13 Case Presentation: Implant-Supported Removable Mandibular Prostheses

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Abstract

Uses of modern dental implants are providing new options for the treatment of complete upper and lower edentulism. Implant-supported removable overdentures have proven to be an effective treatment option, especially for the treatment of patients with severely atrophied residual ridges.

This clinical report describes the treatment of a completely edentulous patient complaining of a lack of retention and stability of her existing mandibular conventional complete denture. Clinical steps and laboratory procedures involved in the fabrication of a removable mandibular overdenture supported by a milled Dolder bar will be described in detail in this chapter.

13.1 Patient History and Background

The patient, a 60-year-old female patient, was referred for prosthodontics evaluation by her general dentist. Her chief complaint at the time of presentation was "My lower denture is becoming very loose and I sometimes feel pain on my left side when I eat." The patient explains that she has been edentulous since a very young age and has been wearing complete dentures since. Her most recent dentures were fabricated approximately 10 years ago, and recently she has been having discomfort described as a tingling sensation when she eats, specifically on the left side.

The patient presents clinically with a severely atrophied mandibular residual ridge with poor soft tissue quality and loading capacity. Due to the extensive resorption, her left mental nerve is now located on top of her residual ridge which may explain her discomfort. In addition, the floor of the mouth is very mobile. She is content with the overall performance of her maxillary complete denture but has noticed that it is starting to "feel loose." She is interested in improving the stability and function of her prostheses.

13.1.1 Medical History

- Hypertension: controlled with medication
- Type II diabetes: controlled with medication
- Medication: Metformin
- No known drug allergy
- No history of smoking or drug abuse

13.1.2 Dental History

- Full mouth extraction at age 24

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13.1.3 Clinical Findings

- Complete edentulism
- Inadequate existing complete dentures
- "U-shaped" arch form
- Mobile floor of mouth
- Left mental nerve located on crest of alveolar ridge

13.1.4 Diagnosis

- Maxillary and mandibular complete edentulism
- Severely atrophied mandibular residual ridge
- Moderately atrophied maxillary residual ridge

Following a preliminary assessment, the fabrication of a new maxillary complete denture as well as an implant-supported mandibular prosthesis was recommended. Four dental implants (Straumann Dental implant system, Bone level, NC) were planned for placement in the anterior sextant of the mandible to improve the support, retention, and stability of her lower prosthesis (Figs. 13.1 and 13.2).

Fig. 13.1 Maxillary residual ridge

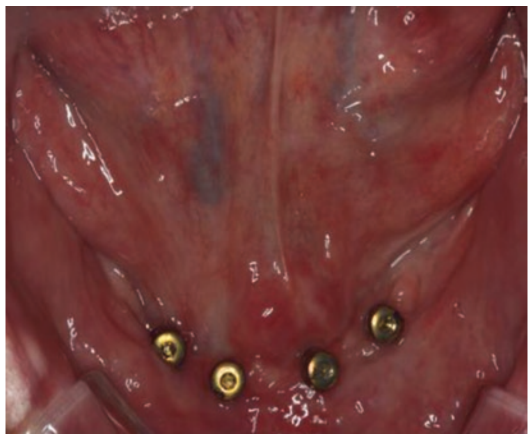

Fig. 13.2 Mandibular residual ridge following implant placement. Surgery: Dr. Veronique Benhamou, Periodontist

13.2 Implant Placement Strategy

Clinical assessment of the edentulous mandible reveals a "U-shaped" arch with severe residual ridge resorption especially in the posterior areas. The excessive amount of resorption has resulted in the left mental nerve being located on the crest of the ridge (Fig. 13.3). The floor of her mouth is very mobile; muscle and frenum attachments are located high on the ridge, her soft tissue is thin, and the buccal vestibule is shallow.

The preliminary assessment was completed, and a removable complete denture to be supported by a Dolder bar on four implants placed in the interforaminal region was planned. The two posterior implants were placed as close as possible to the mental foramen without jeopardizing the nerve. The anterior implants were placed as far anteriorly as possible without compromising distribution (in this situation, the lateral incisor positions) (Fig. 13.4). This careful planning of the implant position should maximize the anterior-posterior spread and allow for the fabrication of a Dolder bar with bilateral distal extensions. Such a bar design would entirely support the mandibular overdenture and greatly increase retention, stability, and support. This will enhance the comfort of the prosthesis by minimizing any pressure on the soft tissue during function, therefore preventing any impingement of the left mental nerve.

Although the survival and success rate of different loading protocols (immediate, early, and conventional) seem to be similar, some authors have reported a tendency toward a slight increase of failure rates when implants are immediately loaded [1, 2]. A conventional delayed approach was favored in this situation due to several factors including quantity and quality of the bone as well as the surgeon's preference.

