Original Article

Impact of Systemic Diseases on the Remodeling Pattern of Mandibular Ridge in Adult Edentulous Population: A Case Control Study

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ABSTRACT

Objective: The study is to evaluate the impact of systemic diseases on the remodeling pattern of mandibular ridge in adult edentulous patients.

Materials and Methods: This case-control study was conducted at the Department of Prosthodontics, Altamash Institute of Dental Medicine, Karachi for a period of six months. A total of 145 patients with edentulous mandibular arch were recruited according to specific criteria; those patients having the systemic disease were included in the case group and patients without morbid illnesses were included in the control group. Data was collected using a well-structured and validated proforma. SPSS-25 was used for statistical analysis. A p-value of < 0.05 was considered significant.

Results: The most common ridge form among the case group was depressed while low well-rounded was prevalent in the control group. Although no significant difference (p=0.301) was found. Moreover, a statistically significant difference was found between mandibular ridge form with a period of edentulism (p <0.001) as well as the duration of previous dentures (p <0.001). There was no significant difference in terms of ridge pattern and resorption between the study and control groups (Chi square-test: p=0.301).

Conclusion: Considering the methodologies implemented and statistical analysis of the data produced, it is reasonable to conclude that the most prevalent ridge form in the control group (patients without any systemic disease) was found to be low well rounded, though depressed form was the most prevalent one in the case group (patients with systemic disease). Additionally, the mandibular ridge resorption pattern was similar in both groups studied.

Keywords: Edentulism, Mandibular ridge form, Residual ridge resorption (RRR), Systemic disorders.

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INTRODUCTION

The teeth, jaws, and oral mucosa tend to change over time in naturally dentate species, as they are not static objects. The residual alveolar ridge is the remaining alveolar bone and its soft tissue covering that is formed after removal or extraction of the teeth and comprises denture-bearing mucosa, submucosa, periosteum, and the underlying residual alveolar bone. However, Residual ridge resorption (RRR) is the variation in alveolar ridge resulting after tooth.[1] Teeth may be lost due to several reasons tooth decay, periodontal problems, and tooth injury being the most frequent causes of tooth loss. When tooth loss occurs the alveolar ridge undergoes a series of changes that lead to different shapes of ridges, thus forming residual ridges.[2,3] The size of residual ridge is reduced most rapidly in the first six months, but resorption of bone continues throughout the life at a slower pace that leads to changes in bone form and structure.[4,5] Maxilla resorbs superiorly and posteriorly; however, mandible resorbs in inferior and anterior directions. The anterior mandible resorbs four times faster than the anterior maxilla. The size, shape, and tolerance of residual ridge provide the basis of stability, retention, and support of complete dentures.[3-4]At wood classified the mandibular ridge form into six anatomical orders. [6]

Order I – Pre-extraction, Order II – Post-extraction, Order III – High, well-rounded, Order IV – Knife edge, Order V – Low, well-rounded, Order VI – Depressed.

Severely resorbed residual ridge gradually results in an increased inter-arch space, significant horizontal discrepancy, flabby tissue, and other sequelae. Classification of the edentulous jaw plays an important role; provides a baseline to evaluate and compare different treatment methods and assists clinicians to communicate regarding the selection of suitable prosthodontic technique.[7,8] There are several factors that accelerate the residual ridge resorption; Atwood postulated the four main factors which are anatomic, prosthetic, metabolic, and functional factors. The anatomical factor that includes the shape and size of the alveolar ridge has a great effect as the well-formed broad ridges show less resorption than narrow thin ridges since the force received per unit area will be less in the former.[9] The bone remodeling is influenced by the forces applied, which may be a result of the factors like parafunctional habits such as bruxism and misuse of prosthesis such as intensive denture wearing, unstable occlusal conditions, immediate denture treatment and use of ill-fitting dentures.[9,10] Other factors of RRR have also been reported such as duration of edentulism, denture wearing habits, quality of dentures, stability of dentures, incorrect horizontal and vertical jaw relation, and nighttime wearing of dentures.[11,12]

In spite of all this, data there is still a gap of knowledge regarding the remodeling pattern (morphological arch form) of mandibular ridge in an adult edentulous population with respect to common systemic diseases including Diabetes, Hypertension, Respiratory diseases, kidney diseases, and Osteoporosis.

