Prosthodontic Management of Ridge Resorption: An Updated Review

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Abstract

Each patient has unique treatment requirements considering that the residual ridge resorption has multifactorial etiology. Management of alveolar bone resorption is considered a challenge in prosthodontic treatment. Numerous methods, techniques and materials are used to reduce the residual ridge resorption.

This review aims to analyze the available evidence of the effect of different denture treatments used to reduce the residual ridge resorption and the factors that may affect the residual ridge resorption. An extensive electronic literature search through PubMed/MEDLINE database by utilizing MeSH keywords was performed to find studies focusing on the effect of prosthodontic treatment and the factors that affect residual ridge resorption. A total of 907 English language tittles were obtained through electronic search, and seven (7) articles were extracted.

This review concluded that proper diagnosis and treatment plan are an important aspect of prosthodontic rehabilitation of edentulous patients. Different methods, techniques and base materials used in prosthodontic management have different reductive ability in residual ridge resorption.

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Introduction

The presence of teeth stimulates and maintains the form and density of bone through the periodontal ligaments prompting the bone to continually remodel and rebuild. The loss of teeth leads to alveolar bone resorption. The loss of permanent teeth and bone has some serious consequences, particularly for older people, causing psychosocial problems and affecting facial aesthetics, phonetics, and functional occlusion.[1]

Complete dentures continue to play a central role in rehabilitation of completely edentulous patients by improving individual's masticatory ability, solving psychosocial problems, and enhancing oral health.[2,3]

Regardless of advances in modern dentistry, use of dentures is necessary in some health and socio-economic cases. There is always indication for complete dentures in edentulous patients. Complete dentures continue to be a major solution even in cases when implants are contraindicated because of unfavorable oral situations (insufficient bone quantity and quality), poor general health, medication taken, systemic diseases and economics factors. A major objective for construction of complete dentures is obtaining a denture base that conforms the supporting tissues to a high degree of accuracy. The success of complete dentures relies on fulfilment of the three basic properties: retention, stability and support. Therefore, various researches focus and search for materials to improve retention, mechanical properties and biocompatibility.[4]

Alveolar ridge resorption is one of the main factors that impact rehabilitation of complete denture wearers. This is a continuous process after tooth extraction, and it is more pronounced in the first few months after extraction than later.[5,6] Residual ridge resorption is a chronic, progressive, irreversible process, particularly for individuals with edentulous mandible and varies from one individual to

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another, at different phases of life and even in different parts of the jaw in the same person.

Considering its complex nature, the bone resorption poses a clinical challenge in finding methods and treatment for management and prevention of alveolar ridge resorption of edentulous patients.

Certain general principles must be kept in mind during fabrication of complete dentures which will help to reduce the stress transmission and to preserve the alveolar ridge. This may be achieved by having a broad area of coverage under the denture base, due to reducing the force per unit area.[7,8] The use of soft liner, different impression techniques, decrease in the number of denture teeth are some of the other methods and material used in the prosthodontic treatment of edentulous patients to preserve the alveolar ridge. There is little information available about the average rate of residual ridge resorption for different denture treatments. Therefore, this review paper aims to collect and analyze the available evidence of the effect of different denture treatments used to reduce the residual ridge resorption and the factors that may affect the residual ridge resorption.

Materials and methods

An extensive electronic literature search was done through PubMed/MEDLINE database for identifying relevant articles in English using MeSH keywords such as “jaw”, “edentulous” “mandible”, “complete denture”, “implant-supported denture”, “ridge resorption”, “denture base material”, “denture impression”, “denture treatment” from February 2000 to January 2021. The reference list of identified articles was then assessed to identify additional relevant articles. The inclusion criteria for selection were clinical studies, case reports, original papers and review articles about the effect of prosthodontic treatment and the factors that affect residual ridge resorption. Non-English articles and those that failed to meet the inclusion criteria were excluded. Two reviewers independently selected titles based on the inclusion criteria. Search strategy included reviewing titles and abstracts of all records received, followed by selection of the articles in the relevant field and further delving into full article analysis. Extracted data were examined in a standardized unblinded procedure. Disagreements, if present, were resolved by consensus.

Results

The electronic search identified a total of 907 studies in the English language. An initial evaluation of these articles removed duplicates and articles not relevant to the scope of this review paper. Following title and abstract screening, a total of 21 articles identified, encompassed full text analysis, out of which seven were finally included in this review. Table 1 shows the studies that used different prosthodontic treatments to reduce the residual ridge resorption.

- **The use of soft denture liner**

The use of soft liner distributes and absorbs loads by a cushioning effect and as a result, decreases the stress on denture supporting structures, therefore this leads to a reduction in residual ridge resorption.[6,9] Clinical efficacy of soft liners on minimizing alveolar ridge resorption has been reported in three studies.[6,10,11] However, in one study, results showed insignificant role of soft liner in the rate of residual ridge resorption.[12]

- **Complete denture impression techniques**

Evaluating the effect of complete dentures fabricated by different impression techniques on mandibular residual ridge resorption, the results showed significantly less reduction in mandibular ridge using the mucostatic impression technique versus selective pressure impression.[13]

- **Complete denture and overdenture treatments**

The results showed insignificant difference in the treatment effect between complete denture and overdenture treatments.[14,15] The patients, rehabilitated with mandibular overdentures are not subjected to more residual ridge resorption when compared to patients wearing complete dentures.

