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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF MANDIBULAR RIDGE RESORPTION IN NONDIABETIC AND DIABETIC EDENTULOUS POST-MENOPAUSAL WOMEN- A CROSS-SECTIONAL STUDY

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ABSTRACT

Background*:** To investigate the amount of mandibular ridge resorption in nondiabetic and diabetic completely edentulous post-menopausal women and to describe the effects of age, duration of edentulousness, time since attaining menopause and duration of diabetes mellitus. ***Methods*:** A cross-sectional, pilot study was conducted on 20 completely edentulous women (10 nondiabetic and 10 diabetic with type 2 diabetes) with a mean age of 56 years (range of 45 to 67 years). Resorption in the mandibular residual ridges was assessed by using the mental foramen and the inferior border of the mandible, as they appear in panoramic radiographs, as reference points using Wical and Swoope Analysis method. The orthopantomograms were digitized using scanner and measurements were performed. The amount of mandibular ridge resorption was calculated and compared between nondiabetic and diabetic groups. Statistical analysis was performed using Statistical Package for Social Scientists (SPSS) version 20. A paired t-test was used to evaluate the differences in mean values of mandibular ridge resorption between nondiabetics and diabetics. Level of significance was set at 0.05. ***Results*:** The mean mandibular residual ridge resorption of all participants was 15.71 mm, diabetic group (10.79mm) had 0.5 times more resorption compared with control group (20.62mm). ***Conclusion: Completely edentulous, postmenopausal diabetic women have more residual ridge resorption than completely edentulous, postmenopausal nondiabetic women.

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INTRODUCTION

Residual ridge resorption (RRR) after loss of teeth is a chronic, progressive, and cumulative disease of bone remodeling (Atwood, 1988; Zarb, 1990). It is a term describing the diminishing quantity and quality of the residual ridge after the teeth are extracted (Atwood, 1962; Ortman, 1962; Glossary of Prosthodontic Terms, 2017). A severely reduced residual ridge constitute a serious problem complicating prosthetic rehabilitation whether by construction of a removable denture or by use of an implant prosthesis. The mandible seems to be the bone within the human skeleton that is most exposed to severe decrease in its height and mineral content as it is one of the primary source of the available calcium in the body (Wowern, 1988). Post-menopausal women comprise most of the female edentulous population with severe RRR. The effect of menopause on the 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 complete denture patients with severe RRR (Wactawski-Wende *et al.,* 2005). Diabetes mellitus is a chronic disease, which occurs when blood glucose concentration in body is in excess (Bianchi, 2008). There are mainly two types; type 1 and type 2 diabetes. Type 1 diabetes, previously known as insulin-dependent is characterized by a lack of insulin production. Type 2 diabetes, formerly called non-insulin-dependent is caused by the body's ineffective use of insulin. It often results from excess body weight and physical inactivity. It has been said to cause bone resorption and has been considered to contribute to failure in dental treatment (Kotsovilis, 2006). Complete dentures are widely used in restoration of completely edentulous dental arches. The resulting shape and size of the residual ridge influence the degree of stability and retention of the denture and affect the amount of applied load. Before considering prosthodontic treatment, both the quantity and quality of the bone must be assessed radiographically (Abraham, 1993; Jacobs *et al.,* 1999). In the literature, limited data exists with regard to RRR in diabetic and nondiabetic post-menopausal women. The aim of the present study was to assess the amount of mandibular RRR in completely edentulous diabetic and nondiabetic post-menopausal women and to describe the effects of age, duration of edentulousness,

time since attaining menopause and duration of diabetes mellitus. The null hypothesis was that there was no difference in the residual ridge resorption rate between diabetic and nondiabetic postmenopausal women and the research hypothesis was that there is difference in the residual ridge resorption rate between diabetic and nondiabetic postmenopausal women.

MATERIALS AND METHODS

This study was carried out at the Department of Prosthodontics and Crown & Bridge, Goa Dental College and Hospital, Bambolim, Goa; over a period of one year from April 2018 to April 2019. The sample for the present study was selected from a population of completely edentulous, post-menopausal women who attended or referred to the Department of Prosthodontics for routine dental prosthetic procedures. The subjects were explained about the study. After they agreed to be volunteers for the study, written informed consents were obtained in the vernacular language.

Inclusion criteria

- Completely edentulous women in natural menopause (which is recognised to have occurred after 12 months of amenorrhoea and for which there is no obvious pathology)
- No history of any previous denture use (including partial dentures)
- No history of oophorectomy or hysterectomy
- For the test group, subjects with history of Type 2 diabetes mellitus were chosen after confirmation with their medical records and cross-checking values of recent Fasting and Post-prandial Blood Sugar (FBS/PPBS) levels or HbA1c levels. Only subjects with FBS of ≥126 mg/dl, PPBS of ≥200 mg/dl or HbA1c of ≥6.5 were included in study (RSSDI, 2018).

