

Assessment of Residual Ridge Resorption in Mandible of Edentulous Patients

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Background: Residual Ridge Resorption (RRR) is a common and often incapacitating problem, particularly in edentulous mandible. Reduction of residual ridges needs to be recognized for what it is: A major unsolved oral disease that causes physical, psychological, and economic problems for millions of people all over the world. The aim of this study was to evaluate the residual ridge resorption in mandible of edentulous patients. To find the mean residual ridge resorption in mandible of edentulous patients.

Methods: All patients who fulfilled the inclusion criteria and underwent prosthodontic rehabilitation at Fatima Memorial Dental Hospital, Lahore were included in the study. After ethical approval, informed and written consent was taken. A brief history was taken, clinical examination conducted and the residual ridge resorption (RRR) of the mandible was evaluated on 3D Cone Beam Computerized Tomography CBCT to assess the outcome that is mean RRR of the mandible.

Results: A total of 60 edentulous patients were included. 37 (61.7%) patients were males while 23 (38.3%) were females with the mean age of 59.1167±5.489 years. The mean ridge residual resorption was 24.283±3.975 mm.

Conclusion: The residual ridge resorption increased with increase in age, duration of edentulism and was more in males than in females.

Keywords: 3D, cone beam computerized tomography, mandible, residual ridge resorption

Introduction

Accurate relationship of dentures to the supporting hard and soft tissues is a demanding biological and mechanical condition that largely ascertains their stability and function in successfully restored completely edentulous or partially dentate patients.^{1,2} But residual ridge resorption (RRR) is a progressive, multifactorial, and inevitable process that damages this support over time.^{3,4} The underlying causes of the RRR are a complex interplay of anatomical, functional, metabolic, and prosthetic factors.^{5,6} This prioritization depends on several factors such as the shape and size of the residual ridge, masticatory forces, the health of the bone system, as well as the fit and function of the selected dentures in the oral environment.^{1,7}

By drastically reducing the denture-bearing area, RRR affects denture stability and retention, which in turn affects comfort and oral function.^{8–10} Complete dentures' (CDs') efficacy is largely dependent on residual ridge morphology and functional loading.^{11,12} Denture misalignment, overnight wear, and occlusal imbalances are examples of local contributing factors that can worsen bone resorption.^{4,5,9,13–16} Bone integrity is also influenced by the length of time spent wearing dentures; both excessive and insufficient use can hasten bone deterioration.^{2,4}

Prior to prosthodontic treatment, diagnostic imaging—particularly radiographic techniques—is essential for determining the quantity and quality of bone.^{3,6,10} Precise treatment planning is made possible by CBCT's superior visualization of anatomical landmarks, including the mental foramen.^{5,15,16} According to research, RRR increases with the length of edentulism, with average values reaching 28.5±8.5 mm.⁵ This emphasizes the significance of early intervention.^{5,17,18}

This study aims to evaluate the extent of mandibular RRR in edentulous patients after three months of complete denture use, considering the duration of edentulism. It seeks to enhance understanding of how denture wear influences mandibular bone changes, contributing to improved prosthodontic outcomes.

Materials and Methods

This study was designed to assess mandibular residual ridge resorption (RRR) in edentulous patients wearing complete dentures. It was conducted at the Department of Prosthodontics, College of Dentistry, University of Lahore, Pakistan, over a six-month period. The study aimed to measure the extent of bone resorption in patients after using complete dentures. A total of 60 patients were included in the study. The sample size was determined based on a 95% confidence level and a 1% margin of error, with an expected mean of 28.5 ± 8.5 mm of bone resorption, as noted in previous studies. A non-probability consecutive sampling method was used, where patients who met the inclusion criteria were selected as they visited the outpatient department during the study period. Patients were included if they were between 50 and 70 years old, had been edentulous for at least six months, and had not undergone any pre-prosthetic surgery. Those were excluded if they had conditions like diabetes with high blood sugar ($BSR > 200$ mg/dL), were taking bisphosphonates, had received immediate dentures, or wore dentures for more than 16 hours per day.

