

Removable Partial Denture – Functional Impression Techniques: Review

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Abstract: The objective of this article is to concisely review the main clinical techniques used to make the functional impression to manufacture a removable partial denture. Through this review, the dentist can develop his clinical knowledge.

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Introduction

Removable partial denture is the treatment of choice for those patients who need to replace missing teeth for aesthetic and functional reasons, but cannot receive implants due to general health problems, financial limitations, or fear of surgery (Costa et al., 2009).

The functional impression to fabricate a removable partial denture is typically taken over the posterior free end of the dental arch (Kennedy classes I and II); and over the entire dental arch, when few teeth remain in the patient's arch (Todescan et al., 1996; Carreiro and Batista, 2014; Sakar, 2016). Functional impression can be made using one of these techniques: 1) "*Individual tray technique*" – In this technique, using an individual tray that covers the entire arch of the patient, the anatomical and functional impressions are taken simultaneously. In this technique, the copy of the teeth represents the anatomical impression, and the copy of the mucosa represents the functional impression. The master cast obtained by this technique is used to manufacture the metallic framework, and all the acrylic bases (saddles) of the future denture; 2) "*Altered cast technique*" – This technique is performed in a clinical session subsequent to the clinical session that aims to evaluate the metallic framework; and, 3 and 4) "*Open mouth technique*" and "*Closed mouth technique*" – One of these techniques can be used in the clinical session for aesthetic and functional evaluation of wax-attached acrylic teeth, immediately after this procedure. In these last three techniques, an individual tray attached to the metallic framework, which only covers the posterior free end of the dental arch, is used (e.g., Kennedy's class II). In Kennedy class I cases, the two posterior free end areas are covered by individual trays attached to the framework. These last three techniques only aim to obtain the definitive acrylic base of the prosthesis, which will be located on the posterior free end, or on the free ends, of the dental arch (Kennedy class II and I cases) (Applegate, 1937; de Fiori, 1993; Todescan et al., 1996; Carreiro and Batista, 2014; Sakar, 2016).

The objective of this article is to concisely review the main clinical techniques used to make the functional impression to manufacture a removable partial denture. Through this review, the dentist can develop his clinical knowledge.

Review

Depending on the functional impression technique chosen, it is performed at a certain time within the clinical sequence to fabricate a removable partial denture. All information reported below is based on the literature (Applegate, 1937; Hidels, 1952; Christensen, 1962; Holmes, 1965; Leupold and Kratochvil, 1965; Blatterfein et al., 1980; de Fiori, 1993; Todescan et al., 1996; Cucci and Vergani, 1997; Kliemann and Oliveira, 1998; Pegoraro, 1998; Gennari Filho et al., 2002; Zarb et al., 2004; Costa et al., 2009; Goiato et al., 2013; Carreiro and Batista, 2014; Yılmaz and Özçelik, 2014; Carr and Brown, 2015; Sakar, 2016; The Academy of Prosthodontics, 2017; www.zhermack.com/en/product/zetalabor/ [accessed on August 12, 2023]; www.zhermack.com/en/product/zetaplus/ [accessed on August 12, 2023]).

Clinical sequence to fabricate a removable partial denture

- 1) Clinical and radiographic examination.
- 2) Mouth preparations (periodontal treatment, restorations using composite resin, etc.).
- 3) Molding to obtain the study casts.
- 4) Assembly of the study casts on the semi-adjustable articulator to study the clinical case.
- 5) Analysis of the study casts using a dental surveyor.
- 6) Planning.
- 7) Abutment teeth preparation (rest seats; guide-planes; preparation of adequate retentive areas, using composite resin, for the retentive arm of the clasp; etc.).
- 8) Molding to obtain the master cast using a metal tray of stock and alginate, or condensation or addition silicone (putty and fluid) (anatomic form impression); or *individual tray technique*, if necessary.
- 9) Metal framework try-in.
- 10) *Functional impression (altered cast technique)*, if necessary, when the *individual tray technique* has not been previously performed.
- 11) Wax rims phase – (i) Use of the facebow to mount the upper master plaster cast (or altered master plaster cast) on the articulator; (ii) maxillomandibular registration; and (iii) finalization of the assembly of the master plaster casts (or altered master plaster casts) on the articulator. At this stage, the selection of artificial teeth is also carried out (size, width, shape, shade, and material).
- 12) Aesthetic and functional try-in of the wax-attached acrylic teeth, and then (in the same clinical session), the *open mouth* or *closed mouth technique* is performed, if necessary (when the *altered cast technique* or *individual tray technique* has not been previously performed). In this step, the shade selection of the artificial gingiva is also carried out.
- 13) Delivery of the removable partial denture to the patient, after the laboratory stage of acrylization; occlusal adjustment; and oral hygiene instructions.
- 14) Clinical controls.

