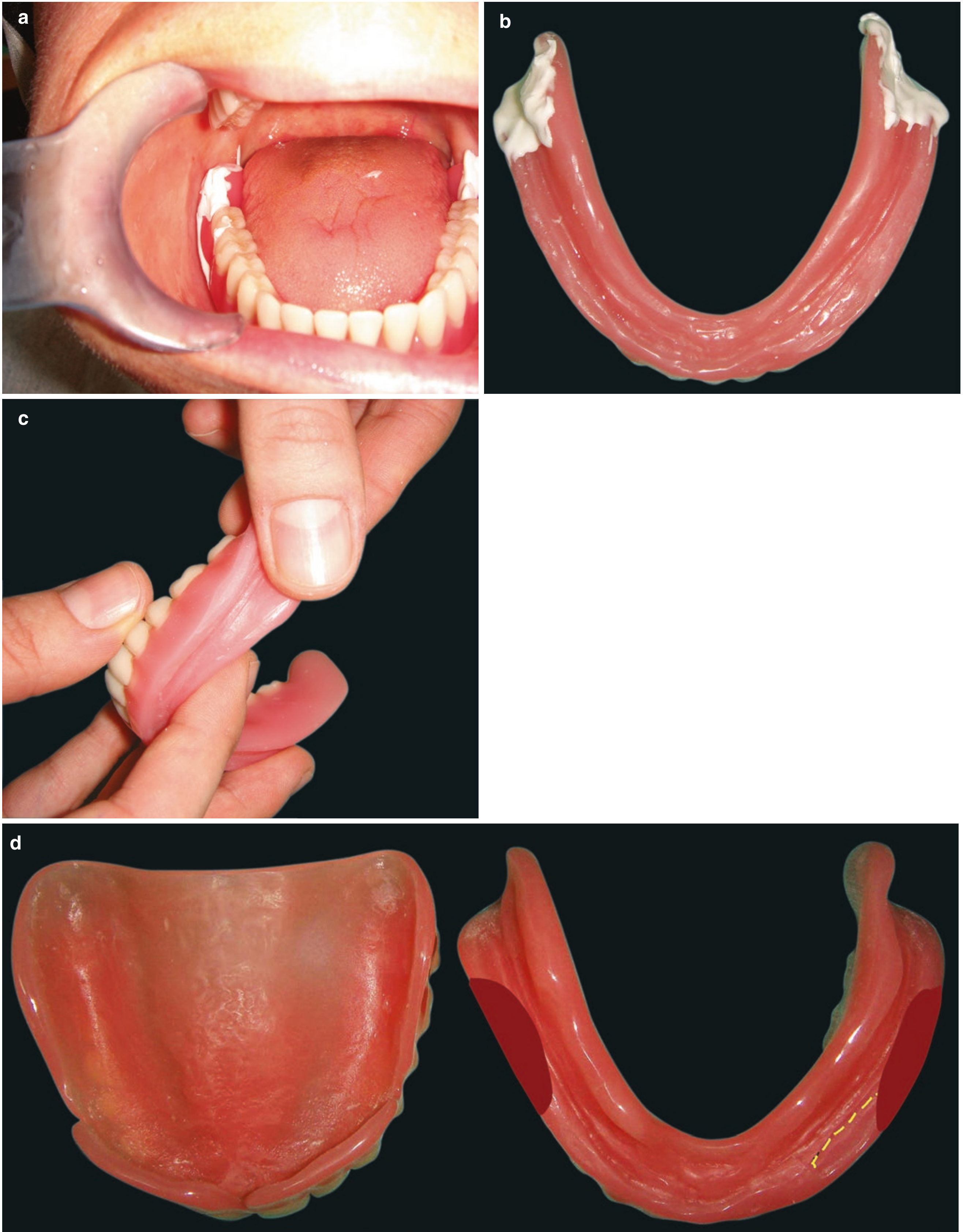


Fig. 4.18 (**a**) Application of pressure indicating paste to retromolar area. (**b**) Control of PIP. (**c**) Making the arrangements (**d**) Checking the buccal shelf area for making arrangements

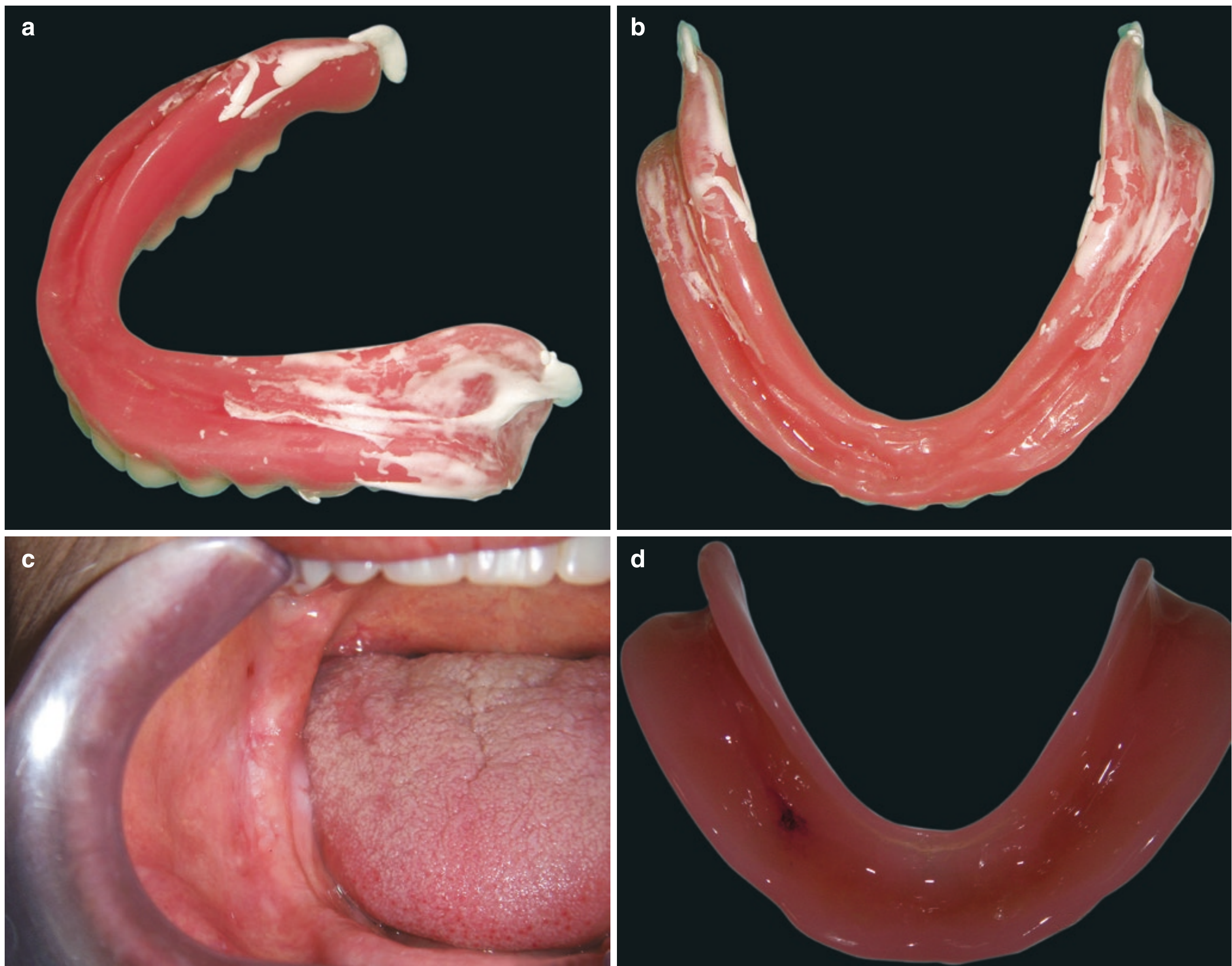


Fig. 4.19 (**a**) Pressure indicating paste is used to determine the prominent mylohyoid ridge. (**b**) Adjustment of pressure areas. (**c**, **d**) Irritation on mylohyoid area

occur. The lingual border seal of the denture is important for retention. Lower dentures should usually be extended to the genial tubercle due to better support and peripheral seal. This border's wideness should be approximately 2 mm; however, due to genioglossus muscle and lingual frenum activation and tonus, the wideness could be wider and narrower. As a rule, wider borderline provides the best seal, but all these procedures should be made properly because overextensions cannot be tolerated. The clinician applies PIP to all lingual borders, and patient is asked to close his/her mouth and swallow and then start licking lower lip from one side to another. The determined areas should be arranged carefully, and then the procedure is repeated (Fig. 4.23a–d). If the flanges are overextended, retention will be affected, and irritation will occur (Fig. 4.23e–h).

Some patients are physiologically sensitive, which could negatively affect toleration of the denture's flanges. If the labial-buccal regions are thick and long, these areas can be arranged easily because the facial seal is provided by the lips and cheeks. If possible, the buccal shelf region should not be shortened by more than 1–2 mm, due to stability. The peripheral seal can be affected or reduced due to shortening of the posterior sides of lingual flanges. The rule is to determine how much shortening the clinician should arrange from the flange areas. Optimum lengths for flanges are shortening approximately 0.5–1 mm for the anterior side of lingual borders, 1–2 mm for flanges of retromylohyoid and mylohyoid regions, and 1–2 mm for posterior flanges. All these arrangements will only minimally affect the peripheral seal and can be tolerated easily. After this, the denture should be polished. Before trying it in patient's mouth, the clinician should explain all details of the arrangements. A recall appointment should be given 2–3 days after insertion.

Checking the Peripheral Seal

If the denture falls when slightly opening the mouth or the lower denture is elevated, it means that the peripheral seal is not sufficient.

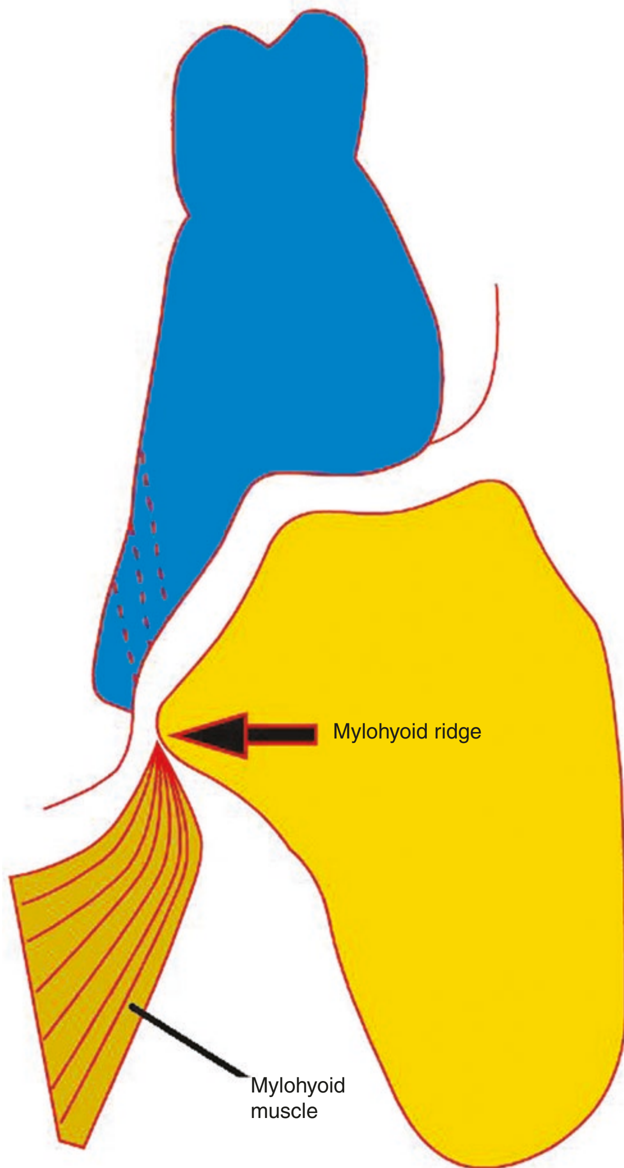


Fig. 4.20 Mylohyoid flange can be prepared 4–6 mm longer than normal

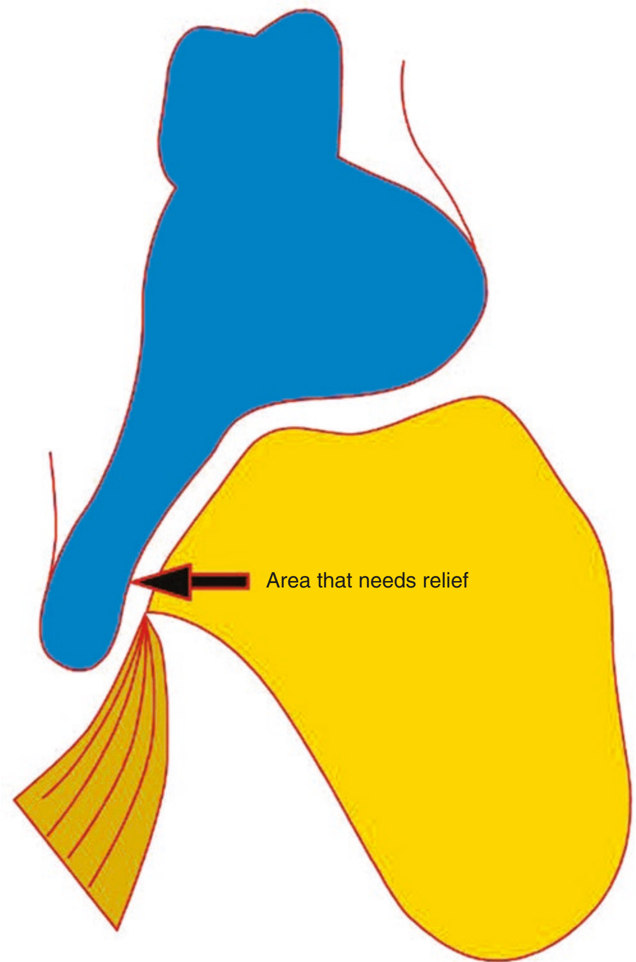


Fig. 4.21 Relief should be made in cases where there is excessive mylohyoid muscle activity

4.1.3.6 Arrangement of Lower Denture

Retromylohyoid margins are prominent, and this is why it is important to insert and remove the denture correctly. If the anterior ridge is low, the denture must be placed approximately 6 mm distally and then placed on mesially. The same procedure should be made when removing the denture. The patient should be informed about this procedure. After this, all retromolar pad regions need to be shortened, which may result in the loss of the peripheral seal. When arranging the flanges, the denture should not be in occlusion. If all the procedures are performed, the clinician should then arrange and determine the occlusion. Usually, retention loss of the lower denture is correlated with peripheral seal deficiency on lingual sides. Lingual borders are arranged with wax addition. Retention of denture increases due to the seal of the peripheral region.

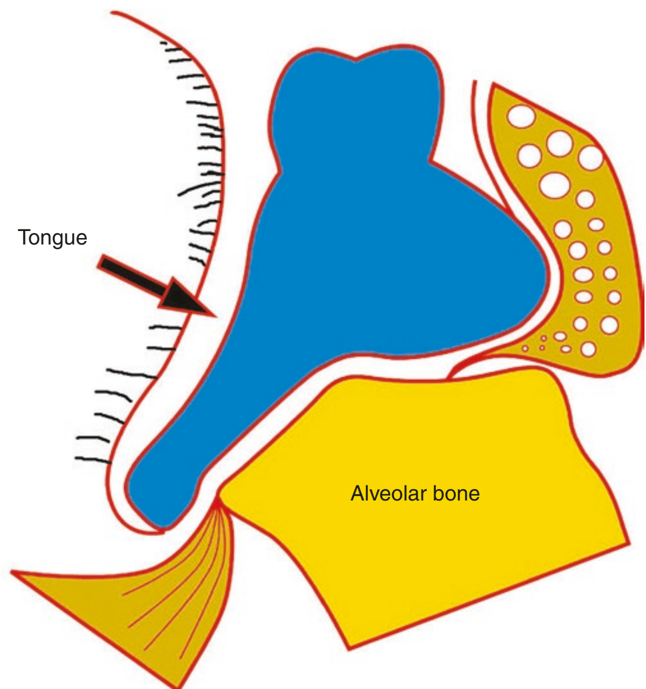


Fig. 4.22 The mylohyoid region should be concave and harmonious with the tongue

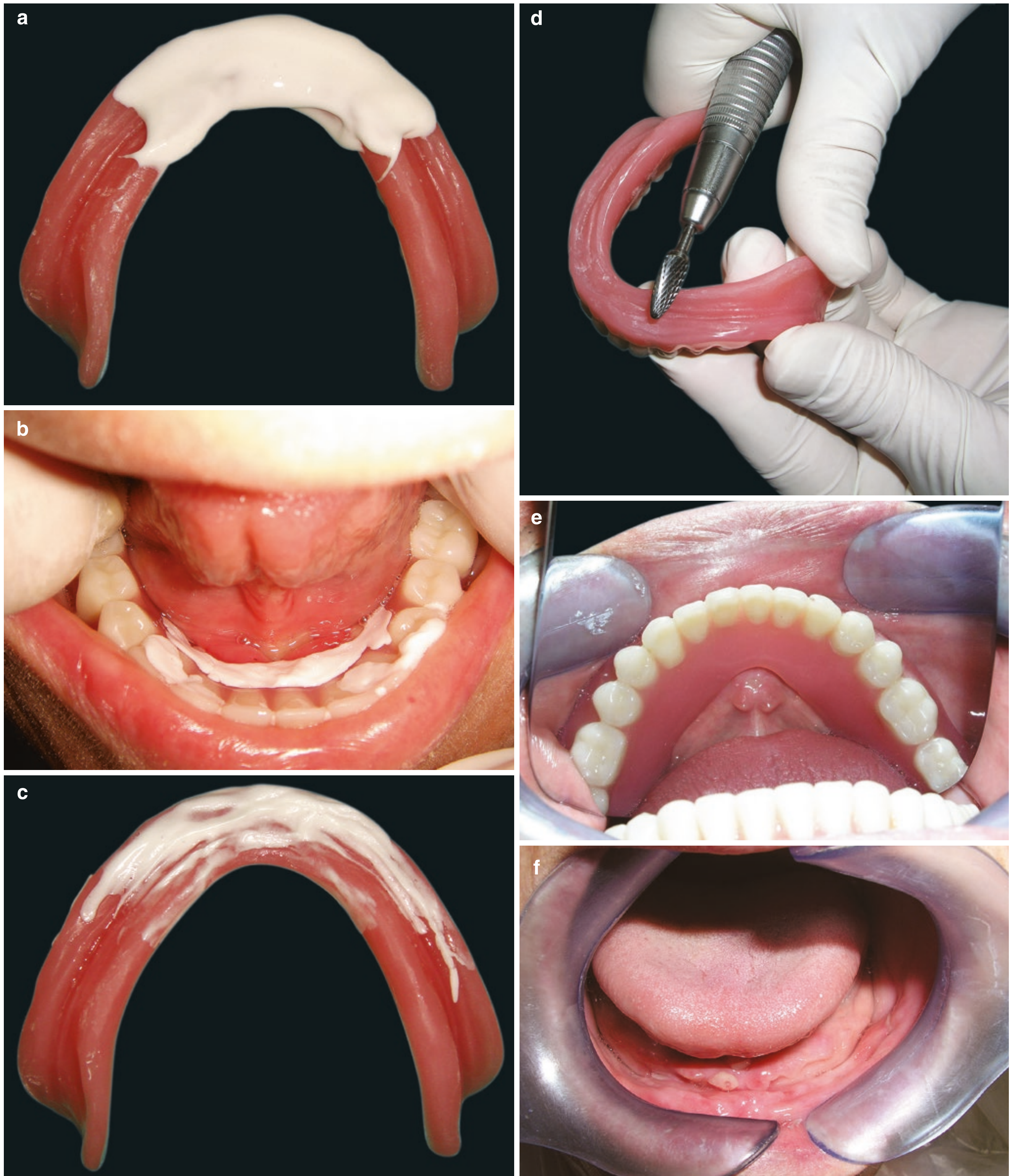


Fig. 4.23 (**a**) Application of pressure indicating paste to lingual areas. (**b**) Positioning the denture in patient's mouth. (**c**) Determination of pressure areas. (**d**) Arrangement of denture (**e**) Extended lingual flange. (**f**) Irritation area. (**g**) Movement of denture due to extended flange. (**h**) Extended flanges. (**i**) Irritation area

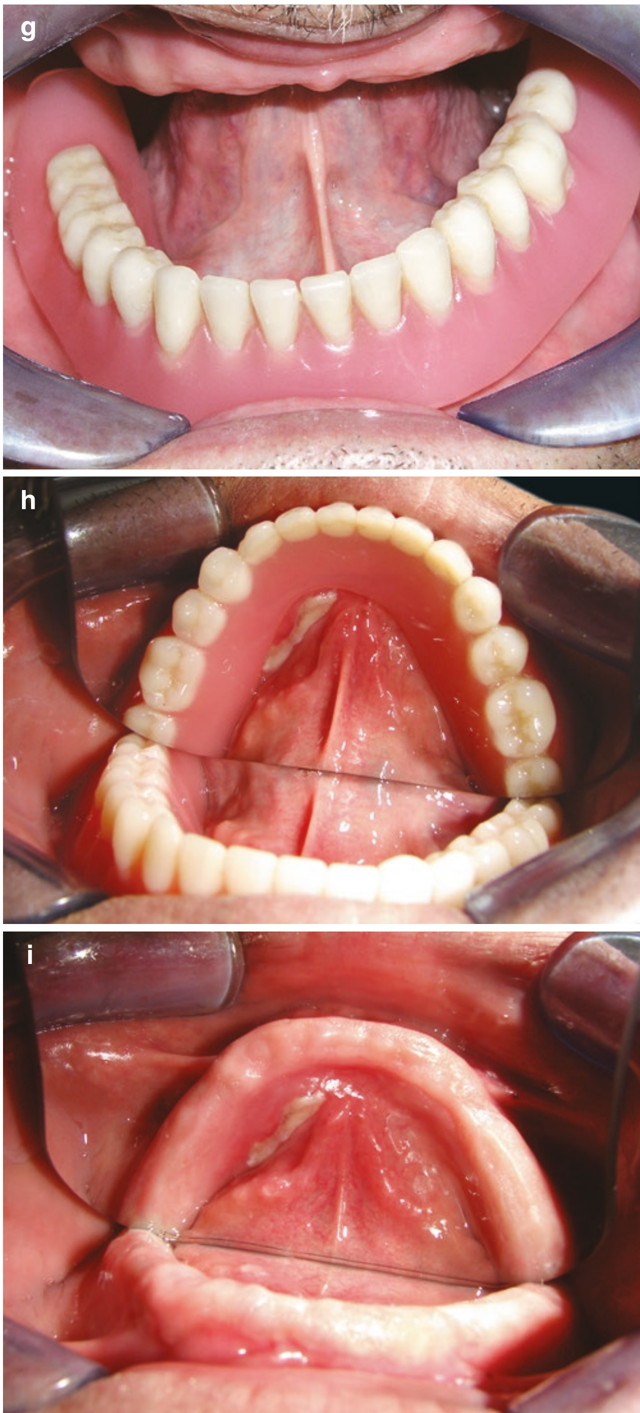


Fig. 4.23 (continued)

1. The clinician should put wax rolls 4 mm in width over all the lingual borders.
2. The clinician gives directions to the patient to swallow and lick the lower lip. When the lower denture is examined, if the retention of denture is not sufficient, other sides are arranged with waxing procedures again, and the buccal frenums are widened. If all peripheral regions are arranged with waxes, the denture must be rebased.

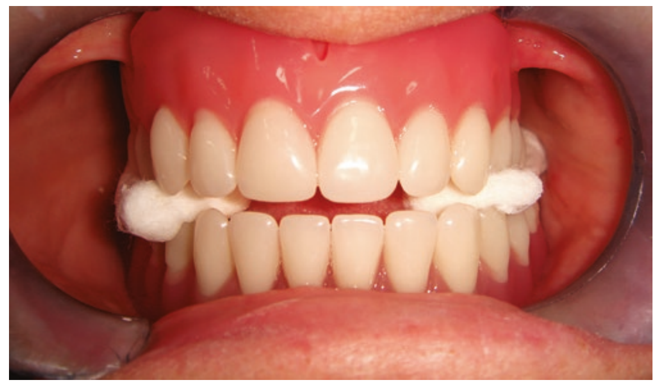


Fig. 4.24 Cotton rolls in molar areas bilaterally

4.1.4 Remounting the Dentures on the Articulator by Using Interocclusal Records and Making the Occlusal Adjustments

The clinical remount process is also known as the patient's remount process. Occlusion is again determined, and thus the elimination of occlusal disharmony is provided. The process of remounting can be defined as the development plan to provide occlusal balance and assisting the analysis on the articulator. The patient's adaptation of the dentures can be used to indicate whether the treatment is negative or positive. The comfort of the patient is necessary for the positive arrangement of the new denture. In this process, many factors may cause mucosal irritation and as a result, tissue ulcerations. Tissue adaptation, the extension of denture flanges, and occlusion are under the control of clinician. Factors, such as using time, diet, and harmful habits, are related to the patient. The clinical remounting process is an important factor for increasing the comfort and effectiveness of the denture or at least for reducing discomfort. Additionally, the remounting process reduces adaptation time and helps to achieve success in patient adaptation.

4.1.4.1 Correction of Occlusion

At this procedure, the patient bites a piece of wax with dentures, and then models are again mounted on the articulator (clinical remounting procedure). The dentures are placed in the patient's mount. Cotton rolls are placed in posterior areas bilaterally, and the patient is told to close in this position for 10 min (Fig. 4.24). The aim of this procedure is to provide a better fit for the denture and to correct mistakes made during centric relation. Then, the jaw is directed many times to the

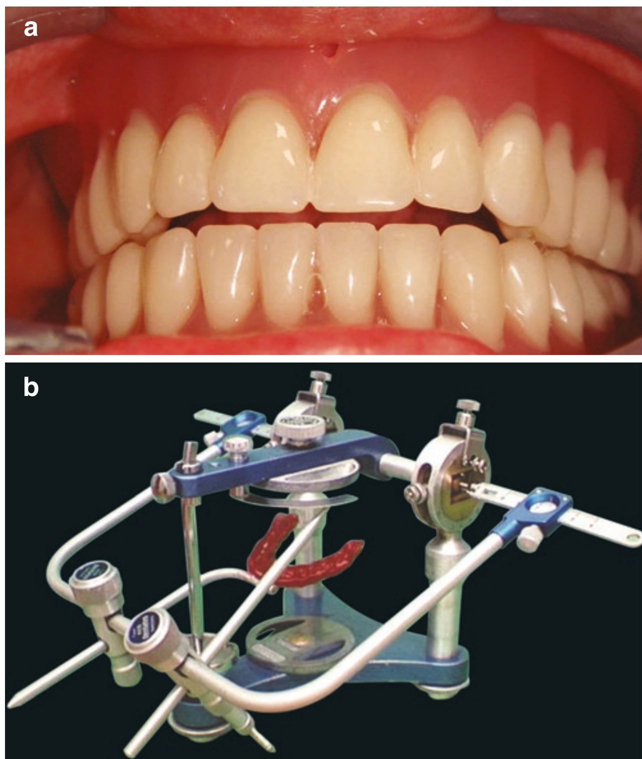


Fig. 4.25 (**a**) Occlusal clearance. (**b**) The patient's existing facebow record

position of centric relation. Wax that is softened slightly in water is placed at the lower posterior region, and the position of the centric relation is recorded. This record is fixed onto the upper denture, and the lower denture is mounted on the articulator. As in this procedure, the upper denture is again fixed to the articulator using the previous face bow record, and the lower dentures are mounted after the centric relation is recorded (Fig. 4.25a, b). After removing the wax, space is available between the teeth (Fig. 4.26a). After removing the wax, 1.5 mm space is seen on the articulator (Fig. 4.26b).

The arrangement of occlusal record with anatomical teeth:

- Rearrangement of centric occlusion
- Correction of occlusal faults on working side
- Correction of occlusal faults on balancing side
- Arrangements of protrusive relation

For occlusal evaluation, all centric and eccentric relations should be controlled. In Fig. 4.27, basic contacts of the teeth can be seen in the centric occlusion, balancing and working sides. The purpose of grinding at the centric occlusion is to provide harmony between the centric occlusion and centric relation. Also, equal contacts and specific mastication pressure for all teeth are delivered on the alveolar crest equally

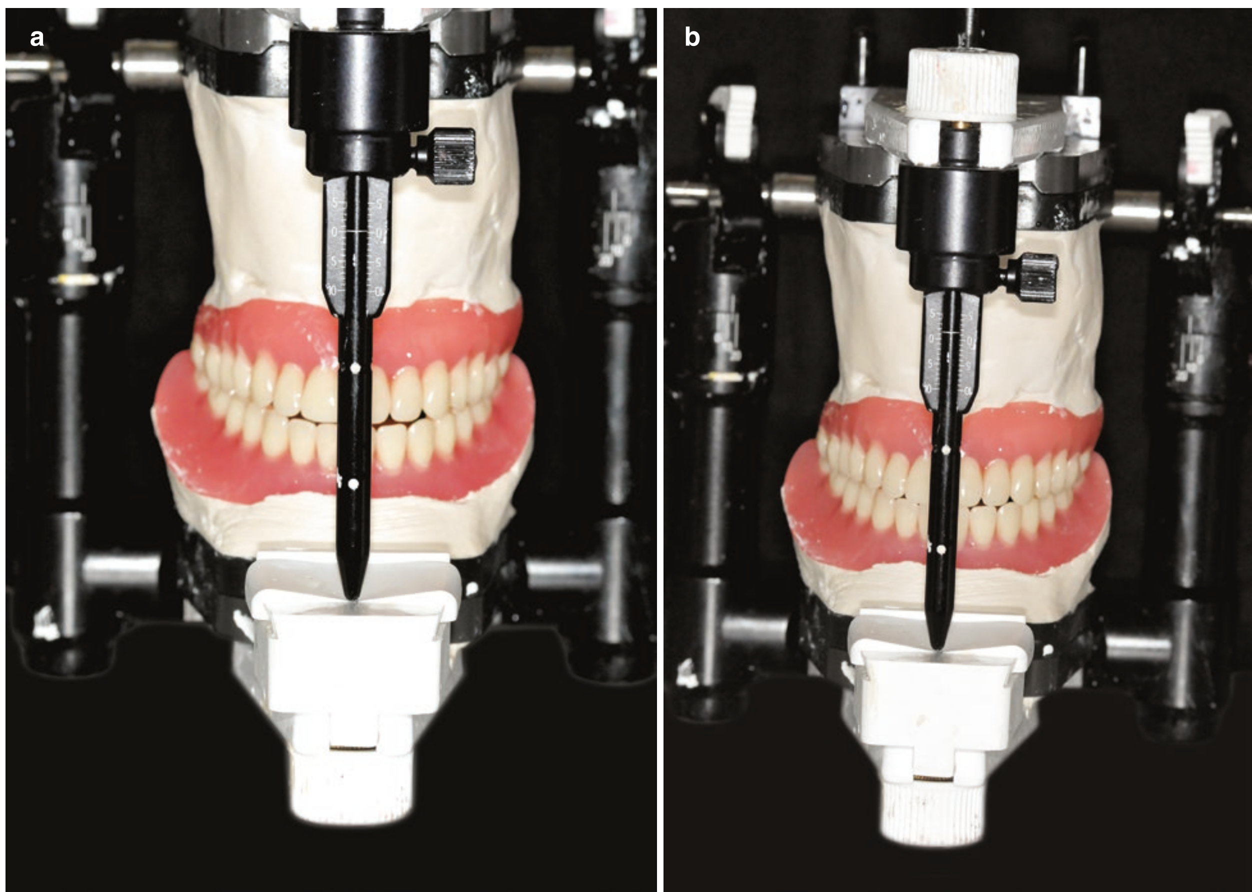


Fig. 4.26 (**a**) Mounting the models on the articulator. (**b**) 1.5 mm height clearance on the articulator

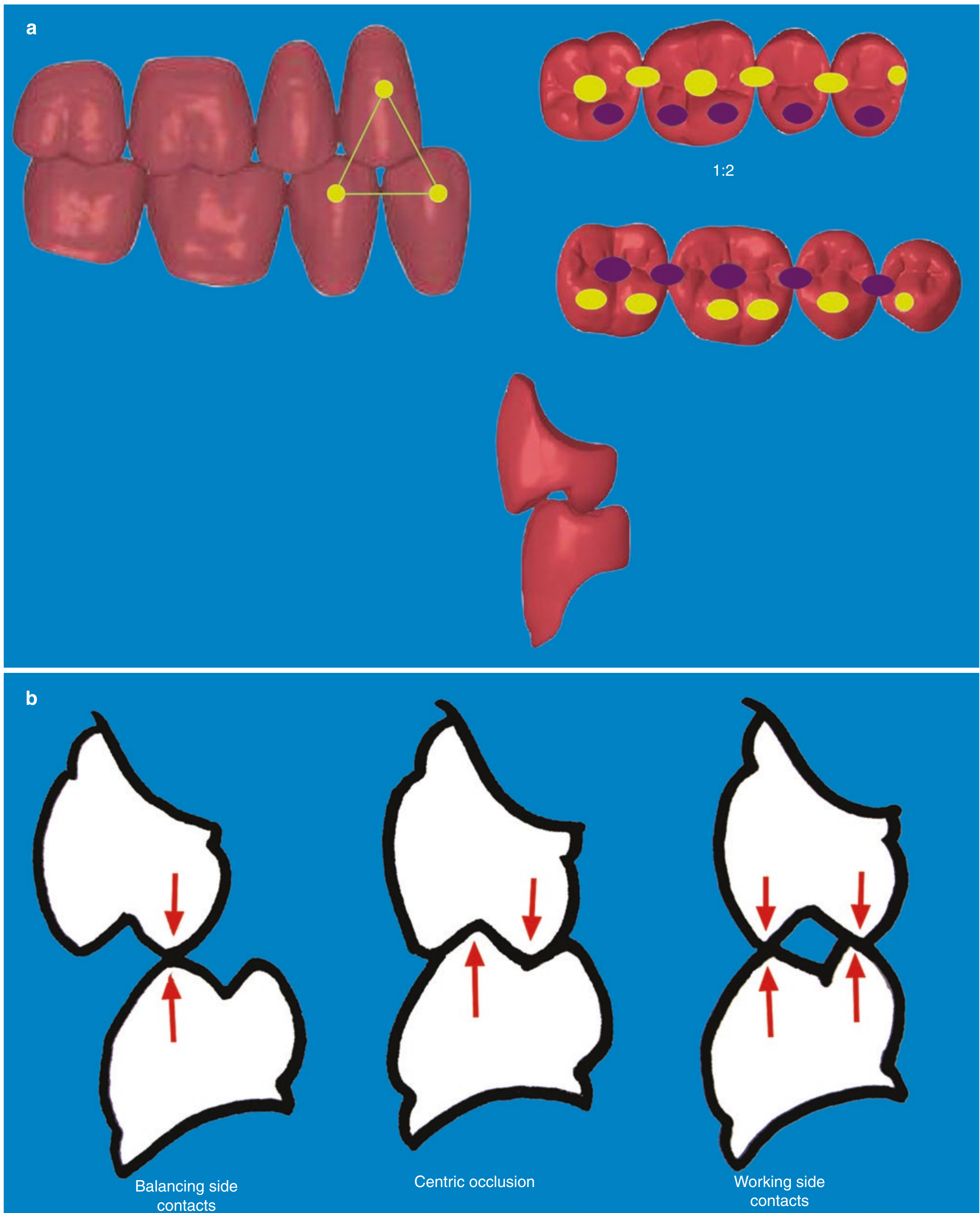


Fig. 4.27 (**a**) Contact areas in centric occlusion. (**b**) Contact areas in centric occlusion and lateral movements

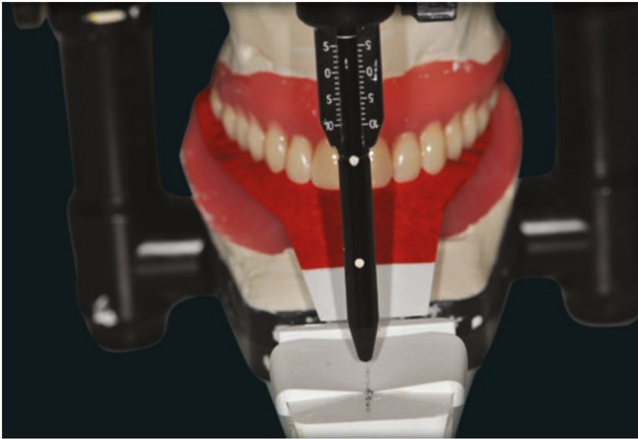


Fig. 4.28 Opening and closing movements are performed with articulating paper

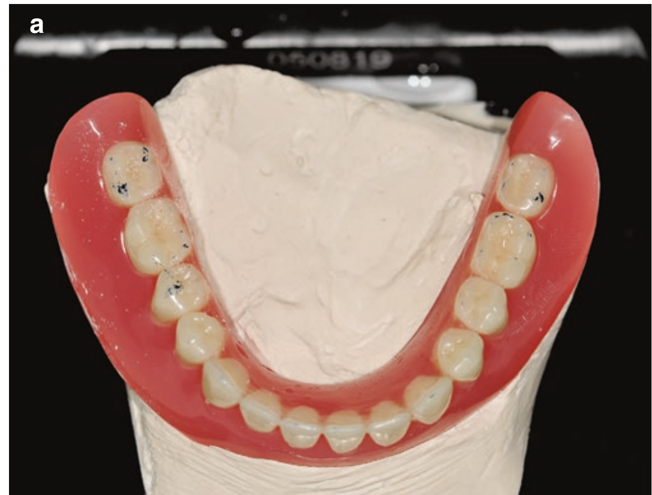
and homogenously. The selective grinding of denture teeth eliminates occlusal disharmony. The selective grinding procedure is performed mostly from the central fossae and less from the triangular fossae and margins, not from the cusp tips (Fig. 4.27a, b). An articulation paper is placed between the teeth, only opening and closing movements are made, and the premature contacts are determined (Fig. 4.28).

Four possible faults can be observed in centric occlusion:

1. Occlusal contacts could be only on the molars. In this case, just the fossae of the upper and lower molars could be deepened. These premature contacts are seen in Fig. 4.29. The clinician should not reduce the length of the cusps.
2. Occlusal contacts could be placed just on the premolars. In this case, only the fossae of upper and lower molars could be deepened. The clinician should not reduce the length of the cusps.
3. Excessive displaying of upper molars to the vestibular. In this case, the occlusal slopes of the lingual cusps and occlusal slopes of buccal cusps could be grinded.
4. Replacement of upper molars to the lingual side. For the correction of this fault, the lingual slopes of the buccal and lingual cusps of the upper teeth and the vestibule slopes of the vestibule and lingual tubercle of the lower teeth could be grinded.

4.1.4.2 Arrangement of Centric Occlusion

If the teeth are excessively visible, fossae are deepened (Fig. 4.30). If the occlusion is edge to edge, grinding the cusp slopes of the upper and lower teeth can solve this problem (Fig. 4.31). After arranging centric occlusion, there is no need to grind the lingual slopes of the maxillary teeth and buccal



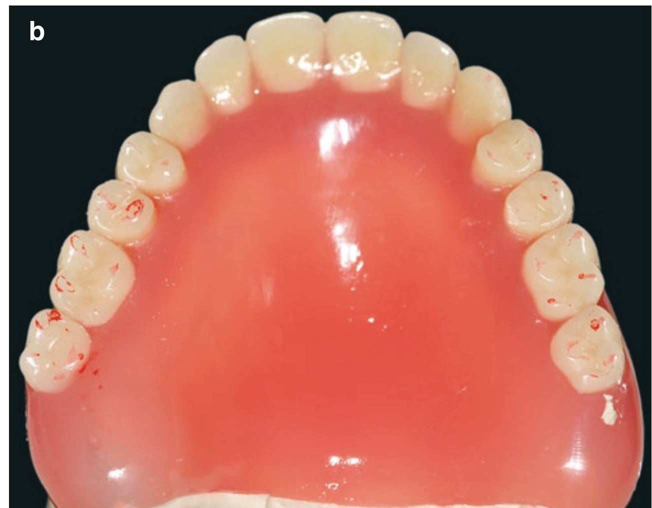


Fig. 4.29 (**a**, **b**) Premature contacts observed on molar teeth

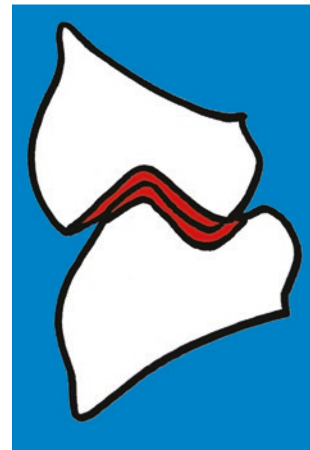


Fig. 4.30 Fossae are deepened when the teeth are excessively visible

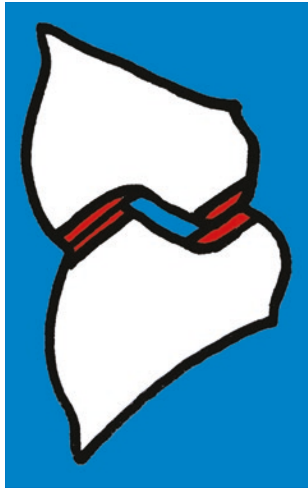


Fig. 4.31 Grinding is performed on the cusp slopes of the upper and lower teeth if the occlusion is edge to edge in the centric position

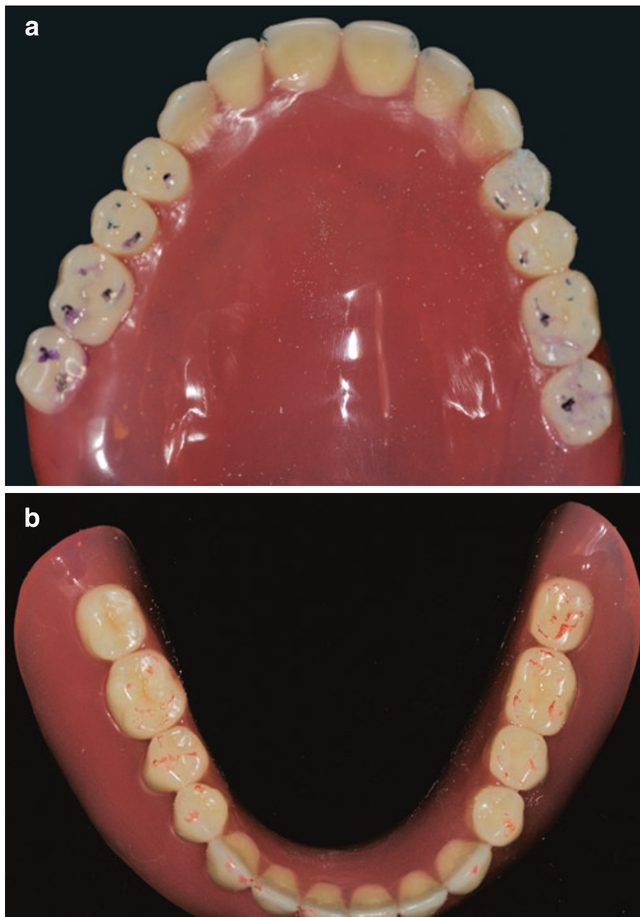


Fig. 4.32 (**a**, **b**) Equal contacts after grinding process

slopes of mandibular teeth, and the fossae should not been deepened. The final controls for occlusion can be performed with re-opening/closing movements using articulation paper (Fig. 4.29a, b). The grinding process should be continued until contact is achieved equally in all teeth (Fig. 4.32a, b).

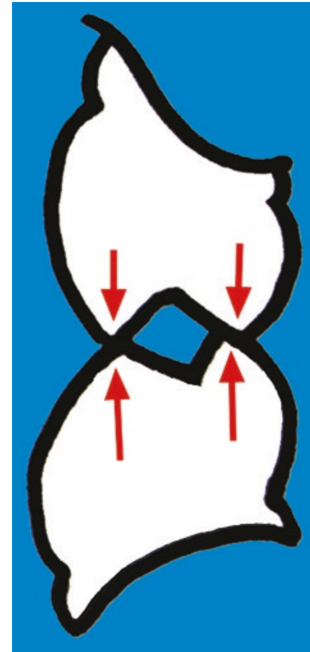


Fig. 4.33 Lingual slopes of the buccal cusps of the upper molars and the buccal slopes of the lingual cusps of the lower molars should be grinded on the working side

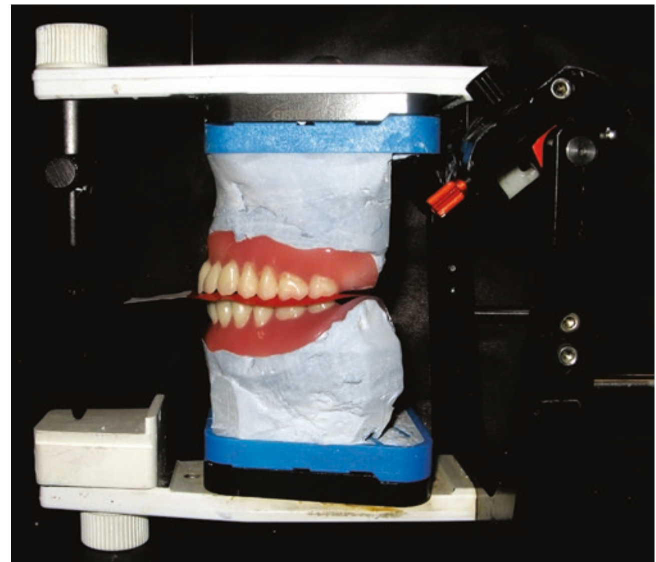
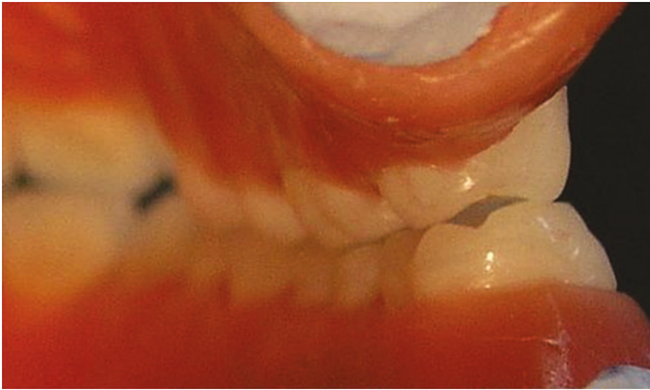


Fig. 4.34 Control of lateral movements with articulating paper

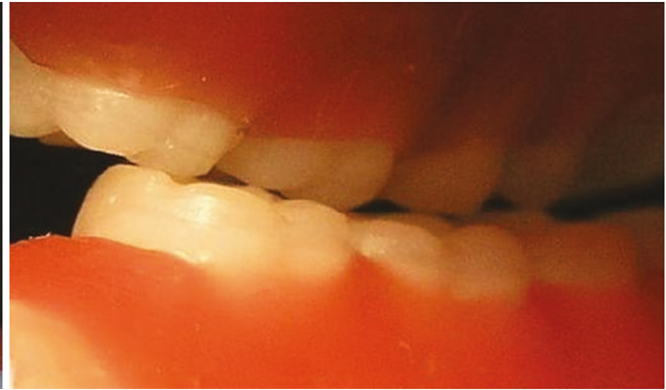
4.1.4.3 Arrangement of Lateral Movements

Correction of Occlusal Faults on Working Side

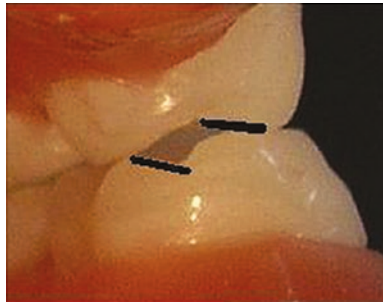
Lingual slopes of buccal cusps of the upper molars and buccal slopes of lingual cusps of the lower molars should be grinded for the correction of occlusal problems on working side (Fig. 4.33; Figs. 4.34, 4.35). If buccal and lingual cusps are too long, slopes of balancing cusps should be grinded (Fig. 4.36). If the buccal cusps are still too long, lingual slopes of buccal cusps of the upper molars should be grinded (Figs. 4.37, 4.38).

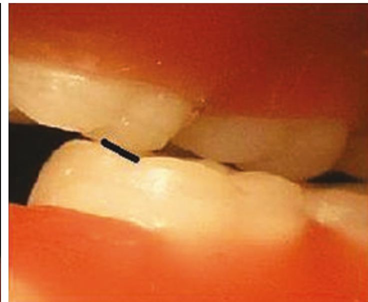


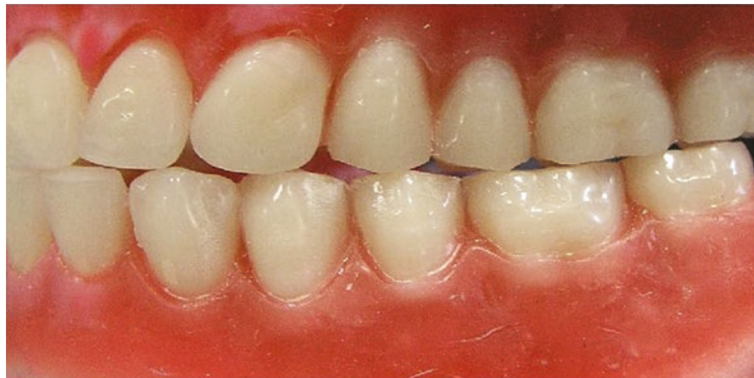
On the working side, lingual slopes of the buccal cusps of the upper molars and the buccal slopes of the lingual cusps of the lower molars are grinded



On the balancing side, lingual slopes of the lower buccal cusps are grinded







In the protrusive movement, distal slopes of upper teeth and mesial slopes of lower teeth are grinded

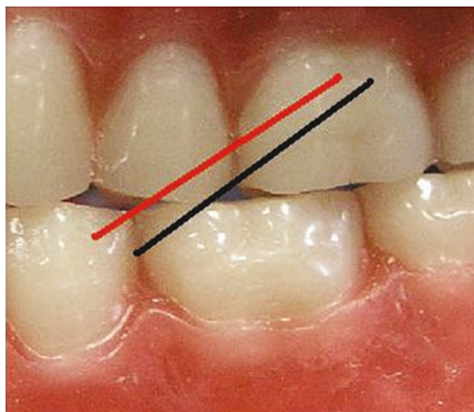


Fig. 4.35 Grinding process during lateral and protrusive movements

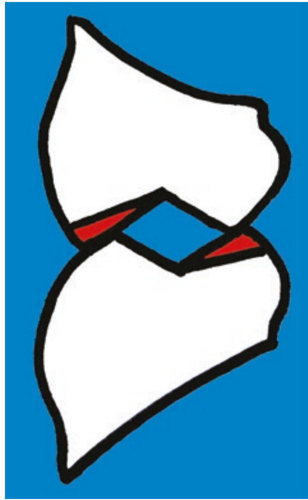


Fig. 4.36 The slopes of the balancing cusps should be grinded if the buccal and lingual cusps on the working side are too long

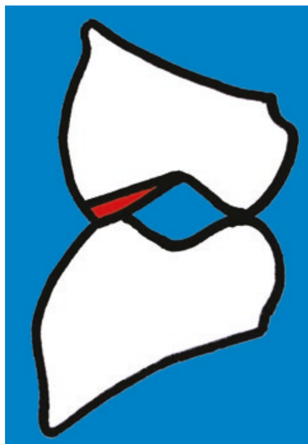


Fig. 4.37 Lingual slopes of the upper buccal cusps are grinded if the buccal cusps are too long

Correction of Occlusal Faults on Balancing Side

The lingual slopes of the buccal cusps of the lower teeth or the antagonist cusps of the teeth that are determined to stay in centric occlusion should be grinded (Figs. 4.39 and 4.40).

Control of Protrusive Relationship

While arranging protrusive relations, the distal slopes of upper teeth and mesial slopes of the lower teeth should be grinded (Figs. 4.35 and 4.41). In cases where there is premature contact on the incisor region and no contact on molar region to determine balance:

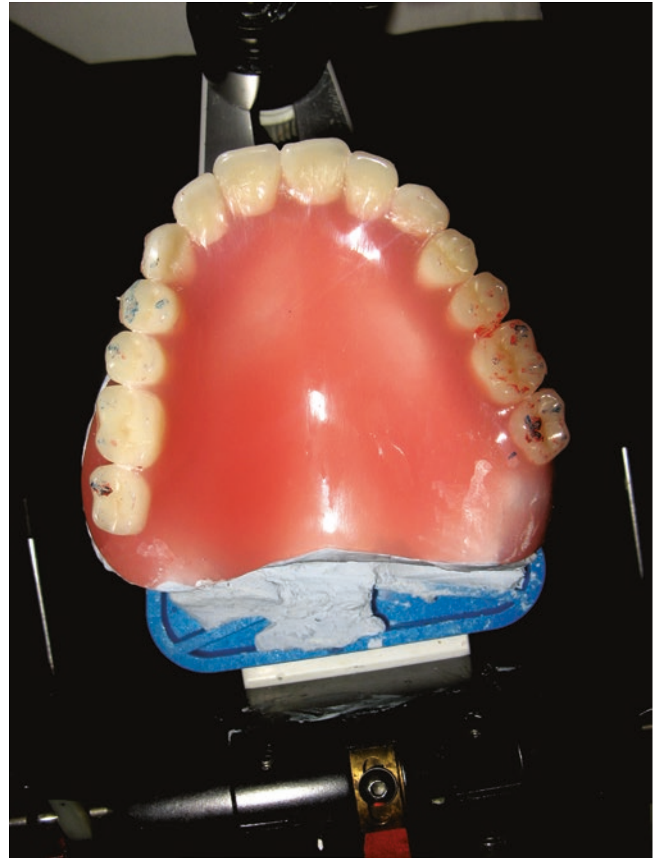


Fig. 4.38 When the buccal and lingual cusps on the working side are too long, the lingual slopes of the buccal cusps of the upper teeth are grinded

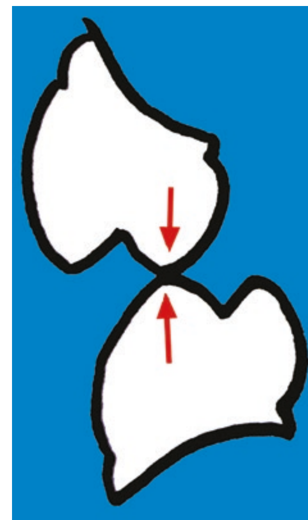


Fig. 4.39 Lingual slopes of the lower buccal cusps are grinded

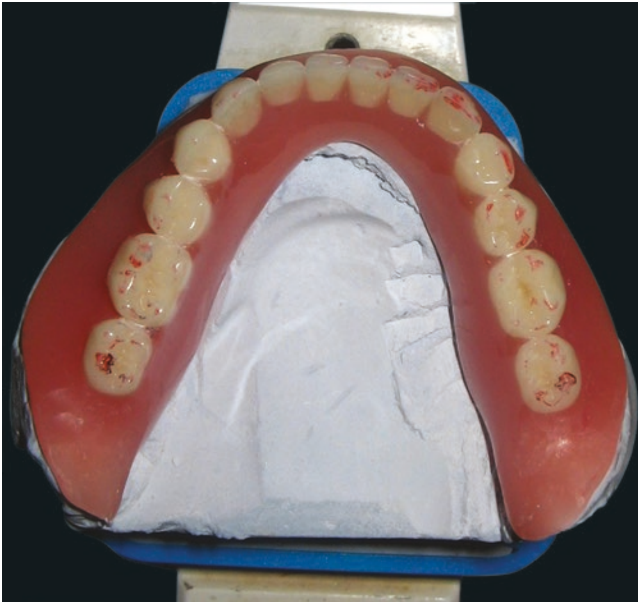


Fig. 4.40 Lingual slopes of lower buccal cusps are grinded

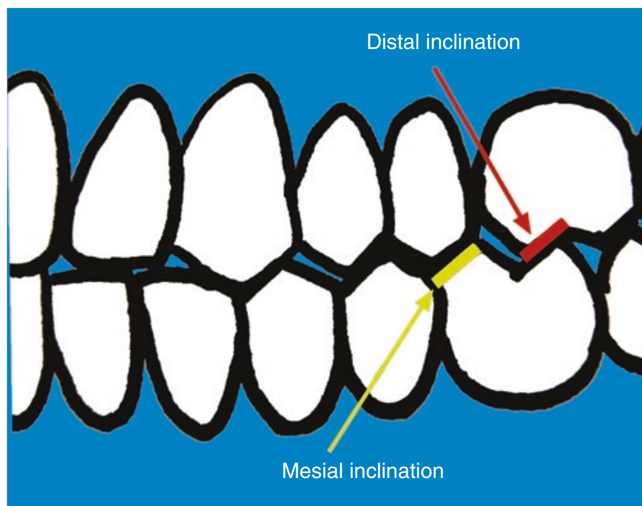


Fig. 4.41 For protrusive movement, the grinding process should be performed from the mesial slopes of the lower posterior teeth cusps and the distal slopes of the upper posterior teeth cusps in the molar region

The palatinal sides of the upper incisors toward the cutting edge and vestibular sides of the lower incisors toward the cutting edge should be grinded without impairing esthetics. It is important not to shorten crown lengths for this procedure.

In cases where there is premature contact on the molar region and no contact on the incisor region:

The mesiobuccal slopes of lingual cusps of lower molars/premolars and distolingual slopes of vestibular cusps of upper teeth should be grinded. The mesiolingual cusps of upper molars should never be grinded.

4.1.5 Control of Occlusion in the Patient's Mouth

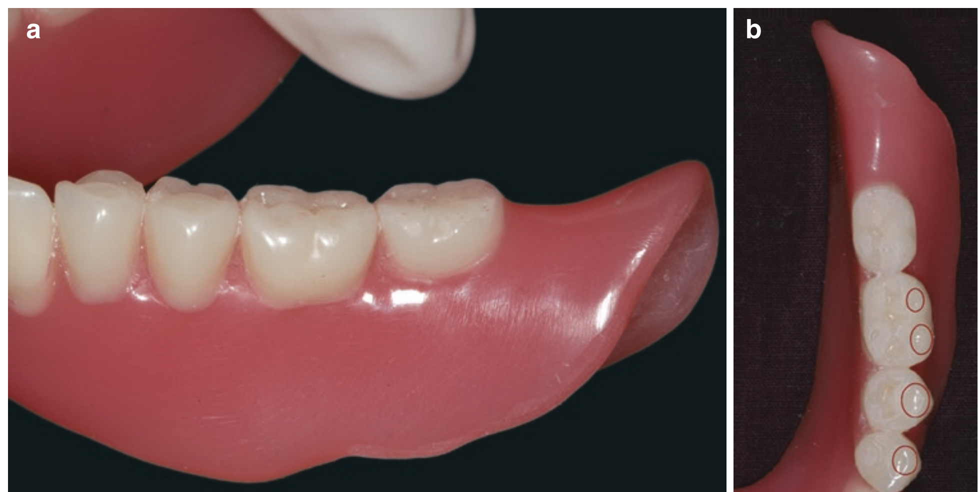
Only minor problems due to soft tissue changes should be arranged in the patient's mouth, following all the articulator grinding. Grinding should never be performed from the tip of the cusps while making an occlusal arrangement (Fig. 4.42a, b). It causes vertical dimension loss, widening of occlusal contacts, and complaints of chewing function loss. Premolars and molars should contact in the centric occlusion, but the anterior teeth should contact slightly to provide an ideal occlusal relationship (Fig. 4.43a–c).

Articulating paper with a thickness of 60 micron is used for the grinding procedure. The clinician requires the patient to bite this paper (Fig. 4.44a, b). The dryness of articulating paper is important. Otherwise, the folding of the paper and the huge contact areas will mislead the clinician.

The clinician should take care to ensure that the patient closes his/her mouth in the right position when taking the centric relation record. The clinician should give instructions to just close his/her mouth with the teeth in contact. In the first control, all right and left posterior contacts should be equal.

When the contacts are not equal (Fig. 4.44c–e), the grinding procedure should be used until all contacts are the same (Fig. 4.44f–h). It is important that the grinding procedure

Fig. 4.42 (**a**) Grinding should never be performed on the tip of the cusp. (**b**) Tips of the cusps should be protected to prevent loss of vertical dimension



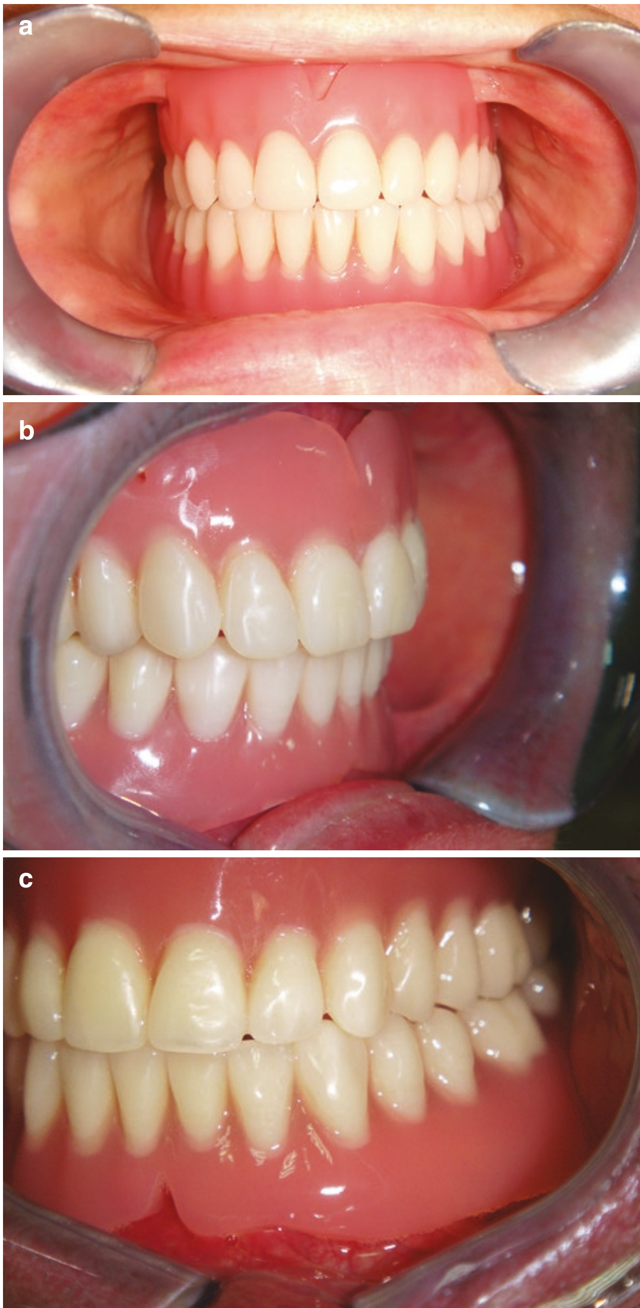


Fig. 4.43 (**a**–**c**) In complete dentures, premolars, and molars should make contact in centric occlusion, but the anterior teeth should make slight contact for an ideal occlusal relationship

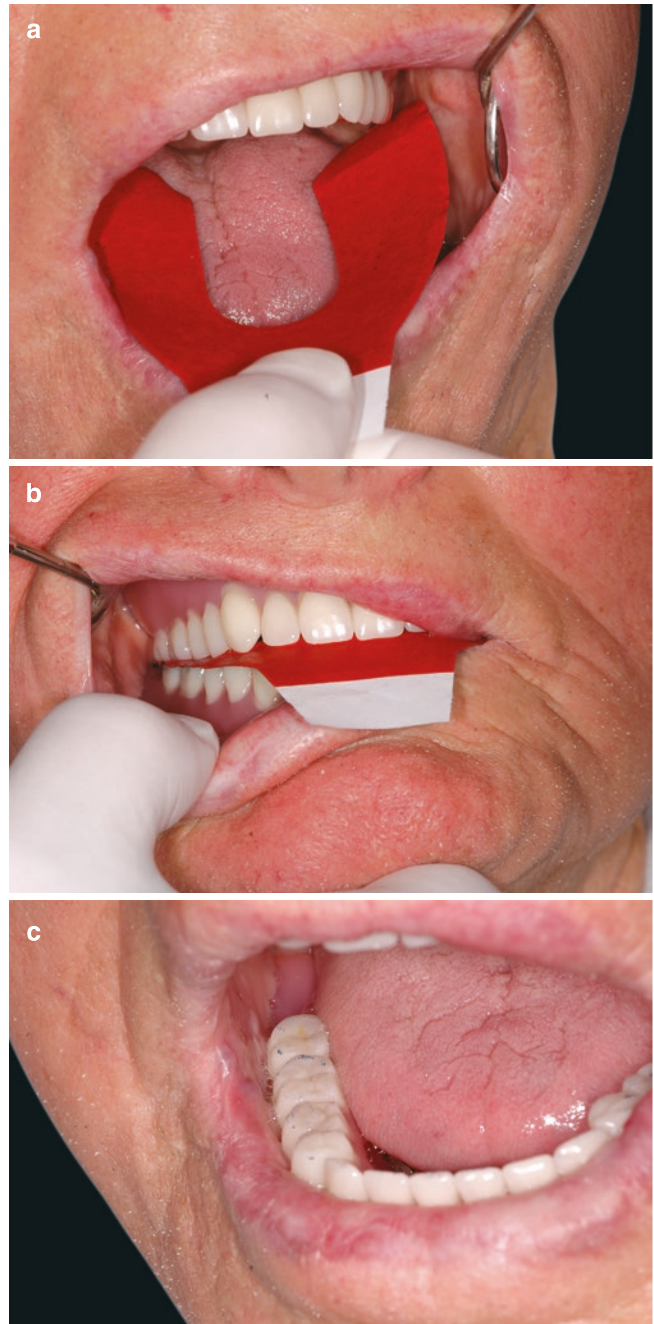


Fig. 4.44 (**a**, **b**) Placing articulating paper and closing the jaws. (**c**–**e**) Non-uniform contact areas in right and left posterior areas (**f**) Unbalanced contacts in centric occlusion. (**g**) Elimination of the premature contacts in centric occlusion. (**h**) Observation of posterior teeth contacts

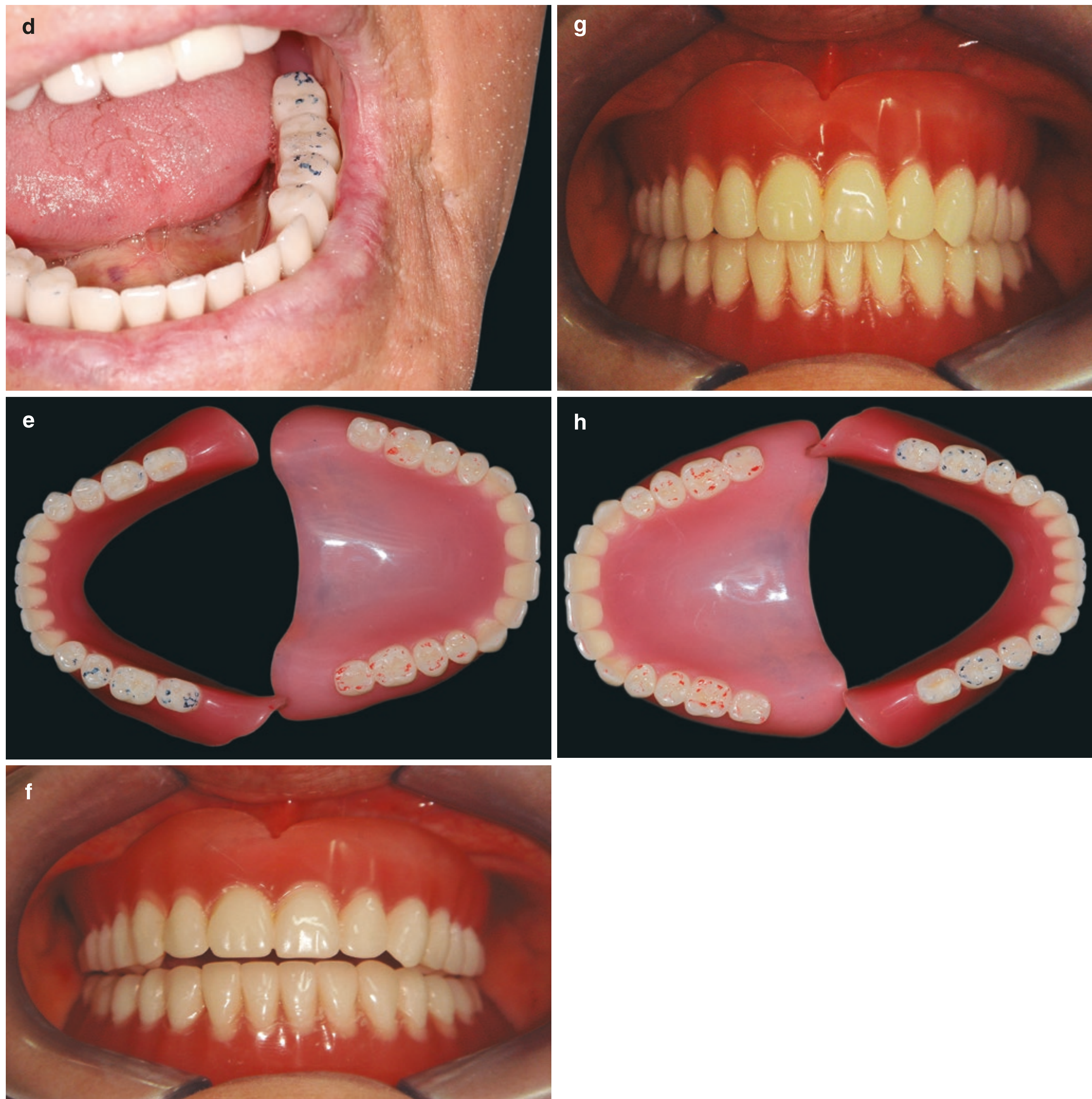


Fig. 4.44 (continued)

should be made with small burs, and the bur should be parallel to the slopes of the cusps (Fig. 4.45). The grinding procedure should be made until all contacts are the same (Fig. 4.46a–b).

4.1.5.1 Grinding in Lateral Movements

Before recording lateral movements, centric occlusion records should be marked. Then, the other side of articulation paper should be placed in the mouth, and the clinician gives directions to the patient to make lateral movements (Fig. 4.47a, b).

The BULL rule (buccal upper, lingual lower) should be performed after the lateral movements are recorded. As a rule, BULL means that slopes of buccal cusps on upper teeth and slopes of lingual cusps of lower teeth should be grinded (Figs. 4.48, and 4.49–4.51).

All grinding procedures should be performed until the mandible makes uniform lateral movements and the cusp tips of the upper teeth make contact with the lower teeth, as in Figs. 4.52 and 4.53. It should be continued until all the teeth have the same and equal contacts (Fig. 4.54). The same procedure should be made for the other side (Figs. 4.55 and 4.56).

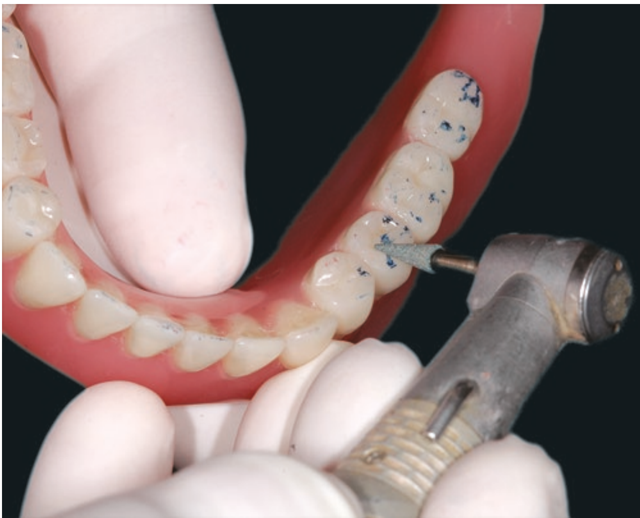
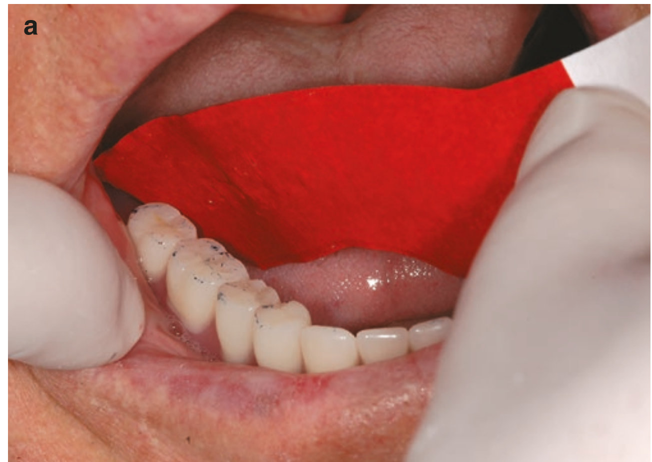


Fig. 4.45 Small burs should be used during grinding of contact points



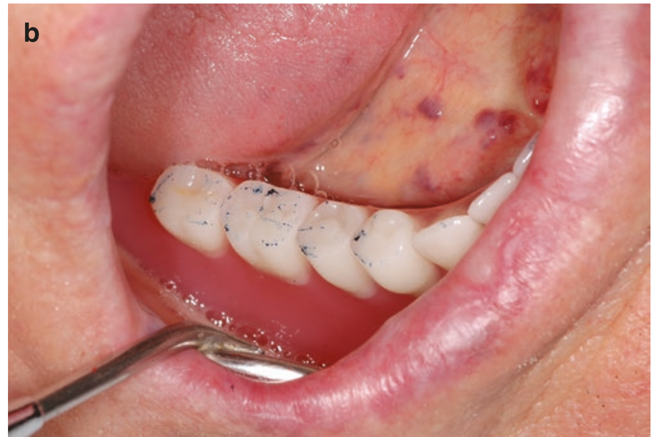
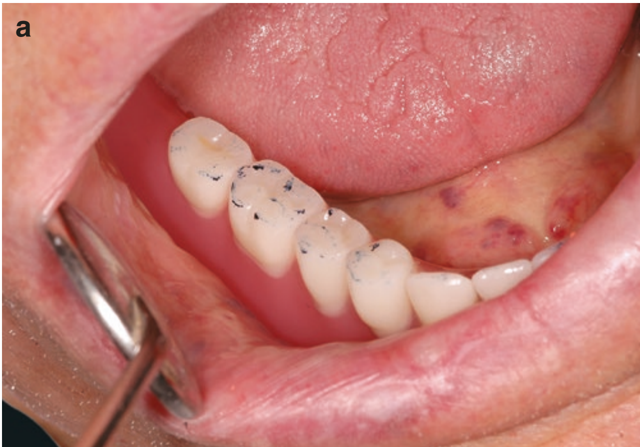


Fig. 4.47 (**a**, **b**) The lateral movements are performed by using the other side of the articulation paper and contact points on the teeth



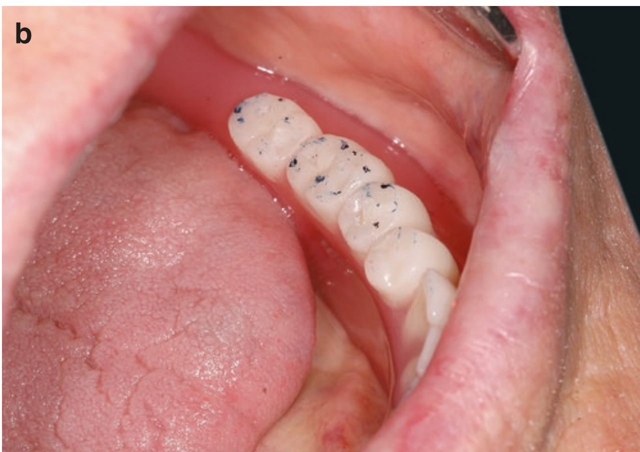


Fig. 4.46 (**a**, **b**) Equalization of contact points in posterior region bilaterally

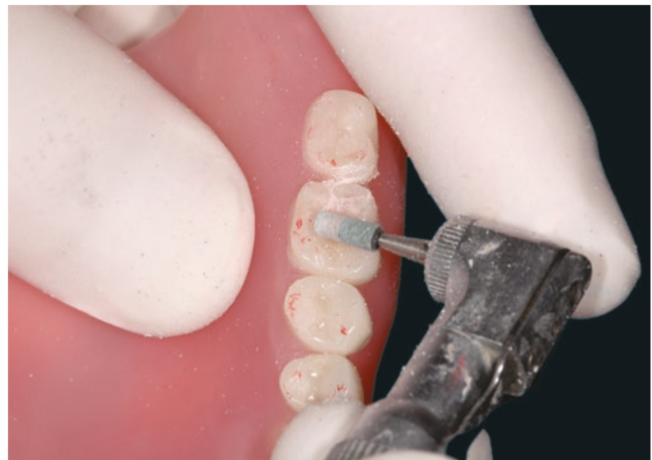
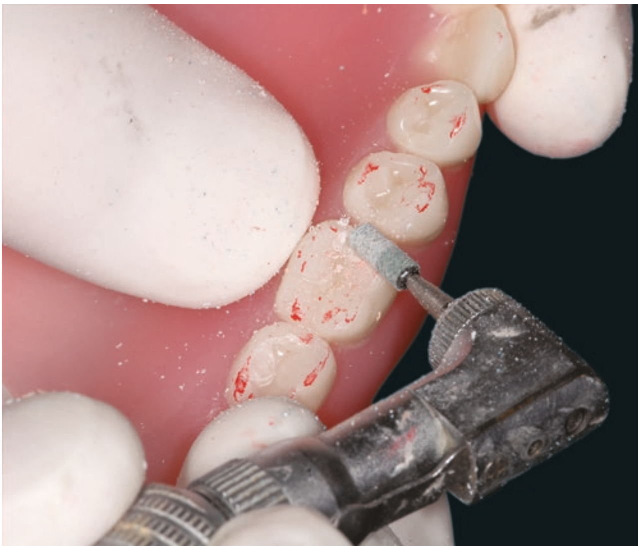
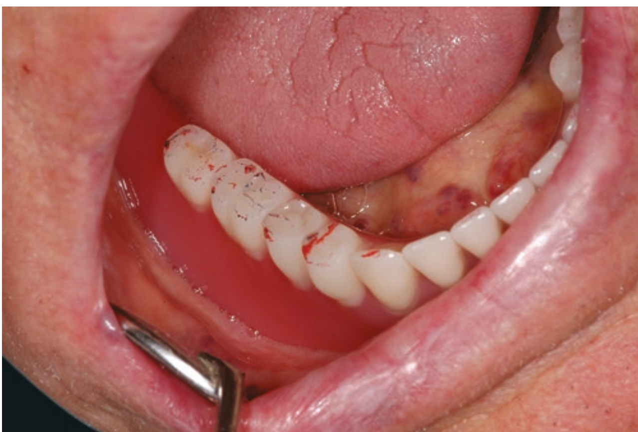


Fig. 4.48 For lateral movements, grinding is performed on the slopes of the upper teeth's buccal cusps





Figs. 4.49–4.51 For lateral movements, slopes of the lower teeth's lingual cusps are grinded

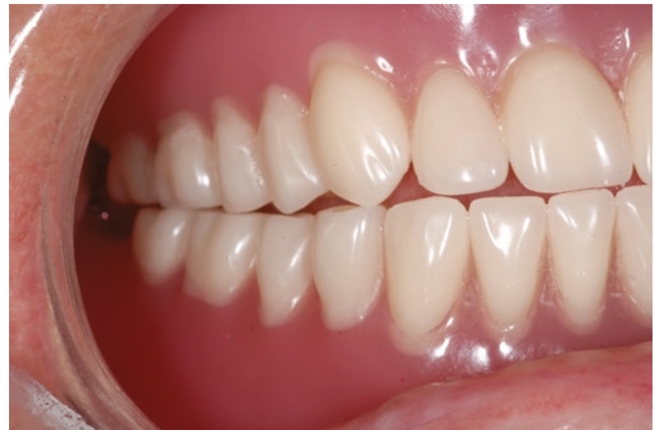


Fig. 4.52 In lateral movements, all teeth should have contact

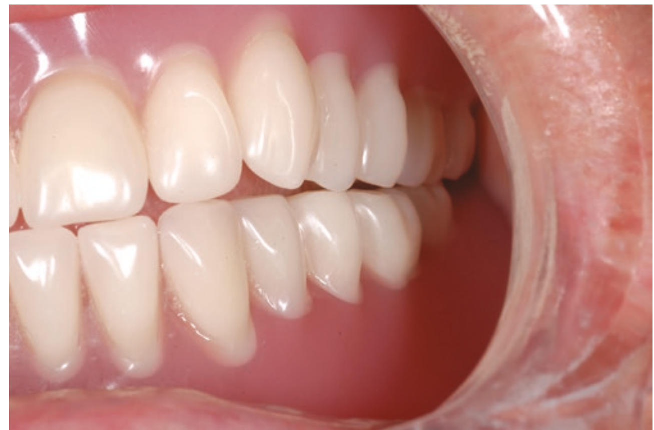


Fig. 4.53 Lack of contact on all teeth in lateral movements

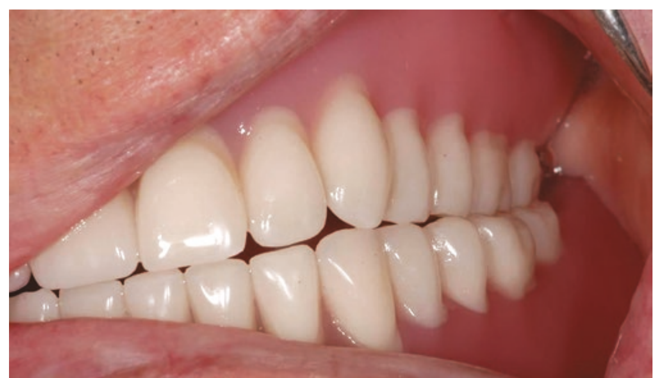


Fig. 4.54 Grinding process should be performed until all the teeth are in contact

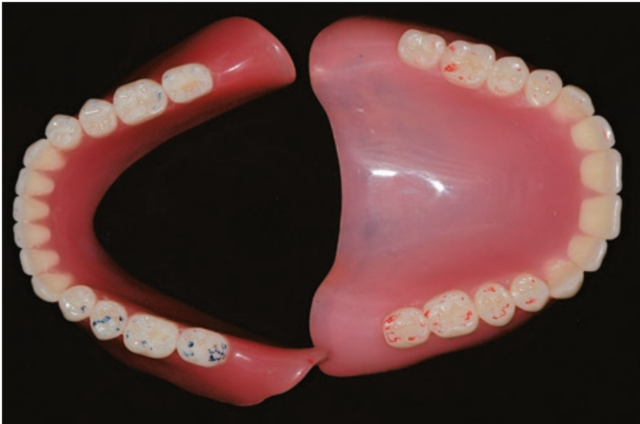


Fig. 4.55 Nonuniform contact points

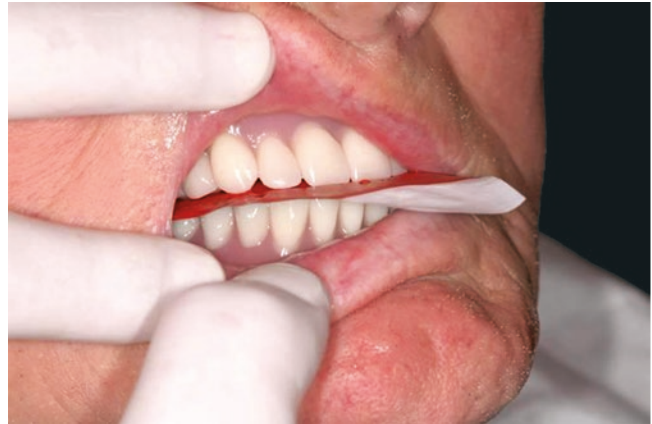


Fig. 4.57 Placing the articulating paper for protrusive movement

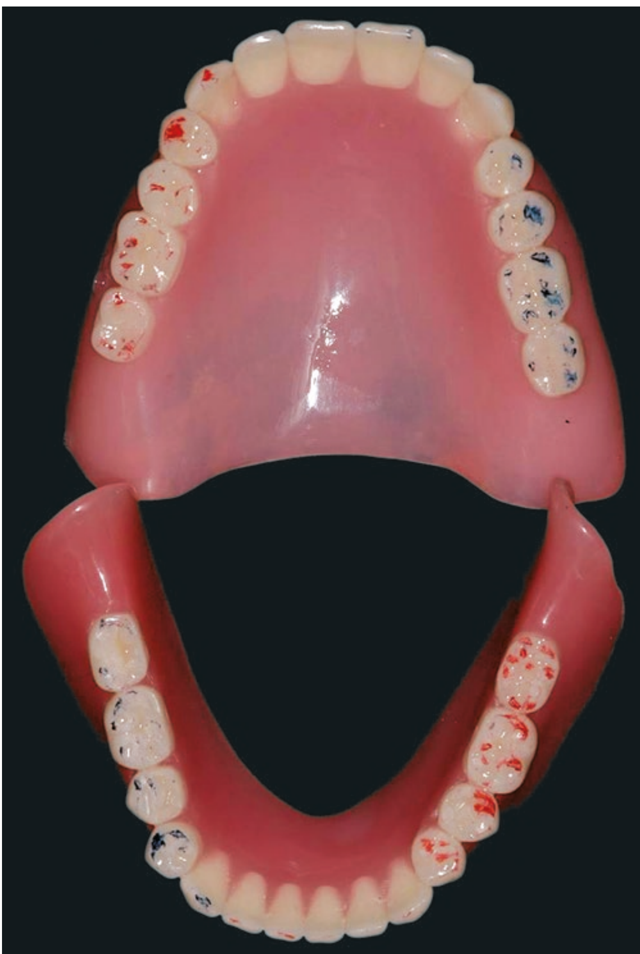
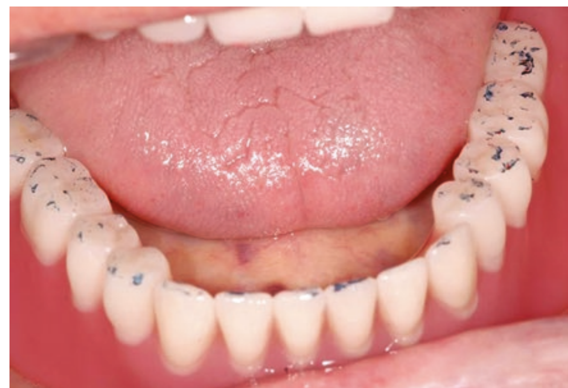
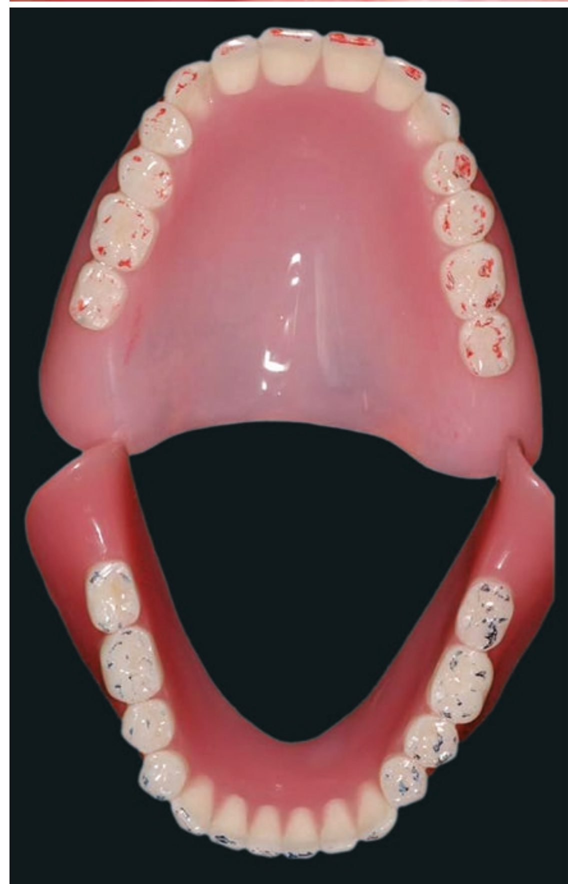


Fig. 4.56 Equal contacts on all teeth

4.1.5.2 Grinding in Protrusive Movements

For this procedure, the clinician should give directions to the patient to move his/her mandible in a forward direction. In the first attempt, the patient cannot usually make the movement correct. Before placing the articulation paper, it is important to practice. Only after this should the clinician use articulating paper (Figs. 4.57, 4.58, and 4.59).