- **Association of the mandibular ridge reduction with denture wearing habit**

Considering residual ridge resorption, there have been no statistically significant difference between daytime and daytime plus night time of wearing dentures.[5,16]

- **Artificial tooth material**

The results of one study showed insignificant role of artificial tooth material in the rate of residual

ridge resorption.[8]

Discussion

The literature search conducted for this review identified a small number of articles related specifically to the prosthodontic treatment on reduction of ridge resorption. However, a good knowledge of various factors that may be responsible for the resorption of the residual ridge, evaluation of the base material and a method which decreases the rate of alveolar ridge resorption is essential for successful prosthodontic treatment of edentulous patients.

Numerous authors have studied the factors that affect the resorption of the jaw bone. In their 5-year study, Kovacic et al.[5] found that the ridge was higher in frontal points of measurement of both jaws and decreased gradually towards the lateral regions. Similar results are found also in other research studies.[16,17] Considering the residual ridge resorption is usually more rapid in the premolar and molar region than the anterior region of the mandible, it is important to analyze the height and width of bone in those regions because of the lower position of the reversal line in the posterior region.[18]

Tallgren[17] stated that the resorption in mandible was about four times greater than in maxilla and the highest level of resorption is in the first year of denture wearing in both jaws.

According to some studies, the rate of residual ridge resorption is higher among women than men, particularly in postmenopausal older women, due to inadequate formation of new bone tissue that occurs because of estrogens deficiency.[19,20,21]

Resorption of the alveolar ridge has been estimated with various radiographic techniques, such as lateral cephalometric radiographs and panoramic radiographs.[22,23] Different rate of resorption in different parts of the jaw leads to loss of retention and stability of prosthesis. One of the most important local factors is a poor fit of the prosthesis that enables the action of harmful occlusion forces, which are considered to be the major factor in bone resorption.[24]

There are experimental studies in literature that show a higher percentage of bone resorption in cases of poor fit of dentures and when patients have worn the prosthesis during the day and night.[16,25,26]

In terms of wearing dentures during the day and night, there are contradictions by different authors, who found that daytime and daytime plus night-time wearing denture had no impact in the rate of residual ridge resorption.[5,16] The loss of permanent teeth causes the loss of periodontal receptors, which can cause overloading of denture bearing tissue during chewing and can result in bone resorption and changes in retention and stability of the dentures.[16] Consequently, the loss of retention and stability of the dentures will cause further bone resorption and severe pain and discomfort to the patient.[20]

Likewise, there is always a tendency to find an option to decrease alveolar ridge resorption. The use of soft liners material for complete denture became popular in dentistry because of their numerous clinical advantages. These materials decrease stress in denture supporting structures and have the ability to distribute the functional load in the support area of the dentures and improve their stability and retention.[6,10,11]

According to Babu BD et al.[6] soft liner in acrylic complete dentures reduces residual ridge resorption compared to the acrylic complete dentures without soft liner. This study contradicts the study conducted by Al-Noori and Said[12], who found no significant difference in bone resorption with and without soft liner in complete denture patients. However, regarding denture satisfaction, patients stated that they felt more comfortable by using dentures with soft liner than without soft liner.[12]

Alveolar ridge resorption can also be affected by the extension of the denture support surface to the tissue. Some studies concluded that dentures with mucosa and mucosa–gingival support cause more bone resorption than gingival-mucosa support.[26]

Tripathi A et al.[13] conducted a study to evaluate the effect of different impressions technique on mandibular residual ridge resorption. The authors found that mandibular residual ridge resorption was reduced in patients with dentures using the mucostatic impression technique compared with selective pressure impression technique.

There are several modifications of denture base materials, including the conventional acrylic resins, high impact resins, glass fibres-reinforced resins and metallic-

reinforced resin.[4] Those modifications were made to improve the quality of life of denture wearers as much as possible. They tend to improve the flexural strength, fatigue resistance, thermal stability, water sorption, solubility, biocompatibility, resistance and structural elasticity, fracture toughness, decrease residual ridge resorption, hardness, color and allergic properties.[1,27]

Rigid acrylic dentures partially meet the compatible, functional and aesthetical requirements, so perfect materials are always searched for. According to studies, thermoplastic materials are a better choice for dentures, taking into account their flexible properties, resistance to breakage, thinner layer which makes speech easier and are more retentive compared to conventional dentures.[28,29,30] However, there is little information which of these denture base materials affect more residual ridge resorption.

