

A Radiographic Evaluation of Residual Ridge Resorption in Mandible in Elderly Diabetic Individuals

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ABSTRACT

Aim: The aim of present study was to evaluate loss of bone height in completely edentulous individuals having diabetes mellitus.

Materials and methods: 72 edentulous subjects, between the age of 56 to 80 years and who had been edentulous for period of at least 10 years were selected. Out of these, 36 individuals were those who had diabetes and 36 were control group without any systemic diseases. Using Wical and Swoope analysis method, the original height of the alveolar ridge was estimated from a panoramic radiograph. Then, loss of bone height of the subjects with diabetes was compared with the control group.

Statistical Analysis: The differences in mean values of residual ridge resorption between diabetic group and control group was evaluated using 2-sample t-Test. The mean differences in male and female group was evaluated using student's t-Test.

Results: The results showed that in individuals with same duration of edentulism, the ones with diabetes showed almost 2.5 times more the mean residual alveolar bone loss as compared to individuals without diabetes.

Conclusion: Within the limits of this current study, it was evident that diabetes can be attributed as a factor of exaggerated residual alveolar bone loss.

Keywords: Alveolar Resorption, Diabetes Mellitus, Panoramic radiography.

INTRODUCTION

Residual ridge resorption (RRR) is one of the most important disease entity that results in functional impairment of stomatognathic system. The resorption of residual bone, following the extraction of teeth at the sight of edentulous ridge has been characterized as a chronic, cumulative and irreversible process that often proceeds at an alarmingly rapid rate. The resorption is greater during the first few months after extraction of tooth in comparison to later times, thereafter, it slows

down gradually with time in normal individuals.^{1,2} Tallgren et al reported that the resorption rate is supposed to be four times more pronounced in the mandible than in the maxilla. Also, the rate of resorption is affected by systemic conditions like asthma, thyroid and diabetes.³ RRR is associated with the fact that the residual alveolar bone on which the prosthesis is judiciously fabricated undergo change in shape and reduction in size at different rates in different persons at varying time. Treatment of edentulous patient requires maintenance of phase that must be carried out for

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FIGURE

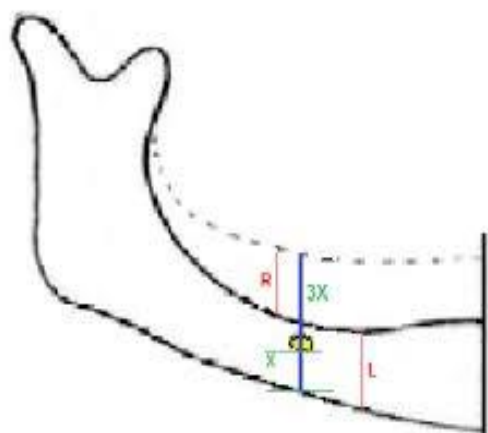
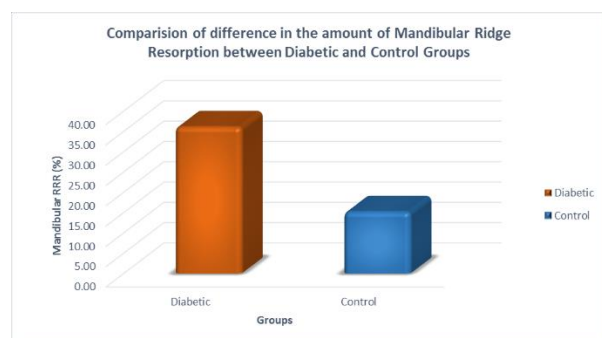
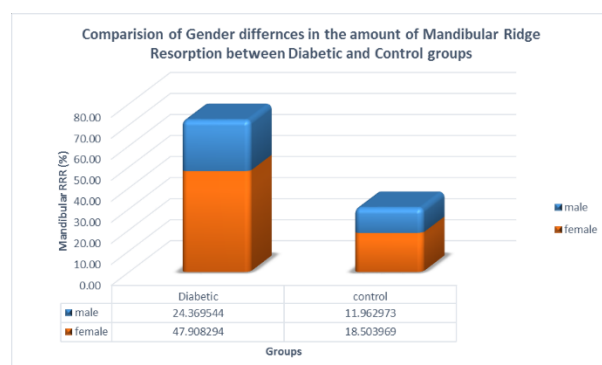


Fig 1: Analysis of residual ridge resorption using Wical and Swoope method.