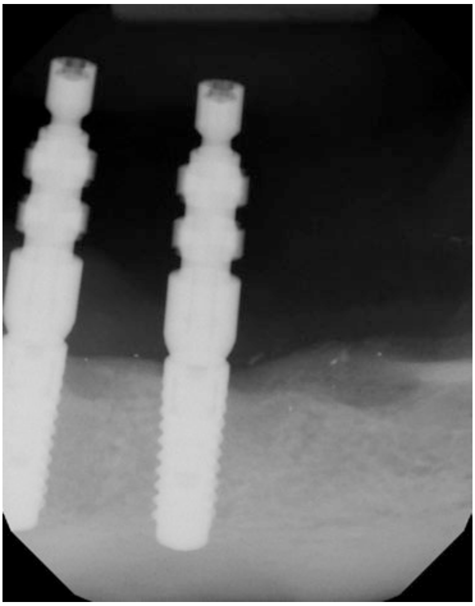

Fig. 13.3 Left mental nerve located on crest of residual ridge due to severe resorption

Fig. 13.4 Strategic implant placement in the interforaminal region resulting in even distribution and maximizing A-P spread

13.3 Clinical Procedures

13.3.1 Abutment Selection

Transmucosal abutments were used to move the prosthetic interface closer to the level of the soft tissue. This will facilitate the prosthetic procedures as well as allow the splinting of the four implants. The abutments are selected based on the height of the soft tissue around each implant (measured from the platform of the implant to the lowest contour of the gingiva) (Fig. 13.5a, b). The required height of the abutment to be selected corresponds exactly to the soft tissue measurement described previously or is the next lowest height available. In doing so, the margin of the prosthetic interface will be located either at the level or slightly below the gingiva (Fig. 13.6).

Four Straumann multi-base abutments are inserted and torqued using the torque wrench following the manufacturer's recommendation.

13.3.2 Preliminary Impression

After ensuring that the tissues are healthy, preliminary impressions of the maxillary and mandibular arches (Fig. 13.7a, b) are completed using irreversible hydrocolloid (*Jeltrate Alginate, Dentsply Caulk, Canada*) with the help of stock edentulous metal trays (*Patterson Dental Supply, Canada*). Impressions are then poured in Type III

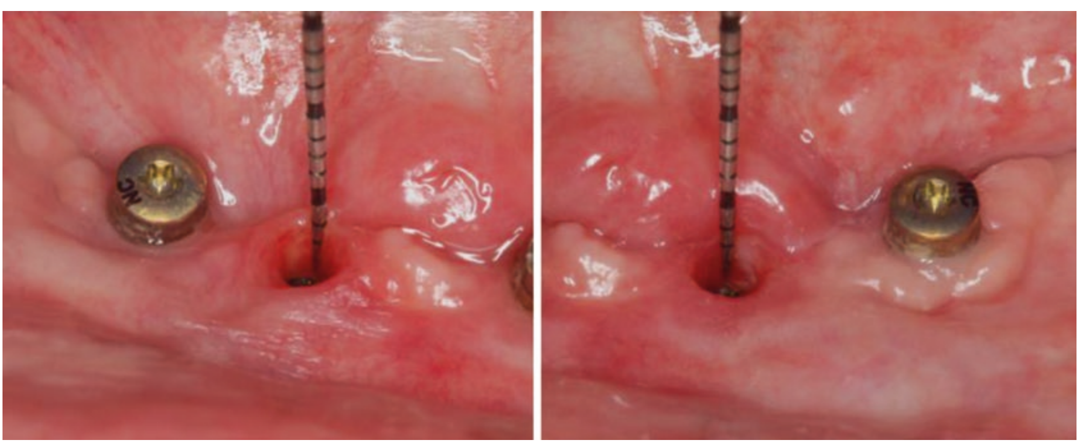

Fig. 13.5 Measurement of soft tissue height for multi-base abutment selection

gypsum (*GC America Inc., USA*) to produce the preliminary casts (Fig. 13.8a, b) for the fabrication of custom trays.

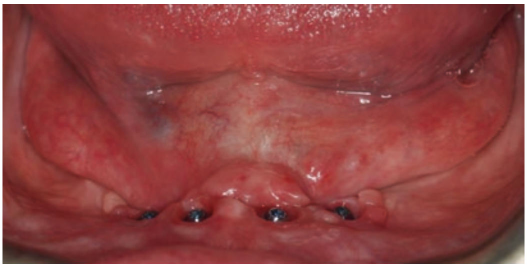

Fig. 13.6 Multi-base abutments inserted and torqued in position following manufacturer's recommendation

13.3.3 Border Molding and Final Impressions of the Upper Arch

The outline of the custom trays was designed based on anatomical landmarks, muscles, and frenal attachments, as well as to accommodate for the space requirement for the border-molding material (Fig. 13.9a, b). The maxillary custom tray was fabricated using a light polymerizing acrylic resin material (*Triad TruTray, Dentsply. Canada*). The custom tray was subsequently tried intraorally and evaluated for proper fit, and the extensions were verified and adjusted to allow space for the modeling compound material