Exclusion criteria

- Partially edentulous patients,
- History of previous use of dentures,
- Patients with history of oophorectomy or hysterectomy,
- Smokers and alcoholics,
- Patients with any known systemic disease that would affect bone metabolism like hyperparathyroidism, hypoparathyroidism, hyperthyroidism, Paget's disease, osteomalacia, renal osteodystrophy, cancers with bone metastasis or significant renal impairment
- Patients who are on specific drugs (corticosteroids) which are known to have adverse effects on bone metabolism.

The study included two groups: Group 1 (Control Group) and Group 2 (Diabetic Group) of 10 subjects each *(n=10)*. Group 1 contained completely edentulous, non-diabetic postmenopausal women and Group 1 contained completely edentulous, diabetic postmenopausal women who met with the inclusion and exclusion criteria completely. A complete recording of the case history (both medical and dental) was done followed with the oral examination. Patient details such as age, duration of edentulousness, duration of diabetes mellitus (in test subjects) and time since attaining menopause were noted. Routine primary and secondary impression of mandibular arch were done to obtain the master cast. A record base was fabricated using clear, auto-polymerising acrylic resin in which a metal ball of 5mm diameter was incorporated during the late dough stage. This was done to calculate any magnification error when obtaining the orthopantomogram (Wical *et al.,* 1974). The record bases were finished and polished. They were tried in the subjects for fit and required adjustments were done. The patients were then subjected to panoramic imaging using Planmeca Proline EC 2002 Radiographic Unit (exposure values for adult female according to manufacturer- 64Kv and 6mA for exposure time of 12 seconds) in the Department of Oral Medicine, Diagnosis and Radiology, Goa Dental College and Hospital, Bambolim. (Figure 1) The radiographs were scanned and digitized with Medi-6000 Plus scanner. Linear and angular measurements were done with Adobe Acrobat Reader DC with a resolution of 0.1 mm.(Figure 2) Measurements were repeated 3 times and average values were taken.

Measurements: Mandibular RRR was assessed by using the Mental Foramen (MF) and the inferior border of the mandible, as they appear in digitized orthopantomograms, as reference points using Wical and Swoope Analysis method; in which the original height of the mandible is assumed to be 3 times the distance between the inferior border of the mandible to the lower border of the MF (Wical *et al.,* 1974).

The amount of resorption was calculated according to the formula:

$R = 3x - L$

Where,
R: amount of mandibular RRR;
x: distance from inferior border of mandible to the lower border of MF;
L: height of mandibular residual alveolar ridge

The evaluation of the height of alveolar bone available was then determined by the application of the following mathematical formula:

$$\frac{ADB}{RDB} = \frac{ABH}{RBH}$$

Where,
ADB=Actual diameter of metal ball
(which is known to be 5mm),
RDB: Diameter of metal ball on radiograph;
ABH: Actual bone height;
RBH: Bone height measured from the radiograph.

Thus actual bone height can be obtained by,

$$ABH = \frac{ADB \times RBH}{RDB}$$

RESULTS

Measurements were done in both right and left sides to rule out any chances of bias (for example, difference in rate of resorption due to different timings of extraction of teeth). Statistical Package for Social Sciences (SPSS) version 20 was used for the analysis of the data and Microsoft Office Excel 2013 & Microsoft Office Word 2013was used to generate graphs and tables. Level of significance was set at $p \leq 0.05$. Descriptive statistics for Group 1 and Group 2 are described in

Table 1. Paired t-test was performed to unveil statistically significant deviation of measurements between right and left sides. The mean of Group 1 Right side minus Group 2 Right side equals 9.18 and 95% confidence interval of this difference: From 7.87 to 10.49. The two-tailed p value is less than 0.0001.The mean of Group 1 Left side minus Group 2 Left side equals 10.49mm and 95% confidence interval of this difference: From 8.61 to 12.37. The two-tailed p value is less than 0.0001. By conventional criteria, this difference between both Group 1 and Group 2 (Right/Left sides) is considered to be extremely statistically significant (Table 2, 3). It was also calculated whether there existed any statistical difference between right and left sides in the same group. Paired sample test (Table 4) to compare the differences between right and left sides of Group 1 and Group 2 showed statistically no difference ($p \geq 0.5$).