Therefore, in this study, we will clinically evaluate the mandibular arch form according to Atwood's Classification amongst two groups, those having systemic diseases or those without any history of comorbid along with effects of other factors including, age, gender, systemic diseases, period of edentulism and previous denture use. The novelty of our research is that this kind of research to our knowledge has not been carried out so far.

MATERIALS AND METHODS

General Information

This is a case control study carried out on 145 patients from November 2019 to February 2020 on dental prosthetic patients. The sample size in this was calculated through Open-Epi software. Considering the minimum alveolar ridge height of 16.13 ±3.69.[11] Keeping the power of test 80. A confidence interval of 95% and a 5% margin of error. The estimated sample size selected for this study was 145 patients. Walk-in OPD patients in the Prosthodontics department of Altamash Institute of Dental Medicine were recruited by applying a nonprobability convenience sampling technique. Participants gave their consent and were informed that their participation in the study will be anonymous with no financial benefits added to it. Prior approval

from the ethics and review committee of Altamash institute of dental medicine was taken. (AIDM/EC/10/2019/15).

Grouping and Methods

Patients were recruited according to the specific criteria. A confirmatory investigation was carried out for the patients with self-reported systemic disease before recruiting them into the case group. Baseline investigations were also carried out to rule out presence of any the systemic disease in the control group. Completely edentulous patients of both gender belonging to an age group 46-85 years were included in this study. Those having systemic diseases (Diabetes, Hypertension, Respiratory diseases, kidney diseases and Osteoporosis) were included in the case group, and those who does not have any underlying medical conditions were included in the control group. Non-compliant patients or those that have undergone immediate denture treatment or misused their prosthesis such as intensive denture wearing, or ill-fitting dentures were excluded. Patients having a history of bone augmentation or pre-prosthetic surgical procedures, parafunctional habits such as bruxism, smoking, metabolic bone disease, or pituitary disease that could affect bone conditions, psychiatric disorders, or taking Psychogenic medications were also excluded.

The mandibular arch form was evaluated clinically according to Atwood's Classification in both groups and was confirmed with an OPG and lateral cephalogram. In addition, the effects of other factors including, age, gender, period of edentulism, and previous denture use were also noted.

Data was collected using a self-structured, validated Performa having two sections. All the demographic details such as age, gender, medical history, and cause of tooth loss were included in section one. In section two, information related to the period of edentulism, previous denture wear, and Atwood classification was included.

Statistical analysis

Data were analyzed using SPSS-25; descriptive analysis was performed for frequency, percentage, mean, and standard deviation. Pearson correlation was applied to find out the relation of mandibular ridge form (classified according to Atwood's Classification) with period of edentulism and period of previous denture. To evaluate the effects of mandibular ridge with advancing age, and to analyze the difference of ridge pattern in study and control groups Chi- square test was applied. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

In our study, out of 145 patients, 79 (54.5%) were males and 66 (45.5%) were females. The most prevalent ridge form found in males was low well-rounded, 27 (34.1%) in contrast to depressed ridge 21 (31.8%) in female. The majority of the patients belonged to the age group 66-75 years (42.1%) with a mean of 67.98 ± 7.45. There was a significant difference (Chi-Square test; $p = 0.001$) between advancing age and ridge form with low well-rounded being the most prevalent 28.27% followed by depressed category, 23.44% from the age of 66 to 85 years Table-1. The major cause of tooth loss amongst the participants was found to be periodontal disease, 91 (62.8%) followed by caries 35 (24.1%) and trauma 19 (13.1%).

Table 1: Relationship of mandibular ridge form to advancing age (n=145)

Ridge form	Frequency (%)	Age group				p- value
		46 - 55	56 - 65	66 - 75	76 - 85	
Post-extraction	27 (18.62%)	0	24	3	0	
High well rounded	33 (22.75%)	0	19	14	0	
Knife-edged	10 (6.89%)	0	4	6	0	0.001
Low well rounded	41 (28.27%)	0	7	23	11	
Depressed	34 (23.44%)	3	1	15	15	

The most prevalent mandibular ridge form among the patients examined was low well-rounded 41 (28.27%), followed by depressed 34 (23.44%) and high well-rounded 33 (22.75%) respectively; 27 (18.6%) reported to fall under post-extraction while only 10 (6.9%) had knife-edged ridge as shown in Table 2.