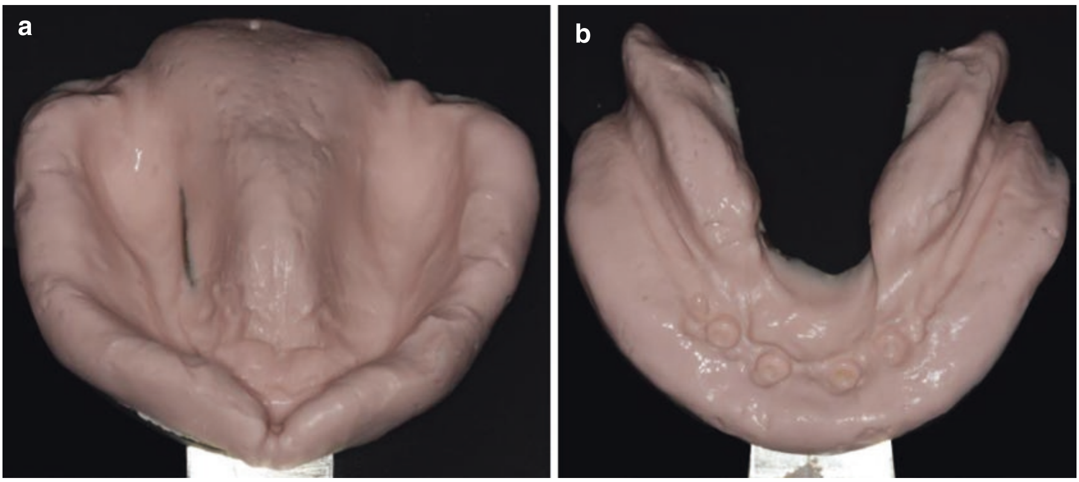

Fig. 13.7 (**a** and **b**) Alginate impression (irreversible hydrocolloid) of the maxillary and mandibular arches using edentulous stock trays

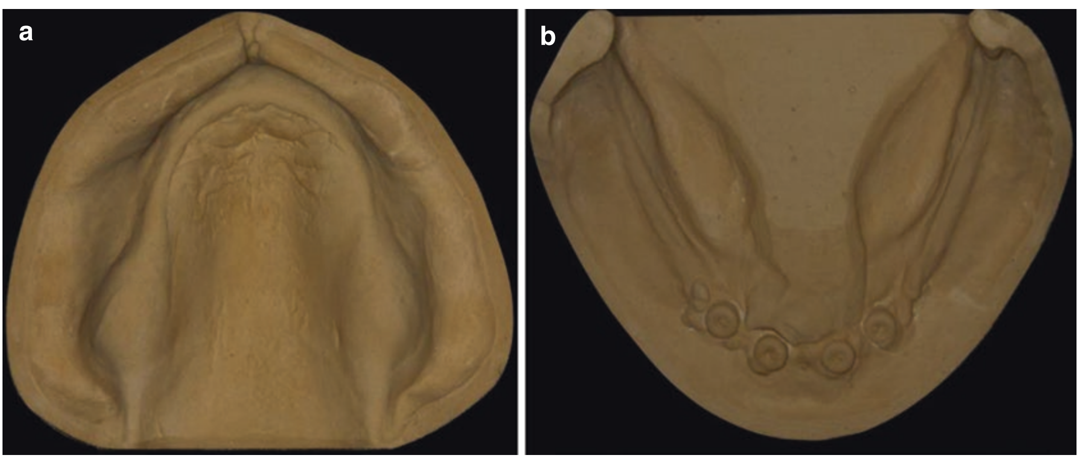

Fig. 13.8 (**a** and **b**) Preliminary models of the maxillary and mandibular arches poured in Type III dental stone

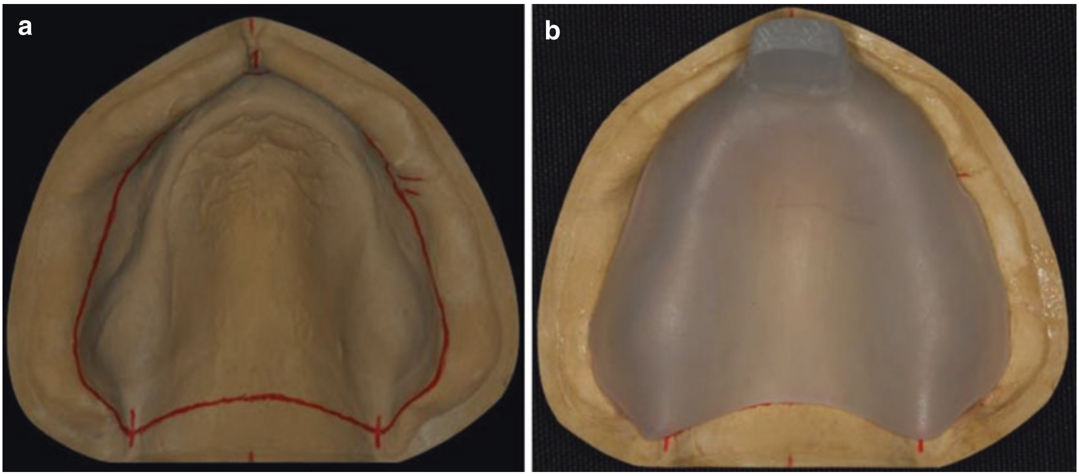

Fig. 13.9 (**a** and **b**) Design and fabrication of the maxillary custom tray for final impression

