Assessment of Alveolar Bone Resorption and an Analysis of Occlusion for Implant Prosthetic Restorations in The Mandibular Molar Toothless Region

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Abstract

The present clinical study evaluated bone resorption and analyzed occlusions in patients who underwent an implant-supported fixed prosthesis operation in the posterior mandibular region.

The study included 28 patients [15 men (53.6%) and 13 women (46.4%)] with a mean age of 54.0 ± 11.1 years (age range: 32–75 years) who underwent an implant-supported fixed prosthesis operation in the posterior mandibular region between 2016 and 2017.

The amount of bone loss at 1 year after treatment and the occlusion analysis outcomes were evaluated. The anterior guidance, posterior dislocation, occlusal table, tubercle inclinations, and dental occlusion status were also determined. Based on the statistical analysis, distal bone loss was higher in female patients than in male patients; mesial bone loss was higher in cases with a wide occlusal table; mesial and distal bone loss was higher in cases with greater tubercular slope; and distal bone loss was more common in cases with surface-to-surface contact with temples.

A wide occlusal table may be a risk factor for mesial bone loss in implant prosthetic restorations in the mandibular molar toothless region.

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Introduction

In recent years, success criteria for dental implants have been expressed as overall implant survival rate, implant durability,[1] radiological bone loss, and infection in peri-implant tissue.[2]

In implant interventions, another key factor for success is appropriate consideration of occlusion biomechanics.[3,4] Before planning treatment with an implant-supported prosthesis, the occlusion type to be used in the patient should be selected.[5–7] Individual patient characteristics and the previous occlusion type should be taken into account in the choice. One must have knowledge about occlusion types seen in natural teeth to choose the appropriate occlusion type.[8] More emphasis should be placed on occlusion principles created for tooth-supported prostheses in osseointegrated prostheses. The occlusion of prostheses has a major role in the longevity of the implant infrastructure carrying any implant-supported prosthesis.[9]

In dental implants, there is no periodontal ligament to absorb excessive loading. For this reason, occlusal trauma leads to injury in peri-implant tissue. Unlike natural teeth, the implant is unable to counteract and tolerate forces acting on it. Regardless of type, the major benefit of receiving implant treatment is to prevent bone loss that may occur at regions of tooth loss in the future.[5,6] Teeth can displace 25–100 µm in the alveolar socket, while implants can displace 3–5 µm as supportive bone tissue allows.[10] Proprioception is developed by deformation in periosteal mechanoreceptors caused by the implant load. Regardless of the mechanism, it was shown that the sensitivity was 8-fold lower in an implant when compared to natural teeth.[11,12] In the literature, there is a limited number of clinical trials about occlusion-related bone resorption in implant-supported fixed restorations.[10–12]

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This study evaluated bone resorption and analyzed occlusion in patients who underwent an implant-supported fixed prosthesis operation in the posterior mandibular region. Our null hypothesis was that distinct occlusion types will not affect alveolar bone resorption in mandibular molar tooth implant-supported fixed prosthetic restorations.

Materials and methods

The present clinical study included 28 patients [15 men (53.6%) and 13 women (46.4%)] with a mean age of 54.0 ± 11.1 years (age range: 32–75 years) who underwent an implant-supported fixed prosthesis operation in the posterior mandibular region at Mustafa Kemal University Dentistry School between 2016 and 2017. The inclusion criteria were age > 18 years, lack of bruxism, absence of systemic disease that would contraindicate implant surgery, smoking less than 10 cigarettes per day, and lack of pregnancy.

The study was approved by the Ethics Committee of Hatay Mustafa Kemal University Medical Faculty on July 20, 2017, with decision number 09. The procedures used in the study were performed based on the Declaration of Helsinki (revised in 2008).

Data collection

Data obtained from radiological imaging studies and clinical screenings were used. In all patients, panoramic radiographs (Planmeca ProMax 2D) were obtained at the Oral and Maxillofacial Radiology Department of Mustafa Kemal University, Dentistry Faculty. The patients were positioned by biting a bite splint, and radiographs were obtained at the same position and angle. Baseline (just after implantation) and final radiographs (control radiographs 1 year after implantation) in the “Romexis” database were compared. Amounts of mesial and distal marginal bone resorption were assessed based on the implant length in baseline and control radiographs; the difference in implant length was defined as the amount of bone loss. The implant neck was measured using a ruler in the toolbox of the Romexis system, which was then used to compare the actual size of the implant, and the magnification rate was calculated for the panoramic radiograph. The amount of bone loss was adjusted according to the magnification rate.

