Complete Denture – Border Molding Technique Using a Laboratory Condensation Silicone Putty: Review

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Abstract: During the fabrication of a complete denture, functional impression is taken. Literature studies show that polydimethylsiloxane (condensation silicone) has not been reported by United States dental schools to perform border molding. Thus, the purpose of this article is to review the functional impression technique when border molding is performed with a laboratory condensation silicone putty.

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Introduction

One of the clinical steps to fabricate a complete denture is the functional impression (Zarb et al., 2004). This step can be performed using the selective pressure technique developed by Boucher (Boucher, 1944; Petropoulos and Rashedi, 2003; Özkan, 2017). The selective pressure technique combines pressure and non-pressure techniques (Boucher, 1944; Petropoulos and Rashedi, 2003; Duncan et al., 2004; Özkan, 2017). After using the wax to create relief on flaccid and retentive areas of the plaster cast, the individual (custom) tray is made. The relief sites will create areas of space between the tray and the mucosa. In these areas, the impression material will not exert pressure on the mucosa, while in other areas, the impression material will exert minimal pressure on it. According to Duncan et al. (2004), "areas that are anatomically favorable to withstanding pressure, such as the buccal surface of the maxillary alveolar process, lateral palate, or buccal shelf in the mandible, are loaded. These areas are supported by dense cortical bone. The rugae, midline raphe, mandibular alveolar ridge, and areas of movable tissue are relieved because they do not provide the same favorable anatomic quality for withstanding functional load (Duncan et al., 2004)".

For complete dentures, the functional impression (selective pressure technique) can be made in two or three steps using an individual tray: Step 1 (Border molding) – It is performed to obtain peripheral sealing of the future complete denture. In this step, one of the following materials can be used: low fusing impression compound, condensation silicone, polyether, polysulfide, wax, or addition silicone. Step 2 (Final impression, *also called* "*corrective impression*") – It is made to copy the oral mucosa of the ridge, and it can be made with the zinc oxide eugenol paste or a fluid elastomer (polyether, polysulfide, or addition or condensation silicone) (Smith et al., 1979; Chaffee et al., 1999; Gennari Filho et al., 2002; Zarb et al., 2004; Solomon, 2011a; Goiato et al., 2011a, 2012, 2013; Carlsson et al., 2013; Mehra et al., 2014; Yilmaz and Özçelik, 2014; Arora et al., 2015; Özkan, 2017; Jayaraman et al., 2018). In addition, it is possible to make the posterior palatal seal or "post damming" (Step 3) in two ways depending on the material that will be used for the final impression (Ansari, 1997; Solomon, 2011a, Carlsson et al., 2013); i.e.:

1) "post damming" after final impression – *when zinc oxide eugenol paste will be used*, posterior palatal seal can be made, after making the final impression, using wax (Ansari, 1997; Goiato et al., 2013);
2) "post damming" before final impression – *when a fluid elastomer will be used*, the posterior palatal seal is made at the same time as the border molding, using an impression compound (Solomon, 2011a) or a silicone putty (Solomon, 2011b). It is important to emphasize that every time an elastomer is used for molding, it is necessary to previously use an adhesive to "glue" it to the individual tray.

There is yet another way to accomplish this step. Before making the individual tray, the "soft palate vibration region of the plaster cast" must be subtly worn down (Solomon, 2011a). Later, during the making of the individual tray, the acrylic resin fills

the worn region of the plaster cast (Solomon, 2011a). Thus, during border molding, the "post damming" is performed by the individual tray.

Functional impression, based on the selective pressure technique, has functions that include: 1) to delimit the area of the ridges where the complete dentures will be supported; 2) to allow mucosal blood flow while the patient wears their complete dentures, promoting comfort and health to the patient; 3) to avoid excessive compression of the ridge, as well as, theoretically, bone resorption; and 4) to allow adequate adaptation, stability, and retention of the complete dentures over the ridges (Chaffee et al., 1999; Petropoulos and Rashedi, 2003; Duncan et al., 2004; Özkan, 2017; Jayaraman et al., 2018). Thus, this step is very important for the fabrication of a complete denture, and it should not be abandoned.

Studies were carried out in dental schools in the United States (US) to verify which materials were used by them, for border molding, to fabricate the complete dentures (Petropoulos and Rashedi, 2003; Petrie et al., 2005; Mehra et al., 2014):

- In 2001, a survey in 41 dental schools in the US showed that the border molding materials used by them included impression compound (28 schools), polyether (2 schools), polyvinylsiloxane (1 school), polysulfide (1 school), Adaptol (Jelenko) (1 school), impression compound and polyvinylsiloxane (5 schools), impression compound and polyether (2 schools), and impression compound and polysulfide (1 school) (Petropoulos and Rashedi, 2003).
- In 2003, questionnaires were mailed to all 1,762 active ACP (The American College of Prosthodontists – US) members and chairpersons of prosthetic/restorative departments in the 54 US dental schools. Nine hundred and forty-five questionnaires were returned by members of the ACP (54% return rate) and 42 questionnaires were returned by the US dental schools (78% return rate). The most popular material used for border molding was impression compound (67% of reporting ACP members, and 95% of the responding dental schools). Other materials used by individuals surveyed, for border molding, were polyvinylsiloxane, polyether, and Adaptol (Jelenko) (Petrie et al., 2005).
- In 2014, an online survey was sent to all program directors of US postdoctoral prosthodontic programs (the overall response rate for the survey was 87%). It was found that 71% of dental schools used the impression compound, 10% of the schools used wax, and the rest of them used polyether, polyvinylsiloxane, or Adaptol (Jelenko) (Mehra et al., 2014).