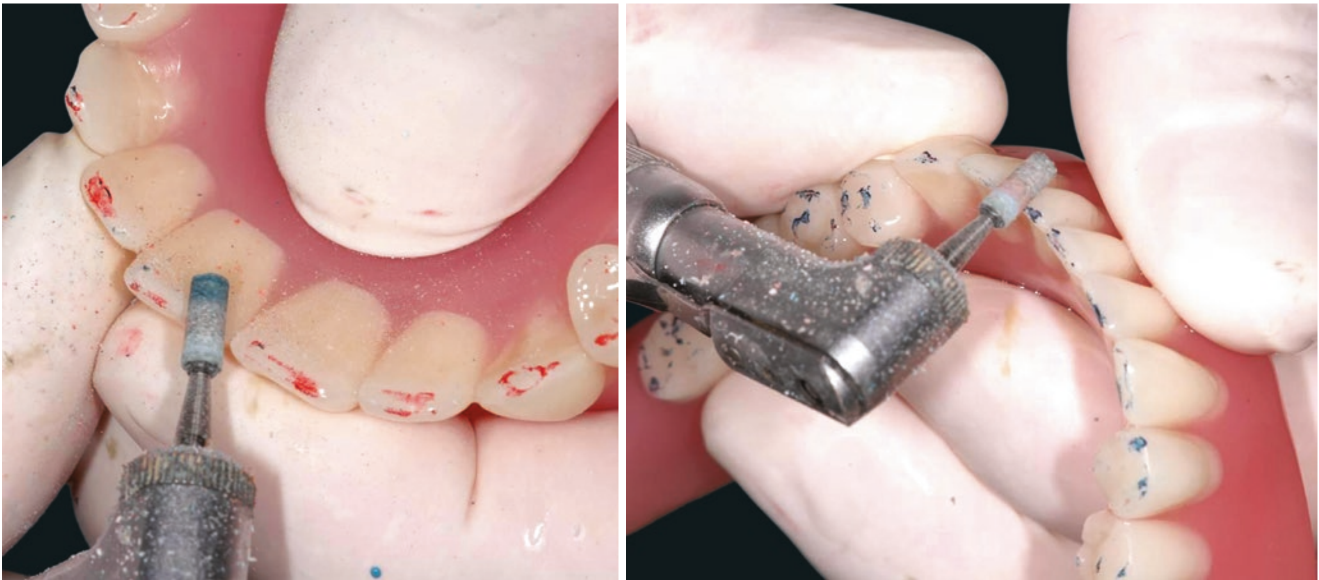


Figs. 4.58 and 4.59 Premature contacts occuring during protrusive movement

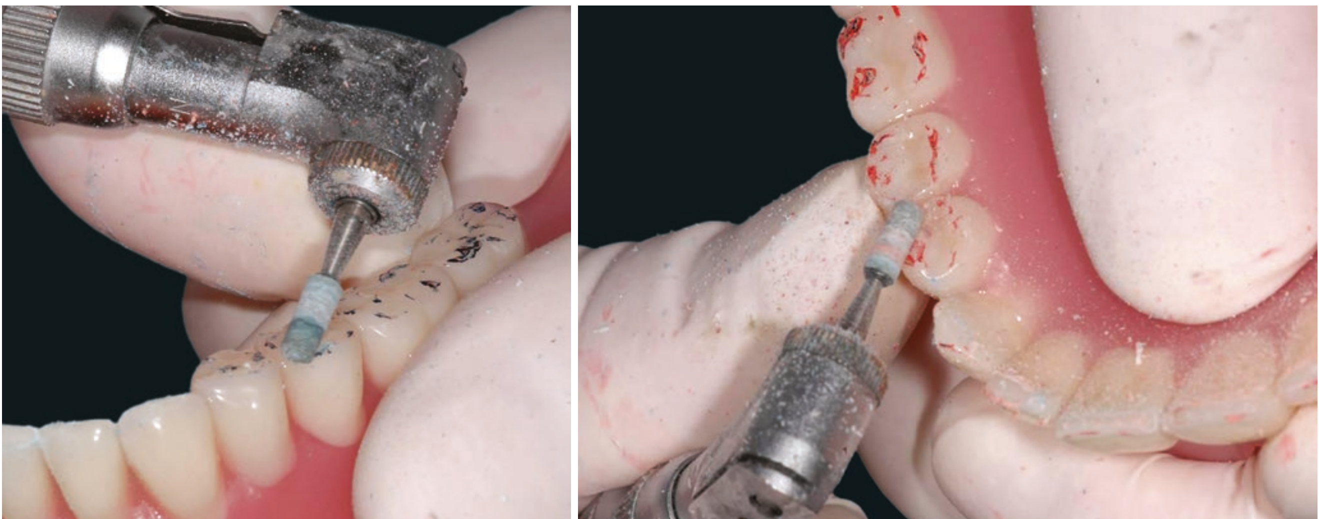
In protrusive movements, the palatinal side of upper anterior teeth and buccal side of lower anterior teeth should be grinded (Figs. 4.60, 4.61). In the posterior side, the procedure should be performed as mesial slopes of lower posterior teeth cusps and distal slopes of upper posterior teeth cusps (Figs. 4.41, 4.62, and 4.63). The ideal protrusive relation is when the mandible starts moving forward and all incisors and posterior teeth cusps are in contact (Fig. 4.64a–c).

4.1.5.3 Denture Delivery

After delivering the denture, recall appointments are really important and essential for success. All directions regarding usage and care should be given to the patient verbally and in writing, and if possible, the clinician should give an appointment after 24 h. This duration is critical and important for the patient to adapt the dentures. Regions determined due to irritation and discomfort and that might



Figs. 4.60 and 4.61 For protrusive movement, the grinding process should be performed from palatinal surface of upper anterior teeth and buccal surface of lower anterior teeth



Figs. 4.62 and 4.63 In the posterior region, grinding is performed on the mesial slopes of the lower posterior teeth cusps and the distal slopes of the upper posterior teeth cusps

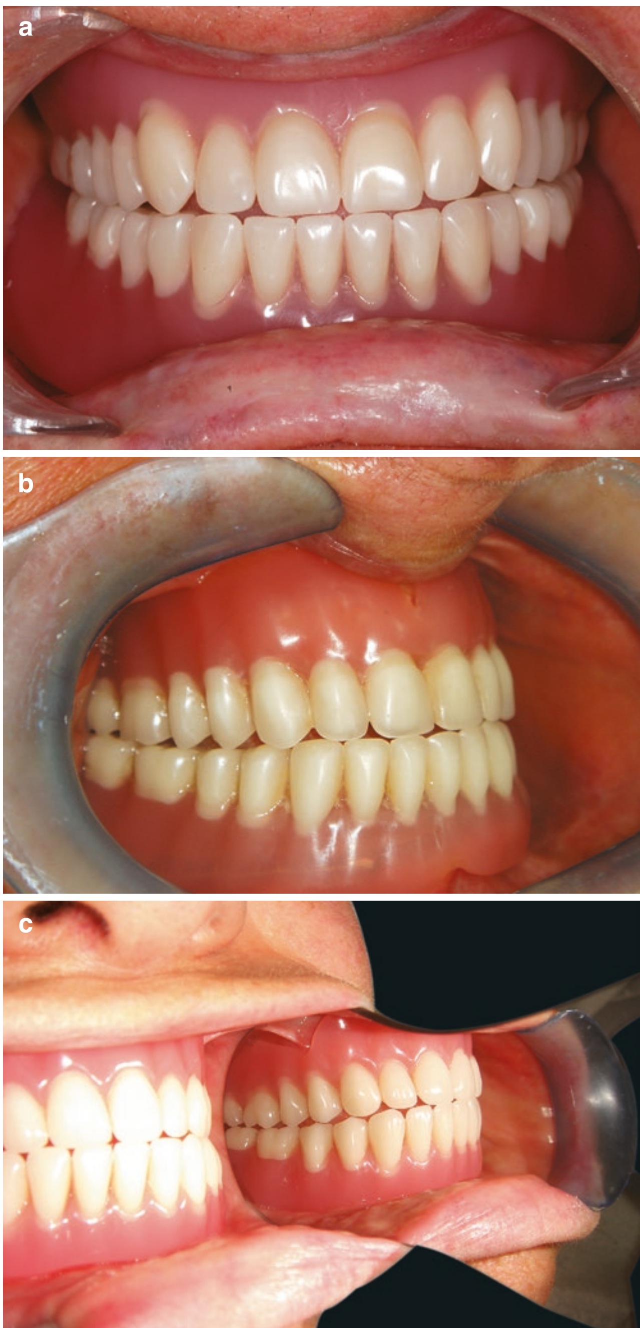


Fig. 4.64 (**a**–**c**) In the ideal protrusive relationship, all posterior teeth cusps and incisal edges of anterior teeth are in contact

cause psychological problems should be grinded. All recall appointments should be given when the patient calls the clinician. If there are minimal grinding and arrangements at the first recall, the clinician can make the second appointment 1 week later. If tissue irritation is significant, the clinician should give the second appointment 1–2 days later. A subsequent appointment is not necessary if the clinician is certain about the patient's comfort and the grindings are sufficient.

4.1.5.4 Points to Which Complete Denture Patients Should Pay Attention

In particular, patients who have not used dentures before may have some problems with adaptation to their dentures. The clinician should give advice and describe all the possible problems prior to starting, as well as during the treatment. It will be beneficial for both the patient and the clinician to discuss and be aware of the difficulties and the procedures that can overcome them, during the last appointment before the delivery of dentures. It will be also preferable and more convenient for the patient to have these directions in writing.

Patience

Dentures will take some time to get used to. Over time, you will accept your dentures as a part of your body. Since your dentures are foreign objects, salivary flow can be more, and you may need to swallow more often. Everything is in your hands: if you have patience, it will be easier to adapt to your dentures. When you start to use your denture, your clinician should give you a recall appointment automatically after 24 h. The patient should go to recalls every week in the first month because of possible problems.

Pain Spots

If your dentures bother you a day or two after delivery, remove them from your mouth. Minor or painful irritation areas may occur under the new dentures. If this is the case, contact your clinician to remedy the problem. Before you visit your clinician for the irritation areas, your dentures must be used for at least 4 h and you must eat at least one meal.

How Long You Need to Use Your Dentures?

The patient must be informed about how to care for both their dentures and their soft tissues. The dentures should not be used day and night. For many patients, removing the dentures will provide stimulation of the tissues with the tongue and saliva and will increase the effect of washing the mucous membranes, and therefore, microorganisms will be removed.

For a healthy mucous membrane, the denture should be outside the mouth for 4–6 h. For patients who have not removed their dentures for a long period, brushing the tissues is recommended.

Lower Dentures

Getting used to the lower denture requires more time than the upper denture. Do not be uncomfortable about the new position of your tongue; you will adapt to the new situation.

Chewing and Biting Food

In the early days, choose soft but nonsticky food. You can easily adapt to the pressure over the crest and the denture by chewing slowly. If you increase your chewing time, it will be easier to adapt the dentures. During mastication, the prosthesis can move very slightly. Over time, as a result of the improvement in muscle coordination, the mobility of your dentures will reduce. If there is no decrease in mobility, you should call and visit your health provider. Your clinician will make the necessary corrections. In the beginning, while biting on food, do not bite at a time. Divide the food into pieces. If your crest support is sufficient, you can bite a piece of bread or apple. When you bite a piece of bread or an apple, you can make sure that the denture is in place by applying pressure through the anterior teeth. Unfortunately, no complete denture patient can bite as effectively as dentate individuals.

Speech

In the early days, it is natural to have speech problems. To prevent this, you can practice speaking by reading aloud in front of a mirror. Furthermore, during the adaptation period, you can take advantage of denture adhesives that are sold in pharmacies (if your dentists approves). If your speech does not improve after 1 week, consult with your dentist to ascertain the origin of your problem.

Cleaning the Dentures

Dentures that are not cleaned carefully may cause tissue irritation, bad odor, and discoloration of the teeth and the denture base. After every meal and before going to bed, clean your dentures with a soft bristle brush, soap, and water. While cleaning your dentures, do not immerse them in extremely hot water, as this may disrupt the structure of the dentures. After cleaning with brush and soap, your dentures can benefit from denture cleanser tablets for those areas that the brush cannot reach. To use these tablets, put one tablet in a glass of water and soak your denture in this solution for 15 min. Effective cleaning is provided in the first 15 min. If you want, you can keep your dentures in this solution, but using a denture cleanser everyday can damage the metal parts of your dentures and cause the color to change. Accordingly, using these tablets one or two times a week will be sufficient. There are solutions containing hypochlorite for plaque removal, but they are not suitable for soft lining materials, metal bases, and the framework of partial dentures. Avoid using denture cleansers that will disrupt the structure of the dentures. If a commercially available solution is used, the patient should follow the manufacturer's instructions and brush the denture after removing it from the solution. In this way both the solution and the debris will be removed. Bicarbonate and hypochlorite containing cleansers may cause sensitivity for some patients. If properly prepared, a homemade denture cleanser can also be used.

Alterations of the Tissue

Although the shape of your crest will change over time, the shape of your dentures will remain the same. Visit your dentist regularly for the harmony of your dentures and the health of your tissues. A visit to your dentist every 6 months is recommended. After a certain time, the renewal or relining of your dentures may be necessary.

Alterations of the Denture

Alterations to your dentures from time to time will be closely related to the changes in your crests. Do not try to repair or adjust your dentures yourself; always consult your dentist for these procedures.

4.1.5.5 Control Appointments (Recalls)

The patient should be asked about the dentures and listened to carefully. During the patient's comments, his/her speech, his/her functional and physiological problems could be evaluated. If the patient has a problem, he/she should be asked to describe it; if there are any problems, the clinician must write them down. In this way, the clinician does not overlook the patient's comments.

During the control session, the clinician should take care while removing the dentures. Determining areas of irritation is easy when the patient removes the dentures. The dentures should be cleaned with water. Intraoral tissues should be carefully examined, and if necessary the patient is asked to indicate any irritation areas. The causes of irritation could include pressure areas on the inner surfaces of the denture, extended flanges, and areas over the blood vessels and nerve bundle (palatine and nasopalatine foramina). Red areas are caused by acute irritations, and white areas are the result of chronic irritations.

The painful regions are dried using air and marked with an indelible pencil. The dried denture is placed inside the patient's mouth, and the marked regions are dyed inside the base. If the base is not dry, this mark spreads to the irritation region, and determining the region becomes difficult. After the denture is taken out, the inner part of the denture base is observed, and the regions that need relief are grinded with appropriate burs.

On the polished surfaces of the denture, the grinded regions are polished once more. Once the inner surfaces are finished with the soft rubber disc, the dentures are placed in the patient's mouth, and the patient's feelings and emotions

are asked. Due to previous irritation areas, the patient may continue to feel pain but generally, if the region is determined correctly, the patient may feel relief. Problems may arise after the procedure is completed. During this time, the patient's comfort and reasons for displeasure must be investigated.

If a problem does not arise within 6–12 months, the patient should be called, and whenever the patient has any questions, they should be assured to call anytime they need.

As a result, any individual who has natural teeth and still has natural tissues must attach importance to preserving and protecting them. This is also true for a patient who is edentulous. Periodical control appointments allow the clinician to pay more attention to the therapy they give to the patients.

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Part II

Post Insertion Problems

Check for updates

Post Insertion Problems in Complete Dentures

5

Yasemin K. Özkan

Post-insertion problems can be divided into seven categories:

1. Pain
2. Retention and stability loss (movement in the dentures)
3. Insufficient chewing
4. Nausea
5. Noise on eating and speaking
6. Poor esthetics
7. Problems relating to speech

5.1 Pain

Pain can be described as the feeling that starts as a result of a chemical or physical stimulus and changes from a stinging sensation to extreme discomfort. It can be experiences in different intensities, depending on the patient's pain threshold and tolerance to pain. Complaints increase due to the decrease of the pain threshold in people whose general health is poor or in those who have psychological problems or nutritional deficiency.

When pain occurs, initially the cause of the pain must be identified by asking the following questions:

- How long has the pain been continuing, does the pain disappear after the removal of the dentures?
- Is there continuous pain during the wearing of the dentures, or is the pain increasing only at certain times, for example, while eating?
- Is the pain in a specific area or widespread?

If the patient is feeling pain as soon as the denture is inserted and this pain becomes more acute when chewing force is applied and there is a deeply or sharply prepared postdam area in the upper denture (Fig. 5.1), irregularities on the tissue surface should be checked (Fig. 5.2a–c).

If the patient is feeling severe pain during the insertion and removal of the dentures, the undercut areas at the tissue surface may cause the pain (Fig. 5.3).

Generally, pain that occurs in the oral tissues can be collected under six headings:

1. Localized pain—pain in a specific region of the supportive tissues
2. Generalized pain—pain involving a major part of the supportive tissues
3. Diffuse pain—pain involving all the supportive tissues
4. Pain resulting from biting the lips and cheeks
5. Pain in the tongue
6. Pain that occurs at the TMJ

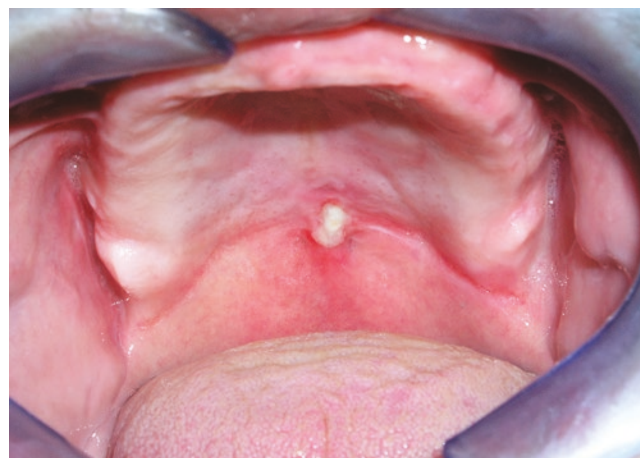

Fig. 5.1 Irritation area due to deeply prepared postdam area on the upper denture

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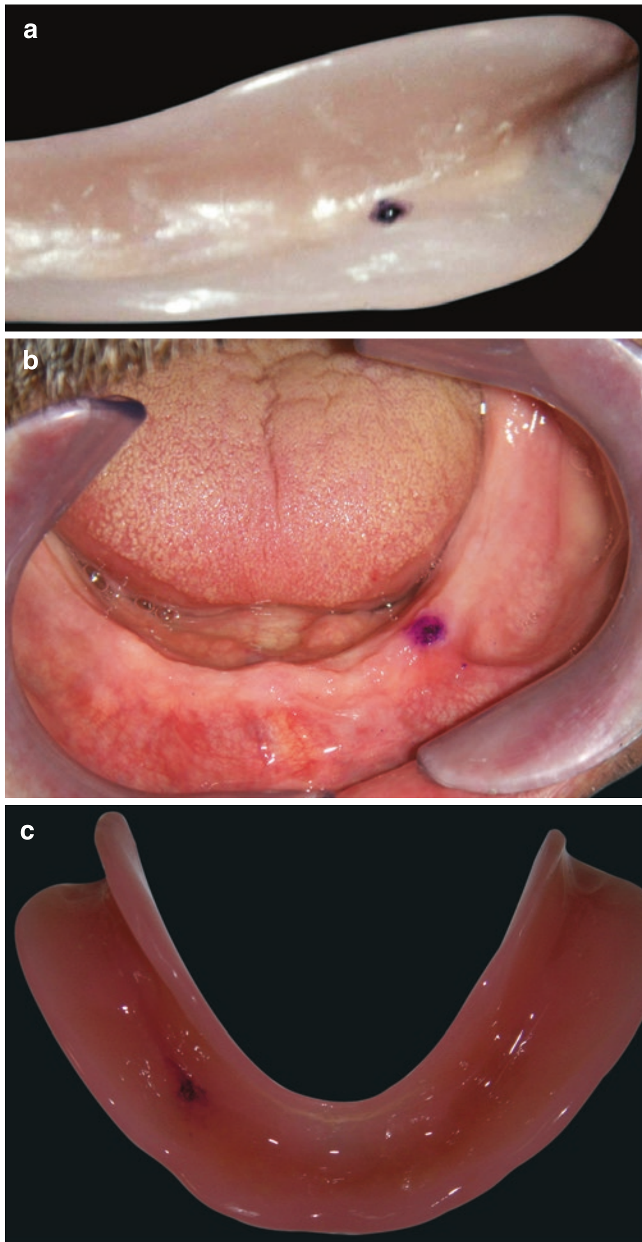


Fig. 5.2 (**a**) Acrylic pearl inside the denture. (**b**) Irritation area. (**c**) Sharp protrusions on the tissue bearing surface of the denture

5.1.1 Localized Pain: Pain in a Specific Region of the Supportive Tissues

This pain appears in a specific region of the upper or lower denture area and can be due to the following reasons:

1. Extended flanges of the dentures

   Inflammatory changes can be seen in related areas of soft tissue. The patient reports that he/she feels severe pain after the insertion of the denture and especially when biting (Fig. 5.4a–d). The denture flanges are shortened without effecting the muscle connections, and the frenums are opened in a way that the frenums are not inside the denture.

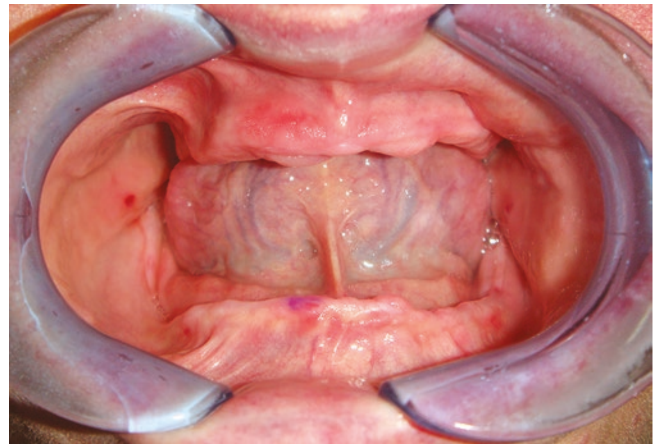


Fig. 5.3 Presence of undercuts on the anterior region of upper and lower jaws

2. Deeply or sharply prepared postdam area

   In the postdam region, the changes characterized by erythema and edema are observed on soft tissues (Fig. 5.5). The patient feels severe pain in this region when he/she inserts the denture and particularly while chewing. A postdam region, which has been prepared in a way that is excessively prominent, has been grinded in a way that makes air intake impossible. If irritation occurs because of the overextension of the vibrating line, this area can be determined by asking the patient to say "ah" and by marking the area with an indelible pencil. After this process, the denture is inserted to the mouth for the replication of this drawing, and the necessary reductions are made, taking into account the marked points (Fig. 5.6a–c).
3. Irregularities on the tissue surface of the denture

   They are seen as dot-like rashes over the crests (Fig. 5.7). The irregular areas within the denture can be controlled with the bare hands and grinded.
4. The presence of premature contacts on the occlusion

   With irregularities in the centric occlusion, lateral or protrusive movements cause an increase of the forces over the crests in certain areas. Inflammatory changes can be easily noted visually and are observed in these areas (Fig. 5.8a–c).
5. The presence of excessive undercuts on areas localized beneath the denture

   When there are unilateral or bilateral deep undercuts in the posterior region (Figs. 5.9a, b, 5.10a–c), the patient

Fig. 5.4 (**a**) Overextension of the denture flange. (**b**) Irritation area. (**c**) Insufficient reduction on the maxillary frenum area. (**d**) Irritation area

feels pain because of trauma in the soft tissues during the insertion and removal of the denture. Relief is provided by grinding from underneath the dentures.

6. Irregularities on the alveolar crest and the presence of thin mucosa over the crests

   These can cause visible tissue damage. The patient, especially during the chewing action, feels pain in these areas when pressure is applied (Fig. 5.11a, b). In these cases, relief is made by grinding beneath the dentures, but this doesn't give successful results all the time. By using soft lining materials, a reduction of the forces on the painful areas can be provided.

7. Possible pathologies on the supportive tissues

   Teeth embedded superficially in the jawbone or pressure on the roots can cause the patient to feel pain. Potential pathologies in the supportive tissue are determined with

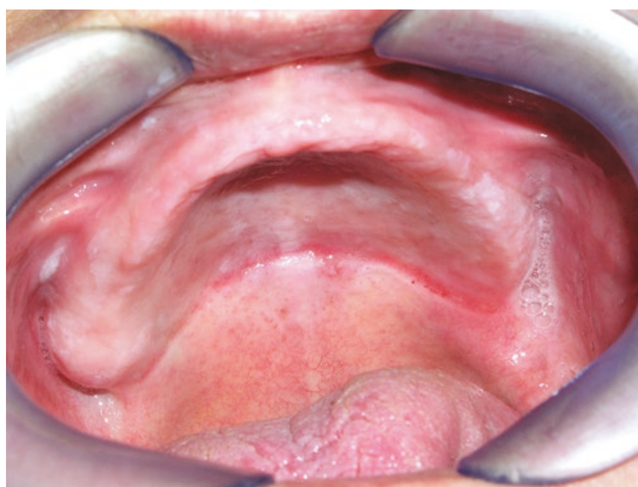


Fig. 5.5 Deeply and sharply prepared postdam area on the upper jaw

Fig. 5.6 (**a**) Determination of vibration line in the mouth. (**b**) Determination of vibration line on the denture. (**c**) Shortening the determined area on the denture

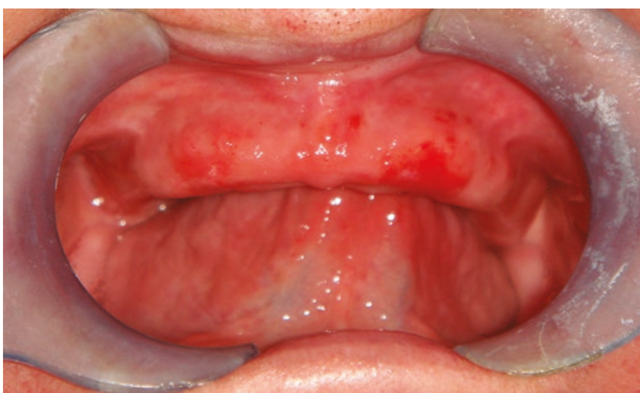


Fig. 5.7 Hyperemic areas caused by irregularities on the tissue-bearing surface of the denture

panoramic X-rays, before fabricating the complete dentures (Fig. 5.12).

8. Pressure over the mental foramen in the lower jaw

   This can be seen as a consequence of superficial mental foramen and the pressure over it due to crest resorption (Fig. 5.13a, b). In these cases, relief of the denture doesn't give successful results all the time. By using soft lining materials, a reduction of the forces on the painful areas can be provided by lining the dentures.

5.1.1.1 Examination of the Localized Pain According to Region

Pain in the Premolar Region

The causes of pain that occurs in the premolar region can be divided into 8 categories:

Fig. 5.8 (**a**) Inaccurate centric occlusion (early contacts on the right side). (**b**) Irritation area over the right crest. (**c**) Correction of inadequate occlusion by grinding in centric relation

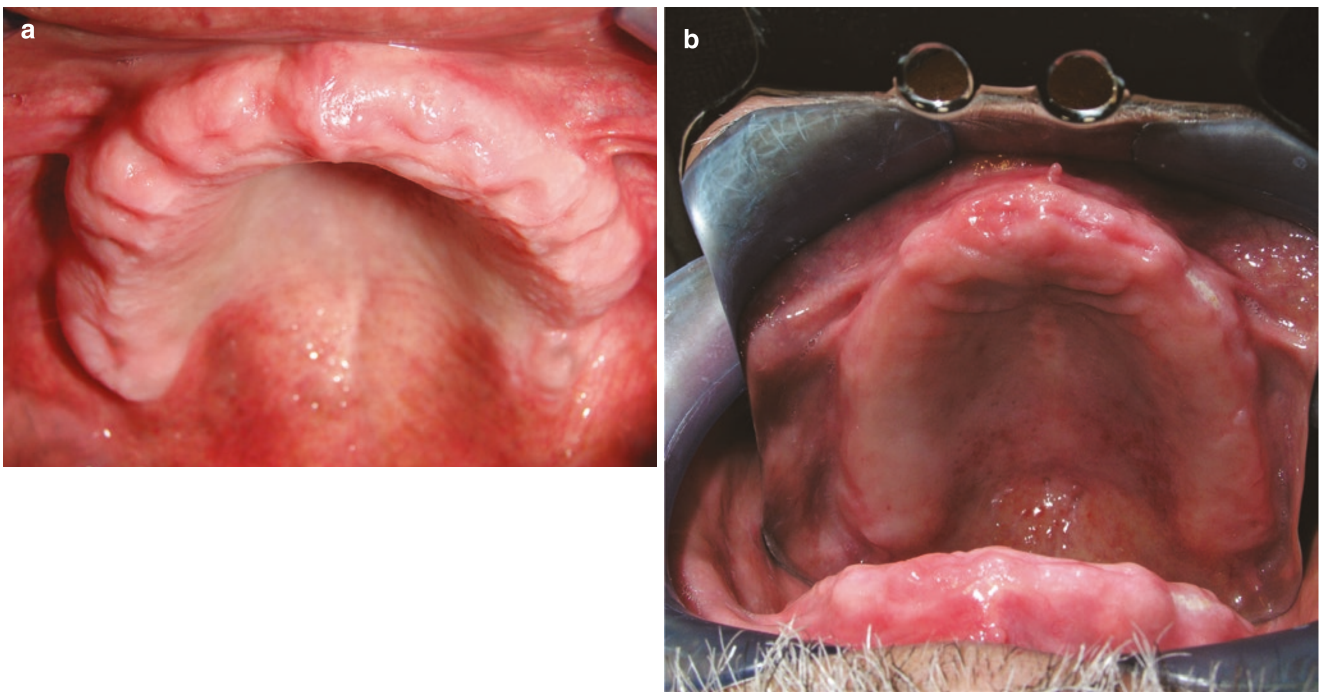


Fig. 5.9 (**a**, **b**) Undercut areas on the palatal and tuber regions

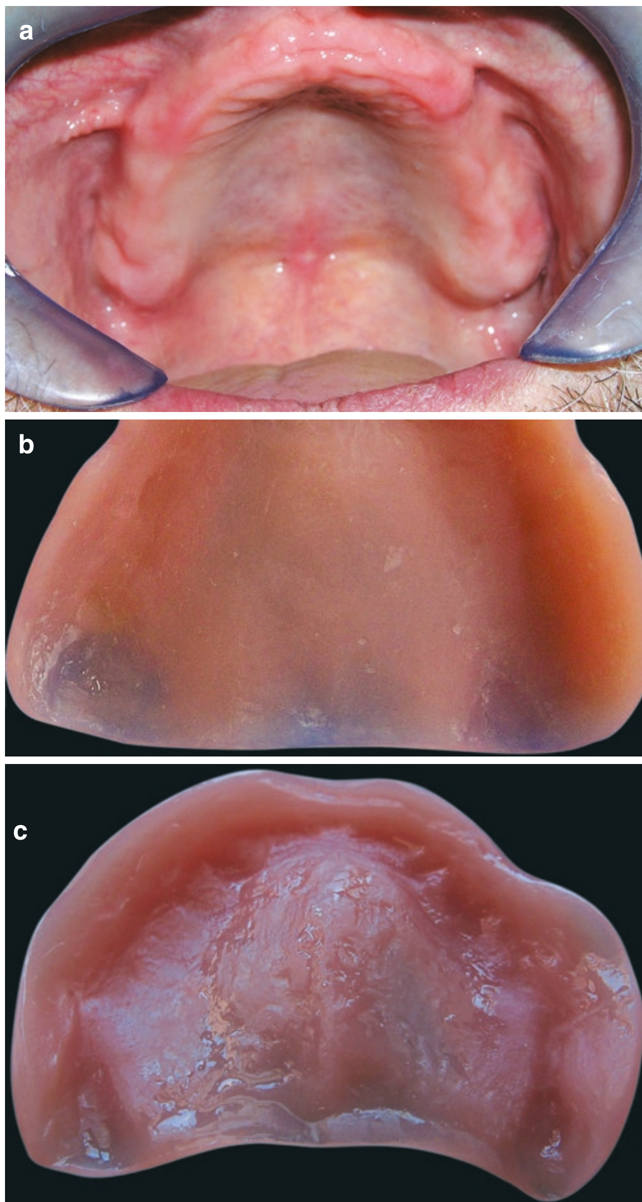


Fig. 5.10 (**a**) Undercut areas in both tuber regions. (**b**) Relief on denture. (**c**) View of a patient's denture with severe undercuts

1. Lingual torus in the lower jaw

   Tori are non-pathological formations caused by the thickening of the cortical bone (Fig. 5.14). The presence of torus affects denture adaptation. If the torus is large, a surgical operation should generally be considered. Unless surgical adjustment is carried out, relief is provided to that part of the denture by determining the relevant area.

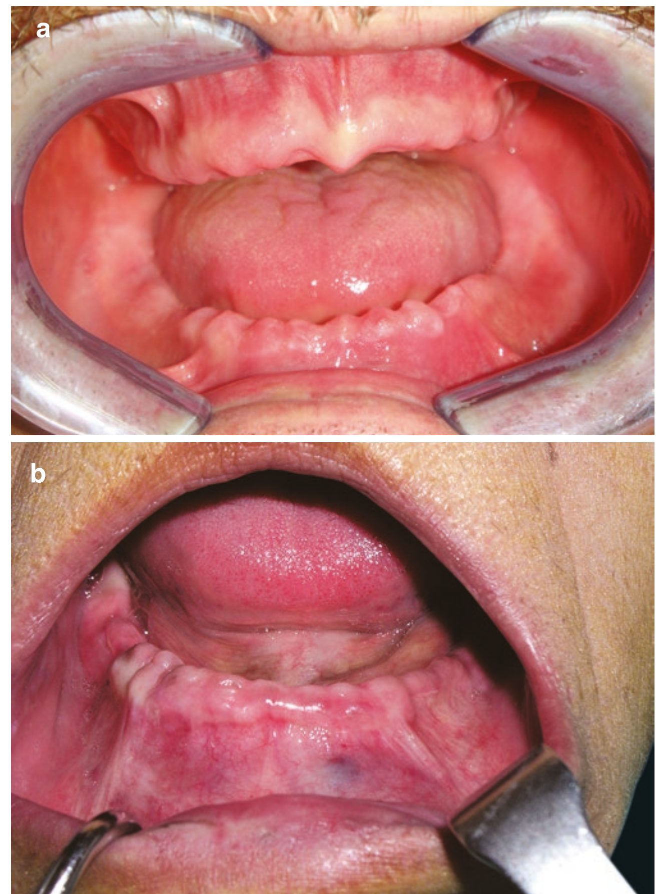


Fig. 5.11 (**a**, **b**) Irregularities of alveolar ridge in the lower jaw

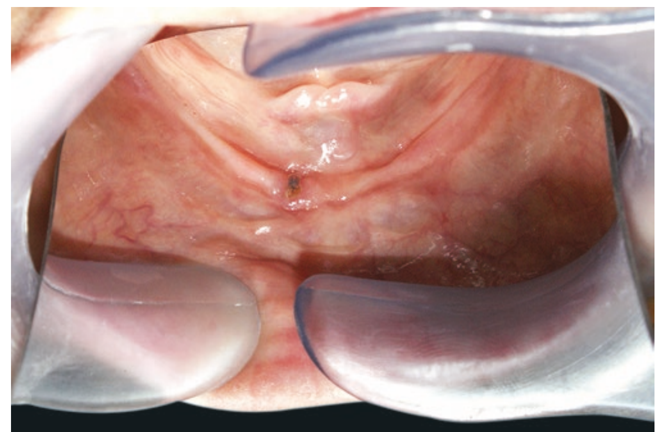


Fig. 5.12 Presence of root on the anterior region of the lower jaw

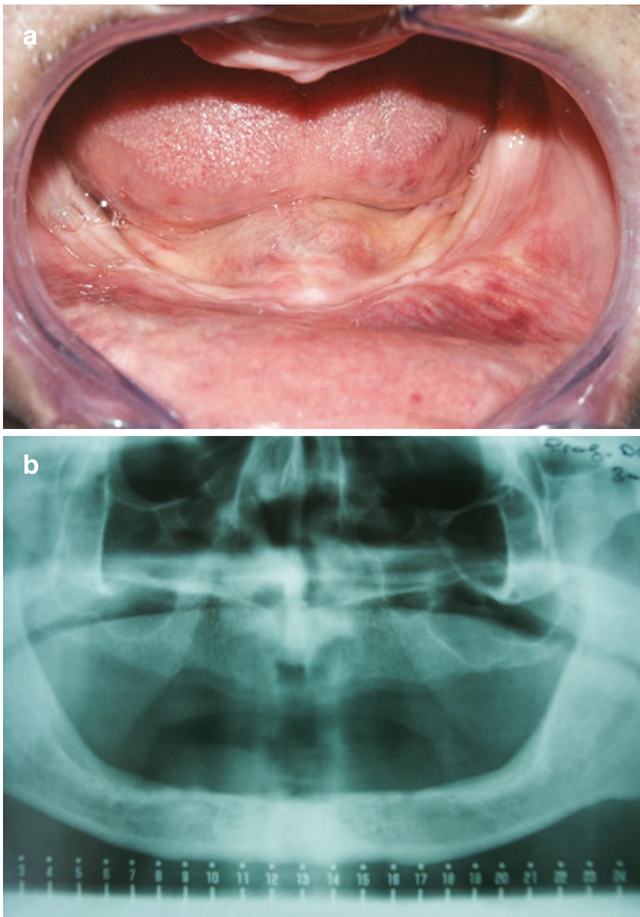


Fig. 5.13 (**a**) Ridge resorption up to the mental foramen. (**b**) Panoramic X-ray image

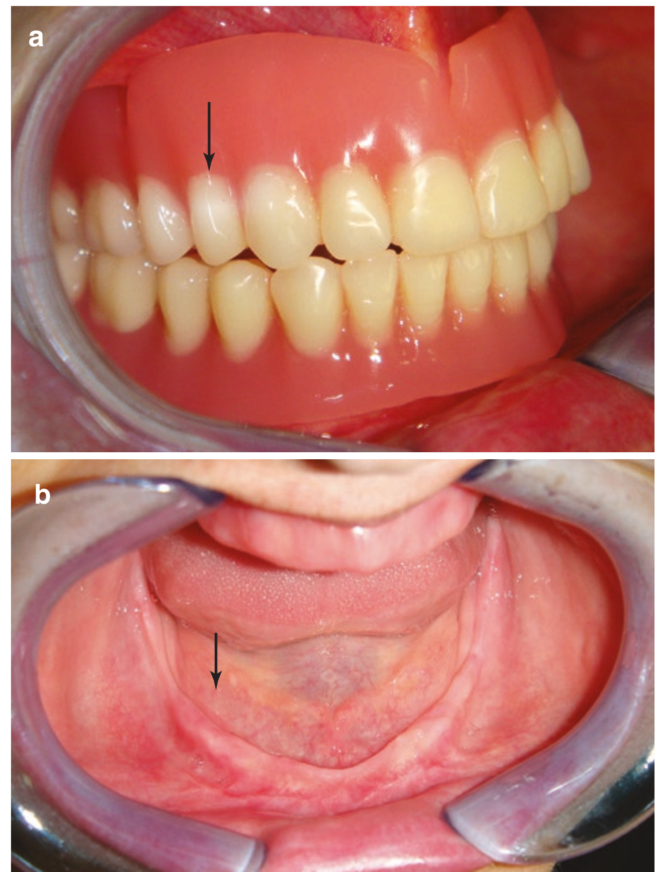


Fig. 5.15 (**a**) Existence of premature contact in the premolar region. (**b**) Irritation area

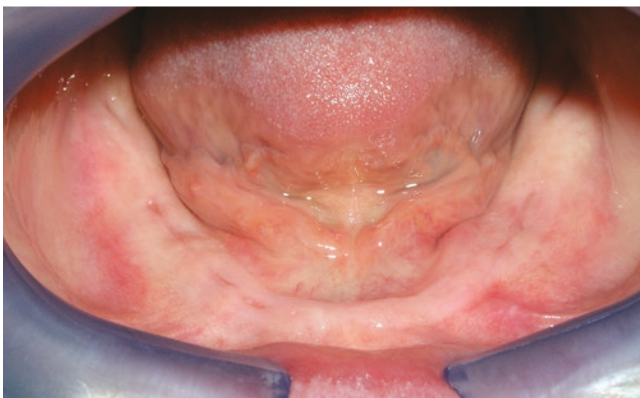


Fig. 5.14 Existence of torus on the premolar region

2. The presence of premature contacts

   Irregularities in the centric occlusion, lateral or protrusive movements, cause an increase of the forces over the crests in certain areas. Inflammatory changes can easily be noted visually in these areas (Fig. 5.15a, b). With occlusal grinding, problems can be solved by providing balanced contacts. An observation of the formation of irritation and soreness on the crest ridge could indicate possible occlusal failures. Occlusal failures usually arise due to a concentration of the chewing forces on a particular area. For the necessary grinding to be made, the clinician should pay attention to simultaneous contacts being present in the centric occlusion. Even so, a balanced harmony must be provided in both the lateral and protrusive movements (Fig. 5.16a–e).

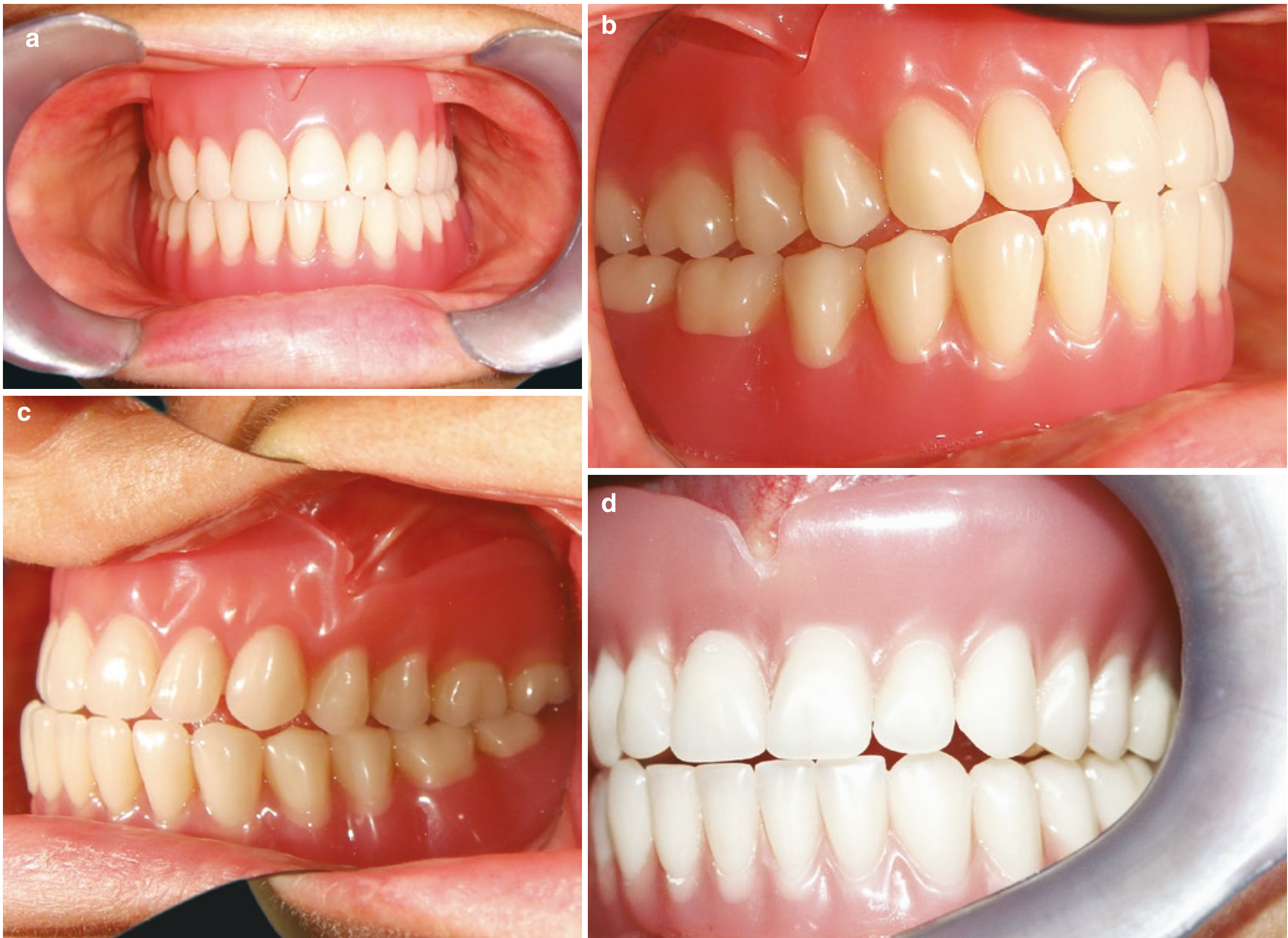


Fig. 5.16 (**a**) Providing balance in centric occlusion. (**b**, **c**) Providing balance in protrusive movement. (**d**) Providing balance in lateral movements

3. Applying too much pressure while taking the impression

   Applying too much pressure to certain areas while taking an impression may cause excessive compression over the mucosa and may also cause pressure inside the final denture, which will cause pain in the related areas. To solve this problem, relief should be made to those areas by marking them (Fig. 5.17).
4. The presence of an impacted tooth or the remains of a root

   The pressure of the denture on impacted teeth or any remaining roots that are present superficially in the jawbone may also cause pain. The correct solution for the problem is to remove them by surgery. Before starting prosthetic treatment, a panoramic radiograph should be taken to determine the impacted teeth, the remaining roots, or any other pathological formations that the clinician must eliminate.
5. Crest resorption through the mental foramen level

   Excessive crest resorption changes the position of the mental foramen superficially, and as a result, complete denture patients may feel pain in those areas because of the pressure. If the patient's health condition is suitable, mental foramen replacement surgery should be undertaken. If not, relief must be given to the related areas or soft relining materials can be used (Fig. 5.18).
6. The presence of irregularities in the denture-bearing area

   Before the insertion of the dentures, the inner surfaces must be controlled with the fingers. Sometimes acrylic pearls occur in the related areas. These pearls cause pressure on the mucosa beneath the denture. While carefully examining the basal surface of the denture, visible irregularities should be removed using a bur (Fig. 5.19).
7. Fabricating dentures before the healing of the extraction sites

   Dentures that are fabricated immediately following teeth extractions cause pressure on these areas during the healing period (Fig. 5.20a–d). Relief should be given for

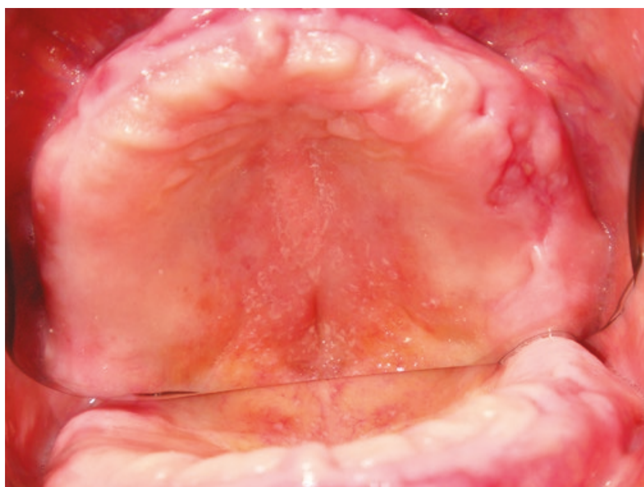


Fig. 5.17 Irritation area on the right side of the palatal area, due to applying excessive pressure while making the impression

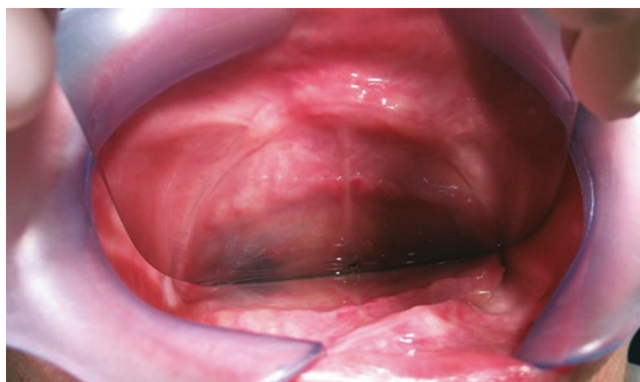


Fig. 5.18 Excessively resorbed mandibula

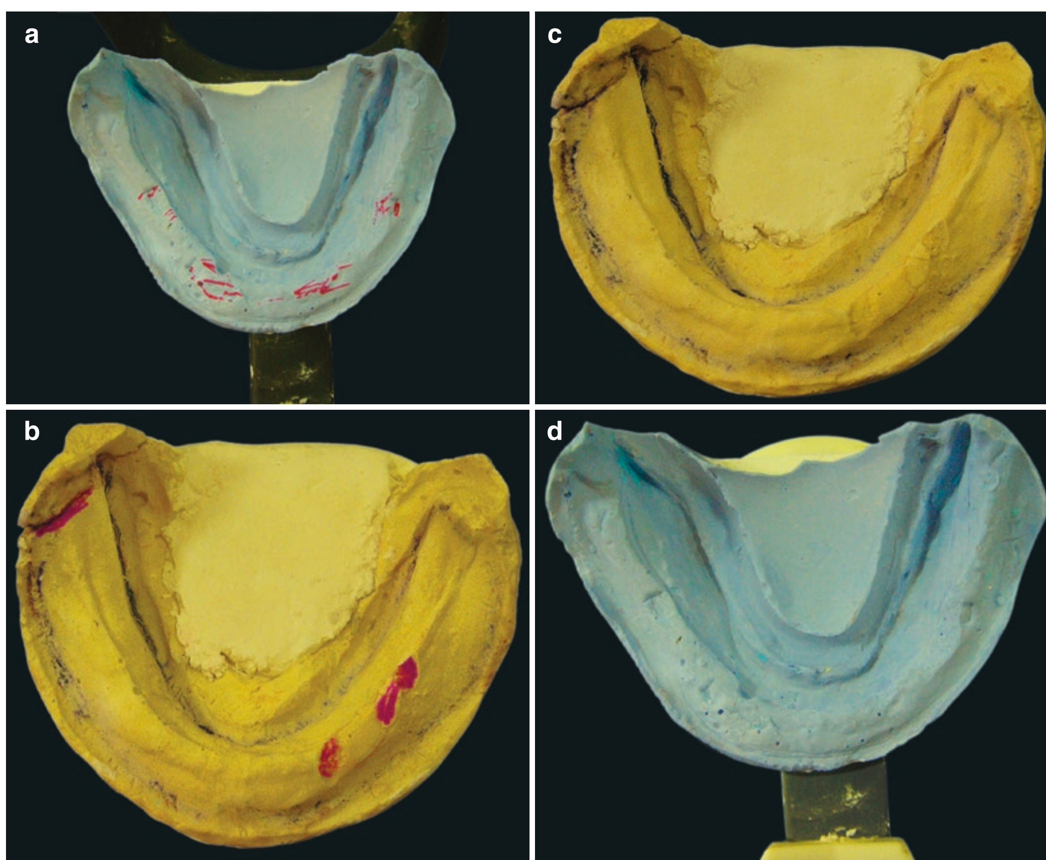


Fig. 5.19 (**a**–**d**) Fractures occured on the models

these regions. But the excessive removal of acrylic material causes looseness of the denture, and after this a rebase will become necessary. There should be a delay of at least 4–6 weeks before the denture is made, so that the extracting areas can heal.

8. The presence of excessive undercuts

In the presence of excessive undercuts, the patient feels pain because of trauma in the soft tissues that occurs during the removal and insertion of the denture. In such cases, if the undercuts are so large, surgical

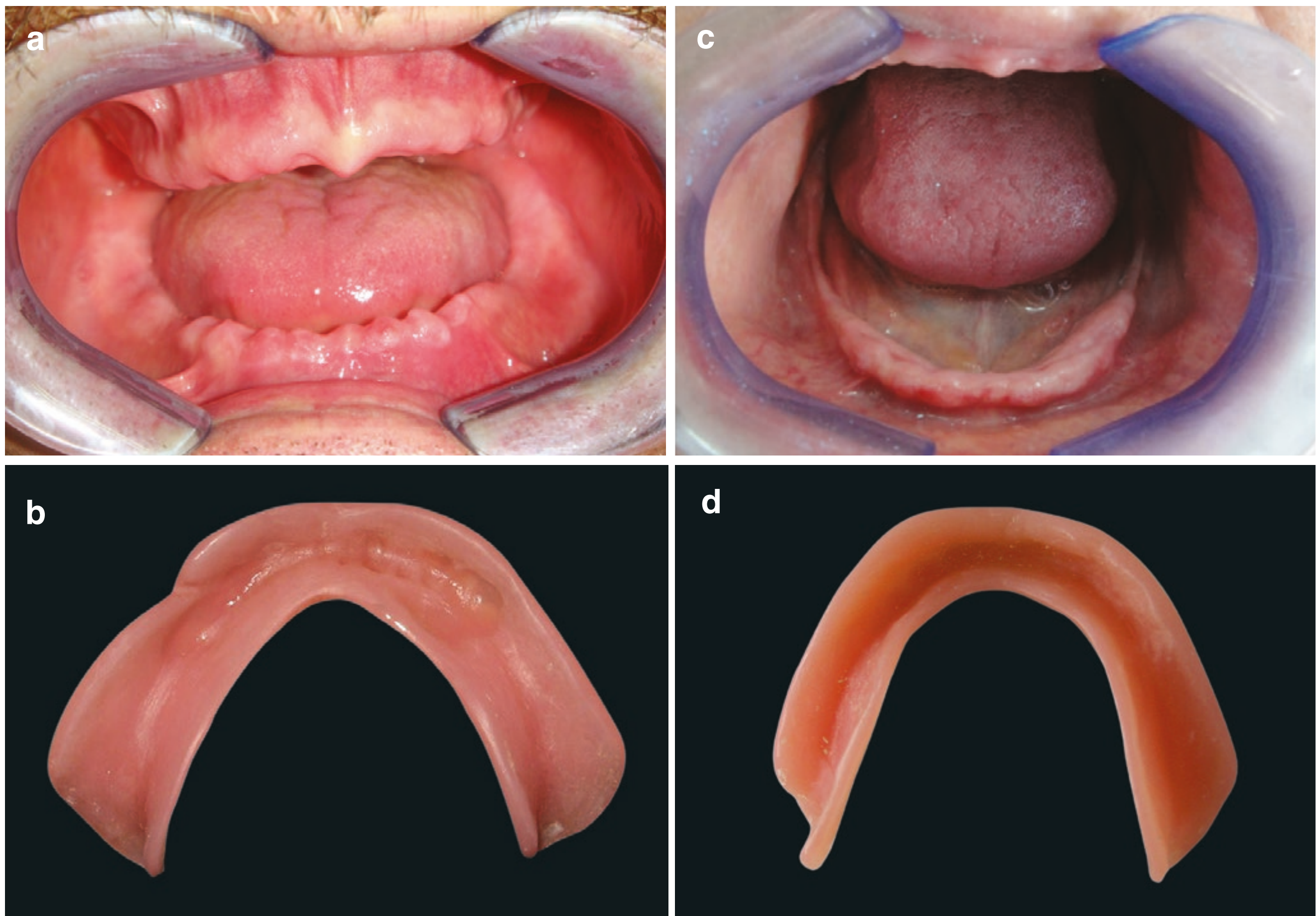


Fig. 5.20 (**a**) Insufficient healing of extraction sites on mandibular jaw. (**b**) Relief on the denture. (**c**) Irritation area on lower jaw due to undercuts. (**d**) Relief on the tissue-bearing surface of the denture

adjustment is necessary. These undercuts form due to the inadequate adjustment of the hard and soft tissues, especially following extraction (Fig. 5.21a–c). If surgical adjustment is not possible, relief should be made, or if the relief does not solve the problem, soft lining materials should be used.

Pain at the Peripheral Regions of the Denture

Pain in the denture's flange area originates from erythema in this area. Overextended denture flanges are the factor. If the excessive length does not affect the muscle connections, denture retention would not be affected, and only pain may occur. If the excessive flanges affect the muscle connections, the retention of the denture decreases together with pain, and the patient complains about the instability of the denture.

1. Overextended denture flanges

   In the related area, inflammatory changes are observed in the soft tissues. When the patient wears the denture and specifically when he/she bites, severe pain feeling is described. The flanges are shortened in a way that does not affect the muscle connections (Figs. 5.22a–c, 5.23a, b).

2. Deep and overextended postdam area in the upper jaw

   In the postdam region, the changes that are characterized by erythema and edema are observed in the soft tissues. The patient feels severe pain in this region when he/she inserts the denture and especially while chewing. The problem can be solved with grinding in a way that prevents air intake on the posterior region beneath the denture (Fig. 5.24).

3. Overextension of the tuber region in the upper jaw

   If the impression was made without opening the mouth enough, the coronoid process will come forward when patient opens his/her mouth, and this will cause pain by coming in contact with the buccal margin of the upper denture. In this part of the denture the thickness should be reduced (Fig. 5.25a–e). While taking the impression of the upper jaw, the clinician should determine the relation of the tuber area with the coronoid notch, asking the patient to open their mouth wide and should reflect this on the impression.

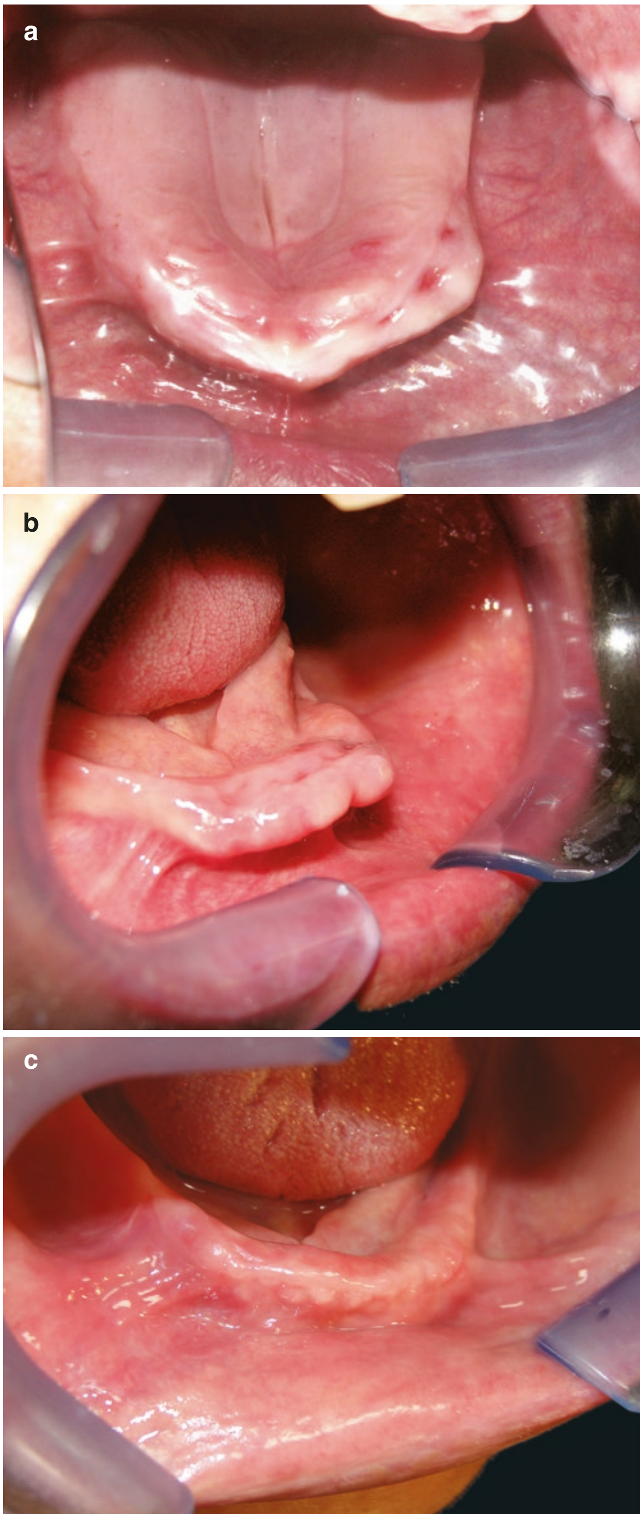


Fig. 5.21 (**a**) Existence of undercuts on the upper jaw due to inadequate healing of extraction sites. (**b**) Existence of undercuts on the lower jaw due to inadequate healing of extraction sites. (**c**) Rehabilitation of undercuts on the lower jaw by surgical operation

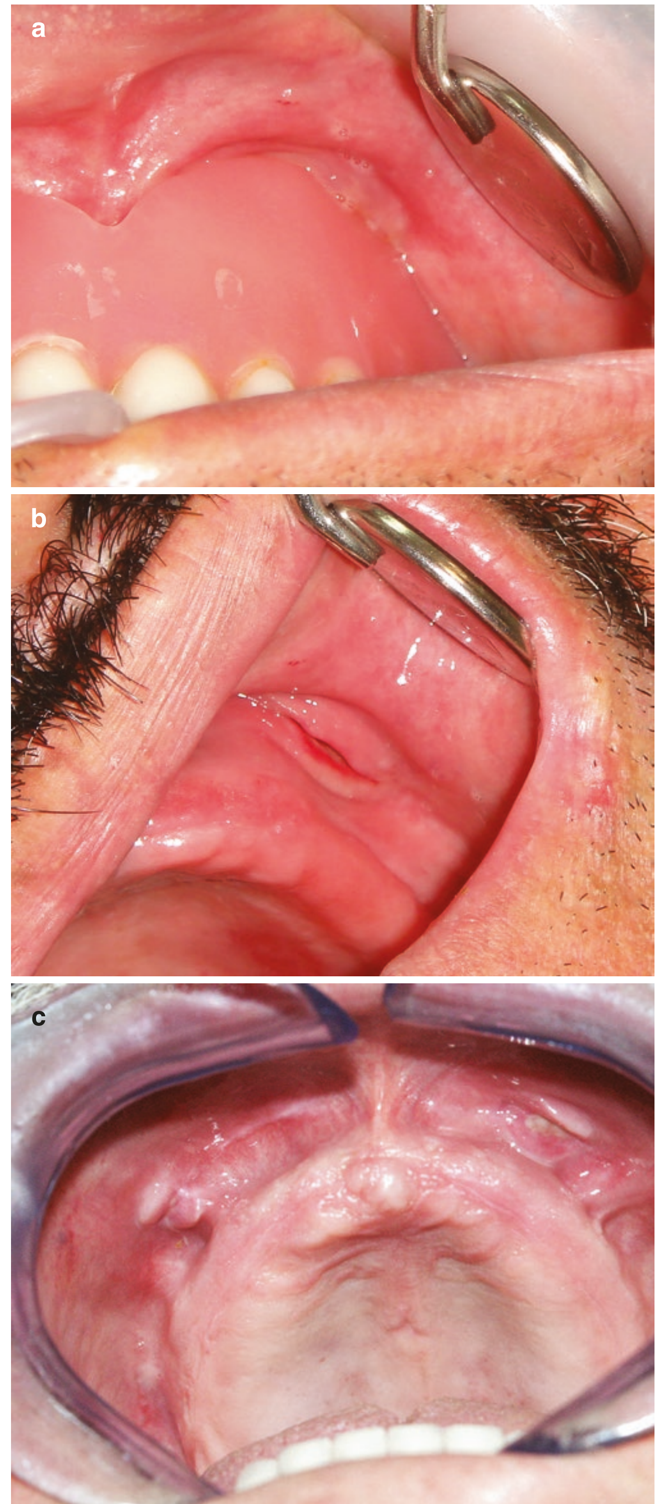


Fig. 5.22 (**a**) Overextension of labial flange on the upper jaw. (**b**) Irritation area. (**c**) Irritation areas due to inadequate arrangement of frenulum areas on the upper jaw

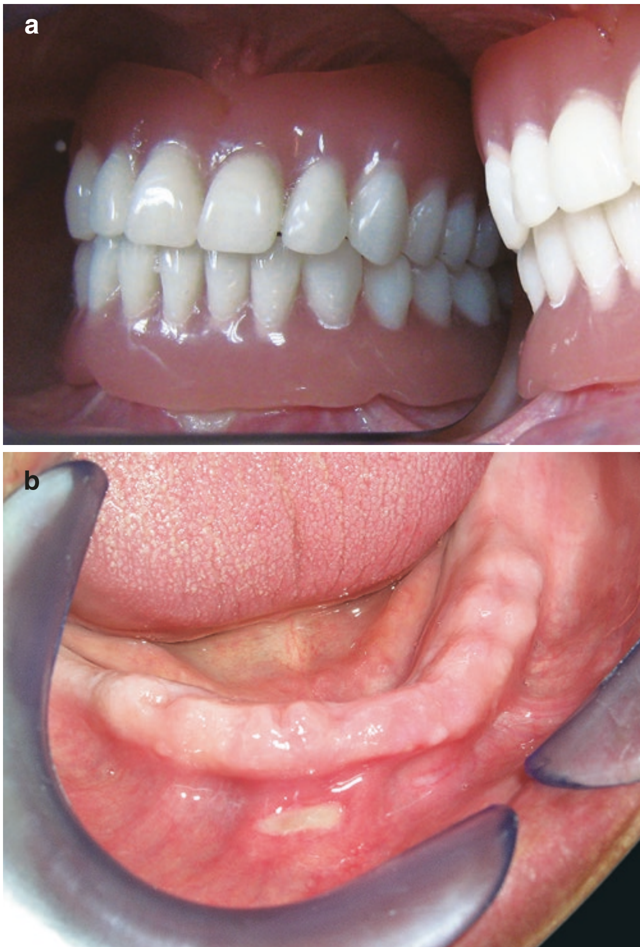


Fig. 5.23 (**a**) Overextension of labial flange on the lower jaw. (**b**) Irritation area

4. Pain in the distobuccal border of the lower jaw

   When there is pain in the distobuccal margin, the patient feels it only while his/her teeth are in occlusion. The reason for this is the contraction of the masseter muscle. If the impression is made when the mouth is opened too wide, the masseter muscle relocates backward with the downward and forward movement of the condyle. When the teeth are in contact, the condyle moves back toward distal and contacts the distobuccal margin of the mandible when the masseter muscle is contracted (Fig. 5.26a–e). A small reduction of this area is required. While making impression from the lower jaw, the clinician should make it without asking the patient to open his/her mouth too wide.

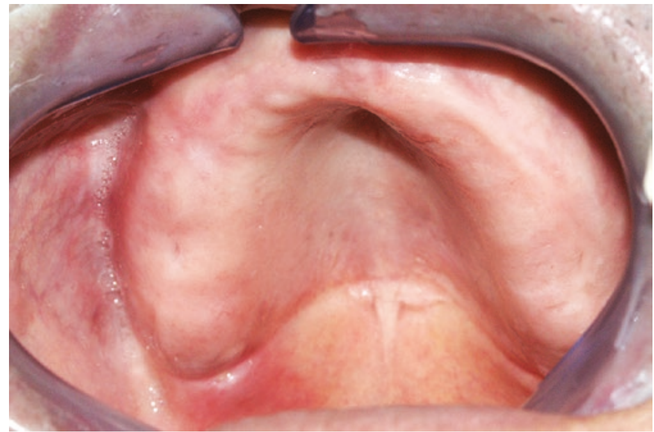


Fig. 5.24 Deeply prepared postdam area

5. Pain in the lingual margin of the lower jaw's anterior region

   There are two reasons for pain in the lingual margin of the lower jaw: Overextended flanges in the anterior area of the denture (Figs. 5.27a, b, 5.28, 5.29a, b) or the presence of premature contact in the posterior region (Figs. 5.30 and 5.31). If the margin areas are overextended, the denture flange areas should be shortened. As a result of the premature contact, the lower denture comes forward, causing pain in the lingual margin. Grinding is made, thereby determining the premature contact areas.
6. Angled and sharp denture margins

   Such margins should be rounded and polished.

5.1.2 Generalized Pain Involving a Major Part of the Supportive Tissues

In such cases, in both jaws there are hyperemic areas on the crests; however, these symptoms develop particularly in the lower jaw.

5.1.2.1 In the Lower Jaw, Wide, Non-diffused, Hyperemic, and Painful Regions

1. The existence of thin mucosa

   Applying soft lining materials is useful in cases of thin and loose mucosa (Fig. 5.32a, b).
2. Reduced saliva flow

   If there is insufficient saliva flow together with thin mucosa, soft lining materials can also be applied for these

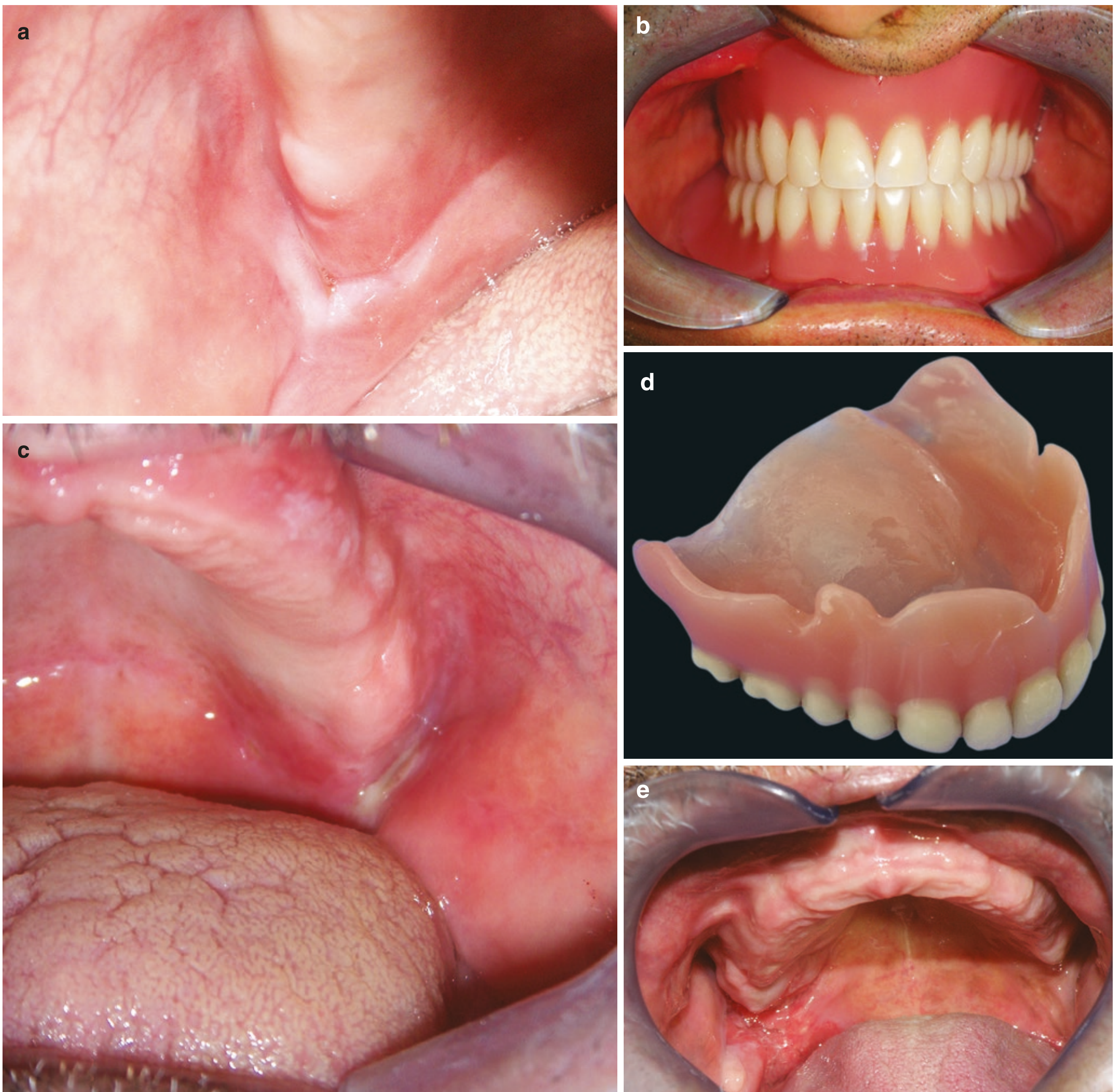


Fig. 5.25 (**a**) Irritation area caused by thick and overextended maxillary tuberosity area of the denture. (**b**) Thick and overextended maxillary tuberosity area of the denture. (**c**) Irritation area on tuberosity. (**d**) Making the tuberosity area thinner and shorter on the denture. (**e**) Irritation areas on both sides

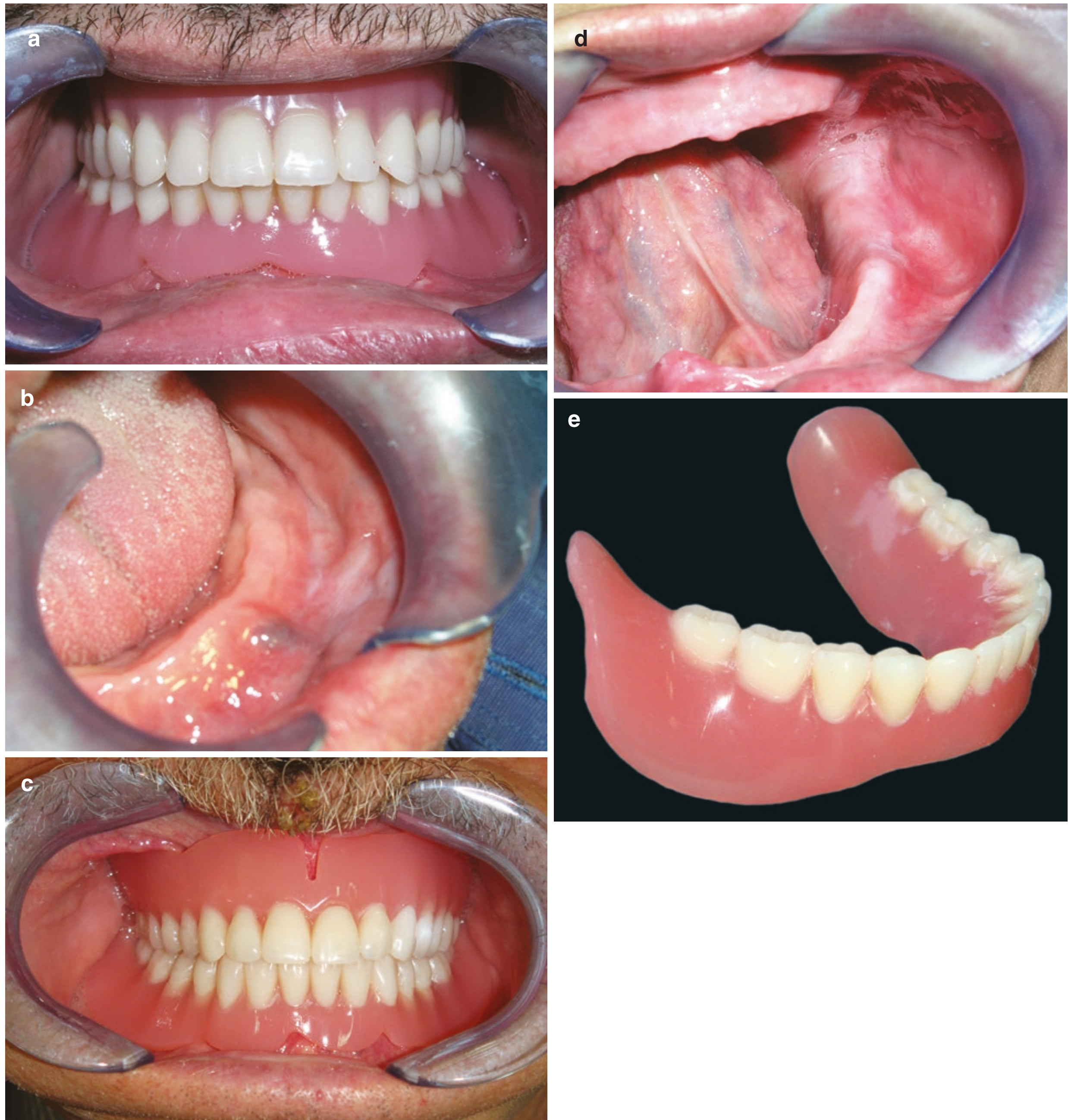


Fig. 5.26 (**a**–**d**) Overextension of the distobuccal flanges of the denture and irritation areas. (**e**) The view of the distobuccal flange of the denture

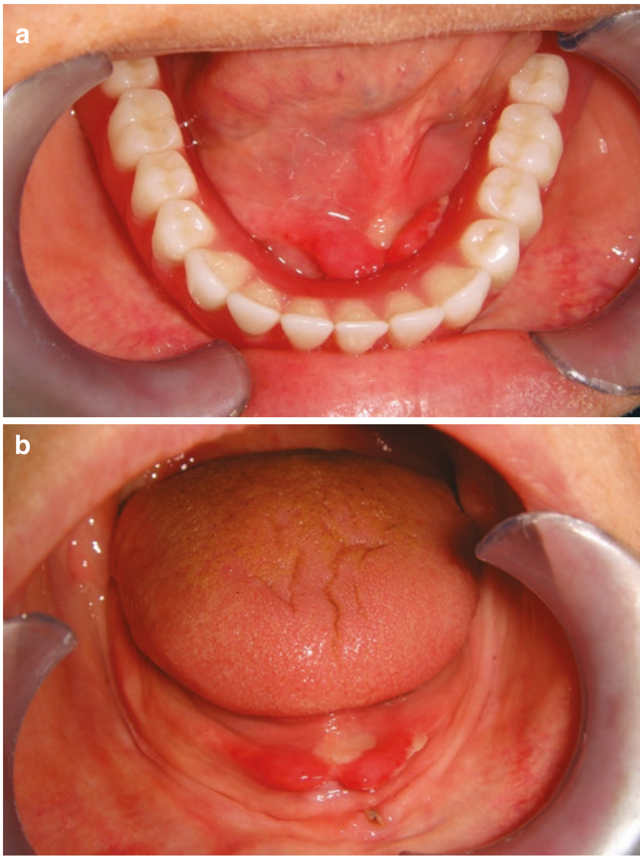


Fig. 5.27 (**a**) Overextension on the lingual anterior region of the lower denture. (**b**) Irritation area includes frenulum and glands

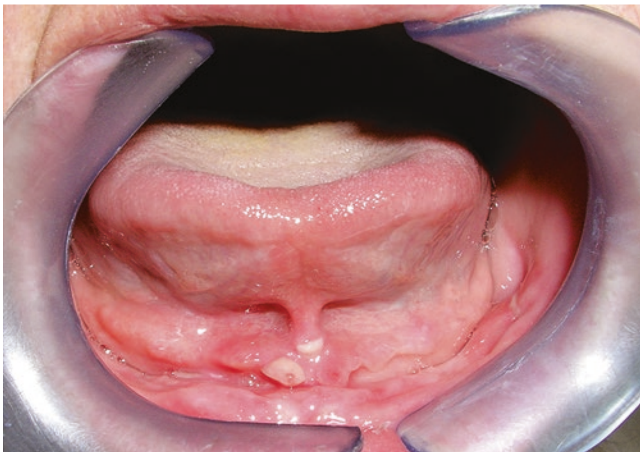


Fig. 5.28 Irritation area on the lingual frenulum region

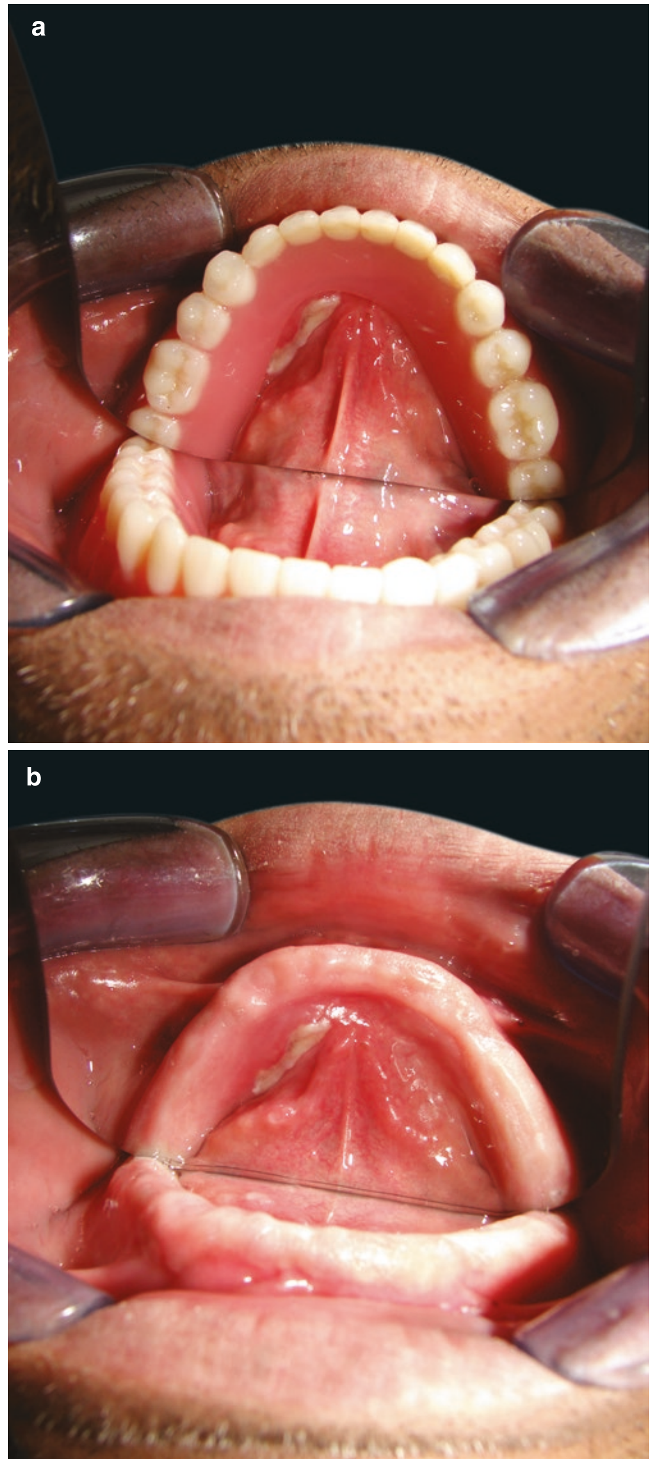
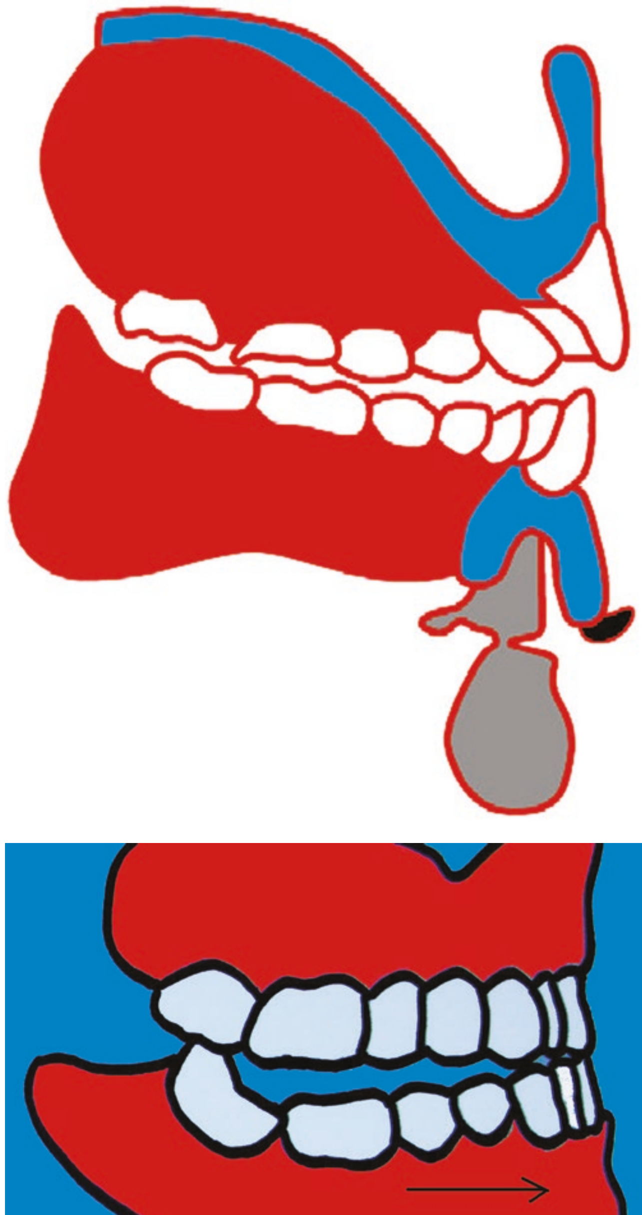


Fig. 5.29 (**a**) Overextension of the lingual region of the lower denture. (**b**) Irritation area



Figs. 5.30 and 5.31 Due to early contacts on the posterior area, the lower denture moves anteriorly and irritation areas occur on the anterior lingual part of the lower jaw

patients. Decreased amounts of saliva and dry mouth make wearing the denture difficult. Decreased saliva flow both reduces the stability of the denture and causes irritations on the mucosa, as a result of the mobility of the denture. Reasons for the decrease of the saliva flow are as follows:

(a) Age-related atrophy of the salivary glands
(b) Radiation therapy (all radiation therapies related to head and neck region cause a reduction in the amount of the saliva)

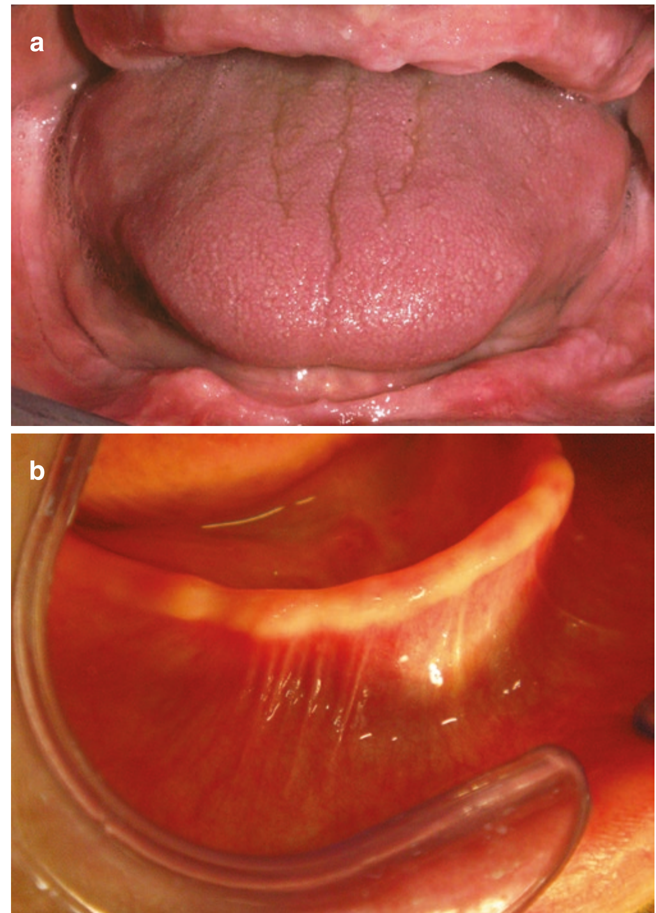


Fig. 5.32 (**a**, **b**) Presence of thin mucosa

(c) Systemic diseases (diabetes mellitus, chronic nephritis, uremia, etc.)
(d) Drugs (some drugs used for heart diseases; barbiturates for a sedative affect, tranquilizers, antihistamines, and antidepressants)

For these patients, the use of artificial saliva and eating moist foods can be recommended. As a practical solution, a few drops of lemon juice added to a glass of water and frequent rinsing can be recommended.

3. The existence of anatomical defects on the crests

In the lower jaw, cases where there is a sharp margin of the residual alveolar crest in the anterior region, a sharp and prominent mylohyoid region, and the excessive prominence of the genial tubercles, can cause the denture to be uncomfortable. For these cases, making relief by grinding beneath the denture will not always be effective; therefore surgical treatment is more appropriate. However, if the patient's health condition is not suitable for surgical treatment, the use of soft lining materials can be provided for the patient's comfort.

5.1.2.2 Moderately Wide, Red, and Painful Diffuse Area

Occlusion Failure

Such failures are chiefly observed in the lower jaw. Because of the abnormal stresses that arise from the occlusion, this is mostly seen in the lower jaw, which has less supportive area. After being determined, the premature contacts arising from the occlusion are grinded. All contact points are grinded until they are balanced (Figs. 5.33a, b, 5.34a, b).

5.1.3 Pain Involving All the Supportive Tissues (Diffuse Pain)

There are two reasons for this type of pain:

1. Increased vertical dimension

   Inflammation and common pain occur in the soft tissues, both in the upper and lower jaws, on the areas that the denture covers. The vertical dimension should be reduced by grinding. If this isn't enough, a new denture with a correctly determined vertical dimension should made (Fig. 5.35a–d).
2. Patient's allergy to the denture base material

   This situation is commonly confused with denture stomatitis. It should not be forgotten that stomatitis occurs after a long period of use. This fact should be considered as a definitive diagnosis. The patient complains of a burning sensation, especially on the tissues beneath the upper denture. Edema and hyperemia are observed on the tissue contact areas. Antihistamines should be given to a patient who is thought to have an allergic reaction. If the symptoms decrease, an acrylic allergy should be suspected. An incidence of allergic reaction is not seen very often. The most accurate way for a final diagnosis is to conduct a patch test on the patient. Allergic reactions generally originate from excess monomer during the polymerization stage and pigments added into the acrylic resin. These monomers are generally methacrylate monomers.

