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RESIDUAL ALVEOLAR RIDGE RESORPTION IN COMPLETELY EDENTULOUS PATIENTS INFLUENCED BY PATHOPHYSIOLOGIC FACTORS

(RESORPSI TINGGI TULANG ALVEOLAR PADA PASIEN TIDAK BERGIGI YANG DIPENGARUHI OLEH FAKTOR PATOFISIOLOGI)

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Abstract

Residual ridge resorption and remodeling directly affect the function of removable prostheses which relies greatly on the quantity and architecture of jaw bones. The purpose of this study was to assess the remaining bone height level in relation to some pathophysiologic factors that may affect on the resorption process. The factors involved in this study were Diabetes mellitus, periodontitis, menopause, and edentulousness time (more than 10 years). Maxillary and mandibular bone height on 115 dental panoramic radiographs belonged to full edentulous patients were measured and compared to 35 controls using MB Ruler software. The soft images were collected using the radiographic machines in the faculty of dentistry. The measurements included maxillary middle anterior and lateral bone heights, middle mandibular dimension, right and left mental bone heights. The results showed that women with completely edentulous arches showed relatively higher rate of bone resorption than men, and control group. Indian patients also demonstrated higher bone resorption rate, particularly on the mandible, followed by Chinese and Malay. In regard to different health conditions, edentulousness time for more than 10 years showed the minimal bone height reduction that affected mainly the mandible sides compared to other conditions and the control group. On the sides of maxilla, periodontitis exhibited higher effect on the residual ridge resorption rather than other studied conditions. However, on the middle of maxilla, menopause was associated with maximum bone resorption compared to the others. As conclusions, residual ridge resorption in completely edentulous patients may be influenced by gender, race and patient's health conditions.

Key words: residual ridge resorption, Diabetes mellitus, menopause, Indian, Malay, Chinese

INTRODUCTION

The goal of modern dentistry is to restore the edentulous patients to normal contour, function, comfort, aesthetic, speech and health, regardless of the atrophy, disease or injury of the stomatognathic system.[1] Residual ridge resorption (RRR) and remodeling directly affect the function of removable prostheses, which relies greatly on the quantity and architecture of the jaw bones.[2] RRR may progress without apparent symptoms until the patient's dentures become loose. Therefore, the ability to predict which patients are likely to lose a greater amount of bone is important both for prevention purposes and for subsequent making proper prosthetic treatment planning.[3] Beside that, to improve the outcome of denture retention, ridge preservation is very important, even if implant therapy is required, sufficient alveolar bone volume and favorable ridge architecture.[4]

RRR has been measured using variety of radiographic techniques.[5] A number of studies has been conducted to describe the structural changes of the residual ridge by means of lateral cephalographs,[6] panoramic radiographs,[7] and Orthopanto-mograms.[8] The dose is equivalent to about 3-4 periapical radiographs. Dental panoramic tomography (DPT) has become a very popular radio-graphic technique in dentistry due to its reasonable simplicity and low radiation dose, particularly with modern DC units supplied with rare-earth inten-sifying screen. RRR is a chronic, progressive and cumulative disease of bone remodeling.[3] It is a complex and multifactorial process.[8] The average change is four times greater in

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the mandible compared to maxilla. Individual variations in the degree of RRR have been the reason for various studies on factors that may influence the progress of such resorption.[9]

The amount and rate of RRR are affected by factors like patient's general condition and duration of edentulousness.[3,10] Mechanical, metabolic, nutriational, hormonal, and probably others, as yet unknown, factors are involved, and these have various effects over time.[8] Generally, the factors are classified into two groups, local and systemic. Local factors consist of the condition of the alveolar process after teeth extraction (quality, size and shape of ridge), duration of edentulousness and bite stress on the edentulous alveolar ridge transmitted by the denture.[11] Systemic and individual factors, such as general pathologic condition, aging, gender, low calcium intake, and osteoporosis, have repeatedly been linked with mandibular atrophy.[12]

