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RADIOGRAPHIC EVALUATION OF PERI-IMPLANT BONE CHANGES IN SMOKERS AND NON SMOKERS IMPLANT RETAINED MANDIBULAR OVERDENTURE WEARERS

Ehab A. Elsaih*; Ashraf A. Gebreel* and Mohamed Ezzat El-Sayed**

ABSTRACT

Background and Purpose: Implant-retained mandibular overdentures have recently become a popular treatment alternative for edentulous patients desiring increased retention of complete dentures. Smoker patient's are routinely excluded from this benefit, therefore the goal of this study was to evaluate marginal bone changes radiographically around implants placed in mandibular canine region for implant retained overdenture patients (smokers and non smokers) 18 months after loading.

Methods: Forty patients received two implants in the mandibular canine region. 13 were nonsmokers and 27 were smokers and subdivided according to smoking ratio to smokers≤ 10cigaretts and smokers >10cigaretts. After three month submerging period healing abutments were connected. Ball abutments were mounted 4–6 weeks afterwards and the complete overdenture was constructed and delivered. Marginal bone level was assessed radio-graphically at time of loading, 6 month, 12 month and 18 month after overdenture insertion.

Results: Two patients had unilateral implants were judged as failures at the second surgical appointment. Three patients with clinically successful implants were blindly selected for exclusion from the grouping for balancing the statistical analysis. After the drop outs, seventy two implants were evaluated. A statistically significant vertical bone loss was seen in the three groups after the first 6 months (average 0.733mm) and after the 2nd 6 months (average .618mm), and after the 3rd 6 months (average .05 mm), with statistically significant differences among the three groups for all periods of study. Likewise, A statistically significant horizontal bone loss was seen in the three groups after the first 6 months (average 0.636mm) and after the 2nd 6 months (average .596mm), and after the 3rd 6 months (average .136 mm), with statistically significant differences among the three groups for all periods of study.

Conclusions: With the limitation of this study it could be assured that smoking is a biological risk factor for osseointegration and the patient should be informed about its possible drawbacks. Also the effect of this bad habit is directly proportional to its rate, so the rate of smoking should be of diagnostic value during treatment planning stage.

KEYWORDS: Dental implants- Overdenture- Smokers

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INTRODUCTION

In implant dentistry, the concept of osseointegration has considerably increased the clinical predictability of oral implants and hence osseointegrated implants are routinely included in treatment planning of partially or totally edentulous patients. Although osseointegrated implants have high survival rates, bone loss around implants occasionally occur [1-3].

The definition of implant failure, however, is still controversial. A variety of clinical situations may – if left untreated – lead to the loss of peri-implant bone and eventually of the implant. Two major mechanisms have been suggested to be responsible for implant bone loss and even implant failure: (1) Substantial evidence indicates that the formation of biofilms on implant surfaces triggers an inflammatory reaction (mucositis)[4] that may also lead to a peri-implant infection (peri-implatitis)[5-8] accompanied by angular bone loss around the circumference of the implant[9,10] (2) Another concept includes biomechanical overload [11-14].

Dental implants are introduced in many treatment modalities and considered important and even inevitable in complete oral rehabilitation. According to ***Feine et al. 2002***[15] the two-implant-supported mandibular overdenture is considered ‘‘the standard of care for the edentulous patient’’. Studies with long evaluation periods have shown that patient satisfaction remains high with a high implant survival rate [16-20].

Smoking is of special interest as it is considered to be a relative contra-indication for implant treatment. It is supposed to have an adverse effect on implant survival and marginal bone loss as well as on the prevalence of peri-implant mucositis and peri-implantitis [21-24]. According to the fourth ITI consensus conference 2009[25,26], smoking was found to be a significant risk for adverse implant outcome.

The aim of this study is to evaluate the radiographic parameters of peri-implant tissues and the influence of smoking. The null hypothesis is that there are no differences in clinical parameters and bone loss between the non smokers and smokers or between smokers with different smoking rate.

MATERIAL AND METHODS

A total of 41 completely edentulous male patients [mean age 62 years (range 58–66 years)] complaining from reduced stability and insufficient retention of their mandibular denture were selected from the outpatient clinic of the Prosthodontic Department. Included patients were required to have; 1-moderately developed mandibular ridges without undercuts and healthy, even thickness, firmly attached mucosa, Also a sufficient interarch space as well as sufficient bone height in the inter-foramina region of the mandible and good bone quality (**table 1**).