Note 1: When the functional impression is taken, it can be made in only one of these steps: 8, 10 or 12.

Note 2: In Kennedy class III and IV cases, when there is no need to make the functional impression, the previously reported clinical sequence is performed without this type of impression. Thus, the master plaster cast will be generated by the anatomical impression, where the metallic framework and the definitive acrylic bases (saddles) of the future prosthesis will be made.

Anatomical impression can be made with alginate using a metal stock tray (step 8). It is recommended that the stock tray always be made of metal, as the plastic tray can generate deformations to the mold after it is removed from the patient's mouth.

Furthermore, it is recommended that the metallic tray be previously customized with wax to increase the extension of its edges. This will provide a complete copy of all areas of the dental arch that will be important to fabricate the removable partial denture.

The anatomical impression can also be made using the condensation or addition silicone (putty and fluid). It is contraindicated to pre-customize the edges of the metal stock tray when using one of these silicones. Two techniques can be used with condensation silicone or addition silicone (putty and fluid): I) For the first technique (one-step technique), silicone putty is added into the metal stock tray, and then silicone fluid is added over the first material. Thus, these two material consistencies are used at the same time to make the anatomical impression; and II) The second technique (relining technique, also known as the two-step technique) consists of a relining procedure. Thus, initially, a mold is obtained with the silicone putty, which is subsequently relieved, and then it is relined with the fluid silicone.

In situations of tooth mobility, and when a silicone will be used to make the anatomical impression, it is more interesting to use the relining technique. This will help prevent tooth movement due to the fluid consistency of the silicone (two-step technique). It is worth remembering that for the one-step technique, the silicone putty can generate tooth movement more easily.

Note 3: The individual tray technique is the only technique in which anatomical and functional impressions are taken simultaneously.

For the other techniques reported in this article, anatomical and functional impressions are taken at different times. In this case, the anatomical impression will be used to generate the master plaster cast, where the framework will be made; and the *altered cast technique*, *open mouth technique* or *closed mouth technique* will be used to alter the master plaster cast, creating the altered master plaster cast. The altered part of the altered master plaster cast will be used to create the acrylic base of the future removable partial denture.

Note 4: In step 11, in a situation of rehabilitation of only the partially edentulous mandibular arch, it would not be necessary to use the facebow again to mount the upper plaster cast on the articulator; because this would have been done before (step 4).

Note 5: The anatomical impression and the individual tray technique generate the master plaster cast (step 8).

Altered cast technique generates the altered master plaster cast (step 10).

The *open mouth technique* or *closed mouth technique* (step 12) can also generate the altered master plaster cast to complete the fabrication process of the removable partial denture (using a muffle). However, this is not a mandatory situation, as the acrylicization stage using a muffle can only be carried out with the mold attached to the framework (without the master plaster cast).

Note 6: When the edentulous space of the posterior free end is short (e.g., Kennedy class II), only the anatomical impression is enough “to fabricate all parts

of the removable partial denture”. Thus, it is not necessary to make the functional impression.

Dentist position during impression techniques

All techniques described below should be performed with the patient comfortably seated in the dental chair. The dentist’s position in relation to the patient depends on the patient’s edentulous arch that will be molded:

- Maxilla – 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.
- Mandible – 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. Respecting these positions, the dentist can perform these procedures with his spine erect.

Border molding

The Glossary of Prosthodontic Terms (The Academy of Prosthodontics, 2017) defines the “border molding” as: “1. the shaping of impression material along the border areas of an impression tray by functional or manual manipulation of the soft tissue adjacent to the borders to duplicate the contour and size of the vestibule; 2. determining the extension of a prosthesis by using tissue function or manual manipulation of the tissues to shape the border areas of an impression material”.

The border molding technique can be performed using materials such as a *low-fusing* compound or a silicone putty. With regard to silicone putty, the authors of the present study indicate the use of a laboratory condensation silicone putty (Zetalabor or Titanium; Zhermack). These laboratory silicones putties (Zetalabor/Titanium; Zhermack) have a higher Shore A hardness than clinical condensation silicone putties (Zetaplus = 70 Shore A/Zetaplus Soft = 60 Shore A; Zhermack). The use of a high-hardness laboratory condensation silicone putty aims to simulate the hardness of the edges of the future prosthesis.