Periodontitis is a common inflammatory disorder characterized by inflammation within the supporting periodontal tissues, often leads to irreversible alveolar bone resorption and teeth loss.[13] It has been suggested that patients with marginal periodontitis is at increased risk for a more progressive form of periodontitis which causes more bone resorption.[14]

Diabetes mellitus (DM) represents one of the major health problems. It is the main endocrine disorder that has been documented to affect the periodontium,[15-17] bone and calcium metabolism.[18] Primary DM has been classified into two major categories; Type I or insulin-dependent DM and Type II or non-insulin-dependent DM.[19] Alveolar bone resorption has been shown to increase significantly with an increment in severity of the diabetic condition. It has been documented to affect bone and calcium metabolism. However, controversy on the changes of bone mineral density and the levels of bone metabolic markers still arises.[20]

Duration of edentulousness has been related to the severity of RRR, particularly in the mandible. Alveolar bone loss in the edentulous jaw is a continuous process that may proceed throughout the lifetime of the denture wearer. According to several cross-sectional studies, patients with a long period of edentulousness had lost a greater amount of the mandibular bone than those with a short period of edentulousness.[21]

The relationship between tooth loss and bone mineral density (BMD) has long been evaluated in post-menopausal women and several studies suggested an association between tooth loss and diminished systemic BMD.[22,23] In postmenopausal women, deficiency of estrogen hormone accelerates bone loss and may result in rapid alveolar bone resorption.[11] Consequently, this loss of bone mass may affect the rate of RRR.[24,25]

The amount of alveolar bone resorption was not correlated with the age of the subjects.[26] However, the decrease in the height of the edentulous mandible and maxilla was more pronounced in women than in men.[27,28]

The purpose of this study was to assess the maxillary and mandibular bone heights in relation to gender, ethnic group, and history of periodontitis, diabetes mellitus, menopause, and edentulousness duration for more than 10 years.

MATERIALS AND METHODS

Data were collected from 115 full edentulous patient's Orthopantomograms radiographs (OPG) and were divided into 65 males and 50 females; their age was 41 to 83 years (mean 64.45±10.01). The sample consisted of 56 Malays, 63 Chinese and 31 Indians (Figure 1, Table 1). A control group composed of 35 partial or full dentate's OPG radiographs (20 men and 15 women, their age ranged from 19 to 79 years, mean 49.1±16.58) was used to compare the former bone measurements in relation to gender, ethnic and other general and local conditions (diabetes mellitus, periodontitis, menopause and edentulousness for more than 10 years). The digital image radiographs were downloaded from computerized radiographic system (Sirona Orthophos XG 5 with magnification 1.2, Instrumentarium with magnification 1.25, and Proline pm2002 CC with magnification 1.25 Siemens). Individual and medical information such as name, gender, race, age, occupation, general and local conditions and year number of being edentulous were recorded.

The inclusion and exclusion criteria of the radiograph selection were as follows: Edentulous patients with Menopausal disorders (>45 years women and >65 years men with osteoporosis as recorded in the folder examination). Edentulous due to periodontitis only (as explained by teeth loss due to mobility). Edentulous with Diabetes Mellitus for at least 5 years under control and edentulous for more than10 years were selected. For the control sample; dentates or partial dentates on the anterior region were included in the study. On the other hand, the folders without adequate data or and vague radiographs were excluded from the study. Maxillary and mandibular bone heights on each panoramic radiograph were measured using the MB Ruler software as follows; for Maxillary arch, the measurements were done in 3 different regions: the

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midline of the maxilla from the crest of the alveolar ridge to a point located at the connecting line of the inferior border of nasal cavity (Figure 2). On the right and left sides, the measurements were made perpendicularly from the most inferior border of maxillary sinus to the crest of the alveolar ridge. On mandibular arch, measurements were made at the midline of the mandible from its lower border to the crest of the remaining ridge. The mental foramen was used as a reference mark for bone height measurement in mental region. Two measurements were made; one to assess the total height of the mandible in mental region on the two sides, and another was to determine the submental bone height (the bone height below the mental foramen measured from the mandibular lower border to the centre of the foramen). The measurements were repeated independently and recorded twice by two examiners. The data were analyzed using SPSS version 14.0 software after correction to 1:1 ratio to overcome different magnification for each of the digital OPG radiograph machines.

