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Original Article

Clinical Evaluation of Residual Ridge Morphology of Maxillary Arch in Relation to Ageing and Length of Edentulism

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A B S T R A C T

Objective: To evaluate the morphology of residual ridge of maxilla according to classification proposed by ACP (American College of Prosthodontics)

Methodology: A descriptive cross-sectional study was conducted Liaquat University of medical and health science, Jamshoro from November 2024 to April 2025 on 118 edentulous patients reporting to the prosthodontic outpatient department. Patients with complete maxillary edentulism of varying durations with six week after extraction of last tooth and both genders were included. Residual ridge morphology was clinically evaluated and classified according to the Atwood classification system. Standardized prosthodontic examination was performed to assess ridge height, width, and form. Data were stratified by age groups (40–50, 51–60, >60 years) and edentulous duration (<5, 5–10, >10 years). Statistical analysis was performed using SPSS 26 version.

Results: A total of 118 edentulous patients were evaluated with a mean age of 63.73±7.12 years. There were 59.3% males and 40.7% females. Most of the individuals (41.5%) had type A ridges, following by type B (36.4%), while the type C was the least common (22.0%). There was a significant association of compromised ridge morphological type with advanced age age groups (p = 0.004), reflecting that the ridge form worsens with increasing age, longer duration of edentulism and duration of denture uses (p = 0.001), while there was no significant association found with genders (p = 0.302).

Conclusion: Study revealed that the compromised ridge forms were more prevalent in advance age groups of individuals and among those with prolonged edentulism, reflecting the importance of early prosthodontic rehabilitation and timely replacement of denture to preserve residual ridge structure and enhance outcomes.

Keywords: Maxillary arch, edentulism, Atwood classification, ridge morphology, ageing, edentulous duration

Introduction

The Edentulism is one of the most significant age-related oral health burdens, with its prevalence and consequences intensifying as individuals grow older. Age is a critical factor affecting the epidemiology of edentulism, with the older age group being most affected, and edentulism continues to grow due to ageing and the increasing numbers of older adults worldwide.[1,2]

It remains a significant public health concern worldwide, particularly among the aging population, and continues to pose considerable prosthodontic challenges. Residual ridge resorption (RRR) is a progressive, multifactorial, and inevitable process that compromises the denture-supporting foundation over time, with its underlying causes involving a complex interplay of anatomical, functional, metabolic, and prosthetic factors.[3] The morphology of the residual alveolar ridge is widely recognized as a critical determinant of complete denture success, directly influencing retention, stability, support, and masticatory efficiency in edentulous patients.[4]

Ridge morphology is one of the important recognized factors affecting denture retention, stability, support, and masticatory function in edentulous patients, as the form of the ridge affects treatment planning and largely determines the prognosis of prosthodontic rehabilitation.[4] As resorption progresses, the denture-bearing area diminishes, making it increasingly difficult to achieve satisfactory prosthetic outcomes through conventional means. Although research has not demonstrated a strong correlation between anatomic conditions, denture quality, and denture success,

conventional wisdom dictates that successful dentures are more difficult to achieve in patients with severely resorbed ridges.[5]

The maxillary arch, despite resorbing at a comparatively slower rate than the mandible, undergoes centripetal resorption that significantly alters its dimensions over time.[6] Presently studies have not reached consensus on the rate, extent, or pattern of residual ridge resorption, which continues throughout the edentulous period with marked individual variability and is influenced by factors such as age, sex, and underlying metabolic conditions.[5] Moreover the prolonged duration of edentulism also considered primary contributing factors. The duration of edentulousness has been found to closely correlate with radiological indices of alveolar bone resorption,[7] highlighting the cumulative nature of bone loss following tooth extraction.