Therefore, in all these surveys, the material most used for border molding was impression compound (Petropoulos and Rashedi, 2003; Petrie et al., 2005; Mehra et al., 2014). Another situation observed was that polydimethylsiloxane (condensation silicone) is not used by dental schools in the US.

For clinical fabrication of a complete denture, border molding using a laboratory condensation silicone putty has been previously reported by two studies (Gennari

Filho et al., 2002; Goiato et al., 2013). Despite this, the step by step of this technique was not reported in English (Gennari Filho et al., 2002; Goiato et al., 2013). In addition, based on the fact that US dental schools have not reported the use of polydimethylsiloxane for border molding (Petropoulos and Rashedi, 2003; Petrie et al., 2005; Mehra et al., 2014), the purpose of this article is to review the functional impression technique when border molding is performed with a laboratory condensation silicone putty.

Material and Methods

A search was performed on the PubMed website in 2022 using combinations of the following keywords: "complete denture" with "functional impression" or "border molding". The search was expanded as needed. Books in English and Portuguese, on the subject of the article, were included when reporting important information. In addition, a Google search was also performed using keywords in Portuguese ("artigo" e "moldagem functional"). Only references in English and Portuguese (Brazil) were considered.

Review

Clinical steps to manufacture and deliver complete dentures
(Collett, 1970; Tamaki, 1983; Zarb et al., 2004; Telles, 2009; Goiato et al., 2011a, 2014; Özkan, 2017)

(I) Anatomical or preliminary impression.
(II) Functional impression.
(III) Wax rims phase (adjustment of the upper wax rim [#]; selection of artificial teeth [size, width, shape, shade and material [# #]; assembly of the upper plaster cast on the semi-adjustable articulator using the facebow; intermaxillary registration [# # #]; and finalization of the assembly of the plaster casts on the semi-adjustable articulator).
(IV) Aesthetic and functional try-in of the wax-attached acrylic teeth; and artificial gingiva shade selection [# # # #].
(V) Delivery of complete dentures to the patient, and adjustments of acrylic bases and occlusion of artificial teeth [# # # # #].
(VI) Control dental appointments (adjustments of acrylic bases and occlusion of artificial teeth, when necessary).

Note 1 [#]: Buccal corridor, level of wax exposure with the upper lip at rest, upper lip support, and adjustment of the occlusal plane with a Fox ruler.

Note 2 [# #]: Selection of the length and width of the artificial teeth can be done using the Clapp technique. The acrylic teeth shape selection can be according to the patient's face shape (e.g., oval, square, or triangular). The material for the artificial teeth can be acrylic resin or ceramic. The selection of the shade of artificial teeth is also carried out at this stage.

Note 3 [# # #]: The intermaxillary registration refers to the restoration of the vertical dimension of occlusion (using the Pleasure or Willis technique) and centric relation.

Note 4 [# # # #]: This step is performed using an artificial gingiva shade scale. The artificial gingiva chosen for the patient should have a shade similar to that of the inner surface of the upper lip.

Mechanical, functional, aesthetic and phonetic aspects must be evaluated in this functional and aesthetic test phase:

- Mechanical: Check the adaptation of the acrylic bases to the alveolar ridges (the bases must not be extremely relieved); contour, volume, and shape of acrylic bases; thickness of acrylic edges; level of union between artificial teeth and wax (artificial teeth must be well attached to the wax); wax sculpture of the gingival part; and thickness of the acrylic base in the palate region.
- Functional: Check the centric occlusion; disocclusion during protrusion and laterality (bilateral balanced joint); free functional space and vertical dimension of occlusion; lip mobility; occlusal plane; and incisal edges of the anterior artificial teeth of the mandibular prosthesis, which should be at the level of the patient's lower lip, when his mouth is slightly open.

According to Zarb et al. (2004)
"In most patients, the incisal edges of the natural lower canines and the cusp tips of the lower first premolars are even with the lower lip at the corners of the mouth when the mouth is slightly open. If artificial lower anterior teeth are located above or below this level, their vertical positioning will probably be incorrect .... When the lower teeth are above the lip at the corners of the mouth, any one or a combination of the following may exist: (1) the plane of occlusion may be too high; (2) the vertical overlap of the anterior teeth may be too much; and (3) the vertical space between the jaws may be excessive. When the lower teeth are below the lip at the corners of the mouth, the opposite situations may exist".

- Aesthetic: Check the exposure of the upper incisors with the upper lip at rest; and shade, shape, disposition, and position of the artificial teeth; lip support; size and alignment of the teeth; exposure of the artificial gingiva during the smile; smile curve; buccal corridor; and midline.
- Phonetic: The dentist must be aware of whistles and other strange sounds during the patient's speech, as they are indicative of invasion of the phonetic space.

Note 5 [# # # # #]: Adjustment of the acrylic base can be done using the white paste of the zinc oxide eugenol impression material. This adjustment aims "to remove areas" of the base of the prosthesis that generate greater pressure on the alveolar ridge. In this phase, only the adjustment of the artificial central occlusion is recommended, due to the patient's neuromuscular limitations. Later, in the control

appointments, occlusal adjustments can be made during the patient's protrusion and laterality.

