Prosthodontic Rehabilitation of Atrophic Ridges: A Review

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Abstract

Prosthodontic rehabilitation of atrophic ridges is a critical aspect of modern dentistry, as a significant portion of the global population faces the challenges of the missing teeth or severe ridge resorption. Atrophic ridges present a complex clinical scenario, necessitating comprehensive treatment approaches to restore oral function, aesthetics, and the overall quality of life. This review article provides an overview of the current strategies and emerging trends in prosthodontic rehabilitation for atrophic ridges. It explores various treatment modalities, including removable prosthesis. Additionally, this article discusses future directions in research and technology that may shape the field of prosthodontic rehabilitation for atrophic ridges in the coming years.

Keywords: *Bone Resorption, Complete Dentures, Impression Techniques, Neutral zone, Residual Ridge, Removable prosthodontics*

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Introduction

The effectiveness of complete denture hinges on achieving three fundamental attributes: retention, stability, and support. Mandibular dentures often encounter greater challenges in attaining these attributes compared to maxillary dentures for several reasons.[1] Firstly, the mandibular ridge offers less residual ridge for both support and retention.[2] Secondly, the mandible experiences a faster rate of bone resorption compared to the maxilla. Research by Atwood and Tallgren suggests that mandibular bone resorption is four times more than that of maxilla.[3,4]

The reduction of resorbed ridge stands as a significant factor contributing to the loss of retention and stability, particularly in lower complete dentures.[5] Excessive resorption of both maxillary and mandibular ridges result in a sunken cheek appearance and leads to loss of stability and retention of dentures accompanied by patient discomfort. This presents that clinical hurdle in creating successful removable prosthetics.[6]

A classification system for edentulous jaws holds crucial importance, simplifying the depiction of residual ridges and thereby aiding communication among clinicians. Such a classification assists in selecting suitable surgical and prosthodontic techniques, establishes an objective baseline for comparing diverse treatment methods, and guides the decision-making process for preserving the alveolar process.[5]

A study conducted by Cawood and colleagues in 1988, they employed a randomized cross-sectional approach to investigate the morphological characteristics of edentulous jaws. Their research findings highlighted that the foundational basal bone undergoes minimal alterations, unless exposed to harmful local factors like the stress caused by ill-fitting dentures. Conversely, the alveolar ridge experiences significant changes in both its width and height, following an anticipated pattern.[1]

Based on these findings, Cawood and Hawell devised a classification system into six categories:

Class I: Dentate.
Class II: Immediately after extraction.
Class III: Well-rounded ridge with sufficient height and width.
Class IV: Knife-edge ridge with adequate height but insufficient width.
Class V: Flat ridge with inadequate height and width.
Class VI: Depressed ridge with noticeable basilar loss.

Treatment Modalities:

- Removable Prosthodontics:
  1) Conventional complete dentures
  2) Implant supported overdentures
- Fixed Prosthodontics:
  1) Implant retained fixed prosthesis

Conventional Complete Dentures

As the residual ridges undergo resorption, oral tissues lose their support and become prone to displacement. This necessitates modifications to conventional impression techniques, as using them would result in distorted impressions.[6] Several modified impression techniques have been proposed by various authors:

a. Flange technique by Lott and Levin (1966)
b. Dynamic Technique by Gerd Tried (1965)
c. Modified fluid wax technique (2009)
d. "Cocktail impression" by Praveen G et al (2011)
e. Two-step technique (using monophase and light body) (2012)
f. Wire impression technique by Tanvir H et al (2017)
g. Admixed impression technique
h. All green technique
i. The neutral zone technique

Flange technique by Lott and Levin (1966): This approach involves creating molds of the soft tissues surrounding the buccal, labial, lingual, and palatal areas of dentures. Following that, these impressions are incorporated into the denture fabrication process through the addition of extensions. These additions, commonly known as flanges or personalized flange modifications, are designed to match the unique structure and function of individual areas within the mouth.[7]