Fig. 13.10 Clinical try-in of the maxillary custom tray prior to the border-molding procedure

(Fig. 13.10). Bolder molding of the periphery was performed using dental compounds (Fig. 13.11a, b) and the manipulation of the patient's tissue to capture the muscles and soft tissue attachments. Final impression of the maxillary arch was taken using a polysulfide rubber material (*Permlastic™, Kerr Dental*).

13.3.4 Border Molding and Final Impressions of the Lower Arch

A mandibular custom tray was fabricated using a light polymerizing acrylic resin material (*Triad TruTray, Dentsply. Canada*) using the same principle as the maxillary arch (Fig. 13.12a, b). Additional space was provided in the anterior sextant to accommodate the implant pickup impression copings. The custom tray was tried intraorally, evaluated for proper adaptation, and the extensions were adjusted approximately 2 mm short of the mucobuccal fold (Fig. 13.13). The custom tray was border molded to the muscles and soft tissue attachments using dental compound (*Kerr Dental, Canada*).

The long-term success of multiunit implant-supported prostheses depends on a multitude of factors of which proper fit and passivity of the superstructure are of prime importance [3]. Multiple studies [4–6] have reported that splinting of the impression copings may improve the accuracy of the final impression and the resulting master cast.

The splinting process is generally done either directly in the mouth or indirectly using a master model. In this situation, a direct technique was preferred, as it requires fewer clinical steps, appointments, and lab work, which ultimately results in a decrease in the cost. The pickup abutment level impression copings were connected to the multi-base abutments. Radiographs were taken to confirm their proper fit (Fig. 13.3). Dental floss was used to link the impression copings together to act as a scaffold onto which a light cured acrylic material (*TRIAD Dual- line, Dentsply. Canada*) was applied to connect all the impression copings together. The splint was subsequently sectioned between each coping and reconnected using the same light cured material (Fig. 13.14). This process of sectioning and reconnecting is done to improve accuracy by reducing internal stresses caused by the

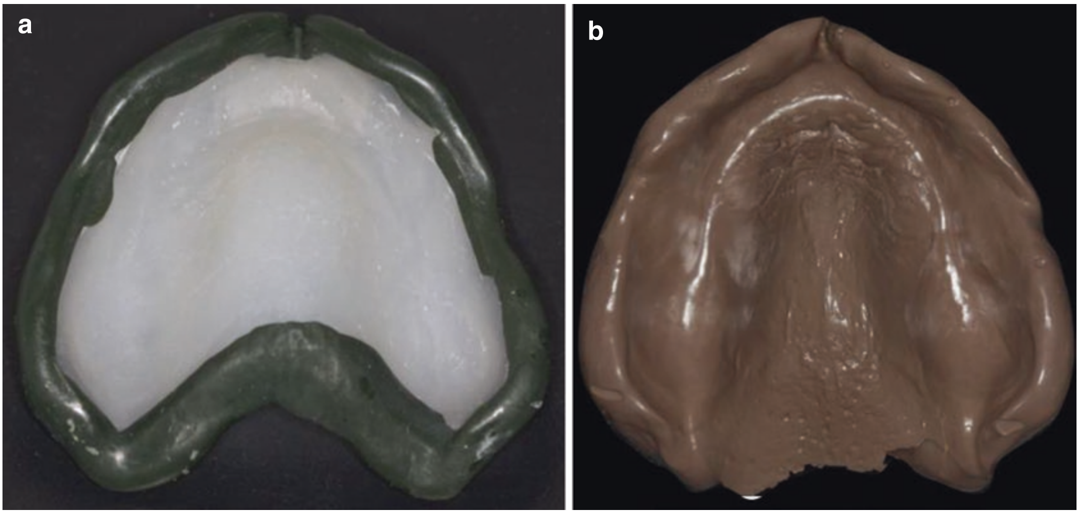

Fig. 13.11 (**a** and **b**) Border-molding procedure is performed using dental compound, and subsequently final impression is made using polysulfide impression material