If the acrylic area of the palate of the prosthesis is too thick, making it difficult for the patient to pronounce sounds, it can be adjusted using the palatography technique.

Anatomical or preliminary impression

(Tamaki, 1983; Tanaka et al., 1994; Telles, 2009; Guiraldo et al., 2012; Anusavice et al., 2013; Chain, 2013; Guiotti et al., 2016; Özkan, 2017; Moreno et al., 2020)

The anatomical or preliminary impression is the first step in making a complete denture. This procedure is performed using a metal tray for a totally edentulous maxilla or mandible. The manufacturers of these types of trays produce them in different sizes so that the dentist can choose the best option for his patient.

Impression compound, alginate, or condensation or addition silicone putty can be used to make the anatomical impression. Impressions using alginate may require pre-customizing the stock tray with wax strips. This happens when the edges of the stock tray are too far from the base of the vestibule and the floor of the mouth. Thus, these strips are mechanically attached to the edges of the stock tray to increase their length and provide support for the alginate. For the other impression materials mentioned above, customizing the stock tray with wax is contraindicated – because the temperature of ~50 °C required to use the impression compound would melt the wax, and the consistency of both silicones mentioned above would crush or remove the wax from the edges of the tray during the making of the anatomical impression.

To make the anatomical impression of the maxilla or mandible arch, the dentist must perform functional movements of the patient's lips and cheeks; furthermore, for the mandibular arch, the dentist must ask the patient to move his tongue in different directions. These functional movements are similar to those performed during the making of the functional impression and will be discussed in the next topic. After completing the technique, it is necessary to verify that the mold does not present any problems. An incorrect anatomical impression generates an incorrect anatomical plaster cast, which generates an incorrect individual tray. Therefore, it is important to make a correct anatomical impression.

Table 1 shows the materials that can be used to make anatomical impressions and their disinfection protocols.

Functional impression technique (selective pressure technique)

The functional impression technique (selective pressure technique) described below is based on information from the literature (Boucher, 1944; Hardy and Kapur, 1958; Collett, 1970; Smith et al., 1979; Storer and McCabe, 1981; Olsson et al., 1982; Tamaki, 1983; Keller et al., 1984; Council on Dental Therapeutics and Council on

Table 1 – Materials that can be used to make anatomical impressions and their disinfection protocols

Impression material	Disinfection protocol	Plaster must be poured into the mold ...
Impression compound	The mold should be immersed in 2% glutaraldehyde or 2% chlorhexidine for 10 min	immediately after its disinfection
Alginate (irreversible hydrocolloid)	Disinfection should be performed by spraying 1% hypochlorite, 2% glutaraldehyde, or 2% chlorhexidine over the impression. Subsequently, the impression should remain inside a closed container for 10 min	immediately after its disinfection
Condensation silicone	The mold should be immersed in 1% hypochlorite, 2% glutaraldehyde, or 2–4% chlorhexidine for 10 min	within 1 hour
Addition silicone	The mold should be immersed in 1% hypochlorite, 2% glutaraldehyde, or 2–4% chlorhexidine for 10 min	within 1 week

Note: For the addition silicone, it is important to wait at least 1 hour before pouring the plaster into the mold, due to the release of hydrogen gas.

Prosthetic Services and Dental Laboratory Relations, 1985; Bergman, 1989; Ansari, 1997; Chaffee et al., 1999; Gennari Filho et al., 2002; Petropoulos and Rashedi, 2003; Rashedi and Petropoulos, 2003; Duncan et al., 2004; Zarb et al., 2004; Jeannin and Millet, 2006; Telles, 2009; Goiato et al., 2011a, b, 2012, 2013, 2014; Solomon, 2011a, b; Anusavice et al., 2013; Carlsson et al., 2013; Chain, 2013; Gennari Filho, 2013; Yilmaz and Özçelik, 2014; Arora et al., 2015; Carr and Brown, 2015; Habibzadeh et al., 2016; Özkan, 2017; The Academy of Prosthodontics, 2017; Jayaraman et al., 2018; Melo Neto et al., 2020; Moreno et al., 2020; www.zhermack.com/en/product/zetalabor/ [accessed on May 1, 2022]; www.zhermack.com/en/product/zetaplus/ [accessed on May 1, 2022]), and it is performed in 3 or 2 steps depending on the edentulous arch:

- Maxilla: I) Border molding; II) Final impression; and III) Posterior palatal seal ("post damming") (Figure 1A–D).
- Mandible: I) Border molding; II) Final impression (Figure 1B–D).

I) Border molding technique

1) Plaster casts are obtained through preliminary impressions using, for example, an irreversible hydrocolloid.