Statistical analysis tests like correlation coefficients (reliability test), descriptive statistics, difference between two means (at $p<0.05$ level of significance) were used to test the null hypothesis of the difference between the alveolar ridge heights in relation to gender, ethnic, and some local and general conditions.

RESULTS

The features of the sample and control groups were shown in (Figure 1, Table 1). The studied population consisted of 43 (37.4%) Malay, 51 (44.3%) Chinese and 21 (18.26%) Indians. The Malay composed of 19 (44.2%) men and 24 (55.8%) women, Indians were 8(38.1%) men and 13 (61.9 %) women, while the Chinese were 16 (31.3%) men, and 35 (68.6%) women respectively.

The number of diabetics was 28 (18.67%), with teeth loss due to periodontitis was 35 (23.33%), 24 (16.00%) for menopausal disorders, and 28 (18.67%) patients with totally edentulous ridges for more than 10 years (Figure 3). Inter observer reliability was highly significant ($p<0.05$) (Table 2). Ethnic factor analysis demonstrated that the Chinese and Indians had reduced heights on the mandible compared to Malays, whereas on the maxillary bone, Malays showed more bone resorption than the Chinese and Indians (Table 3, Figure 4, 5). The effect of gender on bone heights was clearer in women than men. However, in men, the Indians demonstrated greater RRR, followed by the Chinese and Malays. Whereas, in women, RRR was more obvious in Malays followed by the Chinese and Indians respectively (Figure 6, 7).

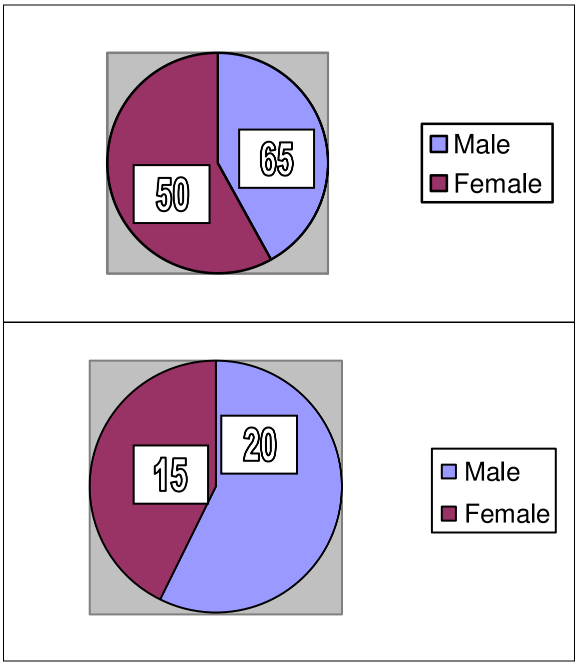

Figure 1. Gender composition of sample and control cases

Table 1. Ethnic composition of the sample and control group

Ethnic group	Sample	%	Control	%
Chinese	51	44.4	12	34.3
Indian	21	18.3	10	28.6
Malay	43	37.4	13	37.1
Total	115	100	35	100

Patients with history of periodontitis showed significant reduction in bone height (at $p<.05$) compared to control for the different maxillary and mandibular arch regions. In addition, diabetics, and edentulous for >10 years demonstrated significant difference (at $p<.05$) for both arches expect on the sides of maxilla. As a general rule for mandible, the edentulousness for more than 10 years induced more bone loss as compared with menopause, periodontitis and diabetes mellitus. On the maxillary arch, the main factor associated with reduced ridge height varied according to examined side. As for the right and left sides, periodontitis was the main. However, for the middle of maxillary arch, reduced bone height was concomitant of menopause (Figure 8, 9).