The border molding technique with a laboratory silicone putty can be carried out by following the steps: 1) After adjusting the edges of the individual tray, mechanical retentions are created on the edges of this tray; and 2) The adhesive is applied to the edges of the individual tray so that the silicone putty is glued to them.

Individual tray technique

This technique is generally indicated for cases where few teeth remain in the patient’s dental arch. Despite this, it can be used for all Kennedy class I, II, III and IV situations.

The authors of this study suggest that the border molding be performed with a laboratory condensation silicone putty.

Technique steps

This technique is similar to the functional impression technique for making a complete denture:

1) The study plaster cast obtained from the impression of the patient's dental arch, using a stock tray and alginate, can be used to manufacture the individual tray. The wax relief is performed on the plaster cast, and then the individual acrylic resin tray is made on the entire surface of the plaster dental arch.

For regions where teeth are located, the individual tray created on the plaster cast is fully relieved by 2 mm, while for the edentulous regions, this individual tray can be partially relieved. In this case, partial relief with wax on the plaster cast is performed only on retentive and flaccid edentulous areas, according to the patient's oral condition. Thus, for flaccid areas of the patient's ridge, the dentist must inform the dental laboratory where these areas are located on the plaster cast, so that the prosthetic technician can perform the necessary reliefs before manufacturing the individual tray.

For partially relieved individual upper tray (edentulous areas of the maxilla), there is the possibility of creating "stops" on its inner part for the teeth. However, for this dental arch, it is possible to take the impression without "stops" for the teeth, as the hard palate acts as a "stop". On the other hand, for a partially relieved lower individual tray (edentulous areas of the mandible), it is recommended to create "stops" on its inner part for the teeth.

When an individual tray is fully relieved (dental and edentulous regions of the maxilla or mandible), "stops" must be created for both the teeth and the edentulous areas to take the impression. In this case, the "stops" have the function of preventing overextension of the edges of the tray. The "stops" can be made with acrylic resin or silicone putty. When a silicone putty will be used, the adhesive must be previously applied to the individual tray regions of interest.

When "stops" are created, they must be made before the next step.

2) It is important to adjust the height of the edges of the individual trays. The edges of a tray should be 2 mm from the base of the vestibule (and from the base of the floor of the mouth, based on the mandible), except for the posterior edge. For the maxilla, the posterior edge of the tray must connect the hamular notch on both sides, passing over the palatine fovea (or the "ah" line), or over the junction between the hard and soft palate. It is important to note that the posterior limit of the future prosthesis will depend on the type of major connector. For the palatal plate, the posterior limit of the major connector must be the "ah" line, or the posterior end line of the hard palate (line between hard and soft palate). The remaining types of major connectors must be located on the hard palate only. For the mandible, the tray must extend approximately one-half to 2/3 over the retromolar pad, based on the posterior free end area of the ridge.

Visually, for the anterior region of the ridge (maxilla or mandible), it is possible to verify approximately the distance from the edge of the tray to the base of the vestibule. However, the visual aspect may not be as reliable for adjusting the height of the individual tray edges. Furthermore, visual assessment is limited to the anterior areas of the maxilla and mandible. Thus, it is important to adjust the lateral and frontal edges of the trays, performing functional movements that will be reported below:

- Maxilla – One of the dentist’s hands must hold the tray in position over the dental arch, while the dentist’s other hand moves the patient’s cheek or upper lip toward the floor. If the dentist notices that during these movements the tray is dislocating from its position, then the edges of the tray are overextended. In this situation, the height of the edges of the acrylic tray must be reduced and, subsequently, the tray must be tested again. This process must be repeated until the tray does not move from its position during movements of these oral structures.
- Mandible – The lower tray adjustment process is similar to the method reported for the maxilla. The difference is that the movements of the patient’s lower lip and cheeks are performed upwards. In addition, it is recommended that the patient move his tongue sideways and upwards. If the dentist notices that during these movements the tray is dislocating from its position, then the edges of the tray are overextended. In this situation, the height of the edges of the acrylic tray must be reduced and, subsequently, the tray must be tested again. This process must be repeated until the tray does not move from its position during movements of these oral structures.

3) Border molding is performed using a *low-fusing compound* or a laboratory silicone putty. When a silicone putty will be used, mechanical retentions are previously created on the edges of the tray, and an adhesive is applied over them. During the border molding, the same functional movements reported previously must be performed. These movements have the function of copying the base region of the vestibule and determining the correct extension of the edges of the acrylic base of the future prosthesis.