Before making the individual (custom) acrylic trays*, reliefs are made with wax over retentive areas of the plaster casts (cast partial relief method). The technician can also use wax to relieve areas of the plaster casts that are flaccid in the patient's

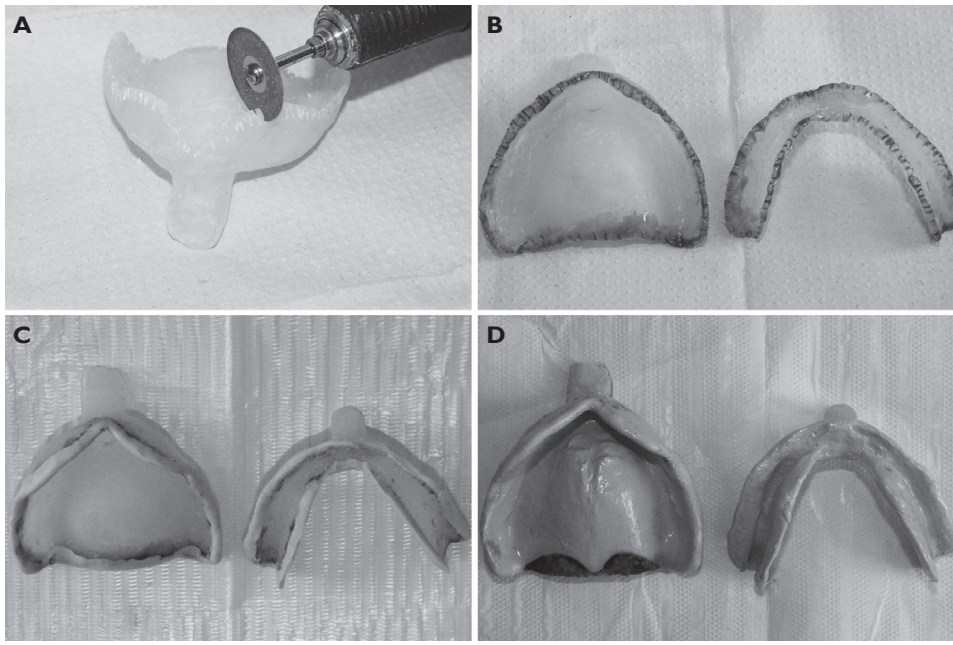

Figure 1 – A) Creation of mechanical retentions; B) adhesive applied to the edges of the trays; C) border molding performed; D) final.

mouth (cast partial relief method)**. However, for this to happen, the dentist must inform the prosthesis laboratory where these flaccid areas are be located. It is noteworthy that these reliefs are created to provide spaces between the flaccid mucosa and the individual tray; which will later be filled with an impression material, during the making of the final impression, without exerting pressure on the flaccid areas.

Note 1: For border molding, it is possible to transfer the wax, which was used to relieve areas of the plaster cast, to the individual tray. Thus, the border molding is carried out with wax reliefs on the inner surface of the tray. This method aims to ensure that, during the border molding, the spaces created between the tray and the mucosa are maintained. Subsequently, before taking the final impression, the wax on the inner surface of the individual tray is removed.

Despite this, it is perfectly possible to carry out the border molding technique without the presence of wax on the inner surface of the individual tray. The technique reported below contemplates this situation.

According to Telles (2009)
*"Regardless of the material used to make the individual tray, it must be rigid to avoid deformation of the impression material supported on it. The most used materials to

make individual trays are: (1) self-curing acrylic resin; (2) thermosetting acrylic resin; (3) light-curing composite resin; and (4) polystyrene sheet".

**"Some authors recommend that relief be performed on retentive areas of the plaster cast to facilitate the removal of the tray from the plaster cast. Others believe it is important to relieve certain regions of the plaster cast where the mucosa has some degree of flaccidity or resilience (e.g., palatine rugae region)".

**"The relief area should be as small as possible, and never cover the entire support area of the plaster cast, as in this case, the area of greatest compression of the tray (overextended edges) would be transferred to the base of the vestibule (and base of the floor of the mouth, for the mandible) (cast partial relief method). It is only possible to relieve the entire support area of plaster cast, if "stops" are created on the inner surface of the individual tray (cast total relief method). Thus, these "stops" can keep the tray in position over the ridge, after the wax relief has been completely removed".

Note: "Stops" can be made with acrylic resin or silicone putty.

2) To make the functional impression, the patient's oral tissue must be healthy and clean.
3) After the dentist receives the individual trays from the prosthetic laboratory, it is necessary to disinfect them before inserting them into the patient's mouth. This disinfection can be performed by immersing individual trays in 2% glutaraldehyde, 1–5% hypochlorite, or 2–4% chlorhexidine for 10 minutes (the higher the concentration of the solution, the greater the antimicrobial effect). Spraying 70% alcohol on the trays and waiting a few minutes, can also be a disinfection method.
4) Impressions of the maxillary and mandibular ridges are taken when the patient is seated in the dental chair. For molding the maxillary ridge – the dentist should be standing and positioned behind the patient. The dentist's elbow should be at the same height as the patient's labial commissure. For molding the mandibular ridge – the dentist should be standing and positioned facing the patient. The height of the patient's labial commissure should be in a position above the dentist's elbow so that the dentist can keep his spine upright. All these precautions allow the dentist to perform these impression procedures in an ergonomically correct position (upright spine).
   Before introducing the individual maxillary or mandibular tray into the patient's mouth, it is important to check its edges. If the edges of the tray are sharp, they must be adjusted so that they are rounded. The inner surface of the trays must also be checked, and if there are any sharp acrylic parts, they must be removed. Verification of the edges of the trays can be done by touch and by the dentist's vision.
5) Typically, the prosthetic laboratory pre-adjusts the individual trays based on the anatomical plaster casts. However, clinically, the dentist must check if the edges of the individual trays are overextended:

- Adjustment of the maxillary individual tray

Initially, the tray must be positioned over the patient's ridge. It is then held in position with one of the dentist's hands (middle finger resting on the tray in the palatal vault region), while the patient's upper lip and cheeks are gently moved towards the floor with the dentist's other hand (functional movements). If during movement of the upper lip or cheek towards the floor, the dentist notices that the individual tray is being displaced from its position, this indicates that the tray edge is overextended. Thus, the height of the edge of the individual tray must be reduced so that the edge of the tray is 2 mm from the base of the vestibule. When movements of the upper lip and cheeks are performed and the tray is not displaced from its position, it means that the edge of the tray is not overextended.