If the patient is allergic to the monomer, instead of an acrylic baseplate, metal baseplates can be used. In complete

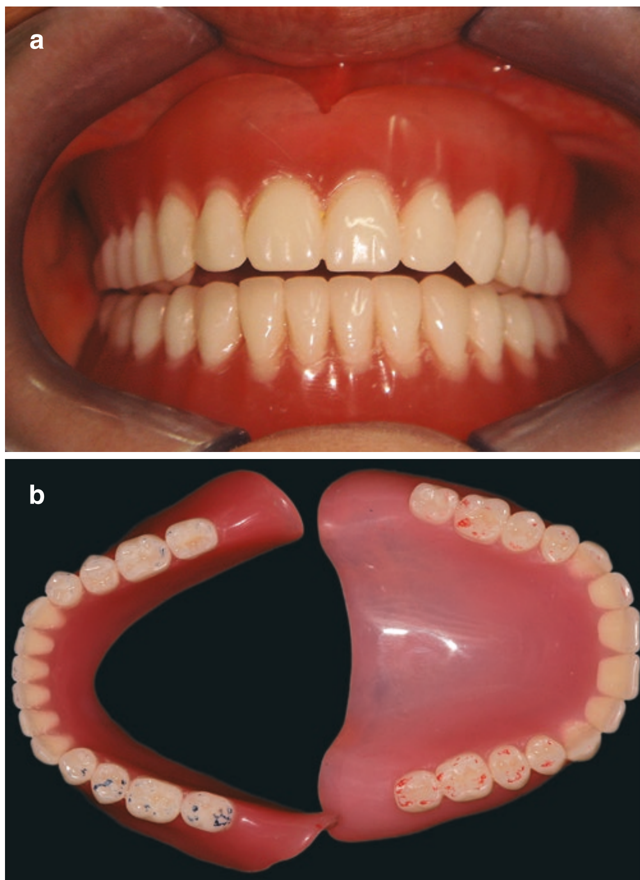


Fig. 5.33 Nonequivalent contacts due to inadequate centric occlusion. (**a**) View of the dentures inside the mouth. (**b**) View of the dentures outside the mouth

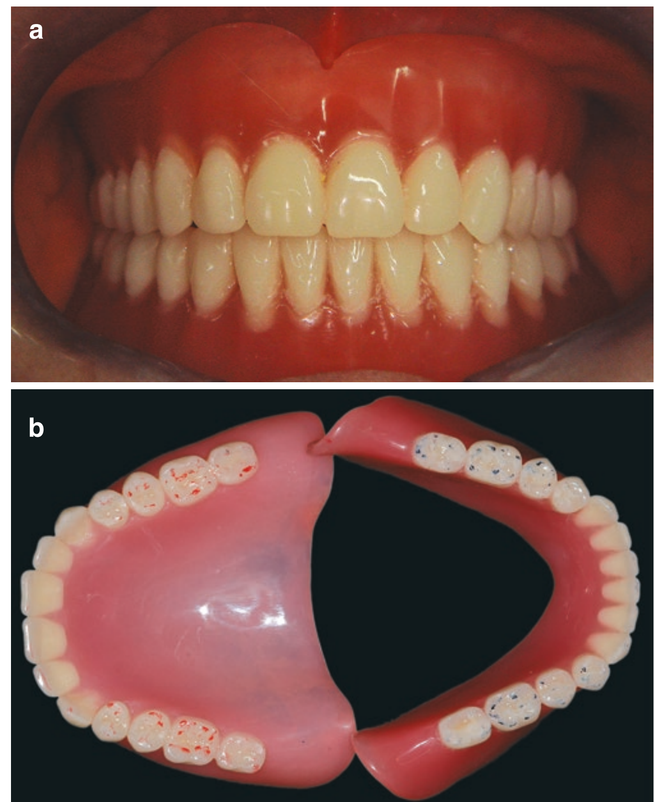


Fig. 5.34 Arrangement of centric occlusion and equalizing the contacts. (**a**) View of the dentures inside the mouth. (**b**) View of the dentures outside the mouth

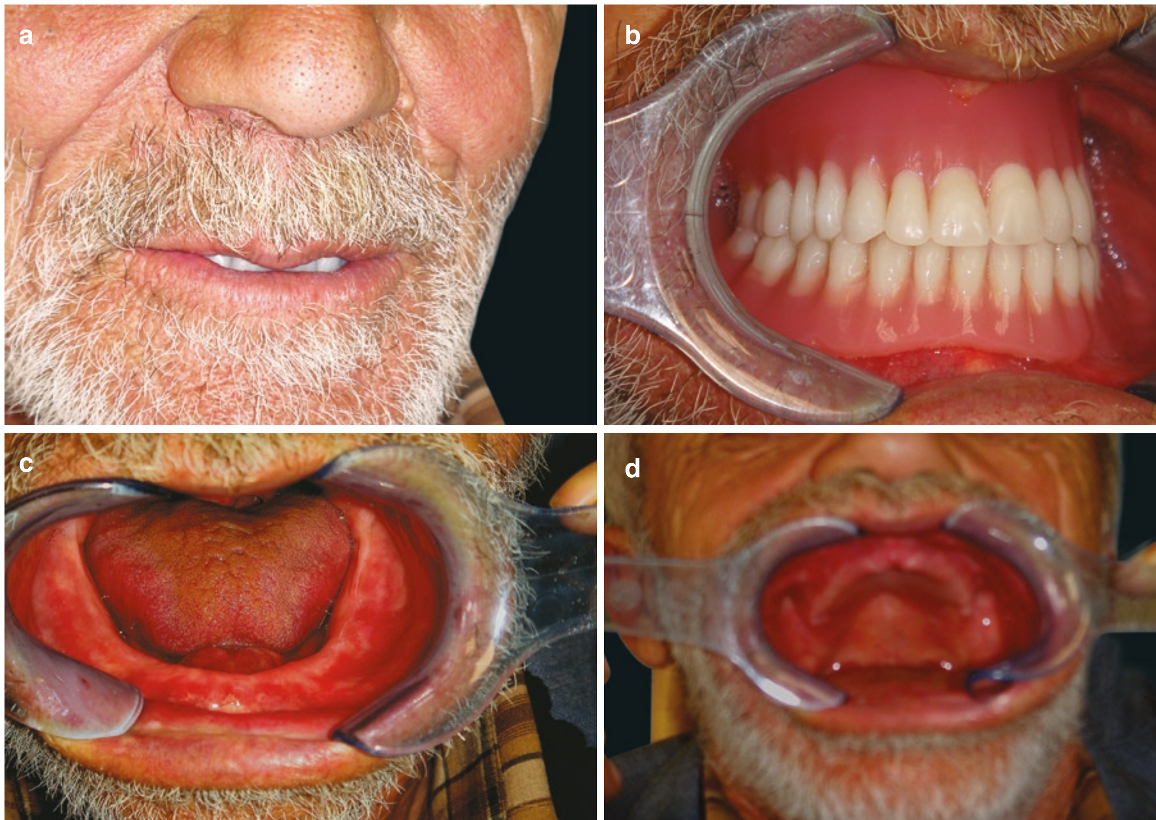


Fig. 5.35 (**a**) Determination of high vertical dimension. (**b**) View of dentures. (**c**, **d**) Expansive hyperemic view on the upper and lower jaws caused by increased vertical dimension

denture patients, due to the need for lining, recently introduced acetyl resin materials are recommended. Polyoxymethylene (POM), which is formed by the polymerization of formaldehyde, is a methyl group chain attached to each other with oxygen molecules. It has a crystalline structure that does not consist of excess monomer. Due to their biocompatibilities, they are used in the fabrication of dentures and artificial heart valves. Acetal resins have a good tissue adaptation, especially for patients with Co-Cr allergy; they are used as main connector in partial dentures. Their color stability shows similar features with PMMA. Their mechanical connection to the acrylic instead of chemicals and the need for the injection technique are the disadvantages of acetal resins.

If patients are allergic to pigments, in such cases the denture base material is renewed with a non-allergic and transparent acrylic material. The appearance of a denture that is made from transparent acrylic may not satisfy the patient. Therefore, polycarbonates and nylons which have lower monomer weight can be used as an acrylic base material.

Polycarbonates and nylon or polyamides are materials that can be obtained using the injection method. The use of polycarbonate and nylons is encountered only when a patient has methacrylate allergy. Polycarbonates and nylons have high impact resistance and low excess monomer consistency. Due to their high cost, they are usually not preferred.

Light polymerized resins may be also preferred in cases of acrylic allergy. This material consists of urethane dimethacrylate monomer and silica particles of a micro size. PMMA particles are added to the material as organic fillers. While visible light (400–500 nm) is serving as the activator, camphorquinone is the material that starts polymerization. Single pieces of denture base layers and rods are available in light-proof packaging in order to avoid unwanted polymerization. The material, which has been adapted onto the model, will polymerize 400–500 nm in the circle of a blue light. When compared to conventional materials, adaptation hardness and polymerization shrinkage are better, and the polymerization time is relatively short.

Acrylic resin polymerized by microwave energy consists of monomer content and can be recommended for these cases. Polymerization is derived from a regular microwave oven, and heat energy is used. Polymerization takes place as in the heat-cured acrylic resins; the only difference is that the temperature is achieved through microwave energy. Despite the differences between the products, using 500–600 W energy, a 3–5-min polymerization process is applied. The advantages of this technique are the decreased polymerization time, less residual monomer, and less polymerization shrinkage. If normal acrylic resin liquid is used instead of their special liquid for the polymerization of microwave resins, high amount of porosity can

be observed in the denture. Researches state that adaptation and physical properties of the microwave resins are comparable to conventional resins.

5.1.4 Pain Resulting from Biting the Lips and Cheeks

Situations that could potentially cause lip and cheek biting and their solutions are as follows: a

1. Excessive interocclusal space

   Due to the fact that the determined vertical dimension is lower than normal, the interocclusal space will be higher than normal. Until the chewing muscles have adapted to the new vertical dimension, the cheeks and lips may be bitten when functioning because of the excessive interocclusal space. If this situation goes on for a long time, the clinician should check to see if there is sufficient buccolingual overjet (Fig. 5.36a–d).
2. Nonexistence of posterior overjet

   The buccal surfaces of the lower posterior teeth need to be rearranged until the problem is solved (Figs. 5.37a, b, 5.38a–c). If it doesn't work, the denture needs to be refabricated, or the positions of the teeth need to be changed in the problematic regions.
3. Cheek impactions due to contact of baseplate with posterior sides

   Usually the upper baseplate has to be thinned (Fig. 5.39a–c).
4. Existence of cross bite

   If there is a problem with cross bite, it should be checked at a try-in session. If it does not work or the position of the teeth is correct, the upper denture plate needs

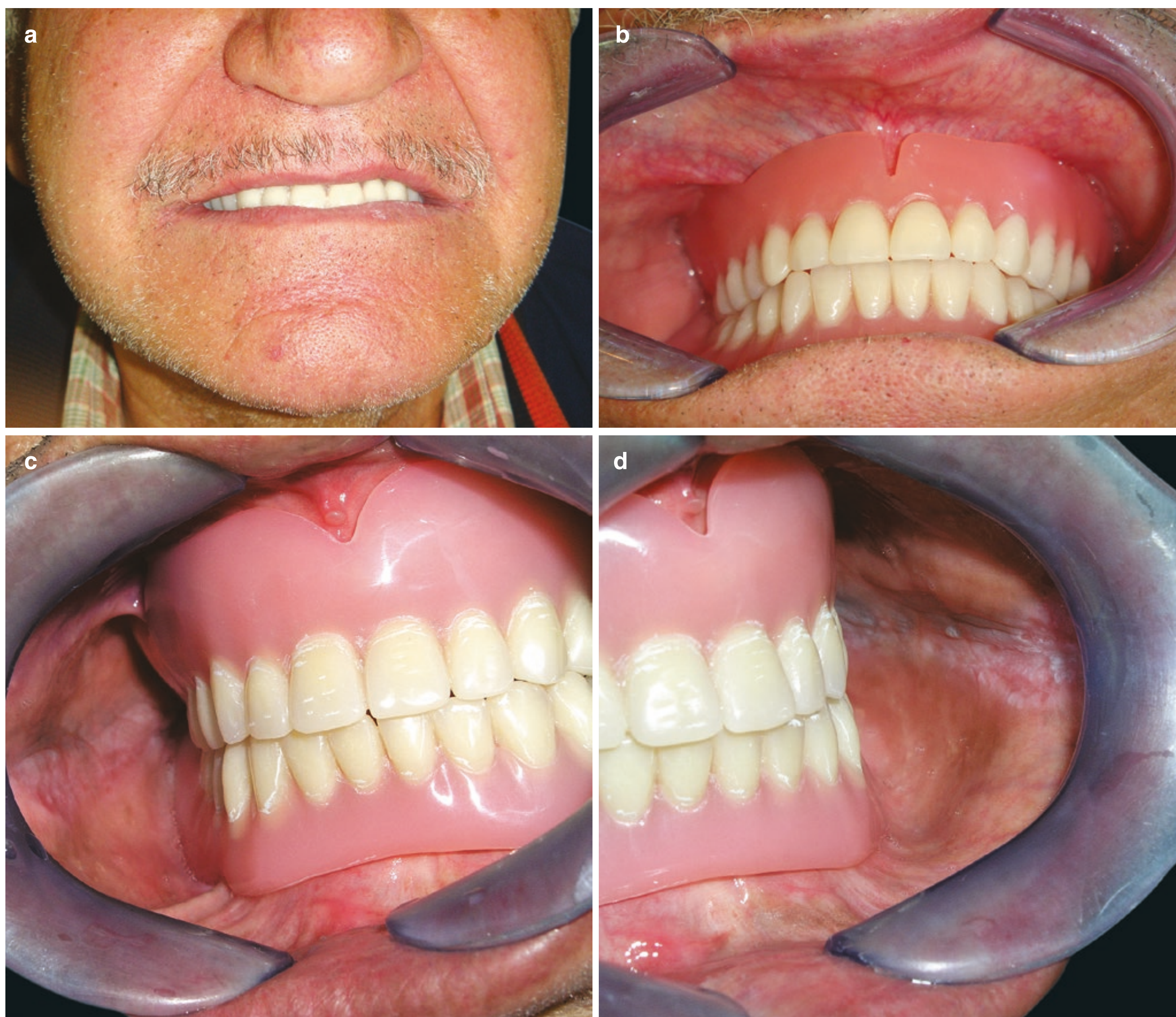


Fig. 5.36 (**a**) Low vertical dimension. (**b**) Patient bites cheek even though there is sufficient overjet on posterior teeth. (**c**, **d**) Chronic cheek biting

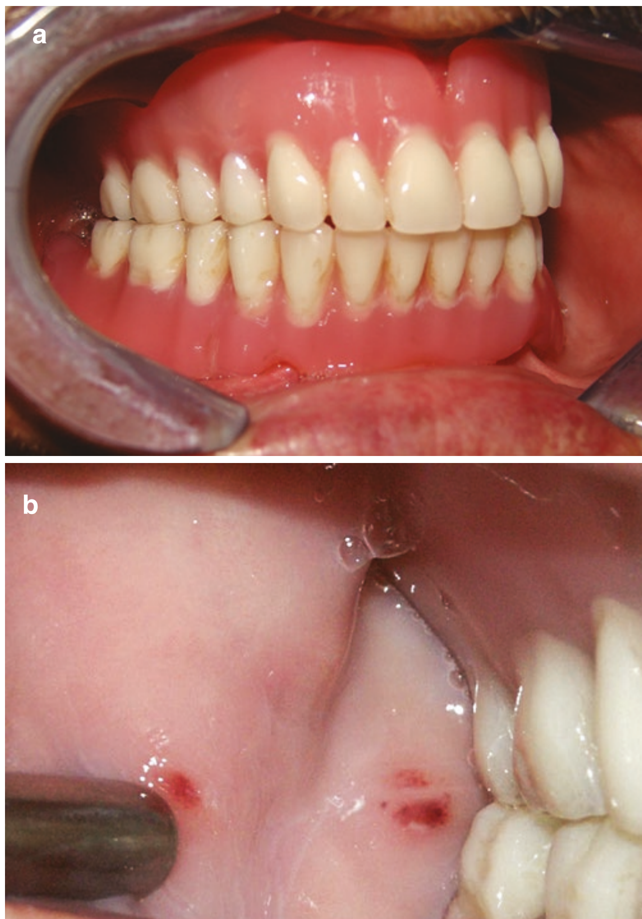


Fig. 5.37 (**a**) Insufficient horizontal overlap on the posterior region. (**b**) Irritation area on the cheek

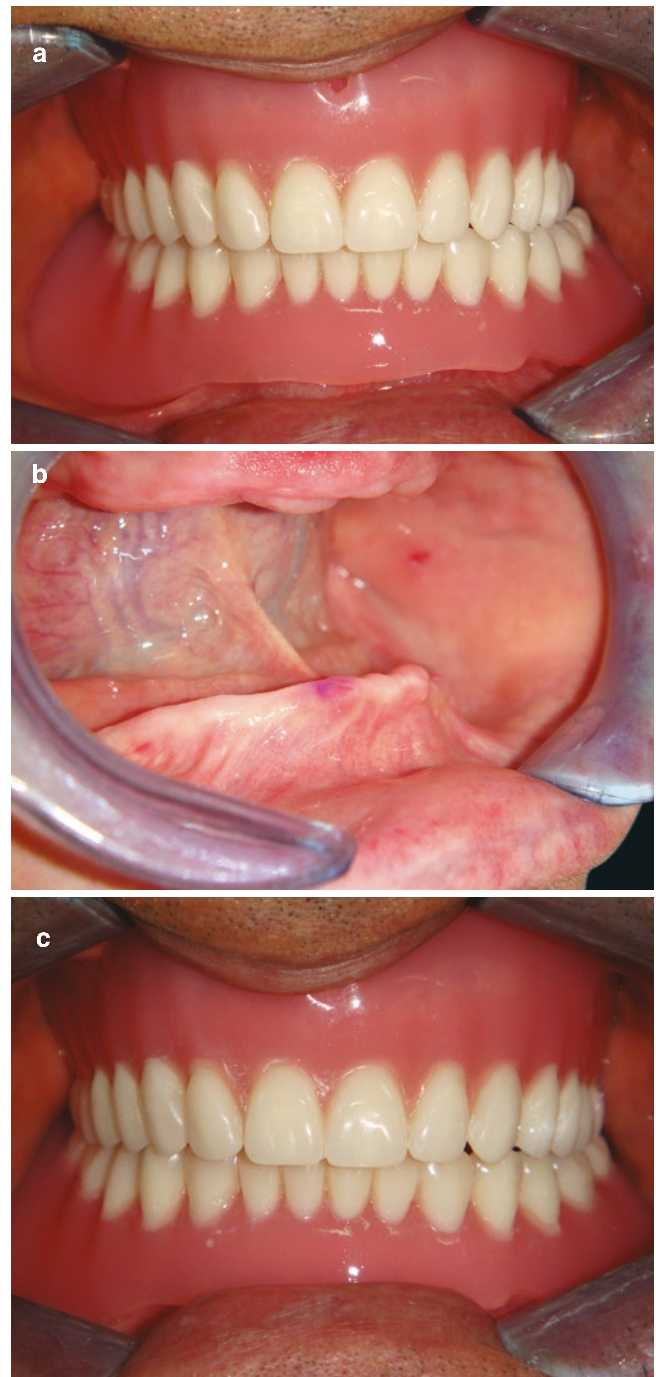


Fig. 5.38 (**a**) Lack of horizontal overlap on the left posterior region of the lower denture. (**b**) Existence of cheek biting. (**c**) Providing adequate horizontal overlap in the posterior area by changing the position of teeth

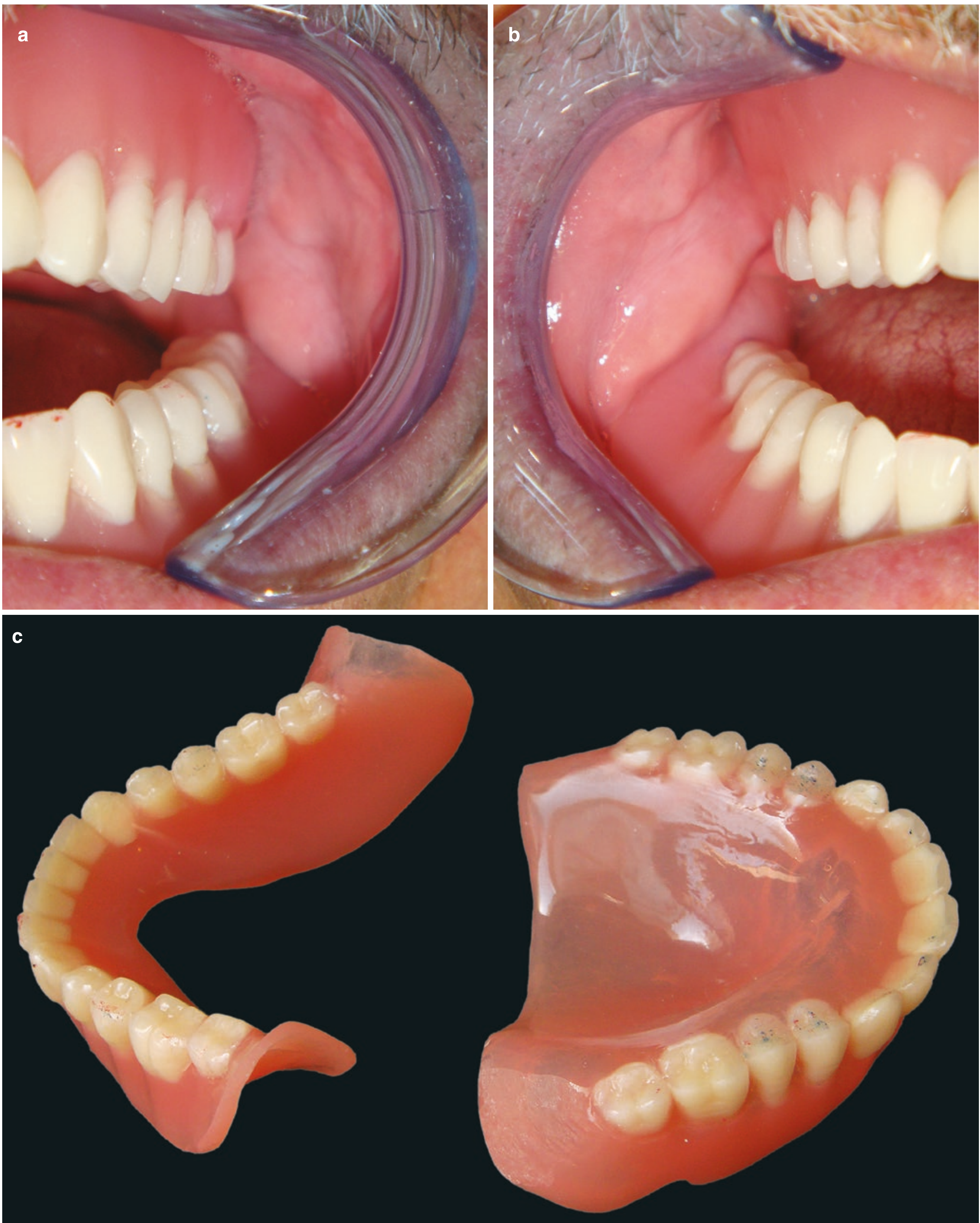


Fig. 5.39 (**a**, **b**) Cheek enters the space caused by the posterior contact of the denture bases. (**c**) Making the flanges shorter and thinner

to be thickened for the prevention of cheek biting. In cases of cross bite, the cheeks are bitten by the patient, as the cheek comes between the upper and lower teeth. To prevent this, upper and lower denture plates need to be thickened (Figs. 5.40, 5.41a–c).

5. Arranging the anterior teeth in the edge-to-edge position

   In such cases, if the patient is complaining about lip biting, overjet is attempted by grinding from the labial surfaces of the lower anterior teeth close to the incisal edge in protrusive movement. If this does not solve the problem, lower anterior teeth should be changed with new ones by placing them more lingually, or new dentures should be fabricated. The reason for choosing the lower anterior teeth is the esthetic and phonetic problems that will be observed in cases of position change for the upper incisors and less visibility of the lower anterior area.

6. Inaccurate position of the teeth

   If the teeth are not positioned in the function area of the lips and cheeks, lips and cheeks might be bitten while functioning. If grinding does not work, a new denture has to be made with the correct position of the teeth.

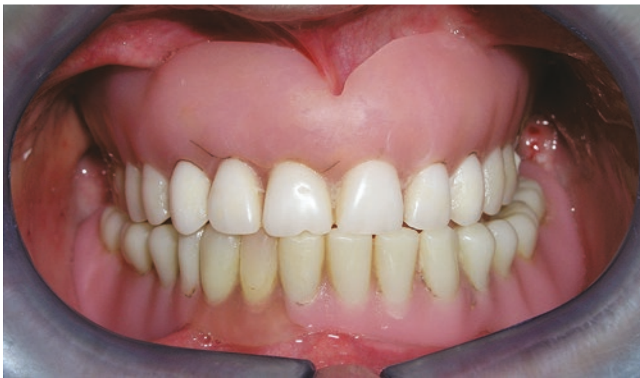


Fig. 5.40 Cheek biting caused by cross bite

5.1.5 Pain in the Tongue

There are three possible reasons for the pain:

1. The lingual surfaces of the dentures or irregular areas on the teeth can traumatize the tongue (Fig. 5.42a, b). By correcting the irregularities with burs, the denture is polished again.
2. Locating the teeth on the lingual side

   If the area of the tongue is restricted, there might be pain related to cramps, and if the teeth are placed excessively to the lingual, the tongue could be bitten (Figs. 5.43, 5.44). There is intense burning sensation on the tongue, and as the tongue gets into the interproximal areas of the

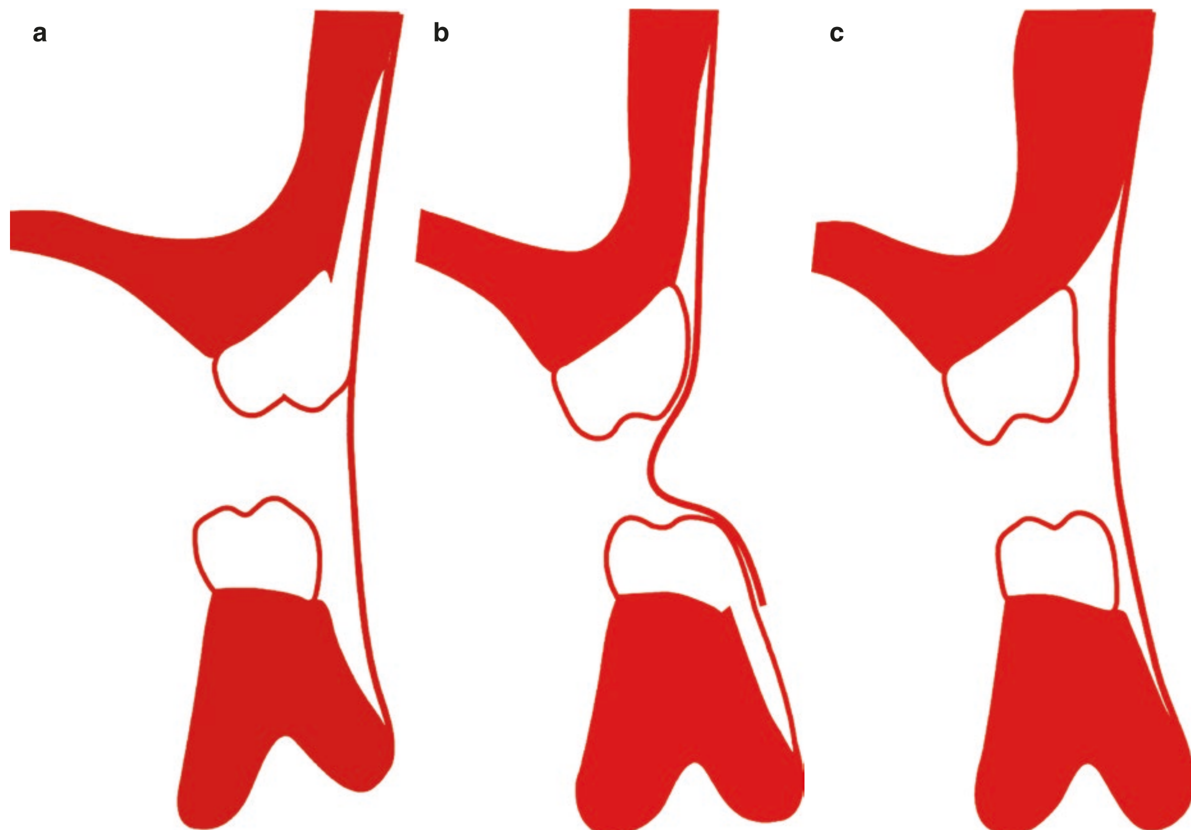


Fig. 5.41 (**a**) In adequate teeth arrangement, cheeks are supported by the denture base. (**b**) Cheeks go between the teeth in cross bite. (**c**) The solution is to make the upper denture base thicker

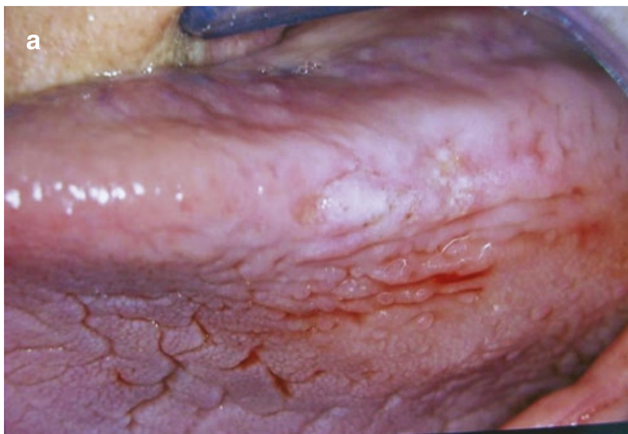
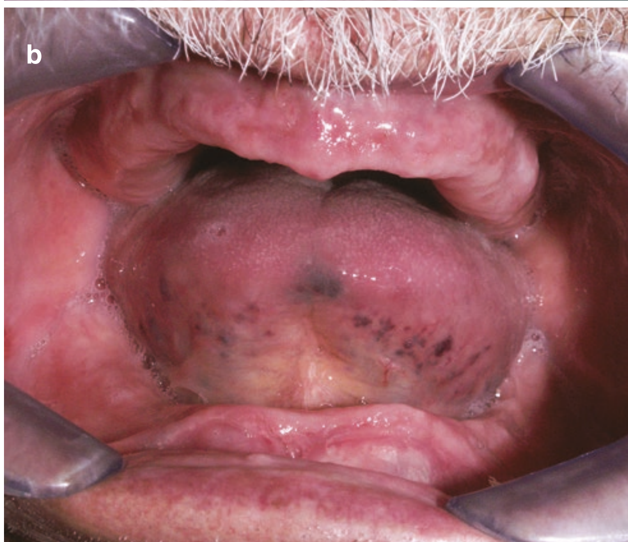
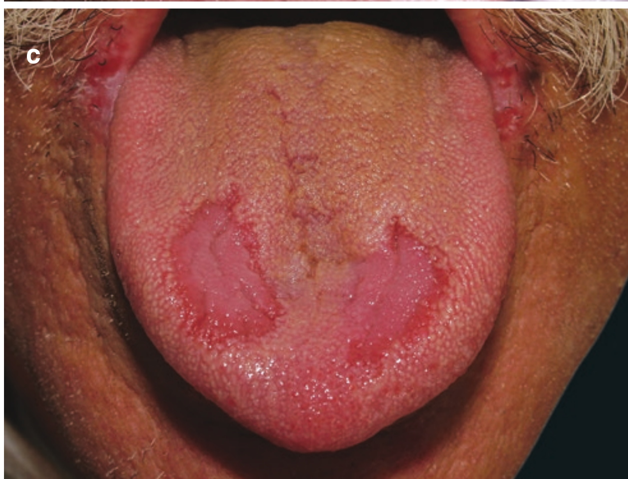




Fig. 5.42 (**a**–**c**) Irritation and ulceration areas on the tongue

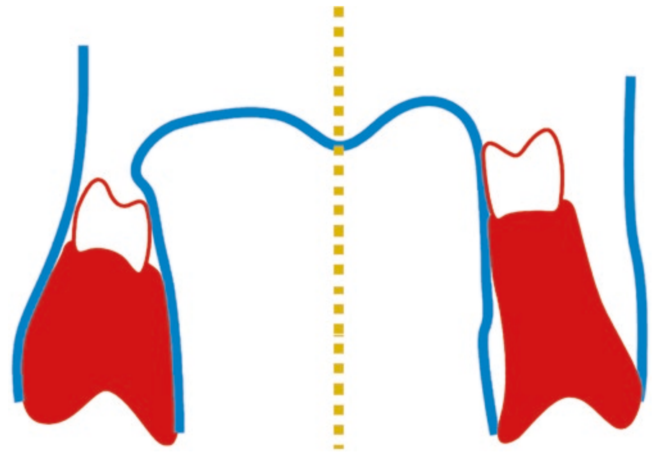


Fig. 5.43 The arrangement of teeth lingually limits the tongue space

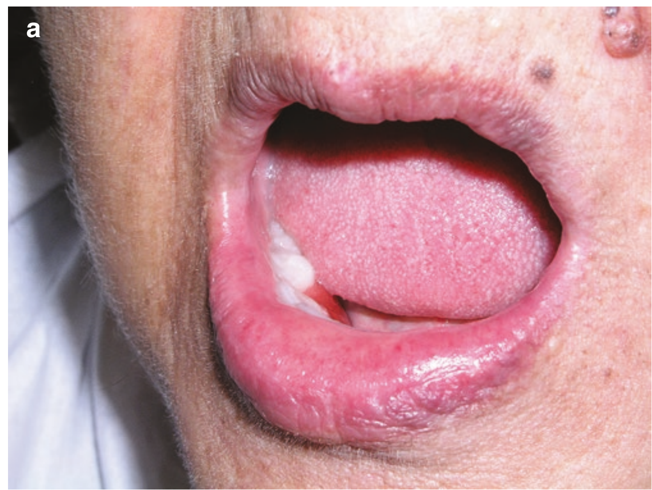
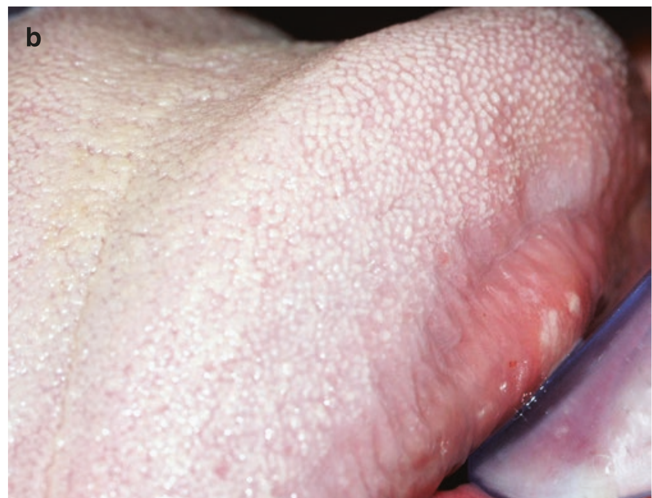



Fig. 5.44 (**a**) Arrangement of teeth lingually limits the tongue space. (**b**) Irritation area on the tongue caused by insufficient tongue space

teeth, lateral parts of the tongue get the shape of the related areas. For widening the area of the tongue, the lingual parts of the teeth and the denture should be grinded and polished again. If it does not work, a new denture has to be made.
3. On rare occasions, pain at the edge of the tongue can occur because of a diastema created between the incisors in accordance with the wish of the patient. To solve this problem, transparent acrylic resin material can be used to fill the diastema.

5.1.6 Pain in the TMJ

TMJ pain is generally caused by insufficient interocclusal distance and freeway space due to inaccurate jaw relation records.

5.2 Loss of Retention and Stability (Feeling of Looseness with Dentures)

Patients generally complain about their dentures feeling loose. To resolve the problem, in these cases it is important to know the difference between the retention and the stability of the denture. If the looseness is caused by forces applied directly up and down, then there is a problem with retention. If the patient complains about looseness but the denture is resistant to vertical forces, then there is problem with stabilization. If the patient reports that dentures become loose while eating and particularly while speaking, there is a problem with stabilization.

There is some loss of retention in dentures, which move because of vertical forces. There are three conditions for obtaining maximum retention:

1. The denture should cover the maximum space in the functional borders.
2. There should be minimum space between the denture and the tissue.
3. The viscosity of the saliva should be optimal.

If there is still loss of retention, then the reasons are:

1. Physiological reasons

   Loss of weight can affect the adaptation of dentures. Patients with diabetes and periodontal diseases might lose supportive tissue quickly, and they should be warned about this previously at the adaptation sessions. Malign growths in the oral cavity can cause adaptation problems. Sometimes, a patient can't use their dentures properly.

   They shouldn't narrow the mouth corners toward the lower denture, they should chew with minimum lateral movements, and they should keep their tongue in a way which will keep the lower denture in the mouth. If there is none or insufficient saliva, the thin salivary film that provides retention between the denture and the tissues is not produced, resulting in a loss of retention.

   Reasons for the decrease in saliva include diabetes, chronic infection, drugs (antianxiolitics, antidepressants, antihistaminic, antihypertensive drugs, diuretics, decongestants, drugs for Parkinson's, antipsychotics, drugs for anorexia), biological aging (degeneration of salivary glands), Sjögren syndrome, vitamin deficiency, stress, and depression.

   For these kinds of patients, suggestions for increasing the amount of saliva include determining the etiological factors; the provision of a balanced diet with vitamins and the necessary minerals; a moisturizer gel, artificial saliva; or a sugar-free gum.
2. Anatomical problems

   In the presence of excessive undercuts, the dentist need to make relief which increase the salivary film thickness in these areas. In these cases, the adhesion of the denture is negatively affected. To solve this problem a hermetic border seal should be obtained. In the presence of thin mucoperiosteum, the dentures can cause irritation. Soft lining materials can be used to prevent this.
3. Clinical errors

   Despite an adequate amount of saliva and the absence of undercuts, a loss of retention can be seen if the clinical procedures have not been followed carefully.

5.2.1 Upper Dentures

If the patient is complaining about movement of the upper denture in the rest position and while speaking, the problem generally arises from a lack of peripheral seal, underextension, and rarely because of the overextension of the flanges. If the extensions and peripheral seal are sufficient, the retention of the upper denture will be good. Overextended flanges will result in pain rather than the movement of the denture. It should be determined whether the peripheral seal is inadequate.

1. Determination of postdam area

   To determine the appropriate postdam area, first the upper denture should be compressed, then pulled back and down. If the denture easily relocates, the postdam area should be arranged functionally by using additional wax. This process functionally determines the most appropriate way for the postdam area. Melted wax is applied to the

postdam area with a brush, and then the denture is dipped in cold water before being placed in the mouth for 6 minutes, under occlusal pressure (Fig. 5.45a, b).

2. Control of denture flanges

   If the adhesion of the denture is still inadequate following the postdam arrangement, denture flanges should be checked. Underextended flanges should be arranged using impression compound.

5.2.2 Lower Dentures

Functional sealing of the lower denture is more difficult to determine due to the muscle attachments in this region.

A lack of retention in the lower denture is usually caused by overextended flanges.

To check whether or not the flanges of the dentures are overextended:

- The patient is asked to slightly extend their tongue up to the lower lip (Fig. 5.46).
- Tissue adaptation of the denture base is checked by placing the index finger on the occlusal surface of the lower denture (Fig. 5.47).
- If the denture flange is overextended in the genioglossus muscle area, the anterior part of the denture relocates. If the denture flange is overextended in the premolar area, entire denture relocates (Fig. 5.48a, b).

Overextension of the distolingual flanges of the lower denture causes the instability of denture depending on retromylohyoid muscles (Fig. 5.49a, b).

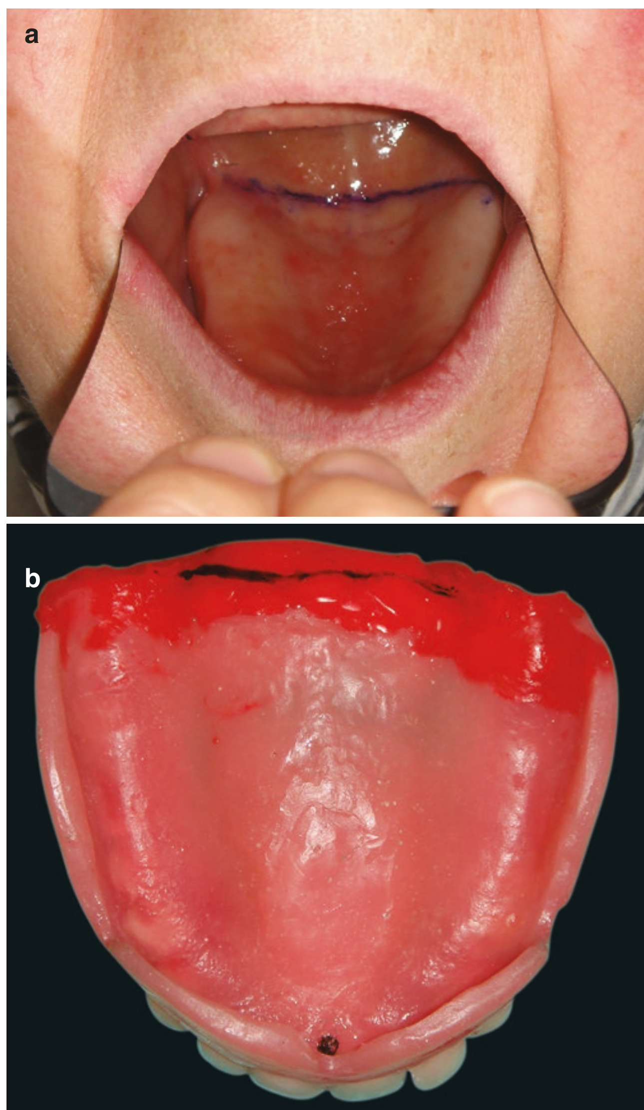


Fig. 5.45 (**a**) Determining postdam area in the mouth. (**b**) Postdam area determined by adding soft wax inside the denture

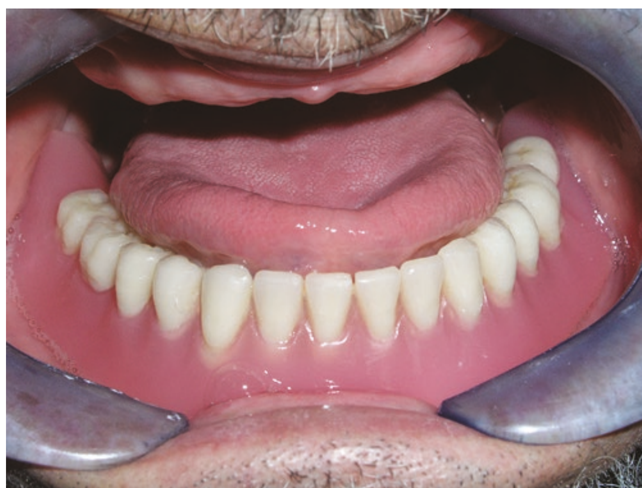


Fig. 5.46 Patient extends the tongue through the lower lip

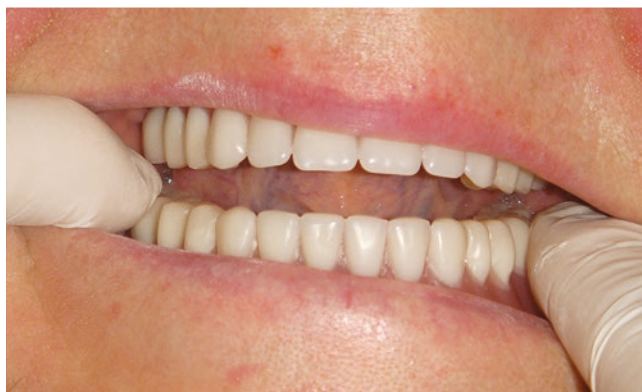


Fig. 5.47 Checking the denture stabilization using index fingers

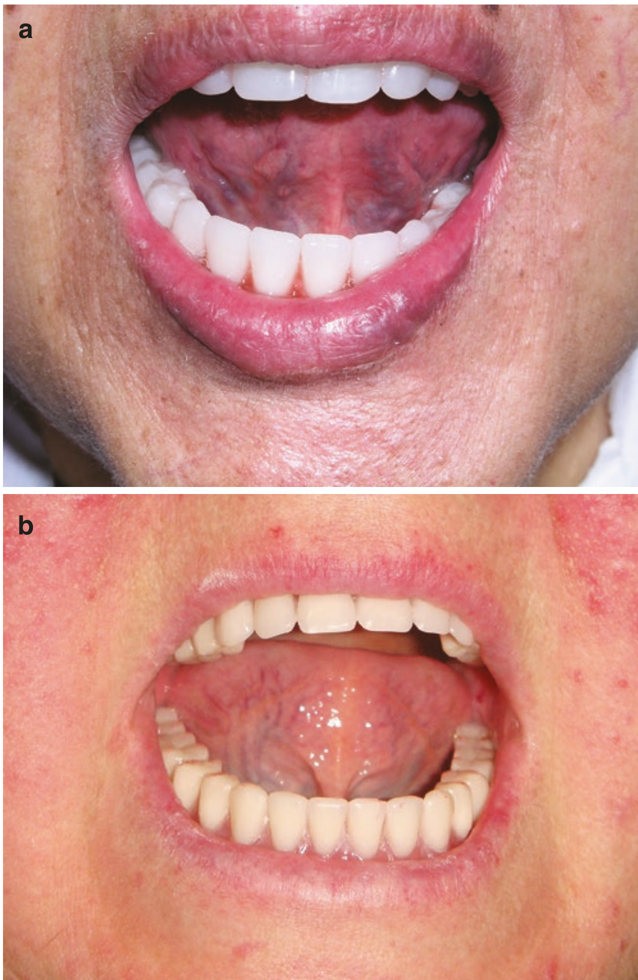


Fig. 5.48 (**a**, **b**) Insufficient retention of the denture (overextension of the flange on the genioglossus muscle area)

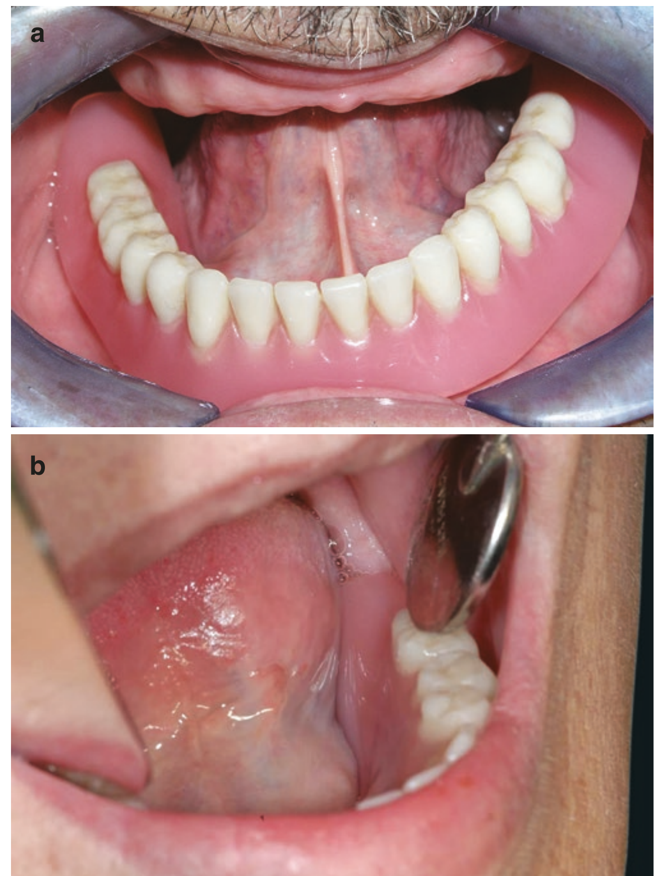


Fig. 5.49 (**a**) Lack of retention in the entire denture (effect of mylohyoid muscle). (**b**) Overextension of the distolingual flange

Technical problems

Polymerization shrinkage may result in a loss of adaptation of the denture; therefore, relining the dentures is essential to solve this problem.

5.2.3 Loss of Stability in Dentures

If the patient is complaining about movements of the dentures during function and speaking, lack of stability may be the reason.

The reasons of stability loss are:

1. Problems on the tissue surface

   If the flanges of the denture are extended up to the muscle attachments, denture will dislocate during function and patient will feel pain.

   In the lower jaw, the dentures should be held by the clinician with their index finger. In the meantime, the patient is requested to place their tongue on the soft palate. The displacement of the dentures against the fingers shows that the denture flanges are overextended on the genioglossus muscle area. If the denture dislocates when the patient touches the right and the left sides of the mouth with their tongue, the flanges near the junction areas of the mylohyoid muscle are overextended.

   If the denture dislocates when the tongue is moved forward, then the distolingual flange, which is located in the movement area of palatoglossus muscle, is overextended. If the denture dislocates during the downward and backward movement of the modiolus, the flange of the denture near the junction area of the buccinator muscle is overextended.
2. Occlusal-incisal surface defects

   These problems should be checked at the try-in stage. Furthermore, these problems can be solved by remounting and grinding. But if the patient is using a denture for the first time, or has been wearing an inaccurate denture for a long time, the grinding process should be made at the second session.

   If the new denture is placed on erythematosus tissue, caused by the old dentures, the adaptation of the new dentures could be worse following the healing of the tis-

sues. This problem can be solved with a recall appointment.

Premature contacts should be determined, and occlusal arrangements have to be made prior to the first recall. All premature contacts cause tipping movements.

A slight distance in the centric relation and centric occlusion is a process carried out to adapt patients to new dentures and help the patients get used to their dentures. Called long centric, this clearance process is 1–2 mm. This process should not be exaggerated. As previously mentioned the stability problem mostly appears in lower denture, and in such cases occlusion should be arranged by eliminating premature contacts in lateral and protrusive movements. By grinding process, bilateral balanced occlusion should be established (Figs. 5.50a, b, 5.51a–f, 5.52a–c).

If full balance is not available with these arrangements, three-point contact should be provided (Fig. 5.53a, b).

3. Lack of interocclusal distance

   Absence of interocclusal distance and tubercle contacts during chewing causes lack of the stability of the lower denture. The problem is tried to be solved by grinding or renewing the denture. Vertical dimension of occlusion should be checked, and if it is necessary, rehabilitation of interocclusal distance should be done (Fig. 5.54).

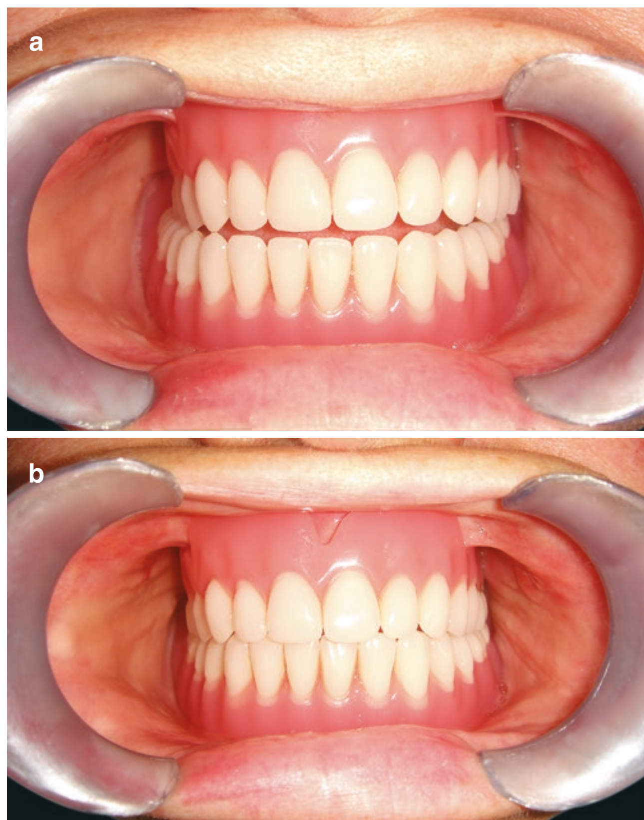


Fig. 5.50 (**a**) Inaccurate centric occlusion. (**b**) Arrangement of centric occlusion by grinding

4. Use of teeth with prominent tubercle on the atrophic crest

   When teeth with prominent tubercle are used on atrophic crests, there are always stability problems even if balanced articulation is provided (Fig. 5.55a, b).

5. Position of artificial teeth

   Normally it is considered that the maximum stabilization of artificial teeth is provided by placing them in the position of natural teeth. But if the patient has not used a denture for a long time, the tongue spreads over a longer area. In such a case, a more stable position is obtained by arranging the teeth more buccally. Although the teeth are aligned in the correct position anatomically for such patients, they complain about the looseness of the denture when he/she speaks. But the dentures are stable during eating. In this case, it is necessary to make the dentures with a "neutral zone" technique.

6. Position of the mandibular molar teeth

   When the molar teeth are arranged in their real position, an undercut occurs on the polished lingual surfaces. In such a case, the denture will not be stable during speaking. By reducing the buccolingual dimension of the teeth, more space is provided for the tongue, and speaking becomes comfortable.

7. Position of the lower incisors

   When the incisal surfaces of the lower incisors are not corrected, the stability of the denture is disturbed; therefore, for the new denture, the lower anterior teeth should be arranged as their position before the extraction of the teeth. Excessive labial placing of the lower anterior teeth, to provide a normal overjet for patients with skeletal class II, leads to the movement of lower denture when the patient opens his/her mouth or laughs (Fig. 5.56). If the amount of resorption in the anteroposterior direction is not determined accurately in the upper jaw, anterior teeth are placed extremely labially, causing deterioration in the stability of the upper dentures (Fig. 5.57).

   Lack of stabilization toward the lingual side for skeletal class III patients is caused by pressure in the premolar region coming from the modiolus area. To prevent this, the premolars are placed buccally in the upper denture.

8. Higher occlusal plane than normal

   There might be looseness in the denture, since the movement of the tongue is restricted during the pronunciations of the letters (Fig. 5.58a, b). Occlusal plane should be at the same level as the dorsum when the patient is in the rest position (Fig. 5.59).

9. Faults in the polished surfaces

   It is generally desirable for all the surfaces on the lower polished surfaces to be concave, to enable the movement of the buccinator muscles and prevent the accumulation of food (Fig. 5.60).

On dentures fabricated with the neutral zone technique, the sublingual polished surfaces extend forward, like a shelf. In practice, this shape of the denture is determined by the

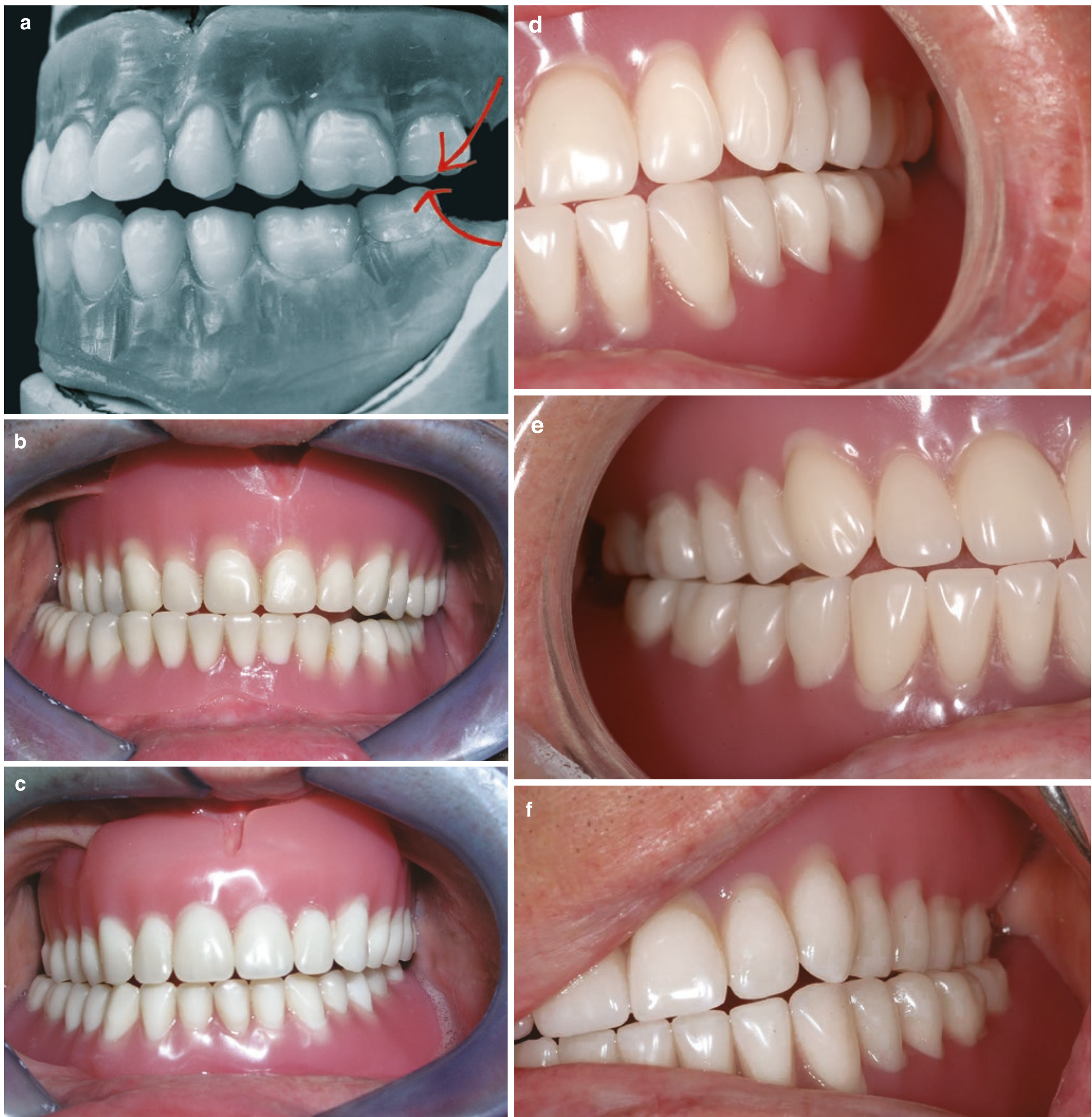


Fig. 5.51 (**a**–**d**) Lack of balance in lateral movements (deficiency in contacts). (**e**, **f**) Providing balance on working and balancing sides

Fig. 5.52 (**a**) Lack of balance on the posterior teeth in protrusive movement. (**b**, **c**) Providing balance on the posterior region in protrusive movement

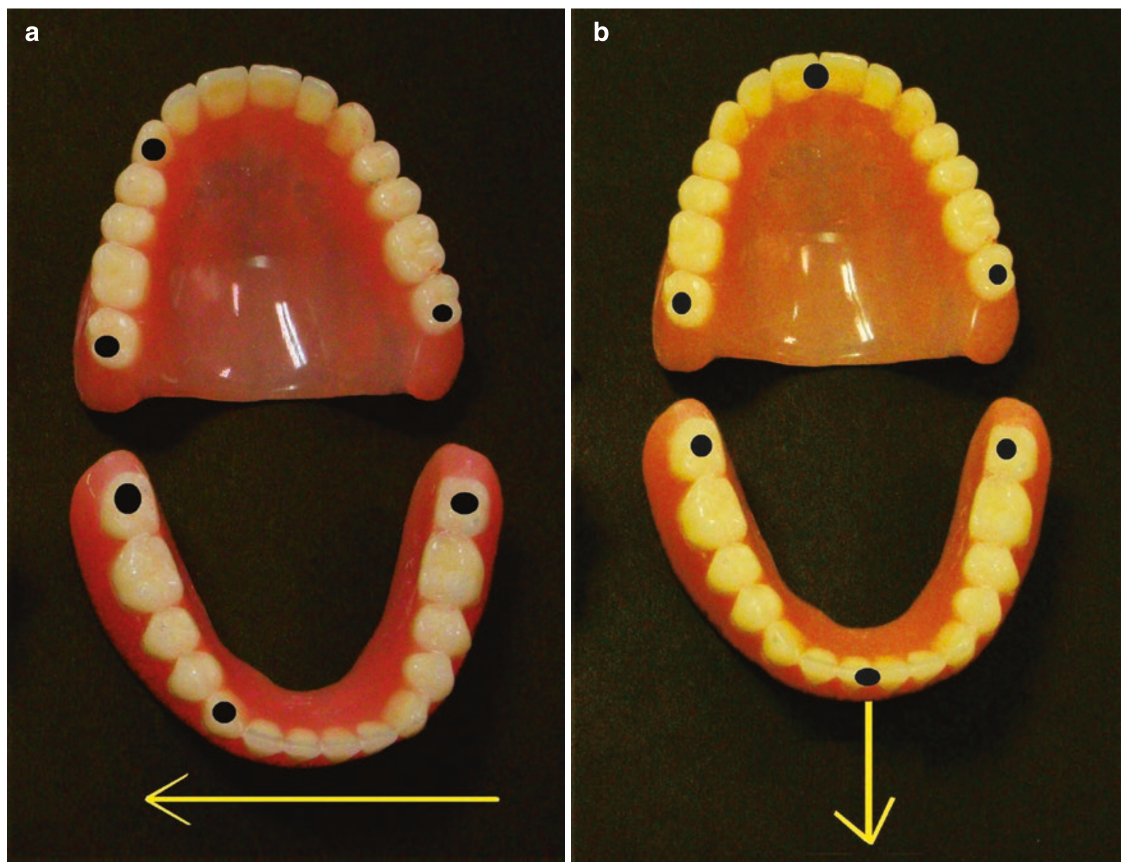


Fig. 5.53 (**a**) Three-point contact in lateral movement. (**b**) Three-point contact in protrusive movement

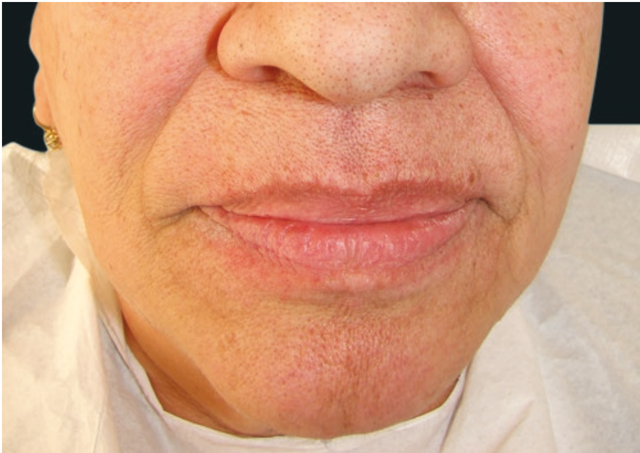


Fig. 5.54 Determination of high vertical dimension

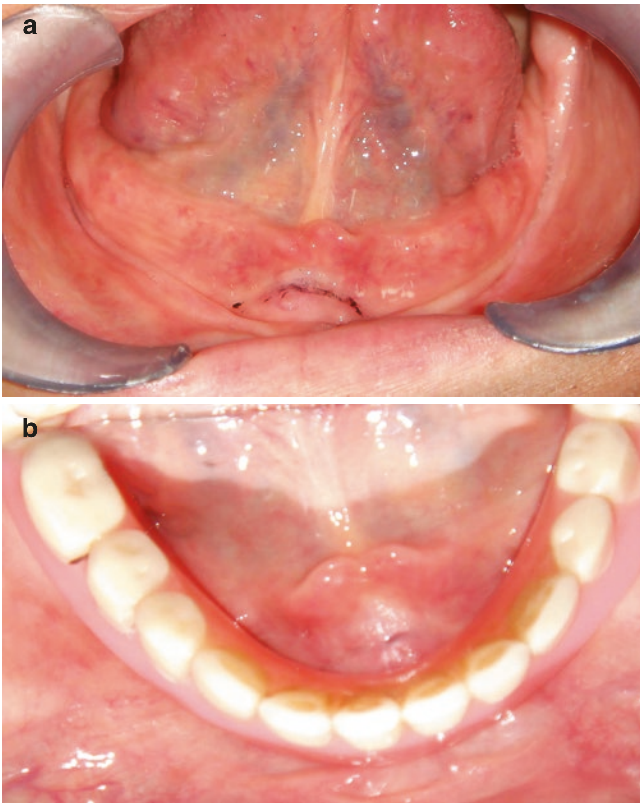


Fig. 5.55 (**a**) Resorbed crest. (**b**) Cusp heights can be reduced to increase stability

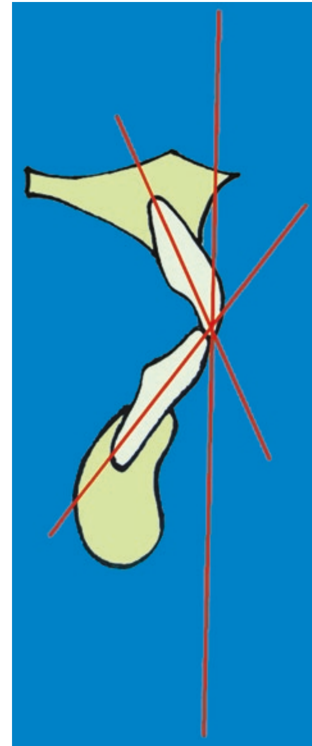


Fig. 5.56 Placement of mandibular anterior teeth exessively labially

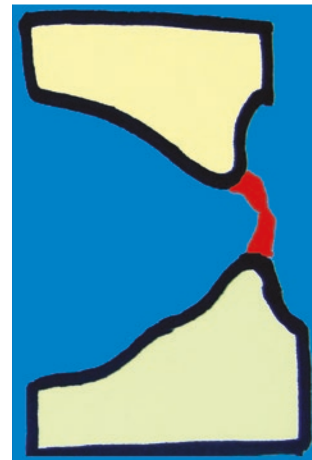


Fig. 5.57 Placement of upper and lower incisors excessively labially

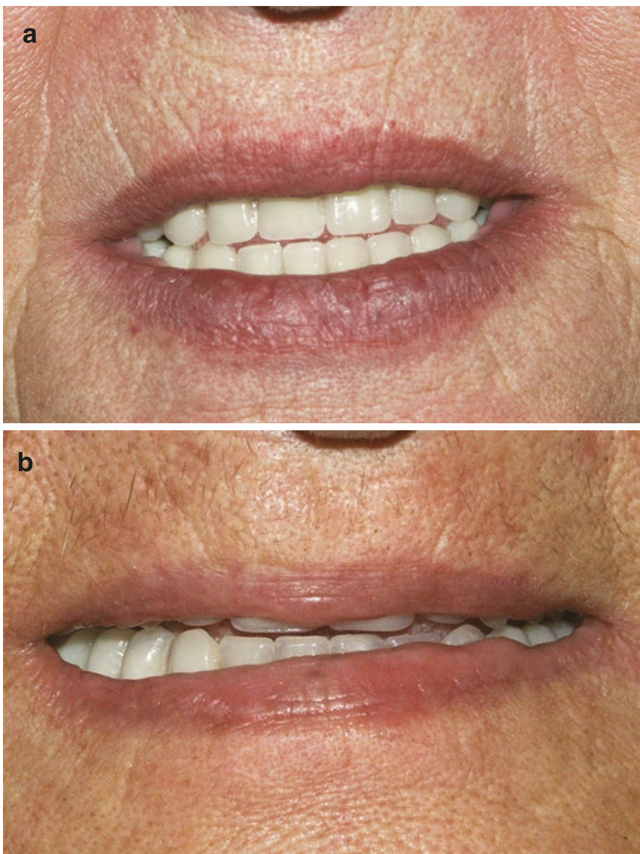


Fig. 5.58 (**a**, **b**) Determination of high occlusal plane

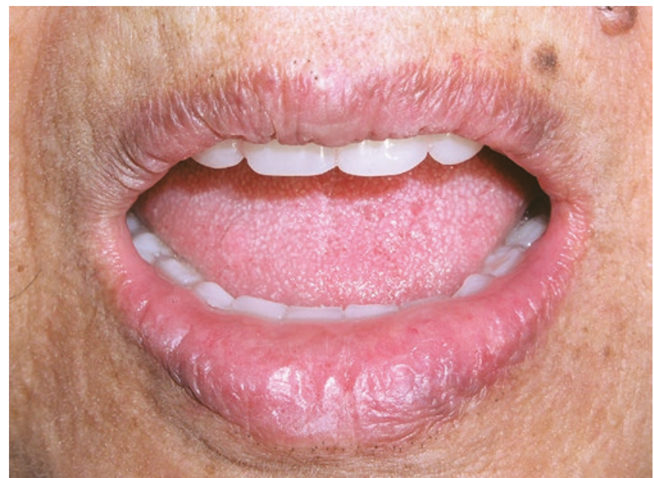
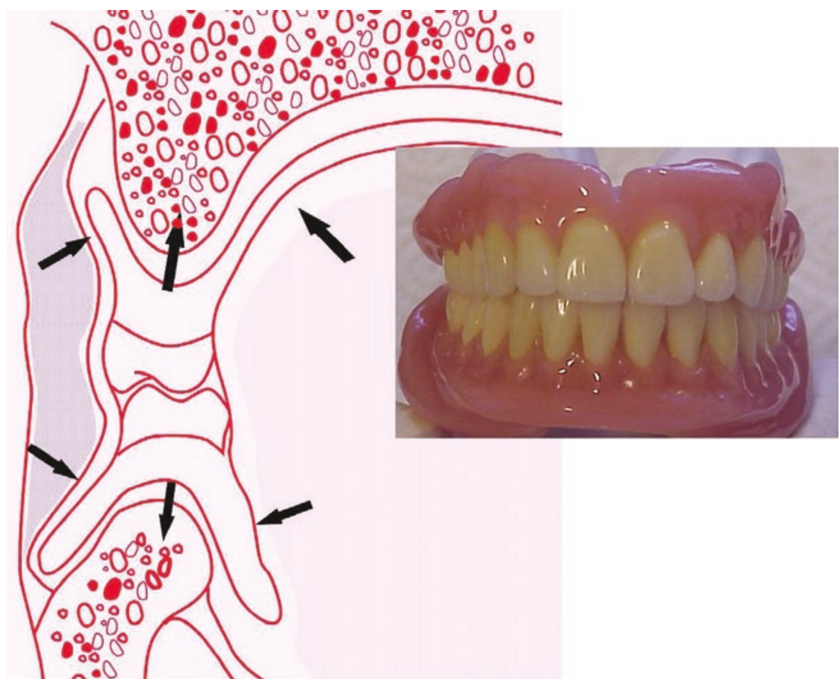


Fig. 5.59 Adequate position of occlusal plane

Fig. 5.60 Polished surfaces of the denture



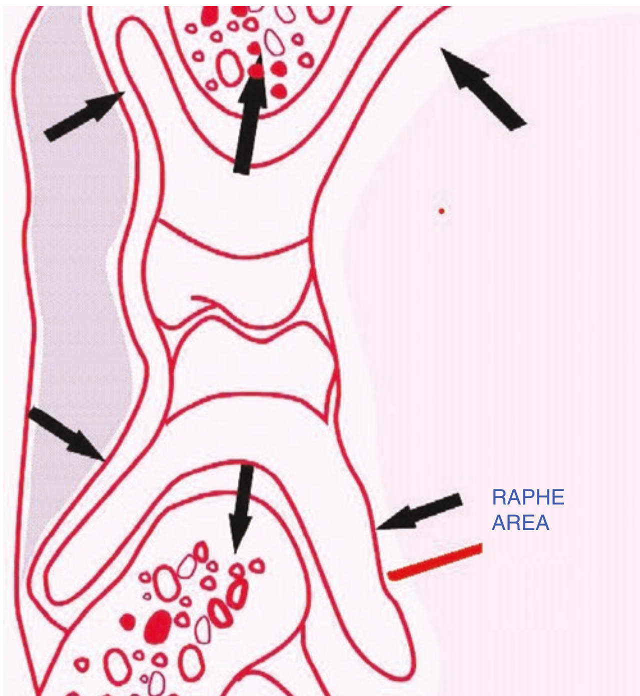


Fig. 5.61 Shelf that occurs on mandibular lingual region

functional peripheral shape, activity of the muscles, and the teeth's occlusal and incisal edges (Fig. 5.61).

When the lingual polished surfaces on the posterior region in the mandible are prepared thicker than usual, the movement space of the tongue is restricted, and the lower denture's stability is disturbed.

If the lingual polished surfaces act as undercuts for the tongue, there will be destabilization due to mechanical problems.

While opening the mouth, in the maxilla, the thick buccal flanges result in a loss of stabilization because of contact with the coronoid process. The thickness of the posterior region should be reduced.

If the denture falls when laughing or opening the mouth, it means that the buccal flanges of the anterior region or the upper teeth are located excessively anteriorly. The buccal flanges should be thinner, or the location of the upper teeth should be altered. If all these arrangements do not solve the problem, the denture should be renewed (Fig. 5.62a, b).

5.2.4 Anatomical Reasons

Even with the most retentive and stabile dentures, in many cases they will not be stable if the ridges are excessively resorbed or fibrotic. This situation should be explained to the patient prior to treatment (using teeth with reduced tubercle, height-reduced teeth, making impression without pressure).

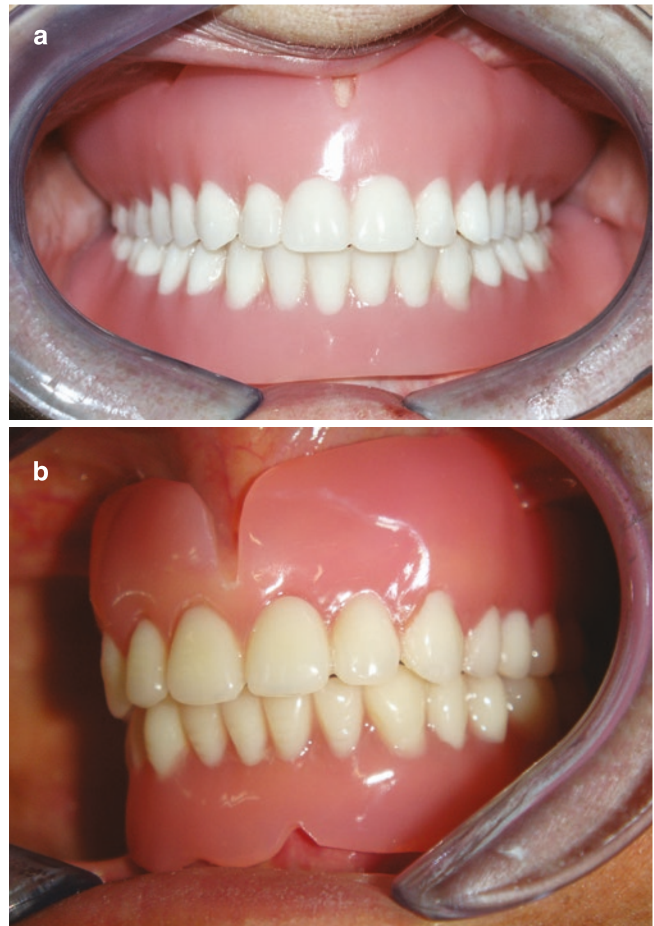


Fig. 5.62 (**a**, **b**) Inadequately arranged polished surfaces of the upper and lower denture

Palatinal torus also causes a lack of stability for the upper denture. Relief should be made on these areas.

5.2.5 Physiological Factors

For elderly patients, adaptation to new dentures is often slow and occasionally is never completed. For non-specific lack of stability, the dentist compares the polished surfaces of the old and new dentures. If the existing denture is suitable for duplication, a duplicate denture is fabricated. But if the patient is dissatisfied with the old denture and has become used to using partial dentures, temporary dentures are recommended.

5.2.6 Pathological Factors

The use of some psychotic drugs causes spasms of the face muscles and tongue. Also for diseases like Parkinson's, it is difficult to control the lower denture, and the retention of the upper denture is insufficient.

5.2.7 Causes of Patient Complaints

1. If the upper denture falls during speaking or in the rest position
   For the upper denture

(a) The peripheral seal is incomplete.
(b) The denture flanges are short.
(c) Rarely, overextended flanges may cause problems.

For the lower denture
The flanges are overextended.

2. If there is a sensation of looseness in the lower denture during speech

(a) Insufficient interocclusal distance.
(b) Using high tubercle teeth on atrophied crests.
(c) Inaccurate position of the artificial teeth (position of the lower molars and lower incisors).
(d) The level of occlusal plane is high.
(e) The lingual surfaces of the teeth are not suitable (arranging the teeth lingually).

3. If the upper denture falls when the mouth is opened

(a) The buccal flange of the upper denture is too thick.
(b) Position of the upper anterior teeth is not accurate.

4. If the denture slides downward and backward during biting

(a) Patients are unable to control the denture with their tongue.
(b) The patient has poor muscle coordination.

5. If there is a sensation of looseness but the denture is not falling
   It can be due to thin mucoperiosteum.
6. If the upper denture falls periodically
   Excessive mucous saliva may affect the denture.
7. If the dentures move while eating

(a) The adaptation is incomplete.
(b) The teeth arrangement might be incorrect.
(c) There may be a lack of stability on both sides.

5.3 Insufficient Chewing

Causes of insufficient chewing can be divided into six categories:

1. Lack of denture experience
   A patient needs time to develop muscle control while using the denture, if it is the first time they have used dentures. This time can vary from a week to 6 months, or even longer. It is dependent on the adaptation of the tissues to the denture.
2. Incorrect position of occlusal plane
   While chewing, the buccinator muscles and tongue play an important role in keeping the food in the chewing area. If the level of the occlusal plane is too high, it might be too difficult for the tongue and cheek to keep the food in the right area. The correct level of the occlusal plane is located a few mm below the back of the tongue while resting. This level is determined with "e" and "o" sounds. While saying the sound "e," the tongue should be on the occlusal surface, and it should be under the occlusal surface while saying "o."
3. Higher vertical dimension than normal
   Most patients can tolerate some deviation in the vertical dimension. The existence of the interocclusal space is important. If the vertical dimension is too high and the interocclusal space is insufficient, food cannot be chewed, as it cannot be located on the occlusal plane. A patient that has difficulty in locating the food on the occlusal surface needs to open their mouth wider than normal. In these cases, the dentures should be renewed (Fig. 5.63a, b).
4. Lower vertical dimension than normal
   The patient's muscles cannot apply enough chewing force. If the freeway space is greater than normal, the force of the chewing muscles will be inadequate. Adapting the vertical dimension will be the most suitable solution for both cases (Fig. 5.64a, b).
5. Lack of balanced contacts in occlusion
   Lack of balance in lateral and protrusive movements will disrupt the stability, and it will prevent the sufficient chewing of food. Balance should be provided between the lateral and protrusive movements.
6. Pain in denture-bearing areas
   If the patient feels pain in an area under the denture, he/she will be reluctant to chew because of the fear of pain while chewing. Low-pressure chewing reduces chewing activity. In such cases, the dentist should determine the cause of the pain and ensure that the patient is comfortable (Figs. 5.65a–f, 5.66).

5.4 Nausea and Retching

The glossopharyngeal nerve is responsible for the gag reflex. This nerve innervates the posterior one-third of the tongue and soft palate. It has been suggested that this is more common in patients with a gag reflex. The gag reflex is a problem that alarms patients and makes them feel

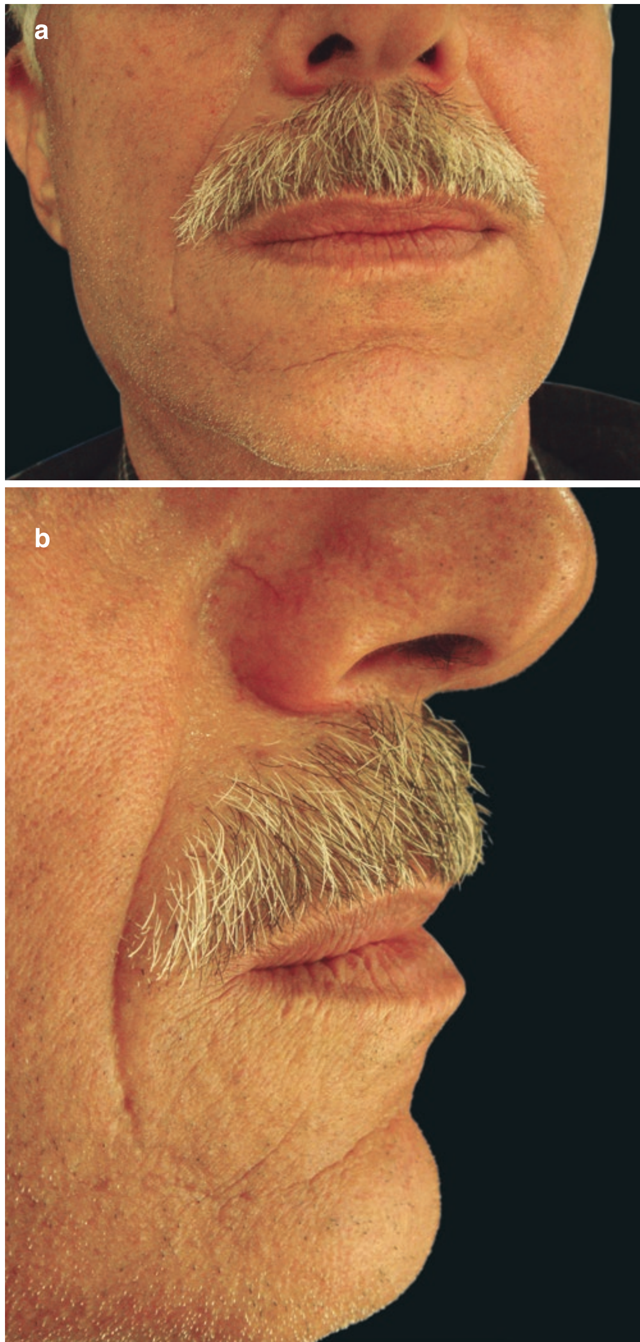


Fig. 5.63 (**a**, **b**) Determination of high vertical dimension

uncomfortable. Sometimes, due to a physical reaction to foreign substances, excessive salivation and the gag reflex occur can be seen in denture wearers, due to excessive salivation.

For increasing the retention of the denture, the peripheral closure of the denture is overextended, and due to this there may be a sensation of mild nausea.

If the patient says that the gag reflex is continuing, a series of questions should be asked:

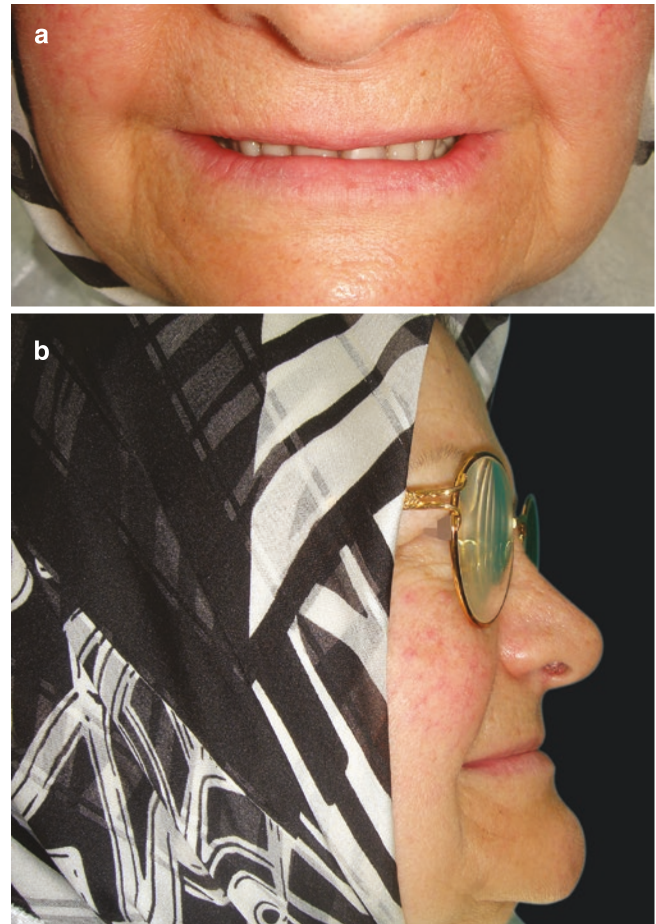


Fig. 5.64 (**a**, **b**) Determination of low vertical dimension

1. Have you ever experienced such a problem with your previous dentures (if he/she has used a complete denture in the past)?

If the patient's response is no, the problem stems from malpractice.

In addition, these questions should be asked about when and how the patient's gag reflex started?

If the patient reports that the gag reflex starts shortly after the insertion of upper dentures:

1. *The posterior region of the upper denture is longer than normal.*

   If the denture sits on the moving soft tissue in the palate, a gag reflex occurs. The postdam area is determined and shortened.
2. *The posterior region of the denture is thicker than normal.*

   While swallowing and speaking, the root of the tongue is in constant contact with the posterior area, causing nausea. The posterior region of the denture should be reduced to make it thinner.

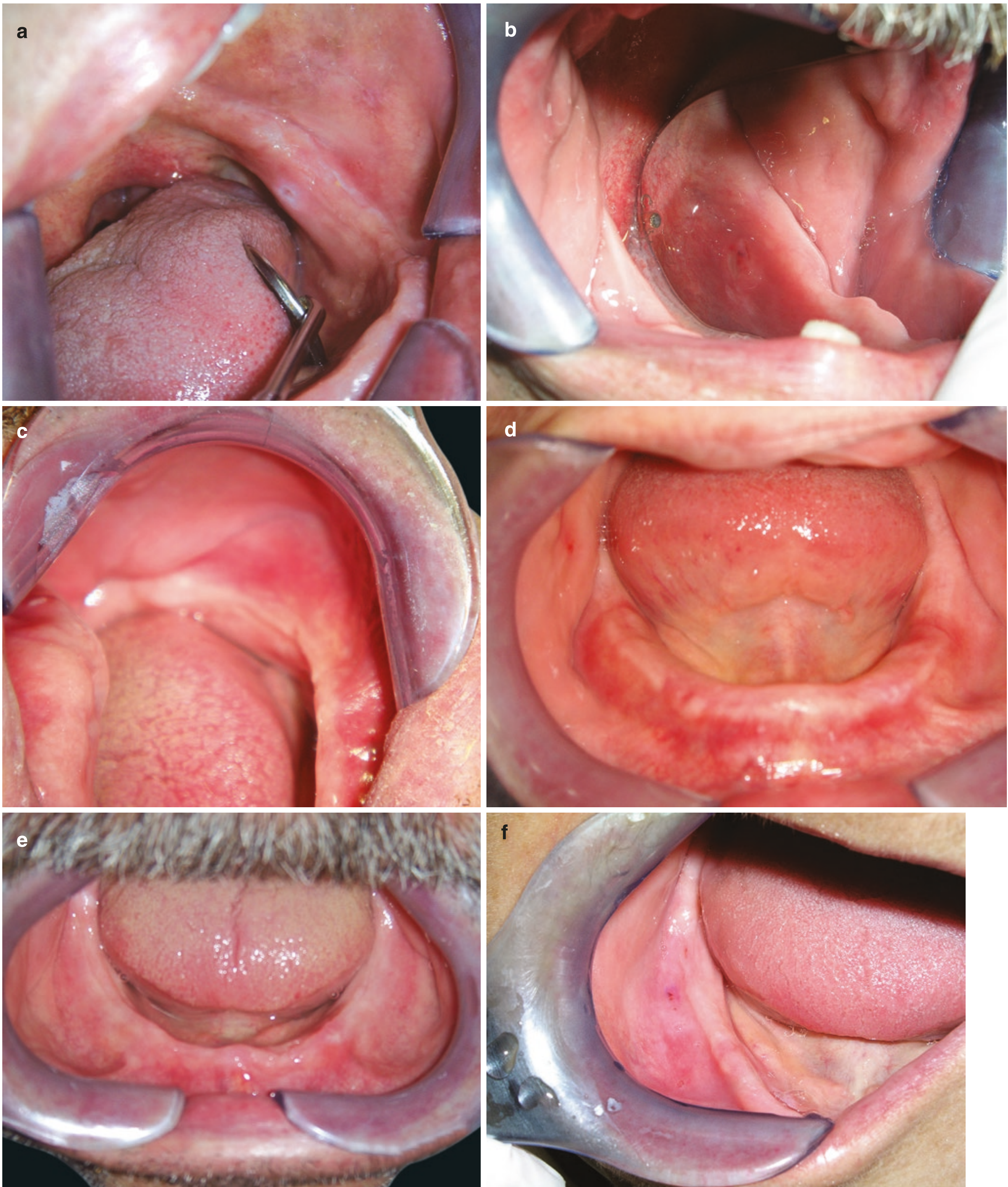


Fig. 5.65 (**a**–**f**) Irritation areas decrease efficiency of mastication forces

3. *A lack of retention, short flanges, or posterior region of the denture.*
   This can be solved by reshaping the postdam area.
4. *The vertical dimension is lower than normal.*
   As the tongue will be in continuous contact with the upper denture, it will cause nausea. The denture must be renewed with the correct vertical dimension of occlusion.
5. *Premature contacts in occlusion.*
   The unstable denture repeatedly falls on the tongue and causes nausea. The provision of balanced contacts solves this problem.
6. *Hypersensitive areas in certain parts of the hard palate.*
   The gagging reflex is frequently seen in patients with atypical postdam areas. This can cause nausea if it is not taken into account. The clinician should determine the sensitive areas on both sides of the midline by applying pressure to the soft palate with a blunt instrument. The posterior border of the denture is reshaped without including sensitive areas (Fig. 5.67).
   If the patient says that lower denture causes nausea:

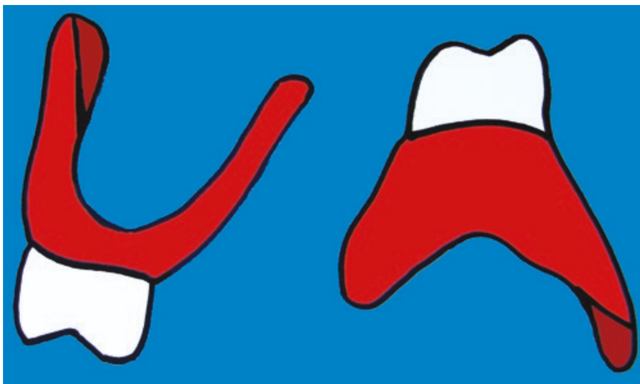


Fig. 5.66 Undercuts may cause irritation areas

1. *Insufficient tongue space*
   The gagging reflex can be reduced by arranging and reducing the lingual flanges of the lower denture. If the nausea continues, the dentures should be renewed.
2. *Overextension of the denture in the posterior tongue region*
   Gag reflex occurs during function, due to the palatoglossal rear contact of the denture. The related part should be shortened until the contact between the denture and the palatoglossal arch is removed (Fig. 5.68).
3. *Insufficient interocclusal distance*
   The necessary arrangements are made by checking the jaw relations, or the lower denture is renewed.
4. *Arranging the teeth away from the neutral area and the reduction of tongue mobility due to bulky denture*
   Any thick areas should be thinned by checking the old denture.

- If there is thickness in the postdam area, the related area is reduced. But the patient should be informed about the reduction in the retention of the dentures.

If the patient reports that the gag reflex occurs after a couple of hours:

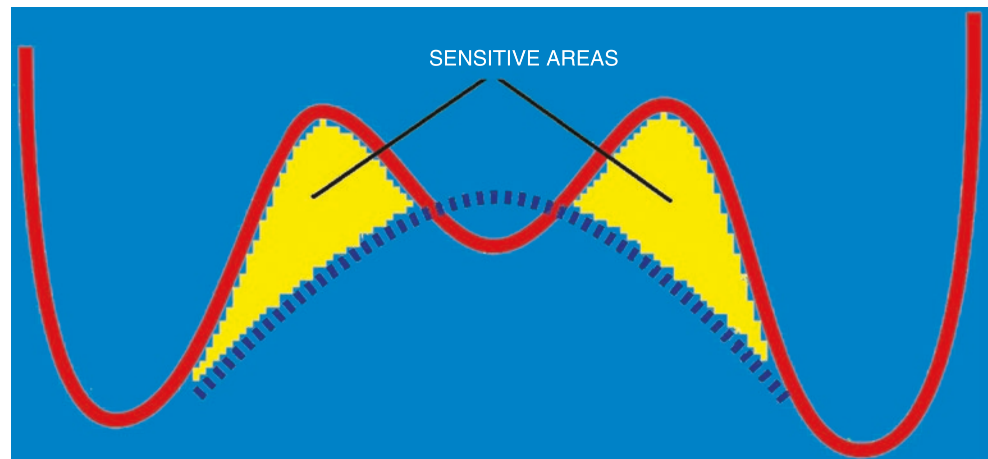
1. Reaction of the tissues to the volume of the denture

The patient is requested to adapt to this situation. If this situation continues, the polished surfaces of the dentures should be thinned. In some cases, the denture thickness is reduced with the use of a metal baseplate.

If the patient indicates that he/she has the same problem with the old dentures:

Treatment protocols will not be so successful for such patients. The treatment will be difficult if these problems are observed while making the impression and other procedures. Relaxing the patient and the use of controlled breathing exercise are recommended. Hypnosis and psychotherapy can also be recommended.