Graph 1: Comparison of difference in the amount of Mandibular Residual Ridge Resorption between Diabetic and Control Groups.



Graph 2: Comparison of Gender differences in the amount of Mandibular Residual Ridge Resorption between Diabetic and Control groups

remaining life of the patient. The amount of the RRR is often so great that properly made dentures need to be relined / remade for the reasons of esthetic or

function. It is considered by some that RRR is a normal physiological process and not a disease but owing to its varying rate in different individuals and at different sites, it has been considered as a disease.

The causes of RRR have remained elusive; some of which include osteogenic cell population, local tissue factors, systemic biomechanical factors, physical loading factors and prosthetic factors.^{4,5} RRR is a multifactorial phenomenon with a number of interacting or coexisting factors that cause bone loss in the residual alveolar ridge. This dimensional reduction should be considered as a complex disease with recognisable features and unwanted consequences that affect vast number of people.

In addition, osteoporosis is one of the most significant clinical situations affecting the aging population and its association to the high incidence of RRR.⁶ It has been found that severity of bone loss increases with the advancement of age and has female sex predilection. Post-menopausal women comprise most of the edentulous females with severe RRR. The effect of menopause on the resorption of mandible was thought to be similar to the effect on the rest of the skeleton and therefore, places the post-menopausal women at a higher risk of becoming completely edentulous patients with severe RRR.^{7,8} Similarly, systemic disease like diabetes mellitus (DM) is a chronic metabolic disorder with high blood sugar levels. Diabetes results from deficits in the production of insulin or deficit insulin resistance coupled with insufficient insulin production. It often leads to serious complications that affect the heart, blood vessels, eyes, kidneys, and nerves. It has also been increasingly recognized that diabetes adversely affects bone health.⁹

As the complete dentures are widely used to restore form, function and esthetic of complete edentulism, the degree of retention and stability of the complete denture affected by the resulting shape and size of the residual alveolar ridge. Thus, before considering prosthodontic treatment, both the quantity and quality of the bone must be assessed radiographically and treatment plan should be modified in diabetics accordingly.¹⁰

Although RRR is a physiologically occurring process in normal edentulous individuals, the presence of

Table 1: Distribution of diabetic and control groups according to age and gender.

Age range	Diabetic group (n=36)		Control group (n=36)		Total (n=72)		Total
	Male	Female	Male	Female	Male	Female	
56-60	3	4	2	4	5	8	13
61-65	3	4	4	4	7	8	15
66-70	6	5	6	5	12	10	22
71-75	4	4	4	3	8	7	15
76-80	2	1	2	2	4	3	7
Total	18	18	18	18	36	36	72

Table 2: Differences in the amount of mandibular residual ridge resorption between diabetic and control groups.

Group	X	3x	L	R=3x-L	%=(R/3x)x100%	2-Sample t-Test	P value
Diabetic	9.85	29.55	19.42	10.13	36.14	12.362	0.000
Control	10.43	31.29	25.56	5.73	15.23		P<0.01

x: distance from lower border of mental foramen to inferior border of mandible; L: height of residual mandibular bone; R: amount of resorption.

Table 3: Gender differences in the amount of mandibular residual ridge resorption between diabetic groups and control groups.

Group		X	3x	L	R=3x-L	% = (R/3x)x100%	Student's t-test	P value
Diabetic	M=18	11.42	34.25	25.83	8.42	24.37	23.339	0.000 P<0.001
	F=18	8.28	24.83	12.94	11.89	47.91		
Control	M=18	11.81	35.42	31.05	4.36	11.96	3.679	0.002 P<0.05
	F=18	9.06	27.17	21.97	5.19	18.50		

x: distance from lower border of mental foramen to inferior border of mandible; L: height of residual mandibular bone; R: amount of resorption.

certain conditions like diabetes predisposes them to accelerated rate of bone resorption. Therefore, the current study aims to assess them in the following ways:

1. To evaluate the relationship of mandibular residual ridge resorption and diabetes mellitus as well as to compare the amount of ridge resorption between the diabetic and the control group.
2. Also, to evaluate the effect of gender on rate of residual ridge resorption in mandible.