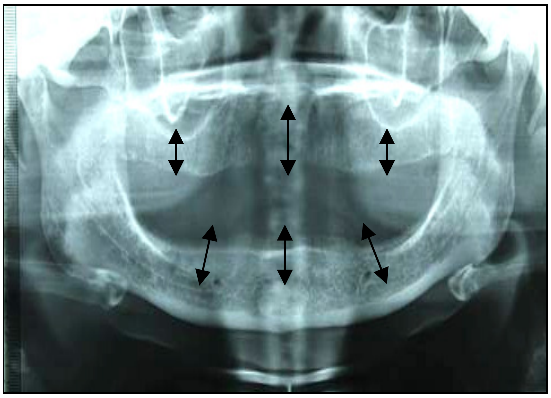

Figure 2. Measuring areas on the maxilla and mandible

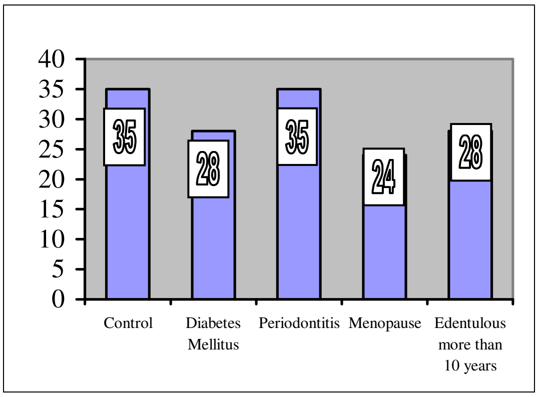

Figure 3. Number of cases with different conditions in relation to control

Table 2. Inter-observers reliability test

	SMRMan2	TRMan2	MidMan2	SMLMan2	TLMan2	RMax2	MidMax2	LMax2
SMRMan1	0.940634							
TRMan1		0.983473						
MidMan1			0.959185					
SMLMan1				0.934075				
TLMan1					0.987655			
RMax1						0.971683		
MidMax1							0.959419	
LMax1								0.967658

SMRMan; submental right mandible, TRMan; total height of mandibular right side, MidMan; midline mandible, SMLMan; submental left mandible, TLMan; total height of mandibular left side, RMax; right maxillary, MidMax; midline maxillary, LMax; left maxillary height.

Table 3. Mean bone heights of different regions for control and tested samples in different ethnics

Race		Malay		Chinese		Indian	
Group		Control	Sample	Control	Sample	Control	Sample
N		13	43	12	51	10	21
SMRMan3	Mean	14.91	13.38	15.65	12.83	14.02	12.18
	S.D.	2.41	2.47	3.84	2.88	1.83	3.98
TRMan3	Mean	35.26	25.17	34.93	23.10	33.04	22.39
	S.D.	6.45	6.10	5.78	6.61	5.09	7.91
MidMan3	Mean	36.7	27.22	35.96	25.36	35.12	23.58
	S.D.	7.32	5.30	4.96	5.31	5.13	6.82
SMLMan3	Mean	14.98	12.79	15.22	12.74	14.26	11.92
	S.D.	2.5	3.02	3.13	2.78	1.33	3.54
TLMan3	Mean	35.55	24.71	34.57	23.51	34.06	22.12
	S.D.	6.16	6.45	5.42	6.05	4.31	7.71
RMax3	Mean	8.57	5.82	6.66	6.82	5.58	4.10
	S.D.	3.82	3.43	2.9	5.11	3.15	3.08
MidMax3	Mean	24.2	17.35	24.01	15.66	23.35	15.76
	S.D.	6.74	4.68	3.9	4.51	4.82	6.25
LMax3	Mean	8.34	6.28	5.57	6.46	6.5	4.70
	S.D.	3.62	4.18	3.65	4.82	2.75	3.08

SMRmand: Right submental height, TRMan: Total right mental height ,MidMan: Middle mandibular height, SMLMan: Left submental height, TLMan: Total mental height, RMax: Right maxillary height, MidMax: Middle maxillary height, LMax: Left maxillary height.