Fig. 5.67 Hypersensitive postdam region



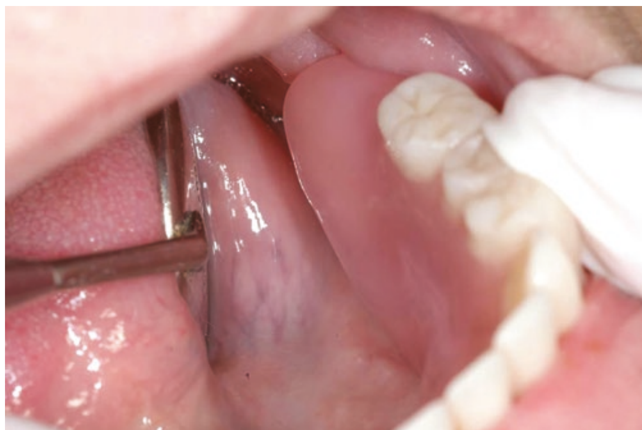


Fig. 5.68 Overextension of distolingual area

If the patient says no to the question, "Did you have a similar problem while the impression was being made?" This means that he/she needs time to get used to the dentures. In such a situation, the dentist should not be in a hurry to reduce the palatal seal, it will be better to wait a little longer.

If the patient's answer is yes but is still using the previous denture, he/she will need time to get used to the new dentures.

If the patient says the gag reflex started recently, gastrointestinal problems should be considered, and they should visit their medical health provider.

5.5 Noise on Eating and Speaking

Noise can occur as a result of the premature contacts of the teeth. There are four main reasons for the noising of dentures.

1. The lack of retention of the denture for any reason
2. The high occlusal vertical dimension
3. Tubercle interferences
4. The use of porcelain teeth

In fact, the use of porcelain teeth can be a separate reason, and it causes an increase of the sound produced by the other three situations. To solve the problem, the reason should first be determined. Then the vertical dimension is decreased, sufficient retention is provided, and acrylic teeth are used.

5.6 Esthetic Problems

Esthetic problems are generally a result of not taking sufficient care at the try-in stage and by not asking the patient's opinion. Besides, the close environment of the patient has a great effect on the esthetic complaints. Generally, the esthetic complaints of patients can be related to the following points:

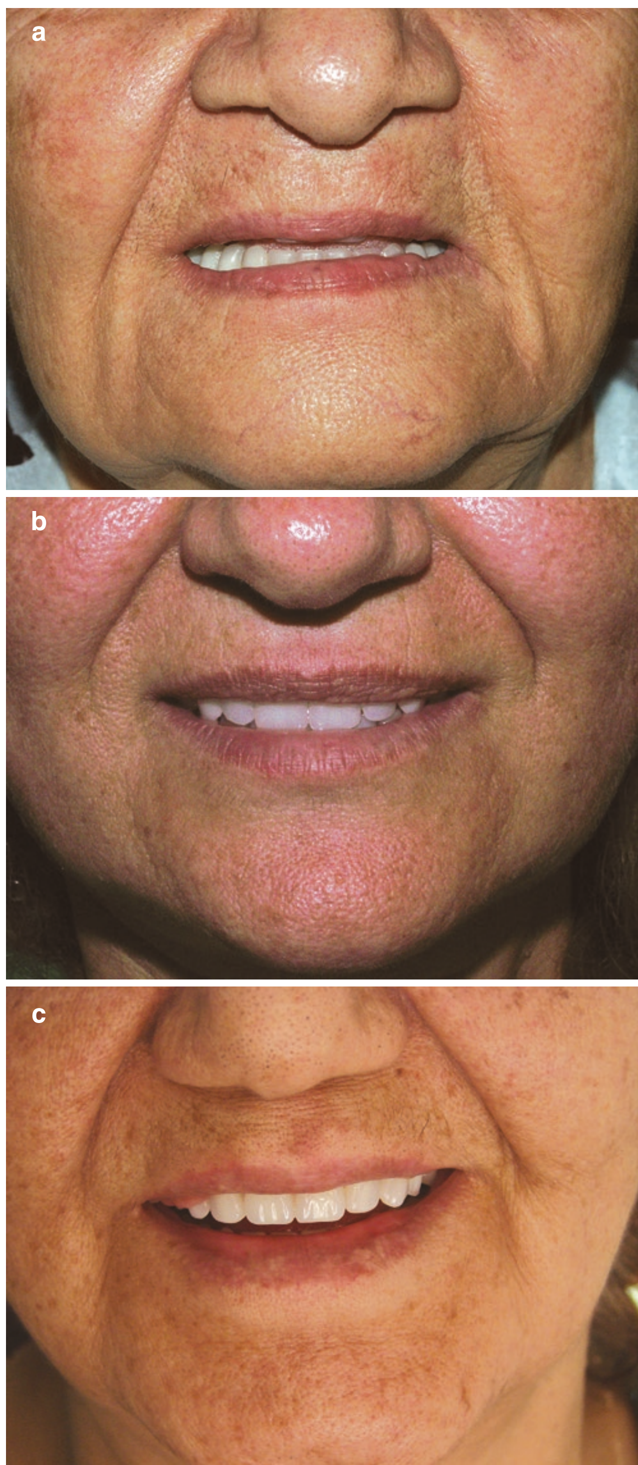


Fig. 5.69 (**a**) Denture with insufficient esthetics, high occlusal plane. (**b**, **c**) Reconstruction of denture according to patient's expectations

1. Insufficient lip and face support

   For middle-aged women in particular, expectations toward their dentures are very high (Fig. 5.69a–c). They think that by wearing the new dentures, all their wrinkles will disappear. This misunderstanding should be explained

to patients. In some cases, the inaccurate arrangement of anterior teeth or thin flanges can cause inadequate lip support (Fig. 5.70a, b). The dentist should take this point into consideration at the try-in stage. The artificial teeth should be rearranged, and the thickness of the flanges should be increased to provide lip support.

2. Inadequate vertical dimension

   Vertical dimension is the combination of relaxed muscles, the lips in rest, changed freeway space, the harmony of lower and middle 1/3 of the face, speech without contacting wax rims, the existence of the tongue chamber for the "the" sound, and a consistent rest position.

Two kinds of patient need more freeway space than suggested (2–3 mm):

- Patients who become used to a deep bite occlusion over a long period
- Patients with mouth breathing

In these cases, it is not appropriate to determine the vertical dimension by subtracting 3 mm from the rest position. A useful method for controlling the occlusal vertical dimension is provided when the maxillary incisors are arranged in the normal position

When the TMJ is in centric occlusion, the lower lip is pushed with the index finger. If lower lip is sliding under the central incisors instead of contacting them, this means that vertical dimension is high.

Making the "the" sound is a useful clue for correcting the vertical dimension. The tongue of the patient moves toward the wax rims when pronouncing the "th" sound. If the occlusal vertical dimension is high, the forward movement of the tongue will be prevented by the height of the wax rims (Fig. 5.71a, b).

3. The closed distance between chin tip to the nose tip

   In order to reduce the amount of load on the supporting tissues, the vertical dimension is decreased for elderly patients; therefore the chin seems more prominent and closer to the nose (Fig. 5.72a, b). An explanation should be given to patients with this condition at the try-in session. If the vertical dimension is too low, then a new denture should be made that has a normal vertical dimension (Fig. 5.72c, d).

4. Color, shape, size, and positions of the anterior teeth

   Mostly, complaints of this nature are about the extreme labial or lingual positioning of the front teeth (Figs. 5.73a, b, 5.74a–d). If the patient is already using an inaccurate denture, before deciding about the final positions of the teeth, it is advisable to wait for a while for the adaptation of the tissues.

5. The visibility of the teeth

   When the vertical dimension and the position of occlusal plane are determined incorrectly, the upper and lower teeth will either be more visible or no teeth will be visible. In all three cases, the renewal of the dentures is necessary to solve the problem. Making a denture with an inaccurate vertical dimension and occlusal plane will also cause insufficient mastication force (Fig. 5.75).

   For patients with a short upper lip, the maxillary teeth can be completely observed or, together with the teeth baseplate, can be observed while laughing (Fig. 5.76). The quantity of teeth visible under the upper lip changes with increasing age. The incisal edges of the anterior teeth are usually 3 mm visible below the upper lip for a young woman and 2 mm for a young man. The teeth are on the same level as the upper lip for middle-aged patients and

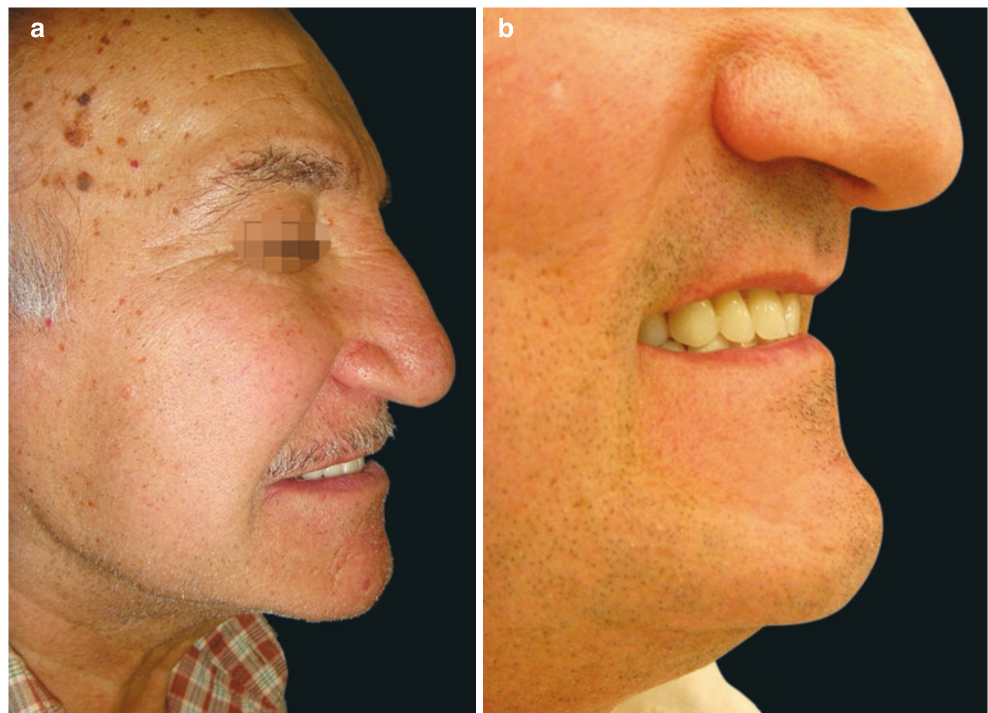


Fig. 5.70 (**a**, **b**) Insufficient lip support

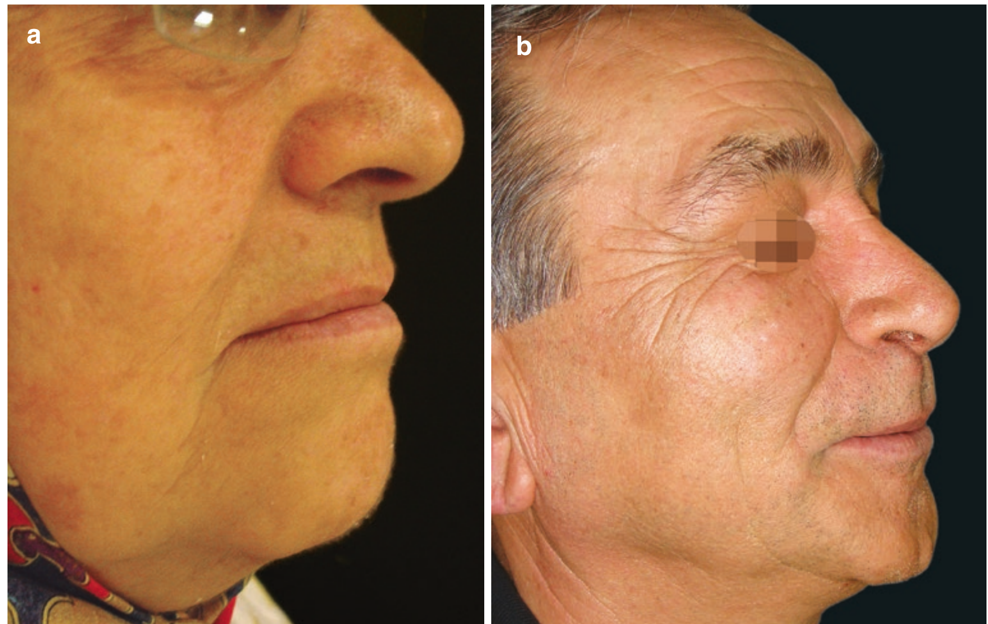


Fig. 5.71 (**a**, **b**) Determining high vertical dimension

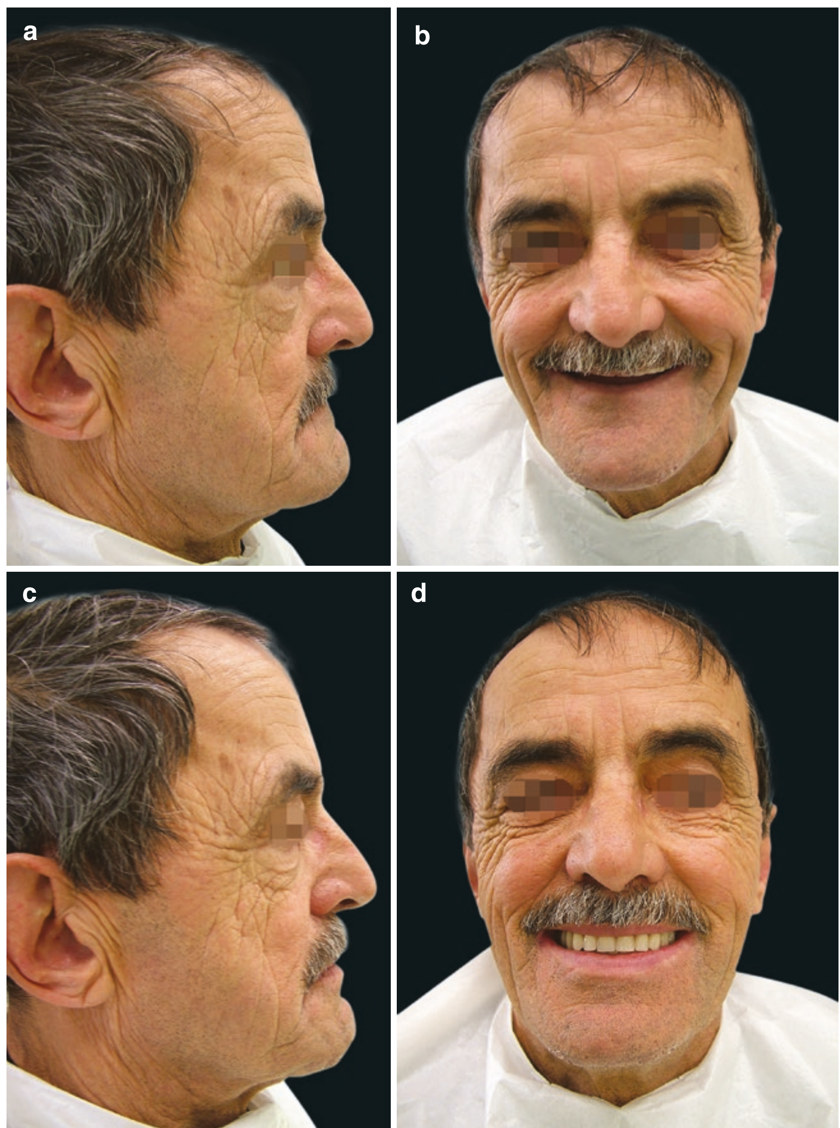


Fig. 5.72 (**a**, **b**) View of a patient with low vertical dimension. (**c**, **d**) Retreatment of the patient with a more esthetic denture with adequate vertical dimension

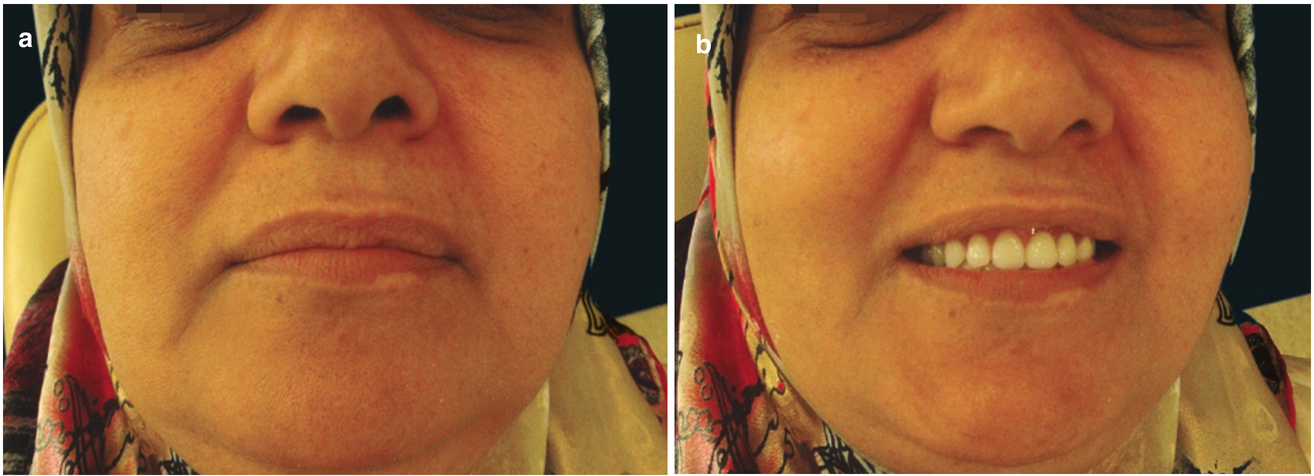


Fig. 5.73 (**a**, **b**) Upper anterior teeth are placed too labially and the flange is too thick

Fig. 5.74 (**a**) Upper anterior teeth are placed too lingually. (**b**–**d**) View of finished dentures with proper positions of the teeth

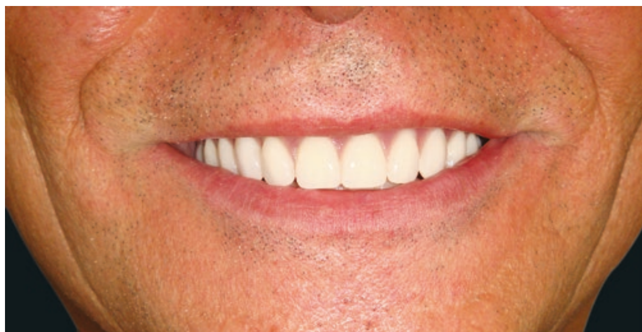


Fig. 5.75 Unesthetic view caused by high vertical dimension

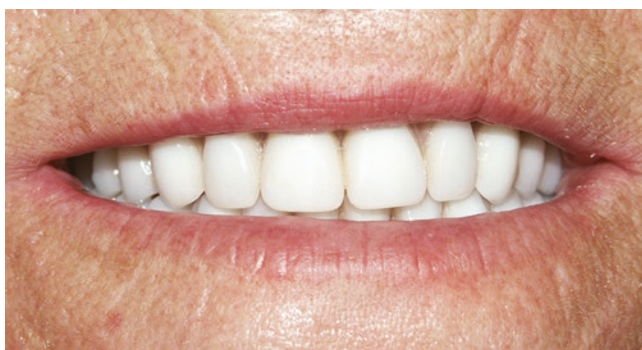


Fig. 5.76 Unesthetic view caused by short lip

above this level in elderly patients. However, modifications can be made, according to the demands of the patient, since the patients, especially women of advanced years, want their teeth to be more visible.

5.7 Problems Relating to Speech

For patients using a denture for the first time or using a new one, a certain period of time is required for the tissues to become adapted. During the adaptation period, the patient may pronounce some words incorrectly, or their speech is disrupted. Patients should be told that this situation is temporary and after a while they will recover. As the adaptation time can vary from 2 to 3 weeks, it is difficult for patients to accept these problems.

These issues can be examined under four headings:

1. Mispronunciation of the "S" Sound

   The "s" sound is pronounced by the passage of air from the small space between tongue and the palatinal part of the denture (Fig. 5.77). A whistling noise may occur while making the "s" sound. This is because the upper premolars obstruct the anterior part of the tongue, making a groove that is too large for the air to escape. Lisping when an "s" sound is made means that the air space is too small; thus, the palatal part of the denture must be thinner. When the word "Mississippi" is pronounced at the try-in stage, there should be no contact between the teeth.

   The occlusal rims are located in the mouth, and the vertical height is adjusted until the minimum space exists between the maxillary and mandibular occlusal rims when the patient pronounces the letter "s."

   Determining the vertical dimension and centric relation are crucial steps in denture construction. First, allow the patient to relax in the hinge position and note the amount of retrusion. The sum of movements will indicate the patient's occlusion. If there is distal movement of the anterior teeth of more than 3 mm for the "s" position, the incisal edges of the lower anteriors will be distal to the cingulum of the upper anteriors.

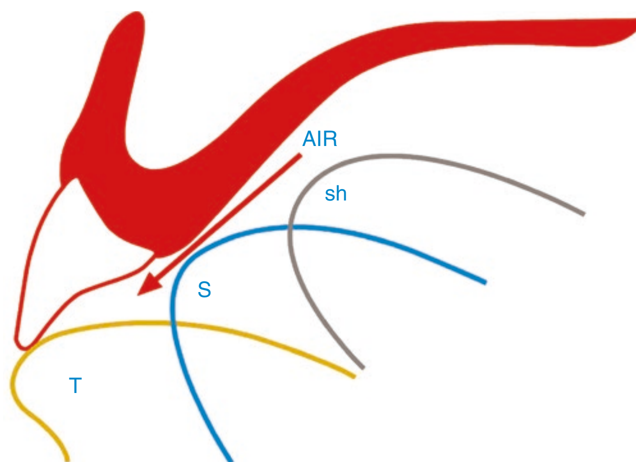


Fig. 5.77 Relationship of tongue and teeth during pronunciation of "s, sh, and t" sounds

2. Mispronunciation of the "t," "d," "l," and "r" Sounds

   The sounds "th" and "t" are distinctive from each other. There is inadequate interocclusal space or the anterior teeth are too extreme. While articulating the sounds "t" and "d," the tongue makes firm contact with the anterior part of the hard palate and suddenly drawn downward to produce a plosive sound. Every effort should be made to ensure that there is sufficient space for the dorsum of the tongue to make contact with palatal surfaces of the upper posterior teeth while articulating the sounds "t" and "d" (Fig. 5.78).

Fig. 5.78 Position of tongue during pronunciation of the "t" and "d" sounds

A lack of speech ability can sometimes occur because of the narrowing of the posterior area of the tongue, due to the lower denture. If the arch is narrow, which will crumple the tongue which affects the size and shape of the air channel, it results in faulty articulation of the consonants like t, d, l, n, s, t where lateral margins of the tongue make contact with palatal surfaces of the upper posterior teeth. Also, the overextension of the upper denture through the soft palate may cause pronunciation problems, as the patient tries to keep the denture in their mouth while speaking (Fig. 5.78).

3. Mispronunciation of "p," "b," "m," and "n" Sounds

These sounds are verbalized while the upper and lower lips are touching each other. Due to the high vertical dimension or the labial placement of the anterior teeth, the patient has difficulty in contacting the upper and lower lips. For the correct articulation of these sounds, the vertical dimension should be adjusted, and the teeth should be aligned in the correct position.

4. Mispronunciation of "f" and "v" sounds

The reason for this is the incorrect anteroposterior or vertical positions of the upper incisor teeth with respect to the lower lip. In such a situation, the upper incisors contact the lower lip earlier than normal, or contact a different point on the lip; thus, "f" is verbalized as "v," and "v" is enunciated as "f." For the solution of this problem, the position of the incisors is altered, or a new denture is fabricated. Usually, when the "f" sound is verbalized, the upper incisors contact the dry part of the lower lip, and when the "v" letter is verbalized, the upper incisors contact the wet part of the lower lip. If there is no lip contact, then the incisal edges are slightly raised. In cases of noisy articulation, the incisors are placed downward (Fig. 5.79a, b).

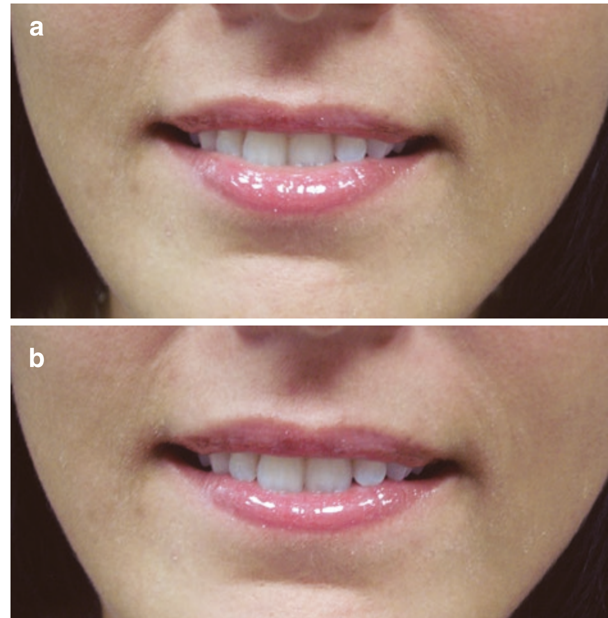


Fig. 5.79 (**a**, **b**) Relationship of upper incisors and lower lip during pronunciation of "f" and "v" sounds

5. Mispronunciation of 'g' and 'k' Sounds

This letter is articulated when the dorsum of the tongue is in contact with the posterior portion of the upper denture. A thick denture in this region causes difficulties in the verbalization of these sounds. These problems can be resolved by thinning the region. In order to determine the fonation correctly, some modifications can be done on the denture by using tissue conditioner materials or powder. Increased thickness in the postdam area results in irritation of the dorsum of the tongue, impeding speech and possibly producing a feeling of nausea.

The denture should be such that the patient gets along with it very comfortably, and the most essential facet of this is speech. For the correct determination of phonation, some modifications can be made by using tissue conditioner materials or powder on the finished dentures.

5.7.1 Providing Phonation by Changing Palatal Contours of Complete Dentures

Disorders in speaking are classified according to three categories. These are language, expression, and articulation. Articulation disorders are those related to dentistry.

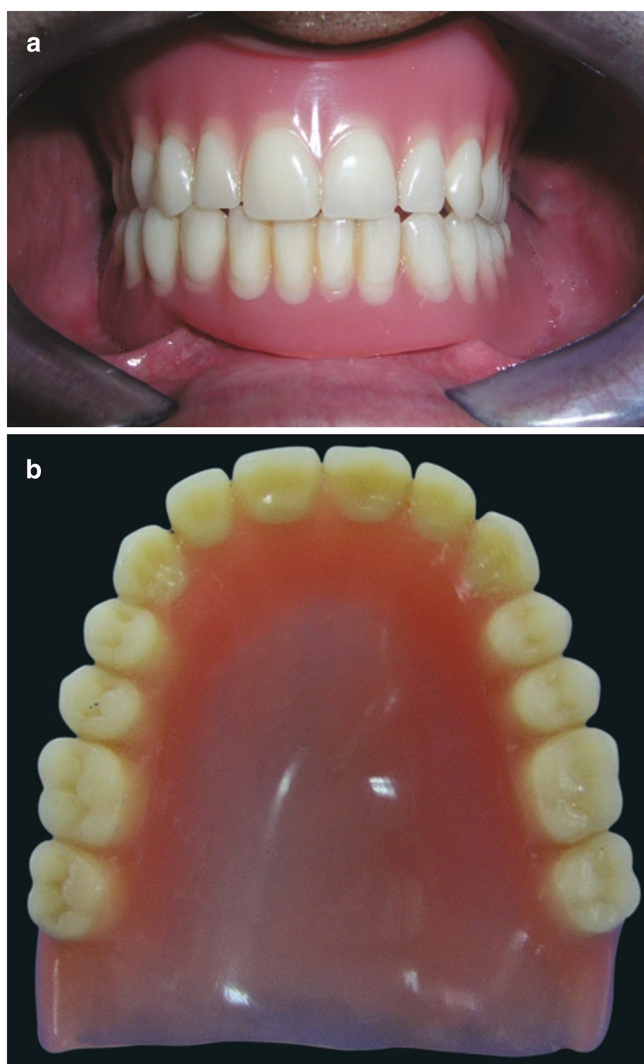


Fig. 5.80 (**a**, **b**) View of the dentures inside and outside the mouth

Enabling phonation is one of the most important factors in correcting articulation disorders. To provide accurate phonation in complete dentures, it is very important to pay attention to the vertical dimension, the placement of the artificial teeth, the tongue area, and the occlusal plane. Similarly, the contour of the palatal surface of the denture effects phonation. In previous studies, it has been observed that complaints regarding phonation are continuing, even if all the rules are implemented. For this reason, an attempt was made to shape the rugae area with wax or tissue conditioner during the try-in stage to prevent this problem, and the outcome was successful. There are studies in which the palatal surface is shaped, using tissue conditioners or powder, after the dentures have been finished.

The dentures are completed and delivered to the patients using the conventional methods. After 3 days, any complaints about enunciation should be evaluated (Fig. 5.80a, b). The process can be accomplished in two ways:

1. *The application of tissue conditioner*
2. *The application of powder*

5.7.1.1 Application of Tissue Conditioner

1. The space for tissue conditioner is provided by grinding the palatal polished surface of the denture by about 2 mm (Visco-gel, DENTSPLY) (Fig. 5.81a, b).
2. After the grinding process, the tissue conditioner, prepared in accordance with the instructions of the company, is applied to the palatal parts of the denture (Fig. 5.82a, b). These surfaces have to be isolated, through the isolation solution of the tissue conditioner material, in order to prevent adhesion to the teeth and the buccal polished surface. The tissue conditioner is applied to the rugae, and the patient is asked to enunciate linguopalatal sounds (c, d, k, l, n, r, s, t) for 2 min. When the patient pronounced all the sounds clearly, conventional flasking procedures are applied (Figs. 5.83, 5.84, 5.85, 5.86).

5.7.1.2 Application of Powder

This method is carried out using powder rather than tissue conditioner. Before grinding the polished surface of the palatal denture, Vaseline is used for the adhesion of the powder (Fig. 5.87a, b). Then, the powder is sprinkled on the Vaseline-coated surface. As with the first method, same words are verbalized for 2 min, and with this process, arrangements are made on the parts where the powder has been removed (Fig. 5.88a, b, 5.89a, b). The same process is carried out on the posterior side (Fig. 5.90a–d). When the patient articulates all the words easily, the denture is delivered to the patient after the palatal side has been polished. The powder method is considered to be more practical, as there is no need for an additional polymerization process (Fig. 5.91).

Denture Fractures

Despite all the developments in prosthetic denture materials, they still emerge as a problem to be solved. Although it is generally believed that fractures occur due to the lack of patient care, clinician- and technician-related faults are far more common.

Denture fractures arise for two different reasons: flexural fatigue and impact. Flexural fatigue occurs as a result of the repeated flexing of the polymer and metal structures. Although there is no harm to the structure when the forces are applied only once, fractures can result if the forces are constantly repeated. This kind of failure can be explained by the development of microscopic cracks. With repeated chewing forces, all these microscopic cracks make the material weaker. The median palatal line fractures seen on the dentures develop due to flexural fatigue, after three years of use.

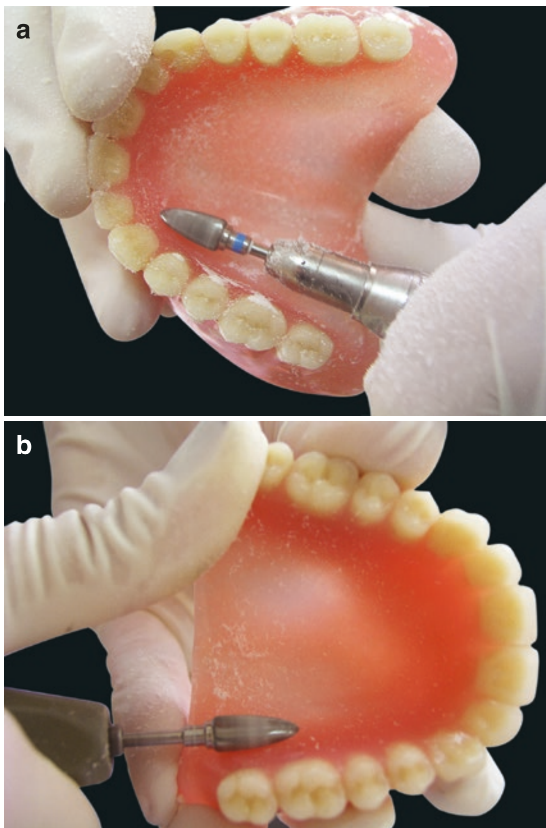


Fig. 5.81 (**a**, **b**) Grinding on the palatal region of the denture to obtain space for the tissue conditioner

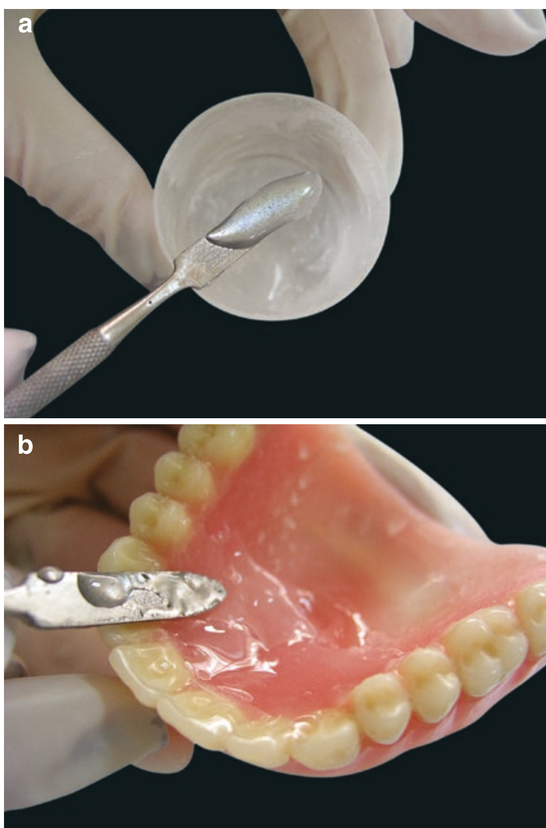


Fig. 5.82 (**a**, **b**) Mixing the tissue conditioner and applying it to rugae region

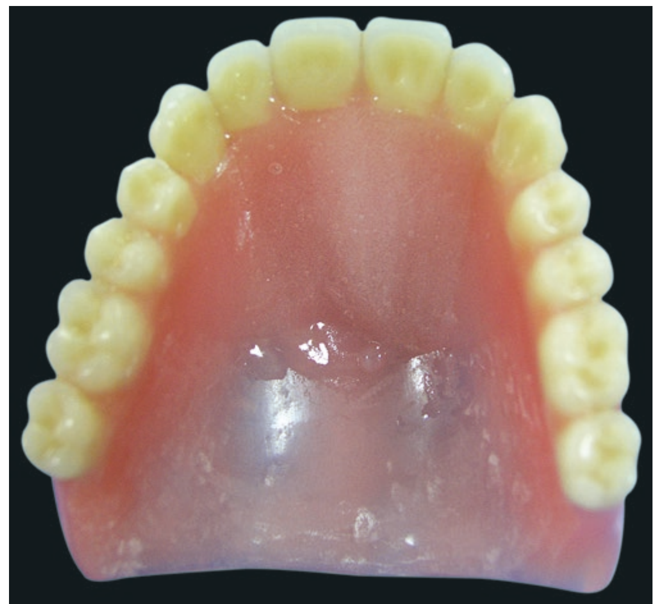


Fig. 5.83 Arrangement of rugae region

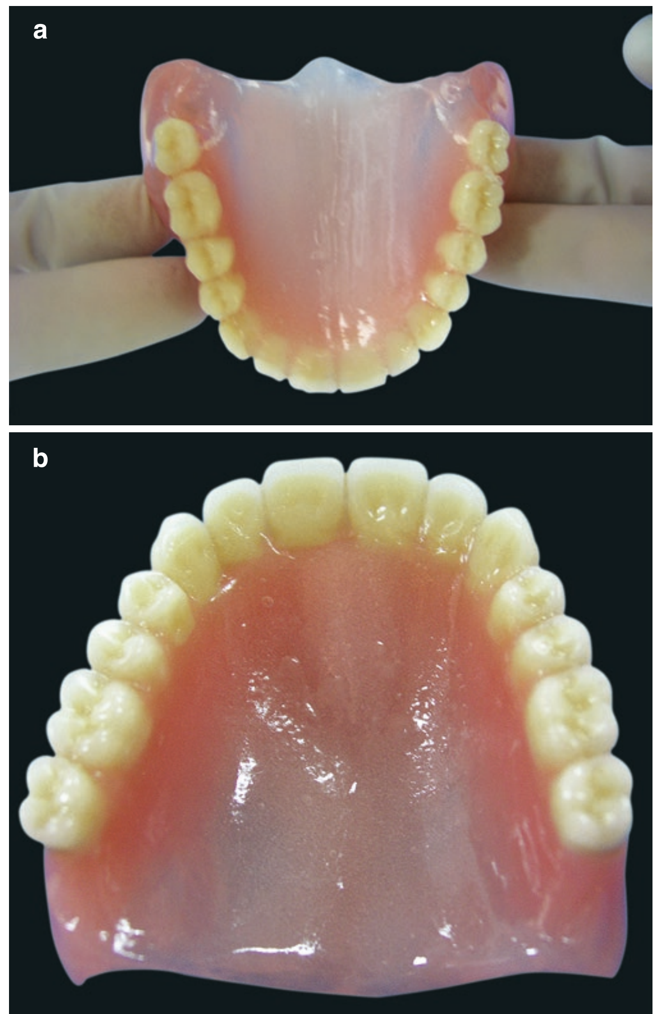


Fig. 5.84 (**a**) Application of tissue conditioner on the palatal region. (**b**) Arrangement of the palatal surface

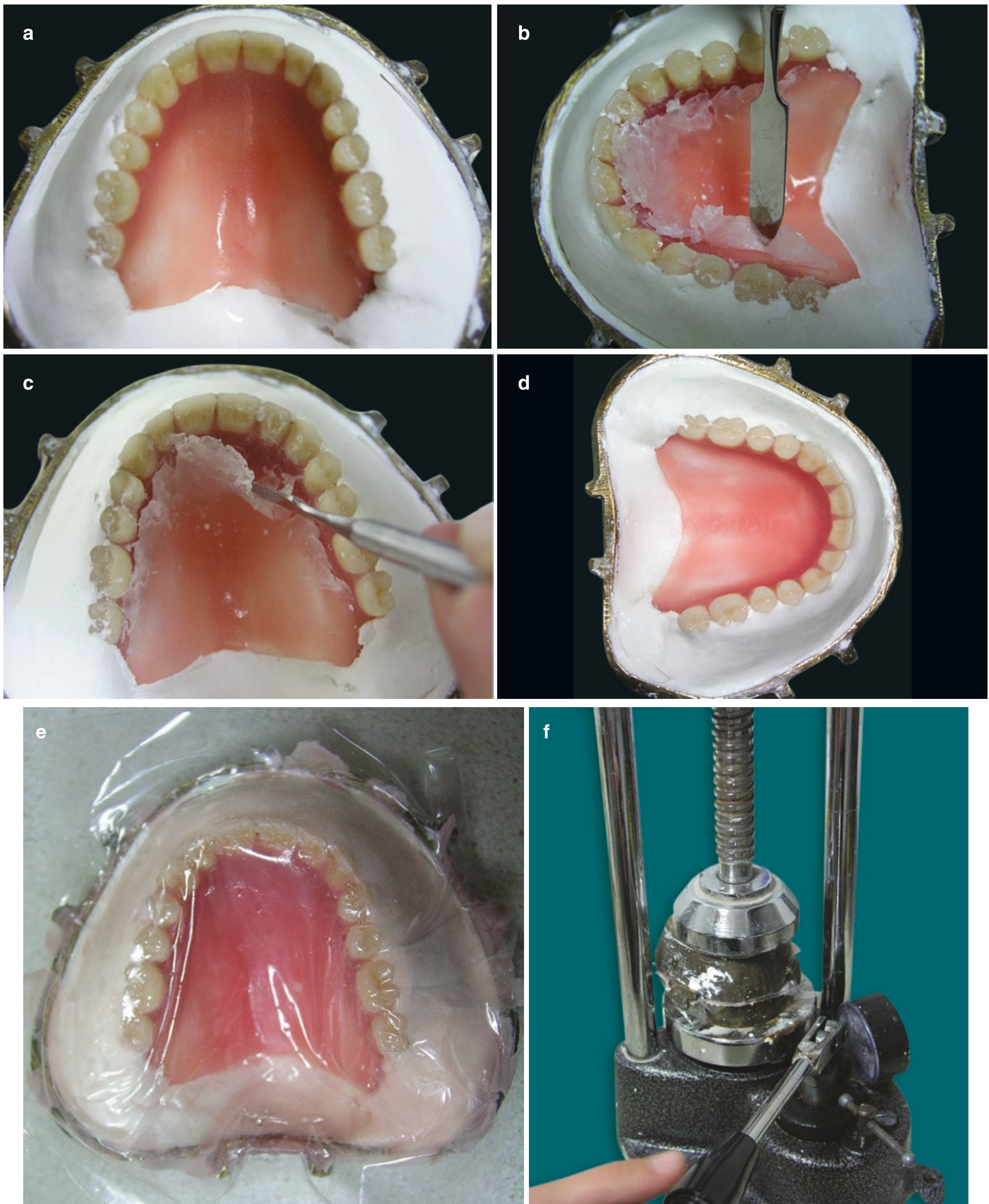


Fig. 5.85 (**a**) Flasking the denture. (**b**, **c**) Removing the tissue conditioner from the surface of the denture. (**d**) Cleaning the denture. (**e**) Placement of acrylic resin over the denture. (**f**) Keeping the flask under pressure

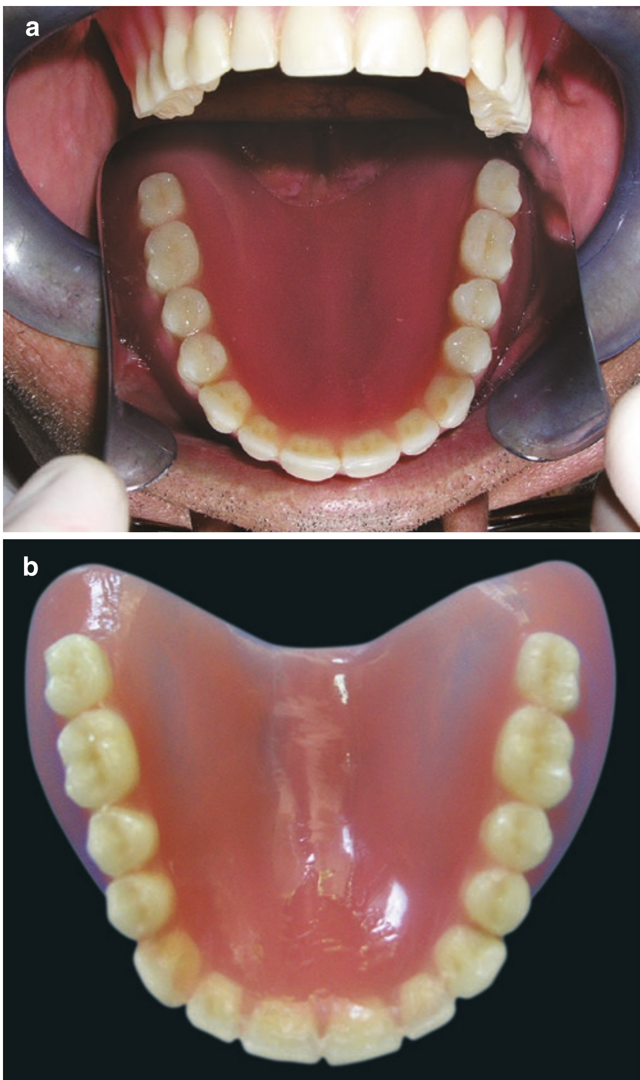


Fig. 5.86 View of denture. (**a**) Inside the mouth. (**b**) Outside the mouth

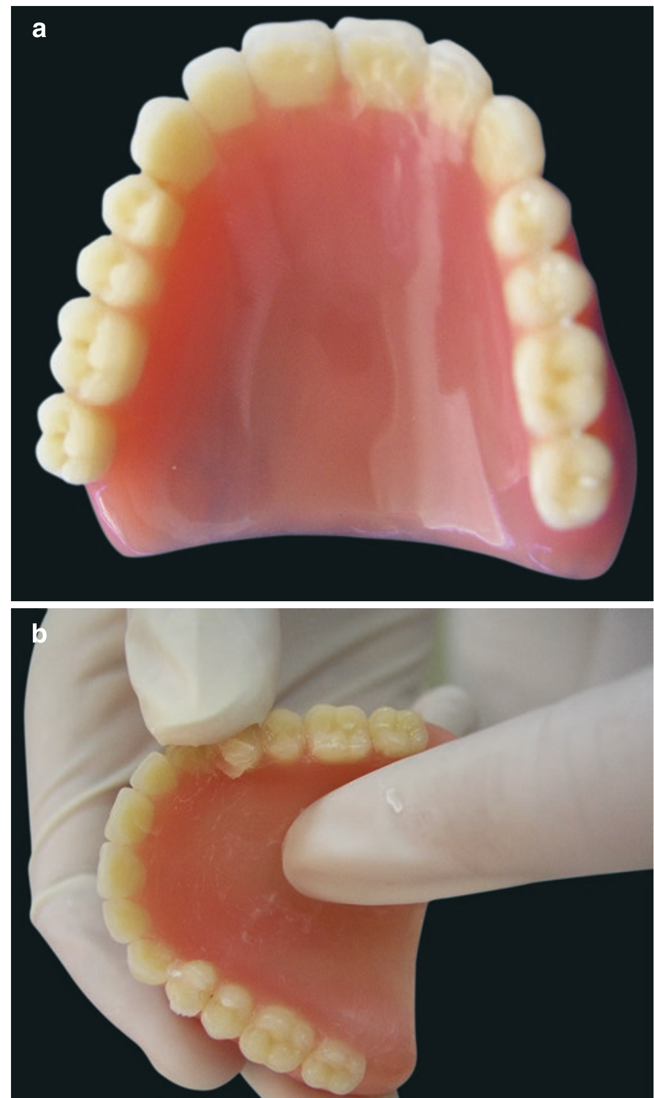


Fig. 5.87 (**a**) Palatal view of the denture. (**b**) Applying Vaseline to the palatal surface of the denture

These prosthetic fractures, which are usually based on two reasons, usually occur in the early stages.

1. *Accidental fractures*

   Accidentally dropping the denture, during cleaning or for some other reason, is mainly seen in the elderly and in patients with insufficient dexterity. The dentures can be repaired but in such cases the best solution is to remake the dentures with impact-resistant resins.

2. *The presence of factors that lead to the formation of stress on the denture bases*

   These are fractures that emerge due to the weak adhesion of the artificial teeth to the denture base and the existence of porosity inside the base (Figs. 5.92, 5.93a, b).

If porosity and cracks are observed, the repair procedures will again cause problems. It will therefore be more beneficial to change the denture base for such patients. If the

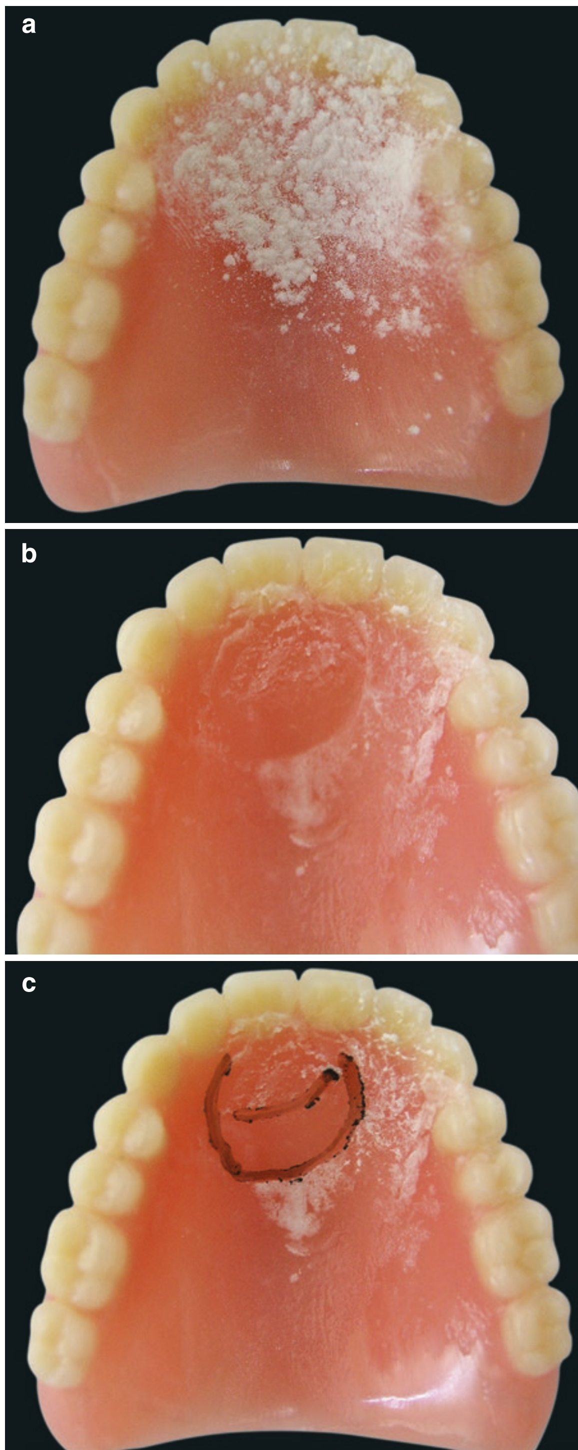


Fig. 5.88 (**a**) Applying powder to the palatal surface of denture. (**b**) Removing powder from palatal surface by contact with the tongue during pronunciation. (**c**) Grinding the powder-free areas on the denture

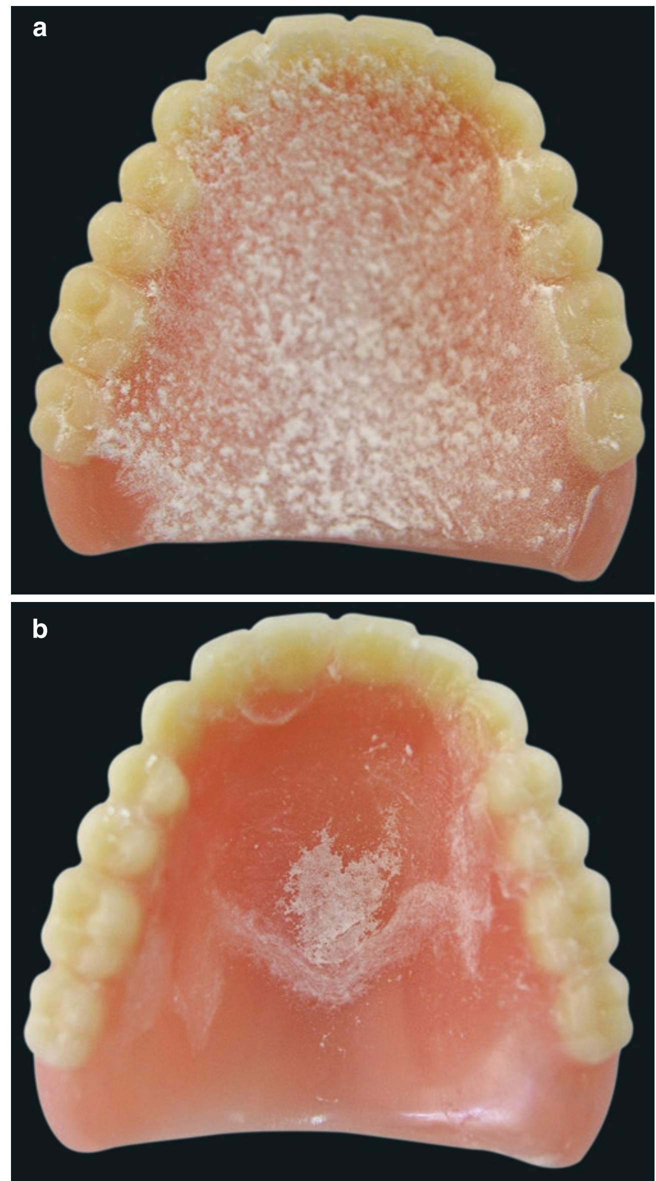


Fig. 5.89 (**a**, **b**) Repetition of application of powder and grinding

Fig. 5.90 (**a**, **b**) Repeating the application of powder and grinding on the palatal regions. (**c**, **d**) Grinding on the palatal region and checking the powder

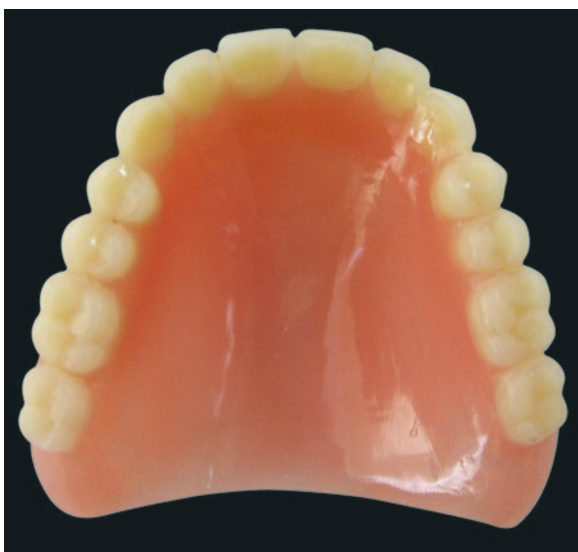


Fig. 5.91 View of the denture following completion of phonation test

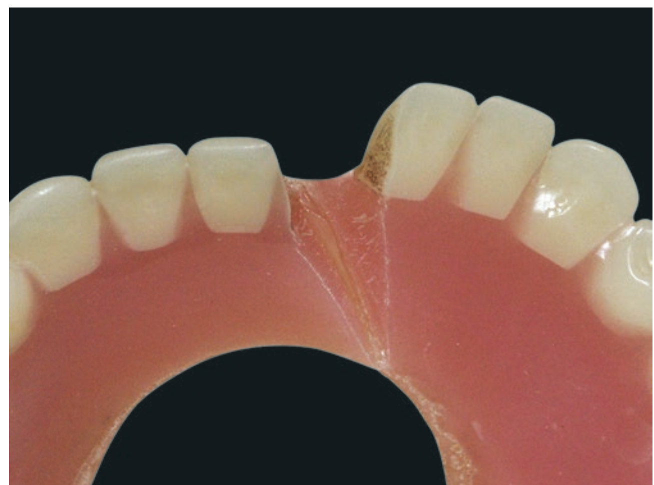


Fig. 5.92 Unattached artificial teeth

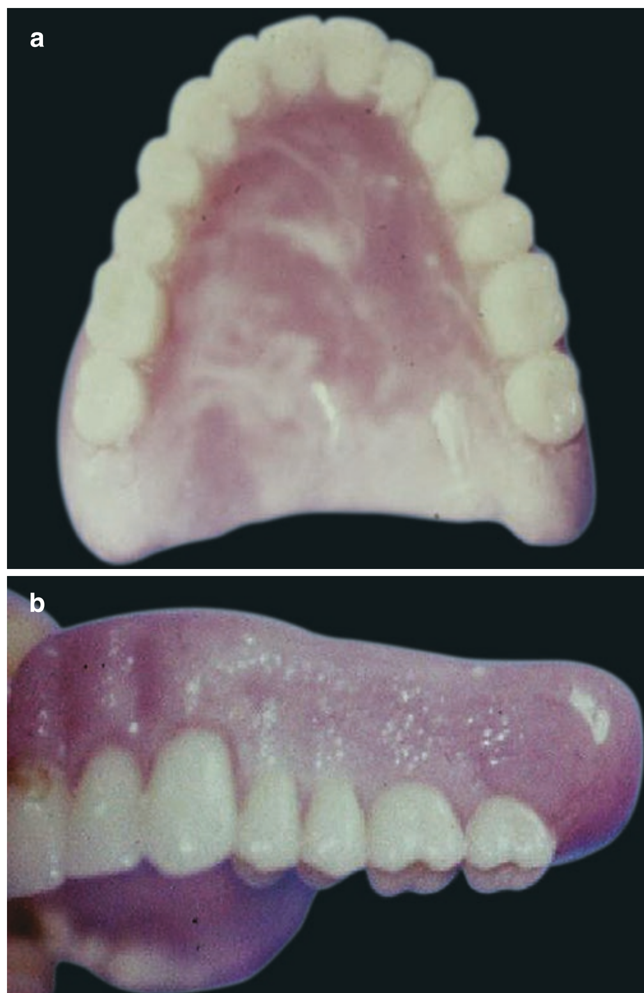


Fig. 5.93 (**a**, **b**) Contraction and granular porosity observed in the upper denture

defects on the baseplate are more visible, the repair surface should be expanded to provide stronger adhesion.

For some patients, denture fracture is unavoidable due to the strong masseter muscle, decreased interalveolar distance and the existence of palatal torus. Metal baseplates may be preferred for such patients. The problems and solutions occurring immediately after the use of the denture are shown in Tables 5.1, 5.2, 5.3, and 5.4.

Table 5.1 Esthetic problems in dentures

Esthetic problems in dentures		
Sign/symptom	Reason	Solution
Swelling under the nose	Labial flange of the upper denture is very thick or overextended	Reducing the thick and overextended flanges
Depressed philtrum or nasolabial sulcus	Labial flange of the upper denture is very thin or underextended	Impression compound is added and flanges are extended
Depressed upper lip	Upper anterior teeth are positioned lingually	Placement of the artificial teeth more labially
Excessive appearance of the artificial teeth	Increased vertical dimension Inferior location of occlusal plane. Lateral incisors and canines are too prominent	Replacement of the artificial teeth
Unnatural appearance	Inaccurate teeth arrangement. Unnatural appearance of gingival contours and color of acrylic base	Patient, dentist, and technician should choose the properties of artificial teeth together

Table 5.2 Phonetic problems in dentures

Phonetic problems in dentures		
Sign/symptom	Reason	Solution
Lisping during the pronunciation of “S” letter. *Whistling during the pronunciation of “S” letter	Insufficient air space on the anterior palatal area of the denture	Rearrangement of the related artificial teeth
Unclear pronunciation of “Th” and “T” sounds	Excessive air space on the anterior palatal area of the denture	
“T” letter sounds like “Th”	Inappropriate interocclusal distance. *Lingual position of the upper anterior artificial teeth	
Unclear pronunciation of “F” and “V” letters	Positions of upper anterior teeth are inappropriate both on vertical and horizontal planes	

Table 5.3 Irritation areas of denture

Irritation areas of the denture		
Sign/symptom	Reason	Solution
Irritation on the vestibular area of the denture	Overextended flanges	Problem should be determined if it is caused by overextended flange or excessive pressure point Determined areas are adjusted
Irritation on the posterior border of the upper denture	Deep posterior palatal seal Sharp posterior palatal seal Overextended flanges	Sharp and overextended areas are determined, adjusted, and polished
Single irritation point on the alveolar crest	Malocclusion on the related area Ill-fitting denture base Acrylic pearls inside the denture base	Selective grinding is performed to adjust occlusal disharmony Flanges and the inner surface of the denture are controlled
Generalized irritation on the alveolar crest	Increased vertical dimension Ill-fitting denture base Incompatible centric occlusion and centric relation, lower denture moves forward	Decreasing vertical dimension on the articulator Refabrication of the denture
Irritation under the labial border of the lower denture	Excessive overbite Overextended labial flange	Replacement of the artificial teeth Overextended flanges are reduced
Burning sensation in the hard palate or anterior crestal region From premolar region to molar tuberosity Lower anterior crest	Pressure on the anterior palatine foramina Pressure on the posterior palatine foramina Pressure on the mental foramina	Pressure indicator paste and bite registration wax should be used to determine the pressure points, and adjustment is performed
Biting cheek and tongue	Edge-to-edge position of the posterior teeth (minimum reduction from the buccal side of the teeth) Deep bite Posterior teeth are placed too much lingually or buccally	Rearrangement of the teeth
Erythema of all the tissue-bearing areas including tongue and cheeks Erythema of the denture-bearing areas	Allergic reaction to denture base material	Allergy is determined definitely Fabrication of the denture with alternative materials that does not contain PMMA
Pain in TMJ	Unhealthy tissue under the denture Deficiency of vitamin A Decreased vertical dimension Incompatibility of centric occlusion and centric relation Arthritis	The denture can be relined Nutrition analysis can be performed Vertical dimension can be increased by adding acrylic resin on the occlusal surfaces of teeth. Selective grinding can be performed to adjust occlusal disharmony A rheumatologist can be consulted for the arthritis

Table 5.4 Functional problems of dentures

Function of the denture		
Sign/symptom	Reason	Solution
Loss of retention		
When the dentures are out of occlusion	Overextension of flanges Underextension of flanges Loss of posterior palatal seal	Pressure indicating paste is used to determine the overextension areas and pressure points Flanges are adjusted by grinding
During chewing	Loss of posterior palatal seal Placement of anterior teeth too labially Mobile anterior tissues Inaccurate biting habits	Border seal is provided by adding wax The positions of anterior teeth are changed. Adequate impression should be made Patient habits are changed
When the dentures are in centric occlusion	Premature individual contacts Higher occlusion in one of the arches High occlusion in the canine area Denture moving over the median suture Fibrous tissues over the crest. Labially placed anterior teeth Incompatible centric relation and centric occlusion	Necessary arrangements should be performed

Table 5.4 (continued)

Function of the denture		
Sign/symptom	Reason	Solution
Limitations		
Swallowing problems	**Upper jaw** Overextension of posterior flange Thickness of posterior flange **Lower jaw** Overextension of lingual flange. Thickness of lingual flange Deep bite in occlusal vertical dimension Posterior artificial teeth are placed too lingually Increased vertical dimension	Reducing the overextended flange Reducing the thickness of the flange Reducing the thickness and the overextension of the lingual flanges Artificial teeth are rearranged The location of posterior teeth is changed Vertical dimension is reduced
Gagging	Immediately after the denture is placed	
	Upper jaw Overextension of the flanges Thickness of posterior border seal	Reducing the overextended flange Reducing the thickness of the posterior border
	Lower jaw Overextension of distolingual flange	Distolingual flange is reduced
Swallowing problems	Gagging after a time (2 weeks–2 months later) Inadequate border seal causes saliva accumulation under the denture. Loss of denture stability Malocclusion causes the movement of the denture and saliva accumulation under the denture. Increased vertical dimension. Instability of lower denture	Complete adaptation of denture borders is provided Stability is regulated Malocclusion is eliminated Vertical dimension is arranged Lower denture borders are reduced
Clicking sound	Decreased vertical dimension. Increased vertical dimension	Arrangement of occlusal vertical dimension
Deafness	Increased vertical dimension	Arrangement of occlusal vertical dimension
Fatigue of mastication muscles	Malocclusion Incompatibility of centric occlusion and centric relation Inaccurate vertical dimension	Occlusion is controlled and necessary grindings are performed

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6 Long-Term Problems with Complete Dentures

Yasemin K. Özkan

6.1 Long-Term Problems with Complete Dentures

Long-term problems with complete dentures are as follows:

1. *Fracture of complete dentures*
2. *Burning mouth syndrome*
3. *Alveolar bone loss*
4. *TMJ disorders*
5. *Fibrous crest*
6. *Epulis fissuratum*
7. *Papillary hyperplasia*
8. *Denture stomatitis*
9. *Angular cheilitis*

6.1.1 Fracture of Complete Dentures

Fracture in dentures results from two different types of forces: flexural fatigue and impact. Flexural fatigue occurs after repeated flexing of a material and is a mode of fracture, whereby a structure eventually fails after being repeatedly subjected to loads that are so small that one application appears to have no detrimental effect on the component. This type of failure can be explained by the development of microscopic cracks in areas of stress concentration. With continued loading, these cracks fuse to an ever-growing fissure that insidiously weakens the material. Catastrophic failure results from a final loading cycle that exceeds the mechanical capacity of the remaining sound portion of the material. The midline fracture in a denture is often a result of flexural fatigue and occurs after approximately 3 years of usage (Fig. 6.1).

The causative factors of midline fractures are as follows:

6.1.1.1 Factors Related to Denture

Stress intensification factors predispose the denture to fracture:

- Cracks in the acrylic base, voids in the material, porosity, inclusions, deep scratches, existence of diastema in the midline, fibers, and metal reinforcements (Figs. 6.2 and 6.3).
- Thin or underextended flanges (Fig. 6.4).
- Poorly fitting dentures (Fig. 6.5).
- Overgrinding of denture base for the application of soft lining material (Fig. 6.6).
- Lack of adequate relief.
- Poor occlusion (Fig. 6.7).
- Lack of sufficient retention due to poor clinical design.
- Previously repaired dentures (Fig. 6.8).
- Inadequate polymerization of acrylic resin.
- The shape of the teeth on the denture. Grinding the functional tubercles and wearing in time can cause wedge effect in the maxillary denture (Fig. 6.9).

6.1.1.2 Factors Related to Patient

- Large frenal notch (Fig. 6.10).

The existence of a large frenal notch brings out a thin and short acrylic resin flange at that area, weakens the denture base, and causes a denture fracture:

- Strong masticatory muscles and bruxism
- The presence of natural teeth against the denture (Fig. 6.11)
- Tori and prominent midline suture (Fig. 6.12)
- Tissue undercuts (Fig. 6.13)

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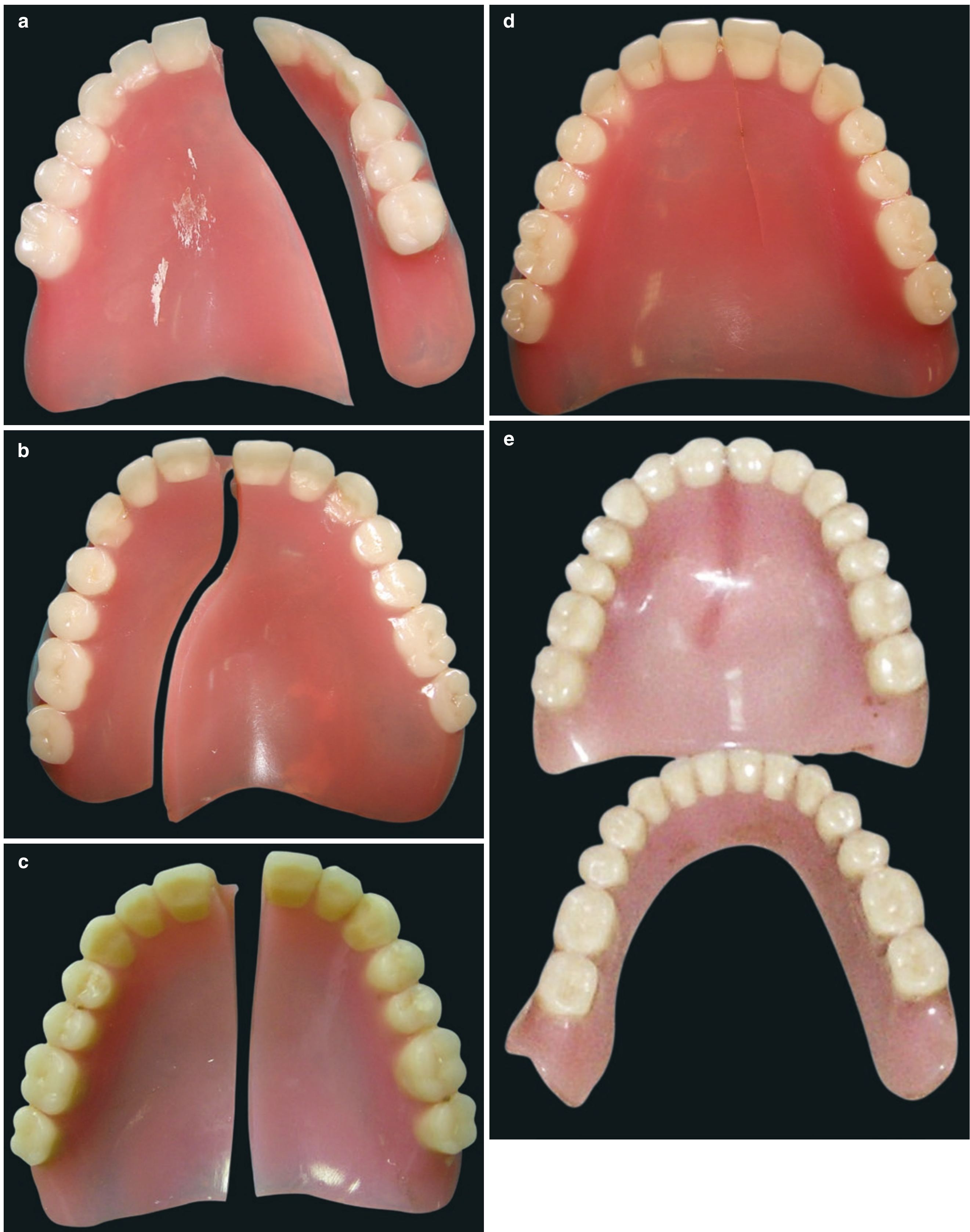
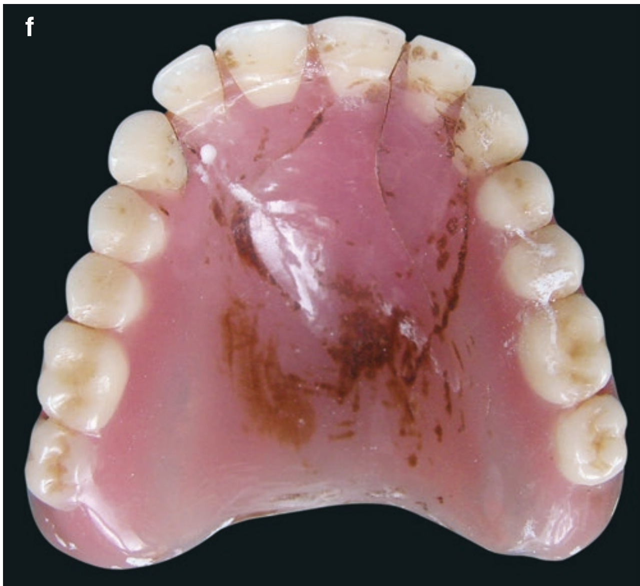


Fig. 6.1 (**a**–**c**) Midline fractures of maxillary dentures. (**d**–**f**) Repair of midline fractures



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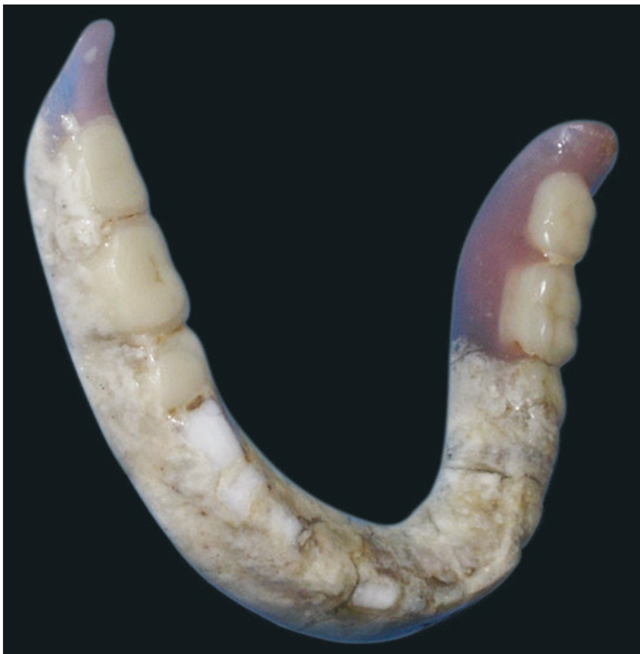


Fig. 6.2 Denture reinforced with marble powder

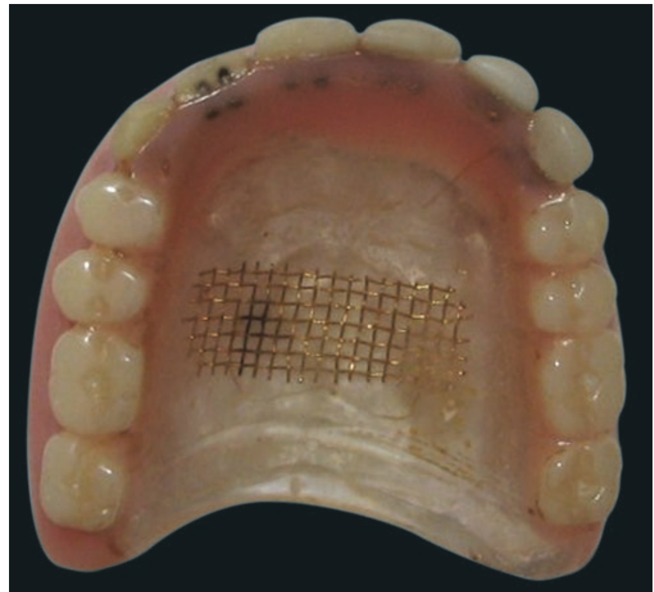


Fig. 6.3 Denture with multiple fractures and repairs

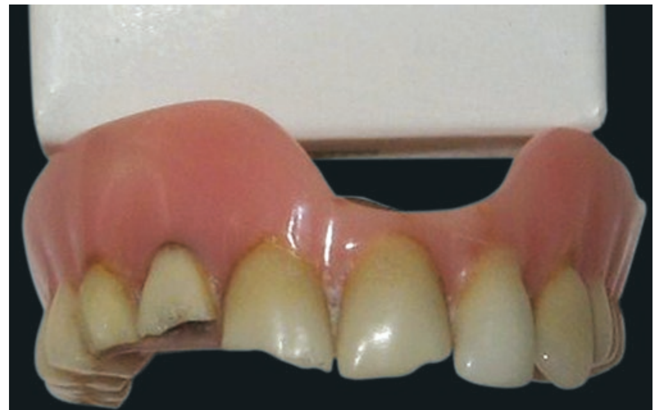


Fig. 6.4 Thinly shaped flanges

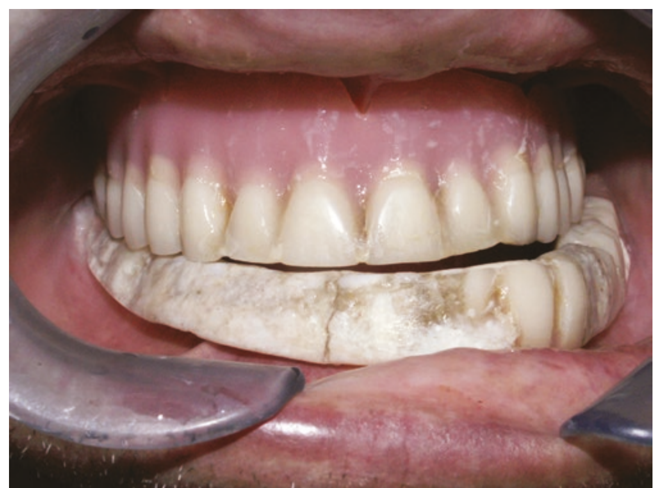


Fig. 6.5 Poorly fitting dentures

Several methods are suggested for the repair of dentures, but auto-polymerizing resin repairs provide a rapid and economic convenience to the patients. A fracture of the repaired denture often occurs at the junction between the old and new material. The most important reason for this is that the transverse strength of the auto-polymerizing resin is lower than that of heat-polymerizing resins. To increase the strength of the repair, several studies have been conducted on surface form and surface agents, during which various materials,

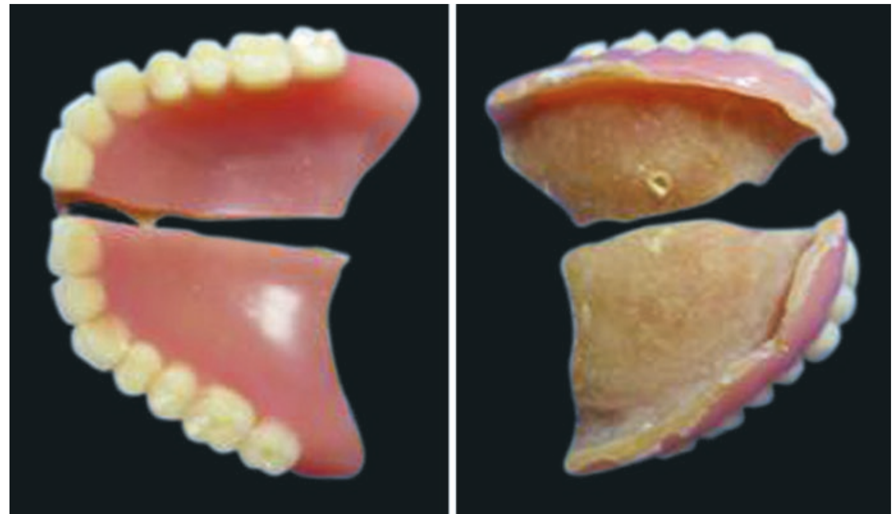


Fig. 6.6 Fracture of the denture base as a result of overgrinding for the application of soft lining material

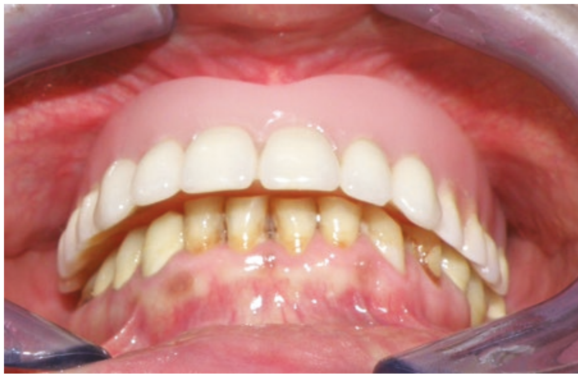


Fig. 6.7 Poor occlusion of a complete denture opposing mandibular natural teeth

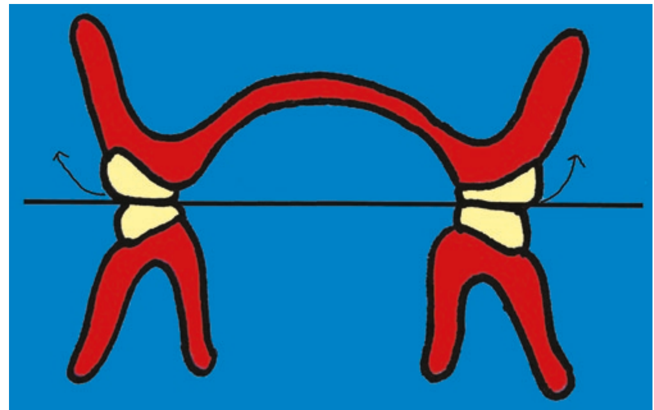


Fig. 6.9 Abrasion of the functional tubercles causes wedge effect in the maxillary denture

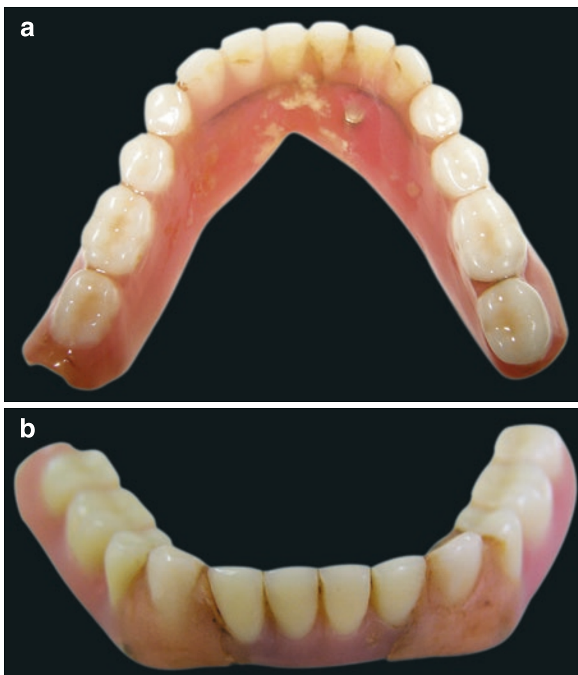


Fig. 6.8 (**a**, **b**) Previously repaired mandibular dentures

such as metal and fibers, were added to repair resin. Whatever the reason for the fracture of the denture, repairs should be resistant and should have a dimensional stability. The material most commonly used for fabricating complete dentures is PMMA. Three fundamental features that have contributed to its success are color stability, simple processing, and the polishing technique. Despite its popularity and esthetic properties, PMMA is far from ideal regarding mechanical properties. As PMMA's impact and fatigue resistance properties are not generally desirable, there are *three ways* to improve the mechanical properties of PMMA:

Alternative Materials to PMMA

Various polymers, such as polyamides, epoxy resin, acetal resin, polystyrene, vinyl acrylic, and polycarbonate, have been developed as denture base resins to overcome some of the mechanical deficiencies of PMMA. Because of the high water sorption of polyamides, the probability of toxicity in epoxy resins, the probability of deformation with polystyrene, and the need for the injection method with acetal resin and polycarbonate, these alternative materials are not usually

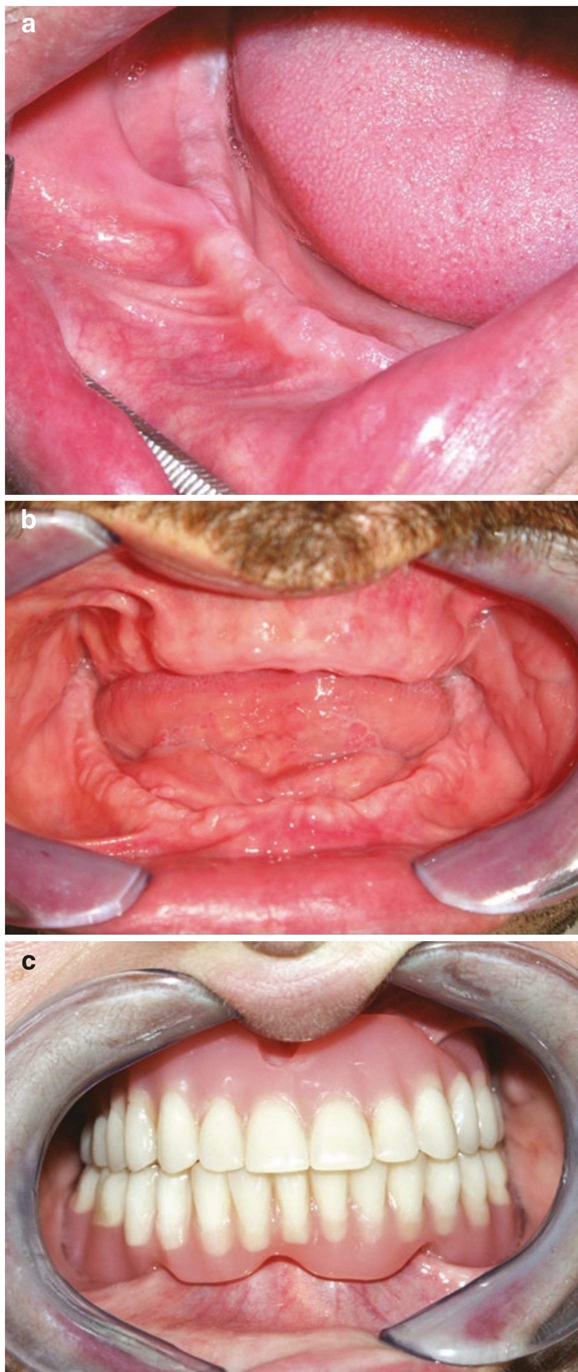


Fig. 6.10 (**a**, **b**) The presence of high frenulum. (**c**) In cases with high frenulum, overgrinding the denture in the related area will cause thin acrylic resin flange

materials of choice. No satisfactory material superior to PMMA is available to date.

Chemical Modification of PMMA

The reinforcement of glassy polymers with rubber is a well-established concept. The addition of rubbers (butadiene-styrene elastomer) to PMMA produces a resin that consists of a matrix of PMMA within which an interpenetrating network of rubber and PMMA is dispersed. A developing crack will propagate through the PMMA but will decelerate at the rubber interface. The objective of the rubber-reinforced or "high impact" resins is that they absorb greater amounts of energy than standard resins before fracturing and at a higher strain rate. A problem is that the impact strength is often improved at the expense of Young's modulus, producing a denture base with increased impact strength but which is too flexible. The addition of rubber to PMMA is to date the most successful and widely accepted method of reinforcement and is an alternative to the conventional PMMA denture base resin; however, although they increase the impact strength of the material ten times when compared to acrylic resin, the high cost restricts its routine use.

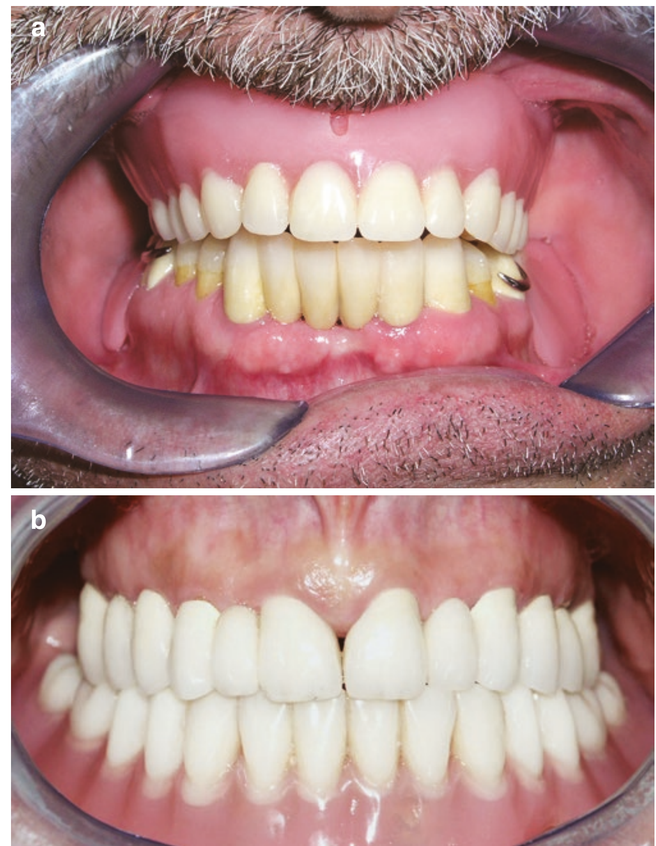


Fig. 6.11 (**a**, **b**) Complete dentures against natural teeth

Reinforcement of PMMA with Various Materials

Metal Inserts

Many attempts have been made to enhance the strength properties of acrylic denture bases, including the addition of metal wires and plates. These materials are added to the denture base either on construction or during the fracture repair process. Although metal plates increase the flexural strength and impact strength of acrylic resin, they may be expensive, unesthetic and prone to corrosion.

Fig. 6.12 (**a**) Palatal torus. (**b**, **c**) Prominent median palatine raphe in the midline

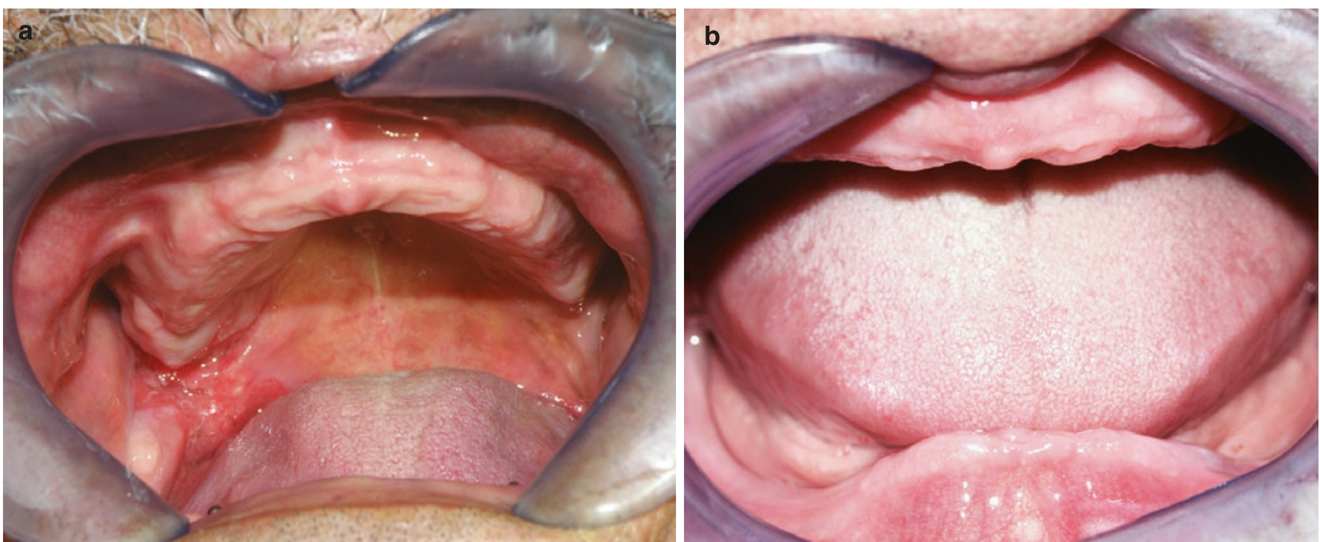


Fig. 6.13 (**a**) Excessive prominence of tubers. (**b**) Protuberances over the crest

Reinforcement with Fibers (Glass Fibers, Aramid Fibers, Carbon Fibers, UHMPE Fibers)

Fibers are used to enhance the strength properties of acrylic denture base. Fibers are preferred in dentistry because of the well-documented improvements in flexural properties and fatigue resistance associated with their use, as well as their good esthetic quality. In addition, when compared with metal inserts, fiber reinforcement has advantages, including enhanced bonding to the resin matrix, ease of repair, and resistance to corrosion.

Removable dentures are reinforced in two ways: one is total fiber reinforcement (TFR) and partial fiber reinforcement (PFR). The entire denture base can be reinforced with a fiber weave, or fiber reinforcement can be accurately placed at the weak region of the denture. These types of reinforcement can be defined as TFR and PFR, respectively (Fig. 6.14a–f, 6.15a–l).

Although the fibers have developed mechanical properties, there are some limitations in clinical use such as:

Carbon and aramid fibers are generally difficult to polish and are not of good esthetic quality because of their black and yellow coloration.