After obtaining written consent, demographic details such as age, gender, and the duration of edentulism were recorded. All participants had been edentulous for at least six months before being fitted with conventional complete dentures at the College of Dentistry. After wearing the dentures for three months, their mandibular ridge resorption was measured using Cone Beam Computed Tomography (CBCT), which provided accurate vertical measurements of bone resorption. The 3D CBCT image of the mandible highlights areas of vertical bone resorption, primarily along the alveolar ridges on both the right and left sides. The resorption is more prominent in the posterior regions, resulting in a noticeable reduction in ridge height and contour. Such changes are commonly observed in long-term edentulous patients and can significantly impact the support, stability, and retention of prosthetic appliances. The detailed visualization provided by CBCT imaging allows for accurate assessment of the extent of bone loss, aiding in treatment planning for dental implants, ridge augmentation, or other prosthetic rehabilitation procedures tailored to the patient's needs as shown in Figure 1. The Figure 2 illustrates the mandibular arch viewed from the lateral aspects, highlighting both the right and left sides. Arrows are used to clearly indicate regions experiencing vertical bone resorption. On both sides of the mandible, the resorption is seen as a reduction in the height of the alveolar ridge, particularly in the posterior regions where the residual ridge has become markedly flattened or thinned. This vertical loss of bone is typical in long-term edentulous patients and may significantly compromise denture retention, stability, and support. The severity of the resorption appears symmetrical, suggesting systemic or functional factors affecting both sides equally. Understanding these resorption patterns is crucial for planning prosthetic rehabilitation, especially when considering implant placement or ridge augmentation procedures.

Data Analysis

Data entry and statistical analysis were conducted using Statistical Package for Social Sciences (SPSS), version 26.0 for Windows. Descriptive statistics were applied to analyze the vertical extent of bone resorption. The mean and standard

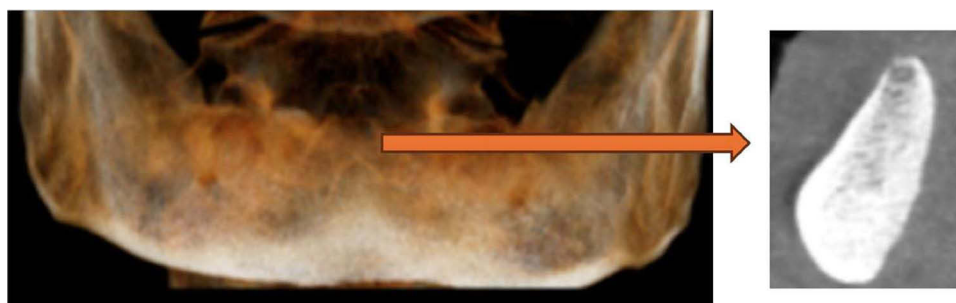


Figure 1 3D CBCT image of the mandible showing areas of vertical bone resorption, particularly along the alveolar ridges.

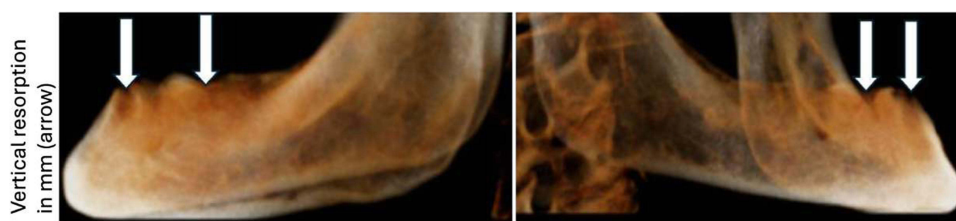


Figure 2 Lateral views of the right and left sides of the mandible showing areas of vertical bone resorption (in millimeters), indicated by arrows.

deviation were calculated for continuous variables such as patient age and duration of edentulism. Categorical variables, including gender, were analyzed using frequency and percentage distributions. Data were further stratified by age group, gender, and length of edentulous period to assess potential associations or trends in residual ridge resorption.