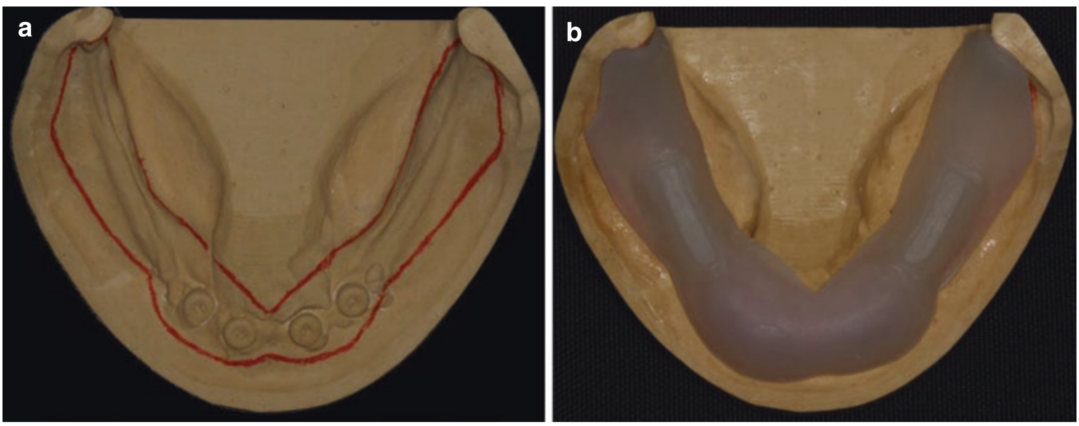

Fig. 13.12 (**a** and **b**) Design and fabrication of the mandibular custom tray for final impression

Fig. 13.13 Try-in of the custom trays prior to the border-molding procedure

Fig. 13.14 Abutment level pickup impression copings were placed onto the multi-base abutments and splinted together using a light curing resin

polymerization process of the material [7]. An open-tray final impression was taken using the previously border-molded custom tray and a high consistency addition type polyvinyl siloxane impression material (*Affinis, Coltene Dental*) (Fig. 13.15).

The maxillary final impression is poured in Type III gypsum (*GC America Inc., USA*) to generate the master cast (Fig. 13.16a). Laboratory abutment analogs are attached to the pickup impression copings, and the mandibular final impression is poured using type IV gypsum (*Fujirock EP, GC America, USA*) with a soft tissue analog to produce the definitive mandibular cast (Fig. 13.16b).

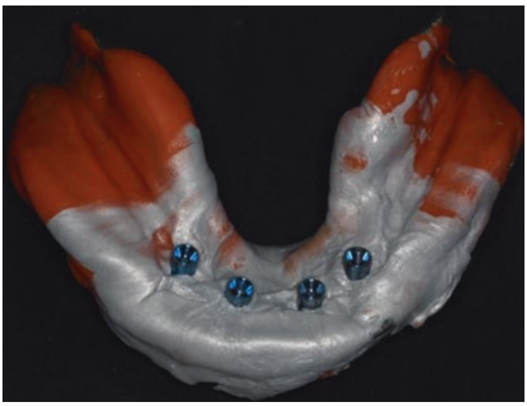

Fig. 13.15 Open-tray mandibular final impression of splinted impression copings using light and heavy bodied polyvinyl siloxane impression material

13.3.5 Wax Rim Adjustments

The maxillary occlusal wax rim was tried clinically and adjusted to establish the anterior and posterior occlusal planes based on lip support, anterior display, esthetic and phonetic parameters, and Camper's plane (Fig. 13.17a–c). The mandibular wax rim was then adjusted to the maxillary record base at the appropriate vertical dimension of occlusion. The vertical dimension was determined using phonetic [8] and facial measurements taken at the physiologic rest space [9] (Fig. 13.18a).

Maxillomandibular relationship was then recorded in centric relation using a fast set bite registration material (*Blue Bite, Polyvinylsiloxane, Henry Schein, Canada*). The recorded position was verified for reproducibility to confirm its accuracy (Fig. 13.18b). A facebow record was also taken to allow for proper positioning of the maxillary cast during mounting on a semi-adjustable articulator. Teeth shade and mold are selected and approved by the patient. All records are sent to the dental laboratory to have the casts mounted and denture teeth set in wax per the determined parameters. Bilateral balanced occlusion is recommended for complete denture therapy, although very little clinical evidence is available to support the use of this occlusal scheme for complete dentures and implant-retained/supported prostheses.

