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UTILIZING NEUTRAL ZONE TECHNIQUE IN DENTURE FABRICATION FOR A PATIENT WITH SEVERE MANDIBULAR RIDGE RESORPTION - A CASE REPORT.

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Abstract

Residual ridge resorption remains a significant concern in the field of prosthodontics and implant dentistry, posing challenges in the successful rehabilitation of edentulous patients. Residual ridge resorption is a common phenomenon following a tooth extraction, leading to significant changes in the alveolar ridge's shape and volume. This review article aims to provide a comprehensive overview of the various treatment modalities available for managing residual ridge resorption. The case report presents a novel treatment modality for managing residual ridge resorption and its successful application in a clinical case.

Keywords: Complete denture, Residual ridge resorption, all green technique, neutral zone, Management of residual ridge resorption, Denture stability

Introduction

Bone, a living and mineralized tissue, experiences a perpetual cycle of resorption and regeneration throughout one's lifetime. The structural and functional uniqueness of the bones in the maxillofacial complex, including the jaw bones and temporomandibular joints, stems from their exposure to ongoing stresses during activities like mastication. This process is known as bone remodeling, which safeguards skeletal structural integrity while contributing metabolically to calcium and phosphorus balance. Old or damaged bone is resorbed, making way for the deposition of new bone material in a continual process. Forces duration, magnitude, and application rate determine how bone integrity changes. [1] The residual ridge pertains to the segment of the alveolar ridge and its overlaying soft tissue that persists subsequent to tooth extraction or loss [2]. In 1971, Atwood characterized residual ridge resorption as a significant oral pathological condition [3]. The term "Residual Ridge Resorption" denotes the progressive reduction in size and configuration of the residual ridge subsequent to tooth extraction. The success of complete dentures hinges on fulfilling three fundamental properties: retention, stability, and support. Mandibular dentures face greater chal-

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lenges in achieving these due to the mandible ridge's reduced residual ridge for retention and support, coupled with a faster resorption rate compared to the maxilla. Research conducted by Atwood and Tallgren suggests that mandibular bone resorption is four times greater than that observed in the maxilla. Initial rapid reduction in residual ridge size occurs within the first six months, followed by ongoing slower bone resorption, resulting in substantial jaw structure loss. This reduction significantly contributes to instability and reduced retention, particularly in mandibular complete dentures[1] The inflammatory response is promptly initiated following tooth extraction, leading to the temporary sealing of the extraction socket by a blood clot. The structural alterations due to resorption-related changes can be observed starting in the initial week, concurrent with the proliferation of epithelial tissue. The residual alveolar ridge bone, even post-wound healing, undergoes continual catabolic remodeling throughout life. This constitutes a distinctive aspect of extraction wound healing. Notably, residual ridge resorption is most pronounced within the initial 3 to 6 months post-extraction, subsequently diminishing gradually. Clinical observation readily captures instances of residual ridge resorption subsequent to tooth extraction, though the precise sequence of underlying biological events remains incompletely comprehended.[4]

Effect on Maxillary and Mandibular Bone

In the maxilla, the natural orientation of the teeth generally points downward and outward. Consequently, bone reduction tends to occur in an upward and inward direction. This resorption process results in a reduction in the overall size of the maxilla, impacting the denture-bearing area or basal seat. The primary areas of bone resorption in the maxilla are the occlusal, buccal, and labial surfaces. As a consequence, the maxilla loses height, and the arch narrows from side to side and becomes shorter from front to back. On the contrary, in the mandible, the anterior teeth tend to tilt upward and forward toward the occlusal plane, whereas the posterior teeth are mostly vertical or have a slight lingual inclination. Mandibular ridge resorption mainly takes place from the occlusal surface. This resorption pattern tends to make the mandibular arch appear wider, in contrast to the maxillary arch, which becomes narrower. Residual ridge resorption (RRR) manifests as a centripetal process in the maxilla, where bone reduction occurs towards the center, leading to a decrease in arch dimensions. In contrast, RRR exhibits a centrifugal pattern in the mandible, where resorption primarily affects the outer areas of the ridge, resulting in a perceived widening of the arch.[5]

Management

Preventive approach- In recognition of M.M. Devan's work, it is essential to implement all required steps to enhance the outlook for the remaining natural teeth. Additionally, it is advisable to replace any missing teeth promptly as they are lost. There are several rehabilitation options available for individuals with partially edentulous conditions, including removable partial dentures (RPDs), complete partial dentures (CPDs), dental implants, tooth-supported overdentures, and precision attachments.[6] People with bone diseases should follow a diet that is high in proteins, vitamins, and minerals while reducing or eliminating their intake of refined carbohydrates, white flour, and white sugar. In crafting dietary recommendations, it's important to consider the patient's ability to chew and digest the prescribed foods.[1]