Results

A total of 60 edentulous patients were selected in this study. The mean age was 59.12 ± 5.49 years as shown in [Table 1](#) among which the male patients were 37 (61.7%) while females were 23 (38.3%) is outlined in [Table 2](#). This reflects a population commonly presenting with age-related alveolar bone resorption. The age distribution underscores the need for careful prosthetic planning and consideration of bone loss patterns typically seen in older adults requiring complete denture rehabilitation as shown in [Figure 3](#). The mean edentulous period was 8.34 ± 3.96 months is outlined in [Table 3](#). The mean residual ridge resorption (RRR) was 24.28 ± 3.98 mm as shown in [Table 4](#). Descriptive statistics of the edentulous period among the 60 patients revealed a wide variation in the duration since tooth loss. The mean edentulous period was recorded, highlighting differences in bone resorption levels and prosthetic needs. Understanding the length of edentulism is essential for evaluating ridge morphology, planning treatment, and predicting the success of complete denture rehabilitation as outlined in [Figure 4](#). Stratification of Residual ridge resorption with respect to age and edentulous periods as shown in [Table 5](#) and [Table 6](#) had no significant but with gender it was observed that male patients had more resorption compared to female is outlined in [Table 7](#).

Discussion

The substantial resorption of the edentulous mandibular alveolar process is one of the main problem's prosthodontists deal with. The available area for denture support is significantly reduced as a result of this condition, which significantly complicates the prosthetic rehabilitation process. In addition to decreasing denture stability and retention, the loss of this vital bone structure makes it more difficult to fit patients comfortably, which complicates treatment.^{6,19–21}

Table 1 Descriptive Statistics of Age

Statistics	Age (Years)
Minimum	50
Maximum	70
Mean	59.12

Table 2 Frequency Distribution of Gender

Gender	Frequency (n)	Percentage (%)
Males	37	61.7
Females	23	38.3
Total	60	100

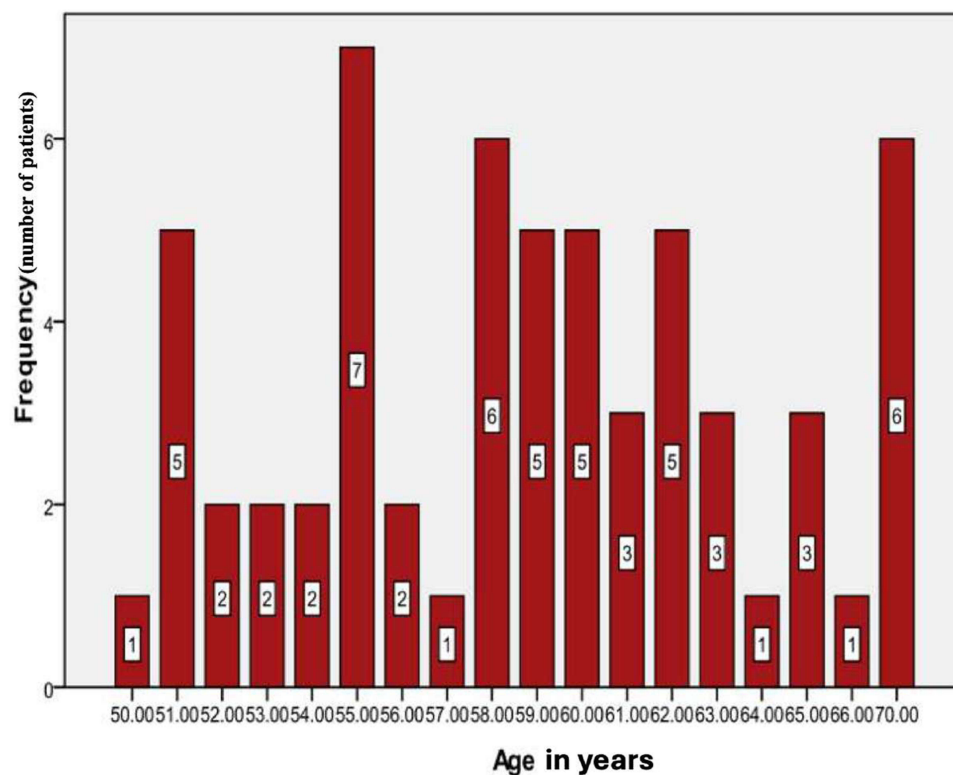


Figure 3 Distribution of the patients by mean age (in years) and frequency of complete dentures provided.