Table 2: Distribution of mandibular ridge form with and without systemic diseases, (n = 145)

Variables	Case group (with systemic disease)	Control group (without any systemic disease)
Post-extraction	15	12
High well rounded	18	15
Knife-edged	7	3
Low well rounded	20	21
Depressed	25	19
Total	85	60

Moreover, in this study, out of 145, 100 patients (69.0%) had no history of denture wearing while 45 (31.0%) participants were already using a complete denture prosthesis, out of which 39

Table 3: Characteristics of mandibular ridge form and period of edentulism (n=145)

Variables	Period of edentulism				Total
	< 3 months	>3 months < 6 months	> 6 months < 12 months	> 1 year	
Post-extraction	27	0	0	0	27
High well rounded	0	18	11	4	33
Knife-edged	0	1	7	2	10
Low well rounded	0	1	10	30	41
Depressed	0	4	0	30	34
Total	27	24	28	66	145

(26.9%) had been using them for more than 1 year and others 6 (4.2%) had < 6 months history of denture wearing, Table 3.

In addition to this, Pearson correlation was applied to assess the association of mandibular ridge form with the period of edentulism and duration of the previous denture as shown in Table 4. A strongly positive correlation was found between mandibular ridge form and period of edentulism since the correlation coefficient for these two was found to be (r_p =0.82) and the relationship was statistically significant ($p < 0.001$); however, a weak positive correlation was found between mandibular ridge form and duration of the previous denture since the correlation coefficient for these two was found to be (r_p =0.433) and the result was statistically significant ($p < 0.001$). There was no significant difference in terms of ridge pattern and resorption between the study and control groups (Chi-square t-test: p =0.301).

Table 4: Correlation between mandibular ridge form and period of edentulism, duration of previous denture (n =145)

Variables		Period of edentulism	Duration of previous denture
Mandibula ridge form	Pearson correlation	0.82**	0.433**
	p-value	0.001	0.003

Correlation is significant at the 0.001 level (2-tailed).

DISCUSSION

The form of residual alveolar ridge impacts different phases of prosthodontic treatment. Hence, before treatment planning, it is essential to know about the bone quality and quantity as residual alveolar ridge varies from patient to patient and the continuous bone resorption affects denture-bearing area; facial muscle support; facial height as well as the ridge morphology.[12] In our study, the most prevalent ridge form found in males was low well rounded, 27 (34.1%) in contrast to depressed ridge 21 (31.8%) in females. There was a significant difference ($p = 0.001$) between advancing age and ridge form, with low well rounded being the most prevalent (28.27%) followed by depressed category

(23.44%) in the age of 66 to 85 years. These findings were somehow in line with another study that found out that with increasing age, the rate of ridge resorption is higher whereas more ridge resorption in females was reported than in males.[13] This can be explained in the light of the fact that with increasing age, the osteoblasts start losing their capacity to proliferate and differentiate, thus there is more bone resorption as the person ages and this resorption may not be compensated by bone formation leading to senile osteoporosis.[12] Another study shows that among women, the angle of resorption is discreetly increased as they are more prone to osteoporosis.[14] More RRR in females is also evident in our study, despite that there were more males in our sample, the prevalent ridge form among females is depressed which means high level of resorption. However, no literature could be found addressing the morphology of the ridge. It has also been witnessed that with age and progressive atrophy of the ridge, muscular function is reduced particularly in the mandible.[15]

Additionally, the most prevalent mandibular ridge form in this study was found to be the low well rounded (28.27%) i.e., Order V according to Atwood's classification followed by depressed (23.44%) i.e., Order VI (25.7%). This is supported by our finding about the period of edentulism i.e., 66 out of 145 patients were edentulous for more than 1 year and greater the time of edentulism greater is the rate of ridge resorption and change in the form of residual ridge into low well rounded and ultimately it appears to be depressed.[11] Besides this, several other studies suggest that the period of edentulism has a major contribution in mandibular bone loss and its severity.[5,9,15]