To initiate this procedure, begin by creating a wax flange that extends from the retromolar pad region to the sublingual area. The size of these extensions should be sufficient to compensate for anticipated resorption. Following that, guide the patient to engage in different activities such as swallowing and speaking with a degree of force. This will help create border extensions that cover a maximum surface area within the oral cavity.[7]

The primary objective of this modification is to augment the extent of close contact between the denture and the surrounding oral structures. By achieving this, the stability, functionality, comfort, and the overall appearance of complete dentures can be significantly enhanced when compared to alternative techniques.[7]

Dynamic Technique by Gerd Tried (1965): First, a custom-fabricated special tray is prepared. Subsequently, a self-curing resin is applied on the premolar-molar areas of this tray. While the thermoplastic material remains moldable, tray is placed in

patient's mouth, covering lower ridge. Then patient is directed to gently close their jaws. Throughout this procedure, the soft thermoplastic material molds an impression of the upper residual ridge, identifying the mandible's resting position. Following this, the tray is taken out of the mouth and left to cool.[8]

An appropriate amount of irreversible hydrocolloid is mixed with an additional 50% of water and is placed directly in the patient's mouth, covering all oral tissues. The tray is then firmly pressed onto the residual ridge using manual pressure until it securely aligns with the tray's stops. Subsequently, instruct the patient to gradually close their mouth, ensuring that the mandibular rests firmly engage with the maxillary region. In this stage, the patient is prompted to swallow 3-4 times with 10-seconds intervals, all while the final impression material is still pliable.[8]

Mandibular rests are vital for preventing mandible from reaching the vertical occlusion position and maintaining in its natural resting state. This method leads to the formation of a denture space registration, typically ensuring the accurate extension of the lingual flanges for the final denture.

When natural or artificial opposing teeth are in place, it's possible to utilize an existing denture for the impression process. Need to adjust the vertical dimension at occlusion, stops are strategically positioned to restore the correct height. Mandibular rests are then added to accommodate inter-occlusal distance. The impression material is placed into mouth, and impression is made. A meticulous examination of the edges is performed to detect any potential perforations resulting from the denture flanges.[8]

In a third method, the denture is initially processed using conventional techniques. Subsequently, a dynamic impression is taken using the dentures to refine the designs, followed by denture relining. It's crucial to highlight that during this procedure, "stops" are excluded from the denture base, as the vertical dimension of occlusion in the initial denture is assumed to be precise.[8]

Modified fluid wax technique by Tan *et al* (2009): To initiate this process, preliminary impression is made with alginate impression material with perforated metal stock tray. Subsequently, obtain a preliminary cast based on these impressions. A fabrication of custom trays on this preliminary cast.[9] This tray is then meticulously border molded in sections, with green stick compound. Once the border molding is completed, spacer wax is removed with scalpel blade.[9,10]

Following this step, the tray is trimmed, and space is generated over the mobile soft tissue on the ridge using a No. 8 round bur. In this phase, the impression wax is melted at oral temperature within a container immersed in a water bath kept at 42°C. Once the wax has liquefied, it is spread along the edges of the tray using a wax spatula.[11]

To record the remaining contours of the residual ridge, application of impression wax to the inner surface of the tray. At same time, administer adhesive along the area surrounding the window and ensure it dries completely before proceeding to the next step.[12]

“Cocktail impression” by Praveen G et al (2011): To initiate the procedure, start by creating an extended preliminary impression using alginate. If the patient has existing dentures, incorporate them to optimize basal seat support. Following this, custom tray is fabricated using auto-polymerizing acrylic resin, including a 1mm spacer wax. In the posterior mandibular region and construct cylindrical rests at an elevated vertical height. Then

soften high-fusing impression compound, placed on the mandibular rests and insert it in the patient's mouth.[13]

Subsequently, Ask the patient to close his mouth, ensuring that the mandibular rests make contact with the maxillary alveolar ridge. This crucial action stabilizes the tray and prevents both front-to-back and side-to-side movement during the final impression.[14]