Conventional approach -The conventional approach to rehabilitating resorbed residual ridge includes the use of complete dentures, which can be employed with or without prior surgical intervention. Various impression techniques can be employed to record the resorbed ridge.[7]

McCord and Tyson's admixed technique[8] -A mixture of impression compound and green stick

compound, with a ratio of 3 parts impression compound to 7 parts green stick compound by weight, is immersed in a bowl of water heated to 60°C. It is then kneaded together until it forms a uniform mass that offers a working time of approximately 90 seconds. After removing the wax spacer from the custom tray, this homogeneous mass is loaded, and the patient is instructed to perform various tongue movements.

All-green technique[9] -The green stick compound is thoroughly kneaded until it achieves a uniform consistency. Subsequently, it is applied to the special tray and border movements are executed. Finally, the ultimate impression is made using zinc oxide eugenol.

Cocktail impression technique[10] - In this approach, a custom tray is meticulously created using self-polymerizing acrylic resin, following the Dynamic Impression Technique. This tray is designed with a 1 mm wax spacer and cylindrical mandibular rests positioned in the posterior region, raised to an increased vertical height. The patient is instructed to close their mouth so that these mandibular rest snugly fit against the maxillary alveolar ridge. This fitting helps stabilize the tray, preventing any unwanted forward-backward or side-to-side movement during the definitive impression-taking process The lingual surfaces of these mandibular rests are deliberately crafted to be concave, providing ample space for the tongue to move freely during functional activities. For the definitive impression, the McCord and Tyson technique designed for flat mandibular ridges is employed. To record the functional state accurately, the patient is guided to perform specific actions such as running their tongue along their lips, sucking in their cheeks, pulling in their lips, and swallowing while keeping their mouth closed—similar to the closed-mouth impression technique—until the impression material solidifies.

Winkler Closed mouth functional impression technique[11] - denture bases with occlusal rims are crafted on the primary cast. Jaw relation is established to accurately capture the appropriate horizontal and vertical dimensions. To enhance tissue compatibility, a conditioning material is applied to the tissue surface of the mandibular denture base. The patient is then instructed to close their mouth at the previously recorded vertical dimension and perform various functional movements, including puffing, blowing, whistling, and smiling. This process involves applying the tissue conditioner material three times, with intervals of 8–10 minutes between applications, during which the patient continues to make functional movements. Finally, the definitive impression is taken using light body addition silicone material, employing a closed-mouth technique.

In 1931, Fish was the first to outline the impact of polished surfaces on denture retention and stability. He also introduced the concept of the "neutral zone," which is an area where forces in the mouth are balanced for optimal denture fit and function.[12] The neutral zone is defined as the potential space situated between the lips and cheeks on one side and the tongue on the other. It represents an area or position within the oral cavity where the forces exerted by the tongue and the cheeks or lips are in equilibrium. Two clinical studies have highlighted the advantages of employing the neutral zone technique. In one set of cinefluorographic studies[13] conducted by Sheppard, it was demonstrated that the muscles within the oral cavity help stabilize complete dentures during functional use. In another clinical study led by Fahmy and Kharat[14], patients' chewing efficiency and satisfaction with complete dentures made using either conventional or neutral zone techniques were evaluated. The findings indicated that patients experienced better chewing efficiency with conventional dentures. However, patients did not perceive any significant difference in masticatory performance between conventionally fabricated dentures and those created using the neutral zone technique.

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Notably, patients reported greater comfort and improved speech clarity with dentures crafted using the neutral zone approach compared to their conventionally prepared dentures. These studies suggest that the neutral zone strategy for denture fabrication may offer benefits in specific edentulous situations.

Teeth arrangement - Control of horizontal forces can be achieved through adjustments in buccolingual cusp height, taking into account the shape of the residual ridge and the available inter-arch space. Functional balance is attained by positioning teeth favourably relative to the ridge crest. This approach ensures efficient cutting and shearing during mastication and allows for anterior tooth clearance to prevent interference. The goal is to minimize occlusal stop areas, thereby reducing pressure during functional activities. To establish coordination between the primary and secondary masticatory organs, it is advisable to position teeth within the neutral zone. Interestingly, non-anatomic teeth have been associated with fewer denture sore spots and less ridge resorption. Semi-anatomic reverse curve posterior teeth are beneficial for the lower ridge, while anatomic posterior teeth tend to lead to increased denture soreness and ridge resorption. Some studies suggest that anatomic posterior occlusion is preferable for lower dentures, whereas non-anatomic posterior teeth are better suited for upper dentures.[1]