After adjusting the front and side edges of the individual tray, it is necessary to adjust the back edge of the tray. The dentist must locate and mark, with a copying pencil, on the mucosa, the posterior limit of the future upper complete denture. The posterior edge of the upper individual tray must end at the limit marked with the copying pencil. It is possible to facilitate the location of the posterior limit of the future maxillary prosthesis, through some methods: I) *Anatomical location*: with a copying pencil, a line is marked on the patient's oral tissue connecting the hamular notch on both sides, passing over the fovea palatinae (the fovea palatinae are located in the region of the soft palate); II) *"Ah" line*: ask the patient to say "ah", and then use the copying pencil to mark the "ah" line. This line must connect the hamular notch on both sides*** (the "ah" line is located in the soft palate region); and III) *"Valsalva maneuver"*****. The difference in colour between the hard and soft palate can help the dentist locate the posterior limit of the future denture (hard palate – pale pink, and soft palate – vivid pink). It is important to emphasize that the posterior limit of the future upper complete denture must be located on the soft palate ("line of fovea palatinae" or "ah" line).

After marking the line on the buccal tissue of the posterior limit of the upper complete denture, the dentist must verify that the individual tray is respecting this limit. Regarding the marked line, if the tray is overextended or underextended, it must be adjusted.

According to Zarb et al. (2004)
***Vibrating line (or "ah" line)
"The vibrating line is an imaginary line drawn across the palate that marks the beginning of motion in the soft palate when an individual says "ah". It extends from one hamular notch to the other. At the midline, it usually passes about 2 mm in front of the fovea palatinae. These are indentations near the midline of the palate formed by a coalescence of several mucous gland ducts. They are always in soft tissue, which makes them an ideal guide for the location of the posterior border of the denture".

"The vibrating line is not to be confused with the junction of the hard and soft palate because the vibrating line is always on the soft palate. It is not a well-defined line and should be described as an area rather than a line. The distal end of the denture should extend at least to the vibrating line. In most instances it should end 1 to 2 mm posterior to the vibrating line".

Important note regarding the vibrating line (or "ah" line)
"The vibrating line of the soft palate, normally used as a guide to the ideal posterior border of the denture, usually is located slightly anterior to the foveae palatinae. However, it may be on or slightly posterior to the foveae palatinae. The slight devia deviation from these markings is estimated by having the patient say "ah" and thus vibrate the soft palate".

****Valsalva maneuver
"The locations of the right and left hamular (pterygomaxillary) notches are marked with an indelible pencil. On the median line of the anterior part of the soft palate are two indentations formed by the coalescence of ducts known as the foveae palatinae. The shape of these depressions varies from round or oval to oblong. The dentist can make them more readily discernible by having the patient hold his nose and attempt to blow through it (Valsalva maneuver). This will accentuate the foveae palatinae and vibrating line".

- Adjustment of the mandibular individual tray

For the mandibular ridge, the same process of adjusting the tray is performed, the difference is that the movements of the patient's lower lip and cheeks are performed in the opposite direction to the floor. During this process, the index and middle fingers of the dentist's hand must gently hold the tray in position over the mandibular ridge, while the dentist's other hand performs the functional movements of the patient's lip or cheek (one finger on each premolar region of the tray). Subsequently, the patient must be asked to move his tongue upward, sideways and forward (functional movements). During this process, the index fingers of the dentist's hands must hold the tray gently over the patient's ridge (one finger on each premolar region of the tray). This will simulate the functional movements of the mylohyoid muscle. If the dentist perceives that the tray is being displaced from its position during functional movements, the height of the tray edge, in the tested region, must be reduced. The edges of the tray must have a distance of 2 mm from the base of the vestibule, and 2 mm from the floor of the mouth.

It is noteworthy that, when the maxillary or mandibular tray is on the ridge, the visual assessment can be performed to complement the adjustment of the lateral and frontal regions of the tray. Visually, it is possible to check the approximate distance between the edge of the tray and the base of the vestibule, and whether the tray is correctly contouring the buccal, labial, and lingual frenula.

The posterior extension of the future mandibular prosthesis must extend approximately one half to 2/3 over the retromolar pad.

Note: The buccal flange of the future denture must cover the buccal shelf. Buccal shelf is the bone area between the extraction sites of the molars and the external oblique line, and it forms the primary support for the mandibular denture as it is made primarily of cortical bone. Thus, the individual lower tray must cover this area on both sides of the mandibular arch.

6) Mechanical retentions with a carborundum disk can be performed along the entire length of the edges of each individual tray (Figure 1A). This creates mechanical retentions for the laboratory condensation silicone putty.
7) Apply an adhesive (Universal Tray Adhesive, Zhermack) to the inside and outside of the edges of the individual trays (Figure 1B). The authors of the present article recommend that initially a small amount of adhesive be dispensed into a sterilized dappen pot and then, using a disposable microbrush, the adhesive be applied to the edges of the trays. This prevents cross contamination. Then, wait 5 minutes for the adhesive solvent to evaporate, before adding the silicone putty to the edges of the tray.
8) Laboratory condensation silicone putty (Zetalabor or Titanium, Zhermack) must be handled according to the manufacturer's recommendations and added to all edges of the tray. After that, the individual tray must be positioned over the patient's ridge.