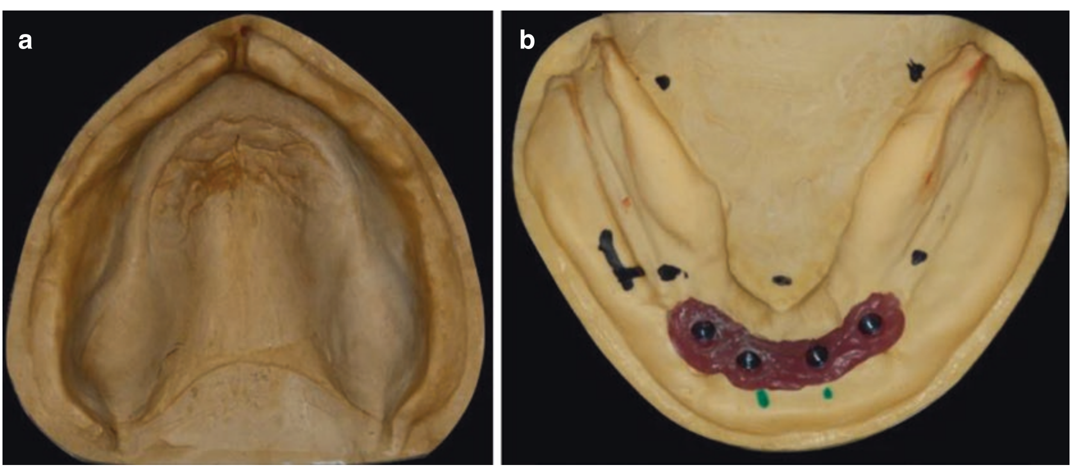

Fig. 13.16 (**a** and **b**) Master casts of the maxillary and mandibular arches

Fig. 13.17 Wax rim adjustments: (**a**) Lip support, (**b**) esthetic, and (**c**) occlusal plane alignment

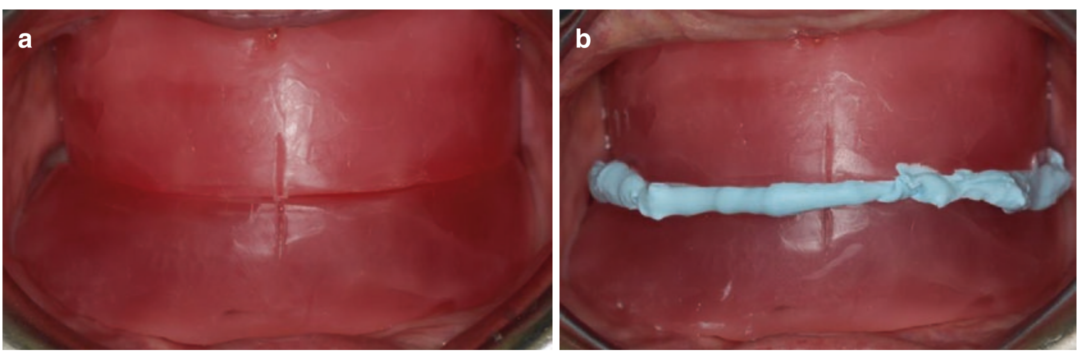

Fig. 13.18 (**a** and **b**) Wax rims are adjusted to the proper vertical dimension of occlusion and the maxillomandibular relationship recorded in centric relation using chin point guidance technique and a fast set silicone bite registration material

13.3.6 The Trial Denture

The teeth are set in wax (Fig. 13.19) and tried clinically to evaluate the esthetics, phonetics, function, stability, and occlusion (Fig. 13.20). Centric relation and vertical dimension of occlusion are confirmed. Once all parameters are verified and the patient is satisfied with esthetics and function, the case is returned to the dental laboratory for the design and fabrication of the mandibular Dolder bar.

Fig. 13.19 Mounting on semi-adjustable articulator and setting of denture teeth per the determined parameters

13.3.7 Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM)

Once all the setup completed and verified clinically, the bar can be designed and manufactured. Most bar-type attachment systems consist of a metallic bar connected to the implant and a clip mechanism nested in the denture base. Most of the retentive bars are often distinguished by the morphological characteristics of their walls and their composition (Ackermann bar/spherical shape, Dolder bar/U shape or ovoid shape, Hader bar/keyhole

Fig. 13.20 (**a**–**c**) Denture teeth try-in to evaluate esthetics, phonetics, function, stability, occlusion and vertical dimension of occlusion during excursive movements

shape). Based on the later, bars can also be characterized as resilient or non-resilient. Resilient bars are designed to allow movement around their axis and are often recommended for the restoration of implants retained prostheses to accommodate the movement of the denture during mastication. The non-resilient designs are often recommended for implant-supported prostheses. They are characterized by parallel walls, which once engaged by the clip assembly, limit significantly the movement of the dentures.

A variety of methods exist for the fabrication of bars. The conventional method consisted of prefabricated bars that are adjusted (cut to desired dimension) and soldered to the abutments that are connected to the implants. Plastic patterns for various types of bars are also available and can be casted to produce the final bar. Bars can also be designed virtually by computer and fabricated by milling machines. The later method is today the most commonly used technique as it is assumed to offer advantages such as precision, accuracy, strength, and individualized design that the traditional methods do not [10]. Katsoulis et al. [11] compared the conventional soldered technique of bar fabrication to the new CAD/CAM approach and observed that milled bars resulted in less technical complications and fractures.

Bar design is dependent on several factors such as the available restorative space, the implant position, the amount of retention desired, the type of attachment systems, and the type of prosthesis desired (rigid vs. resilient).