The Wical and Swoope method is one of the most widely used techniques for measuring residual ridge resorption (RRR).^{7,22,23} The advantages of utilising digital orthopantomographs (OPGs) in conjunction with the Wical and Swoope method to evaluate RRR have been emphasised in earlier research by Al-Jabrah¹ and Hirai.¹¹ This hybrid method enhances precision and aids in developing more effective management plans for individuals. On the contrary, Cone Beam Computed Tomography (CBCT) has many advantages.^{24,25} With the three-dimensional imaging cutting across multiple planes, the information is much clearer for both hard and soft tissues, along with surrounding anatomical structures.²¹ This 3D imaging system allows precise imaging and localization of the MF in both horizontal and vertical planes, which is important for accurate treatment planning.^{26,27}

Table 3 Descriptive Statistics of Edentulous Period

Statistics	Edentulous Period (Months)
Minimum	6
Maximum	14
Mean	8.34

Table 4 Descriptive Statistics of Residual Ridge Resorption (RRR) (Mm)

Statistics	Residual Ridge Resorption (RRR) (mm)
Minimum	20
Maximum	36
Mean	24.28

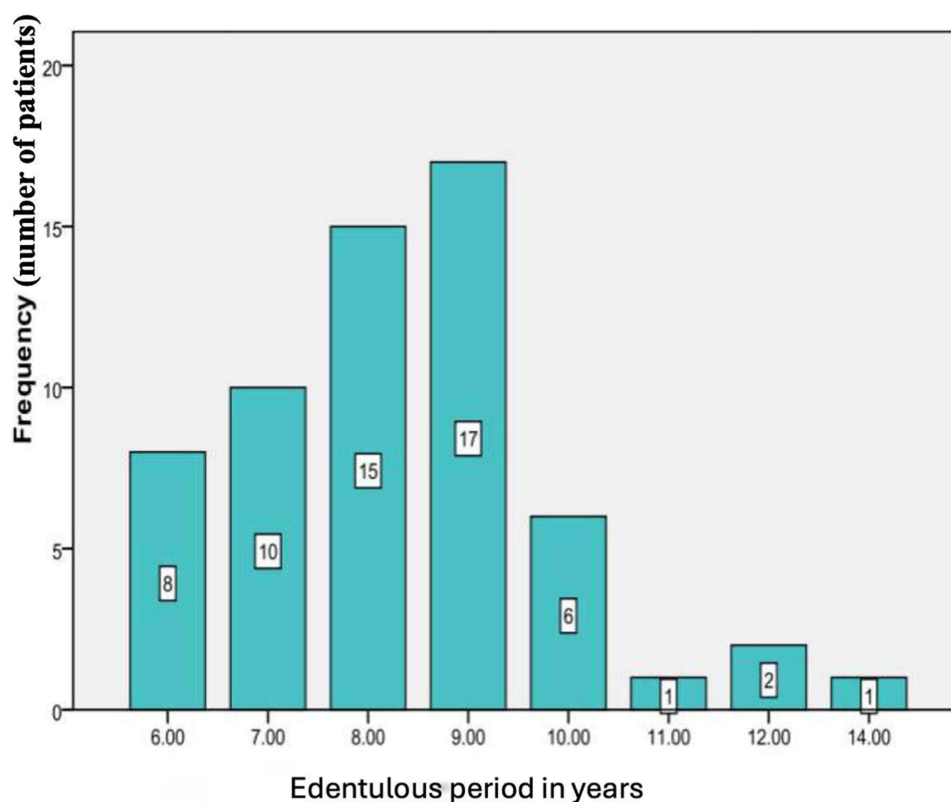


Figure 4 Descriptive statistics showing the distribution of the edentulous period (in years) and the frequency of complete denture use (number of patients).

Karaagaçlıoğlu et al⁸ described how resorption tends to occur more quickly in the premolar and molar regions of the edentulous mandible compared to the anterior mandible. Atwood et al⁹ also noted that ridge resorption is most significant in the first few months after tooth extraction in both the maxilla and mandible.