Intraoral examination

An intraoral examination was performed using an examination set, and a periodontal examination was performed using a periodontal probe (Williams periodontal probe; Hu Friedy, Chicago, IL USA). Occlusions were recorded using occlusion wax and articulation paper (8 µm in size). Articulation paper (8 µm in size) was used to capture the most sensitive contact. After positioning the patient, the intraoral examination was performed using examination sets; articulation paper (8 µm in size) was placed over the arch and the patient was asked to close the teeth. Stained surfaces and points were observed during lateral and protrusive movements, respectively. This procedure determines the type of occlusion in general and allows determination of the occlusion status of implant-supported restorations against the contralateral tooth. After treatment, general occlusion (canine-guided occlusion, group function occlusion) was determined in the patients. Anterior guiding and posterior displacement status (absence or presence) were recorded during the evaluation. The relationship of implant-supported crowns with the corresponding contralateral tooth was assessed and the occlusion theme was determined: 3-point contact, surface-to-surface contact, or failed occlusion. The occlusion table of the crown was assessed (narrow, wide). In addition, tubercle slopes were recorded.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences version 18.0. Descriptive statistics are presented as the mean, standard deviation, and percent distribution. The Mann-Whitney U test was used for binary comparisons, and the Kruskal-Wallis H test was used for multiple comparisons. Pearson correlation analysis was used to assess relationships among numerical data. Cross tabs (chi-square) analysis was used to compare non-numerical data. The significance level was set at $p < 0.05$.

Results

There was canine-guided occlusion in 24 patients (85.7%) and group function occlusion in 4 patients (14.3%). While the tubercle slope of 19 (67.9%) of the patients included in the study was decreased, 5 of them (17.9%) were decreased more, and 4 of them (14.3%) were decreased moderately. The tooth was not at occlusion in 9 patients (32.1%), while there was surface-to-surface contact in 14 (50%), 3-point contact in 3 (10.7%), and fossa-to-tubercle contact in 2 patients during closure. Based on the Mann-Whitney U test performed to determine whether there was a difference in bone resorption according to occlusion type, it was found that mesial bone resorption was higher in patients with group function occlusion, while distal bone resorption was higher in patients with canine-guided occlusion; however, no significant difference was found between the groups ($p > 0.05$; Table 1).

	Occlusion type	n	Average	Ss (+-)	p
Mesial bone loss	Canine guided occlusion	24	1.0042	.67275	.373
	Group function occlusion	4	1.3500	.73258	
Distal bone loss	Canine guided occlusion	24	1.1458	.79179	.792
	Group function occlusion	4	1.1000	.92014	

Table 1. Comparison of bone loss by type of occlusion.

	Occlusal table	*n*	*Average*	*Ss (+-)*	*p*
Mesial bone loss	Narow	18	.8278	.61146	.015*
	Wide	10	1.4600	.62397	
Distal bone loss	Narrow	18	.8944	.55250	.061
	Wide	10	1.5800	.98635	

Table 2. Comparison of bone loss by occlusal plate.

Based on the Mann-Whitney U test performed to determine whether there was a difference in bone loss according to occlusal table, it was found that mesial bone loss was significantly higher in patients with a wide occlusal table (1.46 mm) when compared to those with a narrow occlusal table (0.82; $p < 0.05$); similarly, distal bone loss was higher in patients with a wide occlusal table, but there was no significant difference in distal bone loss between groups ($p > 0.05$; Table 2).

	Occlusal table	*n*	*Average*	*Ss (+-)*	*p*
Mesial bone loss	Narow	18	.8278	.61146	.015*
	Wide	10	1.4600	.62397	
Distal bone loss	Narrow	18	.8944	.55250	.061
	Wide	10	1.5800	.98635	

Table 3. Bone loss according to tubercle slopes.

Based on the Kruskal-Wallis H test performed to determine whether there was a difference in bone loss according to tubercle slope, there was a significant difference in mesial and distal bone loss between groups ($p < 0.05$; Table 3). In the Mann-Whitney U test to determine the origin of the difference, mesial and distal bone loss was significantly higher in patients with an increased tubercle slope when compared with those with a reduced or moderately reduced tubercle slope. No significant difference was detected between patients with a reduced or moderately reduced tubercle slope ($p > 0.05$).

Based on the Kruskal-Wallis H test performed to determine whether there was a difference in bone loss according to occlusion status, there was a significant difference in distal bone loss between groups ($p > 0.05$). In the Mann-Whitney U test to determine the origin of the difference, distal bone loss was significantly higher in patients with surface-to-surface contact compared with those with 3-point contact and no occlusion ($p < 0.05$), but no significant difference was found in distal bone loss among the remaining groups ($p > 0.05$).