When designing the bar, it is critical to determine the restorative space available, as the bar attachment system requires more space than a prosthesis using a stud attachment system (as described in a previous chapter). Sawdosky et al. reported that a minimum of 10–12 mm of space was required for a bar overdenture. This space is measured from the implant platform to the occlusal plane. The tooth setup is often used as a guideline in the design process, and it is an essential component for the design phase. This information is digitally acquired by scanning the mandibular master cast as well as the tooth arrangement (Fig. 13.21a). Once the background information is captured, the virtual design process can begin (Fig. 13.21b, c). When designing the bar, certain important criteria should be respected: the bar should be positioned within the confine of the prosthesis and directly over the crest of the ridge (Fig. 13.21b), a space of about 2 mm or more between the bar and the soft tissue should be left to allow for proper hygiene (Fig. 13.22), and if a distal extension is planned, the later should not extend beyond 1.5 times the distance between the most anterior and most posterior implants [12–14]. Once the virtual design process is completed, the information is sent to a production center to have the bar milled from a titanium block.

13.3.8 Bar Try-In

The Dolder bar is tried intraorally and verified for proper fit and passivity. Alternate finger pressure, direct vision and tactile sensation, radiographs, one-screw test, and screw resistance test [15, 16] are all different methods that have been documented in the literature to evaluate the fit of a framework. Kan et al. [17] suggested using a combination of these different methods to verify and confirm the fit of a framework. The design of the bar is also evaluated visually to ensure that it is not impinging on the tissue and that adequate space is available for proper maintenance.

13.3.9 Second Trial Denture

The bar is returned to the laboratory, and the initial mandibular tooth setup is modified to fit onto the bar. Another clinical trial of the tooth arrangement is then performed. The mandibular tooth setup is tried over the bar and reevaluated to confirm that the parameters

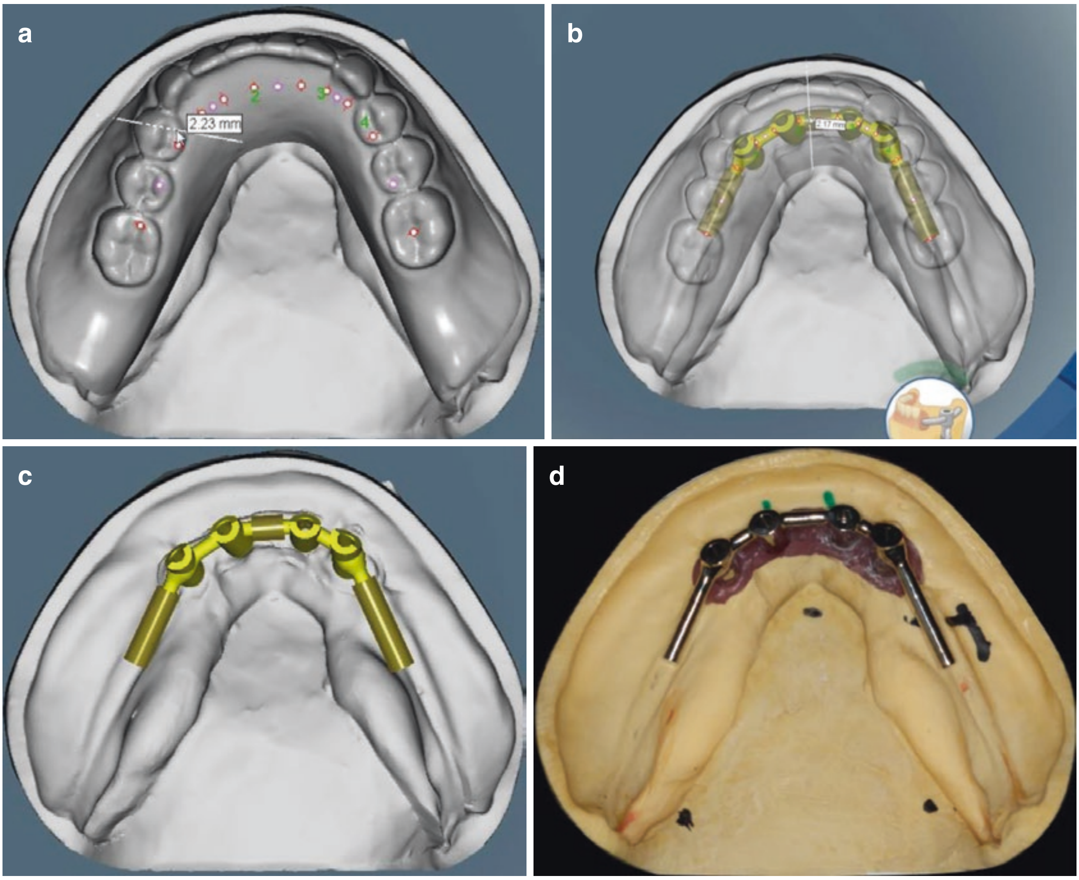

Fig. 13.21 (**a**) Digital scan of the mandibular master cast and tooth setup (**b**) 3-D virtual design of the Dolder bar beneath the planned prosthesis (**c**) Final design of Dolder bar (**d**) Manufactured Dolder bar

Fig. 13.22 Clearance of 2 mm between bar and tissue to allow for proper hygiene

established in the initial clinical trial (i.e., esthetics, phonetics, function, stability, occlusion, and vertical dimension of occlusion) were all maintained. Centric relation is reconfirmed. For implant-supported prostheses, tooth arrangement should not extend beyond the milled bar, which usually limits the occlusion to the first molars. Once all parameters are verified and the patient is satisfied with esthetics and function, the case is returned to the dental laboratory for processing and incorporation of the metal retentive clips (Fig. 13.23). Depending on the type of bars used, the retention mechanism/clips come in different materials. Metal clips are usually more resistant to wear, and their dimension can be customized to fit exactly onto the bar (especially important in small inter-implant segment), while plastic clips are easier to replace.