For the border molding technique using laboratory condensation silicone putty, it is possible to mold in a single step or in more than one step. Despite this, according to Smith et al. (1979):

"A material which will allow simultaneous moldings of all borders has two general advantages: (1) the number of insertions of the trays for maxillary and mandibular border molding could be reduced to two, a great time and motion advantage; and (2) development of all borders simultaneously avoids propagation of errors caused by a mistake in one section affecting the border contours in another section".

9) The functional movements mentioned above must be performed according to the arch of interest (Figure 1C).

According to Chafee et al. (1999)
"The objective of border molding is to "customize" the impression tray to establish the maximal extension and accuracy of the peripheral seal with no functional impingement of the tissues".

According to The Academy of Prosthodontics (2017)
"Border seal: the contact of the denture border with the underlying or adjacent tissues to prevent the passage of air or other substances".

According to Zarb et al. (2004) and Arora et al. (2015)
"Border molding is the process by which the shape of the border of the tray is made to conform accurately to the contours of the buccal and labial vestibules. This essential requirement of the tray's fit ensures an optimal peripheral seal. It begins with manipulation of the border tissue against a moldable impression material that is properly supported and controlled by the tray. The amount of support supplied by the tray and the amount of force exerted through the tissues vary according to the resistance or viscosity of the impression material".

According to Arora et al. (2015)
The peripheral seal is important to prevent air from entering between the complete denture and the mucosa, providing retention.

10) After the material hardens, stability and retention tests are performed for each individual tray.

- For the stability test:
  The tray is placed over the ridge and the index fingers are positioned over the premolar areas of the tray (one finger over each premolar area). The dentist must alternately compress these regions to verify that the tray is correctly seated on the ridge. The tray must not alternately move during this process.
- Vertical and horizontal retention tests:
  Vertical test: For the maxilla or mandible, pull the tray handle vertically downwards (maxilla) or upwards (mandible) respectively.
  Horizontal test: For the maxilla or mandible, pull tray handle horizontally in buccal direction.

Note 1: Normally, only the maxillary tray, after border molding, shows retention with the edentulous ridge.

Note 2: The height of the anterior handles of the individual trays should be 10 mm to simulate the height of the central incisors. This allows the operator to have a more realistic tactile perception of the retention level of the future denture.

Note 3: Based on the maxilla, after correct border molding, it is generally common for the tray to have adequate vertical retention with the ridge. However, the horizontal retention of the individual tray may be less than the vertical one at this time. Despite this, it is possible to increase the horizontal retention of the tray with the ridge later, in the "post damming" phase.

11) After removing the individual tray from the patient's mouth, check the

impression along the entire length of the tray edges. Along the entire length of the edges of the tray, the silicone putty must be well adhered. The width of the silicone edges should be 2–2.5 mm. In addition, it is recommended to inspect the posterior limits of the impressions to verify that they are correct. If there is a problem, it must be resolved.

Note: If any part of the impression shows adhesive failure with the tray, this situation must be corrected. Therefore, the dentist must remove the problematic part of the impression and repeat the previous steps for the affected area to correct it.

II) Final impression (also called "corrective impression")

12) It is recommended to drill the anterior palatal region of the individual tray to create a hole (Ø 1 mm or 1.5 mm). Thus, during the making of the final impression, the impression material leaks through the hole, reducing the hydraulic pressure on the palate.
13) Zinc oxide eugenol paste must be handled according to the manufacturer's recommendations.
14) The maxillary or mandibular tray loaded with impression paste is positioned over the patient's ridge. The previously reported functional movements must be performed. These movements should only be stopped when the material has hardened.
15) Retention and stability tests of individual trays must be performed. Normally, retention of the lower mold with the mandibular ridge does not occur, due to bone resorption.

Important notes:

- After obtaining the impression, if a small negative bubble is identified on its surface, it is possible to fill it with wax. When the negative bubble is medium in size, it is interesting to insert the mold over the edentulous ridge immediately after inserting the wax inside the bubble. Thus, the still softened wax copies the region of interest (Figure 2). This procedure can be performed in conjunction with the "post damming" step. However, when the negative bubble is very large, it is necessary to load the entire surface of the mold with paste for the reline process.
- After making the final impression, if parts of the internal surface of the tray are not covered with the paste (pressure areas), the tray must be relieved in these regions with a spherical dental drill. In this circumstance it is also interesting to relieve flaccid areas. Then it is necessary to load the entire surface of the mold with paste for the reline process (Figure 3).
- Once the impressions are finished, it is interesting to check whether the posterior limits of the edges are correct. If there is a problem, it must be resolved.
- Before carrying out the next step, it is important to wash the molds with water and clean the patient's mouth.