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Table 4. The means of bone height in relation to different pathopysiologic conditions

	SMRMan3	TRMan3	MidMan3	SMLMan3	TLMan3	RMax3	MidMax3	LMax3
Control	14.9101	34.5133	36.0071	14.8561	34.7879	7.0626	23.8913	6.8643
Diabetes Mellitus	13.3348	25.8664	27.2166	13.2984	26.0055	6.718	16.8429	6.1248
Periodontitis	13.3089	24.629	26.7789	13.137	24.6393	4.3861	17.2443	4.8806
Menopause	12.9558	23.7135	25.7071	12.4285	24.037	6.5713	15.0904	6.4785
Edent>10	11.9773	20.5527	22.9523	11.4116	19.9482	6.5966	15.6514	7.1673

SMRMan: submental right side, TRMand: Total mental right side, MidMan: Midline, SMLMan: submental left, TLMan: total mental left side, RMax: right maxillary, MidMax: midline maxillary, LMax: left maxillary.

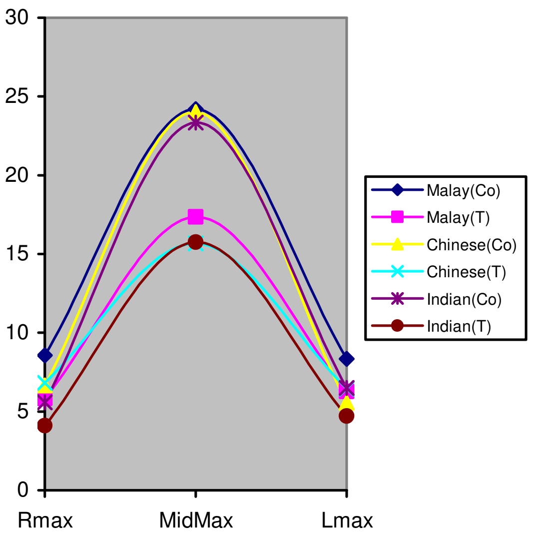

Figure 4. Difference between tested and control in different ethnics (maxilla)

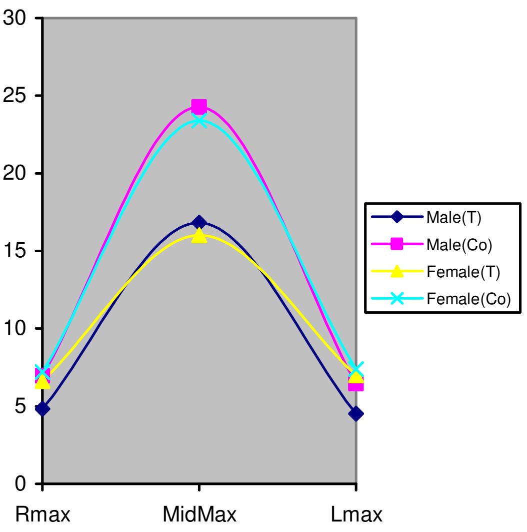

Figure 6. Overlapped bone heights of sample and control for different genders on maxilla

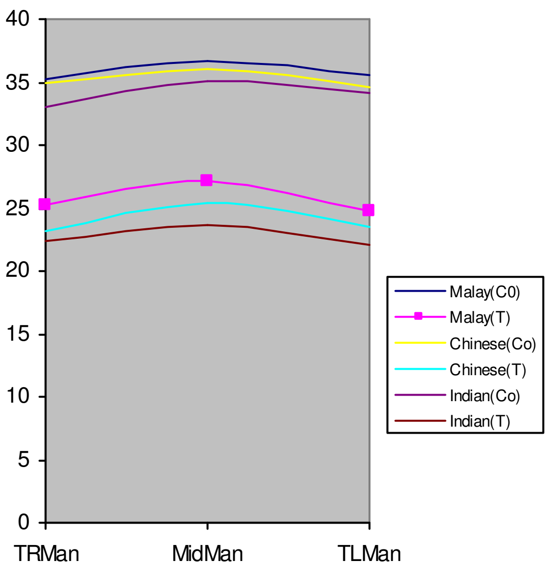

Figure 5. Difference between tested and control in different ethnics (mandible)