Surgical intervention-encompasses a range of preprosthetic procedures, including ridge augmentation, vestibuloplasty, distraction osteogenesis, shelf reconstruction, secondary epithelialization, and grafting techniques. While these surgical methods can enhance denture prognosis, it's important to note that they may not be feasible in all cases. Factors like underlying systemic health conditions or inadequate quality and quantity of available tissue may limit the suitability of these procedures

Implant-Supported Prosthesis[1]: Advantages Offered by Implant-Supported Prostheses: i) Preservation of Alveolar Bone: Implant-supported prostheses contribute to the maintenance of alveolar bone structure. ii) Preservation of Occlusal Vertical Dimension: These prostheses help retain the correct occlusal vertical dimension. iii) Sustained Alveolar Bone Height: The height of the alveolar bone remains stable as long as the implants remain in a healthy condition. iv) Enhanced Psychological Well-Being: Patients often experience improved psychological health and confidence with implant-supported prostheses. v) Restored Proprioception and Improved Bone Quality: Implants can restore proprioception and lead to increased trabeculation and bone density. vi) Enhanced Stability, Retention, and Speech: Implant-supported prostheses offer superior stability, retention, and phonetic performance. vii) Maintenance of Muscle Structure and Function: These prostheses help in maintaining the structure and function of muscles involved in mastication and facial expression. The effectiveness of prostheses supported by dental implants hinges on the expertise and proficiency of the implant specialist. It is closely linked to several factors, including patient selection, choice of implant, surgical approach, postoperative care, and the patient's satisfaction with the treatment.

Case Report

A 68-year-old female patient visited the Department of Prosthodontics at the Faculty of Dental Sciences, SGT University in Haryana, India. She had been edentulous for 8 years and complained of loose mandibular dentures, which had been causing discomfort and difficulty while eating and speaking. She reported that this issue had been progressively worsening over the past few months. Upon intraoral examination, it was observed that the mandibular residual ridge had undergone significant resorption, while the maxillary ridge had moderately resorbed (Fig 1). The patient presented with compromised oral function and aesthetic concerns due to significant

alveolar bone loss. medical history revealed no significant systemic illnesses. Assessment of oral hygiene was within acceptable limits and there were no signs of oral lesions or pathologies. Considering the patient's age and financial constraints, the patient was recommended to undergo the fabrication of complete dentures using the all-green technique and the neutral zone technique.

Procedure - Primary Impression -A preliminary impressions were made of the maxillary and the mandibular arches using an impression compound in a metal stock tray. The impressions were thoroughly cleaned and subsequently poured with impression plaster. Following this, casts of maxilla and mandible were obtained, onto which spacer wax was meticulously applied and shaped.

Custom tray fabrication: A custom impression tray was constructed using self-cure acrylic resin (DPI-RR cold cure acrylic repair material) on the primary cast. The tray's border extension was maintained at a distance of 2 mm from the vestibules.

Final impressions: For the maxillary arch, border moulding was carried out using green stick i.e. low-fusing impression compound. This process aimed to replicate muscle activity, and record the functional depth and width of the sulcus. Subsequently, the final impression was obtained using a zinc oxide eugenol paste. (Fig 2). Due to significant resorption of the mandibular alveolar ridge and a notably shallow sulcus depth, a secondary impression of the mandible was obtained using the "all green" technique. This involved kneading the green stick compound into a uniform consistency, which was then loaded onto the specialized tray, and the border movements were performed. Subsequently, the final impression was made using zinc oxide eugenol impression material (Fig 3).

Fabrication of base plate and wax occlusal rims- The master cast was poured in dental stone and the record base was constructed with self-cure acrylic resin. The wax rims were fabricated and evaluated in terms of comfort, extension, and stability

Jaw relation: Traditional methods were employed to establish the jaw relation for capturing vertical and centric relationships, after which the dental cast was mounted on the mean value articulator. Subsequently, an additional pair of record rims was constructed using new denture bases replicated from the master cast. These rims were made from impression compound material. While keeping the maxillary rim in its vertical position, the mandibular rim was adjusted to the same vertical height. Before recording the neutral zone, the patient assumed a relaxed, upright posture without any head support. Following this, the mandibular compound rim was inserted into the patient's mouth. A sequence of activities mimicking physiological functions was then guided, including smiling, grinning, pouting/pursing of lips, numerical counting, verbal expression, pronouncing vowels, fluid intake,

Fig 1

Fig-2

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PROSTHETIC AND IMPLANT DENTISTRY
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Kerala State Branch

swallowing, gentle tongue protrusion, and lip touching. This sequence was repeated over a duration of 10 minutes until the compound became hard. Both compound rims were replaced on the articulator to reassess the vertical relationship. A putty index was created surrounding the molded impression compound rim (as shown in Fig 4a). After removing the molded impression compound rims from the base plate, the index was placed in position. This index preserved the dimensions of the neutral zone space. Then, molten wax was carefully introduced into this space, yielding a precise replica of the neutral zone. The recently shaped wax rims were subsequently repositioned onto the articulator (Fig 4b). Accurate teeth arrangement was carried out in direct accordance with the provided indices (Fig 5). Throughout the teeth setup process, the indices were employed to verify their placement by aligning them around the wax try-in.