Patients with abnormal habits i.e. bruxism or clenching, as well as patients with diabetes, osteoporosis, local or systemic antibiotic therapy,

TABLE (1) Characteristics of the study sample at the baseline

	Non-smokers (n)	smokers (n)	
		≤10 cigarettes	>10 cigarettes
Mean age (years)	64	62	60
Mean symphysial bone height (mm)	22	21	23
Mean period of mandibular edentulism (years)	6	8	9
Mean number of mandibular dentures	1.5	1.5	1.2

immune deficiency and anticoagulant therapy were excluded. Patients accepted enrollment in this study after being explained about its protocol and objectives.

Radiographic examination was performed to assure sufficient bone height in the inter-foramina region of the mandible and good bone quality.

The patients were grouped according to smoking habits as non smokers **(NS)** group I, Smokers ≤10 cigarettes **(S≤10)** group II and smokers >10 cigarettes **(S>10)** group III. Every patient received two implants (Dyna® Dental Engineering, Bergen op Zoom, Netherlands) inserted parallel to each other in the mandibular canine region, using a standardized 2-stage surgical approach. The length of the implants used can be seen in (**table 2**& **fig.1**).

Post-operative digital panoramic x-ray was made to verify position and orientation of implants (**fig. 2**).

All patients were instructed to avoid denture-wearing for 2 weeks with soft diet. Afterwards the intagliosurface of the temporary prosthesis was relived (2mm) and relined with a resilient liner (Alphasil, Omicron, Germany). Relining was replaced weekly during the three months of the osseointegration period. After 3 months submerging period implants were exposed using a tissue punch and healing abutments were screwed into the fixtures. After 2- 4 weeks, healing abutments were replaced with ball abutments ball abutment (Dyna® Dental Engineering, Bergen op Zoom, The Netherlands).

A new maxillary complete denture and an implant-retained mandibular overdenture were then constructed. Record blocks were fabricated and jaw relations were recorded. Shallow cusp acrylic resin teeth (Vitapan®, Vita Zahnfabrik, Bad Säckingen, Germany) were used and the functional masticatory concept was a bilateral balanced occlusion.

TABLE (2) Implant length distribution in the jaws (mm)

mm	Number of implants in each group			Total implant No.
	Group I (NS)	Group II (S≤10)	Group III (S>10)	82
11.5	4	2	4	10
13	10	16	12	38
15	14	10	10	34

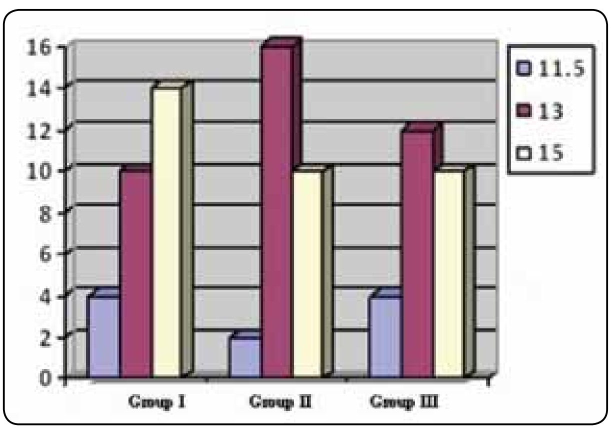

FIG. (1) Graphical illustration for implant length distribution in (mm)

FIG. (2) Post-operative panoramic x-ray made to verify position and orientation of implants

Trial dentures were verified intraorally for esthetics and function. Dentures were processed in the usual manner and retentive sockets with smart matrix (Dyna® Dental Engineering, Bergen op Zoom, The Netherlands) were picked up intraorally using self-cure acrylic resin (**Fig. 3A, B**).

Radiographic evaluation of peri-implant tissues

Radiographic evaluations were performed at the time of overdenture insertion (T0), 6 months (T1), 12 months (T2) and 18 months (T3) after overdenture insertion.

Intraoral radiographs were produced using long cone paralleling technique and a film holder designed specifically for implant imaging (Hawe Neos Dental CH-6934, Bioggio, Switzerland). For maintaining the same film–implant distance and cone–implant distance during subsequent film exposures, a heavy body rubber base material was mixed and applied between mandibular arch without denture and the maxillary denture where the film holder applied lingually to be embedded in, and then patient was asked to close on the material. After setting, this custom bite block was used in sequential radiographs. By this modification, standardized intraoral radiographs were obtained. All radiographs were made with Ultraspeed film (Kodak Co., Rochester, NY, USA) and exposed by using the same X-ray unit. All films were processed using an automatic developing machine.