To prepare the impression material, impression compound and green stick compound in a 3:7 weight ratio and place it in a water-filled bowl at 60°C. These materials thoroughly kneaded until it forms a uniform mass, providing approximately 90 seconds of working time. Following this, we remove the spacer wax, and the patient is guided to close mouth on the mandibular rests, capturing the functional state.[15]

After removing the impression from the mouth, cool it and reinsert it to assess pressure sensitivity within the denture bearing area by apply firm finger pressure to simulate functional loads. To ensure correct loading of the mucosa, the operator places their thumbs on the underside of the patient's mandible and applies pressure. If the mucosa has been adequately loaded, patient should only report discomfort where the thumbs press on the lower border of the mandible.[16]

Two-step technique (using monophase and light body) (2012): Making preliminary impressions using impression compound. After this, fabricate a mandibular custom tray with a 3 mm spacer and handles positioned in the region of the second premolars. The tray should be trimmed so that it remains 1 mm short of the vestibular reflections all around. Once the tray has been tried in the patient's mouth, create relief holes using a No. 10 round bur and coat the inner surface with tray adhesive[17].

Next, measure and mix equal proportions of base paste and accelerator paste on a glass slab until a uniform, monophase consistency is achieved. Load this mixture into the tray to record the denture-bearing area and adjacent soft tissues in a single step. Then, prepare another mix of equal parts base paste and accelerator paste in a light-body consistency. Fill the tray with this lighter material, seat it in the patient's mouth, and stabilize it using the stub handles. Repeat the border molding procedure while incorporating tongue movement to refine the extensions[17].

Once the material has set, remove the tray and carefully check that all required anatomical landmarks have been captured. Finally, clean and disinfect the completed impression[17].

Wire impression technique by Tanvir H et al (2017): To address the challenge of a highly resorbed mandibular ridge, a specialized impression technique was employed, utilizing an orthodontic wires and elastomeric impression materials to enhance retention and stability. Specifically, 19-gauge SS wire was carefully adapted over the mandibular ridge and fabrication of custom tray on primary cast.[18]

The initial impression was performed using a polyvinyl siloxane material with a putty-like consistency. Subsequently, a final impression was taken using a light-bodied addition silicone elastomeric impression material, and the master cast was produced by pouring die stone into the final impressions.

Admixed technique by Mccord and Tyson: The underlying philosophy here is to utilize a uniform thick mixture of impression compound and tracing compound to effectively eliminate any soft tissue folds and create a smoother surface over the mandibular bone. This approach aims to minimize potential discomfort

caused by what's referred to as 'atrophic sandwich'. The presence of creased mucosa trapped between the denture base and the mandibular bone.[19]

Take impression compound and green stick compound in a ratio of 3:7 parts by weight. These materials are then immersed in water at 60°C and thoroughly kneaded until they form a uniform mass, working time of approximately 90 seconds. After removing the spacer wax from the tray, load this uniform mass onto it, and then guide the patient to perform various tongue movements to record the precise borders. Finally, the definitive impression is achieved using a light-bodied polyvinyl siloxane material.[19,20]

All green technique: In this particular method, we create the secondary mandibular impression employing green stick compound. Carefully knead the green stick compound into a uniform mass and load it onto the specialized tray, incorporating border movements as necessary. Then, final impression is made using zinc oxide eugenol impression material.[19]

The Neutral zone technique: Initial impressions are created using impression compound. A maxillary wax rim is prepared along with a mandibular special tray. This special tray features upward projections, often called spurs or fins, designed to enhance the retention of the impression compound with the tray.[21]

Maxillary wax rim is modified according to the usual process for registering complete denture. Subsequently, the mandibular custom tray is placed in the patient's mouth. The fabrication of two occlusal pillars from self-cured acrylic on opposite sides of the mandibular arch. Pillars are adjusted to attain the correct occlusal height and establishing a customary 3mm freeway space.[22]