Try-in and insertion- Wax try-in of the denture was done. Then the dentures were processed, finished, and polished in the conventional manner, and insertion was done (Fig 6).

Discussion

The challenges associated with residual ridge resorption are numerous, with one of the most significant issues being the difficulty in retaining dentures. While osseointegrated dental implants have become the preferred option for complete rehabilitation, they also come with drawbacks such as high costs and surgical risks, especially when dealing with resorbed ridges that may require regenerative techniques. Additionally, medical and social factors, along with cost considerations, may make autogenous bone transplantation impractical for some patients. As a result, conventional dentures continue to be a viable solution for many aging individuals. The

Fig-3

Fig- 4a Fig. 4b

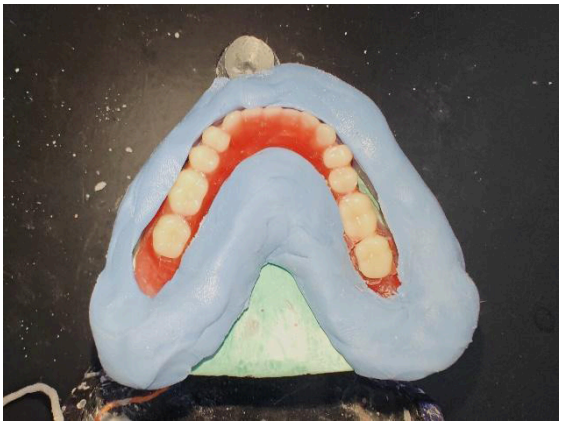

Fig-5

Fig-6

key to achieving proper denture retention, stability, and support lies in the impression of the completely edentulous arch. Various modifications to impression techniques have been attempted in the past to enhance these aspects. [15] The focus of this technique is on the primary impression, spacer design, secondary impression, and the choice of impression materials. Custom trays are employed to create ample room for the impression material, allowing for the capture of both the functional form of the primary stress-bearing region and the anatomical shape of the area that is not designed to endure functional loads. Greenstick compound is employed for border molding, a viscous material that molds tissues without compression. During the final impression, zinc oxide eugenol paste is used to accurately record the ridge with minimal pressure, capturing minute details of the residual ridge in its passive state. In the context of jaw relation, the neutral zone approach is employed to identify the neutral zone's location, which helps determine the correct placement of teeth following ridge resorption. Many experts advocate for positioning the maxillary anterior teeth in proximity to the natural anterior teeth's original location. Failure to do so could potentially lead to compromises in esthetics and speech for the patient. Moreover, the positioning of the maxillary teeth must align with the patient's preferences. The neutral zone registration may indicate the need to reposition the mandibular anterior teeth slightly towards the lingual side. This adjustment can usually be performed without adversely affecting the denture's aesthetic appeal. When the patient naturally molds their maxillary and mandibular ridges into the neutral zone during functional activities, the outcome is a denture that provides enhanced stability. [16]

Conclusion

The presented procedure outlines a straightforward, efficient, and dependable method for capturing impressions of a resorbed mandibular ridge. This technique involves the utilization of a custom tray, green stick compound, and zinc oxide eugenol impression material. Specifically, it focuses on imprinting the ridge's crest in its anatomical form and accurately records the primary stress-bearing area in its functional state, promoting the long-term health of the surrounding tissues. This fusion of methods results in prostheses with superior retention and stability. By employing a viscous material within a closely fitting tray, this technique allows for the physiological compression of tissues in the primary stress-bearing areas, ensuring optimal adaptation and support. This technique offers an effective solution for clinicians dealing with patients who have experienced mandibular ridge resorption. Its simplicity, speed, and focus on maintaining tissue health make it a promising addition to the range of methods available for obtaining accurate impressions and ultimately contributing to the success of prosthodontic treatments. The neutral zone technique is considered one of the most effective alternative approaches for dealing with severely atrophied mandibular residual ridges.[17] However, it is infrequently employed due to the additional clinical steps it entails and its inherent complexity. Failures in both complete and partial dentures can often be attributed to not taking into account the considerations associated with the neutral zone.[18] Consequently, it is crucial to assess the neutral zone as a critical factor before making any alterations to the arch form or the alignment of teeth.

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