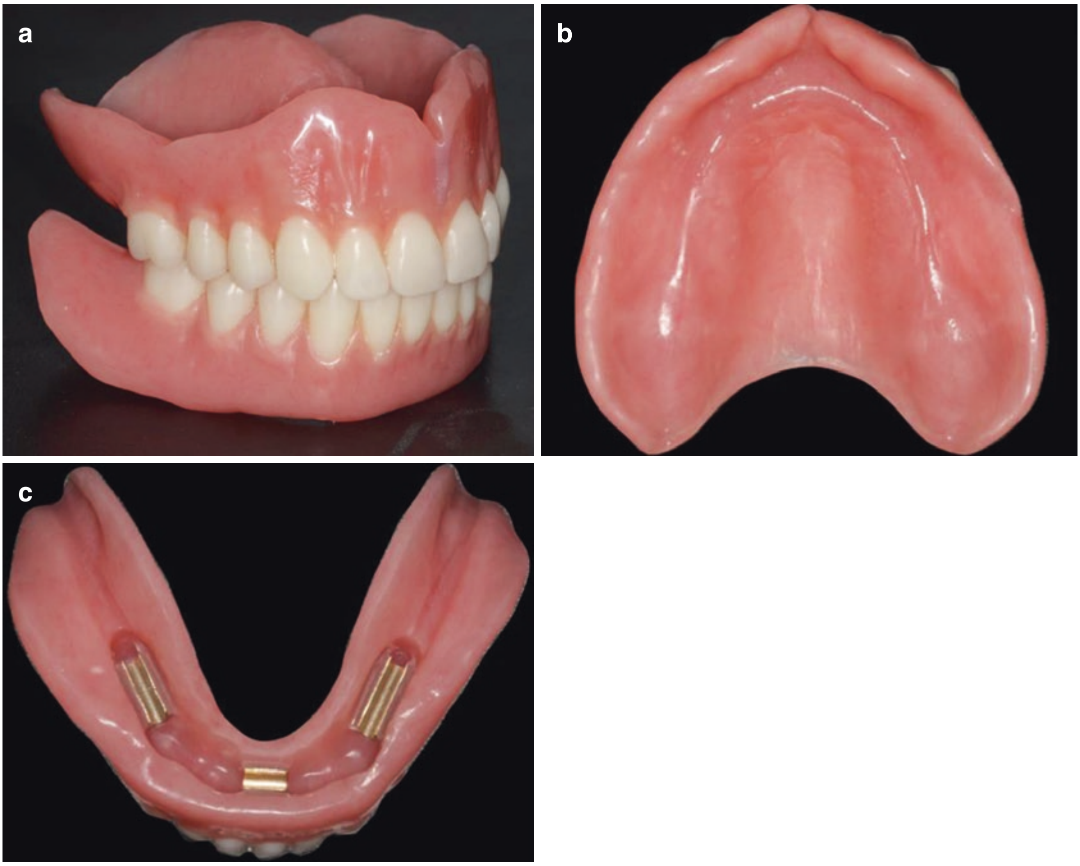

Fig. 13.23 (**a**) Acrylized removable prostheses (**b**) Maxillary complete denture (**c**) Mandibular overdenture with three retentive metal clips positioned in the anterior section and on the distal extensions

13.3.10 Delivery

The Dolder bar is seated in position, and the prosthetic screws are torqued to the manufacturer's recommendation using a torque wrench. The access holes are closed with cotton pellets and a composite material. This cotton protects the head of the prosthetic screws and allows for the removal of the bar at a latter appointment should there be a need. The mandibular implant-supported removable denture is tried onto the bar and evaluated for proper seating, fit, peripheral extension, retention, and stability. If necessary, the metal retentive clips can be adjusted to either increase or decrease the retention as needed. The occlusion is verified last and adjusted if any interference is detected in centric occlusion and eccentric movements (Fig. 13.24). The patient is shown how to insert and remove her prosthesis. Home care is explained, and the patient is shown to use an interdental brush to clean and remove plaque from the undersurface areas of the bar (Fig. 13.25). The patient is also instructed to remove her prostheses at night.

Fig. 13.24 (**a**–**c**) Delivery of complete upper denture and removable implant-supported mandibular overdenture

Fig. 13.25 Careful design of the bar allows for ease of maintenance

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