This study also provides evidence for the association of edentulism with systemic conditions; as mentioned earlier that 85 out of 145 participants reported systemic conditions (including diabetes, hypertension, respiratory diseases, liver diseases and osteoporosis) whereas 60 out of 145 were found to be without any systemic disease. Our findings were in line with a study where 50% of the population had lost their teeth due to mobility and 40% of them presented with systemic conditions, diabetes being the most common.[16-18] In a study by Al-Jabrah et al, amount of RRR was compared between diabetic patients and nondiabetic control group and it was found that the resorption in diabetic group (35.8%) was significantly twice to that of the control group (18.0%).[16] A study reported that patients with type 2 diabetes were at a greater risk for change in bone score as compared to non-diabetic patients. Literature suggests that there is an increased risk of alveolar bone loss and resorption in diabetic patients due to their poor glycemic control.[19]

In addition to this, high prevalence of tooth and bone loss have been found in patients with chronic kidney diseases as well.[20] Other studies also reported more resorption in mandibular ridge of the patients with systemic diseases than those without any systemic disease.[18,21]

Osteoporosis on other hand, is also a metabolic disorder that is characterized by high bone fragility and lower bone mass, with high morbidity and mortality, hence may accelerate the RRR.[22] In a study it was found that there was greater rate of bone loss amongst the osteoporotic subjects with poor efficiency of mastication.[23] this also supports our finding of depressed ridge form amongst the case group and low well rounded amongst the control group. However, no literature could be found addressing the morphology of the ridge with systemic diseases.

Furthermore, a strong correlation between mandibular ridge form and period of edentulism was observed which means the more the period of edentulism, the greater will be the ridge resorption. Likewise, there was a study on the relation of mandibular ridge height with the duration of edentulism, and a negative correlation was found between mandibular ridge height and duration of edentulism ($r = -0.176$).[5] This negative correlation between mandibular ridge height and duration of edentulous state eventually supports our finding because according to this, greater the edentulous time, lesser will be the ridge height which in turn means more resorption. A previous study regarding mandibular ridge resorption also supports our finding; mandibular RRR was reported to increase with an increase in the duration of edentulism.[24] However, on the contrary, some studies suggest a rate of resorption to be significantly higher in patients who have been edentulous for a shorter period of time due to the fact that the

resorption is rapid during the first few years and then gradually slows down over the period of time.[5,11]

Moreover, a weakly positive correlation was found between mandibular ridge form and the duration of previous dentures. This means that the mandibular ridge continues to resorb over time regardless the patient is a denture wearer or not. Literature supports the fact that the degree of mandibular RRR and duration of wearing a complete denture are correlated.[19] According to research, denture wearers lose more bone than non-wearers.[11] In a similar study, it was also suggested that bone resorption might reduce if the dentures are removed during night-time as there would be better blood circulation of the underlying tissues.

The study was only focused on some specific diseases and with limited sample size. Though future studies can include effects of a variety of other co-morbid with a larger sample size.

CONCLUSION

Considering the methodologies implemented and the statistical analysis of the data produced, it is reasonable to conclude that the most prevalent ridge form in control group (patients without any systemic disease) was found to be low well-rounded, though depressed form was the most prevalent one in the case group (patients with systemic disease). Additionally, the mandibular ridge resorption pattern was similar in both groups studied.

Authors Contribution

1. **MSA and NA:** planned and designed the present work
2. **SM and QM: were** responsible for realizing the work.
3. **FB and IG:** collected the data.
4. **NA and QM:** were responsible for the data acquisition and analysis.
5. **QM and SM:** drafted the manuscript.
6. **MSA and NA:** revised the manuscript.

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Institutional ethical board approval

The study was approved by the Ethical Review Committee of Altamash Institute of Dental Medicine, Karachi, Pakistan (AIDM/EC/10/2019/15)

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Conflict of Interest

The authors report no conflict of interest

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