To standardize the clinical assessment of residual ridge morphology, the American College of Prosthodontists (ACP) developed a classification system for complete edentulism. This system defines four categories ranging from Class I, representing an uncomplicated clinical situation, to Class IV, representing the most complex and higher-risk edentulous condition.[8] The ACP classification has since been widely employed in clinical research as an objective tool for evaluating maxillary ridge morphology. Studies utilizing this classification system have evaluated the morphology of the maxillary residual ridge and its association with age, gender, duration of the edentulous period, and duration of denture use.[9]

Despite growing evidence on mandibular resorption patterns, studies specifically focusing on maxillary residual ridge morphology in relation to both aging and the length of edentulism remain relatively limited. The present study therefore aims to evaluate the residual ridge morphology of the maxillary arch using the ACP classification system and to determine its association with patient age and the duration of edentulism, with the goal of improving prosthodontic treatment planning for this vulnerable population.

Methodology

Present descriptive cross-sectional study was conducted on 118 patients at prosthodontics department Liaquat University of medical and health science, Jamshoro. Study was conducted during six months from November 2024 to April 2025 after approval of CPS and ethical review committee of LUMHS. The sample size of 118 patients was calculated through Sample Size Calculator by Wan Nor Arifin By taking prevalence of type C classification= 12.60%[5], Confidence level 1000 (1- α) = 95%, Margin of error=6%. Non-probability convenience sample technique was used. Patients with completely edentulous maxillary ridge, at least six weeks after extraction of last tooth, both genders, cases with sufficient mouth opening to allow clinical and radiographic examination and those who were willing to participate and provide written informed consent were included. However, all the cases with partially edentulism, patient with non-healed maxillary ridge, cases with a history of maxillofacial trauma, tumor resection, or surgical removal of the maxillary ridge, cases with poor oral hygiene or any active oral infection, medically compromise patient and mentally handicapped patient were excluded. After taking verbal consent from patients, the general information including age gender length of Edentulism and duration of complete denture wear were recorded. Among selected patients impression was taken and poured and cast was formed. Ridge morphology of maxillary arch was assessed on cast and patient is divided into four types according to American College of Prosthodontics (ACP). Type A was define as the represents the most favorable ridge with adequate vestibular depth, well-defined tuberosity and hamular notch, and no bony prominences, type B was defined as the loss of posterior buccal vestibule with poorly defined tuberosity and hamular notch but rounded non-interfering tori, type C was defined as the presence of the patients with loss of anterior labial vestibule, minimal palatal resistance, possible bony undercuts, hyperplastic mobile anterior ridge, and coronoid process encroachment, while the type D was defined as cases presence with the most severe form with complete loss of anterior and posterior vestibules, no palatal resistance to denture movement, interfering tori or exostoses, redundant anterior ridge tissue, and a prominent anterior nasal spine, posing the greatest

challenge to denture retention and stability. All the data was analyzed by using IBM SPSS Statistics version 26. Mean and standard deviation were computed for quantitative variables like age. Frequency and percentage were presented for qualitative variables like gender and morphology of maxilla residual ridge according to ACP classification. The stratification was done on age and gender to see the effect of these modifiers on morphology of maxilla residual ridge according to ACP classification ACP classification using Chi-square test taking P≤0.05 as significant statistically.

Results

The mean age of study participants was 63.73±7.12 years, indicating that the majority of elderly individuals with mean duration of edentulism around 5 years (mean= 4.99±3.65 years), and average duration of denture use was 3.68±2.92 years, reflecting that individuals had been wearing their dentures for a relatively shorter period compared to the total duration of tooth loss. There were 59.3% males and 40.7% females. Table I.

According to the type of maxillary residual ridge morphology, the most of the individuals (41.5%) had Type A ridges, following by Type B among (36.4%) cases, while the Type C was the least common, found among (22.0%) participants, as presented in figure 1.