The concentration of fibers in the polymer matrix is not high enough for optimum strengthening. The poor wetting of fibers within the acrylic resin and polymerization shrinkage of PMMA destroy the layer of resin on the surface of the fibers and decrease the bond between the fibers and the polymer. Also, fibers are generally added to the polymer using the hands and are difficult to manipulate.

6.1.2 Burning Mouth Syndrome

Burning mouth syndrome is characterized by a burning sensation in the tongue or other oral sites, usually in the absence of clinical and laboratory findings. Affected patients often exhibit multiple oral complaints, including burning, dryness, and taste alterations. Burning mouth complaints are reported more often in women, especially after menopause. Typically, patients awake without pain but complain increasing symptoms through the day and into the evening. Conditions that have been reported in association with burning mouth syndrome include nutritional deficiencies, such as iron deficiency and protein deficiency.

6.1.3 Alveolar Bone Loss

Increased residual ridge resorption seen in denture wearers is attributed to pressure from the prosthesis (such as intensive denture wearing, unstable occlusal conditions). Clinically the most problem seen in complete denture patients is the “loosening” of the dentures—which is often due to the continual resorption of the alveolar ridge.

6.1.4 TMJ Disorders

Since increased vertical dimension, premature contacts, and disharmony between centric relation and centric occlusion cause early stage problems, occlusal adjustments should be performed. Therefore, no temporomandibular disorder is observed in the long term. Patients having complete dentures with reduced vertical dimension do not generally manifest temporomandibular joint problems. In fact, edentulous patients generally do not have temporomandibular joint dysfunction symptoms.

6.1.5 Fibrous Crest

Fibrous ridge is a superficial area of mobile soft tissue affecting the maxillary or mandibular alveolar ridges. It is probably the sequel of excessive load of the residual ridge and unstable occlusal conditions. It can develop when hyperplastic soft tissue replaces the alveolar bone and is a common finding, particularly in the upper anterior region of long-term denture wearers (Fig. 6.16).

6.1.6 Epulis Fissuratum

Epulis fissuratum is a benign hyperplasia of fibrous connective tissue, which develops as a reactive lesion to chronic mechanical irritation produced by the flange of a poorly fitting denture. Sharp and unpolished flanges are also the reason of epulis fissuratum. Epulis fissuratum appears as a single or multiple fold of tissue that has grown around the alveolar vestibule. The excess tissue is firm and fibrous. The size of the affected tissue varies widely, since almost all the tissues around the denture flanges can be affected (Fig. 6.17a–e).

6.1.7 Papillary Hyperplasia

Papillary hyperplasia of the palate is a benign epithelial proliferation that develops in patients who have complete acrylic maxillary dentures that are often old and poor fitting. It is a fibrous tissue forming by the proliferation of the mucosa through the space between the denture and the palatal mucosa. Histologically, thickness and keratinization of the

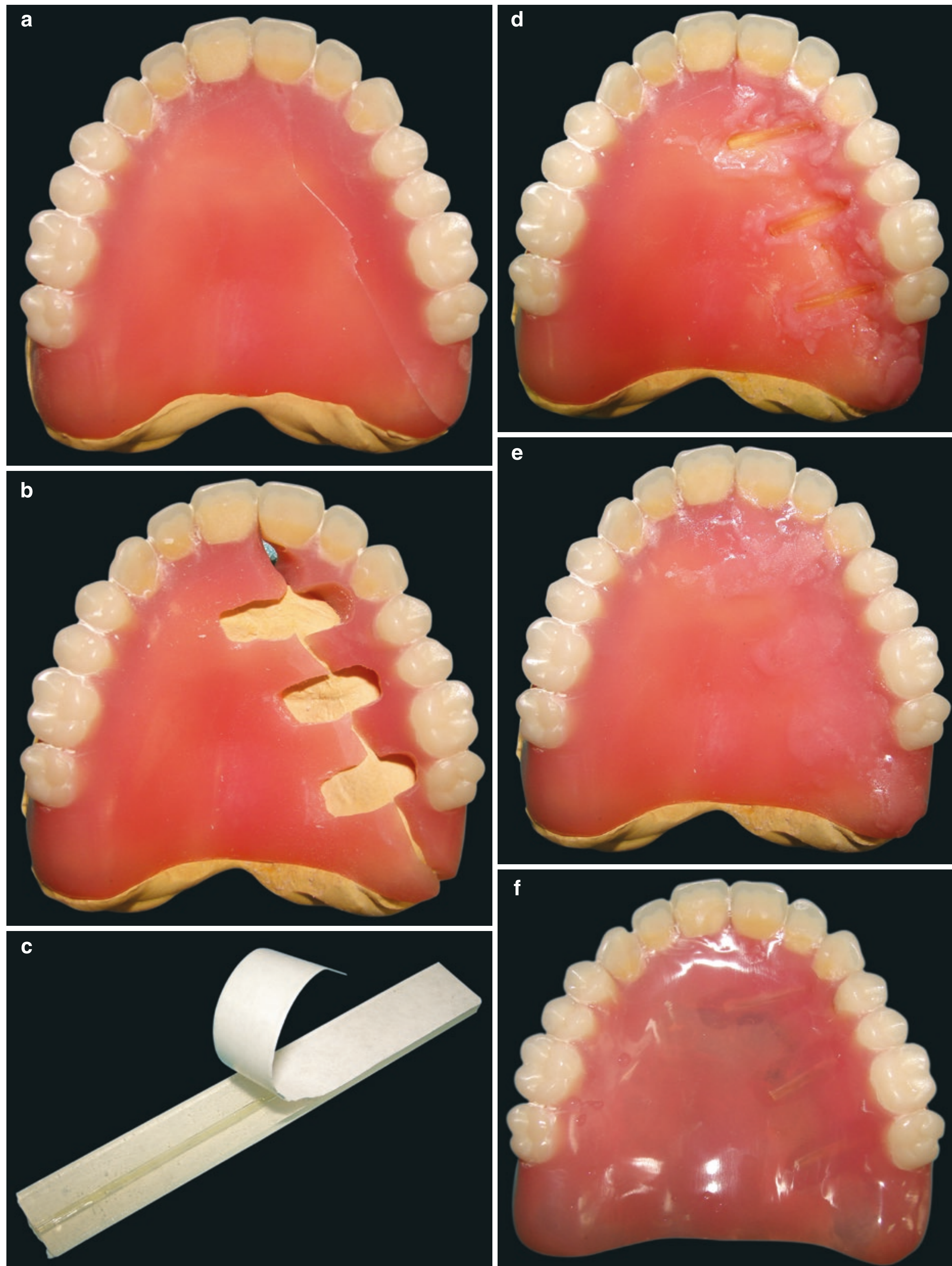


Fig. 6.14 Partial reinforcement. (**a**) Making a model by pouring stone inside the denture. (**b**) Widening the fractured surfaces (horizontally). (**c**) The view of unidirectional glass fiber. (**d**) Cutting the fibers and placing them in the prepared area by wetting them with monomer. (**e**) Adding auto-polymerizing acrylic resin over the fibers. (**f**) The final view of the repaired maxillary denture

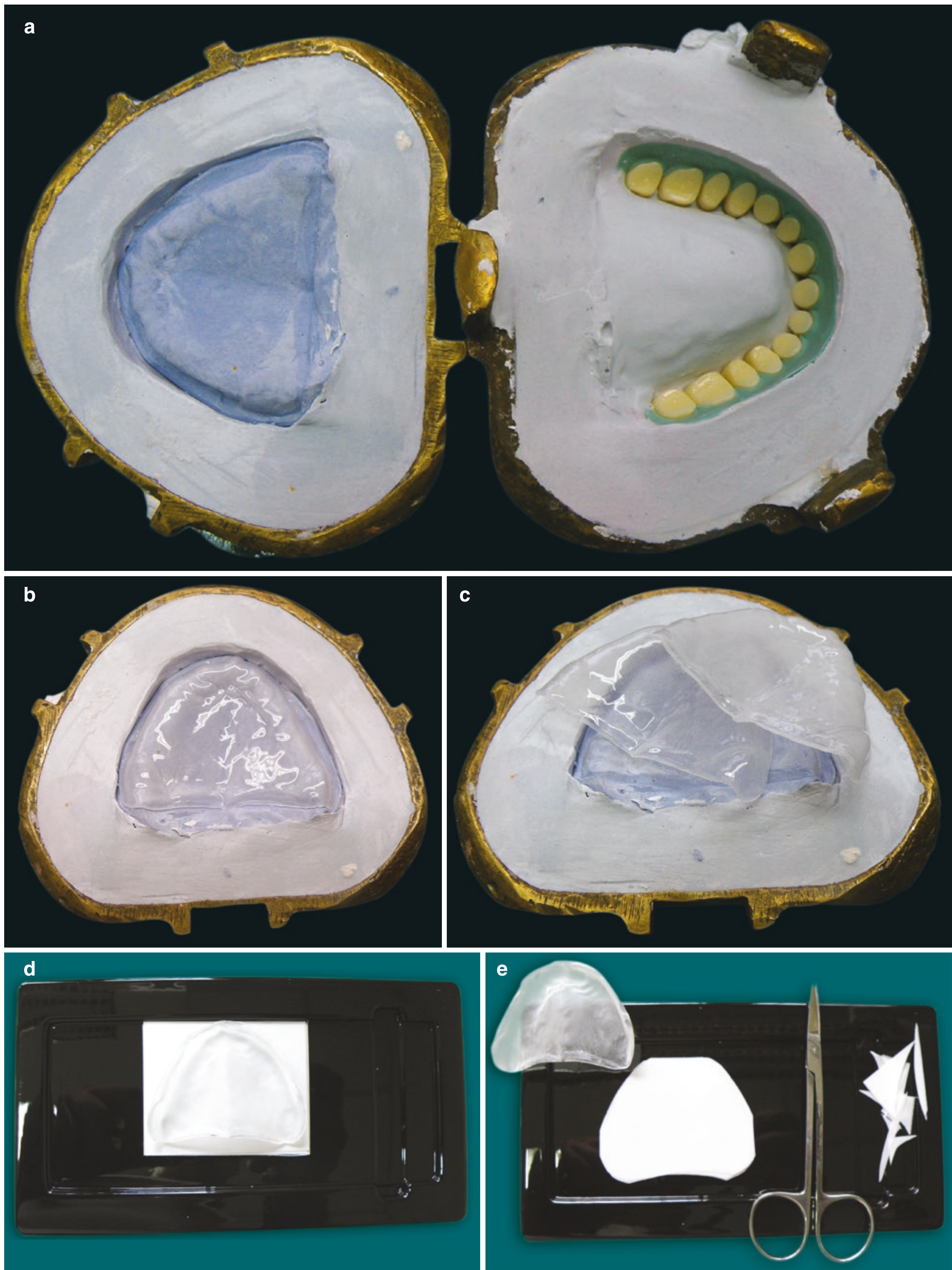


Fig. 6.15 Total reinforcement. (**a**) Flasking the maxillary denture and boiling out. (**b**, **c**) Transparent spacers prepared for the proper thickness of glass fiber. (**d**, **e**) Cutting the fiber sheet in compliance with the size of the spacer. (**f**) Molding the acrylic resin with the spacer. (**g–i**) Preparing the fiber for the space, covering with acrylic resin and placing it in the flask. (**j**, **k**) Closing the flask and making the trial again (removing the excess resin). (**l**) Total reinforcement of a maxillary denture

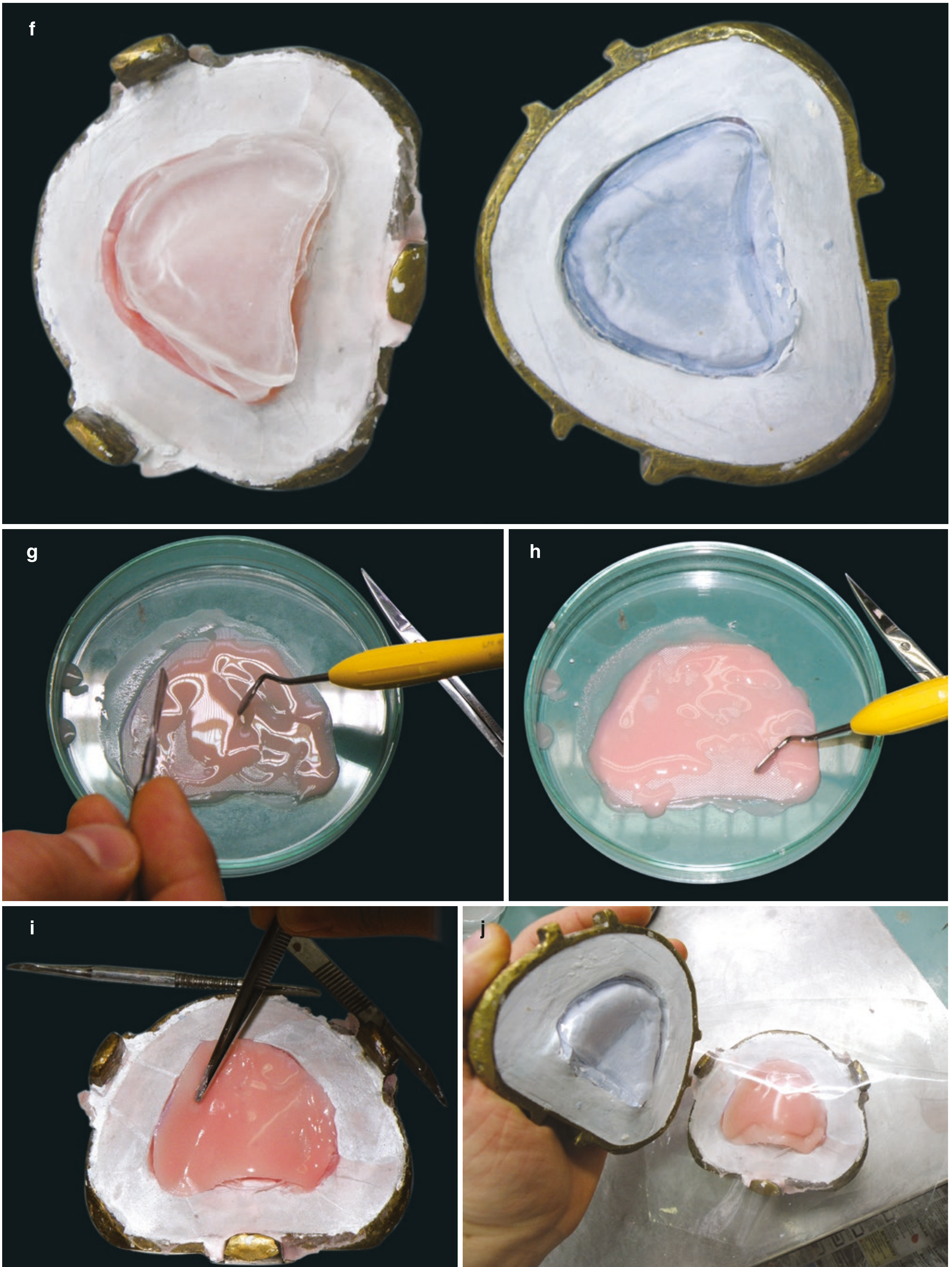
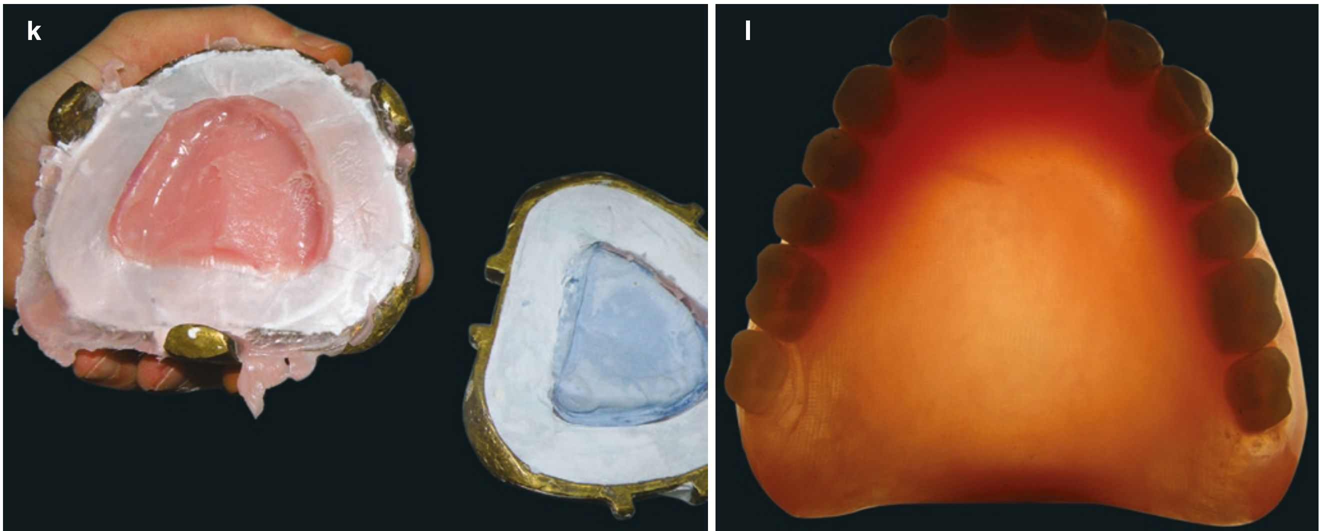


Fig. 6.15 (continued)



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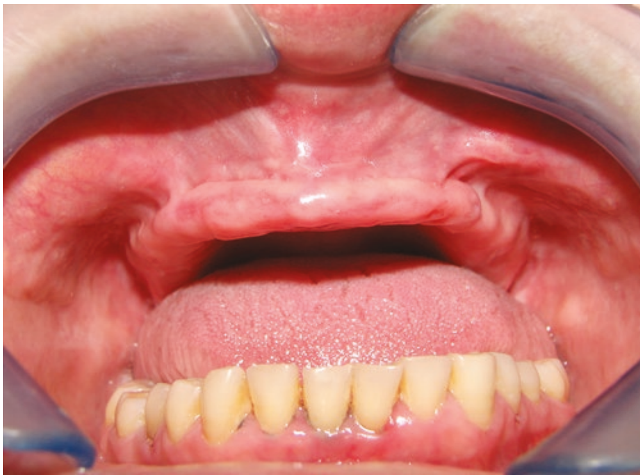

Fig. 6.16 Fibrous hyperplasia observed under complete denture opposing lower natural teeth

mucosa decrease. The facts which disturb the fitting of the denture on the palatal bone, such as resorption on palatal bone and polymerization shrinkage of the resin may be the reasons for the diseases (Fig. 6.18a, b).

6.1.8 Denture Stomatitis

Denture stomatitis is a common disorder affecting denture wearers. In general, the incidence of denture stomatitis is higher among elderly denture users and women. Despite the fact that denture stomatitis is frequently asymptomatic, patients may complain of halitosis, slight bleeding and swelling in the involved area, burning sensation, xerostomia, or taste alterations (Fig. 6.19a–c).

6.1.9 Angular Cheilitis

Angular cheilitis is the clinical diagnosis of deep fissures affecting the corners of the mouth and has an ulcerated appearance. Angular cheilitis, as oral manifestations are frequent in the edentulous elderly using old dentures, is caused by a wide range of *Candida* species colonization. This lesion can be controlled with changing and replacing a new denture to modify the face vertical dimension and improve the angular cheilitis lesions. It is suggested that the loss of vertical height is not as important a cause for angular cheilitis as is active colonization by *Candida* associated with denture wear

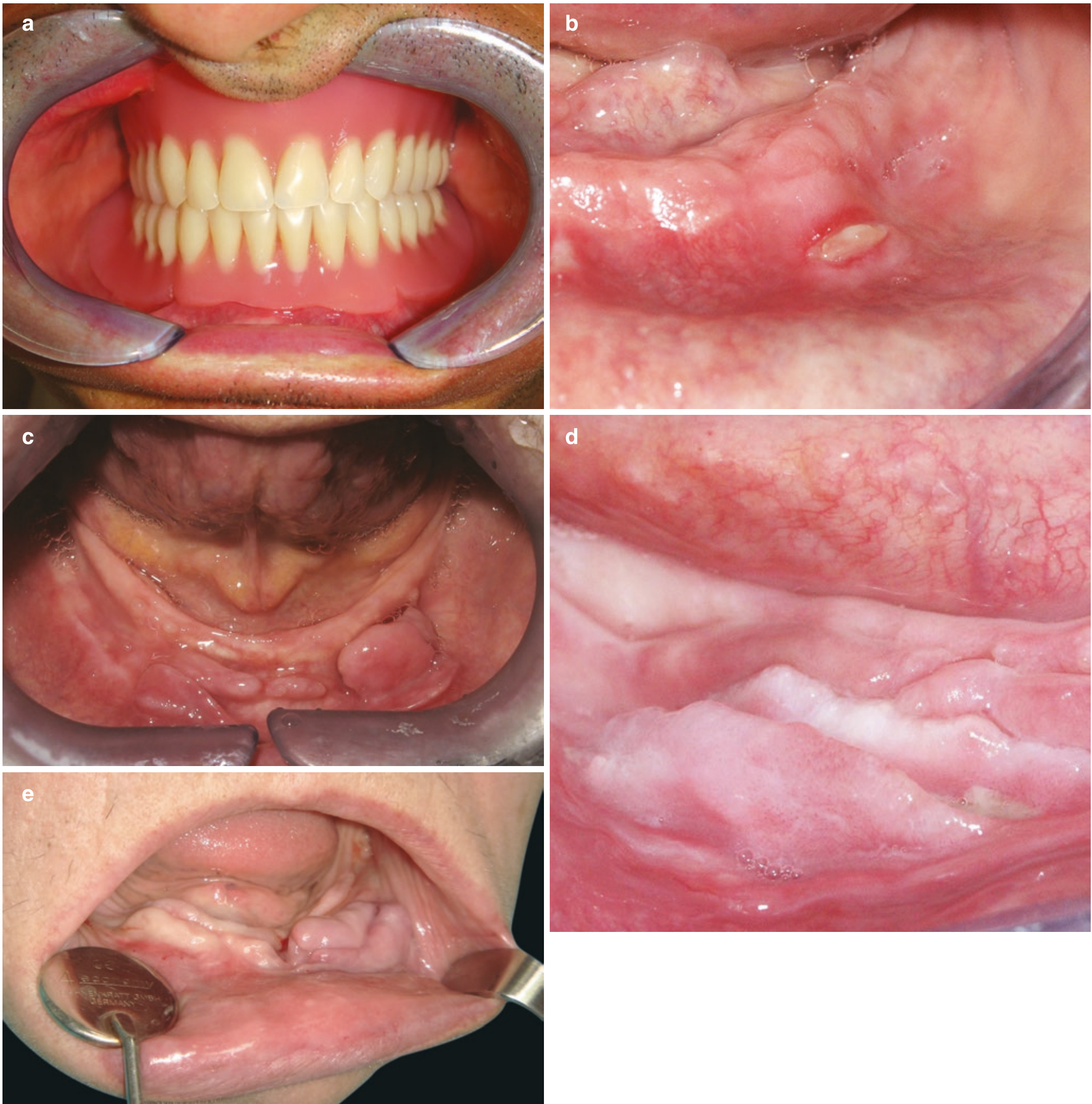

Fig. 6.17 The existence of epulis fissuratum. (**a**) Extended flanges of the lower denture. (**b**) Irritation area. (**c**, **d**) New folds occurring as a result of progression of the irritation without any treatment. (**e**) The view of a second crest due to chronic irritation

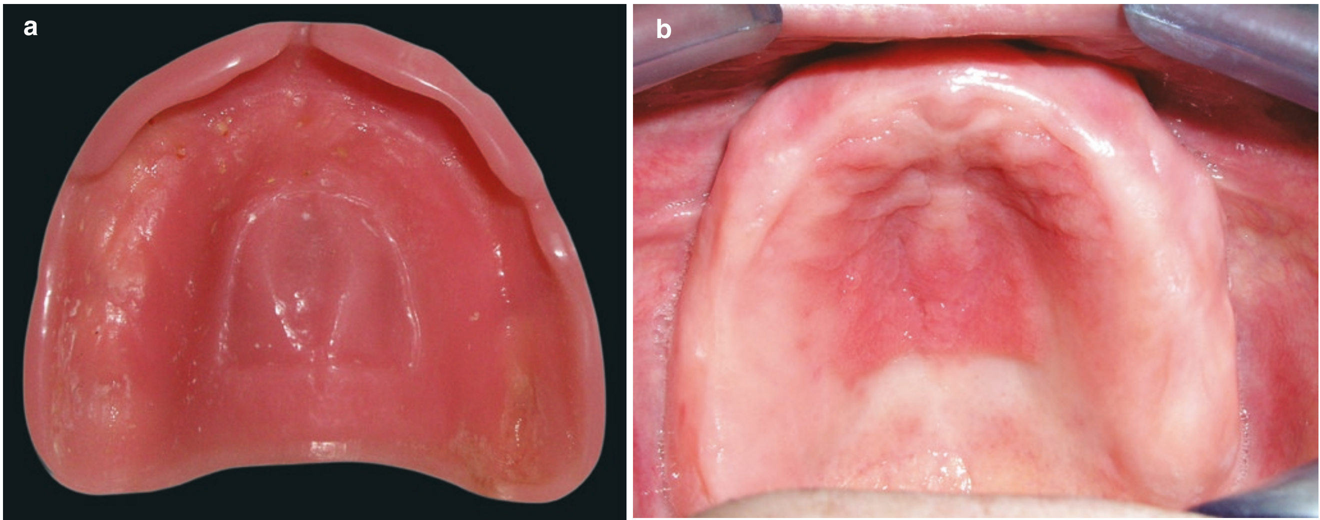

Fig. 6.18 (**a**) Excessive relief prepared inside the denture for the median suture. (**b**) Papillary hyperplasia

Fig. 6.19 Denture stomatitis. (**a**) Hyperemic areas in the form of spots. (**b**) Stomatitis originated from trauma. (**c**) Diffuse stomatitis

and poor oral hygiene. The prevalence of angular cheilitis among wearers of complete dentures has been shown to vary between 8% and 30%.

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Part III

Stress-Reducing Materials for Complete Dentures

Check for updates

Tissue Conditioner Materials

7

Erkut Kahramanoğlu and Yasemin K. Özkan

7.1 Tissue Conditioner Materials

Tissue conditioners are also known as temporary soft lining materials. Intraorally these materials can be used 1 week to 10 days at most. If used more than this, the material loses its softness and applies more pressure to the tissues. Generally known as temporary or short-term soft lining materials, tissue conditioners are used to treat damaged mucosa. If the trauma caused by old denture is not treated, new denture's adaptation will be impeded, and patients' complaints will increase gradually. When fabricating a new complete denture, it is highly important that the tissues are in proper condition with natural contours before impression process. As well as the surgical approach is suggested in excessive hypertrophic cases caused by poorly adapted dentures, it is proposed that if the patient does not use the denture long enough, inflammation and edema in soft tissues will gradually vanish. However, as it is too troublesome for the patients to remain without a denture, in these types of cases, tissue conditioner materials are used as alternatives; therefore, patients can actively use their dentures while tissue conditioner materials heal the wounded areas to regain their normal volume and contours (Fig. 7.1a–c).

Even though they are acrylic based, tissue conditioners do not form cross-links during setting reaction, and they do not involve any methacrylate monomers. Coe Comfort, Coe Soft, Kerr-Fitt, Soft Oryl, Tempo, Visco-Gel, and Fixo-Gel are the most widely used tissue conditioners.

7.1.1 Composition of Tissue Conditioner Materials

The powder of tissue conditioners is composed of acrylic polymer ((polyethylmethacrylate) and (polymethylmethacrylate)), or a copolymer, and the liquid portion of the material is usually composed of ethyl alcohol and an aromatic ester mixture (benzyl salicylate, butyl phthalate, butyl glycolate), plasticizer, and sweeteners. Poly(ethyl methacrylate), poly(methyl methacrylate), or an acrylic copolymer is generally mixed with a 60–80% plasticizer containing aromatic ester ethanol liquid, such as dibutyl phthalate. This liquid does not contain monomer.

In tissue conditioners, polymerization starts with mixing the powder with plasticizer and penetrant involving liquid mixture and letting the liquid penetrating into powder monomers. This procedure is accelerated by the presence of ethyl alcohol. Benzyl salicylate and powder particles react and result in swelling or volume change in powder particles that causes gel formation. These materials do not involve monomer substance.

Once they have final gelation (15–20 min after mixing up), they gradually lose their plastic properties and show more elastic properties. The reason is the loss of ethanol, water, and plasticizer. These materials show viscoelastic properties. In the relevant studies, it has been shown that these materials reach elastic mode in 24 h and if they are to be used as impression materials, they should remain in the oral cavity for at least 24 h. The properties of tissue conditioners are dependent on their compositions and ratios. Therefore, some of them are suitable as tissue conditioners and some as impression materials.

As they can keep their plasticity for a short period, tissue conditioners can be used as a treatment material on damaged mucosa relining caused by poorly adapted denture. At the same time, due to their viscoelastic properties, they relieve the pain during occlusion. On the other hand, since they contain unstable polymer, they expand due to the water absorption and lose their viscoelastic properties because of alcohol release. Tissue conditioners irritate the mucosa because of overuse as they become contaminated and hardened.

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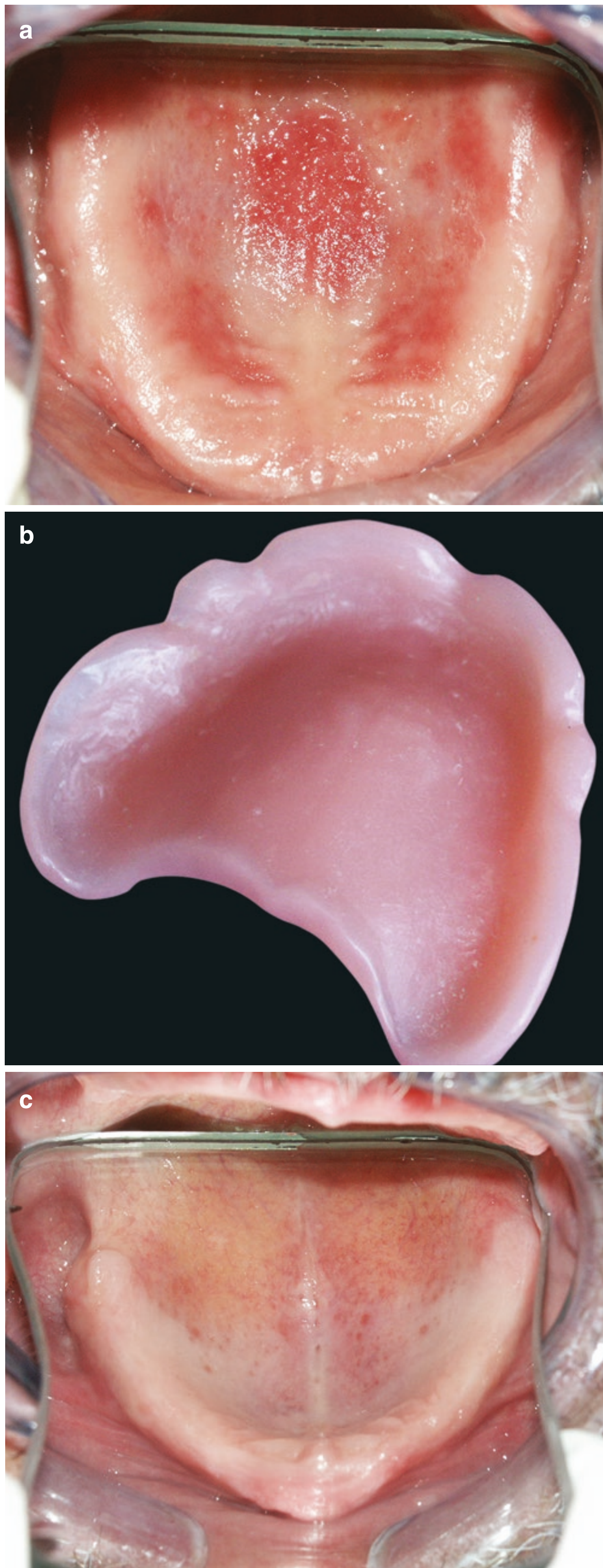

Fig. 7.1 (**a**) View of hyperemic mucosa, (**b**) Application of tissue conditioner in to the denture, (**c**) Tissue healing after tissue conditioner application

7.1.2 Indications of Tissue Conditioners

Tissue conditioners are used:

1. For preventing pressure on oral tissues in the existence of denture stomatitis.
2. For conditioning of denture-bearing mucosa disturbed by ill-fitting dentures before fabricating new dentures.
3. For preventing excessive pressure on healing tissues and contributing to the healing process in patients with temporary or surgical obturators (Fig. 7.2a–c).
4. For implant patients after surgery in order to be able to use the old denture.
5. As a functional impression material (after application of tissue conditioner on traumatized tissues, this material can be also used as impression material). Basic properties of tissue conditioners used as impression material are as follows: (1) dimensional stability, (2) ability to reproduce surface details exactly, and (3) consistency with plaster or plaster-like substances. According to the literature, some tissue conditioners (Hydro-cast, Visco-gel, Fitt, Tempo) have been evaluated to determine whether they can be used as an impression material. As a result, the tissue conditioners performed adequately and as such could be used as impression materials after 24 h of their application.

7.1.3 Features of Tissue Conditioners

7.1.3.1 Gelation and Liquidity

To adapt the mucosa completely, these materials need to show a considerable amount of liquidity. Because they do involve materials that do not polymerize, the gelation procedure is believed to be a physical phenomenon rather than a chemical one. It is reported that the penetration of aromatic esters and polymer powder in the presence of ethyl alcohol is accelerated and a gel-like structure is formed. Just after mixing, early liquidity is important for the denture to appropriately adapt to the mucosa. With occlusal or finger pressure and with lining materials pressure on mucosa, it will be possible for this material to flow and create a certain amount of thickness. After the tissue conditioner becomes a gel, its liquidity under function and parafunction is important in clinical efficacy.

7.1.3.2 Softness and Viscoelastic Features

These features ensure that these materials are suitable for taking a dynamic functional impression. Generally, these materials are expected to preserve their softness during their

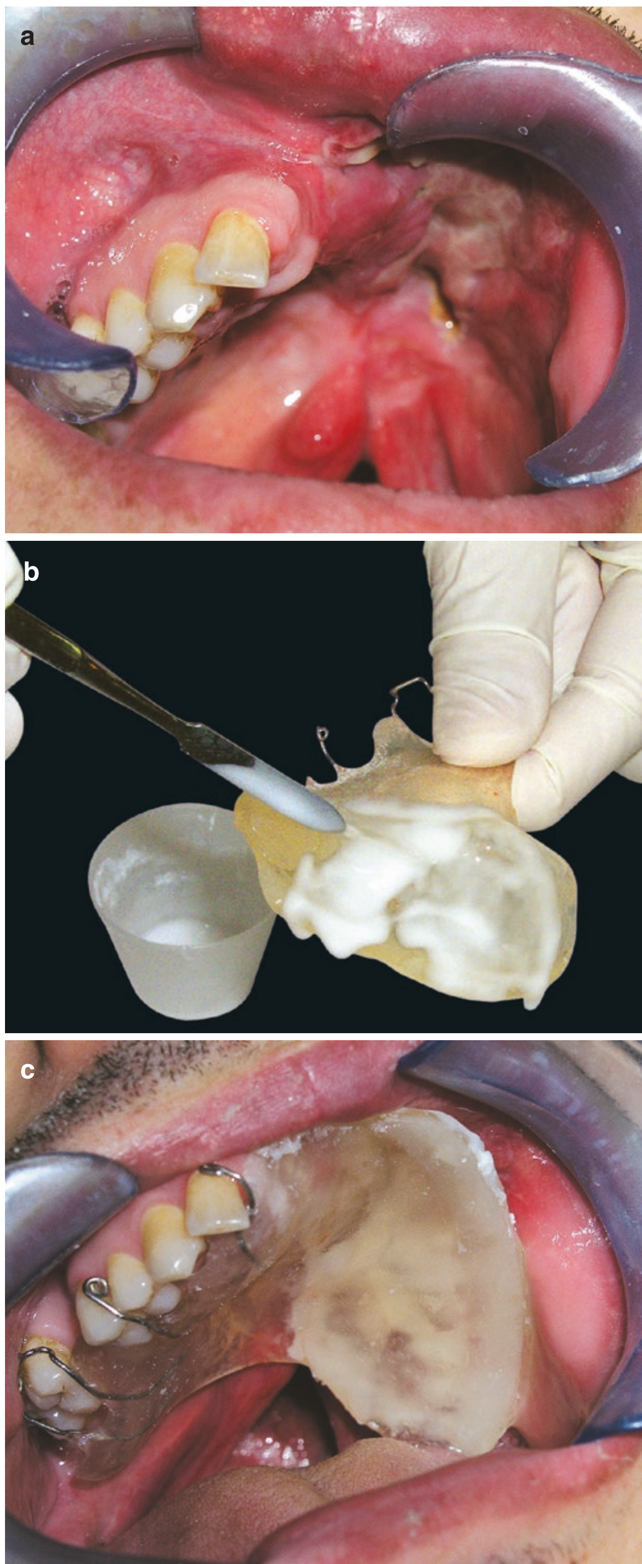

Fig. 7.2 (**a**) Defect seen in maxilla, (**b**) Application of tissue conditioner inside the temporary obturator, (**c**) Intraoral view of tissue conditioner applied to temporary prosthesis

presence in the oral cavity and to have low liquidity and high elastic recovery under functional pressure as a protective pad during the healing process. Researchers concluded that these materials distribute the pressure uniformly and for this reason diffuse functional stresses on mucosa equally and have shock-absorbing properties. As a result, the pressure change on supporting tissues can be regulated by the features of soft lining material.

Generally, for a tissue conditioner to be suitable, the material should absorb the functional forces effectively and distribute them equally. By this way, tissues can return to their normal phases. In these conditions, the soft lining material's cushion effect and features became important.

The tissue-conditioning resins are very effective in that the resin remains relatively plastic and continues to flow under pressure. In this way, the resin distributes applied stresses evenly while maintaining intimate contact with the underlying mucosa as sloughing and healing of tissue occurs.

7.1.3.3 Thickness

For the temporary soft lining material to be effective and to have a long-lasting cushion effect, there should be a maximum thickness. Kawano et al. (1991) and Graham et al. (1990) reported that the tissue conditioner provides more effective result because of better compressibility and absorbs more of occlusal stresses that are transmitted to the liner and more effectively "cushions" the recovering supporting tissues. Kawano et al. (1991) stated that if at least 3 mm thickness is absenting, the material should be changed within a couple of days. They examined six different tissue conditioners' (1, 2 and 3 mm thickness (Hydrocast, Visco-gel, Softone, Fitt, Soft-liner, Coe-comfort)) pressure distribuand concluded that apart from Hydro-cast, no tissue conditioner is affected by the material thickness. They stated that with Hydro-cast, Visco-gel, Softone, and Soft-liner materials, pressure decreased when the material is 3 mm thick and did not change in Fitt and Coe-comfort. They also stated that soft tissue lining thickness affects the pressure distribution and the material should be of a specific thickness. When Hydro-cast, Visco-gel, Softone, and Soft-liner are used, 3 mm thickness is suitable, but acquiring this thickness is not always possible. They have stated that when Fitt and Coe-comfort are used, thickness does not affect the pressure.

As they examined the pressure distribution of tissue conditioners, the same researchers stated that when 1 or 2 mm thick Hydro-cast and Softcore materials were used, pressure increased after 3 days (rather than 3 h) but when 3 mm Fitt and Soft-liner were used, no pressure change was reported regardless of thickness. Since Coe-comfort has low viscosity, the pressure is decreased. If low-viscosity materials (Hydro-cast or Softone) are going to be used on traumatic tissues, it should be changed in a day or two, as tissue liners become thinner and have denser pressure over time.

7.1.4 Problems Seen in Tissue Conditioner Materials

7.1.4.1 Alcohol Loss

The vaporization of alcohol and plasticizer causes tissue conditioner to harden, and it needs to be renewed. Ethyl alcohol evaporates rapidly, there is a large amount of loss in the first 12 h, and it reaches a maximum level within 60 h. Tissue conditioner materials provide immediate relief and comfort but if the patient use the denture for a longer time, then the material will cause trauma on the supporting tissues—thereby producing the very same situation, that their use is intended to prevent or correct. Therefore, it is asserted that the materials should be used for short periods only (Fig. 7.3).

7.1.4.2 Porosity

It is stated that due to their porous structure, these materials prepare a suitable environment for fungal growth. To decrease their porosity, different techniques are being developed. To decrease the porosity, Yoeli and Penchas (1996) declared that, in contrast to suggested mixing procedures, these materials should be very rapidly mixed on a wide pet with a broad spatula with back-and-forth motion, the mixture should be a thin layer, and it should be placed in a tube in order to be injected into the denture base later on. To increase the lifetime of tissue conditioners, decrease the porosity, and prevent color change, Corwin et al. suggested that polymerizing these materials for 20–30 min under a 13–16 °C water and 25–30 psi pressure might be useful.

7.1.4.3 Cytotoxicity

It is known that some plasticizers in tissue conditioners are toxic; however, there have been few studies on this subject, which remains under-researched. It has been stated that tissue conditioners are more cytotoxic then autopolimerized acrylics and the main difference between these materials is the plasticizer content of the tissue conditioners (mostly phthalic ester). These esters come out in time and cause a probable toxic effect.

7.1.4.4 Hypersensitivity

Hypersensitivity against denture materials causes an allergic response. It is stated that, when excess monomers, cleaning agents, and nutrients become absorbed by denture base, it gains antigenic properties. Non-polymerized plasticizers may increase the situation in several types of dermatoses. Additional materials, plasticizers, phthalate, maleate, and dimethylaniline like additives are leading sensitizers. 10% or higher ratios of butyl, dioctyl, and dioctyl phthalate are used as plasticizers and cause sensitivity reactions in polymers. Zaki et al. investigated hypersensitivity in four tissue conditioners (Flexacryl, Soft Oryl, Coe-comfort, Visco-gel) using patch test and found out that only Coe-comfort does not cause allergic reactions.

7.1.4.5 Fungal Growth

Since tissue conditioners have undesired physical properties like porosity, *Candida albicans* growth is easier in these materials. There are contradictory results in the literature regarding this subject. Some research has shown that these materials increase the reproduction of *Candida*, while others insist that they inhibit it (Fig. 7.4).

It can be summarized the features and important points of application of soft lining materials used as tissue conditioners as:

1. Chemically different tissue conditioners should be used until healing is achieved. The dentures should be relined with heat-polymerized acrylic resins later on because open monomers and plasticizers cause allergic and irritant reactions.
2. Tissue conditioner's liquidities and gelation times are important in clinical use. For these materials to fully adapt the mucosa, their liquidity must be satisfactory.

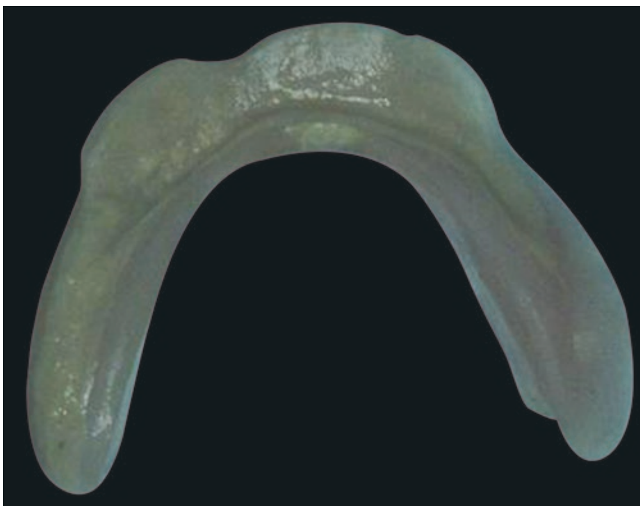

Fig. 7.3 Hardening of tissue conditioner material

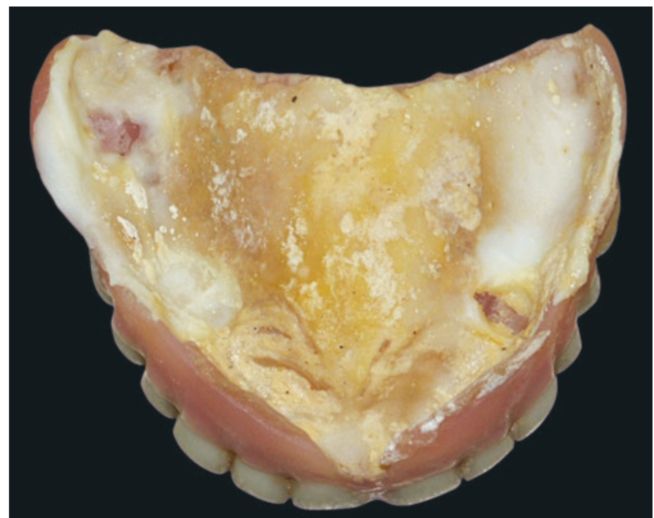

Fig. 7.4 Fungal growth on the tissue conditioner

Concentrations of ethyl alcohol and aromatic ester are important in controlling the gelation time of tissue conditioners. By changing combinations of these materials, gelation time can be controlled.

3. The thickness of tissue conditioners effects the pressure distribution. Because of this, a certain amount of thickness is needed. If this thickness cannot be obtained, they need to be frequently changed.
4. Because of their porous structure, tissue conditioners provide a suitable environment for *C. albicans* growth. Because of this, dentist should be careful in using these materials for denture-related stomatitis treatment. Oral hygiene should be provided, and the materials should not stay in the oral cavity more than a week.
5. If tissue conditioner materials are going to be used as an impression material, they should be removed from the oral cavity after 24 h of usage because it takes 24 h for these materials to reach maximum elasticity.
6. Since tissue conditioners can keep their plasticity even for a short period of time, they can be used in the treatment of damaged mucosa (relining) caused by poorly adapted denture base. At the same time, due to its viscoelastic features, with the relining effect, it releases the pain feeling during occlusion. However, since they contain unstable polymers, they absorb water in the oral cavity, swell, and lose their viscoelastic properties rapidly due to alcohol evaporation. With long-term use, due to their hardening and contamination, they irritate the mucosa. Since tissue conditioners are used temporarily to arrange mucosa and have different usage areas other than soft lining materials, these two materials should not be confused.

Fig. 7.5 Visco-gel tissue conditioner material

7.1.5 Clinical Application of Tissue Conditioners

Tissue conditioner's clinical use resembles the autopolymerizing soft tissue lining materials (Fig. 7.5).

1. In order to make space for tissue conditioners, 2 mm acrylic is trimmed from the tissue surface of the denture (Fig. 7.6a, b).
2. Isolation material is applied to the polished surfaces of the denture and all the teeth surfaces using a brush. According to the manufacturer's instructions, powder-liquid ratio is established and mixed for 1 min in a container until a homogenous mixture is obtained. Then tissue conditioner is applied with a spatula to all tissue surfaces, equally (Fig. 7.7a–f; Fig. 7.8a, b).
3. The denture is placed in the mouth, and the patient is asked to close his/her jaw in centric relation. Then the mouth, cheek, and tongue movements are made, showing which surrounding tissue movements are reflected on the denture (Fig. 7.9a–d). Since it will take 8–10 min for the

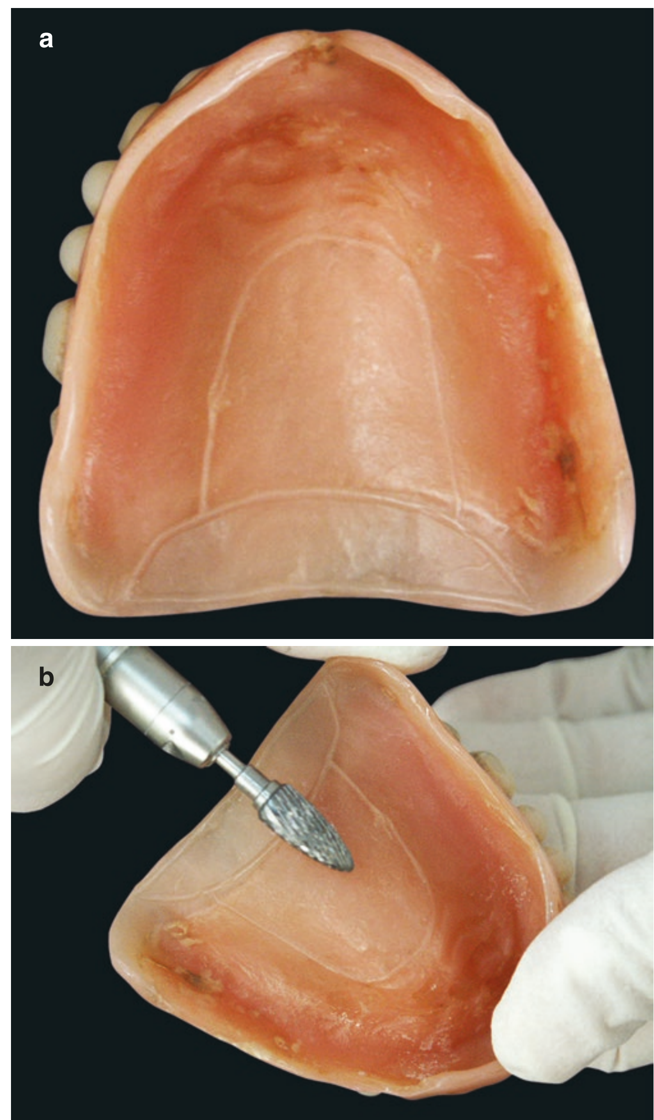

Fig. 7.6 (**a**, **b**) Trimming on the tissue surface of the denture

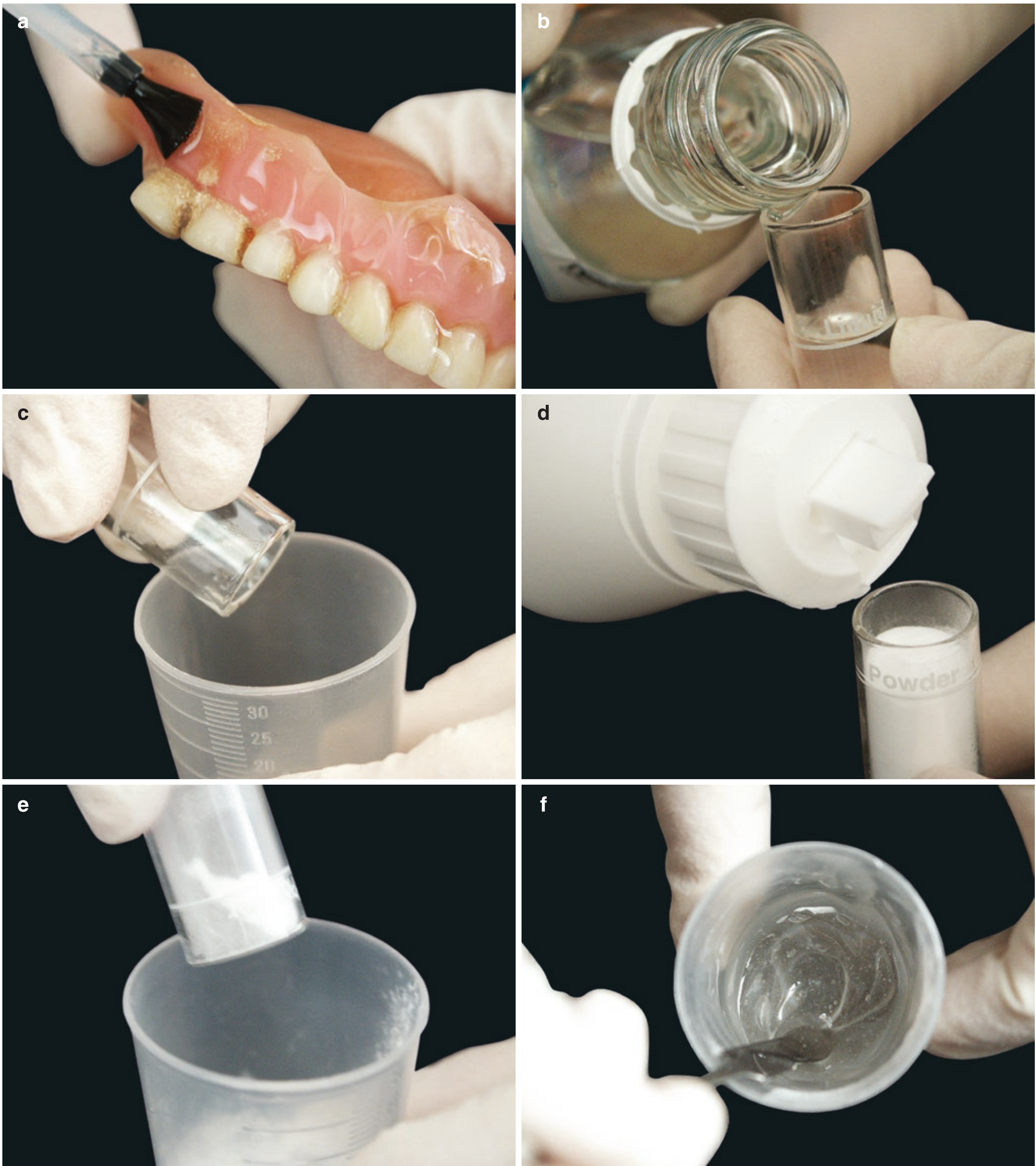

Fig. 7.7 (**a**) Application of isolation material to the outer surface of the denture, (**b**)–(**f**) Mixing the tissue conditioner material according to the instructions of the manufacturer

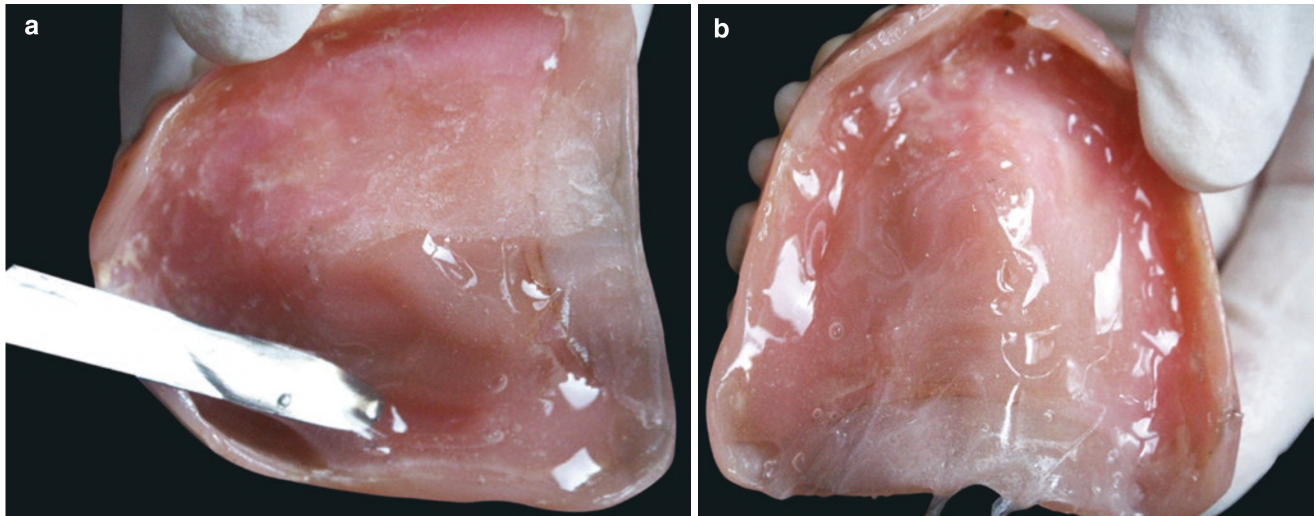

Fig. 7.8 (**a**, **b**) Mixing the tissue conditioner and applying it into the inner surface of the denture

Fig. 7.9 (**a**)–(**d**) Placement of the denture into patient's mouth in centric occlusion and making the movements for surrounding soft tissues

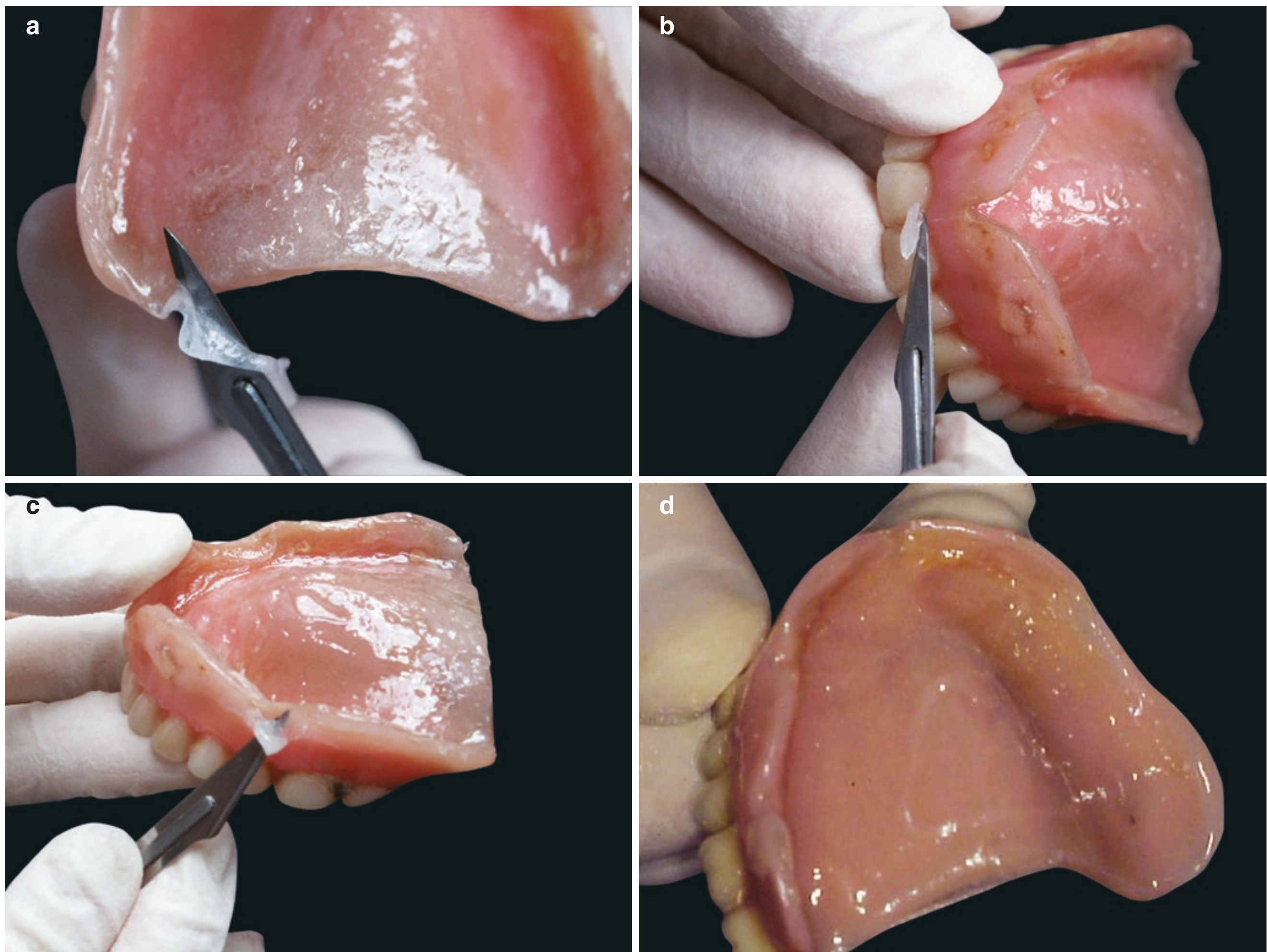

Fig. 7.10 (**a**)–(**d**) Removal of tissue conditioner from the mouth and removal of excess material

tissue conditioner to set, during this time, the same movements are repeated. At the same time, the patient makes various speech movements like reading aloud from a newspaper in order to reflect the soft tissue movements into the denture.

4. One to 2 min before the setting is complete dentures are taken out of the patient's mouth. Excess materials are removed, and the denture is placed again in the mouth for final setting (Fig. 7.10). After the setting process, abrasive and polishing drills are used to prepare the flanges of the denture, and it is delivered to the patient.

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Clinical Applications of Soft Lining Materials

8

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8.1 Clinical Applications of Soft Lining Materials

In some cases, even if dentures have adequate border lengths, teeth alignment, occlusion, denture stability, and adaptation, there may be an unbearable pain in tissues underlying the denture during mastication. In the presence of excessively resorbed alveolar crest, because of the resorption, mucosa's thickness is reduced. As the shock absorbing effect of mucosa diminishes (because underlying tissues directly feel the mastication forces), loading on the residual crest increases (Fig. 8.1). Also (since the diminished mucosa is tightened in between rough denture bases and non-resilient bone support), lesions, irritation, and pain occur during mastication. In cases where the mucosa is thinned, to compensate for the lost thickness and viscoelasticity, it is necessary to reline the inner surface of denture base with a soft lining material that has features similar to the mucosa. The material used in relining is called soft lining material. Soft lining materials can be defined as soft polymer materials that are applied to the tissue-facing surfaces of dentures, transfer decreased amounts of occlusal forces to underlying tissues, and distribute occlusal forces in a more balanced way. Soft lining materials absorb some of the energy by deformation, which decreases energy absorbed by the tissues.

8.1.1 Classification of Soft Lining Materials

According to their purpose, soft lining materials are divided into two groups as long-term (6 months–5 years) and short-term (3 days–30 days). Long-term soft lining materials are referred to as permanent soft lining materials, while those that are short-term are referred to as temporary soft lining materials or tissue conditioners. Even though they are basically the same, these two groups have differences regarding their ingredients and purpose of use.

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8.1.1.1 Classification of Permanent Soft Lining Materials

1. *Natural Rubber*
2. *Vinyl Copolymers*
3. *Soft Acrylics*
   (a) Acrylic-based soft lining materials that polymerize in room temperature
   (b) Acrylic-based soft lining materials that polymerize with heat
4. *Silicone Elastomers*
   (a) Silicone-based soft lining materials that polymerize in room temperature
   (b) Silicone-based soft lining materials that polymerize with heat
5. *Fluoropolymers*
6. *Polyelastomeric systems*

These days, acrylic and silicone-based soft lining materials are the most widely used.

Natural Rubber
Natural rubbers have been used as soft lining materials since the 1860s. Nevertheless because of their quick absorbance of intraoral liquids, difficulty in preparation, and low quality of connection to base material, nowadays they are not the material of choice.

Vinyl Copolymers
Vinyl copolymers are the first synthetic materials. Polyvinylchloride (PVC) is highly brittle in the oral cavity. Polyvinyl acetate (PVA) shows excessive folding. It is necessary to add plasticizer into this combined material. Dioctyl phthalate is used as a plasticizer. Zinc oxide (5%) and calcium stearate are used to increase the fluidity of the material. When the material loses high amounts of plasticizer, its

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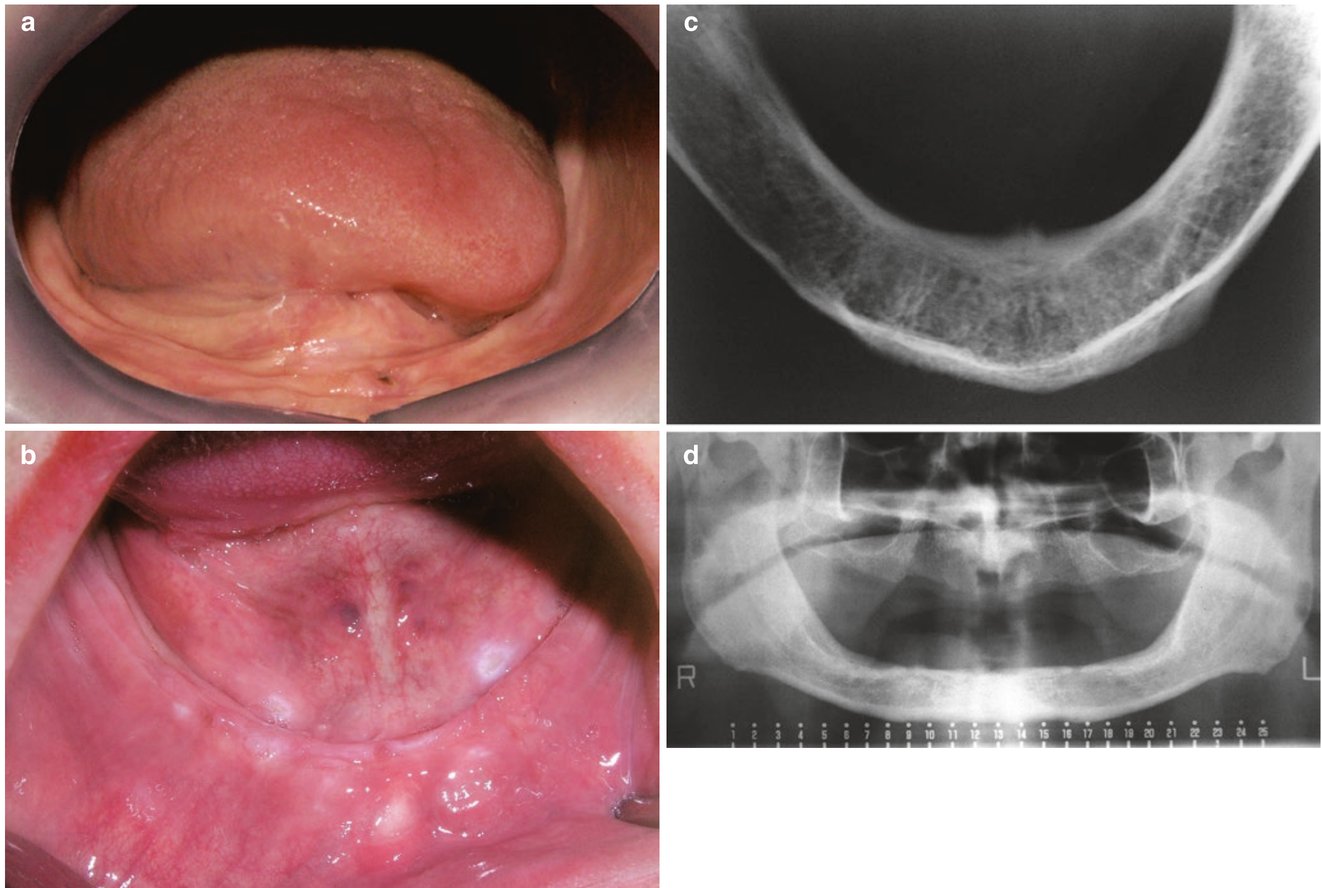

Fig. 8.1 (**a**, **b**) Mandibular resorbed ridge. (**c**, **d**) Occlusal and panoramic x-rays

hardness continually increases and, depending on clinical conditions, it takes between 3 and 18 months to harden completely. Even though it is not difficult to produce combined polymers and they have similar features with other products on the market, they are not widely used as soft lining materials.

Soft Acrylics

The plasticized acrylic resins contain an acrylic monomer and plasticizers (ethyl alcohol and/or ethyl acetate), which act to preserve the *softness* of the material. The plasticizers are not bound within the resin and, therefore in time, will leach out.

They are divided into two groups, based on their preparation methods:

1. Acrylic-based soft lining materials that polymerize in room temperature
2. Acrylic-based soft lining materials that polymerize with heat

Because of their content, they are expected to have a good connection with the denture base. The added plasticizer first penetrates the resins' surface and then, as the lining material dissolves in the saliva, it hardens over time. Also, because of the surface roughness and water absorption, it is possible to have bacteria contamination.

1. Acrylic-Based Soft Lining Materials that Polymerize in Room Temperature

These materials have polyethyl methacrylate in powder, n-butyl methacrylate in liquid and amine as activator. Even though there is an advantage in using it at one session in clinic, the fact that there is more monomer is a disadvantage.

2. Acrylic-Based Soft Lining Materials that Polymerize with Heat

The powder contains polyethyl methacrylate. As a liquid form, they have high portions of the methacrylate ester and as plasticizer generally phthalate ester. Plasticizers are used to ensure material's softness. These function by diminishing the chemical cross bonds between different polymer chains. They also decrease the glass transition temperature. Thus, hard acrylic transforms into a resilient form. Plasticizers first come into contact with the surface of resin material, and then as the lining material dissolves in the saliva, they cause hardening in time. Therefore, less plasticizer involving materials are the materials of choice. Polyethyl methacrylate needs less plasti-

cizer than polymethyl methacrylate. After these materials are prepared, the flasking is made, and during this procedure the material is heated up to 72 °C for 16 h, before being left to cool. The lining materials mostly used in this system are Coe Supersoft, Supersoft, Palasive 62, Vernosoft, and Virina.

These materials lose their plasticizers in time, and because of surface roughness and liquid absorption of the material, bacterial contamination can be a problem. However, due to its good connection to PMMA, they are widely used.

Silicone Elastomers

The most widely used soft lining materials are silicone-based materials. The silicone elastomers are essentially composed of polydimethylsiloxane polymers, similar to the silicone impression materials. This helps to retain the elastic properties of the liner for *longer* periods of time. They do lack the leachable plasticizers (aren't as soft) that the acrylic resins have.

These materials, as with silicone-based impression materials, gain elastomeric properties with the mixture of silicone base and catalyzer. Ease of use and long-term softness are the most important advantages. Their softness in the oral cavity is not because of the plasticizer but their own nature. Therefore, they can maintain their resilient features for a long time. Even though these materials are chemically stable and sustain their elastic properties for a long period, an adhesive application may be necessary since their connection to the acrylic base is not direct. Current adhesives have much stronger connective properties; however, they are still not sufficient. Furthermore, the surface of soft lining material, after trimming for modifications, is not adequately polishable again, which will cause food impaction in these areas. This can lead to food impaction in the porous structure and will cause the growth of *Candida albicans* like fungi colonies, since the silicone is in the porous structure.

These materials generally comprise (poly) dimethyl siloxane + (poly) ethyl silicate. As filler material, thin-grained silica is the material of choice; silica provides roughness after polymerization but causes the dimensional stability to break down. In the market, there is only one product that does not contain filler material. Most of the products structurally contain methyl groups. Also, to obtain a satisfying result after polymerization, filler ratio and molecular group structure are changed, and plasticizer may be added.

Silicone-Based Soft Lining Materials that Polymerize in Room Temperature

In practice silicone-based soft lining materials that polymerize at room temperature are most widely used. They are composed of a polymer and filler-containing paste and a catalyzer-containing paste. As a composition, they resemble impression materials and contain polydimethylsiloxane and as cross-linker alkaloid silicate group organotin. In clinical use, even though it is satisfactory for the patient, it is now proven that it favors *Candida* growth. Even though adhesives are used, PMMA adhesion is not good, and it absorbs large amounts of water. It is advised to use adhesives for the connection of silicone-based soft lining materials to denture base. Flexibase, Ufi Gel P, C, Permaquick, Mollosil, Per-Fit, Cordex-Stabon, and Simpa are examples of silicone-based soft lining materials that polymerize at room temperature.

Silicone-Based Soft Lining Materials that Polymerize with Heat

In these types of silicone-based soft lining materials, hardening agent reacts with the active group of the polymer and frees the methacrylate group that will bond with PMMA. This material also hardens in the microwave oven. PMMA adhesion is much better when compared to other silicones, causes less *Candida* growth, and currently is the best material on the market. It has a short shelf life. However, if it is kept in the refrigerator, the shelf life can be prolonged. When compared with soft acrylics, its most important disadvantage is the low tear strength.

Silicone-based soft lining materials that polymerize with heat theoretically seem that they do not require catalyzers. However, they are generally supported with one in practice. In this way, it is assured to obtain a fast and correct polymerization process. Dichlorobenzoyl peroxide is the most widely used catalyzer for this purpose. Molloplast B and Luci-Sof are silicone-based soft lining materials that polymerize with heat.

One Paste Silicone-Based Soft Lining Materials (Acetoxy Type)

The principal forms of these materials are silicones that are used to prevent water leakage around sinks. This silicone hardens in contact with water and releases acetic acid. Surprisingly, this material gives positive results in vitro. Along with being as resilient and satisfactory as other silicones, they have better tear strength results and better adhesion to denture base. At the beginning, they have fewer wettability features than PMMA; however, they show similar features of wettability after being left in water for 6 months. Before usage, it should be left in a sodium bicarbonate solution to remove acetic acid. Per-Fit is an example of this material.

With their physical and chemical properties, silicone-based lining materials are the closest materials to the ideal form, but along with this, they have some important disadvantages. One of the most important problems is that they need the filling material to have adequate amounts of volume, viscosity, and roughness. However, filler materials absorb large amounts of water. As the water ratio increases, the filler materials swell and widen, which causes variations in dimensional stability and results in a failure of connection with the base.

Fluorinated Soft Lining Materials

A chemically unique, popular laboratory-processed soft liner that disappeared from the market more than a decade ago has recently returned. Polyphosphazene is a fluorinated nitrogen-phosphate elastomer distinctly different from plastisols and silicones. Novus (White Square Chemical Inc.) is a polyphosphazene elastomer unique in its energy-dispersing, elastic behavior. Polyphosphazene quickly deforms under load, converting the deformation energy into a small amount of heat before returning to its original shape. This unique hysteresis behavior likely accounts for the remarkably low incidence of postinsertion adjustments of dentures lined with Novus.

Developed by Japanese researchers, these soft lining materials are produced with a combination of fluoroalkyl methacrylate monomers, vinylidene fluoride/hexafluoropropylene copolymer, or vinylidene fluoride/tetrafluoroethylene/hexafluoropropylene copolymers and harden with visible light. They are chemically stable and resistant to abrasion and solvents. As well as this, the degree of water absorption is low. When compared with silicone-based lining materials, they have better wetting properties, low dissolution, and fewer residual monomers. These materials have perfect viscoelastic features. They have good adhesion to denture base because fluorinated copolymer shows a strong physical connection with acrylic resin. Contamination due to *Candida albicans* colonies is minimal. However, since plaque formation on lining material after long-term use is observed, sometimes it may be necessary to clean with denture cleansers. Recently, developed fluorinated soft lining material (Kurepeet, Kureha, content dependent on the weight of fluorinated copolymer: 50% vinyl fluoride, 30% chlorotrifluoroethylene, and 20% tetrafluoroethylene) has very low water absorption values and a very good connection to the acrylic base. Kurepeet Dough (Kureha) (indirect method) is this type of material.

Olefinic Soft Lining Materials

As well as having good elastic properties, these require a special apparatus for lining, and the lining procedure itself is complicated. As in silicone materials, they need an adhesive. Water absorption is minimal, but since the lining material can be stained by nutrients, a coating agent must be used. Molteno (Molten) (indirect method) is an example of these materials.

8.1.2 Indications of Permanent Soft Lining Materials

Before using any soft lining material, the patient should be observed to see if they really need it or not. To eliminate any mistakes made during impression taking and intramaxillary relation recording, soft lining materials should not be used. Trying to eliminate these types of mistakes by using these materials will not be the correct approach. Stresses caused by these mistakes will cause other problems. For the effective use of soft lining materials, impressions and intramaxillary relation recordings should be perfect.

If the patient has pain with his existing dentures during mastication, to begin with the form of the denture, its adaptation and occlusion should be examined. Primarily, the failings of these parts should be fixed. If the existing pain sensation persists after fixing those failings, then, it may be necessary to apply soft lining materials. For dentists who are not sufficiently experienced on the clinical usage of soft lining materials, it is advised to use a temporary tissue conditioner material for 1 or 2 months. After using tissue conditioner materials, it is decided whether the patient needs a soft lining material or not. To provide adequate space for soft lining material, it would be right to consider removing the resin width from the denture base.

8.1.2.1 Aging and Pathological Changes

One of the most important indications of soft lining materials is to decrease the problems caused by age-related changes on denture carrying tissues. A soft lining material placed in the denture will increase the effectiveness of mastication and regain the lost form caused by the thinning of the mucoperiosteum and loss of resilience. Although in most of the cases mucoperiosteal thinning is age-related, in some cases constant extreme occlusal forces may play a role in creating these kinds of situation. Furthermore, changes in hormonal levels also affect this event.

8.1.2.2 Atrophy and Resorption of Alveolar Ridge

When there is mandibular ridge resorption, the mental foramina and mandibular canal become closer to the surface (Fig. 8.2). In these types of cases, the ridge resembles a knife-edge, and if the occlusal load is applied via a hard denture base, pain sensation occurs. Nerve endings are pressed in-between the thin mucosa and sharp vertical bone tissue. Denture should not apply pressure on the nerve endings and blood vessels because it can create paresthesia in lower lip and jaw, as well as pain and mucosal irritation. In these kinds of cases, lining the tissue surface of the denture may provide comfort. Basis of this kind of treatment is to obtain tissue surface contact with an artificial soft surface that has elastic properties. This kind of material may increase the dentures' peripheral width. Parallel to the extended lifetime, denture usage time is also prolonged. As a consequence, the number of excessive bone resorption cases increased. Additionally, in cases where mandibular ridge form approaches closer to negative form, soft lining material shows less dissolution in water and has a prolonged lifetime of viscoelasticity.

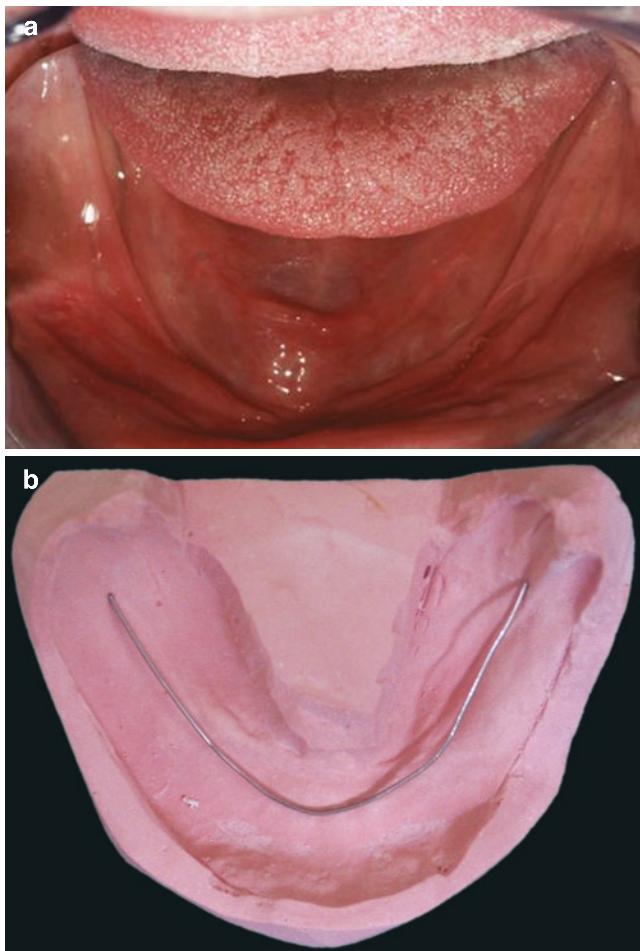

Fig. 8.2 (**a**, **b**) Mental foramen and mandibular canal get closer to the surface by the resorption of mandibular ridge

8.1.2.3 Decreasing the Pressure Locally

After extraction of natural teeth, the socket-covering mucosa may gain a rough surface following the protruding bone contours underneath. This situation is usually a result of irregular bone resorption and appears following traumatic or wrong extractions. To solve these kinds of problems, the bone arrangement is performed. Since the patients mostly do not want operational procedures, lining with soft tissue lining materials is more widely used. Also, soft tissue lining materials can be used in the presence of mandibular tori and sharp mylohyoid ridges.

8.1.2.4 Reducing Occlusal Irritation

Soft lining materials can be used to reduce or eliminate irritation caused by occlusal forces on mucoperiosteal tissues. Patients who have chronic bruxism are also included in this group. Using soft lining materials in conjunction with distributing the occlusal forces evenly, the crest is stimulated for bone tissue formation. Also, these materials increase patient comfort along with denture stability and retention. If the mucosa tissue is thick and has a lining effect, it is advised not to use soft lining material, but it would be wrong to evaluate this situation as a contraindication.

8.1.2.5 Providing Retention in the Presence of Undercuts

If there are undercut areas in the patient's mouth, this will bring about problems during the seating of the rigid denture into the mouth. When these undercut areas are present, the correct way to provide the denture a rotational entrance path is to use soft lining material. Only by placing flexible materials into the base will it be possible to provide retention. Lining materials can also be used if the surgical approach is contraindicated. In the presence of double-sided undercuts, removing them surgically may be the treatment of choice (like in tuberosity and retromylohyoid area). However, most patients do not accept a surgical intervention, as some are not available to pay the surgery costs, and others are contraindicated because of their systemic conditions. In these situations, to ease the use of the denture, the denture is relieved from the undercut facing areas. Soft lining materials can also be used to diminish the pressure on the median palatal raphe and also to prevent irritation. By placing one layer of soft lining material, the necessary relief is achieved. This way, the risk of creating a hyperplastic tissue reaction and spacing maxillary denture for relief is eliminated.

8.1.2.6 Contribution to Denture Retention

Most soft lining materials have high surface friction coefficients. Although this physical characteristic is mostly considered as a disadvantage, in some cases it can contribute to retention through friction between the denture and oral tissues.

8.1.2.7 Rehabilitation of Congenital or Acquired Defects

Soft lining materials are used in prosthetic restorations for congenital or acquired defects. Soft lining materials provide for the construction of highly retentive dentures using deep inner surfaces of defects without traumatizing or irritating the sensitive tissues (Fig. 8.3).

8.1.2.8 Following Radiation Therapy

Soft tissue lining materials are used in preventing excessive irritation in patients receiving radiotherapy. Yet, the materials are only suitable for patients who are receiving low doses of radiotherapy.

8.1.2.9 Some Systemic Diseases or Excessive Usage of Alcohol or Cigarette

Soft lining material is used to prevent the damage to the mucosa caused by the denture due to alcohol, smoking, or various systemic diseases.

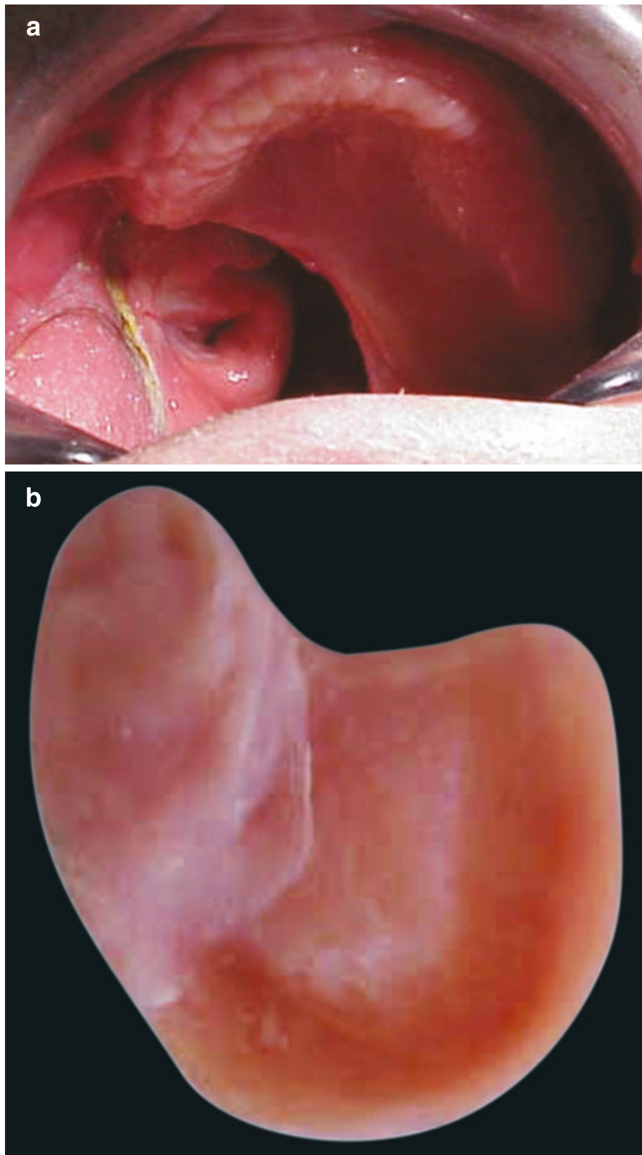

Fig. 8.3 (**a**) Defect seen on maxilla. (**b**) Soft lining material application on the obturator

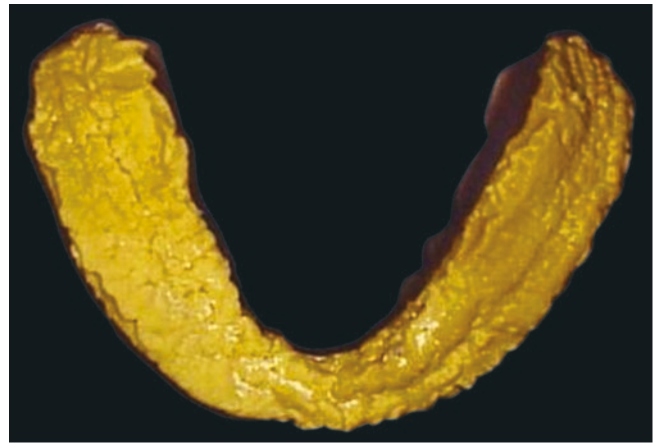

Fig. 8.4 Hardening of soft lining material

8.1.3 Desirable Features of Soft Lining Materials

Soft lining materials' resilience is mostly dependent on their thickness and physical properties. Therefore, this thickness has a critical importance on soft lining materials' clinical success.

Studies have shown that soft lining materials should have a minimum thickness of 2 mm and soft lining materials that are thicker than 2 mm have increased softness and cushion effect due to their increased compressibility. It is reported that acrylic-based soft lining materials should be applied thicker than 2 mm but thickening of more than 2 mm causes an excessive increase in compressibility and causes loss of retention of the denture. It should not be forgotten that providing this thickness could weaken the acrylic base's structural strength.

8.1.3.1 Soft Lining Materials and Viscoelasticity

Soft lining materials are also known as resilient lining materials. If the lining material is excessively resilient, base will have a tendency to hit to the residual ridge after every application of occlusal force. For these materials to function as a shock absorber to diminish the occlusal forces, lining materials should have the same viscoelasticity with the mucosa. A slight elastic turn back after deformation caused by the occlusal load is preferred over a complete elastic turn back. By the point of view, silicone and olefinic soft lining materials have rubber-like elasticity, whereas acrylic and fluorinated lining materials show viscoelastic features. Today, soft lining materials are generally resilient, and even the viscoelastic type materials do not show viscoelastic properties. Acrylic-based soft lining materials have lining effect after application, but they tend to harden in time.

8.1.4 Disadvantages of Soft Lining Materials

8.1.4.1 Hardening of the Material by Losing Its Softness

Soft lining materials are known to harden over time because they lose their plasticizers (Fig. 8.4).

Since acrylic-based soft lining materials involve more plasticizer, they become harder. Silicone-based soft lining materials have successfully passed the hardness tests because they do not involve plasticizers with the exception of a small amount in some cases. Moreover, they become even softer due to their filler material content, which over time absorbs water. Furthermore, for the materials to preserve sufficient softness for the clinical usage, they should not be prepared more than 4 mm thick or thinner than 2 mm.

8.1.4.2 Bonding to the Denture Base

The most important problem concerning a soft lining material in clinical use is its separation from the acrylic base over time, and it is due to this reason that their replacement becomes a necessity.

The bonding strength of soft lining materials becomes diminished at different levels, depending on the forces endured during the clinical usage, water absorption, and the use of denture hygiene products, absorption of nutrients, their chemical structure, and adhesive agents. Quite surprisingly, acrylic-based soft lining materials show a similar bonding strength to heat polymerizing silicone-based lining materials, even though they have close chemical structures with the acrylic base. This result is based on their plasticizer content and degree of cross-linking. Moreover, it has been shown that heat polymerizing lining materials show a greater bonding strength than room temperature polymerizing lining materials. Light polymerizing soft lining materials show a greater bonding strength than heat polymerizing soft lining materials. Finally, polymerization combined with an acrylic base shows greater bonding strength than separate polymerization (Fig. 8.5).

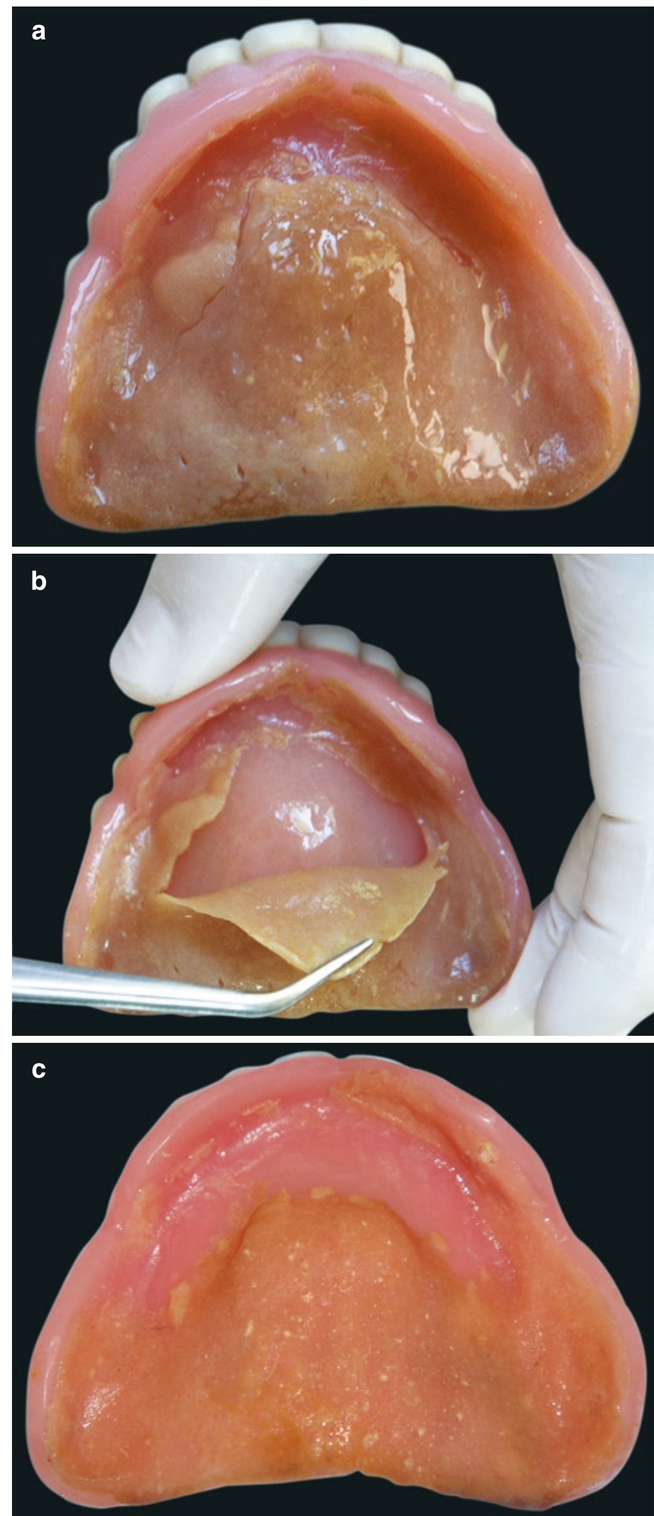

Fig. 8.5 (**a**–**c**) Separation of soft lining material from the acrylic base

8.1.4.3 Fracture of the Denture Base

In order to provide adequate space, before applying soft lining materials, a layer of acrylic is removed out of the denture base, which weakens the base and decreases its rigidity (Fig. 8.6). However, for the lining material to properly accomplish its task, it should have a certain amount of thickness.