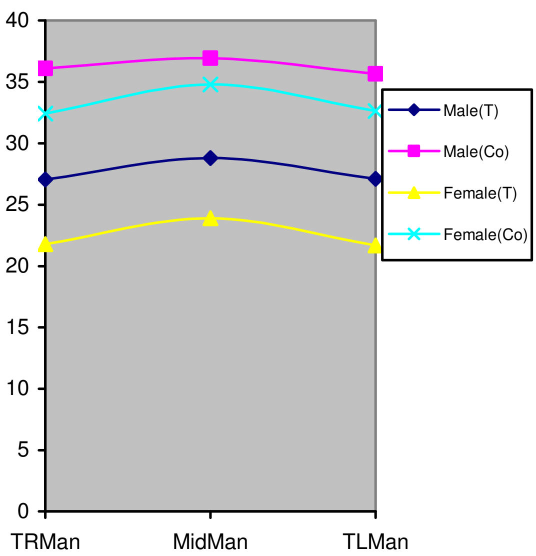

Figure 7. Overlapped bone heights of sample and control for different genders on mandible

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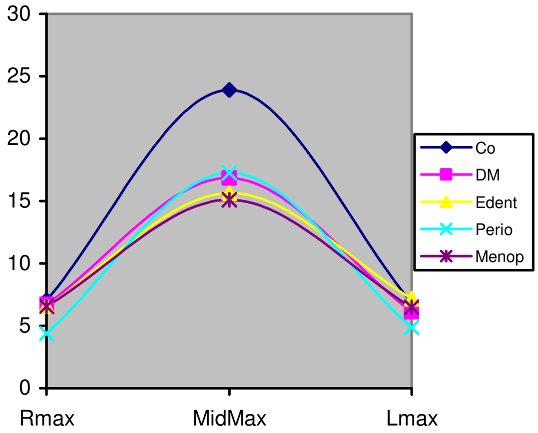

Figure 8. Overlapped bone heights of sample and control on maxillary arch

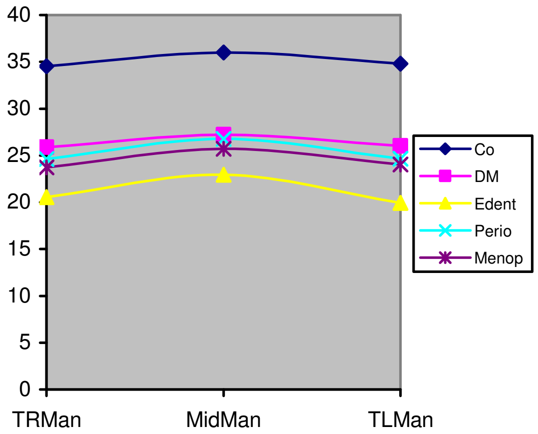

Figure 9. Overlapped bone heights of sample and control on mandible

DISCUSSION

There are obvious advantages in devising a method of using panoramic radiographs to monitor the resorption of the residual alveolar ridge. Firstly, panoramic radiographs are often part of the routine examination of patients, and thus their use for research purposes do not involve the patient in any additional exposure or cost. Secondly, panoramic radiographs are also likely to be found in records reversing several years; they constitute a ready source of data for a retrospective study.[29] Researchers found that the variability of vertical measurements of mandible made from repeated panoramic radiographs is small when patients are properly positioned in the panoramic apparatus.[28] If reference lines and measured points are located in the same vertical plane or approximately in the same plane as the teeth, variations in vertical measurements on the mandible and the posterior regions of the maxilla fall within a small range.[29] However, there are other radiographic techniques which are normally used in studies such as lateral cephalometric. In this research, dental panoramic radiographs were used to evaluate the bone height of the maxilla and mandible. Wical and Swoope used the radiographs in the mandible for classifying RRR by means of mandibular ratio. However, they are seldom used for studying the edentulous maxilla.[27] The new used locations in this study for the maxillary arch were midline, right and left sides heights below the maxillary sinuses.[28] Measurement errors may be reduced by highly significant inter-examiner reliability.