Table I: Descriptive statistical analysis of demographic variables. (n=118)

Variables		Statistics	
Gender	Male	70	59.3
	Female	48	40.7
Mean age of cases		63.73±7.12 years	
Duration of Edentulism		4.99±3.65 years	
Duration of denture		3.68±2.92 years	

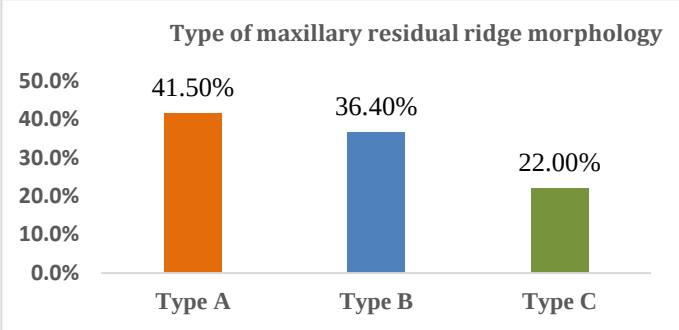

Figure 1. Frequency of different types of maxillary residual ridge morphology. (n=118)

In terms of post stratification of maxillary residual ridge morphological types, a significant association was found between ridge morphological types and age groups (p = 0.004), reflecting that the ridge form worsens with increasing age, while there was no significant association found with gender (p =

Table II: Post stratification of types of maxillary residual ridge morphology. (n=118)

Variables		Type of maxillary residual ridge morphology			Total	p-value
		Type A	Type B	Type C		
Age groups	50 -60 years	23	13	4	40	0.004
		19.5%	11.0%	3.4%	33.9%	
	61-70 years	26	25	16	67	
		22.0%	21.2%	13.6%	56.8%	
	71-80 years	0	5	6	11	
		0.0%	4.2%	5.1%	9.3%	
Gender	Male	25	28	17	70	0.302
		21.2%	23.7%	14.4%	59.3%	
	Female	24	15	9	48	
		20.3%	12.7%	7.6%	40.7%	
Duration of edentulism	1-5 years	49	29	0	78	0.001
		41.5%	24.6%	0.0%	66.1%	
	6-10 years	0	14	17	31	
		0.0%	11.9%	14.4%	26.3%	
	>10 years	0	0	9	9	
		0.0%	0.0%	7.6%	7.6%	
Duration	1-5 years	45	39	6	90	0.001
		38.1%	33.1%	5.1%	76.3%	
	6-10 years	4	4	18	26	
		3.4%	3.4%	15.3%	22.0%	
	>10 years	0	0	2	2	
		0.0%	0.0%	1.7%	1.7%	

0.302). Moreover, a significant association was observed between ridge morphology and edentulism duration, where shorter duration was associated with Type A, while longer duration was associated with Type C (p = 0.001). Likewise, duration of denture uses also showed a significant correlation of prolonged duration of denture uses with more compromised ridge forms (p = 0.001). Table II.

Discussion

The loss of all-natural teeth represents a devastating and irreversible turning point in oral health journey of and an individual, one of which extends far beyond the oral cavity to impose the function with wide-ranging, social psychological and physical consequences on the daily life. Following the loss of tooth, a sequence of intraoral and extra-oral anatomical changes progressively occur, every one carrying its own implications for the oral health, systemic well-being, and quality of life (QOL) overall. This study clinically evaluated the residual ridge morphology of the maxillary arch in the association of age and length of edentulism in completely edentulous individuals, among 118 cases with an overall mean age of 63.73 ± 7.12 years and male predominance of 59.3% compared to 40.7% females. In aligns to this series, study conducted by the by Riaz et al[3] at the University of Lahore, demonstrated average age of patients 59.12 ± 5.49 years, with males comprising 61.7% and females around 38.3% of the study population. Qamar et al[9] conducted the study at prosthodontic department of Lahore Medical and Dental College reported that among 90 completely edentulous patients, where females were 55.6% and males were 44.4%, with an overall mean age of 60.81 years. On the other hand, Sharma et al[4] in a study conducted at Nepal Medical College among 87 completely edentulous patients, reported that more than two thirds of participants belonged to the age group of 60–80 years, with a mean duration of edentulousness of 5.7 years, Almost findings are

comparable to the study and the meeting of age profiles across studies proves that complete edentulism predominantly affects the older adult individuals.