When the intermaxillar distance is decreased, to prevent fracture of the denture, the thickness of the soft lining material should be reduced. Reducing the thickness reduces clinical efficacy as well, but the quality of the material's frictional properties will make an additional contribution to denture's retention.

The application of thick, soft lining materials may weaken the denture base. Therefore, instead of preparing a thick material, it is more important to maintain an equal thickness in all parts of the denture.

8.1.4.4 Reduction in Stability of Denture

It was thought that covering the inside of the denture with soft lining materials could reduce the denture's stability during the function and that the reason for this could be that tissue-supported dentures are already placed on a moving base and the presence of a soft lining material would further intensify this movement. Yet, there are no articles or case reports on this subject.

8.1.4.5 Cost and Application Problems

A soft lining material applied denture costs more than a classical denture. Most of the soft lining materials have complex and time-consuming production stages in the laboratory. Some soft lining materials are applied in one session, clinically; however, they have shorter service lives compared with those prepared in the laboratory. They have polishing problems, especially at the conjunction of soft lining material and acrylic base, that is, polishing procedures may damage the soft lining material and/or the acrylic base.

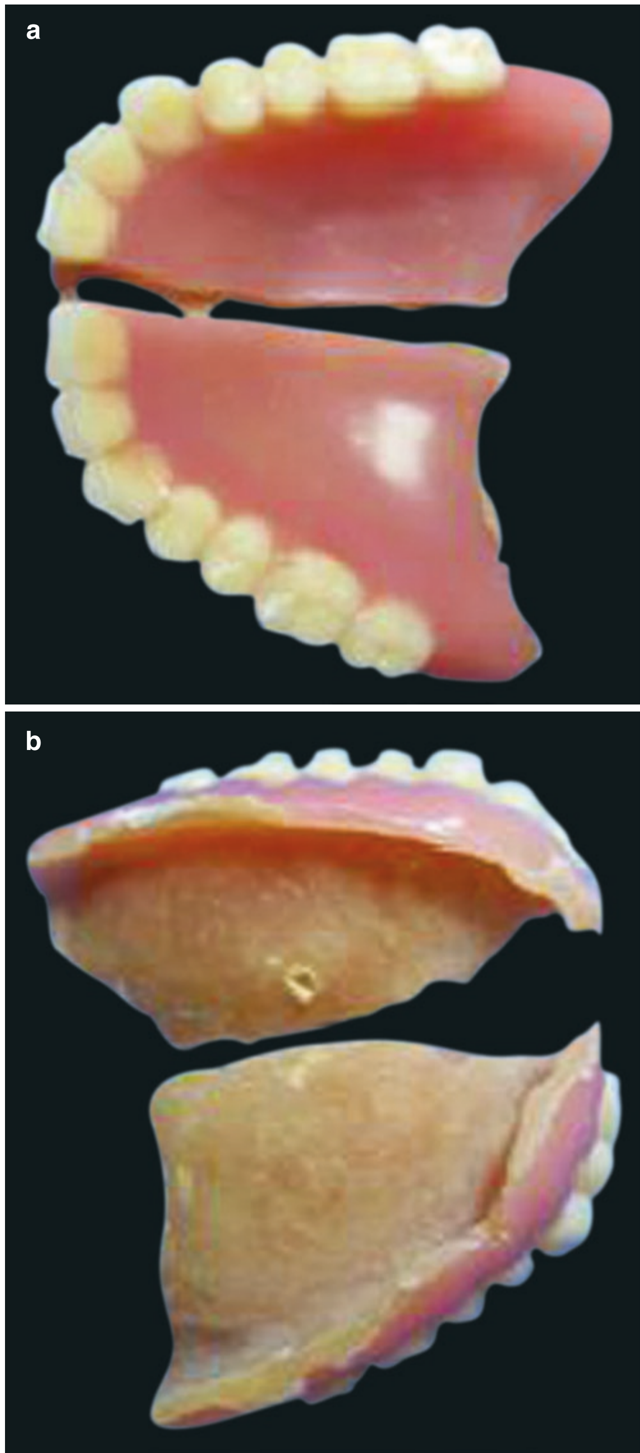

Fig. 8.6 (**a**, **b**) Fractured acrylic base as a result of the use of soft lining material

8.1.4.6 Color Stability

Plasticizers of soft lining materials may evaporate, leading to discoloration or staining. In time they absorb tobacco, denture cleansers, and nutrients, and their color changes to brown or white. Studies on this subject have contradictory results because there is no exact result identifying which soft lining material shows discoloration and which do not (Fig. 8.7).

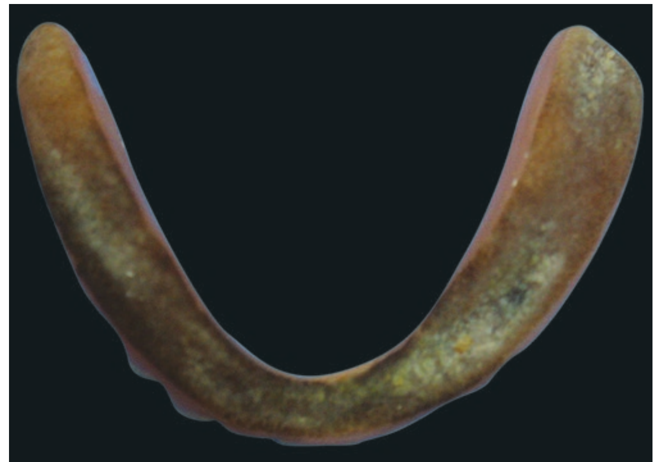

Fig. 8.7 Discoloration of the soft lining material

8.1.4.7 Candida Growth

The conditions under the denture base promote the growth of microorganisms. High humidity and temperature, as well as inaccessibility for self-cleaning by saliva, promote the replication of bacteria and fungi. *Candida* growth is one of the most important problems seen in soft lining materials. Even though silicones do not lead to *Candida* growth, wastes accumulating in their pores could cause this. The most predominant fungus is *Candida albicans*. It is known that soft lining materials show surface denaturation in time and this may cause *Candida* growth (Fig. 8.8).

8.1.5 Clinical Applications of Soft Lining Materials

It is possible to classify the application of soft lining materials as direct and indirect methods. On most occasions, soft lining materials that polymerize at room temperature can be applied with the direct method, while soft lining materials that polymerize with heat are applied using the indirect method. Some materials can be applied with either method.

With the direct method, soft lining materials are applied on the tissue surface of the acrylic base and left to polymerize intraorally. Because compared to the others this procedure is easier and can be applied intraorally, the mistake ratio is lower. However, it is prone to contamination with saliva, and because it is more challenging to protect the lining material, it is difficult to obtain enough lining material thickness. It is also not easy to obtain equal thickness on every spot. Also, some materials, such as irritation causing monomers

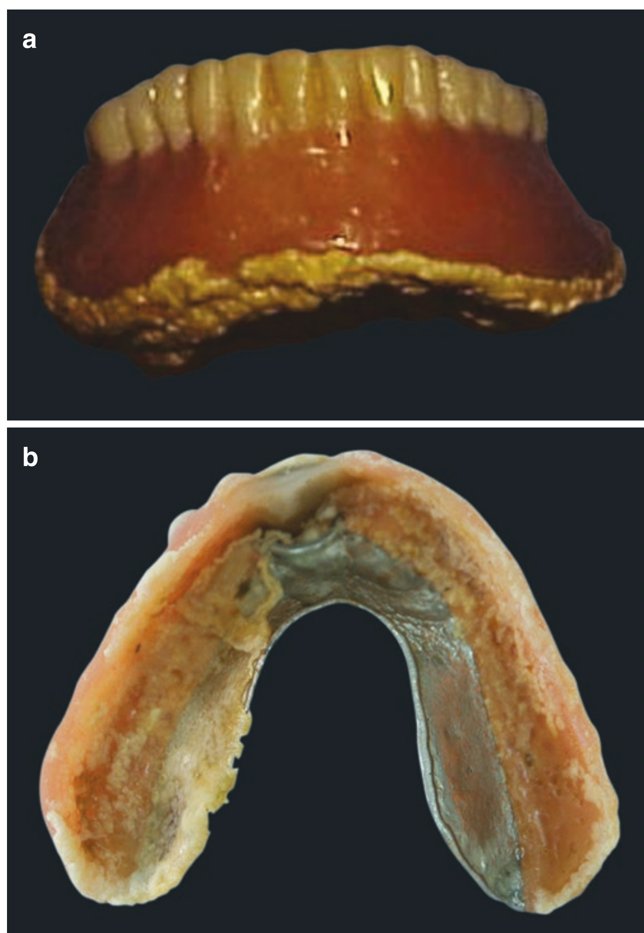

Fig. 8.8 (**a**, **b**) *Candida* growth on the soft lining material

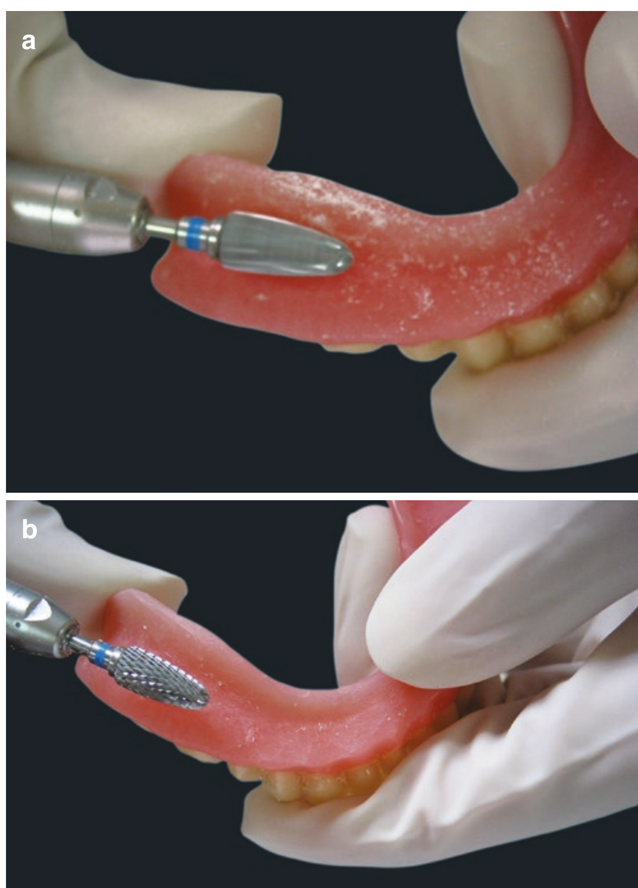

Fig. 8.9 (**a**, **b**) 2 mm trimming from the tissue surface of the denture

and polymerization heat, may lead to discomfort on the mucosa. Compared with the indirect method, the physical properties provided by the direct method are inferior. As a consequence, the direct method is only recommended for the temporary treatment of patients who cannot easily attend the clinic.

In the indirect method, the lining procedure is carried out in the laboratory after the impression is taken. In this method, one more stage is added to the denture production, but time spent in the clinic is reduced. This way, at every stage, the form and thickness of the lining materials can be checked.

The indirect method can also be applied in two different ways:

1. In the final stage of the denture production, during flasking, both the soft lining material and acrylic material are molded at the same time.
2. After the dentures are produced, a functional impression is taken and sent to the laboratory where the soft lining material is added inside the already polymerized denture.

In general, because of their ease of use, silicone-based soft lining materials are the material of choice. Out of these, the silicone-based soft lining materials that polymerize with heat are the preferred choice because of their ease of use in practice.

8.1.5.1 Application of Soft Lining Materials Using Direct Method

In this section, the application of heat-polymerized silicone-based soft liner material (Ufi Gel P, Voco, Germany) is described.

1. In order to use the room temperature polymerizing soft lining material, it is necessary to trim the denture 2 mm to create enough space for its application (Fig. 8.9).
2. The tissue surface of denture is cleaned with alcohol to remove debris (Fig. 8.10).
3. In order to provide the adherence of soft lining material, an adhesive is applied to the tissue surfaces with the aid of a brush. According to the manufacturer's instructions, there should be an interval of 1 min (Fig. 8.11).
4. After the application of the adhesive material, the catalyzer and base are placed on a glass and mixed using a spatula for around 30 s until a homogenous mixture is achieved (Fig. 8.12).

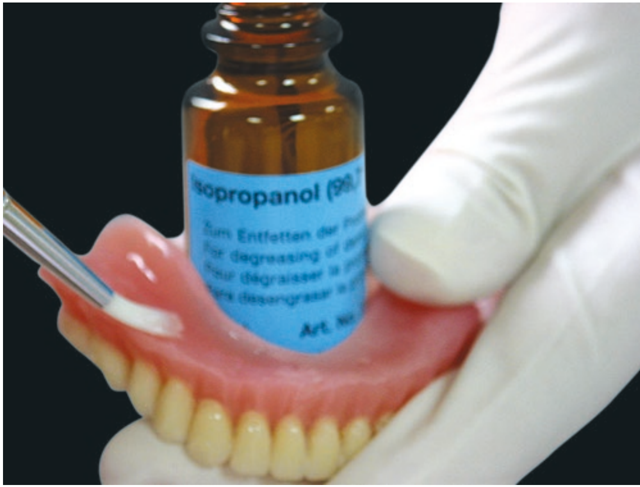

Fig. 8.10 Application of alcohol to the tissue surface of the denture

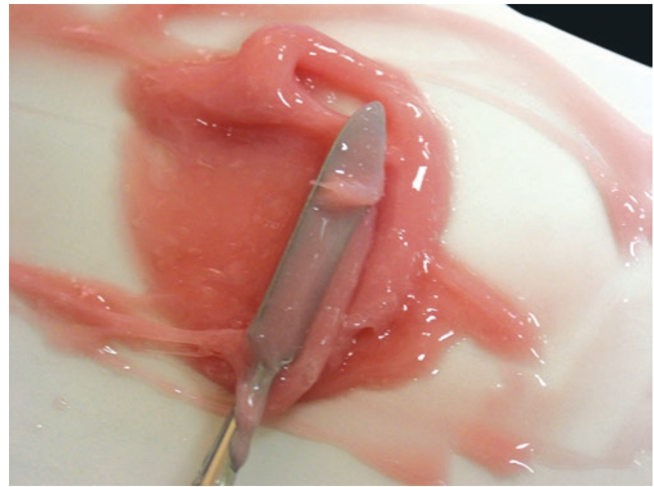

Fig. 8.12 Mixing the catalyzer and the base

Fig. 8.11 Application of adhesive with the help of a brush

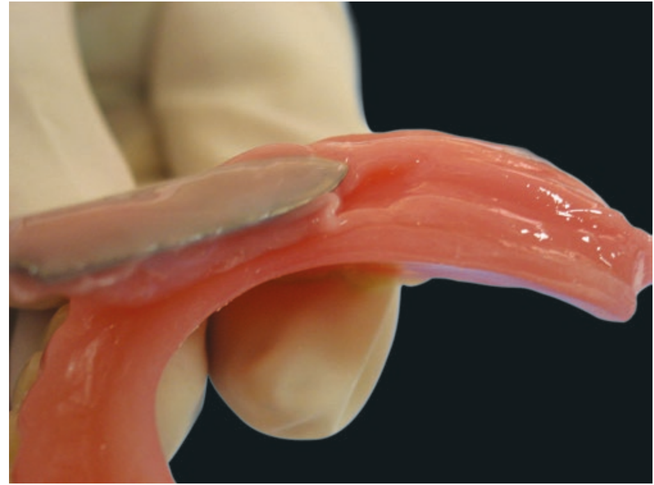

Fig. 8.13 Application of the soft lining material into the tissue surface of the denture

5. The mixture is applied to the tissue surface of the denture using a spatula (Fig. 8.13).
6. When the denture is placed in the mouth, first, the patient is asked to close his mouth in centric relation. After waiting for 1 min in this position, lip, cheek, and tongue movements are performed to transfer the surrounding tissue movements to the denture (Fig. 8.14). Since it will take 6 min for the soft lining material to polymerize, the same procedures are repeated throughout this period. During this time the patient is asked to make some speaking movements or is asked to read aloud from a newspaper to transfer the mobility of tissues to the denture. The dentures are removed from the mouth 1–2 min before the polymerization procedure is complete, and with the help of a scalpel, the excessive parts are cut off (Fig. 8.15). The denture is replaced into the mouth and left there for its final polymerization. During this time, to accelerate the polymerization procedure, it is advised

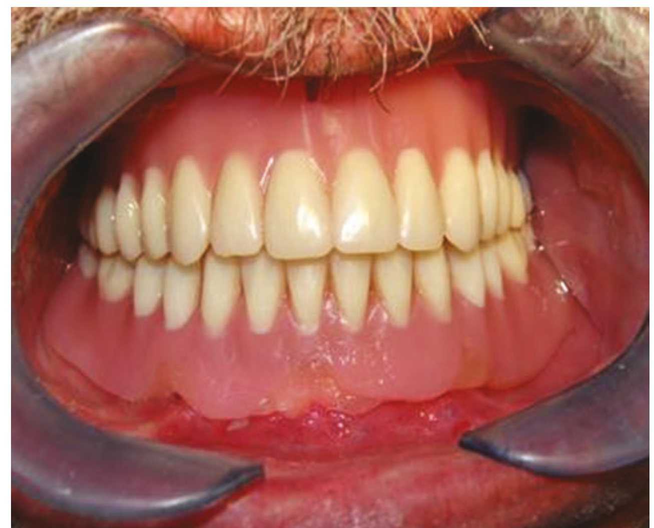

Fig. 8.14 Centric relation

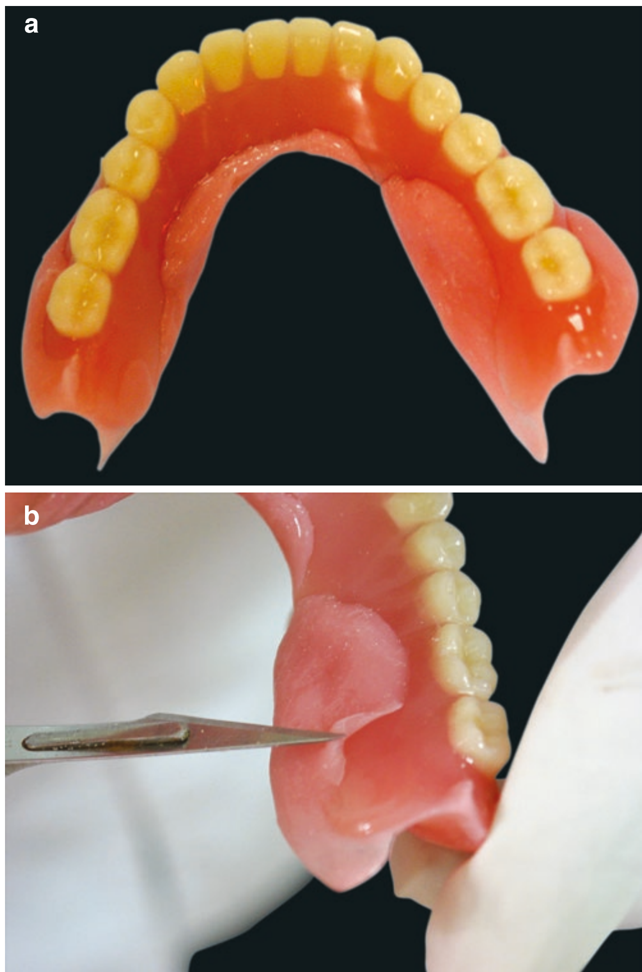

Fig. 8.15 (**a**, **b**) Removal of excess material from the borders of the denture

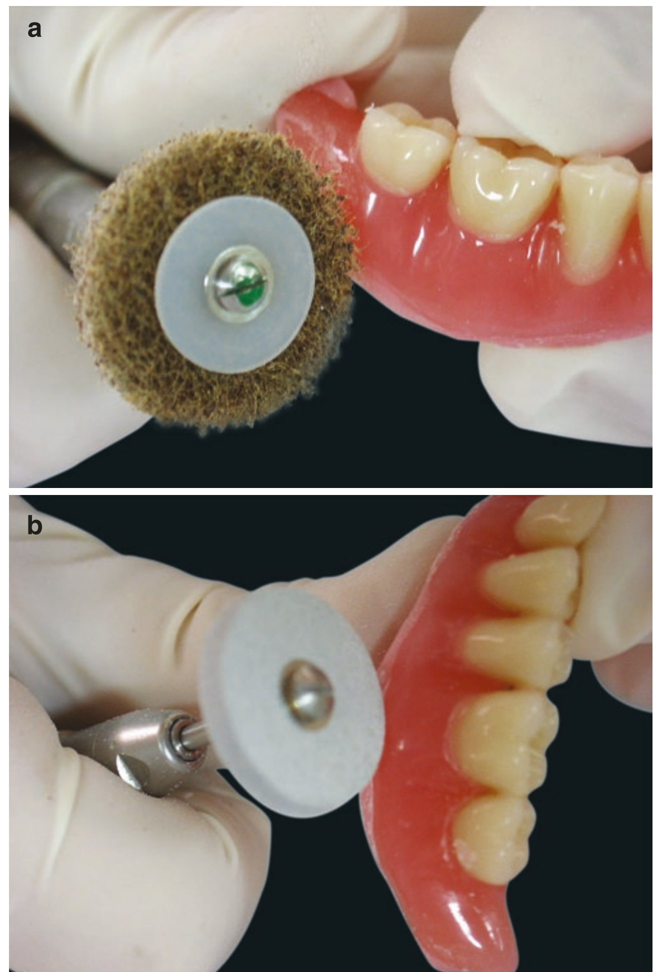

Fig. 8.16 (**a**, **b**) Border finishing of the denture

to take the denture out of the mouth and immerse it in water heated to 40–45 degrees.

7. After the polymerization is complete, abrasive and polishing drills are used for border finishing procedures (Fig. 8.16).
8. Before the dentures are delivered to the patient, polishing liquid is applied to the border areas with the aid of a brush (Fig. 8.17). After waiting for 10 min, the dentures are placed in the mouth.

8.1.5.2 Application of Soft Lining Materials Using Indirect Method

In this section, the use of Molloplast B (Detax, Germany), a heat polymerizing soft lining material, is described.

Polymerization of the Denture and the Soft Lining Material at the Same Time

1. After the try-in and wax-up, the dentures are flasked with the previously noted methods. Following the boil-out process, isolation material is applied to every surface.

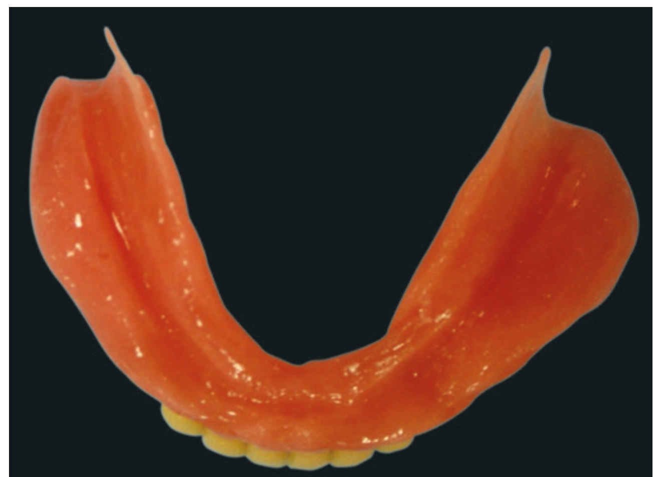

Fig. 8.17 Soft lining material inside the denture

2. An appropriate thickness of wax is applied as a spacer to the tissue surface of the model in the lower part of the flask. By placing this wax, the space needed for the soft lining material is obtained. Generally, in this procedure, a

sheet of wax (1.4 mm) is used. Depending on the mucosa thickness, wax can be applied in pieces (e.g., sharp alveolar ridge or undercut area) (Fig. 8.18).

The spacer will be transformed into lining material. Therefore, for the lining material to have a sufficient cushioning effect, following an inspection of the resorption degree and the situation of the mucosa, the thickness of the spacer should be changed and the cushioning effect should be controlled. Generally, it is enough to adapt one layer of wax to the plaster model, but if there are areas with sharp bone ridges, these areas can be covered with thicker wax. If the soft lining material is too thin, it cannot give the cushioning effect properly, whereas, if it is too thick, the denture base will be too thin and cause it to break down.

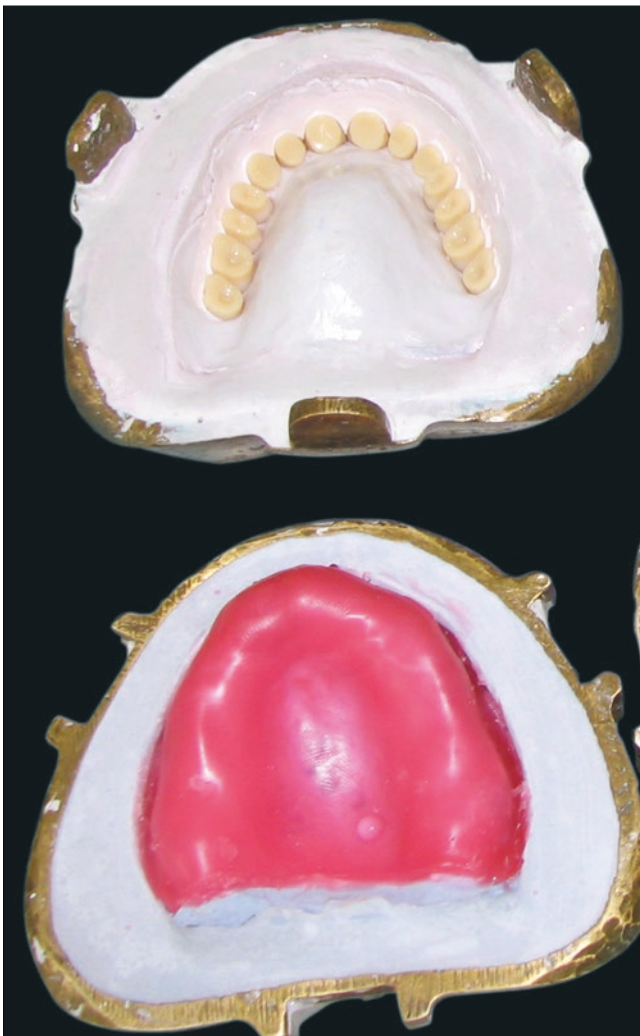

Fig. 8.18 Placement of wax to the lower component of the flask

3. Cellophane paper is placed over the spacer, and acrylic is placed into the upper component of flasks. After closing the two parts of the flask, they are slightly pressed. Then flasks are reopened to take out the excess resin material (Fig. 8.19).
4. The flask is again placed into the press machine and then heated for polymerization. Polymerization time depends on the manufacturer's instructions. Once the polymerization is completed, the flask is opened and cellophane paper is removed (Fig. 8.20).
5. Inside the polymerized denture base, which was inside the upper part of the flask, soft lining material is applied, replacing the space created by the spacer. Cellophane paper is placed over the model, and flask's components are closed up again and pressed (Fig. 8.21).
6. After leaving for approximately 4 min in the press machine, the flasks are reopened and the cellophane paper and excess soft lining material are removed. During this procedure, the denture is checked to see if there is sufficient soft lining material inside the denture. If more is needed, they are filled with more soft lining material (Fig. 8.22). The flask is closed up again and left under 100–200 kPa (kilopascal) pressure for 15 min.
7. The flasks are placed in cold water and slowly heated to 100 °C. They are boiled at 100 °C for 2 h and the polymerization stage is completed. Then the flask is left to cool in the same water. After opening up the flasks, the dentures are carefully removed and the borders are finished using the abrasive and polishing drill supplied with the soft lining material kit (Fig. 8.23).

Applying Heat Polymerized Soft Lining Material to Finished Denture

Laboratory stages are needed for the application of heat polymerizing soft lining materials. However, before sending the dentures to the laboratory for the soft lining material application, it is necessary to do some things at the clinic. To begin with, a functional impression should be taken from the denture.

1. To obtain the space required for the soft lining material, a 2 mm trim should be made (Fig. 8.24).
2. The silicone-based impression material is mixed with the aid of a spatula and applied to the tissue surface of the denture.
3. The denture is placed intraorally, and the patient is asked to close his/her jaws in a centric relation. After waiting in this position, lip, cheek and tongue movements are

Fig. 8.19 (**a**, **b**) Placement of cellophane paper over the wax spacer and placement of acrylic resin on the upper part of the flask. (**c**, **d**) Closure and pressing of the flask

Fig. 8.20 Removal of the cellophane paper after polymerization

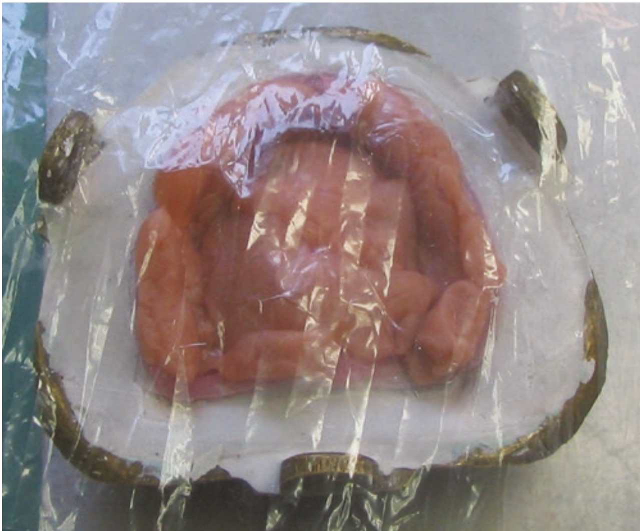

Fig. 8.21 Application of soft lining material and placement of cellophane paper

made to transfer the movements of the surrounding tissues to the denture (Fig. 8.25).

4. Following the setting of the impression material, the denture is removed from the mouth and sent to the laboratory for the application of the soft lining material.
5. In the laboratory, procedures similar to the acrylic molding stages are performed. The dentures are flasked (Fig. 8.26).
6. After the plaster is set, the flask is opened and the impression material is removed. Soft lining material will be applied into the space created by the impression material (Fig. 8.27)
7. If the soft lining material that is going to be applied is silicone based, then, to create a bond with the acrylic-based soft lining material, adhesive is applied inside the denture. It is beneficial to do this procedure more than once. The

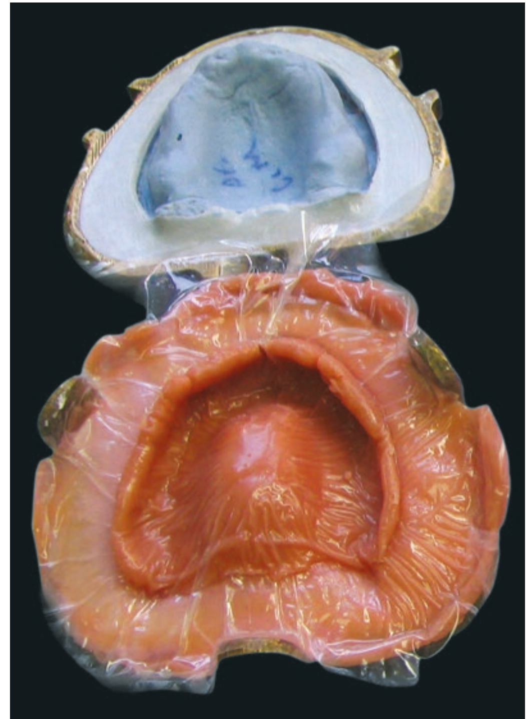

Fig. 8.22 Opening of the flask and removal of excess material

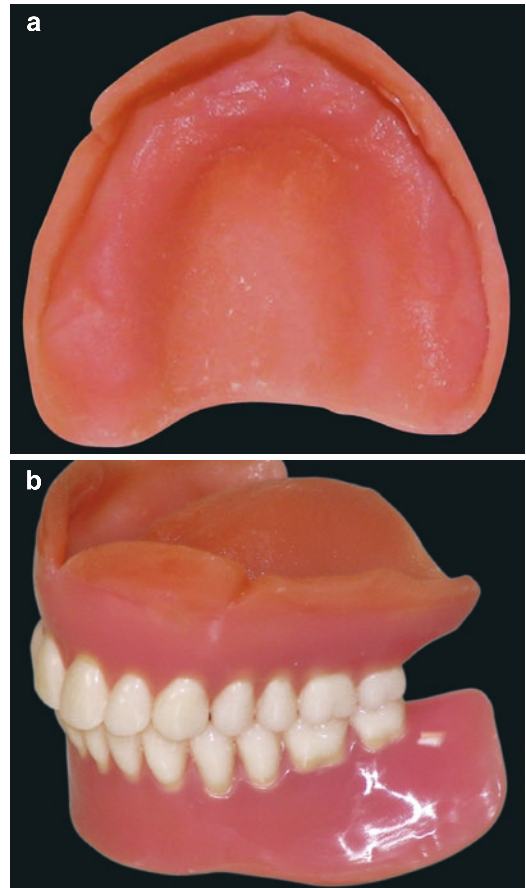

Fig. 8.23 (**a**, **b**) The appearance of the applied soft lining material

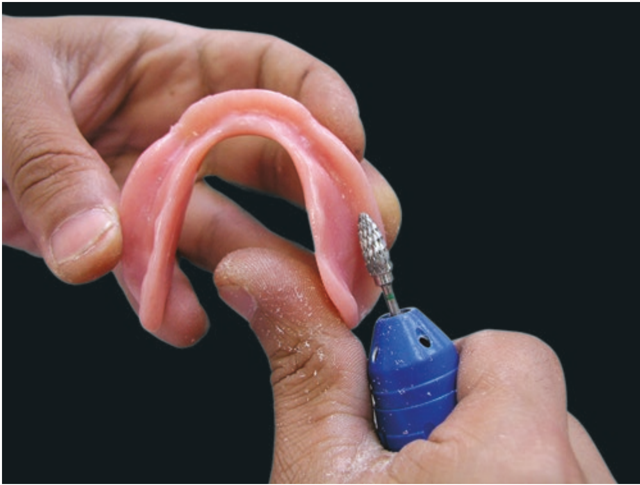

Fig. 8.24 Trimming the tissue surface of the denture

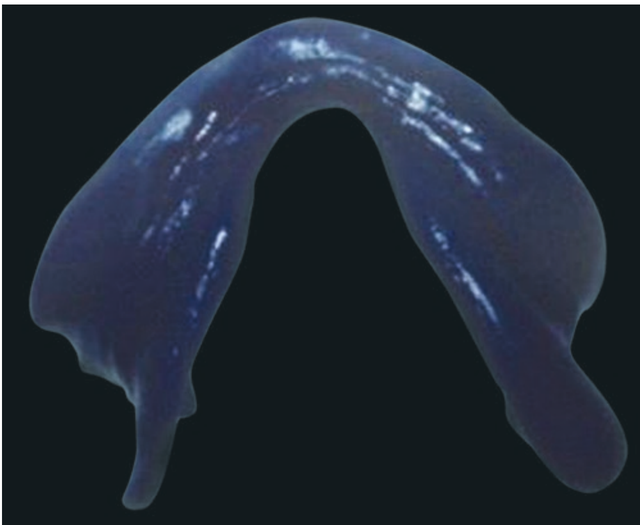

Fig. 8.25 Taking the impression with a silicone based impression material

adhesive needs to dry according to the manufacturer's recommendation (Fig. 8.28). Isolation of the plaster in the other parts of the flask should not be overlooked.

8. Heat polymerizing lining materials are generally available on the market as one paste. After application of the adhesive, soft lining material of a dough consistency is applied inside the denture. In this application, the utmost care should be taken to ensure that material totally covers the inner surface of the denture (Fig. 8.29).
9. Following the application of the soft lining material, cellophane paper is placed over the soft lining material and the flask is closed and pressed (Fig. 8.30).
10. After applying pressure for 4 min, the flask is reopened, the cellophane paper is removed, and excess soft lining material is discarded. During this procedure, a check should be made to see if there is enough soft lining material inside the denture and should it be necessary they are supplied with more soft lining material (Fig. 8.31).
11. The flask is closed up again and left under 100–200 kPa pressure for 15 min.
12. The flasks are placed in cold water and slowly heated to 100 °C. They are boiled at 100 °C for 2 h and the polymerization stage is completed. After polymerization is completed, the flasks should never be placed in cold water for easy cooling, which may cause problems in polymerization.
13. Then finishing and polishing is carried out on the already polymerized soft lining material.

8.1.6 Polishing Procedure

Even if the polymerization procedure is carried out without any flaws and the surface appears smooth, if the denture is not cleaned up properly, it will be contaminated in a short time.

Fig. 8.26 Flasking the denture

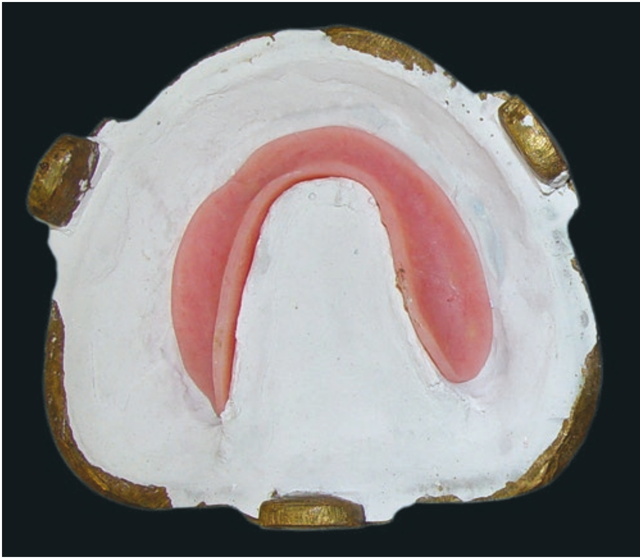

Fig. 8.27 Removal of impression material out of the tissue surface of the denture

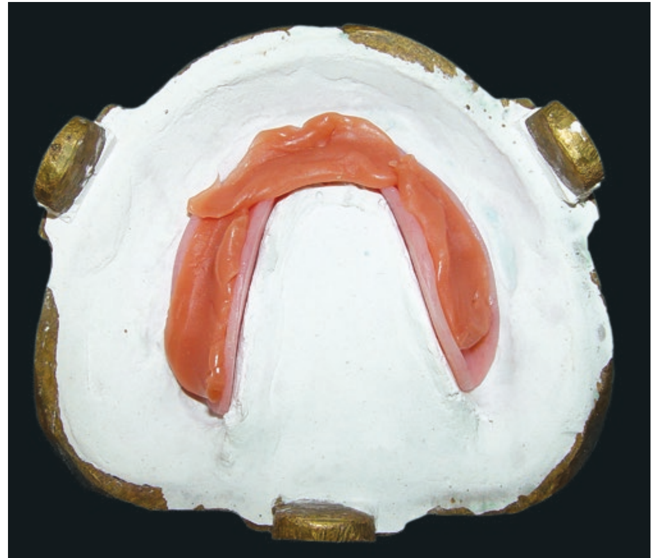

Fig. 8.29 Application of soft lining material inside the denture

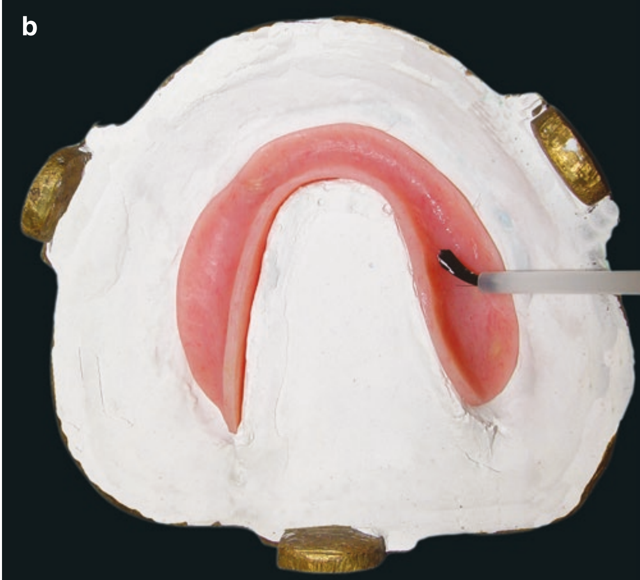

Fig. 8.28 (**a**, **b**) Application of adhesive to the tissue surface of the denture

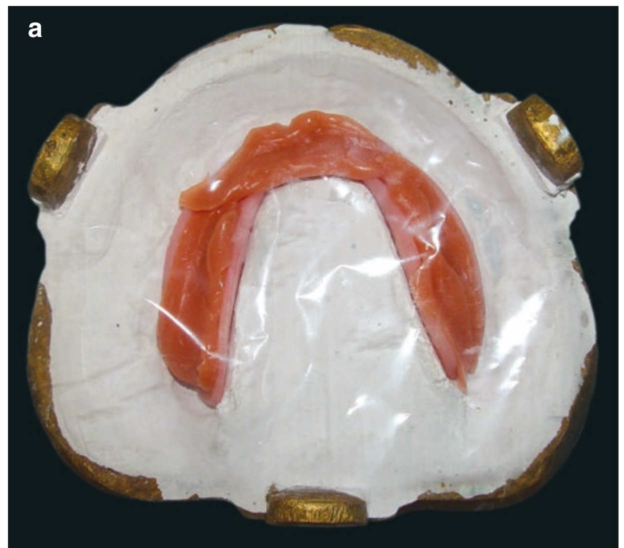

Fig. 8.30 (**a**, **b**) Placement of cellophane paper and closing the flasks

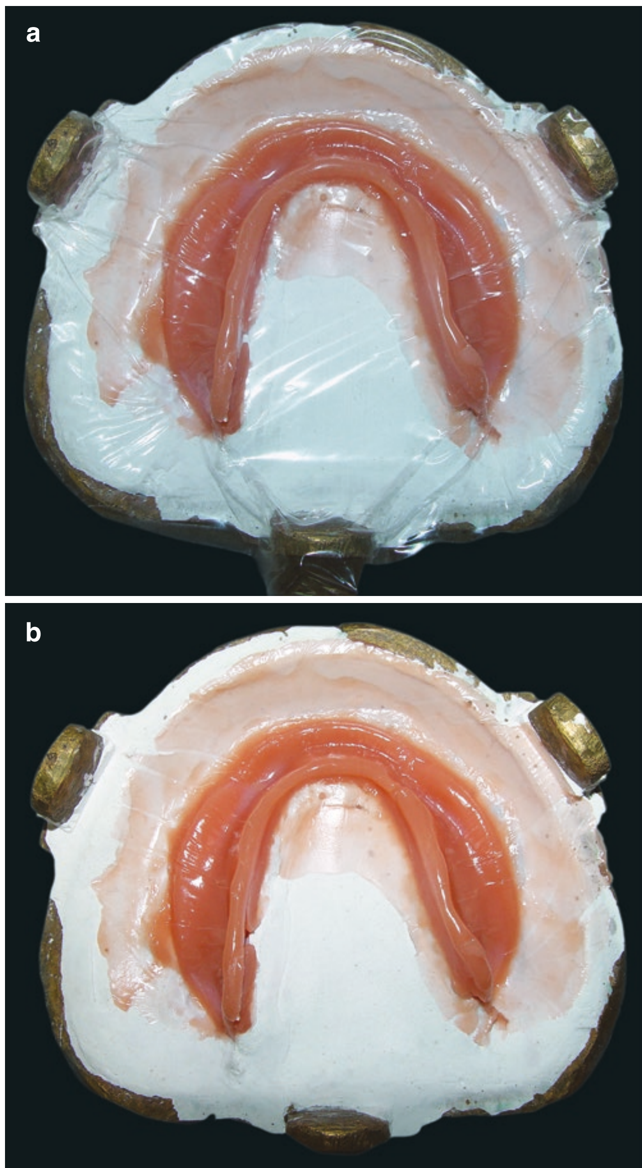

Fig. 8.31 (**a**, **b**) Opening of the flask, removal of cellophane paper, and control of the soft lining material

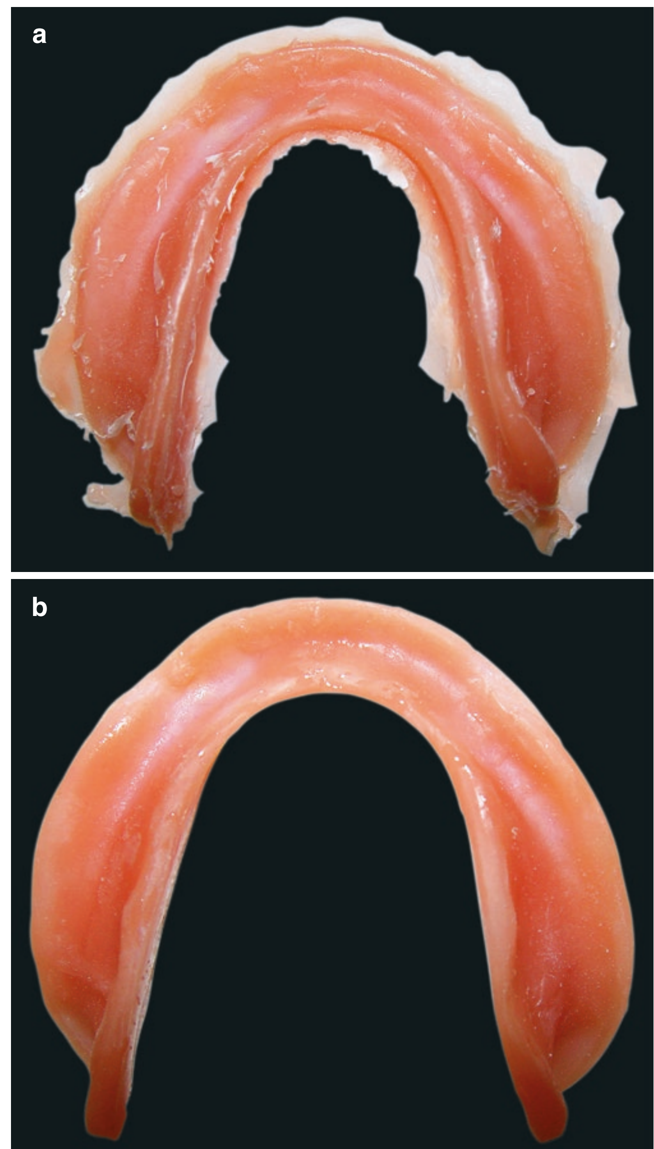

Fig. 8.32 (**a**, **b**) Polymerized and finished soft lining material

Soft lining materials, depending on the materials' fatigue, will crack and be easily contaminated during long-term use. If the contamination occurs rapidly, the primary reason for this could be the roughness of the material. The soft lining material affected by the roughness of the plaster model during polymerization causes this roughness. Hence, to decrease contamination following the polymerization, it is necessary to polish the soft lining material surface as well as the acrylic base. As a matter of fact, the polishing procedure of an elastic material is not easy, and it is useful to be aware of the basic polishing method. In this method, before polishing the soft lining material after polymerization, the soft lining material and denture are placed in a refrigerator and hardened. This way, it is possible to obtain a polished surface as with the acrylic resins.

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Part IV

Different Techniques for Problem Cases

9 Single Complete Dentures

Coşkun Yıldız and Yasemin K. Özkan

9.1 Single Complete Dentures (SCD)

SCD are complete dentures applied to whether mandible or maxilla without an antagonist complete denture. Since tooth loss is observed earlier in the maxilla than the mandible, they are usually applied to the maxilla.

Regarding the antagonist arch, there are four types of SCD:

1. SCD opposing natural dentition (Fig. 9.1a, b)
2. SCD opposing fixed partial denture (Fig. 9.2)
3. SCD opposing an existing partial denture (Fig. 9.3a, b)
4. SCD opposing an existing complete denture (Fig. 9.4)

While a complete denture is one that is fabricated according to prosthetic rules to regain chewing and speaking functions and esthetics, it should not bring about harmful effects on the teeth and supporting tissues. Even though the success criteria of complete dentures depend on the case, there are three important factors that determine a complete denture's functional success. These are *stability*, *retention*, and *support*.

In the fabrication of upper and lower complete dentures, the teeth could be arranged to obtain an ideal occlusion, whereas in SCD opposing natural dentition, this may not always be possible. Because of natural teeth positions in the dental arch, it is generally very demanding to obtain a bilateral balanced occlusion in SCD. Also, there may be teeth that are tilted mesially or distally because of an extraction space; teeth that are overerupted, which do not have an antagonist; and teeth that are rotated or located in vestibular or lingual areas, due to orthodontic anomalies. The occlusal plane inclinations of the opposing dentition of SCD are mostly inaccurate (Fig. 9.5a, b). Teeth may be malpositioned, and they can present increased tubercle inclinations (Fig. 9.5c, d), and natural teeth may be too wide buccolingually. To obtain a bilaterally balanced occlusion during eccentric movements of the mandible, these situations need to be evaluated and converted. In addition, if a SCD is produced without fixing these problems, during occlusion, the denture will receive forces that exceed physiological tolerance limits with a high lateral

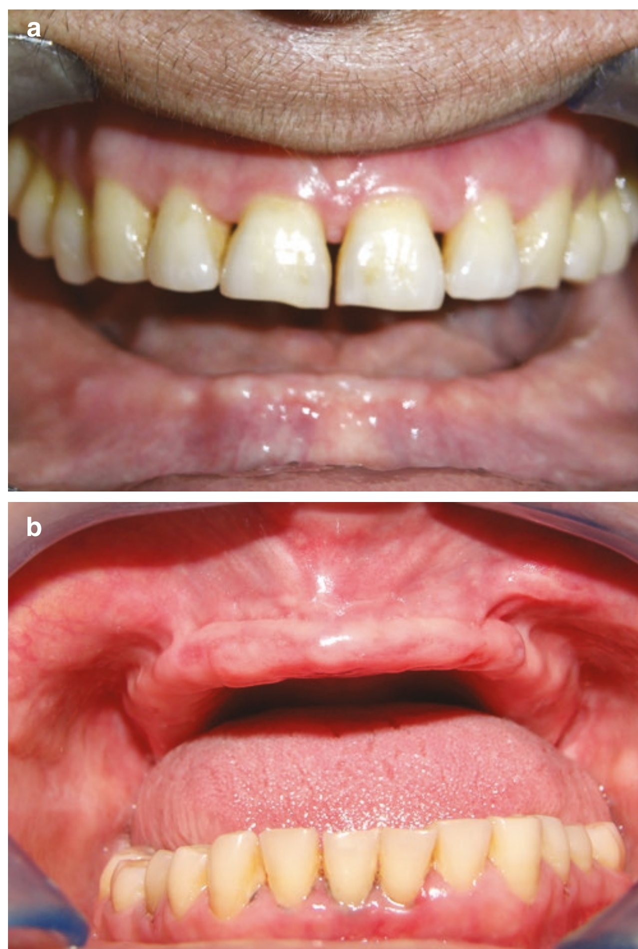

Fig. 9.1 (**a**) Edentulous mandible opposing maxillary natural dentition. (**b**) Edentulous maxilla opposing mandibular natural dentition

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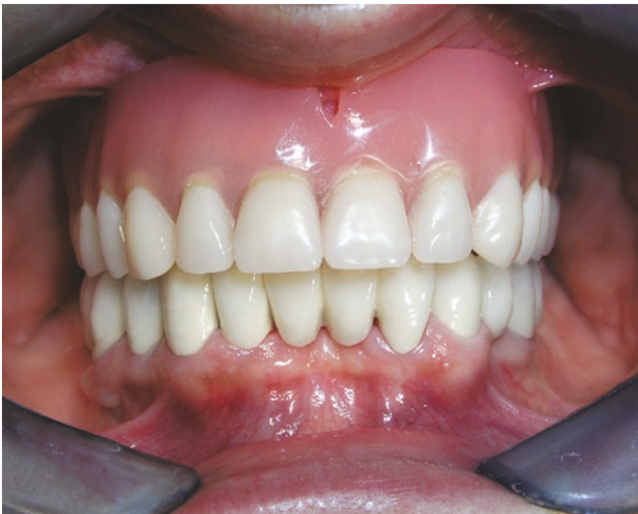


Fig. 9.2 Maxillary complete denture opposing mandibular fixed prosthesis

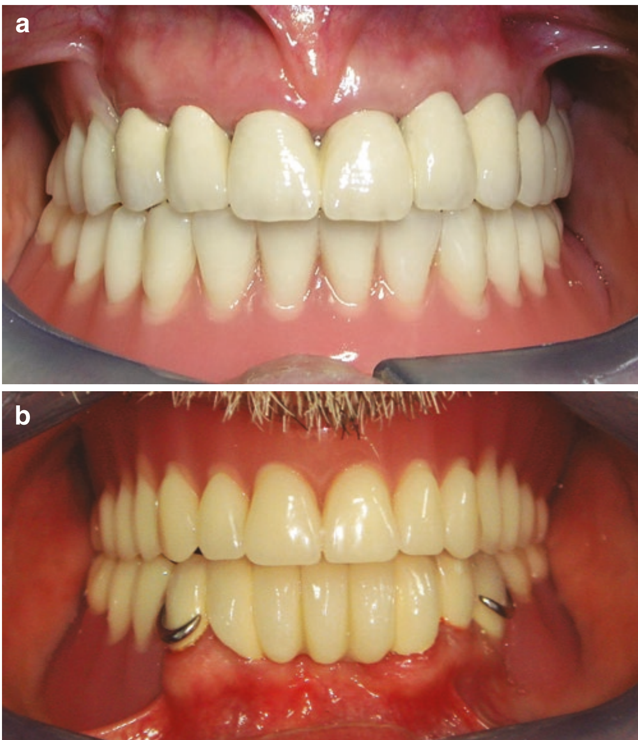


Fig. 9.3 (**a**) Mandibular complete denture opposing maxillary removable partial denture. (**b**) Maxillary complete denture opposing mandibular removable partial denture

component from the natural dentition, and this will cause traumatic occlusion. At the same time, since the natural teeth have periodontal receptors, which enable higher chewing forces than an edentulous crest, the effects of the destructive forces will be higher. Owing to limitations in the occlusal rearrangement of natural dentition, obtaining an occlusal

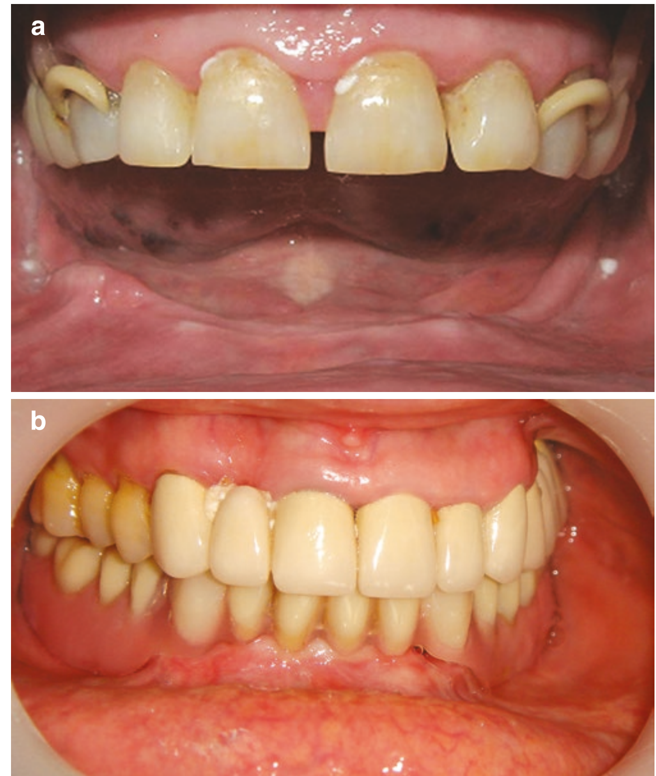


Fig. 9.4 Mandibular complete denture opposing preexisting maxillary fixed and partial prosthesis

harmony is more problematic. While obtaining good harmony with the surrounding tissues in a SCD opposing natural dentition is easy, rearranging the occlusal surfaces is very testing.

In the fabrication of SCD, it is important to know and apply all the factors that are available to obtain a bilateral balanced occlusion. To provide balance and stability, the five components of Hanau's law of articulation should be known. These are condylar path guidance, incisor path guidance, compensating curve, tubercle height, and occlusal plane. Condylar path guidance is inversely proportional with the incisor path guidance, while it is directly proportional with the compensating curve, tubercle height, and occlusal plane. Balance can be achieved when these five components are in a harmony. A change in one of these five elements requires change in one of the four other components and thanks to this balance can be achieved again. For example, if incisor path guidance increases to regain balance, condylar path guidance needs to be decreased or compensating curve, tubercle height, or occlusal plane increased. In this situation, since condylar path guidance cannot be changed, one of other three components should be increased.

Many problems are experienced, particularly during the production of a SCD opposing natural dentition or fixed

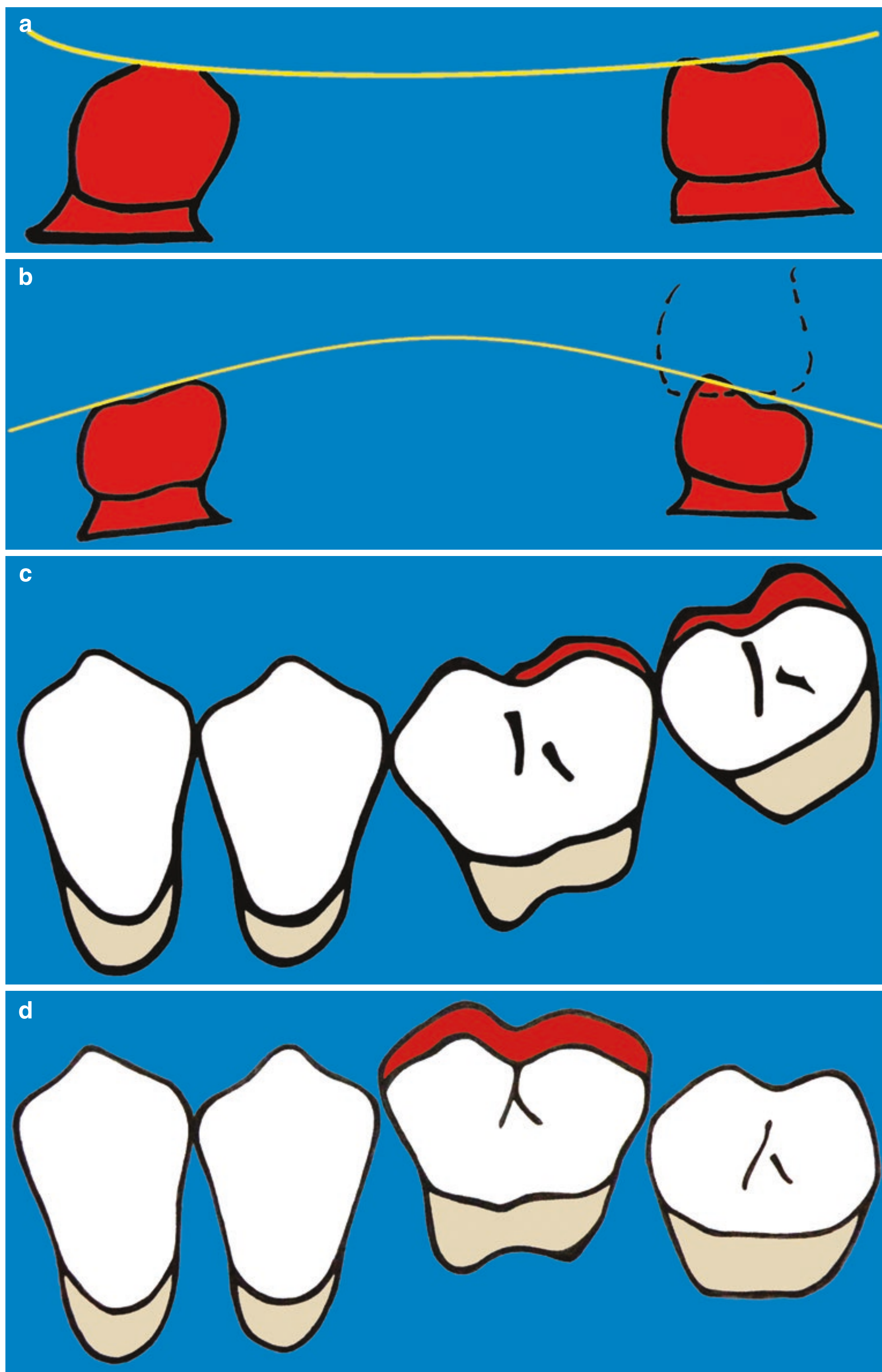


Fig. 9.5 (**a**, **b**) Inaccurate occlusal plane inclination of natural teeth. (**c**, **d**) Increased tubercle inclination of molar teeth

partial dentures. It cannot be denied there are specific rules at every stage of fabrication from beginning to end. A fabrication resembling a classical complete denture without following these rules mostly results in numerous problems.

The remaining teeth need to be fully analyzed to decrease the emanating force during function. Most dentists cannot apply the advantage of occlusal rearrangement. As a result, they have difficulties while trying to stabilize or adapt the denture.

9.1.1 Reasons That Complicate the Fabrication Stages of SCD

1. Due to the excessive forces from natural dentition or fixed dentures, loss of denture stability, undesirable movement of the denture, fracture due to the bending forces, and excessive ridge resorption may occur (Fig. 9.6a, b). Excessive forces coming from anterior natural dentition lead to alveolar bone resorption of the opposing edentulous crests, called the "mobile ridge," which makes denture fabrication difficult (Fig. 9.7a, b).
2. Disruption of stability and retention, as a result of the inability to create a balanced occlusion, due to the malposition of natural teeth (e.g., tilting, overeruption, rotation).

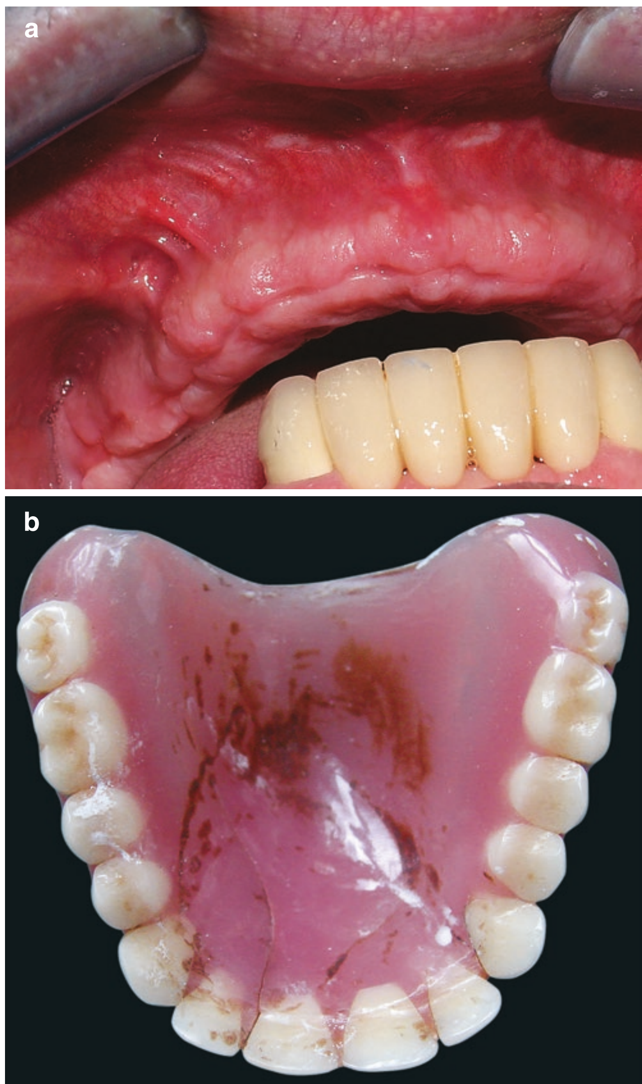


Fig. 9.6 (**a**, **b**) Denture fracture occurring due to the excessive forces in a mandibular Kennedy I case opposing maxillary complete denture

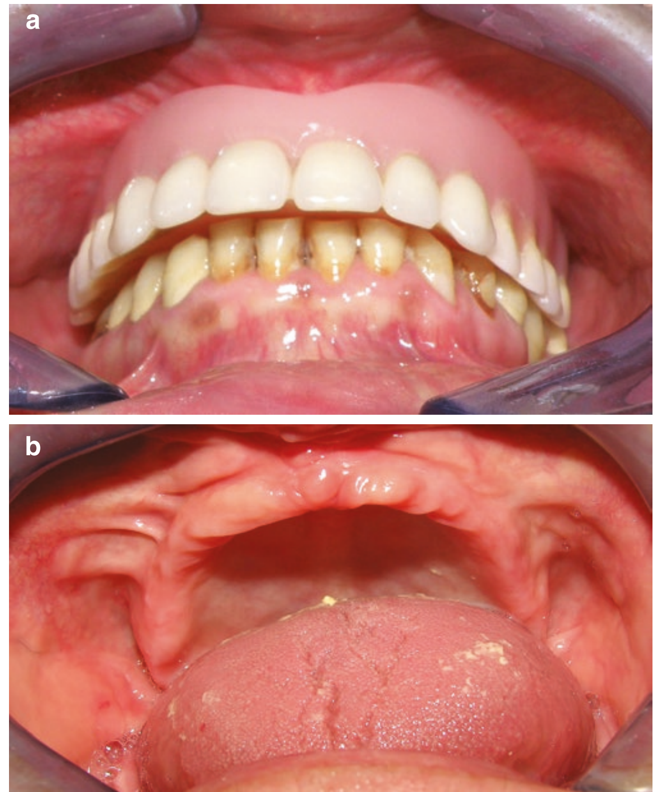


Fig. 9.7 (**a**, **b**) Anterior labile ridge formation on maxilla due to unbalanced maxillary complete denture opposing mandibular natural dentition

3. Disruption of occlusal plane harmony because of the mesial tilting of teeth on the antagonist arch can cause problems.

To overcome these problems, the diagnosis and treatment plan is very important.

9.1.2 Examination of Patients for SCD

1. *Examination of the edentulous area*
2. *Examination of the natural teeth on the antagonist dental arch*
3. *Features of denture base*
4. *Occlusion*
5. *Types of artificial teeth*

9.1.2.1 Examination of the Edentulous Area

(a) *Alveolar ridge*
(b) *Features of the mucosa*
(c) *Frenums*
(d) *Tori*

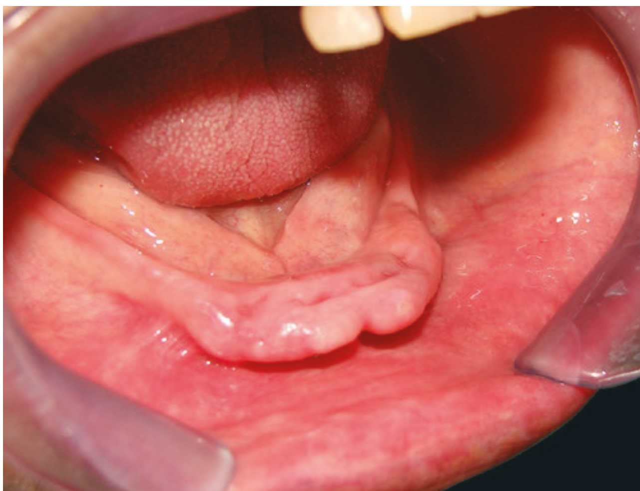


Fig. 9.8 Protrusive ridge resulting from improper extraction in mandibular anterior area

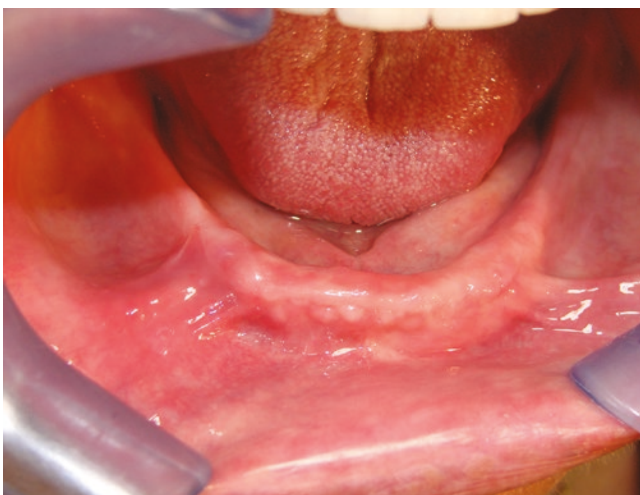


Fig. 9.9 The view of the ridge after alveoloplasty operation

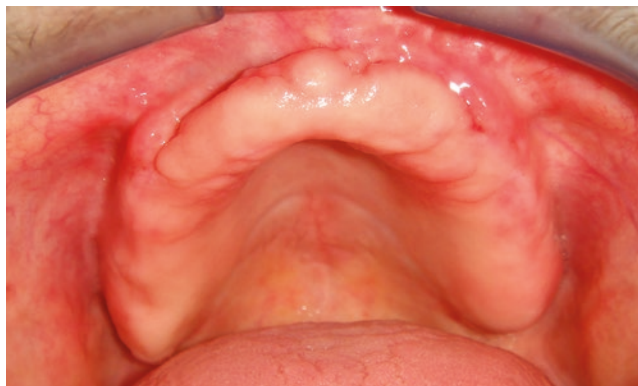


Fig. 9.10 Mobile ridge formation on the maxillary anterior area

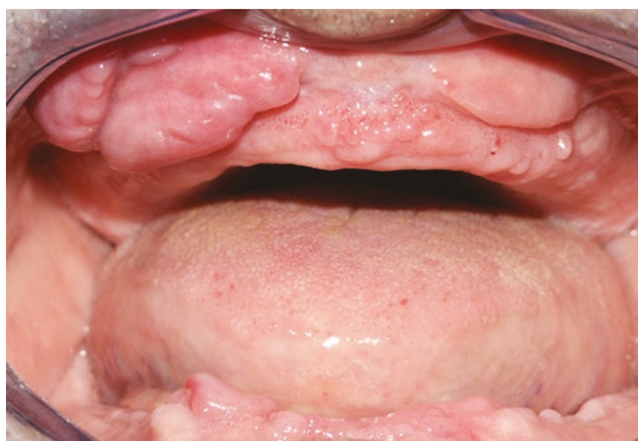


Fig. 9.11 Excessive formation of epulis fissuratum in the maxilla

Alveolar Ridge

Because the alveolar ridge plays a great role in denture stability and retention, the resorption amount of the alveolar ridge is very important for the prognosis of the SCD. Bone irregularities on the alveolar bone should be removed surgically (Fig. 9.8), or soft lining materials should be applied (Fig. 9.9).

Features of the Mucosa

Ideal mucosa thickness is about 1.5 mm. While thinner mucosa becomes irritated easily, a thicker and mobile mucosa may cause difficulties in denture usage. The formation of the mobile ridges is directly related to alveolar ridge resorption and is mostly seen in patients who have been using dentures for a long period of time. This situation, which is encountered more on the upper alveolar ridge, is mostly seen in the anterior region on both of the arches (Fig. 9.10). Since mobile ridges provide a weak retention for the denture, they need to be removed surgically. However, if removing this mobile mucosa will decrease the supporting area, they can be kept in the mouth, as it is better to have a mobile ridge rather than no ridge at all.

Fibrous tissue hyperplasia or epulis fissuratum may occur due to an ill-fitted denture (Fig. 9.11). Before fabricating a SCD, these problems should be resolved. Denture flanges should be shortened, and/or the epulis fissuratum should be removed surgically.

Frenums

Frenum areas should be trimmed in the denture base to prevent retention loss of the denture (Fig. 9.12a). However, if these frenum are too long and wide, the area prepared for the frenum on denture base will be too wide and will eventually weaken the denture (Fig. 9.12b). In this case, especially if there is natural dentition on the antagonist arch, the occlusal

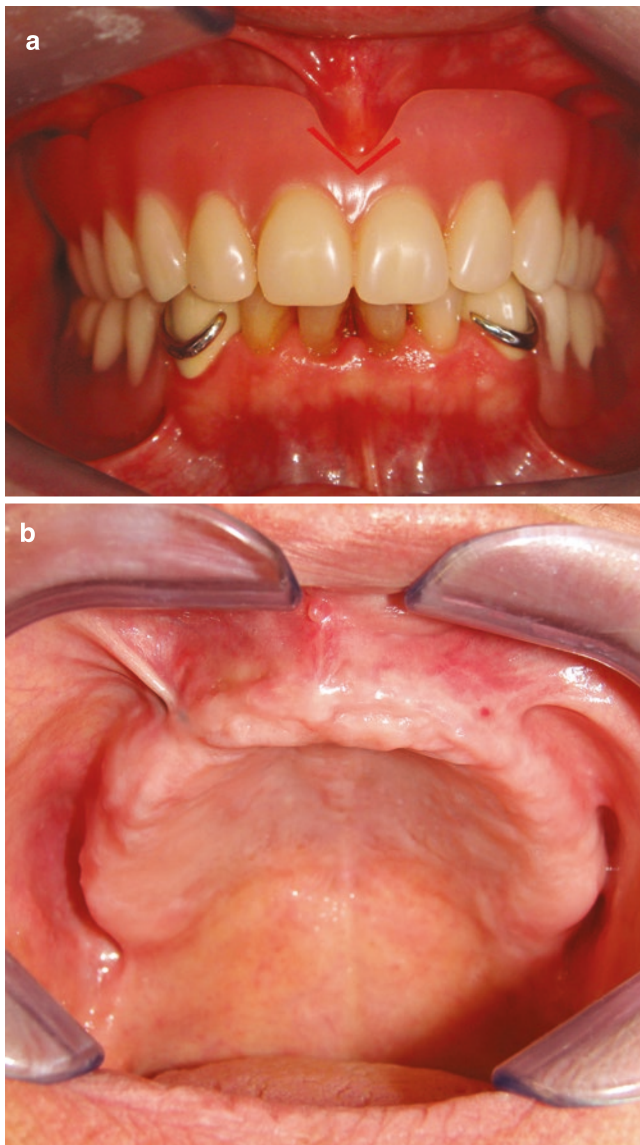


Fig. 9.12 (**a**, **b**) Distinct maxillary labial and buccal frenums

forces will be concentrated on this particular area and will result in denture fractures. In such conditions, a frenectomy procedure is advised.

Tori

Tori, which are nodular projections on the bone, could be seen in both the upper and lower arch. Although small tori do not create many problems while using dentures, large tori may disturb denture stability, irritate the mucosa, and cause fractures in the denture base. Wide tori that cause difficulties when fabricating and wearing the denture should be surgically removed. If the tori are small, relief should be made in the areas (Fig. 9.13a, b).

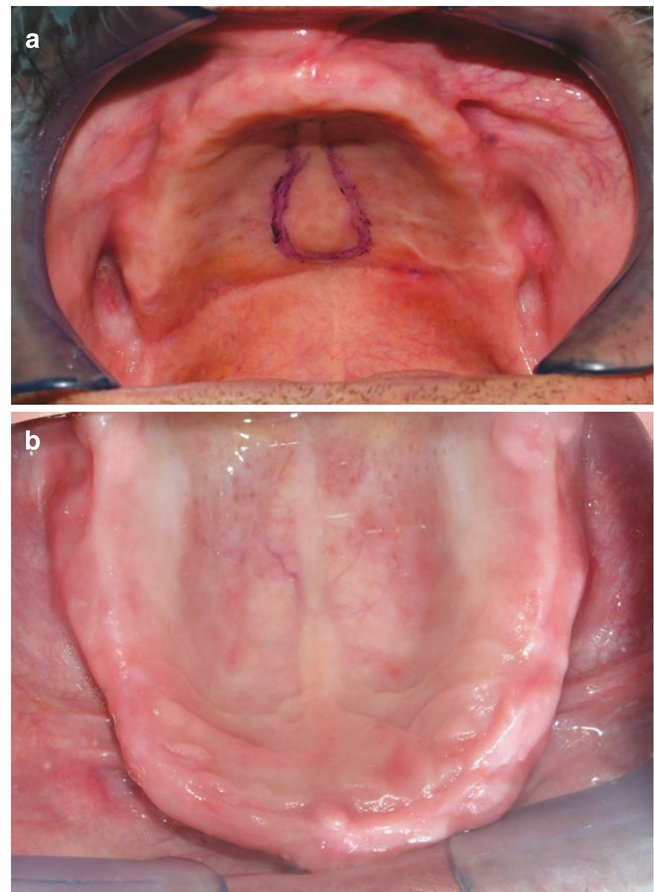


Fig. 9.13 (**a**) Maxillary palatal torus on midline. (**b**) Prominent maxillary midline suture

9.1.2.2 *Examination of the Natural Teeth in the Antagonist Arch*

(a) *Number and position of natural teeth*
(b) *Occlusal surface of natural teeth*
(c) *Crossbite relationship*

Number and Position of Natural Teeth

The number and position of the natural teeth play a significant role in the success of SCD opposing natural dentition (Fig. 9.14a, b). The wrong distribution of the forces that are applied on a complete denture and alveolar ridge will affect denture stability, cause resorption in the alveolar ridge, and damage the mucosa. Disruptions in the occlusal plane may be encountered due to the tilting, overeruption, and rotation of teeth, which can be caused by orthodontic anomalies and/or extraction sites. When a SCD is fabricated opposing these malpositioned teeth, the contact occurring during

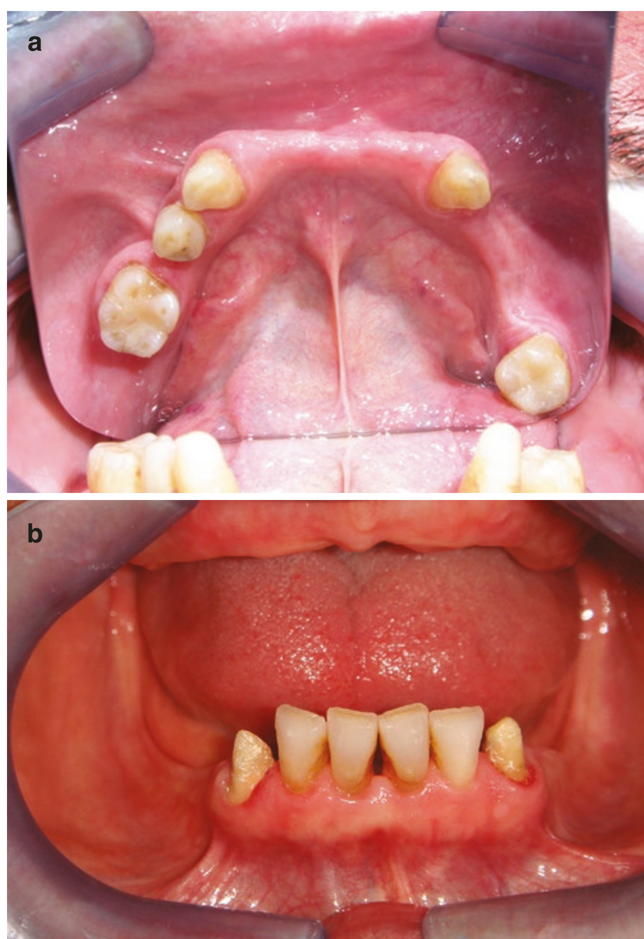


Fig. 9.14 (**a**, **b**) Different distributions of mandibular teeth opposing a maxillary single complete denture

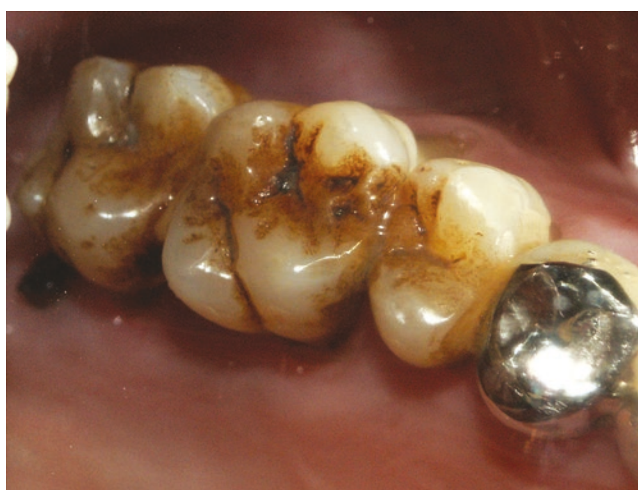


Fig. 9.15 Having high tubercles on natural dentition indicates that the patient has low chewing force

functional movements will disturb stability. Teeth with positional anomalies should be moderated to obtain a bilateral balanced occlusion, by trimming the overerupted teeth and restoring the teeth that cannot be treated in any other way.

Occlusal Surface of Natural Teeth

While natural teeth having high tubercles indicate that the patient has a low occlusal force and performs less eccentric movements during function (Fig. 9.15), excessively abraded teeth show that the patient has high occlusal force, performs wide lateral movements during function, grinds abrasive nutrients, and performs parafunctional movements (Fig. 9.16a, b).

Prior to the production of the SCD, decreasing the tubercle height of the teeth with high tubercles will positively affect the stabilization of the denture (Fig. 9.17). SCD applied to patients with excessively abraded teeth will have a

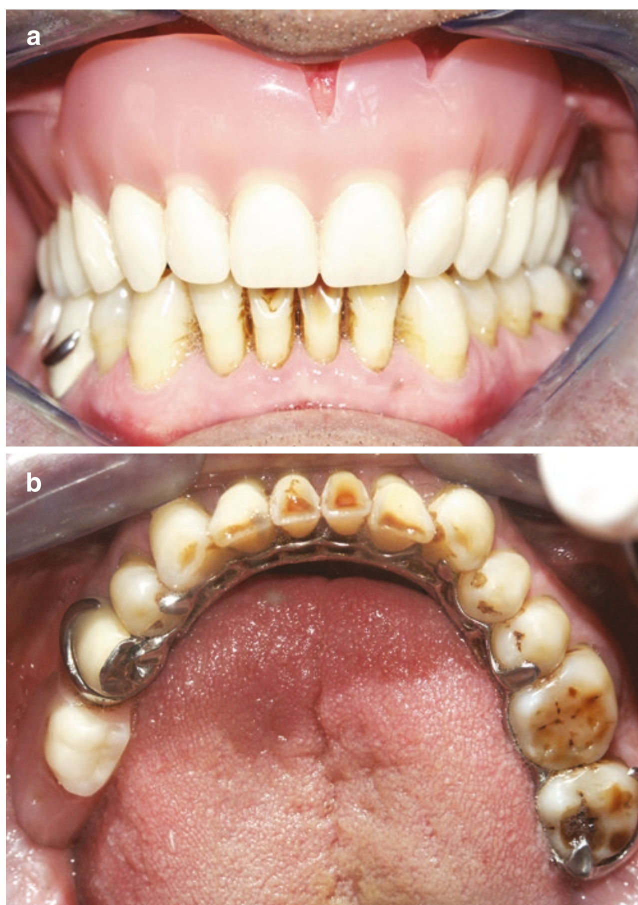


Fig. 9.16 (**a**, **b**) Having abraded tubercles on natural dentition indicates that the patient has high chewing force

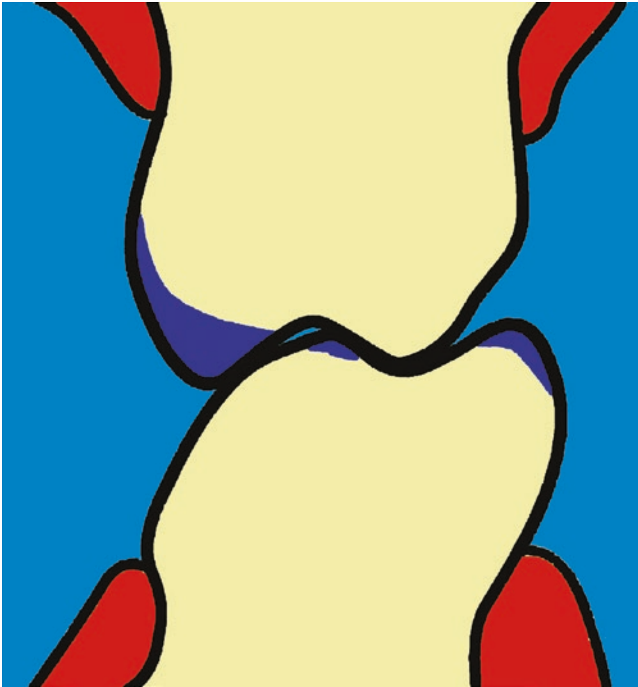


Fig. 9.17 Decreasing the tubercle height of natural teeth that have high tubercles

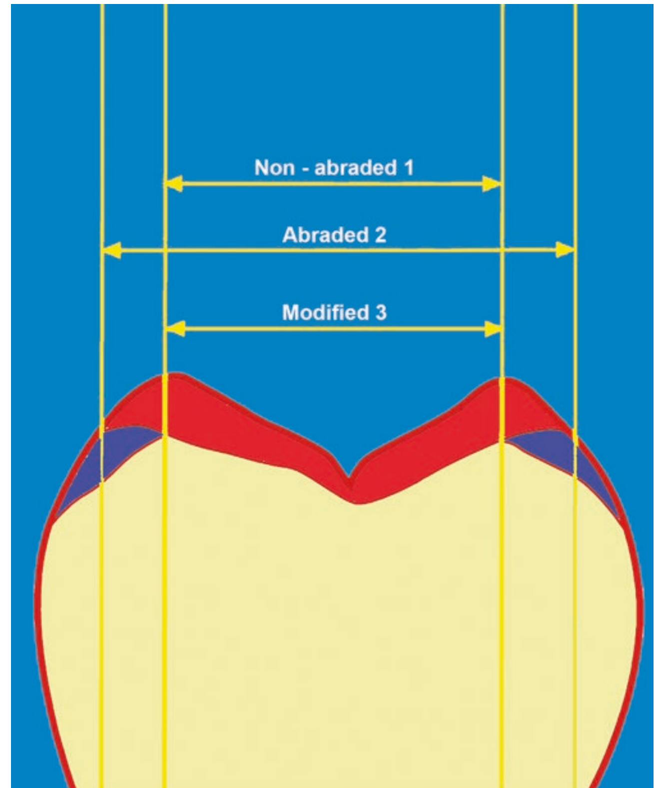


Fig. 9.18 Since the buccolingual width of teeth which have reduced tubercle height will increase, before fabricating a single denture, buccal and lingual surfaces of these teeth should be grinded

lower chance of success. Since the buccolingual distance of the abraded teeth will be increased as well, first, an attempt should be made to regain the former functional width of the occlusal surfaces, by grinding on the buccal and lingual surfaces (Fig. 9.18).

Crossbite Relationship

A narrow maxilla opposing a wide mandible creates disharmonies in teeth relations, and crossbite negatively affects the prognosis of a SCD. In situations where teeth are in crossbite, extra care should be taken during the teeth arrangement procedure. For a SCD that is going to be fabricated opposing a wide mandible with natural dentition, the posterior teeth should be aligned peripherally from the denture base but should never be on the denture border; otherwise, harmful forces will emerge. To centralize the occlusal contacts in the event of crossbite, the central fossa of maxillary teeth and lingual tubercles of mandibular teeth should be in contact and the buccal tubercles modified to increase denture stability (Fig. 9.19a, b).

9.1.2.3 Features of Denture Base

Bases of SCD, as in conventional complete denture, should cover an area as wide as possible within the limitations of physiological tolerance, and with this pressure on a unit area is minimized.

On areas that have tori or bone protuberances that cannot be surgically removed, relief should be made on the tissue surface of the denture base; if not, irritation on mucosa, loss of stabilization, and denture base fractures will occur. If there is excessive resorption on the alveolar ridge, the palatal raphe is protruded, or tori or bone protrusions are present, soft lining materials could be applied. Thus, both pressure on the alveolar ridge is decreased and denture base fractures are prevented. Reinforced base materials could be also used to prevent denture fractures.

9.1.2.4 Occlusion

In SCD, most important reason for denture fracture is the inaccurate arrangement of the occlusion. The occlusion will create unstable pressures on denture and result in denture base fractures. On account of this, during fabrication of the denture, occlusal rearrangements and occlusal control should be done carefully, and the occlusion should be rechecked before it is delivered to the patient, and occlusion control should be performed during the repair of probable denture base fractures.

To obtain maximum denture stabilization in SCD, there should be bilateral balanced occlusion in which simultaneous bilateral contacts form without any early contacts in posterior teeth during eccentric movements (Fig. 9.20).