Digitizing of the peri-apical films was done by scanning using a black and white translucent scanner. Subsequently, lines and reference points were marked using Corel draw program (CorelDRAW® version 10TM, Kodak Digital Science) (**Fig. 4 A**). The radiographic images were magnified x 10 after the radiographs. Implant dimensions in the radiographs were compared with actual implant dimensions to detect magnification errors. The ratio between implant dimensions in the radiographs and actual implant dimensions was used to modify the apparent measurement of peri-implant bone levels in the radiographs to obtain their actual values.

Peri-implant marginal alveolar bone changes were determined along vertical and horizontal planes as recommended by ***Walter et al. (2000)***[25] and ***Heckmann et al. (2004)***[26]. For vertical alveolar bone changes, the distance between implant shoulder (A point) and first bone to implant contact (B point) indicated vertical alveolar bone level (VBL) in mm (AB line) (**Fig. 4 B**).

Vertical bone loss (VBL) was calculated by subtracting VBL at T1, T2 and T3 from VBL at T0. For horizontal alveolar bone loss (HBL), the distance between the marginal bone level (C point) [which represents the intersection point of a tangent to the horizontal bone crest (CD line) and another tangent to the crater-shaped defect (CB line)] and the implant perpendicularly indicated horizontal bone level in millimeters. Horizontal bone loss

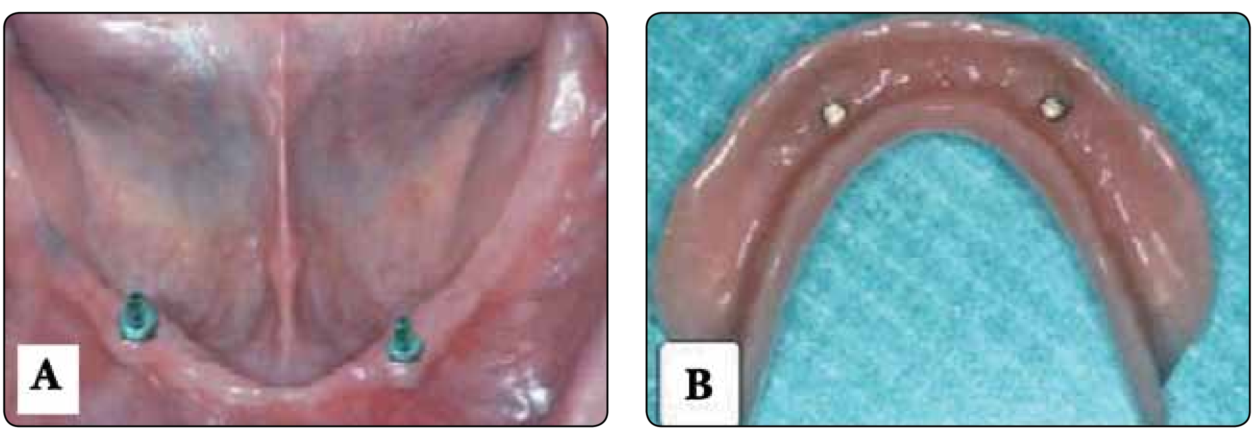

FIG. (3) **A-** intraoral photo of the ball abutment **B-** intaglio surface of implant overdenture

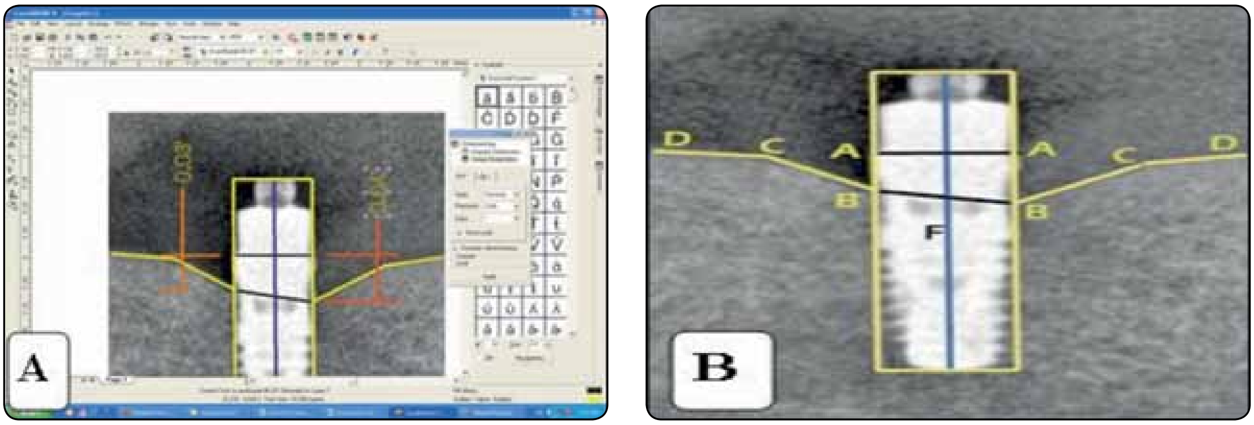

Fig. (4) **A-** computer program measuring the radiographic bone loss **B-** Lines and reference points marked on the screened peri-apical radiograph.