DISCUSSION

The null hypothesis was rejected as there was statistically significant difference between the residual ridge resorption rate of nondiabetic (control) group (20.62mm) and the diabetic (test) group (10.79mm). The diabetic group had twice (1.9 times) more resorption rate than the non diabetic group. Extensive RRR is one of the many problems in geriatric dentistry. Many local and systemic factors are related with RRR. Local factors include conditions after teeth extraction (quality, quantity and shape of the residual ridge, muscle attachment, etc.), edentulousness, bite stress from the denture to the edentulous ridge. Systemic factors include patient's age, gender, calcium deficiency, calcium & phosphate metabolism disorders, systemic osteoporosis and hormonal disturbances. Diabetes mellitus has become a common lifestyle disease of the 21st century. India leads the world with the largest number of diabetic patients and has been declared as the "Diabetic Capital of the World" by the WHO (Mohan *et al.,* 2017). A study on the global estimates of diabetes reported the total number of diabetic patients in India to be around 50.8 million which are expected to increase to 87 million by the year 2030 (Sicree *et al.,* 2009). Devlin et al found that the amount of mandibular RRR among diabetic subjects was higher than that among nondiabetic subjects (Devlin *et al.,* 1996). Furthermore, the prevalence of bone resorption among patients with diabetes tends to be greater than among the general population; this difference may be related to hyperglycemia in the former group (Mathiassen, 1990). Accursi examined the impact of DM on the success of dental implants. He concluded that the diabetic patients were more likely to have greater loss in crestal bone levels around the implants than the nondiabetic patients (Accursi, 2000). In the present study, diabetic females suffered more resorption than the nondiabteic female controls. In addition, diabetic females suffered more resorption than the female controls. This phenomenon could be explained with the effect of the menopausal activity causing estrogen depletion combined with effects of diabetes in women on the alveolar RRR. Previous studies have reported similar results (Elders, 1988; Engel, 1994; Elsubeihi, 2001). Conversely, some researchers have reported that it is not known, if mandibular bone loss observed in the edentulous mandible in association with estrogen deficiency, results from increased bone resorption alone or the combined effect of increased bone resorption and reduction in bone formation rate (Elsubeihi, 2001; Kingsmill *et al.,* 1998). Mental foramen landmark selected for the present study is commonly used for studies of mandibular bone as it is fairly reproducible (Wical, 1974; Apinhasmit, 2006; Al-Khateeb, 2007; Al Talabani *et al.,* 2008). The location of the MF relative to the inferior and superior borders of normal mandibles, as expressed by the mean ratio of total bone height to height of the foramen above the inferior border, appears to be consistent enough to justify its use as a reference point in clinical studies. Since the bone below MF constitutes a predictable proportion of the total bone height in the majority of normal subjects, and since this bone is not significantly affected by resorption until extreme atrophy occurs, its height may serve as the basis for estimating the original mandibular height in elderly subjects (Wical, 1974). In this study, Wical and Swoope method was used to evaluate the amount of mandibular RRR (Wical, 1974). Clinically, lower edge of the MF appears to be a more useful reference mark in OPGs. Observing the distance from the inferior border of the mandible to the lower edge of MF and using the approximate ratio of 3:1 can help to estimate conveniently the original height of the mandible before resorption (Krajicek, 1984; Zengingul *et al.,* 2007). The main objectives of preoperative assessment are to determine if there is sufficient bone in the alveolar ridge and to determine the precise position of the anatomical structures in order not to be damaged during surgery (Abraham, 1993; Frederiksen, 1995). OPG is a widely used technique because it has the advantage of providing, in a single film, the image of both jaws, with a relatively low radiation dose, in a short period of time, and at lower cost if compared to more sophisticated techniques (Wilding, 1987). This technique can offer information about the localization of anatomic structures and vertical bony dimensions. However, without knowing the magnification degree and the image distortion, mistakes in measurements may occur, in addition, OPG does not provide the buccolingual view of the bone (Rockenbach, 2003).