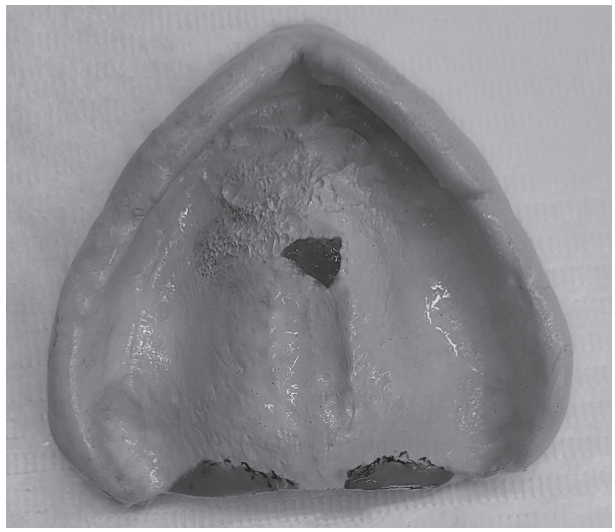

Figure 2 – Result obtained after inserting wax into a medium-sized bubble, and then inserting the mold over the patient's edentulous ridge. Note: The final impression correctly copied the patient's palatine torus region.

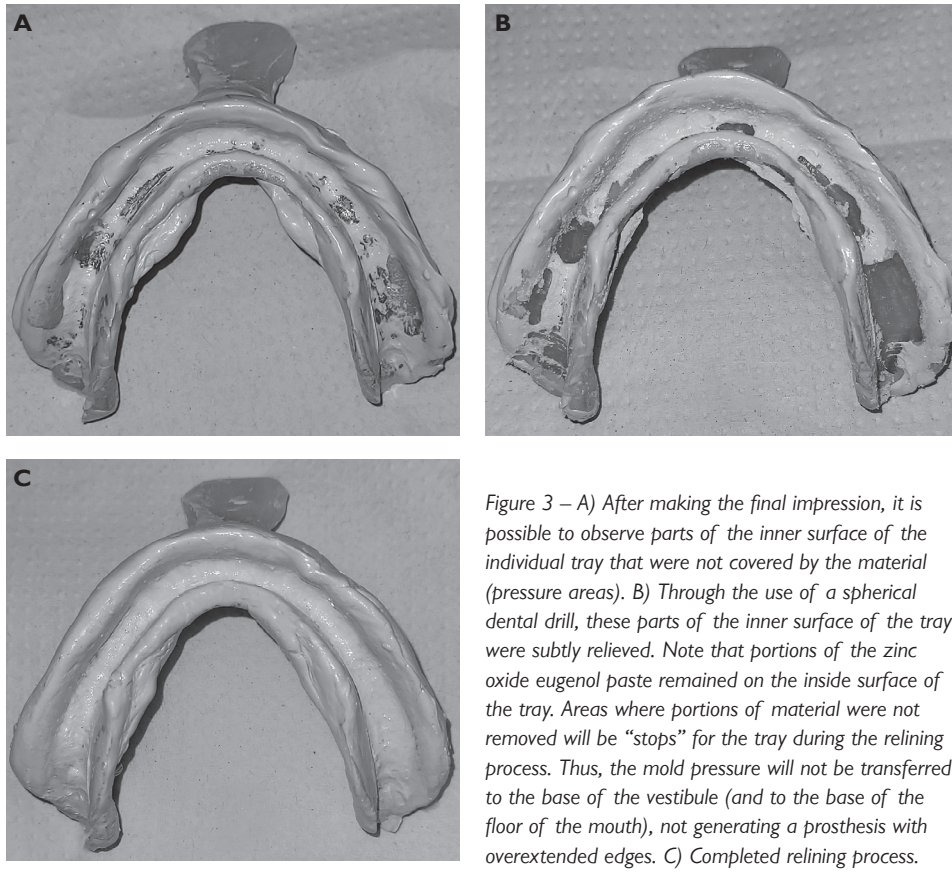

Figure 3 – A) After making the final impression, it is possible to observe parts of the inner surface of the individual tray that were not covered by the material (pressure areas). B) Through the use of a spherical dental drill, these parts of the inner surface of the tray were subtly relieved. Note that portions of the zinc oxide eugenol paste remained on the inside surface of the tray. Areas where portions of material were not removed will be "stops" for the tray during the relining process. Thus, the mold pressure will not be transferred to the base of the vestibule (and to the base of the floor of the mouth), not generating a prosthesis with overextended edges. C) Completed relining process.

III) Posterior palatal seal ("post damming")
According to Jeannin and Millet (2006)
"The soft palate can move in a superior position, which may result in air leakage in the posterior area of a complete denture. To prevent dislodgement of the denture, the soft palate must be impressed in its superior position when making the definitive impression. By creating this contact, air is prevented from passing under the denture during speech or respiration".

According to The Academy of Prosthodontics (2017)
"Posterior palatal seal area: the soft tissue area limited posteriorly by the distal demarcation of the movable and nonmovable tissues of the soft palate and anteriorly by the junction of the hard and soft palates on which pressure, within physiologic limits, can be placed; this seal can be applied by a removable complete denture to aid in its retention".

According to Hardy and Kapur (1958) and Rashedi and Petropoulos (2003)
"The development of the posterior palatal seal on the denture has the following advantages: (1) it provides retention, (2) it provides a close contact of the denture base with the mucous membrane which prevents food from getting under the denture; and (3) it supplies a thickened area that provides added strength across the denture".