Discussion

This study assessed 1-year bone resorption and analyzed occlusion in patients

with implant-supported prostheses in the posterior mandibular region. Our null hypothesis was that distinct occlusion types will not affect alveolar bone resorption in mandibular molar tooth implant-supported fixed prosthetic restorations; the hypothesis was validated ($p > 0.05$). The mean mesial and distal bone losses were found to be 1.05 ± .67 mm and 1.13 ± .79 mm, respectively, in patients who underwent an implant-supported fixed prosthesis operation in the posterior mandibular region. Mesial bone loss was higher in patients with a wide occlusal table than those with a narrow occlusal table. Accordingly, we suggest that an occlusal table is a risk factor for mesial bone loss.

Mesial and distal bone losses were significantly higher in patients with an increased tubercle slope when compared to those with a reduced or moderately reduced tubercle slope. Based on these results, we suggest that tubercle slope is a risk factor for mesial bone resorption in patients who have undergone implant-supported fixed prosthesis operations in the posterior mandibular region.

We found that distal bone loss was significantly higher in patients with surface-to-surface contact at occlusion when compared to those not at occlusion or those with 3-point contact, suggesting that occlusion status is another factor that affects bone resorption. It has been reported that tubercle slope is a major factor in the development of tilt over momentum. Flat circumference of centric contacts will transmit occlusal forces in the apical direction.[13]

Mesial bone resorption was higher in patients with group function occlusion, while distal bone resorption was higher in patients with canine-guided occlusion; however, no significant difference was found between the groups. Given this finding, our initial hypothesis proposing that occlusion will affect alveolar bone resorption in mandibular molar tooth implant-supported prosthetic restorations was ruled out.

We found that the canine-guided occlusion incidence was higher in patients with narrow than those with wide occlusal tables, suggesting that occlusal table is a factor affecting occlusion. Moreover, the canine-guided occlusion incidence was higher in patients with a reduced tubercle slope, with no significant difference between the groups. Based on these results, it can be concluded that tubercle slope has no substantial effect on occlusion. We observed that canine-guided and group function occlusions were most commonly seen with surface-to-surface contact at occlusion, but no significant difference was detected among the groups. Therefore, mode of occlusion has no significant effect on occlusion.

In the mandibular molar tooth-free region, it was found that occlusion of the arch had no significant effect on bone resorption in implant-supported fixed prosthetic restorations, while increased tubercle slope of implant-supported restorations and superficial occlusion against the contralateral tooth caused significant increases in bone resorption.

In single tooth restorations, using the available occlusion is widely accepted. In single tooth implants, the success rate is lower in the posterior region when compared to the anterior region. In the posterior region, the bone height is lower and a bicortical implant cannot be inserted in the mandible due to the presence of the mandibular canal. In addition, occlusal forces are stronger in the region. Complications such as screw breaks, implant breaks, or loosening of screws can be seen.[13–15] To prevent these complications, or at least to reduce damage from them, 3-point contact (tripodal centric occlusal contact) should be ensured, and the occlusal table should be narrowed to achieve aesthetic results and formed to direct occlusal forces toward the long axis of the implant. In such restorations, a tooth form with a low tubercle slope should be modeled and full protection in lateral and protrusive movements should be achieved. In single tooth implant-supported restorations, anterior and lateral guiding should be ensured over natural teeth. Contact over the single tooth restoration and balancing contact should be prevented. As with posterior bridge restorations, reducing the tubercle slope; central-oriented, smooth contact surfaces (1–1.5 mm in size); and a narrowed occlusal table should be employed. In implants, load distribution is affected by many factors, including the geometry, number, length, diameter, and angle of the implant; implant location; geometry and type of prosthesis or prosthesis material; superstructure adaptation;

direction and intensity of forces on the prosthesis and status of the contralateral arch; mandibular deformation; bone density; patient age and sex; and food stiffness.[16–18]

One limitation of this study is that it is not appropriate to determine the optimal occlusion type based on a single rule. Thus, all cases should be assessed individually, and occlusion type should be determined by taking the dentition in the contralateral jaw, the prosthesis material, the number of implants used, and localization into account.

Conclusions

In implant prosthetic restorations in the mandible molar region, the effect of occlusion of the arch on bone resorption was not found to be significant. Mesial bone loss was higher in cases with a wide occlusal table, and mesial and distal bone loss was higher in cases with a greater tubercular slope. Distal bone loss was more common in cases that had surface-to-surface contact with temples.

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Declaration of Interest

The authors report no conflict of interest.

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