MATERIAL AND METHOD

SUBJECTS

The samples for this study were selected from walk-in patients who visited the Department of Prosthodontia, Karnavati school of dentistry, Gandhinagar, Gujarat. The patients who were selected for this study were completely edentulous and came for replacement of their missing teeth with complete dentures. 72 edentulous subjects (36 males and 36 females) were made to participate in this study. Selected subjects were between the age group of 56 and 80 years, in which, 36 were having diabetes mellitus and 36 were controls without any systemic diseases. The panoramic radiographs were taken as part of the patients' routine treatment and thoroughly examined for this study.

INCLUSION/EXCLUSION CRITERIA

For considering a subject in the study, every subject had to satisfy the following requirements: (1) Only clear panoramic radiographs with visible mental foramen on both sides of the jaw for the measurements were included in this study. (2) Minimum 2 mm of alveolar bone must be present overlying the mental foramen in the selected subjects. (3) Each subject was completely edentulous since 10 years, when panoramic radiograph was taken. (4) Diabetic participants should have had diabetes for 5 years or more. (5) None of the subjects had undergone pre-prosthetic surgical treatment (*i.e.* sulcus deepening or ridge augmentation).

MEASUREMENT

For assessment of mandibular RRR, original height of mandible should be known. The mental foramen has been considered as having a fixed position in relation to the inferior border of the mandible. Using Wical and Swoope's analysis method (1974), the original height of the mandible from panoramic radiographs prior to any bone loss is assumed. According to the methodology of these authors, distance from the lower edge of mental foramen to inferior border of the mandible was measured and the original height of the mandible can be obtained by multiplying the distance from the lower edge of the mental foramen to the inferior border of the mandible by three.¹¹

The amount of residual ridge resorption was calculated using the formula: $R = 3x - L$, (where R: amount of mandibular residual ridge resorption; x: distance from lower edge of mental foramen to the inferior border of mandible; L: height of measured mandibular residual alveolar ridge).

Each panoramic radiograph was evaluated using a standard light box and measurements were made using a transparent millimetre ruler by same operator. The distances from the inferior border of the mandible to lower edge of mental foramen were measured at right angles to the body of the mandible. The distances were measured on both left as well as right sides and the average value for each subject was calculated. The amount of resorption from the original alveolar height to the measured level of the residual alveolar ridge was expressed as a percentage of the original height of the mandible (Fig.1). This permitted the comparisons to be made

between subjects, and prevented any error due to radiographic magnification or distortion.

The amount of mandibular residual ridge resorption was calculated and correlated with diabetes mellitus. The rate of resorption of diabetic group was compared with those of non-diabetic (control) group. The rate of resorption in both the genders were also investigated and correlated.

RESULTS

- **Table I** shows distribution of subjects in diabetic and control group according to age and sex.
- **Table II** shows that the amount of mandibular residual ridge resorption in diabetic group is almost 2.5 times more as compared to control group. The difference between groups was statistically highly significant ($p < 0.001$; two-sample t-test).
- **Table III** shows amount of mandibular residual ridge resorption in both the gender groups. Here, results showed that statistically significant gender differences in mandibular residual ridge resorption have been observed between the Diabetes Mellitus ($P < 0.001$) group and the control ($P < 0.05$) group.
- Also diabetic females have more severe resorption than control females.

DISCUSSION

Alveolar bone loss after tooth extraction is a chronic, progressive and cumulative disease of bone reconstruction. Extensive RRR is one of the many problems in prosthetic rehabilitation of completely or partially edentulous subjects.^{12,13} A number of local and systemic factors are related with RRR. Local factors include conditions after teeth extraction (quantity, quality and shape of the residual alveolar ridge, muscle attachment etc.), duration of edentulism, retention and stability of denture, masticatory or other functional forces from denture to the underlying residual ridge, incorrect jaw relation of dentures, night time wearing of dentures, lack of balanced occlusion and the denture wearing duration.⁴

Systemic factors which are contributed to the RRR are nutritional insufficiency, hormonal imbalance, metabolic disturbance, renal impairment, drugs affecting bone metabolism, postmenopausal hormonal disturbances in women, age changes, gender etc.⁵ All these factors together cause more resorptive changes in residual alveolar ridge of maxillary and mandibular jaws.