16) Between the junction of the hard and soft palates and the "ah" line, there is a vibrating region located in the soft palate. During speech, this region vibrates due to the action of two muscles (tensor veli palatini and levator veli palatini). With the aid of a copying pencil, this region must be contoured on the patient's oral tissue. Thus, after inserting and removing the mold from the patient's mouth, the marking is transferred to it. A thin film of heated wax is applied over the demarcated region over the mold. After correctly covering the area of interest of the mold with wax, it is interesting to heat the wax again so that it becomes softer. Immediately after this procedure, the mold must be inserted and correctly fitted over the ridge. During the time that the mold is positioned on the ridge, the patient should be asked to say "ah".
17) After the wax has hardened, the previously reported retention and stability tests must be performed with the mold. Then, the tray is removed from the patient's mouth, and the dentist must check the impression. If the dentist verifies that the wax has flowed over the region of the posterior nasal spine or palatine raphe of the impression, it is necessary to remove it from that region and repeat the technique. The "post damming" has the function of increasing impression retention with the ridge, mainly in relation to horizontal retention. Thus, if after this procedure the retention of the final impression with the ridge is reduced, there was probably a failure in the technique, and it must be repeated.
18) The impression obtained must have clear details of the anatomical characteristics

of the ridge and adequate thickness of the impression materials (Figures 1D and 2). The width of the edges of the mold should be 2–2.5 mm. In addition, the mold must not have bubbles and fractures that could negatively influence the making of the functional plaster cast.

19) Wash the impressions and soak them in 2% glutaraldehyde, or 2–4% chlorhexidine for 10 min. Later, before pouring the plaster into the mold, it is important to wash the impression again to remove the disinfectant.
20) A wax strip must be attached ~2 mm below the outer edges of the mold, and a vertical wall of wax should be firmly attached to this wax strip, forming a wax box. Then, type III or IV plaster is poured into the mold.

Notes:
Some professionals prefer that the cast be made with type III plaster for the acrylization process. This occurs because type IV plaster is very hard and, therefore, after acrylization of the complete denture, it is difficult to separate the cast from the acrylic base. This difficulty in separating these materials can lead to human error, causing damage to the complete denture.

Based on the study by Habibzadeh et al. (2016), it is possible to pour the plaster into the mold, composed only of the zinc oxide and eugenol, within 7 hours. Within this time interval, this material maintains its dimensional stability. However, based on the reported technique, laboratory condensation silicone putty is also used. For this elastomer, it is necessary that the plaster be poured into the mold within 1 hour, to avoid alterations in its dimensional stability. Therefore, for the reported technique, the plaster must be poured into the mold, composed of condensation silicone and zinc oxide and eugenol, within 1 hour.

Based on the reported functional impression technique, the impression created with the previously reported materials simulates the hardness of the future complete denture. According to the authors of this article, this hardness of the mold gives the dentist, during tests of retention and stability of the mold, a more adequate tactile perception of how the retention and stability of the future prosthesis will be, which will be rigid. *The functional mold represents the acrylic base of the future complete denture*.

Discussion

The border molding technique, reported in this review, can also be used to make the functional impression to fabricate removable partial dentures, immediate complete dentures, obturator prostheses, overdentures, and Branemark protocol dentures (Gennari Filho et al., 2002).

As previously reported, the laboratory condensation silicone putty indicated for this technique is Zetalabor (Zhermack – 80 Shore A) or Titanium (Zhermack – 90 Shore A) (www.zhermack.com/en/product/zetalabor/ [accessed on May 1, 2022]). Zetalabor or Titanium silicone has a Shore A hardness greater than clinically

used condensation silicones (Zetaplus Soft [putty] – 60 Shore A, and Zetaplus [putty] – 70 Shore A; Zhermack) (www.zhermack.com/en/product/zetalabor/ [accessed on May 1, 2022]; www.zhermack.com/en/product/zetaplus/ [accessed on May 1, 2022]). Thus, the purpose of using a laboratory silicone putty, for the border molding, is to simulate the hardness of the acrylic base of a complete denture.

For border molding, the advantages of using a laboratory condensation silicone putty compared to an impression compound include: 1 – the silicone does not need preheating like impression compound (temperature of ~50 °C) (Tamaki, 1983; Özkan, 2017), avoiding burning the patient's mouth (Gennari Filho et al., 2002); 2 – *Gain clinical time*, because when using silicone putty, the dentist does not need to handle water heating equipment and wait for the water to heat up (Gennari Filho et al., 2002); 3 – it is easier to correct mold failures when silicone putty is used; 4 – it is easier to remove excess material after border molding (Gennari Filho et al., 2002); 5 – the plaster must be poured into the functional impression, composed of zinc oxide and eugenol and a laboratory condensation silicone putty, within 1 hour. On the other hand, when using compound in this case for border molding, the plaster must be poured into the impression within 10 min; and 6 – it is easier to avoid cross-contamination when a silicone putty is used.

Regarding cross-contamination, one of the problems with using compound for border molding, is the container used to receive the hot water (Gennari Filho et al., 2002). Typically, dental students and dentists pour hot water into PVC dental bowls. These PVC bowls normally cannot be sterilized because they become deformed. Thus, after using these PVC bowls, their disinfection may be inefficient, which favours cross-contamination (Gennari Filho et al., 2002). Furthermore, even if the dentist uses a device to heat the compound, the problem would be the same, due to the need to disinfect this device, which can also be inefficient (Gennari Filho et al., 2002). This situation is even more worrying today due to the COVID-19 pandemic (Melo Neto et al., 2020).

It is also important to note that a laboratory condensation silicone putty is less expensive than other materials used for border molding such as addition silicone and polyether, and it does not have an unpleasant odour like polysulfide (Petropoulos and Rashedi, 2003; Mehra et al., 2014).

Conclusion

The border molding technique reviewed in this study is comfortable and safe for the patient.

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