Several investigations have shown that a correlation exists between the degree of alveolar bone resorption in the mandible and the year's number of complete dentures worn.[28] This implies that the mandibular ridges of people who have been edentulous for long periods of time are typically extensive resorbed. Since a correlation has been demonstrated to exist between alveolar bone resorption and wearing dentures, it could be expected that the removal of dentures at night has a positive influence on the degree of alveolar bone resorption. In contrast, some studies, conducted in early post-menopausal women, failed to find such an association.[22] It has been suggested that patients with concomitant post-menopausal osteoporosis are at increased risk for a more progressive form of periodontitis. Interestingly, estrogen suppresses the expression of several cytokines suggested to be responsible for osteoclast stimulation in inflamematory conditions. There is also evidence that patients with post-menopausal osteoporosis have decreased bone mass in the jawbones. Therefore, estrogen deficiency may enhance the progression of marginal periodontitis, either by causing increased expression of osteotropic cytokines, or by decreasing the amount of alveolar jawbone. The data from clinical studies on the degree of periodontal disease in patients with concomitant periodontitis and post-menopausal osteoporosis are inconclusive, and there is a need for well-controlled prospective studies in which the progression of periodontal bone loss is followed in relation to estrogen levels.[14]

The amount of alveolar bone resorption was not correlated with the age of the subjects.[26] The reduction of the height of the edentulous mandible and maxilla was more pronounced in women than in men.[28] There was no significant decrease in the vertical height of the maxilla in edentulous men.[29]

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In this study, a strong tendency for the extent of resorption in the edentulous jaw had been found related to patient's health condition (diabetes mellitus, periodontitis, menopause, and edentulousness time). Factors such as gender and ethnic may also play important role in bone resorption. In this study, the pattern of residual ridge loss on maxillary ridge was more on the sides in men followed by women. In contrast the middle maxillary region in both men and women have nearly the same amount of bone resorption compared to the controls. On the mandible, the phenolmenon was entirely different. The highest bone resorption was found in women in three different areas (side and middle) of mandible compared to the control group. The men had almost uniform resorption on the three locations of the mandible. However, compared to the maxilla, the bone resorp-tion on the mandible was higher in both males and females. The results regarding the increased amount of residual ridge resorption in females compared to men were similar to that found early by other re-searchers, particularly in the mandible. [27,28] It may be due to menopause factor in women which starts earlier than men in whom it starts at 65 years old.[11]

In this study, the right and left maxillary regions showed the highest resorption level in patients with periodontitis compared to the control group. While, in the middle of maxilla, menopause associated with maximum bone resorption as compared to the control group. On the mandible, the bone resorption was highest over all the three measured regions in patients with edentulous state for more than 10 years compared to the controls. Bone loss due to menopausal condition occupied the second level. Edentulousness time increases the tendency for more amount of residual ridge resorption, particularly on the mandible[21] followed by menopause, periodontitis and finally diabetes mellitus. Residual ridge resorption is a physiological reaction to complete teeth loss[1] which continues throughout life time but in slow rate.

On the maxillary arch, Malays had the highest bone resorption on the sides compared to the control group, whereas, the Chinese have the highest rate of resorption on the middle part as compared to the control group.

As for the mandible, among the three races, the Chinese have the highest bone resorption rate for the right mandible side compared to their control group, whereas for the middle and left maxilla, the Indians had the highest rate of bone resorption compared to their control group.

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