For posterior artificial teeth selection with SCD, form and size of natural teeth on antagonist arch should be kept in

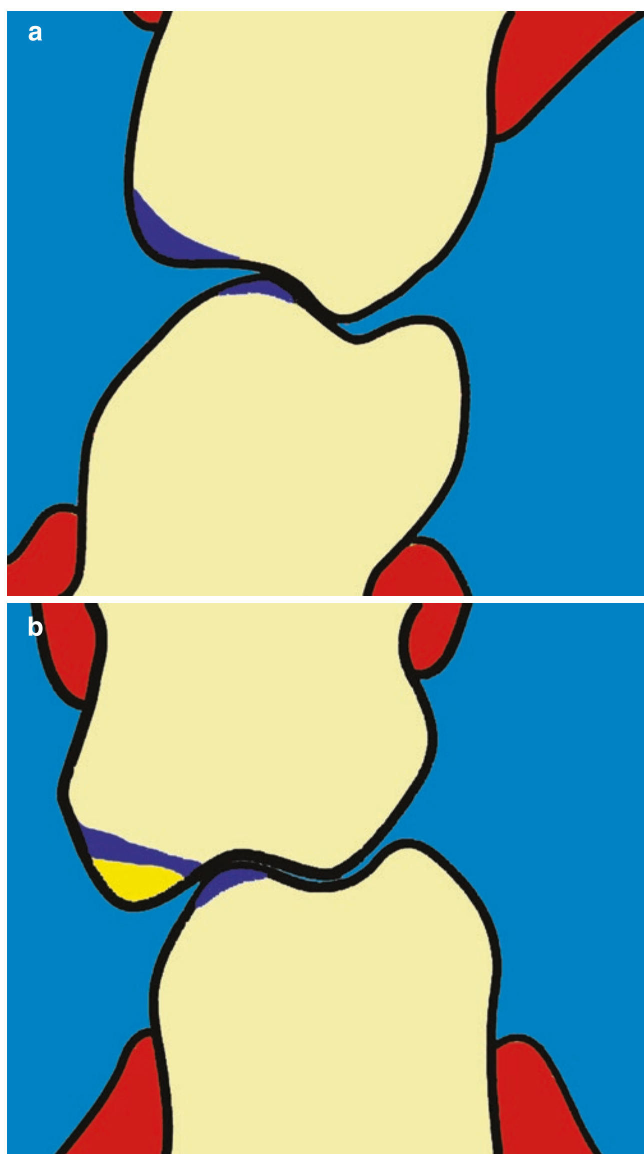


Fig. 9.19 (**a**, **b**) In case of crossbite, to centralize the occlusal contacts, central fossa of maxillary teeth should be in contact with mandibular lingual tubercles. While doing this, to increase the stability of denture, buccal tubercles should be modified

mind. If tubercle inclinations of natural teeth are low, teeth with approximately 20° tubercle inclinations should be selected, and if tubercle inclinations of natural teeth are high, teeth with 33° tubercle inclination should be selected. If posterior teeth have a straight occlusal surface, then, teeth with 0° tubercle inclination should be selected. Yurkstas defends that, rather than having teeth that have contacts on steep surfaces, which is an occlusion in which the teeth show a strong interdigitation, it is better to have a tubercle-tubercle relationship in which teeth contacts are on shallow inclinations with point-like contact surfaces (Fig. 9.21).

In SCD, incisal path inclination should be close to 0 degrees as long as the esthetic and phonation allow. To obtain

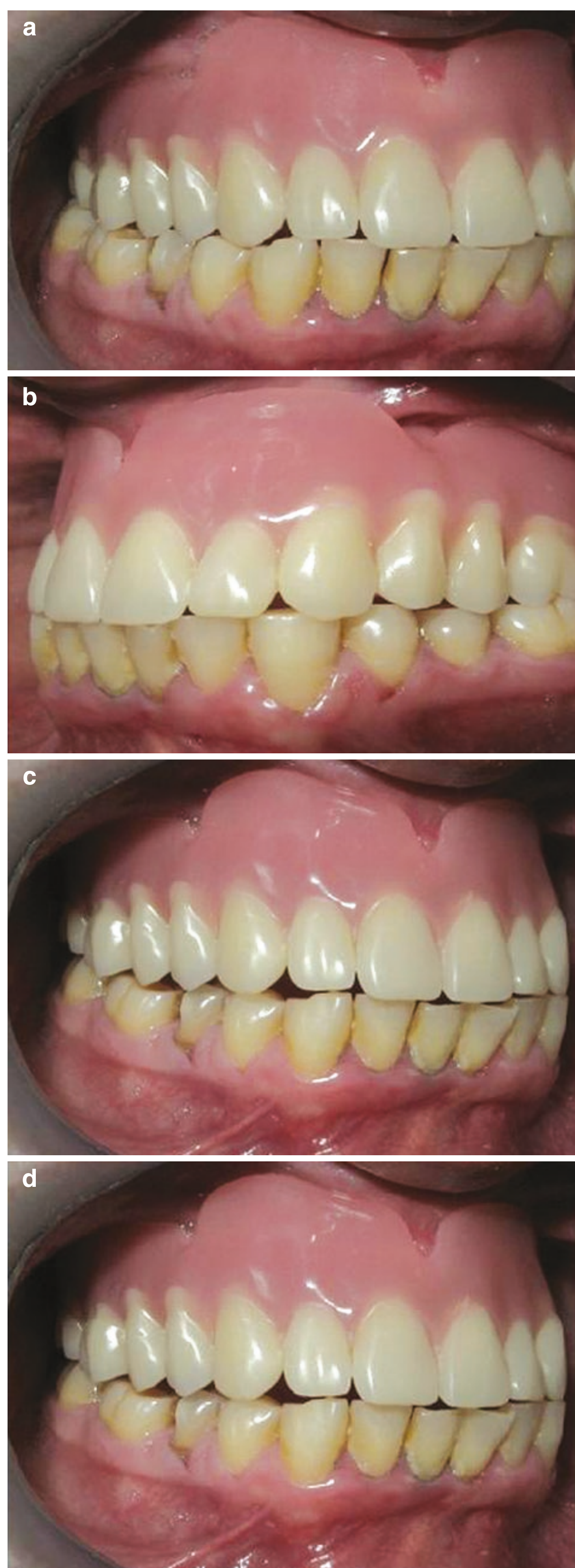


Fig. 9.20 (**a**–**d**) It is necessary to obtain bilateral balanced occlusion on maxillary complete denture opposing mandibular natural dentition

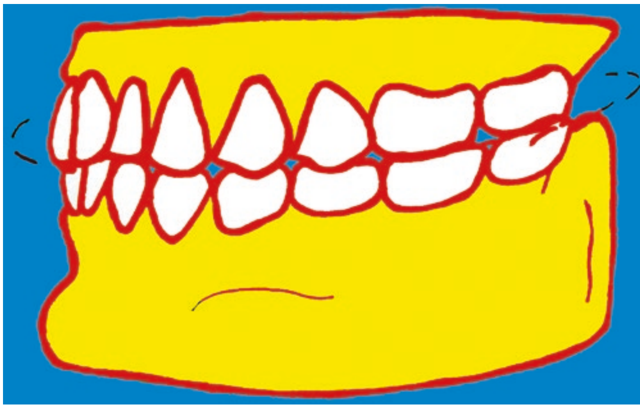


Fig. 9.21 Arrangement of teeth with tubercle-tubercle relation in which point contacts form on shallow slopes of posterior teeth in single dentures

this, deep vertical overlap in the anterior region is avoided, and horizontal overlap is increased. Decreasing incisal path inclination provides less stress on the anterior teeth, therefore, increasing denture stability.

For the stability of denture base, forces that are transferred to denture bearing area, patient's comfort and function and dynamic teeth contacts play a great role. Research showed that to improve denture stability, linear occlusion (i.e., linear occlusion, monoplane occlusion) could be used.

Concept of Linear Occlusion

Linear occlusion, in the prosthetic terms dictionary, is defined as an occlusion in which straight, long, and narrow occlusal faced posterior teeth that can be seen on the same line when viewed from the horizontal plane, making an occlusion with monoplane teeth on the antagonist arch. In linear occlusion, there should be no conflictions on protrusive and lateral movements of the mandible. While applying vertical forces during centric and eccentric movements, linear occlusion largely eliminates the lateral forces.

Jameson (2004) defends the formation of linear occlusion for increasing the stability of the denture and for minimizing the harmful effects of forces applied by the upper teeth on the lower alveolar ridge in cases where there are fixed maxillary restoration and a mandibular SCD. Jameson also performed linear occlusion for a patient with combination syndrome and concluded that by applying the linear occlusion concept and using teeth in harmony with this concept, an esthetically approvable denture was fabricated, the patient's phonetic and esthetic improved, and he/she gained effective mastication and that by eliminating anterior contacts, the bone loss caused by anterior hyperfunction syndrome was diminished.

To diminish the forces that can move the SCD from its bearing area, lingualized occlusion is another recommended method. Kimoto et al. (2006) made a comparison between lingualized occlusion and bilateral balanced occlusion and determined that patients who have lingualized occlusion were more satisfied with their denture's retention. However, no difference in mastication effectiveness was observed.

Clough et al. (1983) made a comparison between lingualized occlusion and monoplane occlusion. Thirty patients were asked to use a denture that had lingualized occlusion and a denture that had monoplane occlusion; as a result, 67% of the patients stated that mastication effectiveness, comfort, and esthetics were enhanced with the dentures that had lingualized occlusion.

9.1.2.5 Types of Artificial Teeth

Acrylic teeth are the most commonly used type of artificial teeth in SCD. The advantages of acrylic teeth are they do not cause abrasion on natural teeth or absorb occlusal forces and cause less resorption on the supporting tissues, while their disadvantages are abrasion in time and vertical height loss. Nowadays, the production of acrylic teeth with a higher quality and hardness has eliminated these disadvantages. Because of the abrading nature of acrylic teeth, some researchers have advised the use of ceramic teeth for second premolars and first molars on which occlusal forces concentrate.

Porcelain Teeth

Although not abrading, and by this securing vertical height, is their biggest advantage, to counter this, porcelain teeth also have many disadvantages. They cause abrasion on natural teeth. The occlusal forces on the teeth may cause a fracture of the palatal tubercles on the upper arch and buccal tubercles on the lower arch. They do not bond chemically to the denture base. Their retention to the denture base is mechanical, and therefore, they may separate from denture base. Porcelain teeth transfer occlusal forces directly to the underlying alveolar ridge without absorbing them, therefore accelerating resorption on alveolar ridge. Using porcelain teeth on SCD is not advised.

Teeth with Modified Occlusal Surfaces

To prevent abrasion of the acrylic teeth used on SCD, cavities on top of occlusal surfaces of these teeth can be prepared and filled with amalgam. With this method, it is possible to prevent vertical height loss; however, one disadvantage of this method is that acrylic portion around amalgam filling wears in time (Fig. 9.22a, b). Pravinkumar et al. (2009) tested a novel method because of the abrasive effect of upper natural dentitions on lower artificial teeth, for patients who have natural dentition on the upper arch and a SCD on the lower arch. They prepared cavities on the occlusal surfaces of the artificial teeth. Without touching the tubercle tips, after

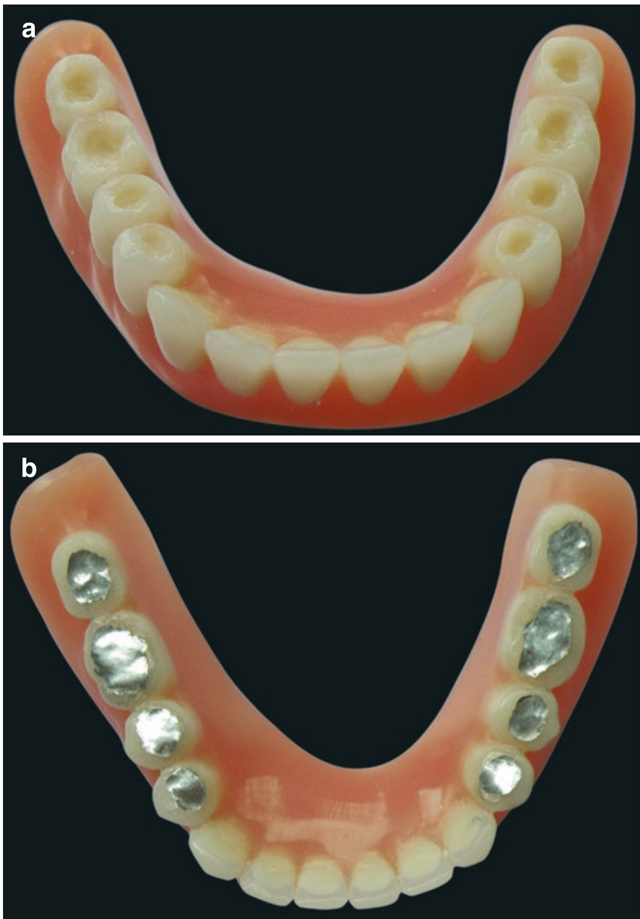


Fig. 9.22 (**a**) Preparing cavities on the occlusal surfaces of mandibular complete denture. (**b**) Application of amalgam fillings on the occlusal surfaces

the occlusal rearrangements were finished, they placed amalgam fillings in each of the cavities they prepared. Before the amalgam fillings were hardened, they requested the patient to make centric and eccentric movements and cleaned up the excess amalgam material. They subsequently reported that a SCD with amalgam occlusal surface would have less abrasion.

Another type of artificial tooth used in SCD has gold occlusal surfaces. Schultz first recommended gold occlusal surfaced teeth in 1951. Gold, being a harder material, will prevent occlusal abrasion, and lower plastic parts will absorb excessive occlusal forces. The disadvantage is their cost.
In their research, in which they examined treatment options for patients who have combination syndrome, Langer et al. (1995) reported that in the posterior teeth arrangement of these cases, reinforced resin or metal cast occlusal surfaced teeth, and in the anterior teeth arrangement, acrylic teeth, which wear off against incoming forces to decrease stress concentration on the upper ridge area, should be used.

9.1.3 SCD Opposing Natural Dentition

9.1.3.1 Single Complete Denture Opposing Lower Natural Dentition

Single upper dentures opposing lower natural dentition cases are most likely to be encountered in SCD opposing natural dentition. These are the problems seen with these types of patients:

Irregular Distribution of the Teeth

Tilting, overeruption, and other natural anomalies change the ideal inclination of the occlusal plane (Figs. 9.23 and 9.24). It is generally seen as overeruption because of the absence of an antagonist tooth (Fig. 9.25a, b). With proper grinding, these teeth can be leveled to be on the occlusal plane. Tilted teeth can be modified with various tubercle grindings. In some heavy cases, in which teeth are overerupted, touching the denture base or decreasing the intermaxillary distance, the extraction of such a tooth may be considered (Fig. 9.26a, b). Mostly, a modification of every tooth may not need to be applied for a good occlusal plane. In these cases, only one

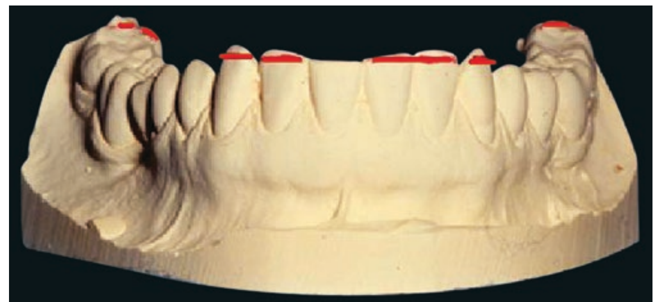


Fig. 9.23 Irregular distribution of the lower natural dentition

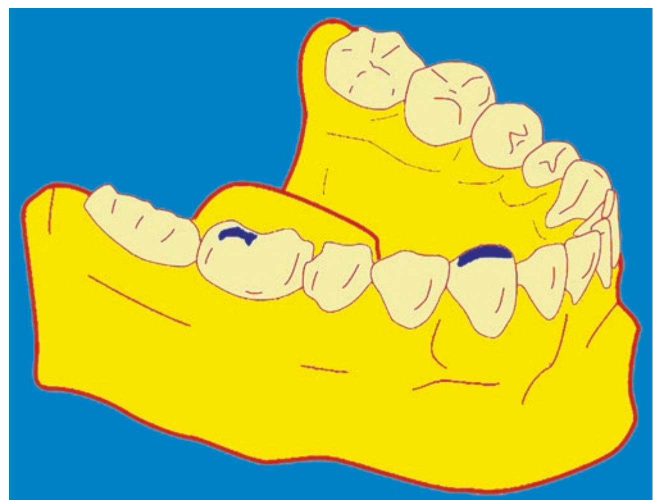


Fig. 9.24 Early contact points on canine and molar teeth on the mandibular model

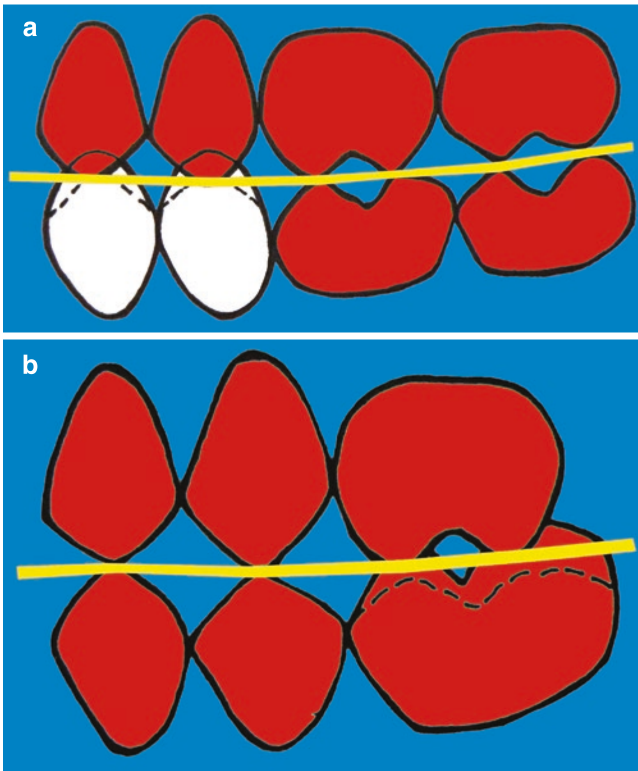


Fig. 9.25 (**a**, **b**) Lower premolar and molar teeth overerupting and disrupting occlusal plane

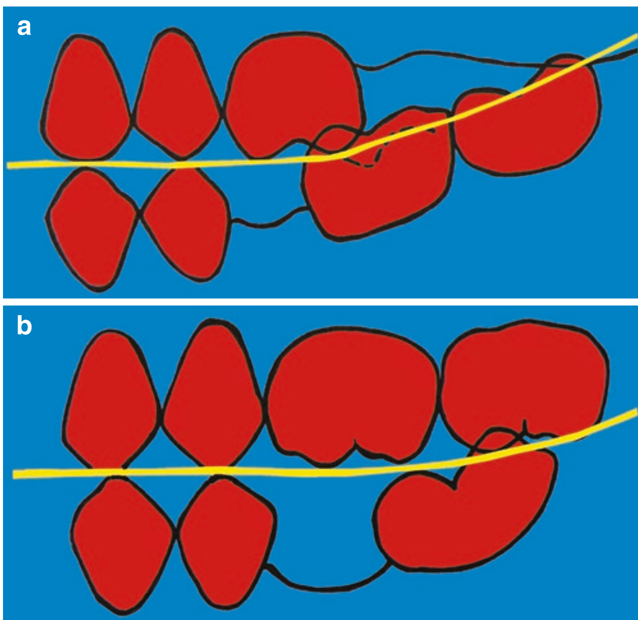


Fig. 9.26 (**a**) Overeruption of mandibular second molar, (**b**) extraction of second molar

part of the tooth could be modified, or the tooth could be modified leaving enough tissue thickness to maintain its vitality. While placing the tooth onto the denture base, only the part of it that suits the intended plane is left in contact with the natural teeth. In extreme cases, before preparing a beveled surface, it is necessary to ensure a 2–3 mm space anteroposteriorly.

Features of Occlusal Surface

Since the occlusion of natural teeth is generally unsuitable, they need to be modified in order to obtain a balanced occlusion. Tilted or overerupted teeth regarding the occlusal plane disrupt occlusal harmony and create undesirable forces on the denture.

It is necessary to decrease the Spee curve by reducing overeruption of teeth via occlusal modifications. If there are rotated teeth, they should be recontoured (e.g., grinding, crowning) to obtain their contact with plane surfaces.

The relation of the occlusal plane with antagonist supporting structures must be evaluated. If it is lower or higher than the midpoint of intermaxillary distance, it should be leveled according to the upper or lower denture (Fig. 9.27).

The relation of occlusal plane inclination against the antagonist arch must be evaluated (Fig. 9.28). If there is even

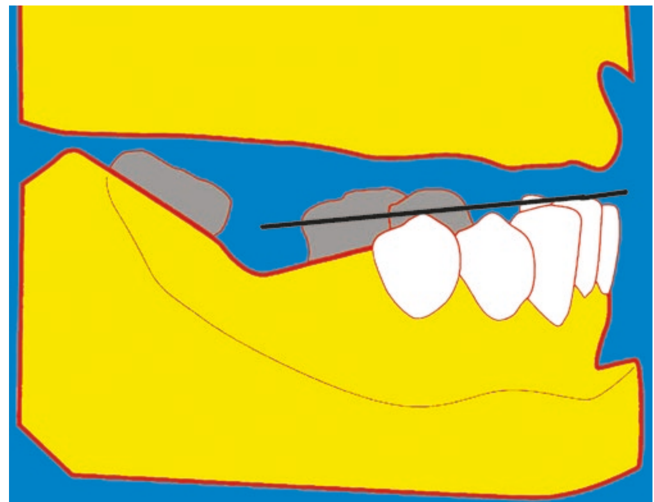


Fig. 9.27 Evaluation of teeth and ridge relationship

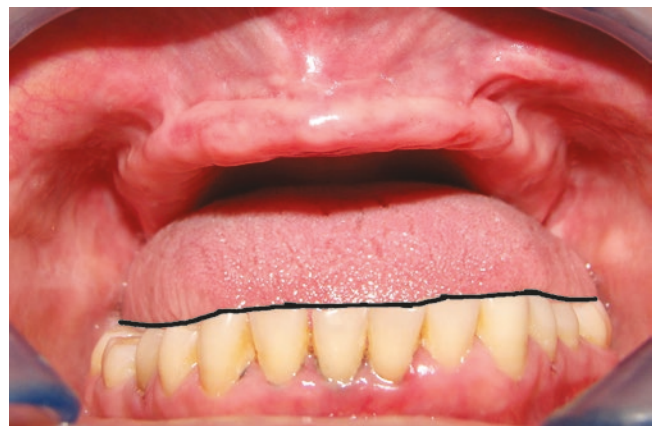


Fig. 9.28 The relation of occlusal plane inclination with the antagonist arch

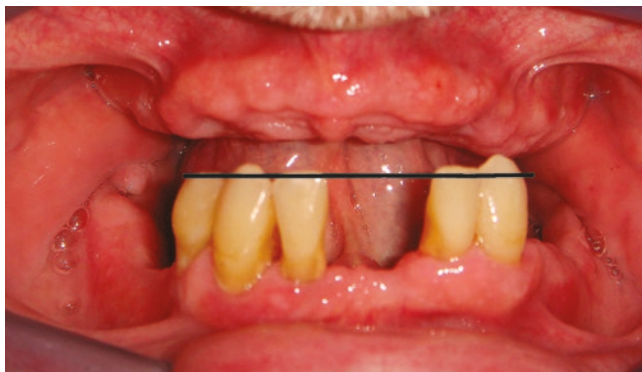


Fig. 9.29 Occlusal disharmony due to the overeruption of mandibular natural teeth

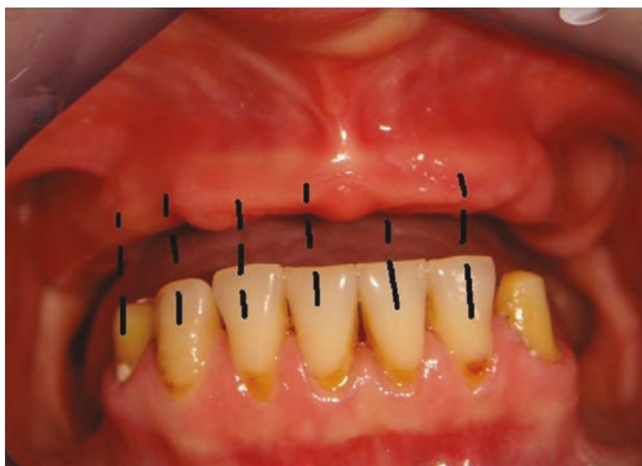


Fig. 9.30 Facio-lingual positions of the mandibular natural teeth regarding maxillary ridge tip

the slightest deviation on their parallelism, the stability of the denture against occlusal forces will be problematic (Fig. 9.29).

At the same time, the faciolingual positions of the upper teeth according to the tip of lower ridges should be evaluated (Fig. 9.30). When the teeth are placed toward the facial area of resorbed alveolar ridges, the denture will be exposed to tilting and moving forces during function. A mechanically ideal teeth arrangement should be just on top of the resorbed alveolar ridge, or a little medially. Care should be taken during lingual or palatal placement; otherwise the patient could bite their tongue, and there will be functional problems with the denture (Fig. 9.31).

Problems in Recording Intermaxillary Relations

A problem occurs while arranging parallelism between the upper wax rim and ala-tragus line because occlusal surfaces of antagonist teeth determine the slope of the occlusal plane. If overbite is needed on the teeth that are to be aligned, in the upper anterior region, the labiolingual thickness of the wax rim prevents accurate recording of vertical height (Fig. 9.32).

Before starting the fabrication of a SCD, the teeth on the antagonist arch should be evaluated. For the harmony of the occlusal plane, it is essential to carry out selective grinding on the teeth. These rearrangements should be undertaken before the fabrication of the SCD, as afterward it may be impossible to provide a harmony between the natural dentition and artificial teeth. Thus, a diagnostic impression is made, a plaster model is obtained, and the teeth are evaluated (Fig. 9.33). A calotte is used to determine the occlusal irregularities. Articulation paper is placed on top of the calotte, and the stained areas are trimmed.

9.1.3.2 Evaluation on the Model

Nonuniform Alignment of Teeth

Tilting, overeruption, and other anomalies cause the occlusal plane to diverge from its ideal inclination. One of the most common occlusal disharmonies observed in natural dentition is overerupted teeth (Fig. 9.34a, b).

In the arch with natural dentition, overerupted teeth are trimmed to a certain degree and brought to the same occlusal level with other teeth. After this, the teeth arrangement of the SCD should be performed (Fig. 9.35).

One of the other occlusal disharmonies is the second molar being a little tilted. When the tooth is tilted mesially, the distal portion of the second molar is positioned higher than the occlusal plane (Fig. 9.36). These types of occlusal surfaces tend to push the denture anteriorly. In such a situation, occlusal forces occur that disturb denture stabilization. If the relation between the edentulous ridge and the natural teeth is to be evaluated, it is seen that the tilting of the second molar is the vertical component of the force that is going to develop in the upper denture. The tubercle step inclination of the premolar teeth is clearly seen with the step, and two of them form a wide step on the ante-posterior inclination (Fig. 9.37). In these cases, the step on the tubercle of premolar tooth and the distal tubercle of the molar tooth is grinded, and the grinded area is polished. Following this, the teeth arrangement of the denture is completed (Fig. 9.38).

If tilting of the tooth is excessive, the grinding that will be done to fix this problem will be excessive too, as it will expose the pulp and result in the loss of vitality. In this condition the needed procedure is not touching the distal tubercle and leaving it out of occlusion (Fig. 9.39). No contact is provided with the highest part of the tooth; therefore, by leaving a 2–3 mm gap anteroposteriorly, the limitation in the eccentric movements is prevented. If there is an extreme disharmony of occlusion in the second molar area, it is most probably because of an early extraction of a molar and overeruption of the second molar with its alveolar socket toward the extraction space. In this case, overerupted teeth are left out of the occlusion, and the teeth arrangement is made according to this (Figs. 9.40 and 9.41). Therefore, if there is

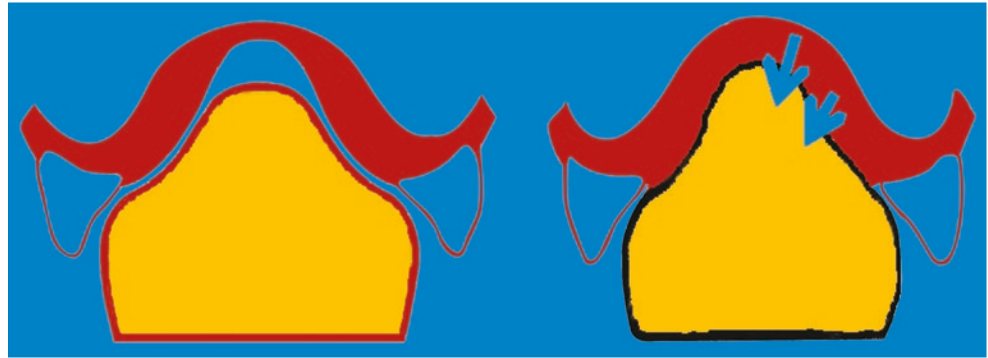


Fig. 9.31 Lingual alignment of lower posterior teeth will narrow the tongue space

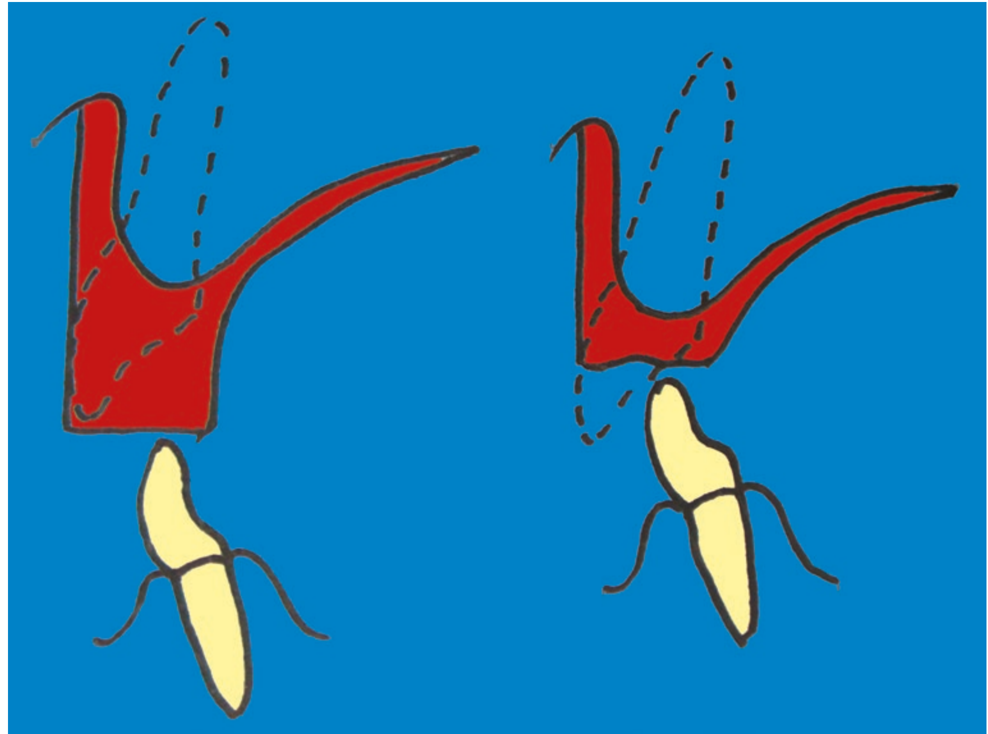


Fig. 9.32 Labiolingual width of the wax rim in maxillary anterior area prevents accurate recording of the vertical height

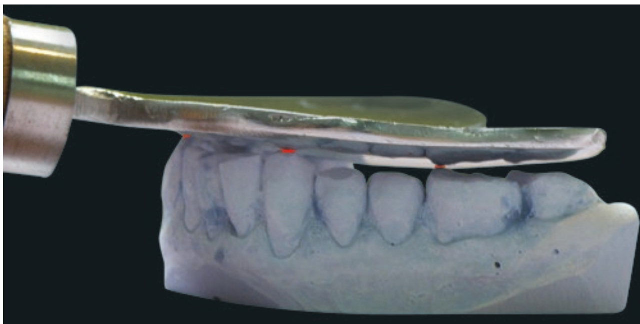


Fig. 9.33 A callote which is used to determine occlusal irregularities

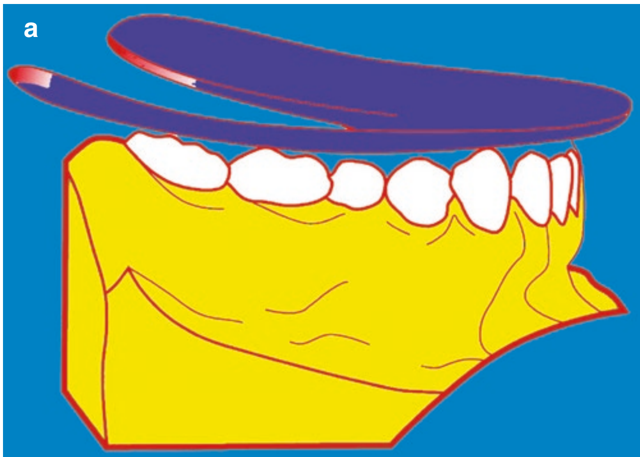
a problem due to the reduced intermaxillary distance, the second molar may be extracted (Fig. 9.42).

While making the occlusal arrangement, attention should be paid to not to increasing the buccolingual width of the teeth. To provide this, not only the tubercle tips should be grinded but also the buccal surfaces of the lower teeth as well. After grinding, the enamel surfaces should be polished. Even though it is not common, sensitivity in grinded teeth may occur; in these cases, local sodium fluoride can be applied.

In SCD, prepared opposing lower natural dentition, the first molar teeth on class I and class III relations, and anterior teeth and bilateral premolar teeth in the class II relation may be sufficient bilaterally. The class III relation or mandibular prognathism can take shape in two ways:

1. Normally developed mandible opposing a less developed maxilla
2. Normally developed maxilla opposing an excessively developed mandible

Prognoses on cases with less developed maxilla are generally worse because the denture support area is less than a normal maxilla. Since denture stability and retention is directly related



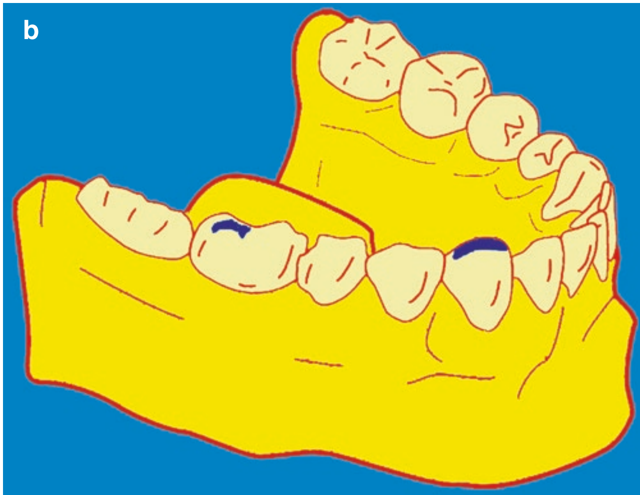


Fig. 9.34 (**a**, **b**) Early contact points on the lower model determined with a calotte

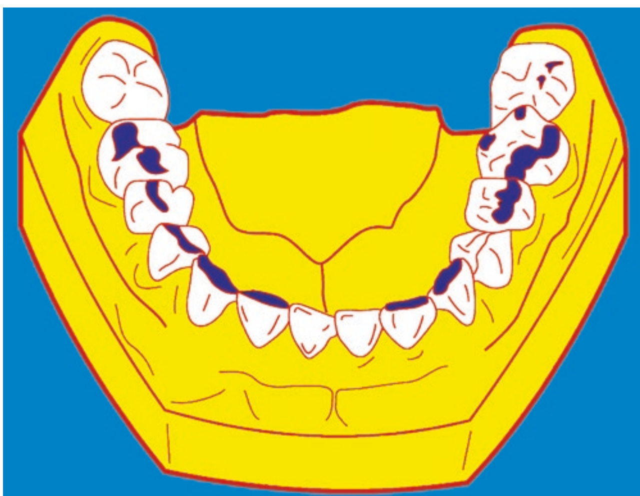


Fig. 9.35 Equalizing contact points

with the area that it covers, success rates with these patients are low. With these cases, it is necessary to place anterior teeth in the class III relation (upper anterior are palatal to lower anterior), or at best they need to be placed in an edge-to-edge

Fig. 9.36 Tilted second molar in mandible and its prevention of occlusion

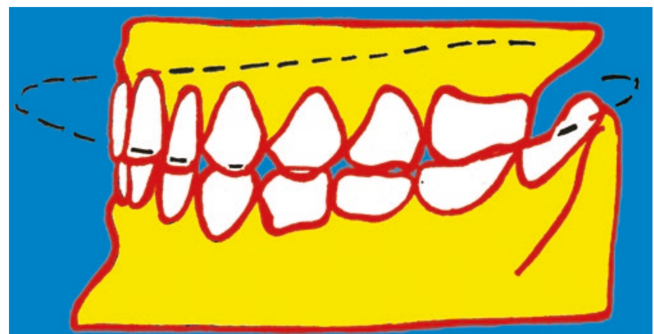


Fig. 9.37 In such a case, forces that will disturb denture stability will occur

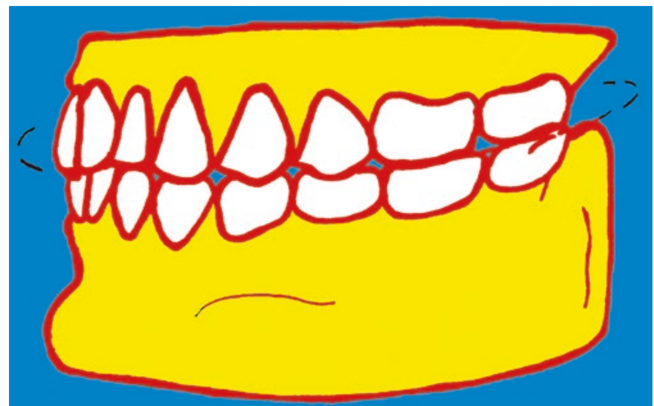


Fig. 9.38 Step on premolar tubercle and grinding of the distal tubercle of molar tooth in order to obtain stabilization

relation (Fig. 9.43a, b). Positioning the maxillary anterior teeth away from the alveolar ridge will create problems, such as phonation difficulties, pain on the alveolar ridge, and damage to the lips and cheeks due to permanent pressure.

For patients who lost their upper posterior teeth earlier, if the mandibular teeth are not lost, the mandible will show two planes (an anterior plane between canine and canine and a higher plane on the posterior region). In such a case, restorative procedures on the mandibula and surgical interventions on the maxilla may be needed to produce a SCD (Fig. 9.44).

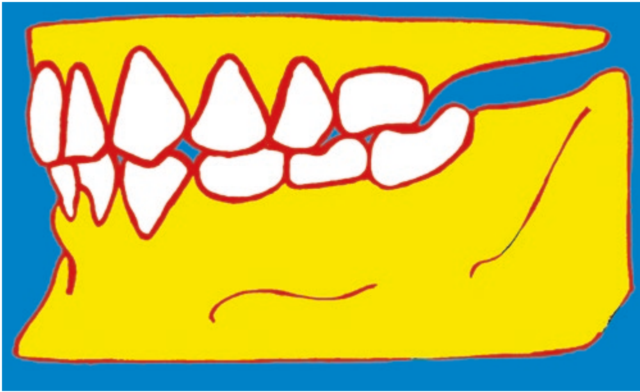


Fig. 9.39 If tilting is extreme on the second molar, teeth arrangement should be performed without involving the tubercle that is too high

Figs. 9.40 and 9.41 Excessively overerupted teeth should be left out of occlusion

On SCD that will be produced opposing natural dentition on the mandible, patients generally have long lower anterior teeth (Fig. 9.45a, b). If the lower anterior are tilted labially, to increase overjet and decrease overbite at the same time, the lower anterior labioincisal surfaces are grinded. In some cases, this grinding may not be enough,

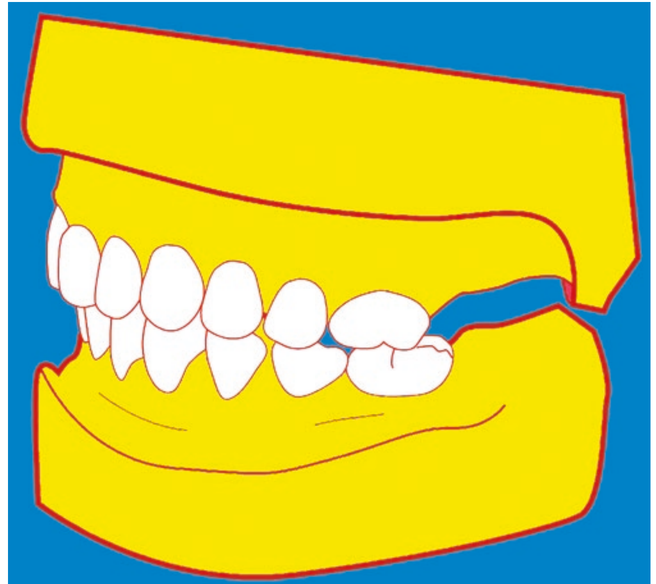


Fig. 9.42 If the distance between the arches is decreased, second molar might be extracted

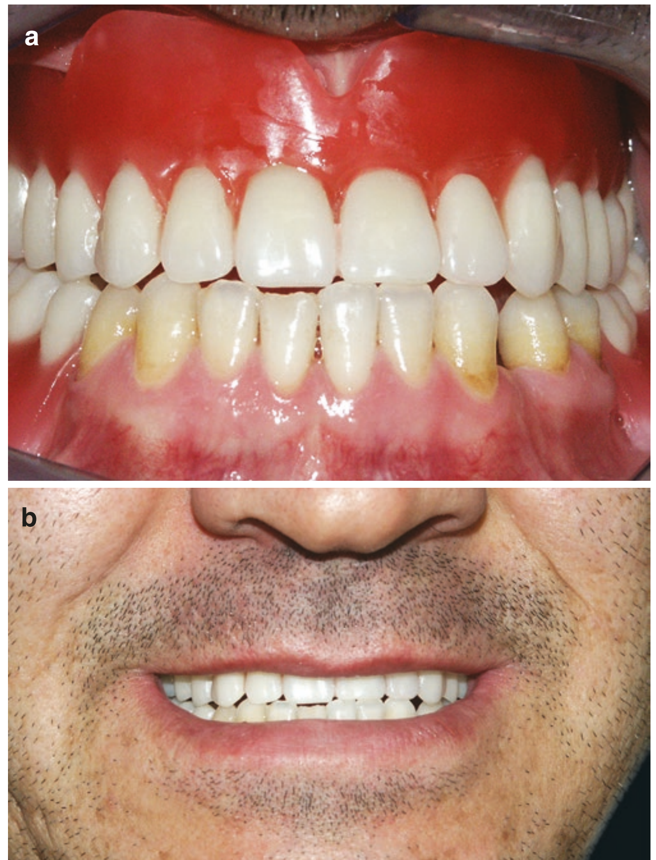


Fig. 9.43 (**a**, **b**) Edge-to-edge arrangement of teeth in a class III intermaxillary relation case

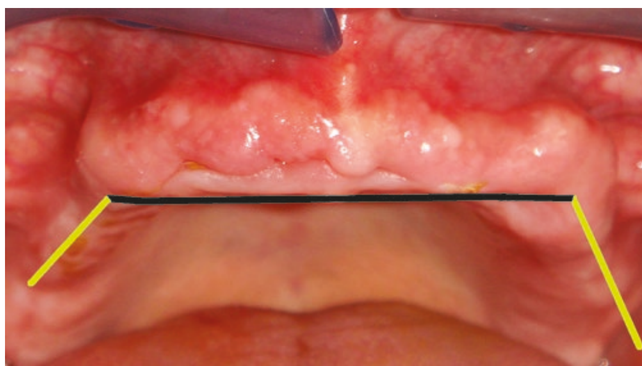
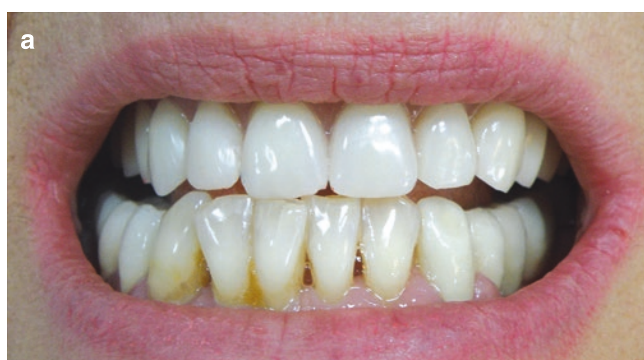


Fig. 9.44 Double occlusal plane in a patient who has lost his maxillary posterior teeth prior to anterior teeth



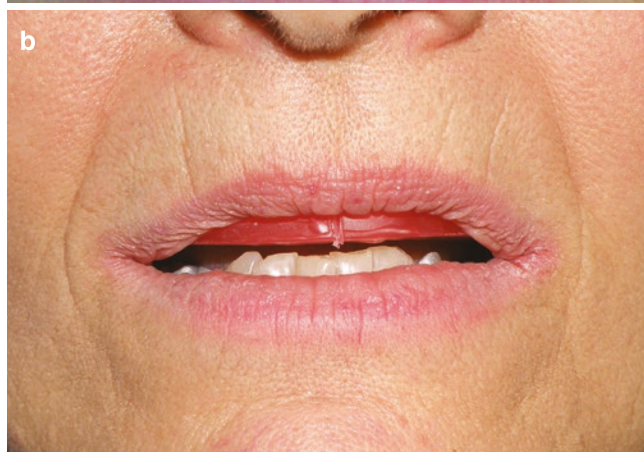


Fig. 9.45 (**a**, **b**) Overerupted mandibular anterior teeth that will oppose a maxillary complete denture

in which case the lower teeth should be restored (Fig. 9.46).

For a mandibular natural dentition and a maxillary SCD case, the following stages are followed:

1. Preparation of acrylic transparent resin template on the lower model
2. Determination of the areas that are higher than occlusal plane with the aid of a calotte (Fig. 9.47)

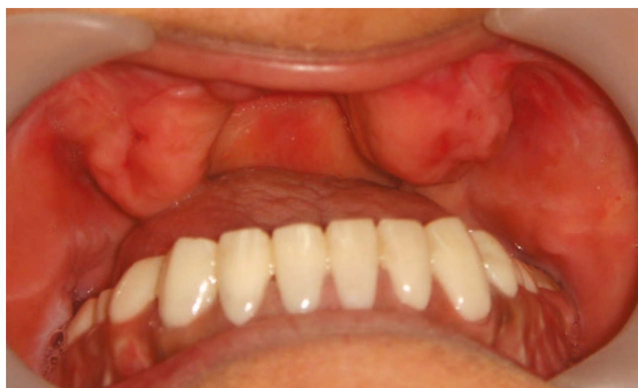


Fig. 9.46 It is necessary to restore the lower natural teeth in case of inadequate grinding

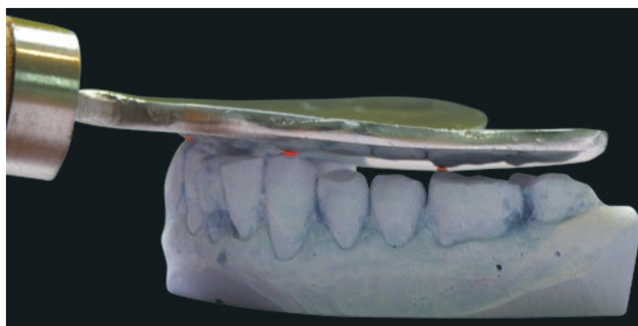


Fig. 9.47 Areas higher than occlusion are determined using a callote for a maxillary single denture case

3. Staining the irregularities on model and placing the template (Fig. 9.48a, b)
4. Placing the template on to the model and cutting off the stained areas with a surgical blade (Fig. 9.49)
5. Placement of the template into the mouth and grinding the uncovered areas (Fig. 9.50)
6. Finishing the dentures and their control phase (Fig. 9.51a–c)

Before finishing the denture, a few precautions should be taken. The deep bite should be avoided in the anterior area. Shallow incisor guidance will increase denture stability. To decrease the incisal path angle, increasing the horizontal overjet is a method, but anterior locking should be avoided. For a SCD to be successful, unconstrained occlusion, unconstrained premature eccentric contacts, and bilateral balanced contacts on the posterior elements are necessary. There are many methods for arranging posterior teeth. This shows alterations, from a tightly closed occlusion to one-point contact occlusion on the lower buccal tubercle. Tight interdigitation is avoided, as this creates wide contact areas on the vertical slopes. One-point occlusal contact concept on shallower slopes is obtained through arranging the posterior tooth in an edge-to-edge position and having contact on their

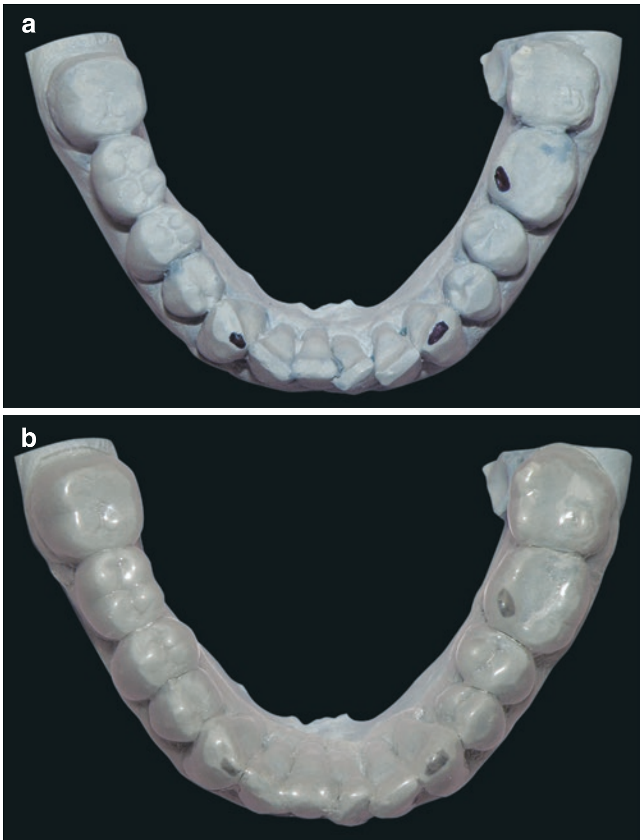


Fig. 9.48 (**a**, **b**) Irregularities are stained on the model, and transparent acrylic template is prepared

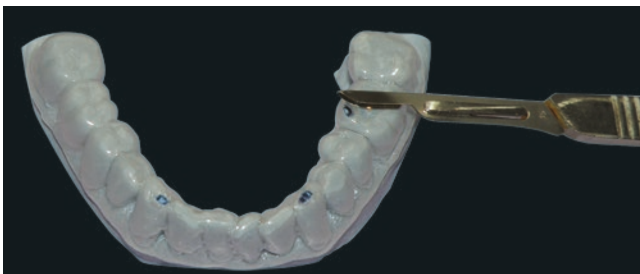


Fig. 9.49 Template is place onto the model and stained areas are cut.

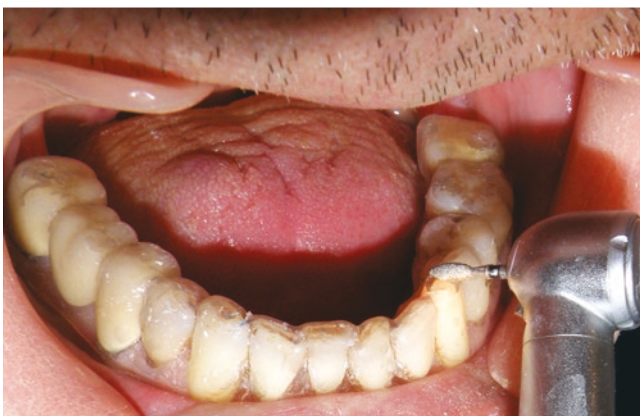


Fig. 9.50 Template is placed into the mouth, and visible areas are trimmed

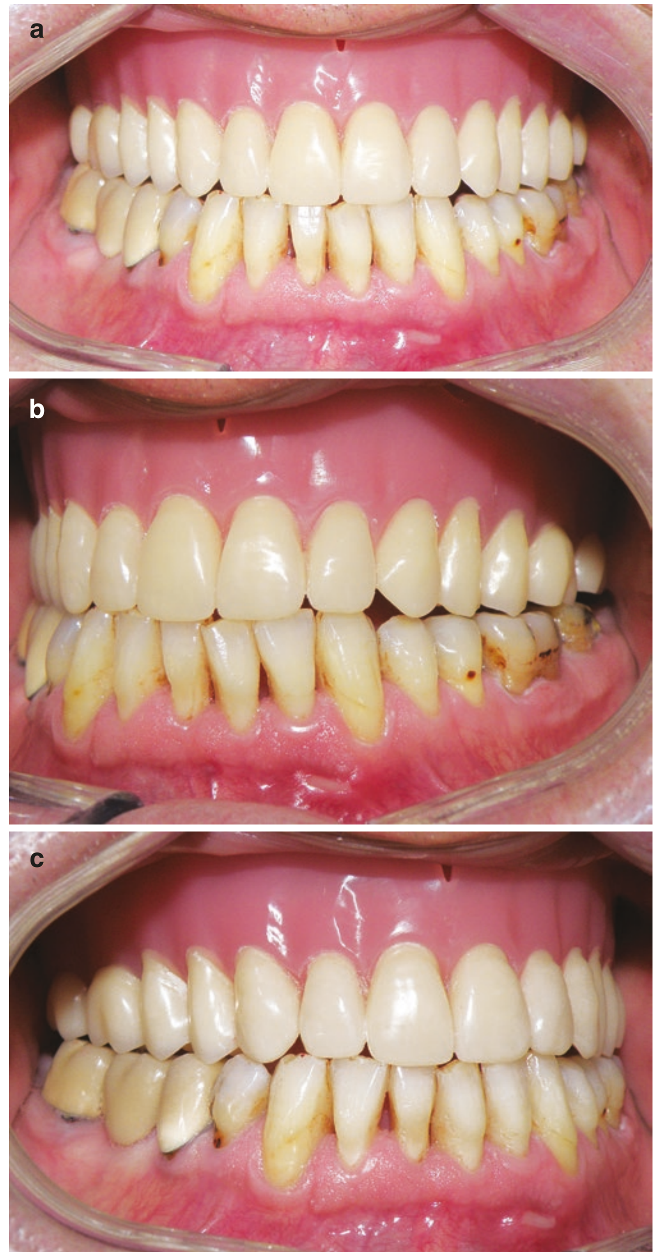


Fig. 9.51 Placement of dentures into the mouth and control phase. (**a**) Control of centric relation. (**b**, **c**) Control of lateral movements

tubercle tips. Anterior teeth are aligned, providing very little overbite. Posterior teeth should be placed having minimum tubercle contact and, therefore, should be arranged using minimum sloped surface contact and having the tubercle-tubercle relation. Ideally, the maximum number of point-like contacts should be present. In conventional ridge relations, an exaggerated buccal overlap is used to prevent cheek bites. Therefore, the teeth are arranged to have maximum contact on their palatal area. This results in the centralization of occlusal forces and an increase in stabilization (Fig. 9.51). Figure 9.52 shows a non-balanced upper complete denture case. This condition will result in excessive forces on the

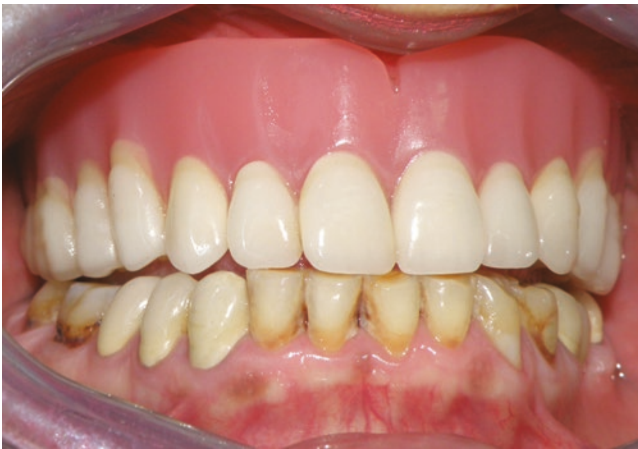


Fig. 9.52 No contacts in centric occlusion

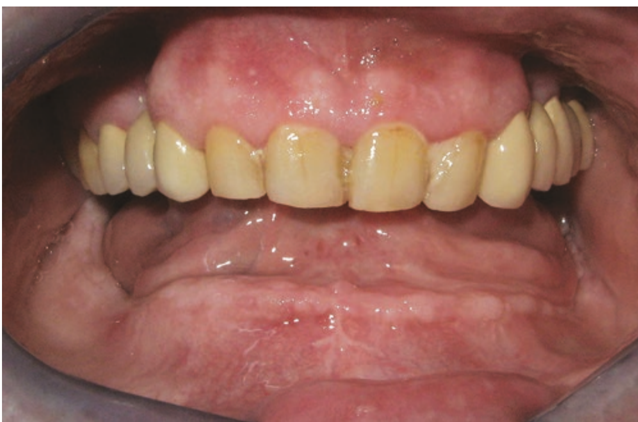


Fig. 9.53 Edentulous mandible opposing a maxillary natural dentition

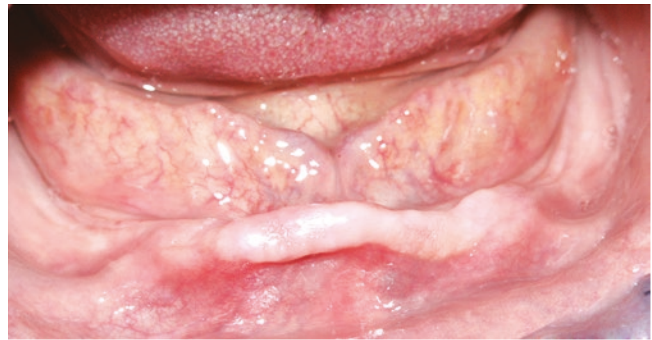


Fig. 9.54 Excessive deformation on mandibular anterior ridge

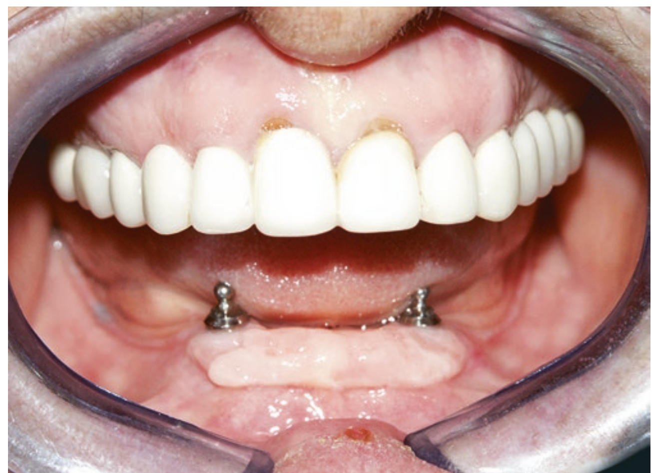


Fig. 9.55 Two implants placed in the mandible to diminish the forces applied by the maxillary natural teeth on to the mandibular edentulous area

anterior portion of the denture, disturb denture stability and retention, and subsequently cause numerous problems that will lead to the formation of combination syndrome.

9.1.3.3 Single Complete Denture Opposing Upper Natural Dentition

One of the common clinical situations involving a single denture is that of a complete lower denture and upper natural teeth. Even though it is rare to encounter an edentulous mandible, these types of occlusal combinations are possible (Fig. 9.53). The mandible is a moving component of the stomatognathic system, and, because of this, balancing lower dentures is more difficult. Another factor that complicates the stabilization of the lower denture is the presence of the tongue. The denture may move during tongue movements. This movement of the denture increases pressure and stress on the mucosa and bone. Also, fabricating a conventional lower denture without making occlusal rearrangements on antagonist arch causes functional forces to destabilize the denture. These forces occur as a result of eccentric and parafunctional occlusal contacts, causing the movement of the denture, and also due to the muscle activity occurring around the overextended flanges during normal function. This situation both disturbs the patient and harms the supporting structures (Fig. 9.54).

Without doubt, it is more difficult to produce a lower SCD opposing an antagonist arch with natural dentition, and it will create greater problems in the future. The most important factors in the treatment plan are intermaxillary relations and the morphology of the bone that forms the alveolar ridge. Having a narrower supporting tissue surface, being susceptible to resorption and having low stability and retention, lower SCD have a lower chance of success when compared to single upper dentures. If producing a SCD is essential, to diminish the intensity of forces, soft lining materials should be used, and in these cases, implant application may be a better choice of treatment for providing long-term health benefits (Figs. 9.55 and 9.56).

The patient should be informed on how to overcome problems when using lower SCD. Some patients believe that they will be able to use their SCD as easily as they have used their natural dentition or previous fixed prosthesis. Patients should be informed on ideal tongue positioning, crucial oral hygiene, and potential problems regarding denture retention and stability that may occur. Food should be cut up into small

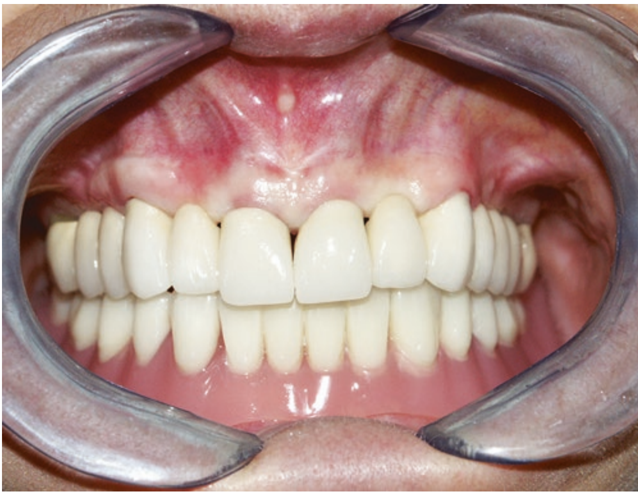


Fig. 9.56 The view of implant-retained overdenture

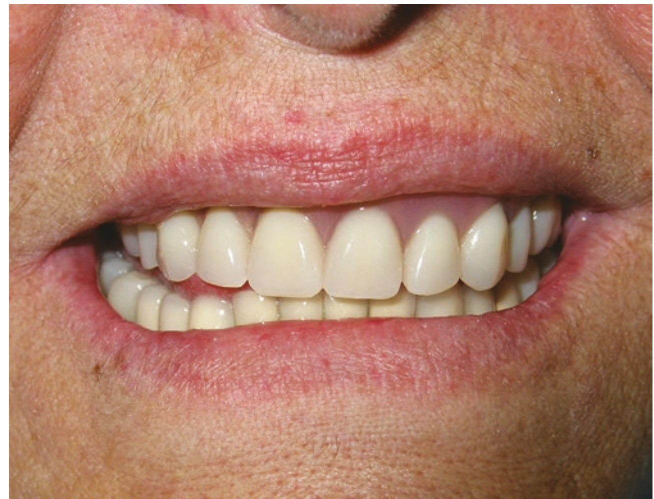


Fig. 9.57 Occlusal disharmony in maxillary complete denture opposing lower fixed prosthesis

pieces and masticated slowly. The importance of bilateral mastication should be made clear. Bilateral mastication will increase denture stability.

The lower denture base should cover the maximum area within the patient's anatomical and functional borders. This will help with the equal distribution of occlusal forces. A denture base extending bilaterally toward the retromylohyoid areas will increase its retention. To increase denture stability and equalize occlusal force distribution, bilateral contacts should be present both in centric relation and during functional movements.

Problems Encountered with Lower SCD Opposing Natural Dentition

1. If porcelain artificial teeth are used in the SCD, they will cause abrasion on the antagonist natural dentition.
2. If acrylic artificial teeth are used in the SCD, the acrylic-based teeth will abrade. To prevent this, amalgam fillings on artificial teeth or cast metal occlusal plane can be prepared.
3. Because of the natural dentitions high occlusal forces, excessive resorption of the alveolar ridge under the SCD is possible.
4. Because of the natural dentitions high occlusal forces, excessive stress accumulation on SCD may cause denture base fractures.

9.1.4 SCD Opposing Fixed Partial Dentures

If there is a fixed partial denture present on one arch, it should be treated as if the SCD is opposing natural dentition. It will be possible to fix occlusal disharmony problems that cause the exposition of excessive occlusal forces.

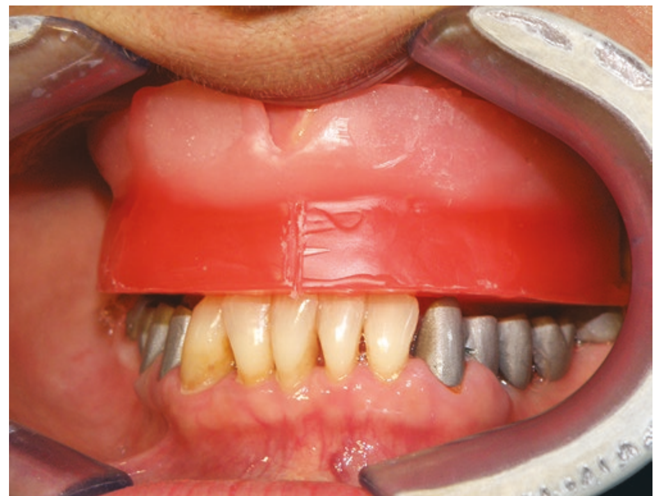


Fig. 9.58 Preparation of the wax rims during mandibular restoration's metal framework try-in stage

Harmony between SCD teeth and fixed restoration should be fixed during the wax rim try-in on the articulator; otherwise, there may be inharmonious intermaxillary relations after the denture is finished (Fig. 9.57). If there is an indication to produce a lower SCD, it is best to create occlusal surfaces of the fixed prosthesis during the try-in stage of the SCD. Upper occlusal rims should be prepared during the lower metal try-in stage of fixed restorations, if there is a case with lower fixed bridge and upper SCD (Fig. 9.58). Following this stage, the anterior teeth arrangement and control should be made. After every tooth arrangement is completed, it is tried intraorally (Fig. 9.59a, b). Following these stages, the lower fixed bridge is checked intraorally (Fig. 9.60), and the denture is then ready for the finishing process. In the case shown on Fig. 9.60, we

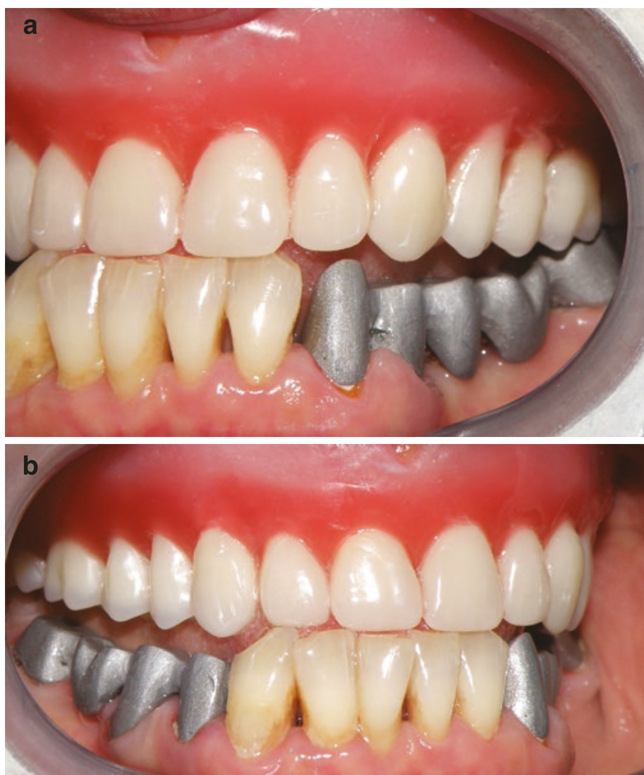


Fig. 9.59 (**a**, **b**) Maxillary teeth arrangement try-in during mandibular restorations metal try-in stage

experienced difficulties with the anterior teeth arrangement because the patient had his own intact anterior teeth. On the lower anterior teeth, a little grinding was done, but as the patient refused to accept more grinding, it was not sufficient. Because of this, a small overbite in the anterior region had to be made. Sufficient grinding should be performed on upper complete dentures until equal contacts on centric and lateral relations are obtained. In order not to perform excessive grinding on teeth, the teeth arrangement should be thoroughly checked (Figs. 9.61 and 9.62). In the case shown on Fig. 9.63, since each of the patient's lower teeth was treated with fixed restorations, teeth

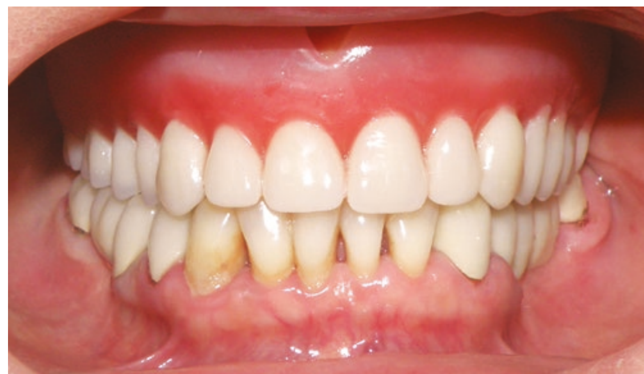


Fig. 9.60 Mandibular porcelain restorations and maxillary teeth arrangement try-in

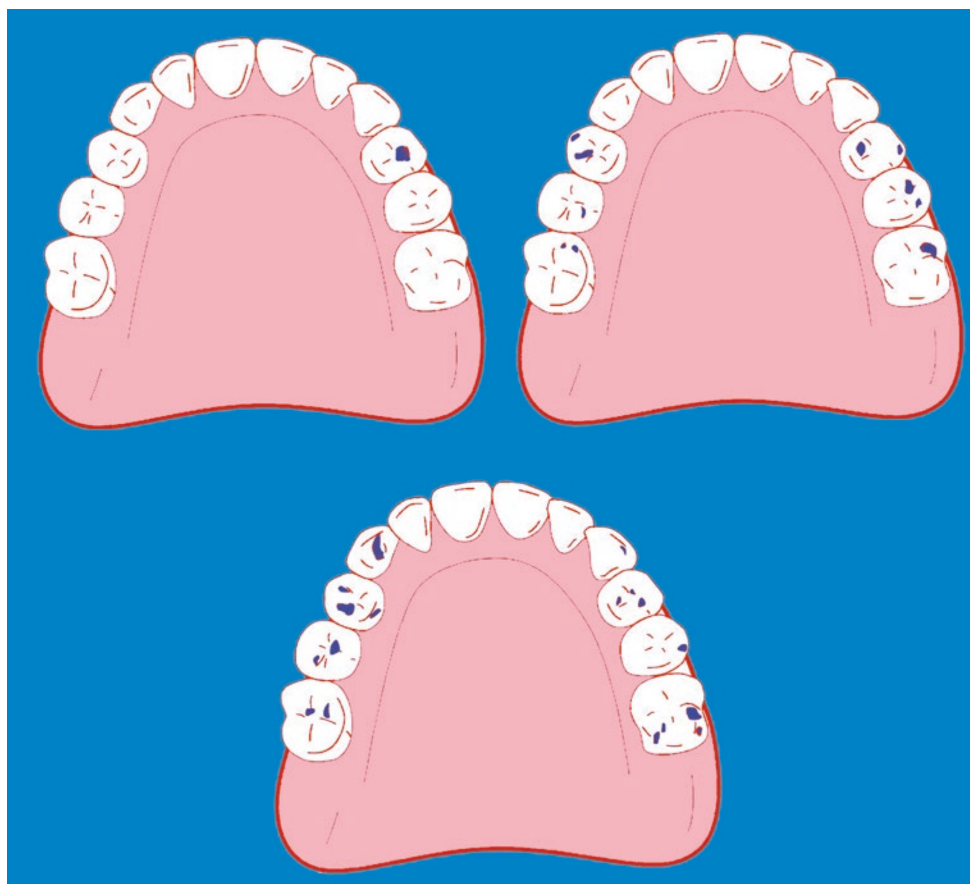


Fig. 9.61 If contact points are not equal on the maxillary complete denture, more grinding will be needed

alignment was completed easily, and the overbite was not overly done. Tubercle-tubercle contact was easily achieved.

9.1.5 SCD Opposing Removable Partial Dentures (RPD)

One of the most common situations encountered is a SCD opposing a RPD (Figs. 9.64, 9.65, and 9.66). Placing posterior teeth on RPD will positively affect the prognosis of the SCD. Therefore, if some or all of the posterior teeth are absenting at the opposing arch of the SCD, a RPD may not always be indicated. For example, in the class I jaw relation, lower molar teeth may not be involved in denture design, and a SCD contacting only lower anterior and premolar teeth can be fabricated. In this case, lower premolar teeth will be able to administer the occlusal forces that are

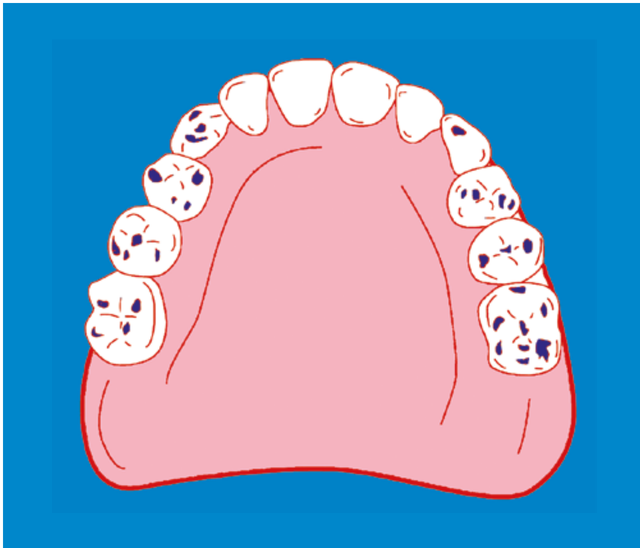


Fig. 9.62 If contact points are equal on the maxillary complete denture, less grinding will be needed

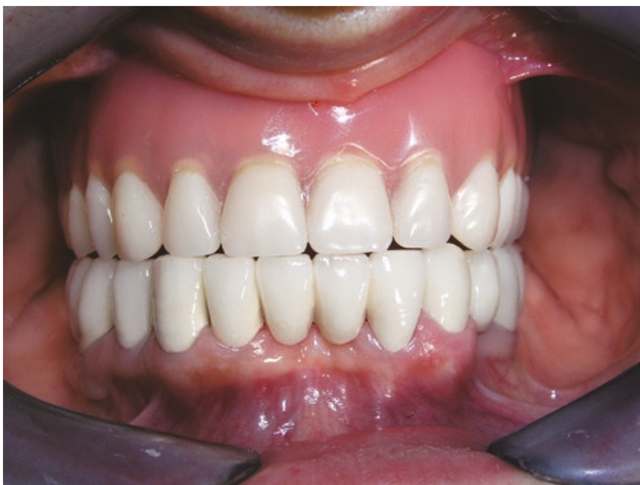


Fig. 9.63 Obtaining tubercle-tubercle contact and edge-to-edge arrangement of teeth in a maxillary complete denture case opposing mandibular fixed restorations

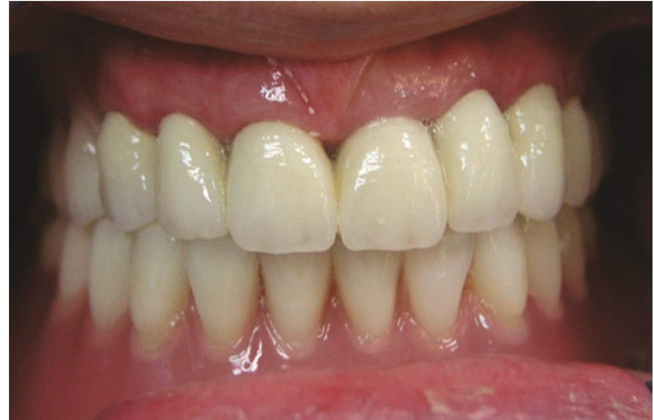
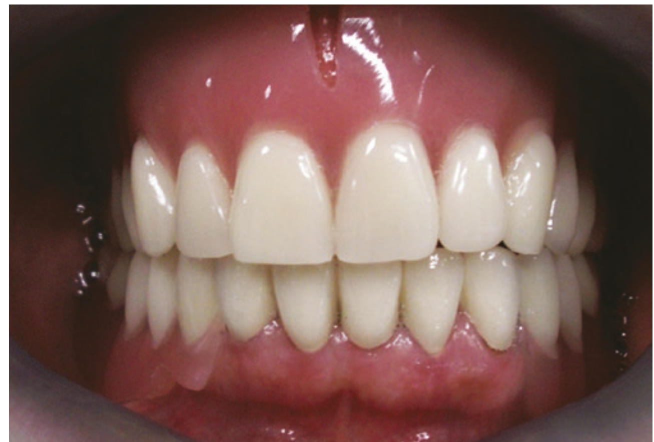
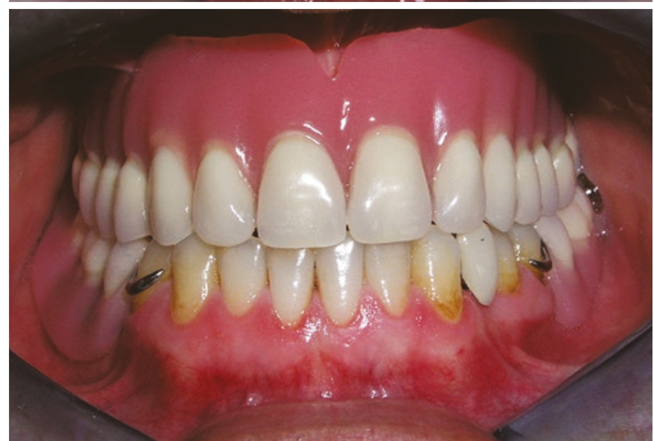


Fig. 9.64 Mandibular complete denture opposing maxillary removable denture





Figs. 9.65 and 9.66 Maxillary complete denture opposing mandibular removable denture

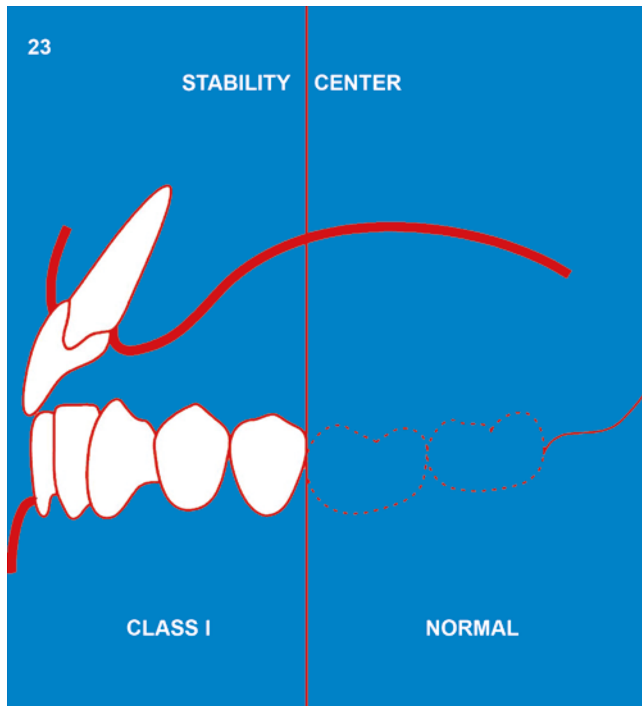


Fig. 9.67 Class I jaw relation and center of stability

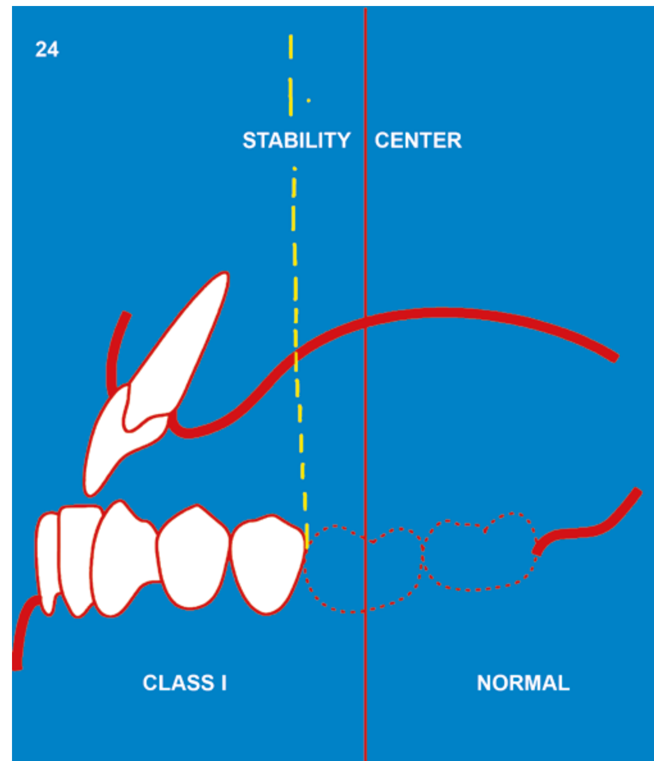


Fig. 9.68 Class III jaw relation and center of stability

directed to the mid-posterior region of the SCD, and therefore a sufficient relation with upper dentures posterior area will be achieved (Fig. 9.67). If a patient in the same condition has a class III jaw relation, since the occlusal forces applied by lower premolars will be directed toward the anterior portion of the upper alveolar ridge, it will be obligatory to treat the lower arch with a RPD (Fig. 9.68). If mandibular premolar teeth can have a relation with the complete dentures posterior area, a clinically successful maxillary single complete denture can be fabricated. In the situation where 6–8 teeth are present in the mandible, the single upper denture should not be produced before the posterior teeth are restored with a removable partial denture. In this case, excessive resorption in the alveolar bone underlying the upper denture, stability loss, and midline fractures of the denture with the existence of combination syndrome will be observed (Fig. 9.69).

Most of the patients develop a tongue habit to increase the retention of their upper denture. However, the result of this habit, clinically, is excessive resorption of the upper anterior alveolar ridge and the formation of mobile, hyperplastic tissues (Fig. 9.70). This situation is also known as combination syndrome. Designed prosthetic treatment should provide posterior occlusal support and should minimize the pressure on the maxillary anterior region.

In each case when all the molar teeth are absenting in the mandible, the partial removable denture is indicated. The upper complete denture and lower partial denture should be produced at the same time, and optimal occlusion should be obtained (Fig. 9.71a, b).

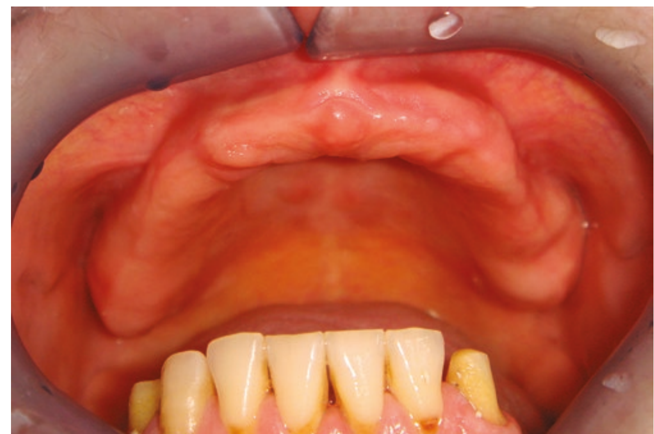


Fig. 9.69 A maxillary complete denture opposing mandibular Kennedy I case

If two molar teeth are absenting on one side and only the second molar on the other, in this situation, it may not be necessary to fabricate a removable partial denture. In this situation, a cantilever bridge can be prepared for the missing molar tooth.

Medium periodic forces applied on the alveolar ridge are known to stimulate bone formation and protect the alveolar bone, instead of causing its resorption. However,

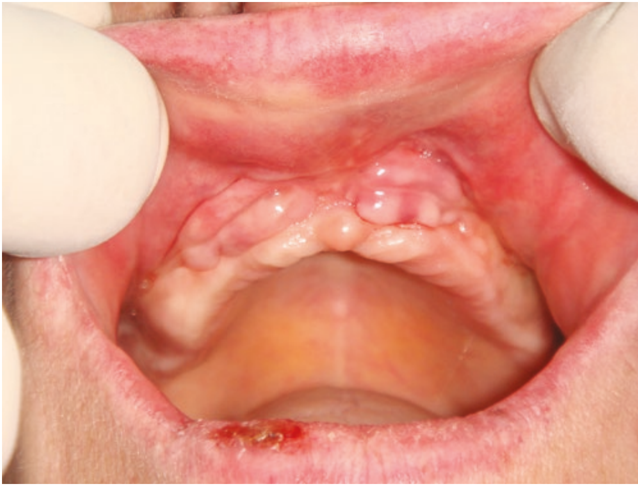


Fig. 9.70 Mobile ridge formation under a maxillary complete denture opposing mandibular Kennedy I case

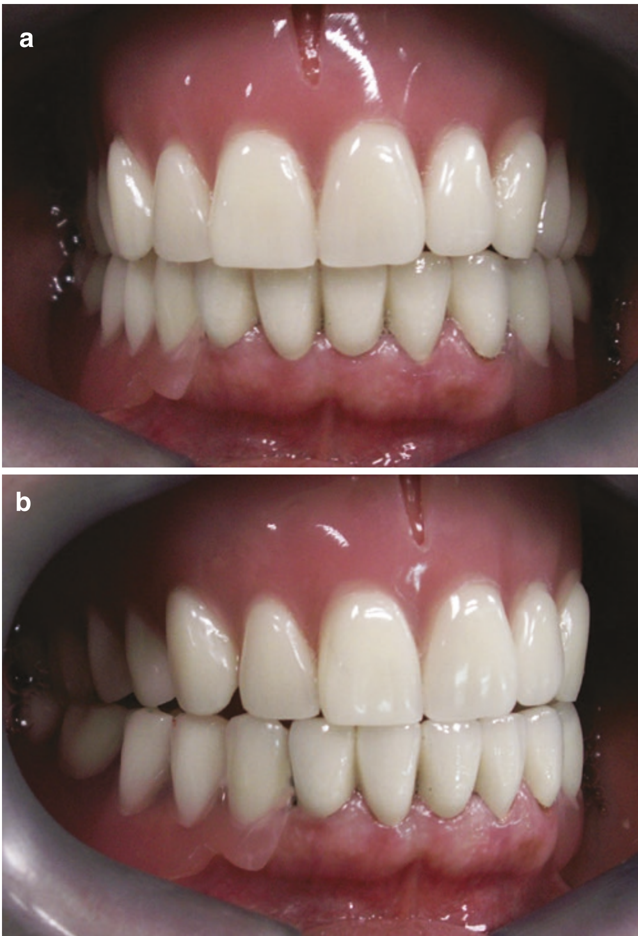


Fig. 9.71 (**a**, **b**) Optimum occlusion should be obtained on a maxillary complete denture opposing mandibular Kennedy I case

excessive forces on the alveolar ridge cause its resorption. An edentulous ridge tolerates compression forces well but not sliding or lateral forces. Even though the degree of resorption in the alveolar bone changes from person to person, depending on metabolism, hormonal and nutritional habits, and faulty denture design, excessive forces are known to be the most important causes of alveolar ridge resorption.

The most unresisting part of the upper ridge against occlusal forces is the anterior area, and when there is a case in which the natural mandibular dentition is opposing the upper complete denture, high amounts of resorption are observed. With these patients, the degenerative changes are much more frequently observed than ridge resorption. Most of the time, excessive enlargement in the tuber area is observed. Even though these enlargements are generally of a fibrous composition, sometimes they can be seen as bone formations. At the same time, on the palatinal mucosa, papillary hyperplasia can be observed. Together with these changes, overeruption in mandibular anterior teeth and excessive bone resorption of the posterior portion underlying the removable partial denture is observed. These observed changes create a syndrome, which called *combination syndrome* (Figs. 9.72 and 9.73a, b).

9.1.5.1 Combination Syndrome

In 1972, Kelly reported combination syndrome: a syndrome that is observed in patients who use upper complete dentures and lower distal extension partial dentures together.

Saunders et al. (1979) stated that the following six changes also occur over time:

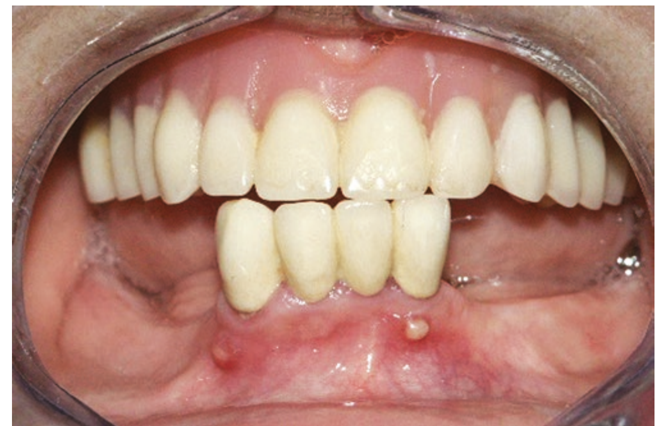


Fig. 9.72 Maxillary complete denture opposing four natural teeth in the mandible

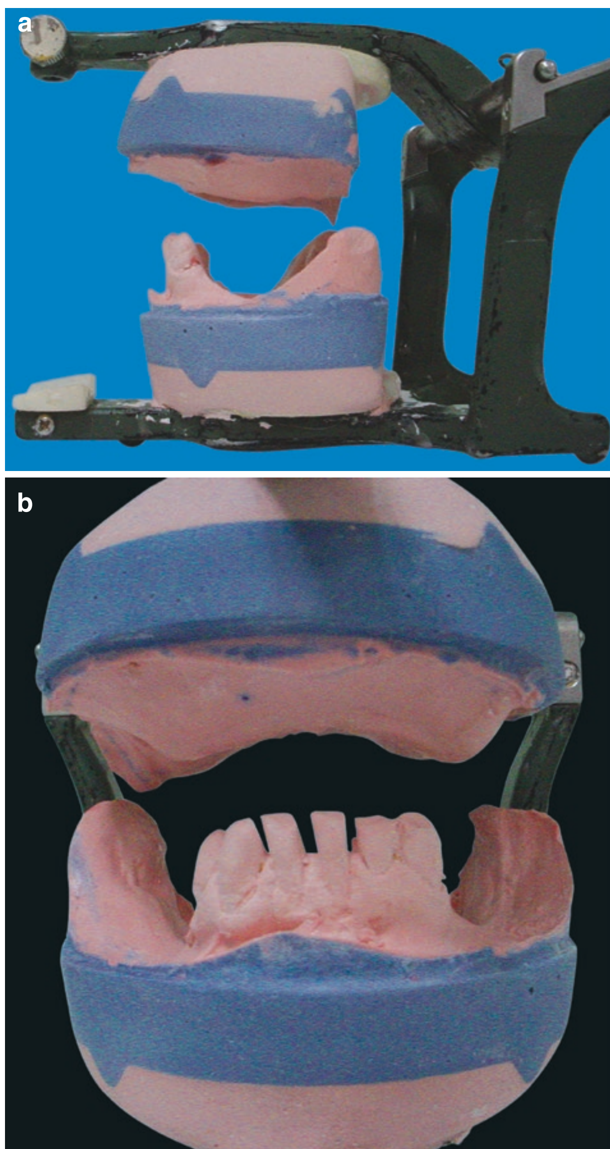


Fig. 9.73 (**a**, **b**) Bone resorption observed in cases with a maxillary complete denture opposing a mandibular Kennedy I case

1. Loss of vertical height
2. Irregularities on the occlusal plane
3. Anterior positioning of the mandible
4. Loss of denture adaptation
5. Epulis fissuratum
6. Periodontal changes

This syndrome periodically worsens. The patient has a tendency to condense occlusal load on the natural dentition. For example, for proprioception, the lower anterior teeth have a more forceful effect on the anterior portion of the maxillary teeth, and this creates mobile tissue (Fig. 9.74a), and the occlusal plane moves upward and anteriorly (Fig. 9.74b). Depending on the increased resorption and decreased support in the anterior region, epulis fissuratum occurs in the vestibular area of the denture. Also, due to the loss of support in the anterior region, occlusal loadings increase on the posterior region of the denture, leading to resorption and occlusal disharmony. The posterior portion moves downward, depending on the severe resorption of the mandibular posterior region (Fig. 9.74c). Downward movement of the occlusal plane on the posterior region causes the denture to move anteriorly, thus overeruption of the natural teeth; therefore open bite occurs (Fig. 9.74d). Because of the ongoing excessive load on the anterior portion, this vicious cycle continues.