The masticatory performance is a very important criterion for the success of denture.[31] Hazari P et al.[28] found that masticatory efficiency and performance were better with conventional dentures compared to flexible dentures, but results of a questionnaire of patients' satisfaction with dentures revealed that patients with flexible dentures were more satisfied than those with acrylic denture. In terms of patient satisfaction with dentures, similar results are found in the study which concluded that flexible dentures in comparison were significantly much better than conventional dentures.[32]

The implant supported overdentures are a reliable choice of prosthodontic treatment in complete edentulous patients. This treatment improves retention, stability and support of dentures and minimizes ridge resorption.[14] There is a consensus that a large majority of implant supported overdenture wearers are satisfied with the benefits they get from their dentures.

Conclusions

This review concludes that different methods, techniques and base materials used in prosthodontic management have different reductive ability in residual ridge resorption. Denture wearing habit and artificial tooth material showed no significant effect on the rate of residual ridge resorption. However, gender, impression technique, and denture soft liner significantly affected the rate of residual ridge resorption.

Declaration of Interest

The authors assert that they have no conflict of interest.

Authors	Summary	Main results	Reference
Babu BD et al.	Comparison between the complete denture with soft liner and without soft liner in the rate of residual ridge resorption. A total number of 28 completely edentulous patients within the age group of 45-60 years following the inclusion criteria; edentulous patients for the last 6 months, having class I jaw relation, well developed ridges with firm mucosa and no previous denture experience were selected to participate in the study.	Results showed decrease in bone height at all time intervals in both groups, and the change was statistically significant ($P < 0.05$). The use of complete denture with soft denture liner significantly reduces the residual ridge resorption as compared to the one without denture liner.	6

Al-Noori et al.	Evaluation of mandibular residual ridge resorption for patients wearing lower complete dentures made of heat curing acrylic resin lined with acrylic soft liner and compare it with patients wearing conventional heat curing dentures. As well as the satisfaction of patients with dentures for both groups were compared. Residual ridge resorption was evaluated in 35 male patients through a period of six months by means of digital panoramic radiographs.	The results indicated insignificant difference in the rate of residual ridge resorption between the three tested groups in six months period. Regarding denture satisfaction, most patients seem to have more comfortable denture and better chewing ability by using soft liners.[16]	12
Kovacic I et al.	Examination of the rate of residual ridge resorption in edentulous patients through the five years of denture wearing. Radiographic measurements were made on lateral cephalometric radiographs. The first lateral cephalogram was made at the delivery of complete dentures and the second one five years after the denture placement.	Results show statistically significant differences of ridge height at all of the five measurement points after the five years denture wearing period. There has been no statistically significant difference between daytime and daytime plus night time of wearing dentures.	5
Tripathi A et al.	Evaluation of the effect of complete dentures fabricated by different impression techniques on mandibular residual ridge resorption in individuals with different bone mineral density. Two impression technique were used: selective pressure impression technique and mucostatic impression technique. Computed tomographic scans of the mandible were made at denture delivery and 1 year after prosthesis use.	Significantly less reduction in mandibular ridge height and width was found in the mucostatic impression technique versus selective pressure impression subgroups in both osteopenic and osteoporotic participants.	13
Mercier P, Bellavance F.	This study investigated whether a distribution of mechanical stress, would reduce residual ridge resorption or improve ischemia. Thirty rats were divided into six experimental groups (n=5). The control group received no intentional stimulation, but rats in the experimental groups wore denture stimulators made of acrylic resin and soft lining material. The four types of soft lining materials investigated in this study dispersed the applied pressure, with compressive stress ranging from 20.8 to 90.8kPa.	Non-viscoelastic material clearly induced bone resorption and ischemia of denture foundations, while viscoelastic materials reduced these phenomena to different extents according to their viscoelastic properties.	8

Kordatzis K, Wright PS, Meijer HJ	Comparison between the conventional dentures and overdentures supported by two implants in the rate of residual ridge resorption. Proportional area measurements of the posterior mandible were made on rotational tomograms taken immediately before and five years after treatment. The area was bounded by a line joining gonion to the lowest point of the mental foramen and the crest of the residual ridge and was expressed as a proportion of an area that was not dependent on the ridge.	The estimated average reduction in height was 1.25 mm in 5 years (1.63 mm for conventional denture groups and 0.69 mm for implant overdenture groups, almost 1 mm less in the overdenture group).	14
Al-Jabrah O, Al-Shumailan Y	Association of the mandibular ridge reduction with duration of complete denture wearing in relation to age and gender is using digital panoramic radiography. Resorption in the mandibular residual ridges was assessed by using the mental foramen and the inferior border of the mandible, as they appear in digital panoramic radiographs, using Wical and Swoope Analysis method. Measurements were performed digitally using Sidexis next Generation software. The amount of resorption was calculated and correlated to gender, age and duration of denture wearing.	The mean ridge resorption was 7.74±5.80 mm (20%), Women significantly (P<0.05) recoded more resorption than men (women: men ratio was 3:2). Men significantly (P<0.0001) had greater mandibular ridge and mental foramen heights than women. Ridge resorption significantly increased with increasing age (P<0.0001) and duration of denture wearing (P<0.001). Women significantly(P<0.05) had greater ridge resorption than men below 50 and above 80 years old; and in all denture wearing duration groups.	22

Table 1. Studies of different prosthodontic treatment used to reduce residual ridge resorption.

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