4) The adhesive must be applied to the entire internal area and edges of the individual tray.

5) Use a fluid elastomer to make the final impression (i.e., polyether, condensation silicone, polysulfide, or addition silicone). During the final molding, the same functional movements reported above must be performed.

6) The plaster cast obtained using this technique is called the master cast.

Note: The final impression may also be called “corrective impression”.

Altered cast technique (or applegate technique)

“Altered cast removable partial denture impression” is defined by the Glossary of Prosthetic Terms (The Academy of Prosthodontics, 2017) as: “a negative likeness of a portion or portions of the edentulous denture bearing area made independent

of and after the initial impression of the natural teeth; this technique uses an impression tray(s) attached to the framework of the removable partial denture, or its likeness". Furthermore, the term "altered cast" is defined by the Glossary of Prosthetic Terms (The Academy of Prosthodontics, 2017) as: "a final cast that is revised in part before processing a denture base".

This technique is indicated for molding the free end (Kennedy class II), or free ends, of the arch (Kennedy class I). The disadvantage of this technique is that it requires one more clinical session compared to the other three techniques initially reported.

The authors of this study suggest that the border molding be performed with laboratory condensation silicone putty.

Technique steps

1) In another clinical session, after trying and adjusting the metallic framework, this technique is performed. It is important to highlight that before the clinical session to make the functional, the prosthesis laboratory makes an acrylic resin tray attached to the framework (only for the free end area). Therefore, for Kennedy class I, the functional impression is taken over two edentulous areas (two free ends), and for Kennedy class II, over one edentulous area (one free end). The posterior edentulous area at the free end of the dental arch is a region that will provide mucosal support for the denture. The tray made by the dental laboratory is relieved (1 mm) to provide space for the impression material.

Costa et al. (2009) reported important information about removable partial dentures with dental and mucosal support: "On one hand, the abutment tooth presents a limited movement of around 0.1 mm; on the other hand, the mucosa, which varies in compressibility from 0.4 to 4 mm, has an average resilience of 1.3 mm. This means that the mucosa confers a freedom of movement to the saddle approximately 13-fold higher than that allowed by the dental organ in its alveolus".

The functional impression is important to prevent the saddle of the future prosthesis from excessively compressing the mucosa of the free end, during mandibular rest or mastication. Excessive compression of the mucosa can cause failure of the blood supply, mucosal damage, discomfort, and bone resorption. In addition, it is important to report that the lack of adequate contact between the saddle and the posterior free end mucosa generates an overload on the abutment tooth, leading to periodontal problems (e.g., bone resorption). Thus, the functional impression is also important for a more favourable distribution of masticatory stress, and reduction of the leverage effect on the abutment tooth, generating greater comfort and oral health for the patient.

2) The edges of the tray should be 2 mm from the base of the vestibule (and from the base of the floor of the mouth based on the mandible), except for the

posterior edge. For the maxilla, the tray must cover the tuber maxillae (the limit of the posterior edge of the tray is the hamular notch); and for the mandible, the tray must extend approximately one-half to 2/3 over the retromolar pad.

3) Border molding is performed using a *low-fusing compound* or a laboratory silicone putty. Remembering that to use silicone, it is important to create mechanical retentions on the edges of the tray, and then apply the adhesive over them. Material is added to the edges of the tray, and the framework is fitted over the patient's teeth. It is worth mentioning that it is important to make sure that the framework is well fitted over the patient's teeth. During this process, the dentist must hold the framework with one of his hands and perform the previously reported functional movements with his other hand. In addition, for the lower arch, the patient is asked to move his tongue sideways, upwards and forwards while the dentist keeps the framework stabilized in position.

4) Final impression can be made with zinc oxide eugenol paste or a fluid elastomer (i.e., polyether, condensation silicone, polysulfide, or addition silicone). Remembering that to use an elastomer it is necessary to previously apply the adhesive on the inner surface of the tray. During this process, the dentist must hold the framework with one of his hands, and the previously reported functional movements must be performed. During border molding and final molding, the patient remains with his mouth open. In addition, the dentist must not apply pressure with his fingers on the acrylic tray.

5) The free end of the master plaster cast is cut and removed (e.g., Kennedy class II), the framework is fitted over this cast, and the plaster is poured over the mold. Subsequently, the altered master plaster cast is obtained.