9.1.5.2 Prevention of Combination Syndrome

Combination syndrome should be determined in the early stages and prevented. To prevent combination syndrome, some applications should be made on the denture.

These are:

1. The mandibular partial removable denture should provide maximal occlusal support from the remaining natural teeth in the mouth, and distal extensions should cover the maximum area possible.
2. The denture design should be rigid and provide maximum stability while minimizing excessive forces on the teeth.
3. The occlusal plane should be of the appropriate vertical height and centric relation.
4. Anterior teeth should only be used for esthetic and phonetical purposes.
5. Posterior teeth should have balanced occlusion.
6. The denture should cover the maximum area.
7. To stabilize the occlusion, the removable partial denture should be frequently relined.
8. If there are mandibular premolars, a cantilever bridge could be fabricated with canine and premolars.
9. If the crown-root ratios of the teeth are not ideal, by planning overdentures and implant treatment, it is possible to prevent combination syndrome. Overerupted anterior teeth are reduced and used as an abutment for overdenture (Fig. 9.75). Keeping these teeth as overdenture, the abutments prevent bone resorption, and in the future the anterior portion will have adequate bone height for implant applications (Figs. 9.76 and 9.77).

In the research of Shen and Gongloff (1989), in which they examined Combination Syndrome frequency in patients who used maxillary complete dentures, they reported that in 26% of the patients who had mandibular anterior natural dentition and used upper complete denture, the changes that take place in combination syndrome were observed.

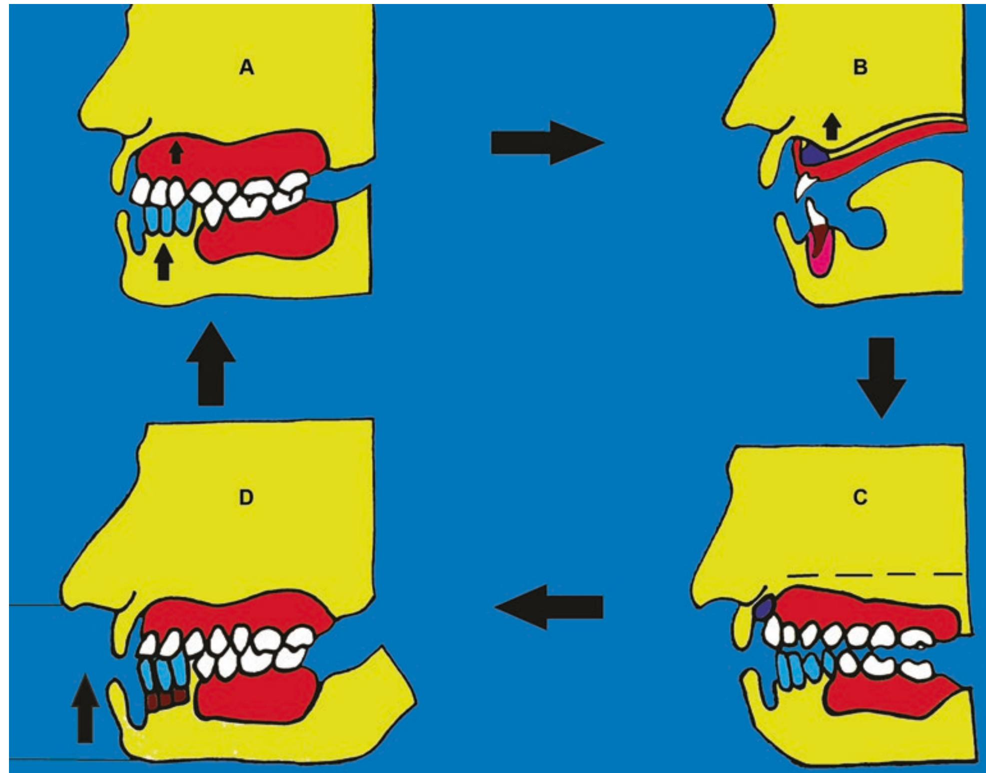


Fig. 9.74 Formation phases of Combination Syndrome

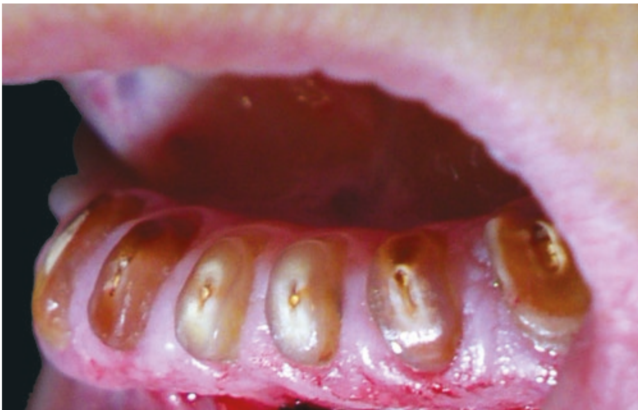


Fig. 9.75 Reduction of overerupted anterior teeth to be used as overdenture abutments

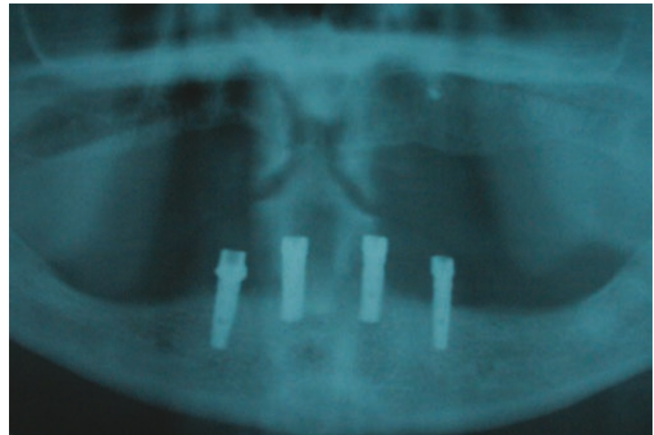


Fig. 9.76 Keeping the roots inside the alveolar bone prevented bone resorption, and four implants were easily placed (radiographic view)

9.1.6 SCD Opposing an Existing Complete Denture

Instead of fabricating a SCD opposing an existing complete denture, fabricating a lower and upper complete denture together is a safer and easier way. If the existing complete denture does not meet certain standards, a SCD should not be fabricated for the antagonist arch.

These standards are:

- Having a good teeth arrangement on the existing denture to provide effective mastication and denture stability
- Having esthetically acceptable teeth
- Having adequate tissue support
- Having proper tubercle heights harmonious with the SCD
- Having sufficient esthetics and base thickness to support perioral structures
- Having a denture base that covers all supporting structures
- Having a good stability and retention

If the preexisting denture is suitable regarding these criteria, then a SCD can be fabricated. It will be beneficial to

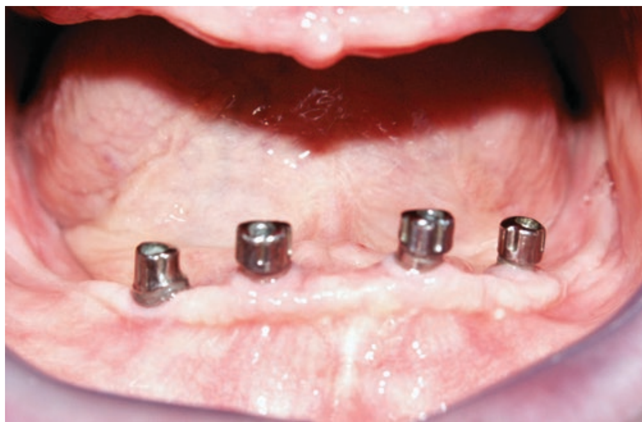


Fig. 9.77 Intraoral view of implants

grind the second molar of the preexisting denture to increase the compensation curve. This process helps to obtain a balanced lateral and protrusive occlusion; however, very few of the existing dentures show these features. If a single complete denture is produced, opposing such an existing denture that does not meet these criteria, denture stability and retention will be affected. If the dentist decides that the prognosis will be affected, after obtaining the patient's approval, it is best to reproduce both of the dentures.

9.1.7 Problems Encountered in Single Complete Dentures

Problems seen in SCD can be summarized as follows:

1. Deficiency of stability
2. Damage on the mucosa and resorption of the alveolar bone
3. Deficiency of function
4. Denture base fractures
5. Depending on the teeth material used for the denture, abrasion of artificial teeth or antagonist natural teeth

Having only one of these problems is enough to have an unsuccessful denture. One of the most disadvantageous problems is the resorption observed in the alveolar bone, because we are against the protection of continuity and integrity of remaining tissues principle, which is one of the most important aims of prosthetic treatment.

SCD are usually the patient's first dentures. Therefore, it will take time for the patient to get used to them. After the delivery of the denture, the patient's expectation is to have mastication effectiveness and an esthetic appearance, as if these where their own teeth. If there is lack of retention of the denture, there will be discomfort accompanying the tissue changes on the edentulous ridge, denture base fractures, and the adaptation need of the tongue for better mastication, together with speaking and adaptation needs of the lips and cheeks for functional movements. Any change in appearance will eventually result in the patient's dissatisfaction.

The SCD patient generally complains of retention loss and rotation of denture in the mouth. In such a case, damage to mucosa and resorption in the alveolar bone will be observed after a clinical examination. Relining the denture is a temporary solution, and after a while, patient will have the same complaints he had before. To completely solve this problem, the SCD should cover the maximal area and should be realigned to have a proper occlusal plane opposing antagonist natural teeth. This way, forces on the SCD should be minimized.

For the success of SCD, the teeth on the antagonist arch, the fixed prosthesis, removable partial dentures, and the existing complete denture should be examined carefully. Before starting the fabrication of the single complete denture, all observed problems should be resolved, and only then should the production stage begin. Occlusion of teeth in the antagonist arch should be carefully examined. Situations that may cause deviations on the ideal curvature of the occlusal plane should be arranged. The occlusal plane may diverge from its ideal form because of tilting caused by extraction spaces, overeruption, and rotation. If SCD teeth are arranged without fixing occlusal deformities, the natural teeth will strike the single complete denture during protrusive movements of mandible, and denture stability will be lost. Likewise, natural teeth that are tilted toward the vestibule or lingual side will negatively affect denture stability during lateral movements.

Natural teeth that are on the opposite side of the SCD arch generally show different depth and abrasion characteristics of the tubercles. Because of this, to preserve the same functional width on occlusal surfaces, appropriate changes should be made on the buccal and lingual surfaces of the teeth.

The reasons for denture base fracture are as follows:

- Occlusal stresses on the upper denture and underlying edentulous ridge caused by antagonist dentition and muscles
- Alignment of mandibular natural teeth inhibiting bilateral balance for the stability of denture
- Elastic denture bases

For the success of SCD treatment, the most important factor is to accomplish harmonic occlusion. Obtaining these desirable occlusal features regarding teeth alignment procedures is very challenging when compared with complete dentures. To obtain desirable bilateral balanced occlusion, Hanau's five should be well understood and applied. The primary principals should be successfully applied to obtain denture stability, retention, and support.

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10 Duplicate (Copy) Dentures

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10.1 Duplicate (Copy) Dentures

In prosthodontics, the copy technique (or copy dentures) refers to duplication of an existing denture(s) with or without modification of the existing denture. They are a faster alternative to a remake of complete–complete acrylic dentures. Duplication or copying techniques offer both the patient and the doctor important advantages on time-saving and satisfaction with treatment results. Duplicate dentures can easily be applied to geriatric patients, patients with diminished neuromuscular control, and those who are pleased with their old dentures but simply want to change their appearance.

10.1.1 Aims of Duplicate Denture Fabrication

1. Obtaining the right maxillomandibular relations by the correction of the occlusion
2. Minimizing adaptation problems by producing a new denture that, as far as possible, resembles the old one (The shape of the base, the form of the palatal vault, the transfer of teeth regarding axial inclination, shape, form and arrangement are all important.)
3. Uniting some stages of the production process and fabricating the denture within a few clinical visits

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10.1.2 Indications of Duplicate Dentures

1. Those patients who are used to their old dentures and are going to experience difficulties in adapting to new dentures due to their physical or psychological disorders
2. To remove the stained and damaged appearance on the base of the denture
3. To change worn teeth with new ones
4. To obtain an acceptable esthetic quality
5. The refinement of functional capacity and esthetics by increasing the vertical dimension
6. The improvement of patient comfort by increasing retention of the denture

While fabricating a duplicate denture, it is necessary for the old denture to have an excellent adaptation; therefore, the relining procedure can be used to increase the retention and provide a record of the exact position on the alveolar crest.

A denture has three surfaces:

Occlusal surface—the biting surface of the artificial teeth on the denture

Fitting surface—the unpolished surface that contacts the mucosa of the denture-bearing area

Polished surface—the part of the denture which is not the biting surfaces of the teeth and which does not sit on the mucosa

The purpose of the copy technique is to reproduce as closely as possible the polished surface shape of the old dentures in the new dentures. The principal changes in the new denture will be to the impression surface and occlusal surfaces.

While fabricating a duplicate denture, all or most of the features below should be duplicated to the new one:

1. Shape of the polished surfaces
2. Vertical height or the controlled modification of the height

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3. Occlusal plane
4. Size, position and arrangement of the anterior teeth
5. Size and position of the posterior teeth
6. Occlusal surface
7. Area and shape of the tissue-bearing surface

The first and most important stage of fabricating duplicate dentures is to decide which features of the existing denture are acceptable and which need modifications. In some cases, the existing dentures can be duplicated extensively, apart from the tissue-facing surfaces. In some other cases, although the anterior teeth positions, relations and polished surfaces are being duplicated, both the occlusal surfaces and tissue-facing surfaces can be modified. If several modifications are planned, the dimensions, shape and surfaces of the existing denture can be used as a guide in fabricating the new denture.

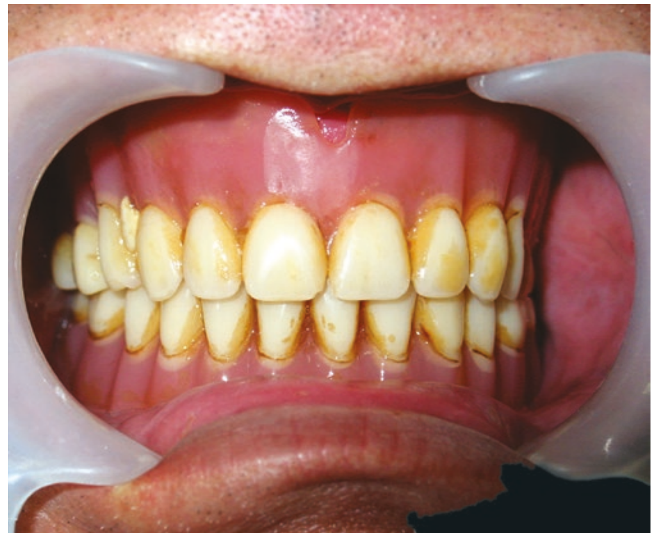


Fig. 10.1 Intraoral examination of the existing dentures

10.1.3 Denture Duplication Techniques are Examined in Two Main Categories

1. In the first method, as a starting point, a duplicate of the existing denture is obtained using wax or another material. If necessary, modifications of these duplicates can be made afterwards.
2. In the second method, a plaster model of the denture is used as the existing guide in the fabrication of new dentures.

Researchers usually prefer the first method, as they consider that better results can be achieved with this method.

10.1.4 Fabrication of Duplicate Dentures

1. First, the margins of the existing denture should be examined. If necessary, the margins should be extended using impression compound (Figs. 10.1 and 10.2).
2. To provide a better adaptation to the tissues, tissue conditioner materials could be placed inside the denture, or a new impression could be made during the try-in stage.
3. The vertical height should be examined. In case of low vertical height, vertical dimension determining methods could be performed (Figs. 10.3 and 10.4).

If there is distinctive occlusal wearing and the patient is elderly, adding auto-polymerizing acrylic resin to the occlusal surface, to evaluate the patient's reaction towards the modification, is recommended. Face bow recordings are obtained during this stage. Following this stage, as it is planned to return the dentures to the patient, the dentures should be temporarily relined with a tissue conditioner once the modifications are made. For this reason, the dentist is generally advised to take impressions for

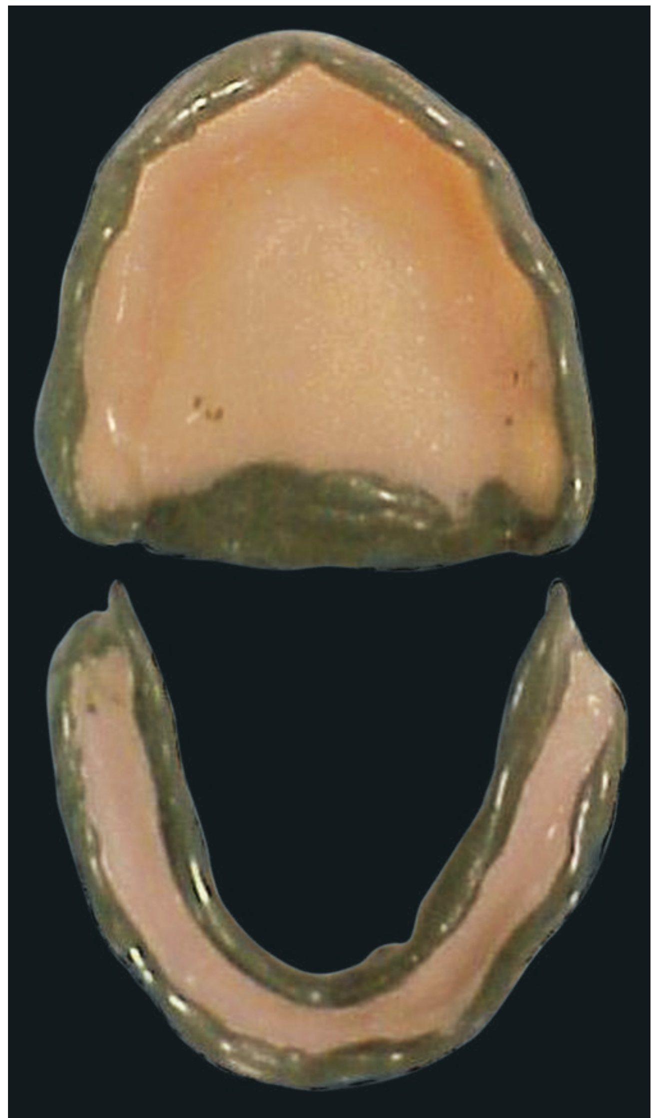
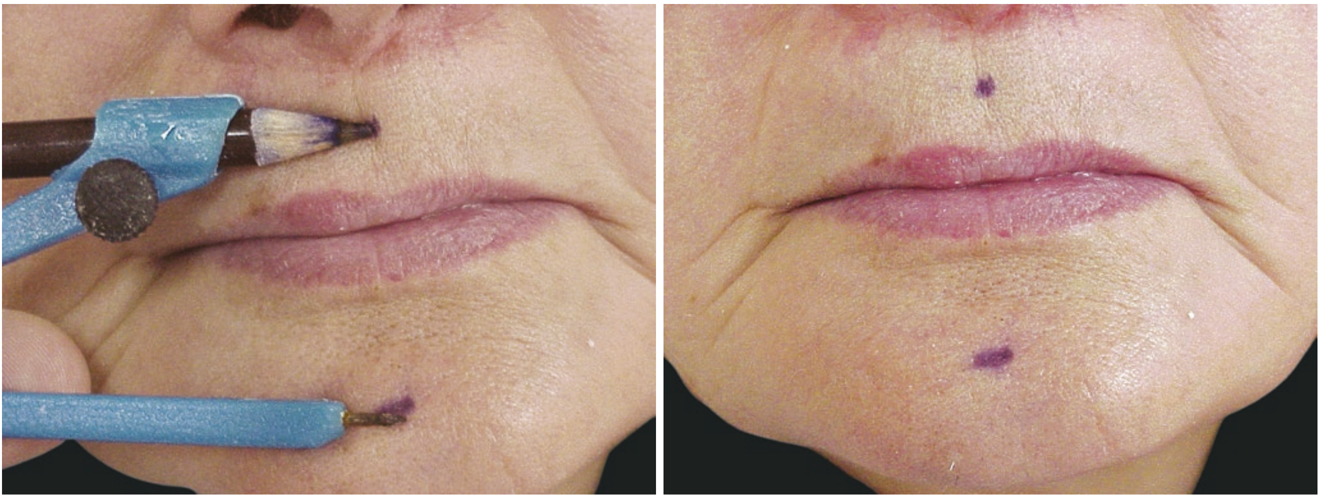


Fig. 10.2 Functional border moulding of the existing dentures



Figs. 10.3 and 10.4 Checking the vertical dimension

duplicate dentures in the subsequent stage. After adjusting the margins and recording the occlusal relations, the patient is requested to wait for an hour. For the impression of the denture, even though any elastic material could be used, silicone-based impression materials are the most rewarding.

To prevent the silicone impression materials from adhering to denture surface, it is recommended to gently lubricate the denture with silicone oil. The prepared putty impression material is rolled out to form a dough consistency. First, the impressions of the tissue-facing surfaces should be made and then the occlusal and polished surfaces (Figs. 10.5–10.7).

To make the impression of the polished surfaces, the prepared silicone impression material is placed over the first impression material. To ensure a secure connection between two impression materials, it is advisable to create wedge-like grooves on the first impression material. In this way, it will be easier to separate and to reintegrate the two impression materials. To prevent the silicone materials from sticking to each other, applying Vaseline between the silicone impressions is beneficial (Figs. 10.8, 10.9, and 10.10). During the copying procedure of the dentures, the denture's tissue-facing surface and polished surface are obtained using a silicone-based impression material. This is because silicone materials are heat resistant and give approvable results in recording the undercuts and maintaining base materials adaptation. Alginate impression materials are too elastic to give appropriate results, and they change dimensionally in a short period of time. After the silicone-based material has hardened, the mould is opened and the dentures are removed (Figs. 10.11 and 10.12).

4. Auto-polymerizing acrylic is prepared according to the instructions of the manufacturer and applied to the tissue surface in a fluid form (Fig. 10.13). After this, the melted wax is poured into the negative spaces of the teeth in the silicone pattern (Fig. 10.14).
5. The moulds are sealed and secured with plastic bands (Fig. 10.15). After the cooling process, a wax copy is obtained in which the teeth are composed of wax and the base is acrylic (Fig. 10.16).
6. During this stage, for a short period of time, it is possible to control the denture intraorally. If the wax is exposed to intraoral temperatures for a long period, it could become distorted. If the dentist wants to check the denture intraorally during this stage, the teeth could be made out of acrylic instead of wax. However, it should be kept in mind that the removal of acrylic teeth will create a more problematic situation during this process (Fig. 10.17).
7. Next, both copies of the dentures are transferred to an articulator. The individual wax teeth are removed, and the artificial teeth are placed on the acrylic denture base. Required adjustments are performed intraorally (Fig. 10.18).
8. The trial of teeth arrangement is completed (Fig. 10.19). Following the patient's approval, points that need to be fixed are determined, and to obtain a detailed record of the tissue surfaces, impressions are made, usually with zinc oxide paste. The posterior vibrating line is determined and defined by the impression (Figs. 10.20 and 10.21).

To make impressions of duplicate dentures, the closed-mouth technique is needed. Also, impressions should be

Figs. 10.5–10.7 Placement of upper and lower dentures into silicone-based impression material

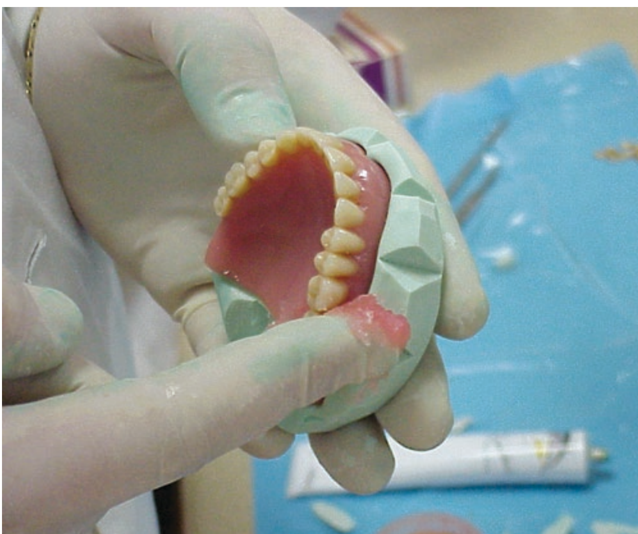
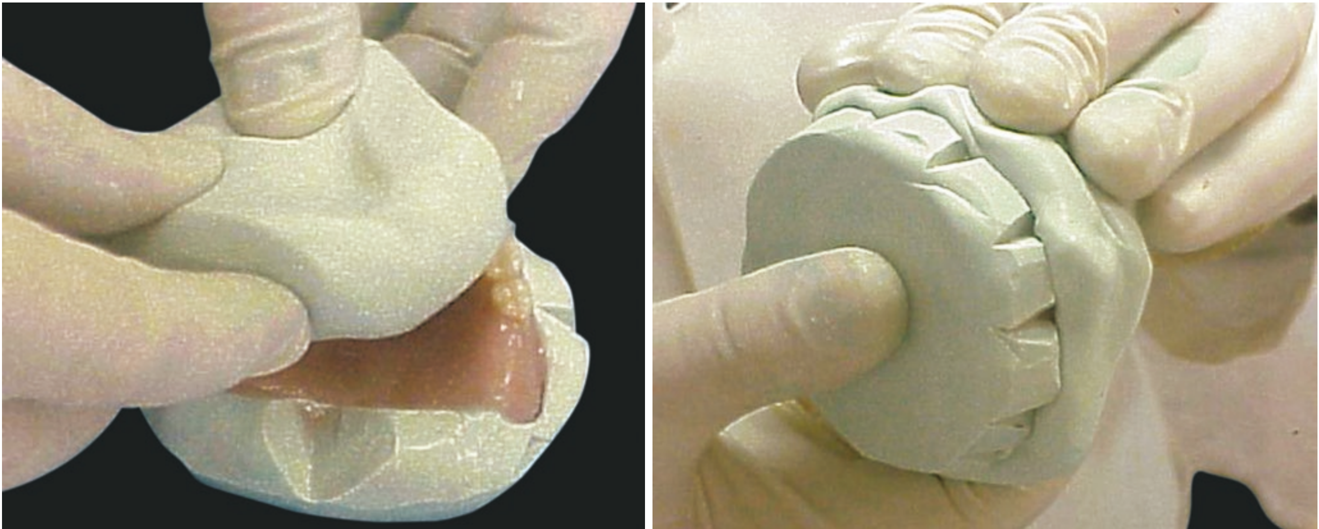
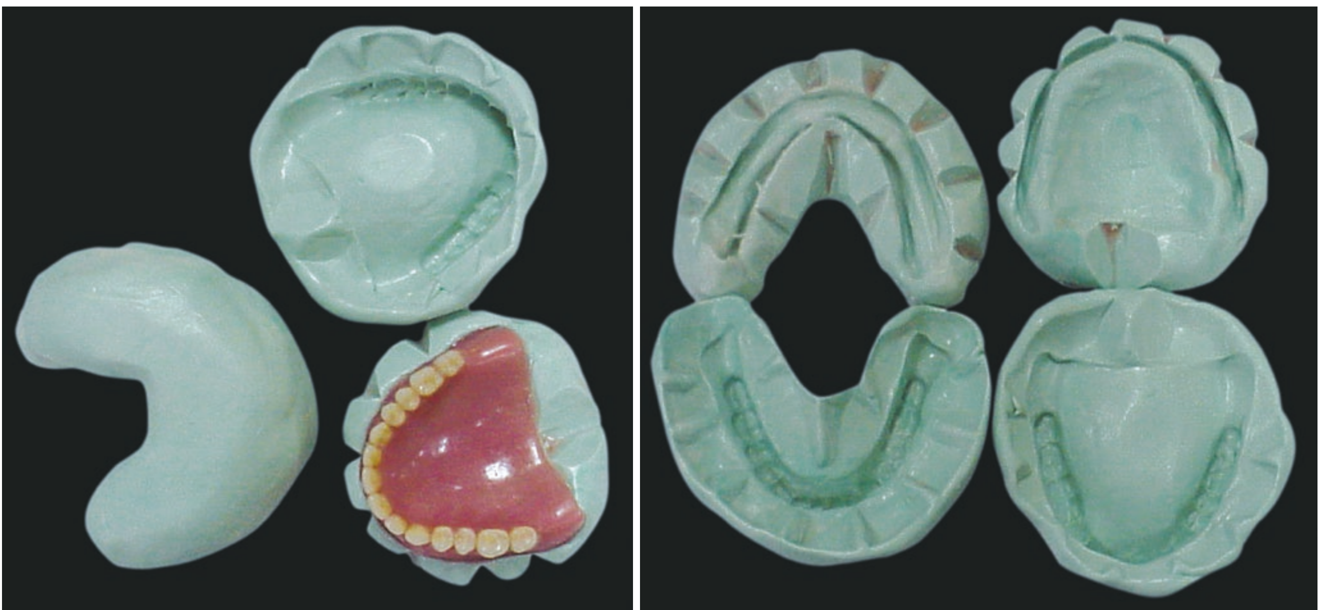


Fig. 10.8 Application of vaseline on the interface

obtained when the patient is in the centric relation position. If not, dentures fabricated from impressions that have been taken separately from two jaws may cause occlusal problems. If the teeth arrangement trial and impression stages are completed successfully, the dentures are sent to the laboratory for the flasking procedure. The finishing stage of the dentures is made using standard procedures. Following occlusal modifications and controls, the patient is called for routine checkups (Figs. 10.22 and 10.23). In this technique, anterior teeth that resemble the teeth in the previous denture are commonly used. The occlusal surfaces are arranged in correlation with traces on the previous denture. If the patient exhibits severe abrasion pattern on the occlusal surfaces of the old dentures, balanced occlusion should be provided for the new dentures.



Figs. 10.9 and 10.10 Preparation of the upper impression and placing it over the lower impression



Figs. 10.11 and 10.12 Opening the silicone moulds and removing the dentures

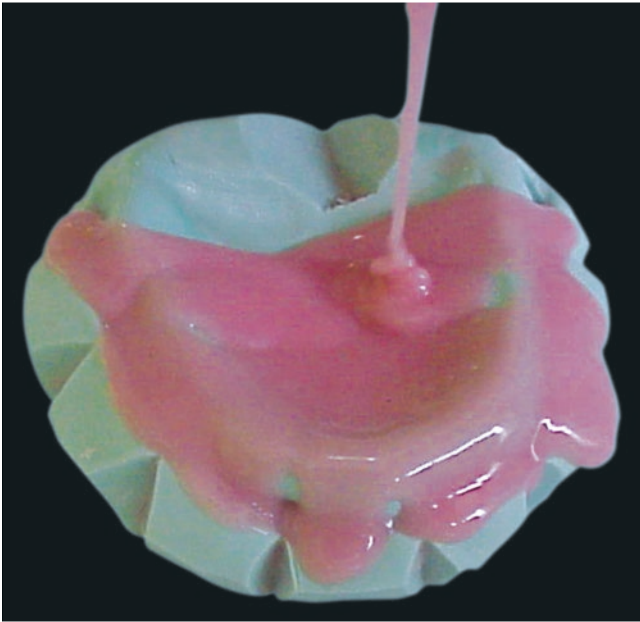


Fig. 10.13 Application of auto-polymerizing acrylic resin

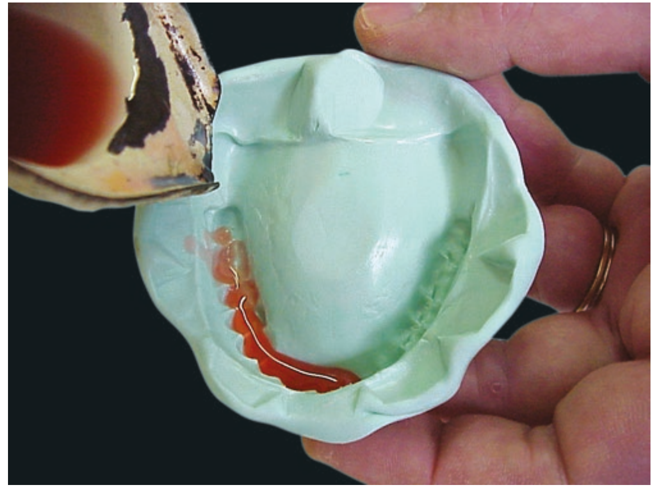


Fig. 10.14 Pouring wax into the negative spaces of teeth

Fig. 10.15 Sealing the moulds

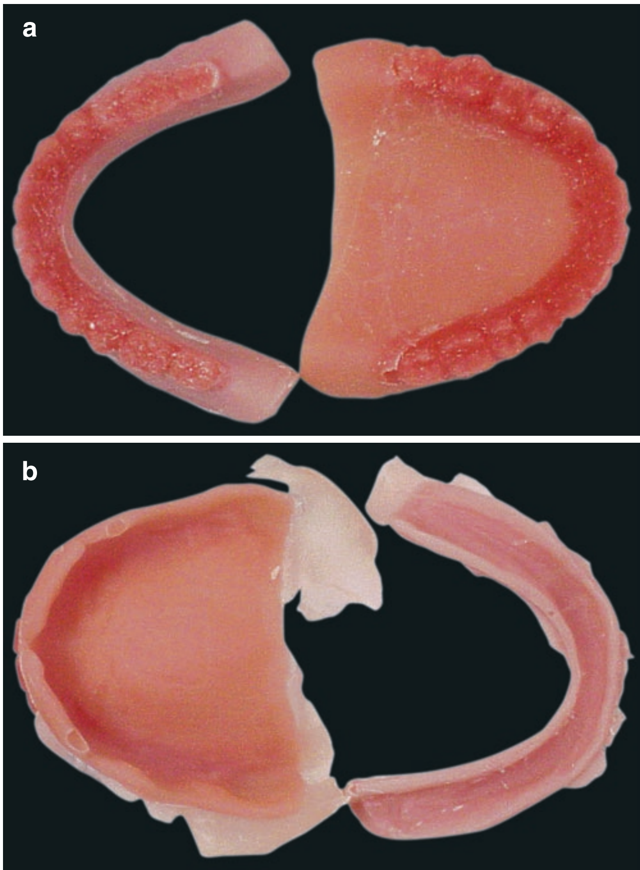


Fig. 10.16 (**a**, **b**) A wax copy in which the teeth are wax and the denture base is acrylic resin

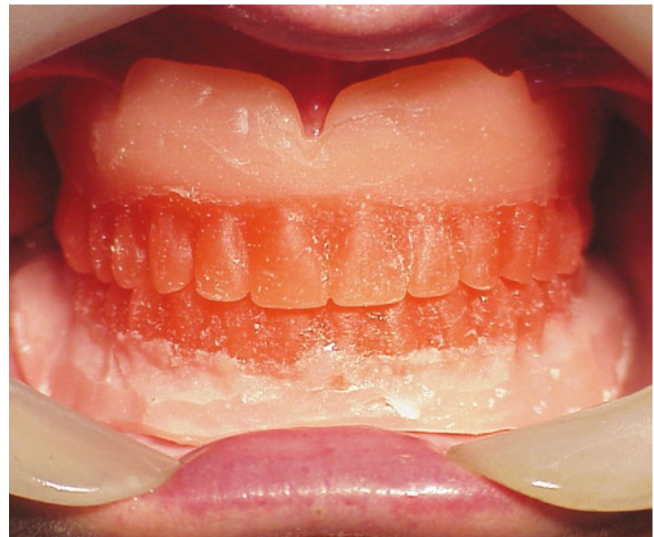


Fig. 10.17 Intraoral view of wax copies of dentures

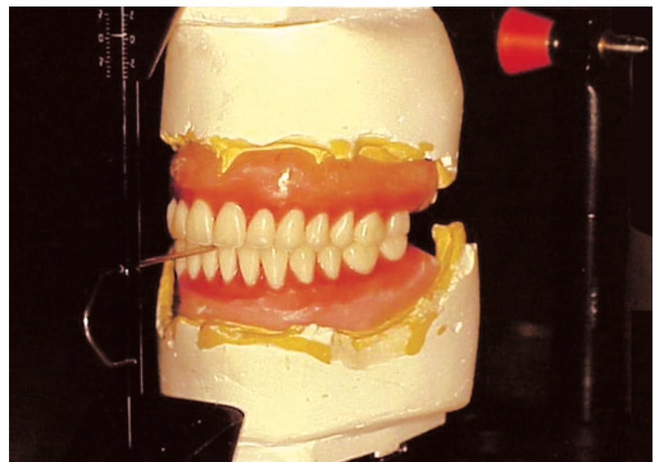


Fig. 10.18 Teeth arrangement on the articulator

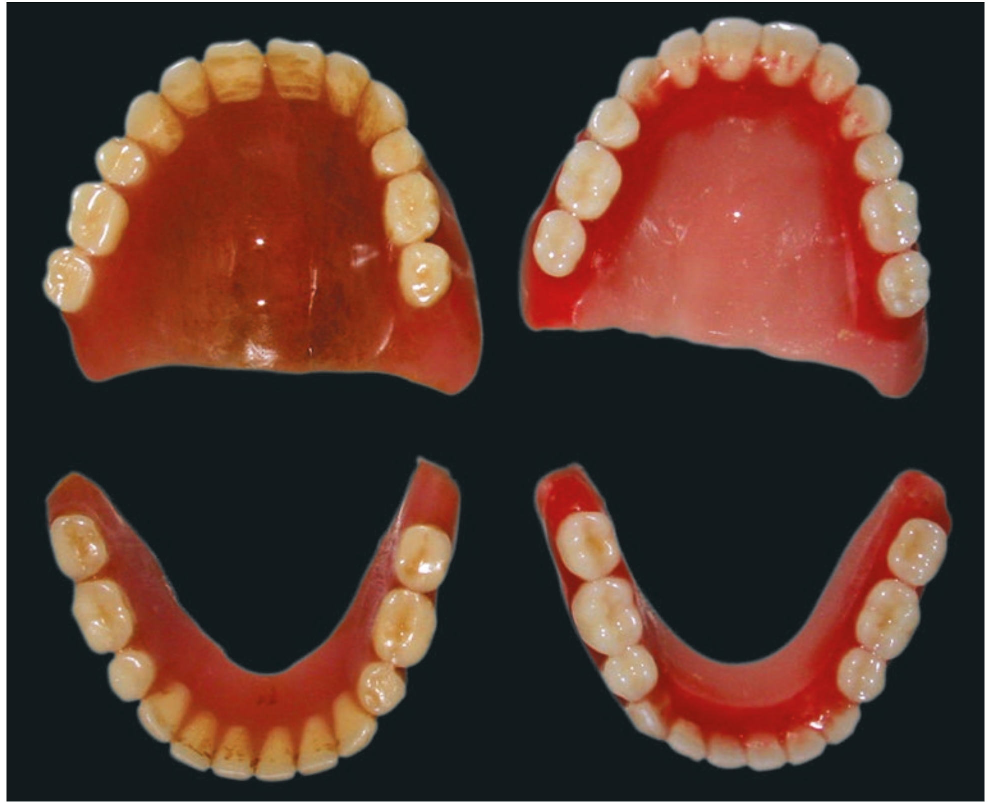


Fig. 10.19 Old dentures and wax duplicates

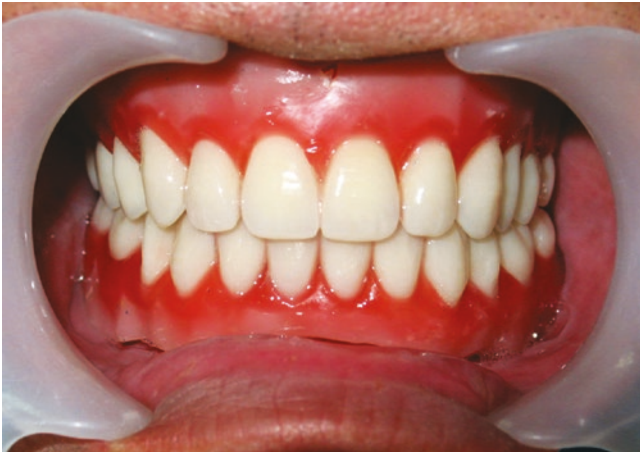


Fig. 10.20 Evaluation of teeth arrangement

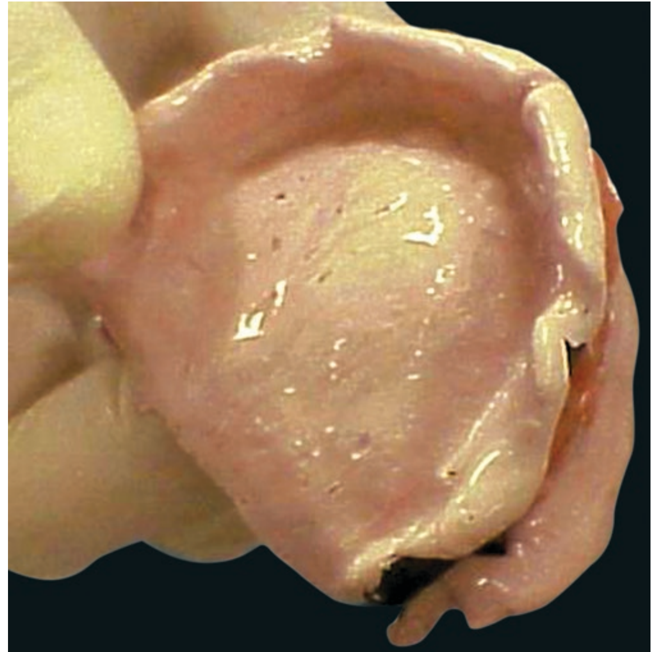
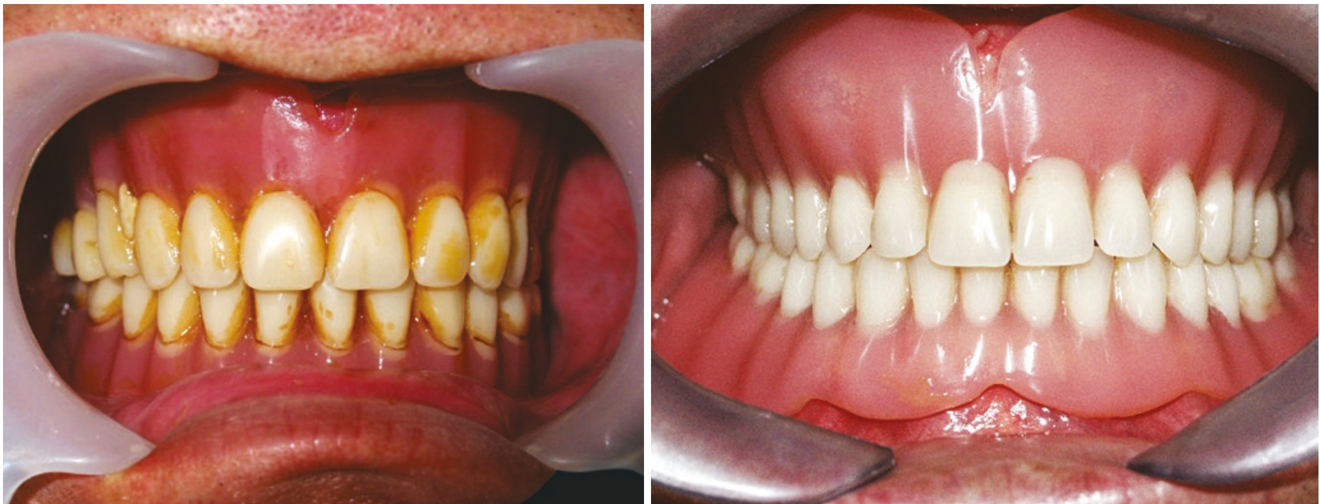


Fig. 10.21 Making the impression



Figs. 10.22 and 10.23 The appearance of old and new duplicate dentures

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Managing the Edentulous Dry Mouth: Reservoir Complete Denture

11

Yasemin K. Özkan

11.1 Managing the Edentulous Dry Mouth: Reservoir Complete Denture

Xerostomia (xero, dry; stomia, mouth), a clinical condition caused by a decrease in the production of saliva, may present itself as a local symptom, as part of a systemic disease such as Sjogren's syndrome, diabetes, and alcoholism or as side effects of medications or during following therapeutic radiation to the head and neck regions. Edentulous patients suffering from xerostomia may complain of not only dry mouth but also of difficulty in normal functions like eating, speaking, swallowing, etc. Extreme discomfort in wearing dentures is a common complaint. Xerostomia may or may not be associated with a decrease in the production of saliva. Saliva is one of those things that is appreciated only in its absence, when the patient perceives a significant negative effect on quality of life.

Whole saliva (commonly referred to as saliva) is the mixture of specific salivary fluid as produced by individual glands. It is composed primarily of water (~99.5%), with the remaining properties being proteins (0.3%) as well as inorganic and trace substances (0.2%). Though saliva is often perceived to be a fluid substance, it exists in gaseous and gel phases as well, sometimes simultaneously. *Many factors influence the composition of saliva and its flow rate, including* type and size of the salivary glands producing saliva, presence or absence of stimulation, diet, drugs, age, and physiological status. Two different kinds of saliva help in oropharyngeal health and function: stimulated saliva and unstimulated (resting) saliva.

Stimulated saliva is produced before, during, and after eating in the presence of various sensory inputs (e.g., mechanical, gustatory, etc.). It may also be secreted as a reflex to input from the higher centers of the brain in response to an emotional reaction.

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Unstimulated or resting saliva is not produced in the presence of these apparent stimuli. Instead, it has two components that affect its production: spontaneous and continuous secretion and reflexive secretions to the sensation of dryness of the oral mucosa. This complex process serves in preserving the health of the oral cavity while also maintaining the moisture of the oral and pharyngeal mucosa.

Total daily whole saliva flow may be between 500 mL and 1.5 L depending upon the individual, with average values for pH and flow rate for healthy individuals. Average whole saliva flow rate is 0.3 mL per minute for unstimulated and 7 mL per minute for stimulated saliva, respectively, and average values for pH are 6.2 for unstimulated and 7.4 for stimulated saliva, respectively.

Evidence from the literature strongly suggests that a reduction in salivary flow is observed with aging. Reduced salivary flow may cause extreme problems in the oral cavity. It is stated that the flow rate of unstimulated whole saliva may decrease by about 40% in older subjects, whereas that of stimulated whole saliva may be reduced by about 15%. Also, it is stated that it observed a significant decrease in flow rates from the sublingual and submandibular glands, but did not observe similarly significant decreases in flow from the parotid or minor salivary glands. Hyposalivation can be described as an objective measurement of decrease in typical salivary flow rate. It may come about as part of the aging process, due to disease (especially of neurological or tissue-altering origin), due to radiation, or as a side effect of medication, such as anticholinergics or antipsychotics.

Patients with hyposalivation may experience the following problems:

Difficulty in clearing food and bacteria from dental and oral surfaces
Difficulty in chewing, swallowing, and speaking
Increased caries (tooth decay or cavities)
Problems retaining dentures
Sensations of burning mouth or xerostomia

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A strong association has been observed between xerostomia and hyposalivation. Hyposalivation is defined as any objectively demonstrable reduction in whole and/or individual gland flow rates. When the unstimulated whole saliva flow rate is less than 0.1 mL per minute (normal values, 0.3–0.4 mL per minute) and stimulated saliva flow rate is less than 0.5–0.7 mL (normal values, 1–2 mL per minute), it can be defined as hyposalivation.

Hyposalivation is a measurable reduction in salivary flow from individual or all salivary glands; xerostomia is the subjective sensation of having dry mouth. In dentistry, xerostomia is referred to as dry mouth. It is the subjective feeling of oral dryness. The patient complains of dryness due to the reduced salivary flow function. Xerostomia can be observed without the symptoms of hyposalivation (mouth breathing), and also hyposalivation can be observed without the symptoms of xerostomia.

For individuals who suffer from xerostomia, a clinically significant decrease in flow rate has been observed, as normal residual volumes are slow to be replaced following mucosal absorption or evaporation. In addition, changes to the thickness of the salivary film covering palatal and mucosal surfaces may occur. These flow rate and thickness changes result in localized areas of dryness in the mucosa, particularly in the palate. Dry mouth may cause increased food and plaque retention around the teeth and stomatitis in complete denture patients

A study conducted by Dawes and Odlum found that patients who experienced severe hyposalivation and reported sensation of very dry mouth had salivary flow reduced by 29%. Dawes suggested that in order for the xerostomia to be avoided, an unstimulated salivary flow rate greater than 0.1–0.3 mL per minute may be necessary.

Saliva acts as a thin film between the dentures and the oral mucosa, and its absence may lead to decreased retention as well as the increased possibility of inflammation and ulceration in the oral cavity. For individuals with dry mouth, the mucosal film thickness is 27.8 μm (7.4 μm in hard palate, 19.6 μm in lip mucosa), while it is 41.8 μm for patients without dry mouth.

11.1.1 Reasons for Dry Mouth

1. Biological aging: This is an effective factor but not the primary cause.
2. Systemic diseases: Rheumatoid diseases (Sjogren's syndrome), immune system damage (AIDS), hormonal disorders (diabetes mellitus), and neurological disorders (Parkinson's disease).
3. Decrease in the chewing efficiency: In cases with increased fluid and soft food diet, chewing function decreases.
4. Inflammation in the salivary glands, surgical removal of salivary glands.
5. Side effects of drugs (e.g., antidepressants, antihypertensive, diuretics, antihistaminic, ant anxiolytics): Some drugs affect the receptors over the salivary glands and change the water salt balance and transport.
6. Radiotherapy (ionized radiation): Radiotherapy may cause atrophy on the salivary components of the major and minor glands.
7. Caffeine and alcohol consumption.
8. Depression.

Dry mouth (xerostomia) may be the result of head and neck radiation and surgical removal of the salivary glands. Reduced salivary flow also can be a result of vitamin B and iron deficiency, diabetes mellitus, and diabetes insipidus. Also, it can be combined with tricyclic antidepressant treatment. Xerostomia causes increased discomfort to patients with removable dentures. Movement of the dentures during function may increase and cause decreased retention as well as an increased probability of inflammation and ulceration in the oral cavity.

11.1.2 Symptoms of Xerostomia

1. Burning sensation on the tongue
2. Difficulty in eating, especially dry food
3. Difficulty in swallowing, chewing, or speaking
4. Frequently feeling thirsty
5. Difficulty in using dentures
6. Dryness and cracks in the lips
7. Halitosis
8. Fissured tongue with atrophy of the filiform papillae and a lobulated, erythematous appearance of the tongue
9. Increased risk of salivary gland stones
10. Mouth soreness and oral mucositis
11. Dysgeusia—altered taste sensation

11.1.3 How to Treat Dry Mouth

The successful treatment of xerostomia is difficult to achieve and often unsatisfactory. Treatment of xerostomia involves finding any correctable cause and removing it if possible. However, in many cases, it is not possible to correct the xerostomia itself when the symptom is caused by hyposalivation due to an underlying chronic disease, given that xerostomia could be considered permanent or even progressive. The management of salivary gland dysfunction may involve the use of saliva substitutes and/or saliva stimulants.

11.1.4 Recommendations

1. Drinking liquids frequently, even during the night.
2. Sugar-free chewing gums may increase salivary flow.
3. Smoking, alcohol, and sugar intake must be avoided.
4. The humidity of the environment should be controlled.
5. Saliva substitutes and saliva stimulants (methylcellulose) could be used in severe cases.
6. Bacterial plaque should be controlled.
7. Tooth pastes, gels, and mouth rinses with fluoride should be used.
8. Vitamin C intake can be increased.
9. Oral health products containing alcohol and sodium lauryl sulfate should not be used.

For complete denture patients with dry mouth, soft lining materials could be used to decrease friction on the mucosa, and reservoir complete dentures can be fabricated.

11.1.5 Reservoir Complete Dentures

In patients with reduced salivary flow, reservoir complete dentures can be recommended. To treat the patient with reservoir dentures, the distance between the crests and the vertical dimension must be high enough. These restorations need more vertical dimension than classical dentures.

Reservoir complete dentures are heavier than the conventional complete dentures, and the patient's tolerance is low.

11.1.6 Fabrication Steps of the Reservoir Complete Dentures

11.1.6.1 Maxillary Denture

The complete denture is constructed conventionally until the try-in stage (Fig. 11.1). Following the try-in stage, a layer of wax is placed on the palatal surface of the denture (Figs. 11.2 and 11.3). In this stage, the denture is duplicated with a stone or PVS impression material (Figs. 11.4 and 11.5). In the model, the area of the metal plate is defined, and the wax-up is constructed (Fig. 11.6). The thickness of the wax should be 0.45 mm, and two holes with a diameter

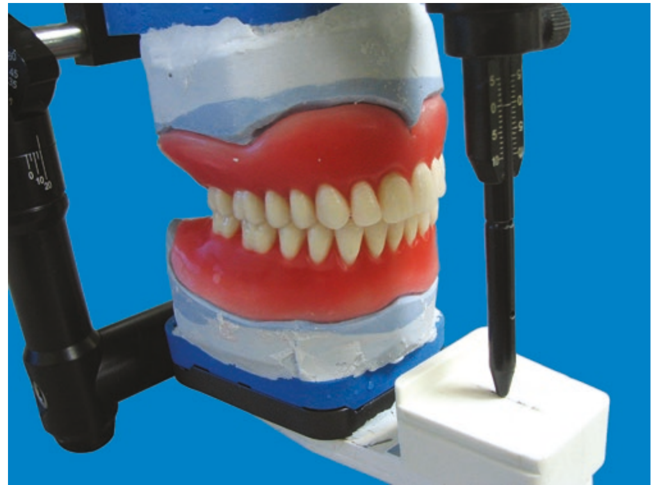

Fig. 11.1 The view of dentures after the try-in stage on the articulator

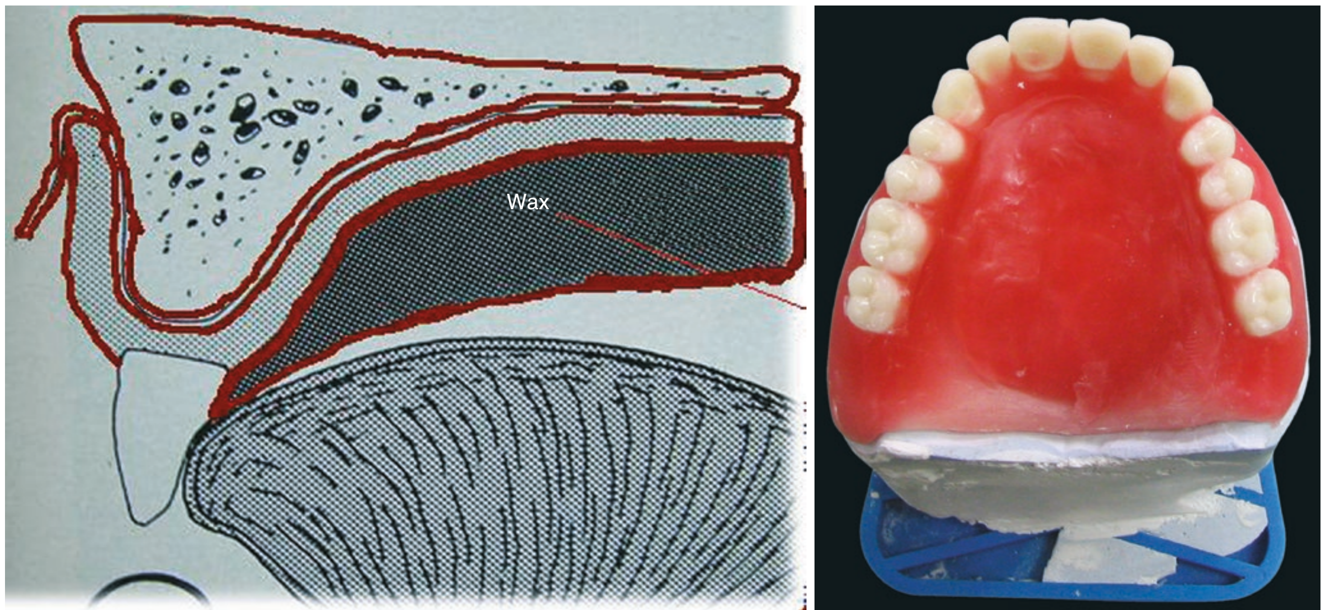

Fig. 11.2 and 11.3 The palatal contour of the denture is thickened with a layer of wax

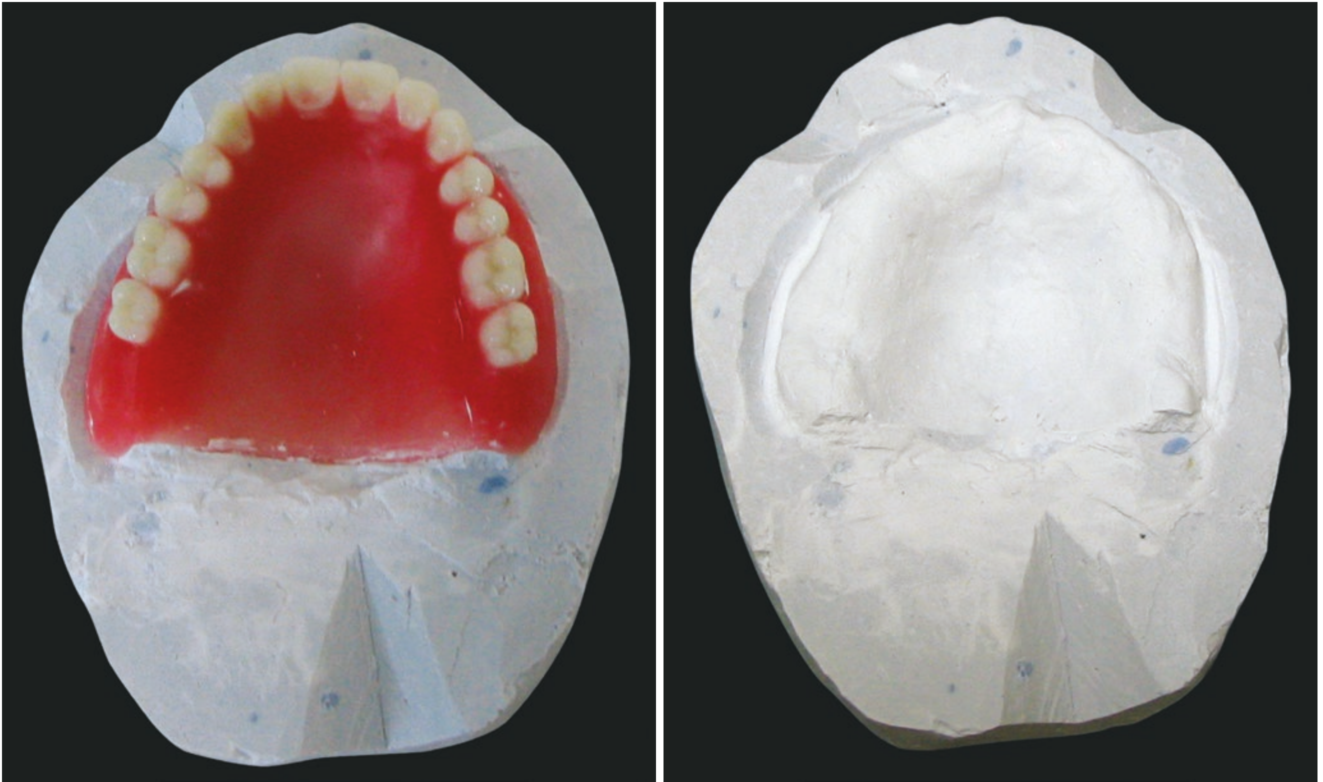

Fig. 11.4 and 11.5 The maxillary denture is duplicated with stone

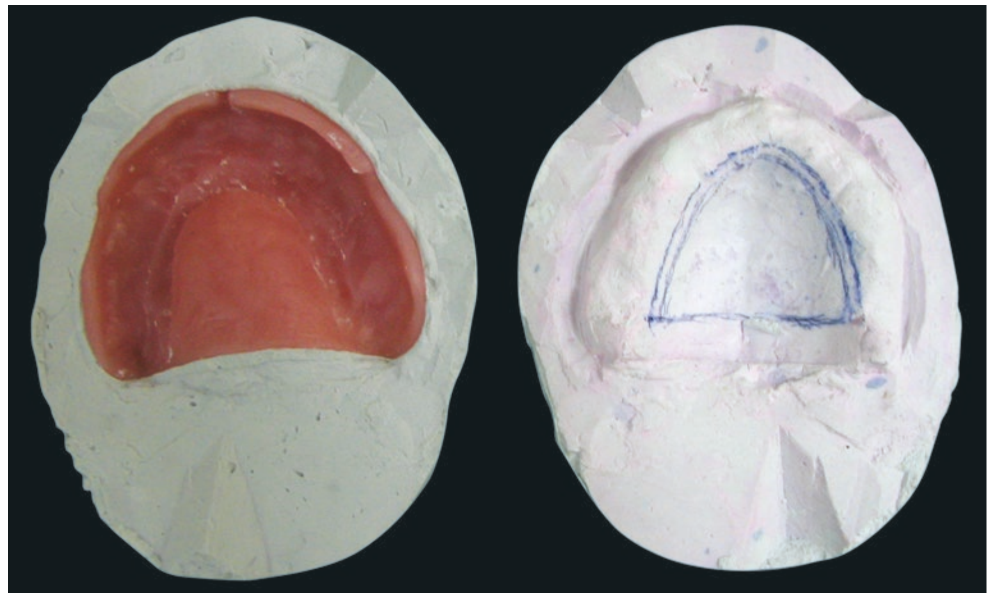

Fig. 11.6 The borders of the metal plate is drawn on the stone model

of 1.5 mm, one in the front and one in the back of the middle line, should be prepared to allow salivary flow. The connection of the metal plate and acrylic should be 1 mm in thickness. A sleeve of 0.3 mm height should be performed for the tight connection of the metal and acrylic. Casting procedures are performed with investing and casting. The adaptation of the metal is controlled after divesting and polishing (Fig. 11.7).

The metal plate is adapted on the palatal surface (Figs. 11.8 and 11.9). Silicone or stone is placed over the metal to provide space for the reservoir, and the wax-up is completed (Figs. 11.10 and 11.11). A hole is prepared on the additional wax with a depth of 0.1–0.2 mm to make the palate moistened during tongue movements. Flasking and deflasking procedures are performed (Fig. 11.12), and the dentures are polished (Figs. 11.13 and 11.14). The metal and the acrylic should be separated carefully (Fig. 11.15). The silicone or stone in the pool region should be carefully removed. The holes are checked, since these holes are important for the salivary flow.

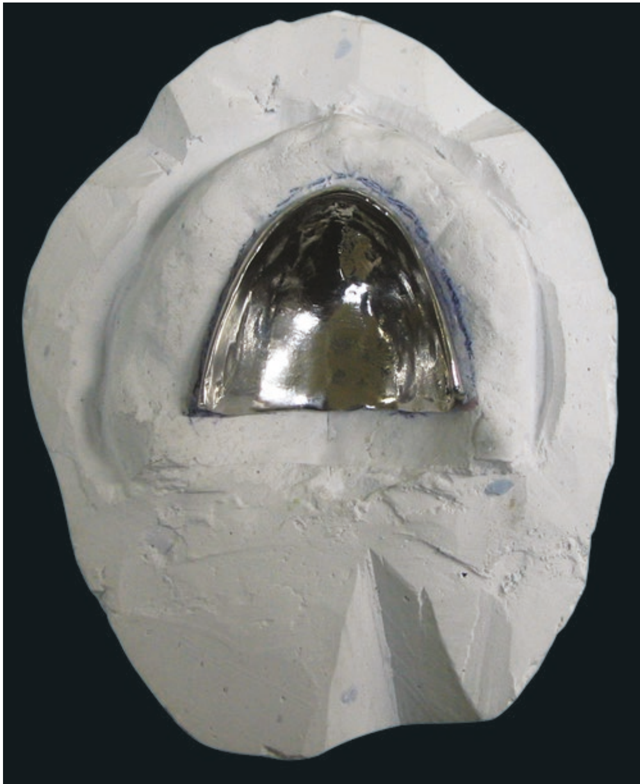

Fig. 11.7 The adaptation of the metal plate is checked on the model

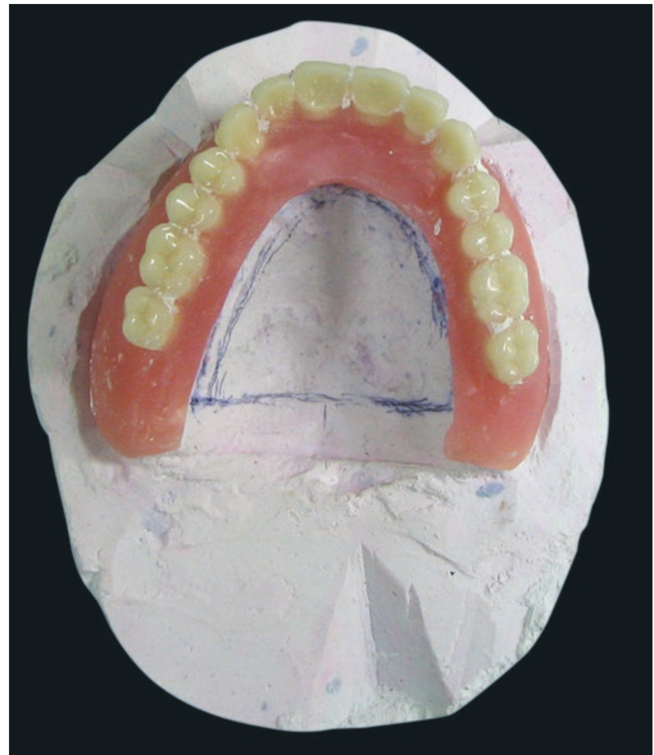

Fig. 11.8 The palatal part of the maxillary denture is removed

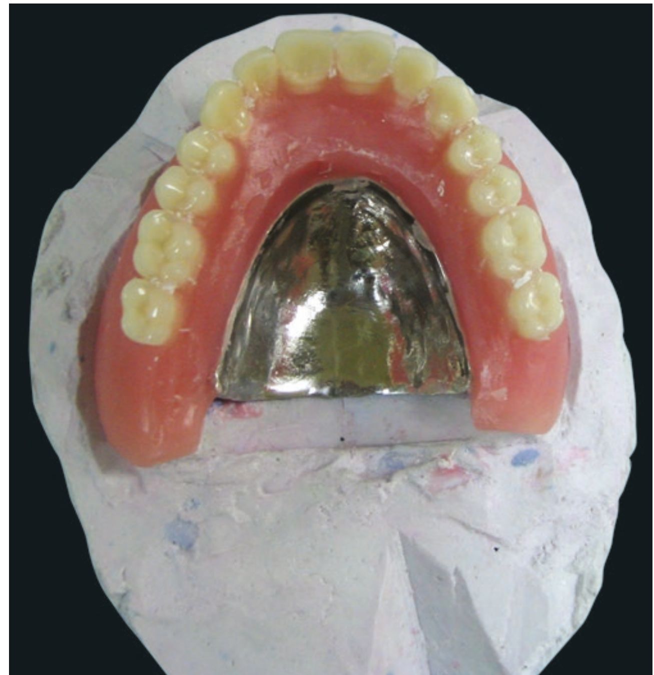

Fig. 11.9 The metal plate is adapted to the maxillary denture

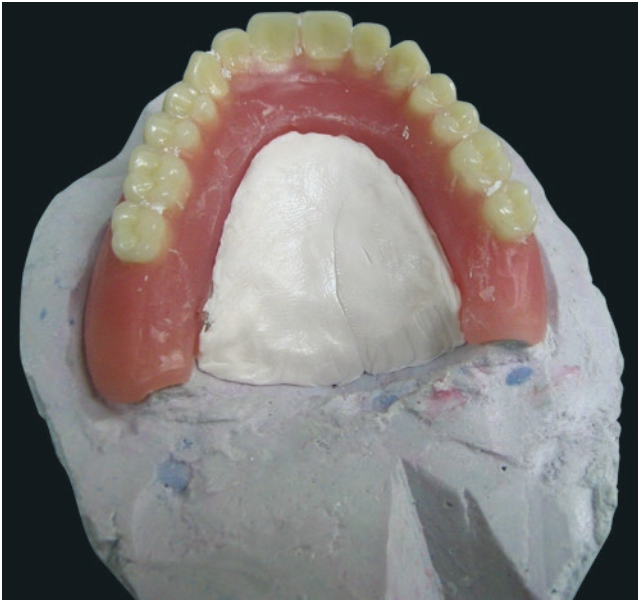

Fig. 11.10 PVS impression material is placed over the metal plate for the reservoir

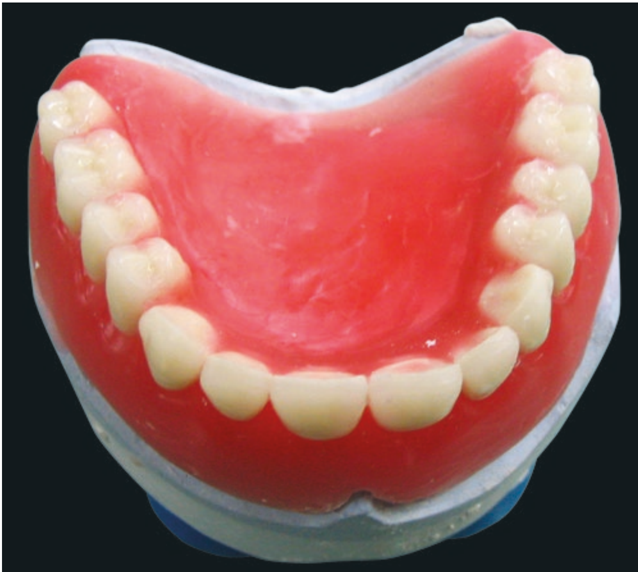

Fig. 11.11 Wax is added over the PVS material and the wax-up is finished

11.1.6.2 Mandibular Denture

The try-in stage is performed using conventional procedures as the maxillary denture, and the teeth are separated from the base plate 1.5–2 mm below without affecting the esthetics. Three parts of Lego should be placed on the lower part for the connection of these two separated parts (Figs. 11.16 and 11.17). (Any material can be used but the author prefers Lego because it is readily available.)

The flasking procedures are performed, and the lower part with Lego is transferred to transparent acrylic and controlled

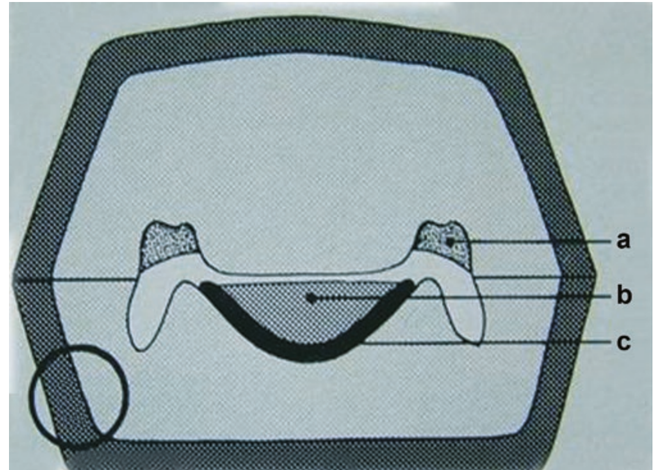

Fig. 11.12 Flasking. (**a**) Wax-up. (**b**) Silicone reservoir. (**c**) Metal plate

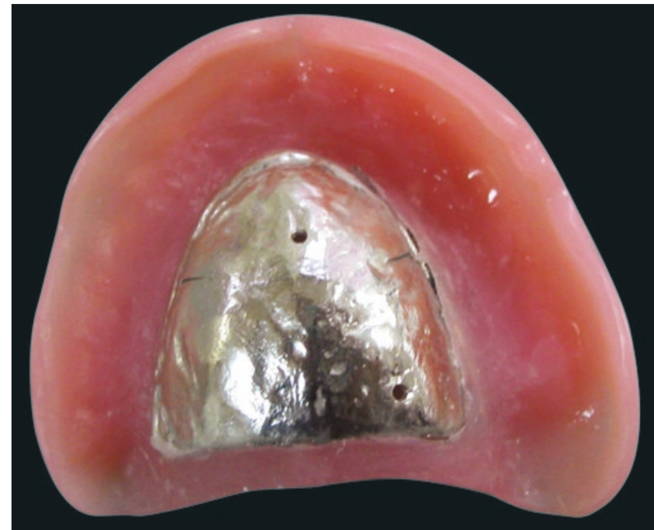

Fig. 11.13 The finished denture. Inner surface. The holes on the metal plate can be seen clearly

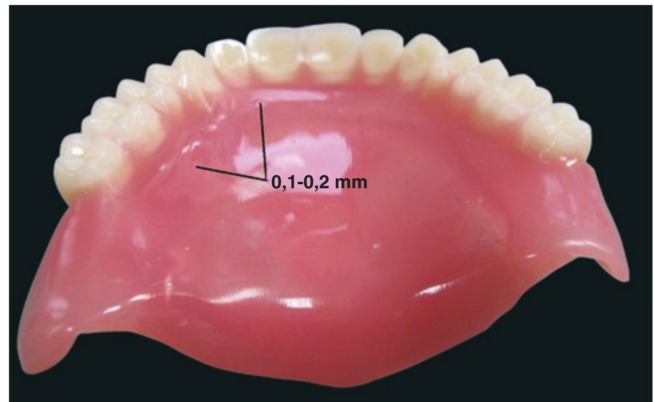

Fig. 11.14 The finished denture. Outer surface. The holes on the outer surface can be seen

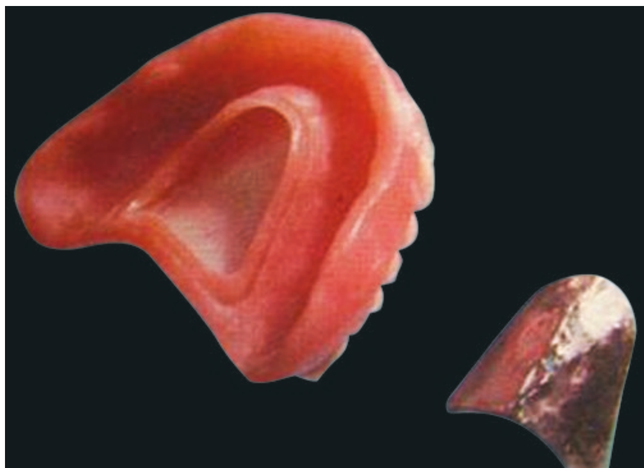

Fig. 11.15 The appearance of the reservoir and the metal plate

Fig. 11.16 The dentures after the try-in stage on the articulator

in the articulator (Figs. 11.18 and 11.19). A PVS impression is made over the transparent acrylic, and a stone duplicate is fabricated (Figs. 11.20 and 11.21).

The duplicated model is placed in the articulator, and the vertical dimension is controlled. The separated upper part with teeth is checked on the model (Figs. 11.22 and 11.23). The wax-up is completed, and the procedures are performed conventionally. A two-piece denture is prepared with the lower part made from transparent acrylic and the upper part from pink acrylic and teeth (Figs. 11.24 and 11.25). The adaptation is controlled between the two parts. Then, the

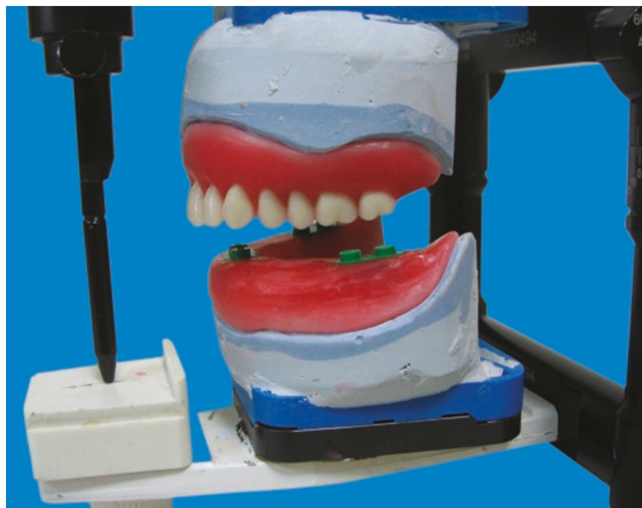

Fig. 11.17 The teeth are removed and three pieces of Lego are placed on the base plate, and the interocclusal distance is checked on the articulator

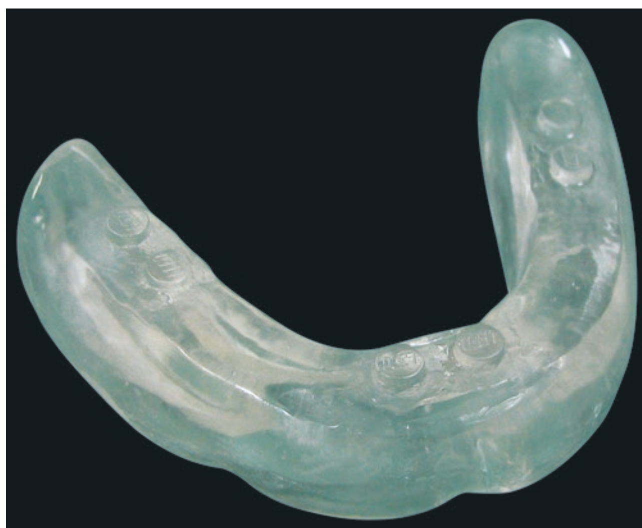

Fig. 11.18 The mandibular base plate fabricated from transparent acrylic

parts are detached, and reservoirs are prepared in the desired width and length. At this stage, the dentist uses burs to create the space. (In Figs. 11.26 and 11.27 the space is filled with red liquid wax to make them visible.)

The final controls are performed after the reservoirs are prepared (Fig. 11.28). In the mandibular denture, holes with 1 mm diameter are prepared in the lingual part of the transparent acrylic for the salivary flow (Fig. 11.29), and the dentures are placed in the patient's mouth.

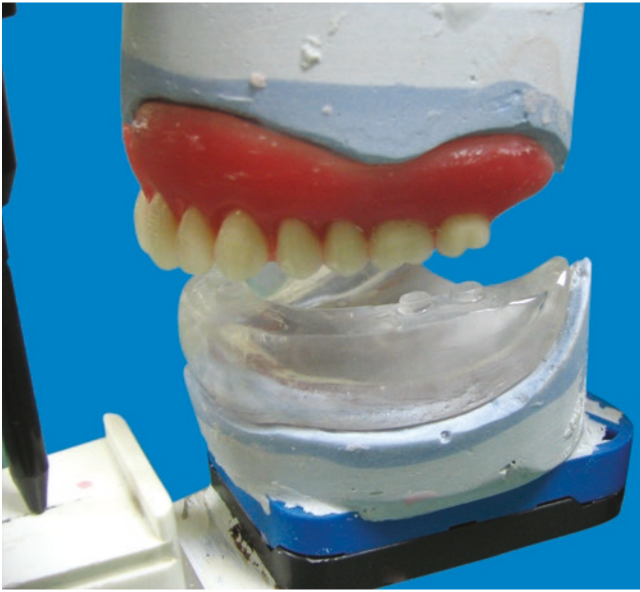

Fig. 11.19 The transparent acrylic is controlled on the articulator

Fig. 11.20 PVS impression made from the transparent acrylic

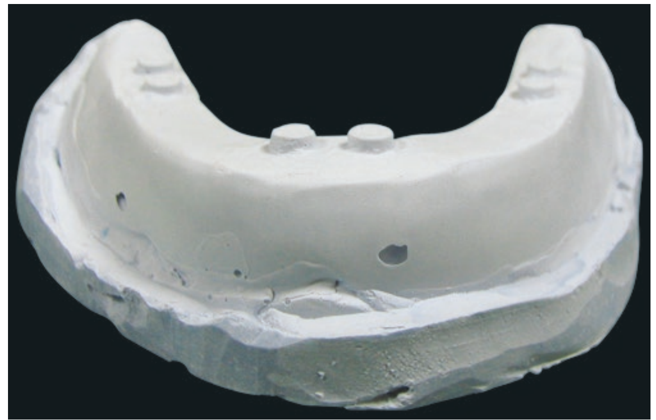

Fig. 11.21 The stone duplicate of the transparent base

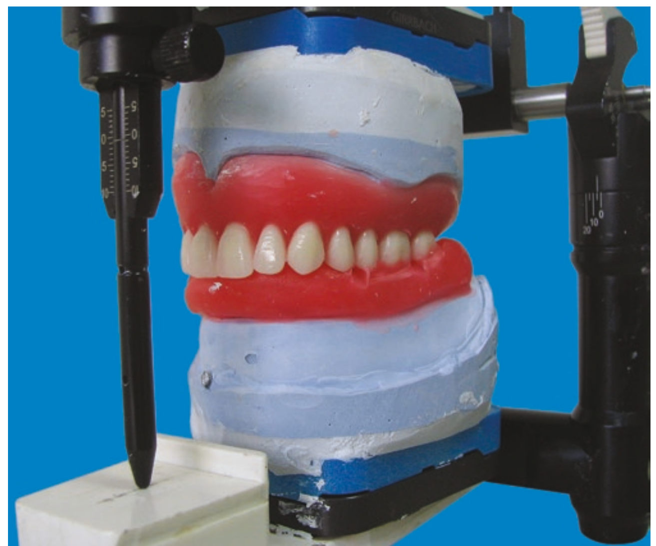

Fig. 11.22 The stone duplicate and the interocclusal distance are checked

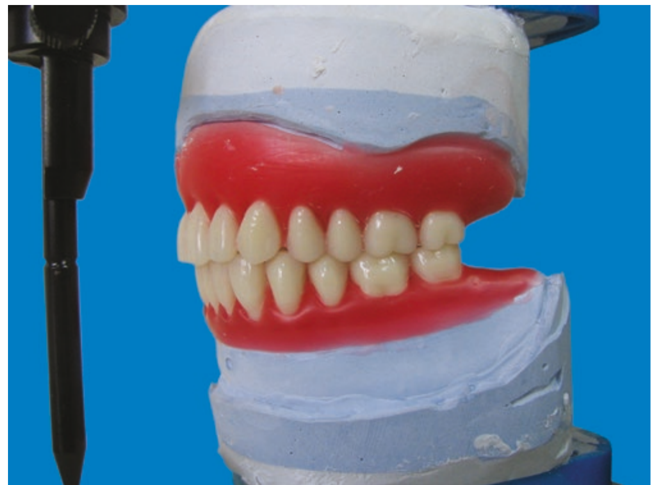

Fig. 11.23 The teeth are adapted on the duplicated model and the wax-up is finished

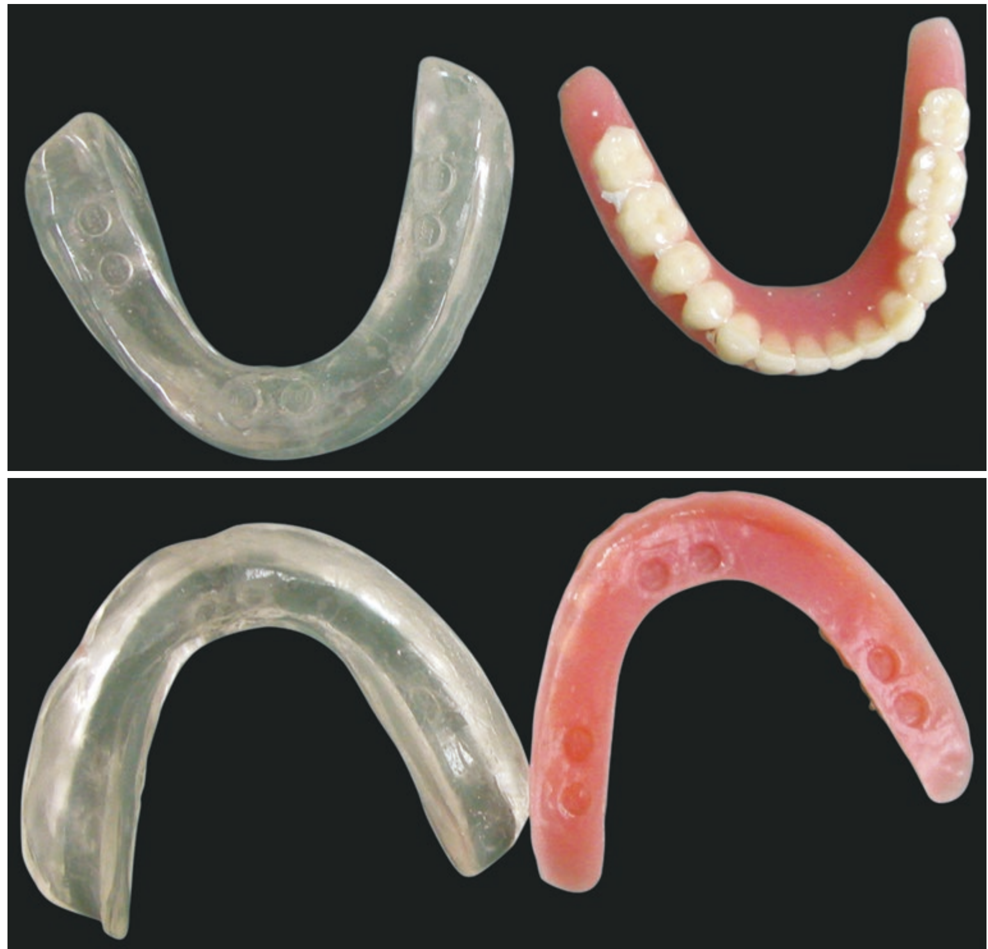

Fig. 11.24 and 11.25 The inner and outer view of the transparent acrylic base and the acrylic part with teeth

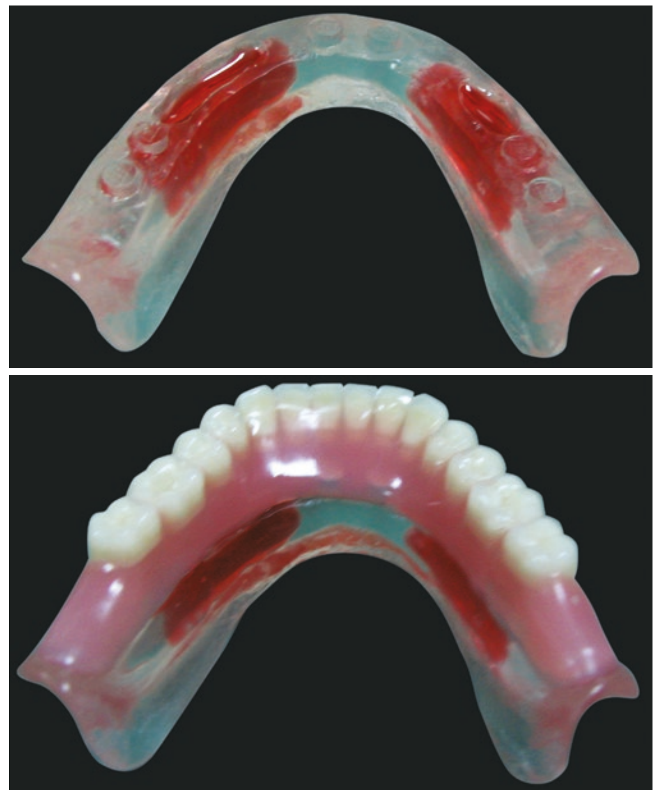

Fig. 11.26 and 11.27 The appearance of the reservoir filled with red wax

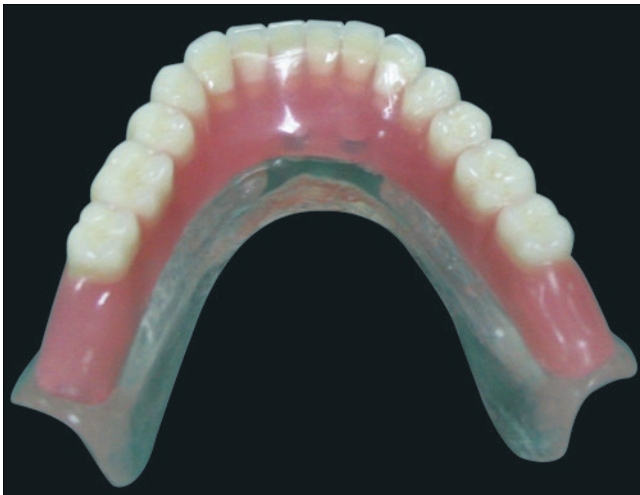

Fig. 11.28 The appearance of finished mandibular denture

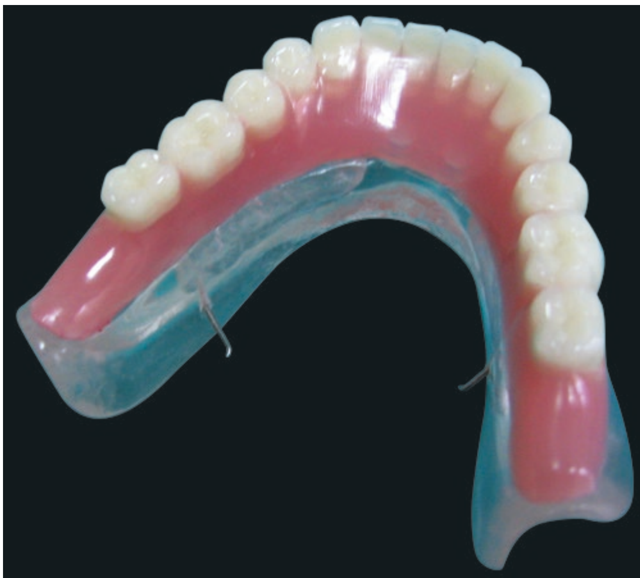

Fig. 11.29 The reservoir holes are ckecked in the mandibular denture

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