In this study, the most of the cases (41.5%) presented with type-A ridge morphology, followed by type-B in 36.4%, and 22.0% of cases with type C. This distribution indicates that a favorable ridge form remains the most prevalent morphological type in the study population, reflecting a relatively shorter mean duration of edentulism. Consistently Qamar et al[9] also used the same ACP classification system among 90 completely edentulous patients at Lahore Medical and Dental College, where they reported that Type A was the most prevalent ridge morphology, a finding consistent with the present study, and further confirmed a significant association between ridge morphological type and both age and duration of edentulism.[9] In the study by Sapkota SM et al[10] reported that the type B was the most prevalent residual ridge morphology among (51.4%) cases, followed by Type A among (41.1%) patients, while types C and D were the least common, each found in only (3.7%) of the cases, indicating that the majority of the maxillary ridges in this study population retained a relatively favorable morphology, with around 92% of participants had either Type A or Type B maxillary ridges. In the comparison of this study, Alshenaiber et al[5] reported that the average maxillary residual alveolar ridge height was 14.09 ± 3.78 mm with the average anterior ridge angle of 104°, while using the Cawood and Howell classification, the distribution of maxillary ridge resorption showed that Class V was the most prevalent class in around 29.5% of the cases, followed by Class VI around 28.1%, representing that the most of the cases (57.6%) presented with advanced to severe maxillary ridge resorption, while class IV, Class II and Class III were noted among 20.5%, 14.4% and 7.5% of the cases respectively,[5] On the other hand Al-Naser ZH et al[11] conducted on 300 completely edentulous patients, the evaluation of maxillary residual ridge morphology using the PDI revealed type A as the predominant ridge form in most of the cases 65%, type C as the second most common in 20% cases followed by type B among 15% of the patients.

Furthermore, this study found a significant link between residual ridge morphological type and age group (p = 0.004), indicating that ridge form progressively deteriorates with increasing

of the age, which is consistent with the well-established understanding that residual ridge resorption is a chronic, age-dependent, and irreversible process. According to a clinical and radiographic study the age and duration of edentulism significantly influenced the resorption of residual ridge, with oldest cases consistently had greater bone loss.[12] However the Riaz et al[3] consistently stated that the that the age distribution of edentulous patients underscores the need for careful prosthetic planning among older individuals. Additionally, like Qamar et al[9], there no any significant link found between ridge morphological type and gender in this study (p = 0.302), indicating that the both genders are equally susceptible to the ridge resorption. On the other hand Riaz et al found inconsistent findings where males had more residual ridge resorption in contrast to the females in their study of mandibular ridges.[3] Likewise there was found a highly significant relationship between duration of edentulism and ridge morphology (p = 0.001), whereby the shorter duration was correlated with the more favorable Type A morphology and prolonged duration was linked to the more compromised Type C. Overall finding underscores that the length of time a patient has been edentulous is one of the most critical determinants of residual ridge status, which also supported by few other studies also found the a significant link between ridge morphological type and duration of edentulism.[3,12]

However, the present possess certain limitations that should be essentially measured when interpreting the findings, like very limited sample conducted as single center using a convenient sampling technique, duration of edentulism was obtained through patient history rather than verified clinical records, along with we did not incorporate radiographic evaluation like panoramic radiography or CBCT to properly measure the residual bone height, which could limit the generalizability of the findings to the broader edentulous individuals. However further studies should be conducted with multicenter designs and more diverse sample sizes to improve the representativeness and generalizability of the findings. Moreover the systemic factors influencing bone metabolism should be incorporated and controlled for in future studies.

Conclusion

According to the conclusion, the residual ridge morphology of the maxillary arch observed a clear pattern of deterioration with advance age and rising edentulism duration. Specifically, the compromised ridge forms were more prevalent in advance age groups and among those with prolonged edentulism, reflecting the importance of early prosthodontic rehabilitation and timely replacement of denture to preserve residual ridge structure and enhance outcomes of prolonged treatment. However further large-scale studies are recommended to more confirm the findings.

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