(HBL) was calculated by subtracting HBL at T1, T2 and T3 from HBL at T0. Marginal bone changes (vertical bone levels and horizontal bone loss) were measured at mesial and distal surface of each implant.

Results were collected from three different examiners; blindly from the patient group they calculated the VBL and HBL for each implant as mesial+distal/2 and the average of right and left implants were calculated to for each patient. The mean of the three examiners were processed for statistical analysis using computer program (SPSS® 18), the means of marginal bone vertical height and horizontal extension changes for teeth abutments and implants were compared between the groups in different periods using ANOVA at 5% level of significance.

RESULTS

In this study, two smokers were excluded due to unilateral implant failure before loading and three more of the successful implants were blindly excluded from the study for the uniformity of statistical output.

In table 3 the mean vertical bone resorption (VBL) around implants in millimeters for group I *(NS)* was **.639mm±.032, .479mm±.019 and .023mm±.006** in 6, 12 and 18 month respectively after overdenture insertion. VBL in millimeters for group II *(S≤10)* was **.739mm±.033, .579mm±.019 and .055mm±.011** in 6, 12 and 18 month respectively after overdenture insertion. VBL in millimeters for group III *(S>10)* was **.823mm±.008, .796mm±.074 and .072mm±0.008** in 6, 12 and 18 month respectively after overdenture insertion. The results were significant for all periods of study for group III *(S>10)* compared to both group I *(NS)* and group II ***(S≤10).*** The results were significant for all periods of study for group II *(S≤10)* compared to group I *(NS)*.

In table 3 the mean HBL around implants in millimeters for group I *(NS)* was **.54mm±.033, 0538mm±.048 and .064mm±.011** in 6, 12 and 18 month respectively after overdenture insertion. HBL in millimeters for group II *(S≤10)* was **.631mm±.026, .671mm±.088** and **.122mm±.037** in 6, 12 and 18 month respectively after overdenture insertion. HBL in millimeters for group III *(S>10)* was **.739mm±.037, .879mm±.058** and **.222mm±.037** in 6, 12 and 18 month respectively after overdenture insertion. The results were significant for all periods of study for group III *(S>10)* compared to both group I *(NS)* and group II ***(S≤10).*** The results were significant for all periods of study for group II *(S≤10)* compared to group I *(NS)*.

TABLE (3) Comparison between group I, II and III peri-implant vertical and horizontal bone resorption in mm at 6, 12 and 18 month after denture insertion

Bone resorption	Vertical bone resorption			Horizontal bone resorption		
Period of evaluation	6 month	12 month	18month	6 month	12 month	18month
	X ± SD	X ± SD	X ± SD	X ± SD	X ± SD	X ± SD
Non smokers Group I	.639±.032	.479±.019	.023±.006	.54±.033	0.238±.048	.064±.011
smokers≤ 10 cigarettes group II	.739±.033	0.579±.019	.055±.011	.631±.026	.671±.088	.122±.037
Smokers > 10 cigarettes group III	.823±.008	.796±.074	.072±0.008	.739±.037	.879±.058	.222±.037
Group I & Group II	P< .05 *	P< .05 *	P< .05 *	P< .05 *	P< .05 *	P< .05 *
Group I & Group III	P< .05 *	P< .05 *	P< .05 *	P< .05 *	P< .05 *	P< .05 *
Group II & Group III	P< .05 *	P< .05 *	P< .05 *	P< .05 *	P< .05 *	P< .05 *

n per group = 12, p* is significant value (p ≤ 0.05)

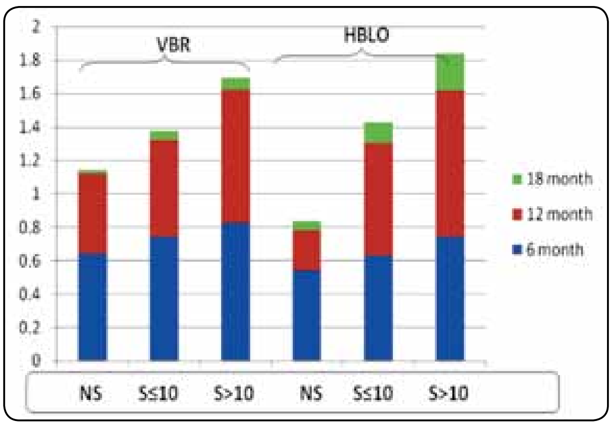

Fig (5) graphic illustration of the measured VBR and HBLO in millimeters for all groups in 6, 12 and 18 month after overdenture