Diabetes mellitus (DM) is a group of metabolic disorder characterized by hyperglycemia resulting from inability to absorb excess blood sugar by insulin dependent cells.¹⁴ The main two types of diabetes mellitus are Type 1 DM and Type 2 DM. Type I DM occurs due to loss of pancreatic β -cells which leads to insufficient production of insulin. Type II DM occurs because of tissue resistance to the action of insulin. Both Type 1 and type 2 diabetes are known to have significant effects on bone health.¹⁵ The rate of alveolar bone loss is greater and also the progression of bone loss is more severe for subjects with diabetes mellitus compared to non diabetic individuals. Diabetes mellitus is positively associated with changes in bone quality compared to subjects without diabetes. These results suggest that hyperglycemia or increased blood sugar level leads to increase in residual ridge resorption.

The first objective of this study was to know the effect of diabetes mellitus on mandibular residual ridge resorption. In this study, it was found that amount of mandibular residual ridge resorption among subjects having diabetes mellitus was higher than those subjects without any systemic diseases. It has been reported that the formation of the collagenous framework in the tooth extraction socket is inhibited in diabetic individuals, resulting in delayed healing and there is increased alveolar destruction.¹⁶ In diabetes mellitus insufficient insulin causes the improper utilization of glucose. In absence of insulin, a relative nitrogen starvation occurs from increased gluconeogenesis with the amino acids being diverted from protein synthesis, which leads to poor healing, low tissue tolerance and rapid resorption of bone.¹⁷ Insulin binds to receptors on osteoblasts and stimulates anabolic effects. It is possible that the reduced insulin levels or reduced insulin signaling in osteoblasts negatively affects

bone and contributes to reduced bone formation caused by diabetes.⁹

The second objective of this study was to know the effect of gender difference on mandibular residual ridge resorption. Here, female subjects were found to have more amount of mandibular residual ridge resorption compared with their male counterparts which was similar to the study carried out by Humphries S and Devlin H. In addition, diabetic females were having more resorption than the control females. Most of the females in the present study were in the age group of post-menopause period, and this may explain the gender-related difference observed in this study. Furthermore, experimental evidence has shown that estrogen depletion leads to decreased apoptosis of osteoclast which causes a significant loss of bone mass in the edentulous mandible but not in the dentate mandible.¹⁸

Panoramic radiography is extensively used technique because it has the advantage of providing the image of both the jaws in a single film, with relatively low radiation exposure, in a short period of time and at lower cost if compared to other sophisticated techniques.¹⁹ This technique can provide information about the localization of anatomic structures and vertical bony dimensions without much distortion. However, without knowing the magnification degree and the image distortion, mistakes in measurements may occur as well as OPG does not provide the buccolingual view of the bone.²⁰ As changes in the mandibular cortex can be detected on the OPG of patients with osteoporosis, it can be considered an important diagnostic tool provided that diagnostic values are not lost due to projection errors resulting from disposition of the head.

Diabetic individuals vary greatly from non-diabetic individuals in conditions of their oral tissues and underlying bone. Precise care should be taken, beginning from impression making procedures to repeated follow up of such individuals. For patients having diabetes mellitus, every effort should be made to retain natural teeth to the longest time possible as the amount of alveolar resorption would increase with increasing duration of wearing complete denture. Basker *et al.* reported that the amount of alveolar bone

resorption in the edentulous area is eight times than that in dentate area in the same subject.²¹ Hence, preserving natural teeth and using them for constructing overdentures can greatly reduce RRR.

Further research using other systemic and local factors, duration of wearing complete denture, oral health of denture foundation area as well as denture quality, status of general health may be considered.

CONCLUSION

Within the limitations of this study, the following conclusions can be made:

1. Statistically significant difference ($P < 0.01$) between the two study groups has been recorded, diabetic patients have 2.5 times greater amount of RRR compared to controls (36.14% versus 15.23%).
2. When compared with males, female subjects have significantly greater amount of RRR in both groups ($P < 0.001$).

Thus, from the result of this study, a prosthodontist should try to maintain and prevent the further resorption of the residual alveolar ridge by modifying routine prosthodontic procedures, especially for diabetic patients. For these type of patients, the required modifications in prosthodontic procedures are as follows:

1. If possible, tooth / root supported overdenture should be planned.
2. During impression making, a minimal pressure technique should be followed.
3. During jaw relation record, a correct vertical dimension of occlusion should be established which is esthetically and functionally permissible.
4. Non-anatomic teeth should be selected and neutral zone record technique is used for arrangement of teeth.
5. A lingualized occlusion should be given.
6. If further required, resilient soft liner can be used.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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