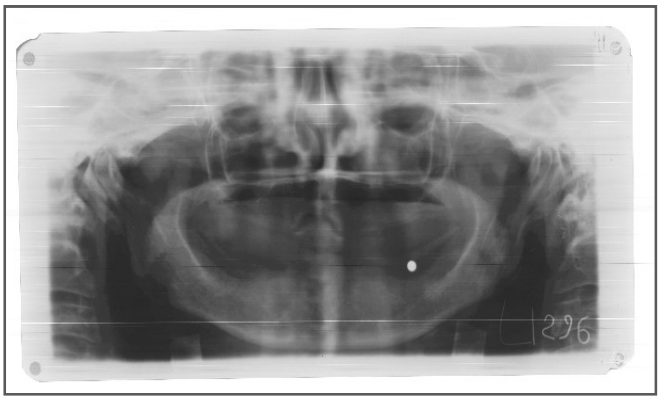

Figure 1. Scanned OPG showing 5mm radiographic marker

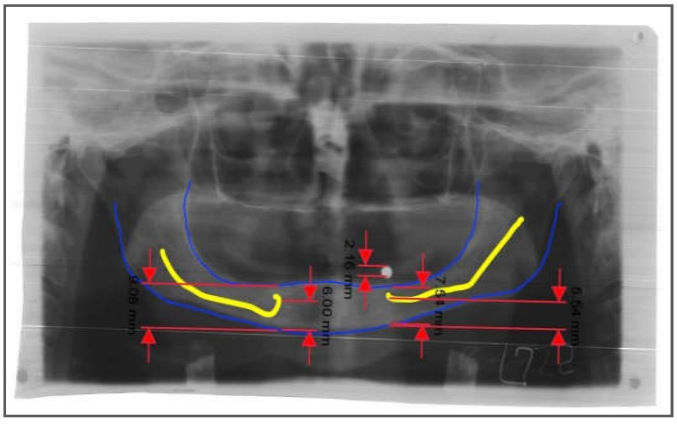

Figure 2. Markings using Adobe Acrobat Reader

Table 1. Descriptive statistics for Group 1 and Group 2

Groups		n	Minimum	Maximum	Mean	Standard Deviation
Group1	Age (in years)	10	45	67	55.7	8.04
	Duration of edentulousness (in years)	10	1	7	3.2	1.93
	Time since attaining menopause (in years)	10	2	19	8.5	5.32
Group 2	Age (in years)	10	45	67	55	7.57
	Duration of edentulousness (in years)	10	2	7	3.9	1.66
	Time since attaining menopause (in years)	10	1	13	7	4.22
	Duration of diabetes mellitus (in years)	10	1	8	4	2.06

Table 2. Paired t test for right side of Group 1 & Group 2

Groups	n	Mean	Std. Deviation	Std. Error Mean	t	df	p value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
										Lower	Upper
Group1 (Right)	10	20.68	1.76	0.56	14.74	12	0.00	9.18	0.62	7.87	10.49
Group2 (Right)	10	11.50	0.89	0.28	14.74						

Table 3. Paired t test for left side of Group 1 & Group 2

Groups	n	Mean	Std. Deviation	Std. Error Mean	t	df	p value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
										Lower	Upper
Group1 (Left)	10	20.56	1.92	0.61	11.73	18	0.00	10.49	0.89	8.61	12.36
Group2 (Left)	10	10.07	2.07	0.66	11.73						

Table 4. Paired t test between right and left sides of Group 1 and Group 2

Groups	Mean	Std. Deviation	Std. Error Mean	t	df	p value	95% Confidence Interval of the Difference	
							Lower	Upper
Group 1 (Right-Left)	0.12	2.20	.69	0.18	9	0.86	-1.45	1.69
Group 2 (Right-Left)	1.43	2.18	.69	2.07	9	0.07	-.13	2.99

As changes in the mandibular cortex can be detected on the OPG of patients, 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 (White *et al.,* 2005; Klemetti *et al.,* 1994). Several studies have reported that OPGs are reproducible and accurate for the linear and angular measurements on mandibles (Ceylan, 1998). It has been shown that reliability of the OPG technique for imaging of the mandible is highly dependent on head position. In the present study, OPGs were made by same operator using the same panoramic unit. The technique for the measurement of the alveolar ridge resorption used was essentially the same as that described by Wical and Swoope (Abraham, 1993). In a study of Wilding *et al.,* in which the reliability of this technique was tested, it has been concluded that the use of this technique is sufficient to provide information about RRR of mandibular alveolar bone compared to a more complicated method (Ceylan *et al.,* 1998). The results of this study highlight on the association between DM and RRR in completely edentulous, postmenopausal women. It has been shown that diabetic women in particular, are at risk of RRR than nondiabetic subjects. For diabetics, effort should be taken to retain natural teeth to the longest time possible as the amount of resorption would increase with increasing CD wearing period. Studies on association of diabetes, edentulism and menopause are sparse. Further research on a larger sample is needed before the results of this study can be applied on the general population.

Conclusion

Within the limitations of this study, it has been found that completely edentulous, postmenopausal diabetic women have more residual ridge resorption than completely edentulous, postmenopausal nondiabetic women. This reinforces the necessity of dental practitioners to have a multidisciplinary understanding of the patients' systemic conditions like menopause and diabetes mellitus, and correlate it with clinical findings; given that these may influence individuals' dental planning and treatment.

Conflict of Interest: The authors declare no conflict of interest.

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Keypoints

- Importance of oral healthcare in postmenopausal women with comorbidities such as Type 2 diabetes mellitus must be reinforced in general practice.
- Use of accurate diagnostic methods to determine bone findings must be taken care of.

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