Around the remaining portion of the mandibular custom tray, particularly on the distal and mesial sides of the occlusal pillars, a thick mix is applied. The patient is instructed to swallow and then purse their lips, allowing for the correct molding lingual surface of the impression. Following a curing duration of 5-10 minutes, the impression is taken out of the mouth and meticulously inspected.[23]

Patient's musculature naturally shapes the thick material into a state of equilibrium. Afterwards indices are subsequently made using dental plaster or putty, and wax rim is fabricated in this space. Teeth arrangement is carried out accordingly. This approach enhances comfort, stability and retention of the denture, ensuring that it doesn't impede the functions of the lips, cheeks and tongue.[24]

These modified techniques offer the benefit of precisely capturing both the preliminary and secondary stress bearing areas while avoiding resorption of the residual ridge. One of the key advantages of these modified impression techniques is their effective controllability to attain comprehensive coverage.[25,26] These methods prove valuable in accurately assessing the extent of mucobuccal reflections and directing pressure toward the load-bearing regions, specifically targeting the buccal shelf and the slopes of the residual ridges in the mandible.[27,28]

In cases of atrophic ridges, selecting the appropriate denture teeth is crucial to ensure stability and comfort for the denture wearer. Various factors should be considered:

Neutrocentric Occlusion: In cases where posterior teeth need to be placed centrally without compromising tongue space, it's essential to follow specific guidelines. Mathematical formulas involving inter-canine width may be used to arrange maxillary posteriors. For aged patient,

mandibular posterior teeth can be placed over the buccal shelf area to provide more tongue space. [29]

Zero-Degree Teeth: Using zero-degree teeth with a monoplane articulation can enhance denture stability by minimizing cusp forms that might lead to interlocking and instability. [30]

Understanding Occlusal Guidance: Regardless of the chosen occlusal scheme, it's vital to consider that influence of condylar and anterior guidance to develop a stable denture occlusion.[31]

Weighted Dentures: Adding weight to mandibular dentures may not necessarily improve retention and stability. In fact, excessive weight could contribute to ridge resorption due to constant pressure on the residual alveolar ridge, especially at rest.[32]

Hollow Denture Technique: In excessive ridge resorption and adequate inter occlusal distance, a modified technique involving a hollow denture can help maintain the Vertical Dimension at Occlusion (VDO). Special orientation locks can ensure accurate seating of two parts of split denture, minimizing unwanted rotational forces and occlusal discrepancies.[33]

Soft Liners: The use of soft-liner has become popular due to numerous clinical advantages. Soft liners can facilitate healing of inflamed mucosa, effectively distribute functional loads, and enhance overall fit and retention of dentures. Cushioning effect provided minimizes the force transmitted to the underlying bone during various functions. Consequently, this leads to decrease in the rate of residual ridge resorption.[34,35]

Emerging Trends in Atrophic Ridge Rehabilitation: Atrophic ridges, characterized by bone loss and soft tissue deficiencies, pose significant challenges in dentistry. Emerging trends in their management hold the promise of improving treatment outcomes, patient satisfaction, and the overall quality of care.[36]

Digital Workflow: Digital dentistry, encompassing intraoral scanning, computer aided design (CAD) and computer aided manufacturing (CAM) has streamlined diagnosis and treatment planning process. Clinicians can visualize and simulate treatment outcomes more effectively, leading to improved decision-making and patient communication.[37]

Artificial Intelligence (AI): AI-driven software is being developed to assist clinicians in treatment planning, risk assessment, and outcome prediction. These tools analyze patient data, radiographs, and 3D scans to provide evidence-based recommendations, improving treatment accuracy and efficiency.[38]

Conclusion

Atrophic ridges pose unique challenges for traditional impression techniques due to the lack of tissue support and distortion. The modified impression techniques listed above represent various approaches to address these challenges and improve the accuracy in cases of resorbed ridges. Choice of technique depend on specific clinical situation, patient's anatomy, and preferences and expertise of dental professional. Keeping up to date with latest developments in impression techniques is crucial for providing optimal care for patients with atrophic ridges.

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