DISCUSSION

In this prospective study, peri-implant marginal bone level was followed up in patients assigned to three groups receiving ball retained two implant mandibular overdenture. Smokers were included in this study in two levels the first in group II; were the consumption were less than or equal to 10 cigarettes/day, they may be considered as moderate smokers, the second level in group III; were the consumption were more than 10 cigarettes/day, they may be considered as heavy smokers. Females were excluded as they have greater risk of bone resorption due to hormonal factors [27].

Ball and socket attachments were chosen to retain overdenture rather than Bars as free spaces within the denture base become larger with bars. These spaces encourage plaque accumulation, pathologic microflora and peri-implant inflammation [28] which may affect the marginal bone loss rate besides ball retained implant overdenture is also a simple and easier to replace.

The evaluation were done using peri-apical radiographs taken by long cone paralleling technique rather than panoramic radiographs to avoid distortion as well as possible magnification errors. Panoramic radiographs is of limetted use in the anterior mandible due to; over-projection of vertebra[29], poor image resolution, image distortion of at implants bone level[30] and difficulty of standardization [31].

Implant loss in this study is limited to only two implants out of 82 (nearly 2.4% of implants), which occurred during the healing period with no additional loss occurring during the follow-up period. This percentage was in accordance with the results of ***Jemt et al. (1996)*** [32] and ***Batenburg et al. (1994)*** [33].

The mean implant VBL after one year (1st and 2nd periods of this study) in all groups could be considered as being acceptable, given the generally accepted values for implant marginal bone resorption in the first year, which range from 0.5 mm to 1.4mm[34- 40]. In this period marginal bone loss is related to a multi-factorial etiology including healing of alveolar bone, bone remodeling, and bone response to primary loading [41- 42].

The implant loading subjects the bone around it to functional forces in the form of direct short range forces due to mastication, and long range forces due to jaw flexure [43]. But the significant difference between groups tells about the effect of the smoking as the only variable exists.

In the 3rd period the rate of vertical bone loss in the first group average 0.023mm±.006 which in fact applies to the internationally accepted values that range .02 to .04mm annually [35-39]. But the average increases in a significant value 0.579mm±.01 and .796mm±.0749 for group II and group III respectively this is in accordance with the finding of ***Vervaeke et al (2011)*** [44] which emphasis the effect of smoking on the implant marginal bone level.

In this study, smokers showed significantly higher HBL in the three periods that reached more than twice the horizontal marginal bone loss of non-smokers considering the cumulative values along the three periods (fig.5).

Referred to above, ***Roos-Jansaker et al. (2006)***[22,45,46], studies showed that smoking was associated with both bone loss vertical to a level of 3 threads and the presence of peri-implantitis which accordingly associated with the horizontal bone loss. Implantitis is known to cause both vertical and horizontal bone loss as well. ***Haas et al. (1996)*** [47] examined the association between smoking and the presence of peri-implantitis in 107 smokers and 314 non-smokers. Smokers had more radiographic bone loss around implants than nonsmokers besides higher bleeding scores, more signs of clinical inflammation and deeper peri-implant pocket depth.

Other studies have shown a significant increase in marginal bone loss in smokers compared with non-smokers [22, 45-50]. This increase of bone resorption in smokers may contribute to future implant failures. That was assured by ***Levin et al. (2008)*** [51], in their study showed a significant relation between smoking and the observed bone loss.

In this work, it is obvious that the marginal bone resorption values are statistically significant between group I & II along the three periods of study, which in fact reflects the effect of smoking rate on both HBL and VBL. In other words, smoking rate appears to have direct harmful effect to the implant affecting its success and even its survival.

CONCLUSION

From the results of this study, it could be concluded that smoking has regressive effect on peri-implant marginal bone level vertically and horizontally, these effect were worsened with increased rate of smoking. Therefore, the null hypothesis was rejected.

From the clinical point of view, the results of the present and previous studies [52,53] should be implicated in the decision-making process during treatment planning. It would be reasonable to assume that higher risks for biological complications for implants in the form of marginal bone loss which may lead consequently to implant failure in heavy smokers seeking implant therapy.

RECOMMENDATION

It is, therefore, recommended to analyze the risk profile of smoker patients, including the smoking rate, seeking implant dependant treatment modalities and inform them accordingly.

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