In several studies, including those by Karaagaçlıoğlu and Ozkan, and Al AlSheikh et al, the duration of edentulism has been identified as one of the key factors influencing the extent of mandibular bone loss and resorption.⁹ In our study, we observed a significant increase in resorption (36mm) as the duration of edentulism increased, which matches the results found in other studies.^{5,8}

Table 5 Stratification of Residual Ridge Resorption with Respect to Age: (n=100)

(Stratification of Residual Ridge Resorption with Respect to Age: (n=100))		
Age (Years)	Residual Ridge Resorption (mm)	P-Value
50–60	23.61±3.86	0.081
61–70	25.45±3.95	

Table 6 Stratification of Residual Ridge Resorption with Respect to Edentulous Period: (n=60)

Stratification of Residual Ridge Resorption with Respect to Edentulous Period: (n=60)		
Edentulous Period Months	Residual Ridge Resorption(mm)	P-Value
6–10	24.20±4.01	0.53
11–14	25.50±3.32	

Table 7 Stratification of Residual Ridge Resorption with Respect to Gender: (n=100)

(Stratification of Residual Ridge Resorption with Respect to Gender: (n=100))		
Gender	Residual Ridge Resorption (mm)	P-Value
Male	24.48±4.02	0.600
Female	23.90±3.91	

Interestingly, we found no correlation between residual ridge resorption and age in either gender, which is consistent with studies by Atwood,⁹ Lopez-Roldan et al,¹⁰ and Hirai et al.¹¹ Though the general trend is that bone resorption increases with age, some studies, like those by Solar et al¹⁶ and Al-Jabrah,⁴ show that older age does not always correlate directly with greater resorption, especially in patients with conditions like osteoporosis or diabetes.

Al-Jabrah⁴ also found that women tend to have higher rates of residual ridge resorption than men, which has been confirmed in studies by Lopez-Roldan et al,¹⁰ Bairam,¹² and Kordatzis et al.¹⁴ In postmenopausal women, the average decrease in mandibular ridge height over five years in those wearing conventional dentures was found to be 1.63mm. This suggests that being female is a risk factor for increased resorption. Solar et al¹⁶ also noted that postmenopausal women, regardless of underlying medical conditions, tend to experience more severe bone resorption. Devlin et al¹⁷ reported that while both men and women experience increased resorption during the edentulous period, women have a higher incidence of severe atrophy. This is likely due to hormonal changes after menopause, where a decrease in estrogen leads to increased bone loss, contributing to faster alveolar bone resorption.²⁸

However, in our study, the mean residual ridge resorption (RRR) was 24.28±3.98 mm with sample size of 60 among which females were 23 and male were 37, while the RRR was observed more in males than females which is contradictory to some research findings the reason being the limited sample size and a smaller number of female patients which were observed in the study center.

Limitations and Recommendations

The limitation of the study was the single center study and smaller sample size and the inclusion criteria was kept simple due to limited number of subjects visiting the outpatient and limited funds sponsored by the institute. Further studies can be carried out either with regression sampling or with larger sample sizes involving multi-centers with inclusion and exclusion criteria being modified specifically focusing on the risk factors influencing the residual ridge resorption.

Conclusion

In conclusion, this study highlights that residual ridge resorption (RRR) in edentulous patients wearing complete dentures is influenced primarily by the duration of edentulism, with longer periods of edentulism associated with more significant resorption. Our findings suggest that RRR tends to be more pronounced in males compared to females, though this could be influenced by specific inclusion criteria used in our study.

While age did not show a direct correlation with RRR in both genders, the duration of edentulism remains a critical factor for assessing the rate of bone loss. The use of complete dentures is also a significant aspect of this process, as it may contribute to the ongoing resorption over time. Further research is necessary to explore the long-term effects of denture wear, the role of different denture materials, and the potential interventions to slow or reverse ridge resorption in edentulous patients. This will ultimately help in improving the clinical management and prosthetic rehabilitation of patients suffering from RRR.

Data Sharing Statement

The authors will transparently provide the primary data underpinning the findings or conclusions of this article, without any unjustified reluctance. If require, please contact the correspondence author. Human Ethics and Consent to Participate Declarations Since there no direct images of subjects and their personal information in not compromising so consent is – Not Applicable.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of College of Dentistry, University of Lahore, Pakistan.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest in this work.

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