Note: Functional impression of an edentulous area not located at the posterior free end of the arch is not advantageous using this technique. This is because in the laboratory, the technician would have to cut the plaster master cast into several pieces to remove the edentulous areas. This could later make it difficult to create the altered master cast. Furthermore, in the acrylization step using a muffle, parts of the altered master plaster cast could separate, resulting in failure of the prosthesis fabrication.

Closed mouth technique/open mouth technique

These techniques are indicated for molding the free end (Kennedy class II) or free ends of the arch (Kennedy class I). Immediately after the aesthetic and functional try-in of the wax-attached acrylic teeth, one of these techniques can be used. For these techniques, the provisional acrylic base (saddle) serves as an individual tray.

Closed mouth technique

Technique steps

1) For this technique, an occlusal adjustment of the acrylic teeth is required. For this, carbon paper is used to detect premature contacts of acrylic teeth. Subsequently, premature contacts must be worn down.

2) It is important to wear down the inside surface of the acrylic base to provide space (1 mm) for the impression material. An evidencing paste can be used to help with this process. Normally, it is common that the dental laboratory does not perform a previous relief of the internal part of the acrylic base or does not perform a sufficient relief for this clinical phase.

3) There are two possibilities for adjusting the edges of the acrylic base:

I) When border molding is not performed – After fitting the framework over the patient's teeth, the dentist must gently move the patient's cheeks to check the extent of the edges of the acrylic base. The edges of the acrylic base must not impede movements of the patient's cheeks; or the movements of the patient's cheeks must not displace the acrylic base from its position. This is also important when the patient moves his tongue. A distance from the edge of the acrylic base to the base of the vestibule (and to the floor of the mouth, based on the mandible) of 1 mm may be a satisfactory distance. Obviously, the edges of the acrylic base cannot impede functional movements, therefore, their wear in height can exceed 1 mm in certain areas when this happens (i.e., 1.5 or 2 mm). The posterior limit of the acrylic bases of the maxilla and mandible is the same previously reported for the altered cast technique.

II) When border molding is performed – It can only be done with a silicone putty, and this technique is performed with the patient's mouth open. A distance from the edge of the acrylic base to the base of the vestibule (and to the floor of the mouth, based on the mandible) of 2 mm is recommended. The posterior limit of the acrylic bases of the maxilla and mandible is the same previously reported for the altered cast technique. The technical procedures for border molding are similar to those previously reported for the altered cast technique.

4) Apply Vaseline to buccal and lingual/palatal surfaces of acrylic teeth. Vaseline is only necessary if the zinc oxide eugenol paste is to be used later. If a fluid elastomer is used, it is not necessary to apply Vaseline.

5) Final impression can be made with zinc oxide eugenol paste or a fluid elastomer. Remembering that to use an elastomer it is necessary to previously apply the adhesive on the inner surface of the acrylic base. Load the acrylic base with an impression material. Then, the metal framework must fit correctly over the patient's teeth. The patient with his mouth still open must move his tongue sideways, upwards, and forwards, while the dentist holds the metallic framework in position. Subsequently, the patient must gently occlude his teeth (note: the dentist must verify that the occlusion of the patient's teeth is correct), and the same functional movements previously reported must be performed by the dentist.

6) The free end of the master plaster cast is cut and removed, the framework is fitted over this cast, and the plaster is poured over the mold. Subsequently, the altered master plaster cast is obtained. However, there is another way to end the process without creating the altered master plaster cast. Thus, after this technique, the plaster can be poured directly onto the free end mold, without the framework

being fitted over the teeth of the master cast. Subsequently, this set is included in a muffle (without the master cast) to complete the fabrication of the removable partial denture. It is important to point out that before completing the manufacture of the prosthesis using the muffle, it is necessary to correct the waxing of the gingival region, as it is common for it to be damaged during the technique.

Open mouth technique

Technique steps

For this technique, a previous occlusal adjustment with carbon paper is not necessary. This technique will follow the same principles as the previous technique (closed mouth technique); however, the patient's mouth will always remain open during this technique. The border molding is also optional.

Immediately after performing the open mouth technique, before removing the impression from the patient's mouth, it is important that the patient correctly occlude his teeth to prove the success of the procedure.

Note: Border molding is optional for open mouth and closed mouth techniques. For these techniques, it is not recommended to use a low-fusing compound due to the need to heat it, which can melt the wax that holds the artificial teeth.

Based on all the techniques reported in this review, when border molding is performed, the width of the mold edges should be 2 to 2.5 mm. Furthermore, after making the final impression, the width of the edges should also be within the range of 2 to 2.5 mm.

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