

# Evaluation of bone resorption after implant surgery: Analysis of short-term follow-up

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## Abstract

**Aim:** The aim of this study was to investigate the amounts of marginal bone resorption around the implant that occurs after the implant surgery before the prosthetic loading by evaluating the patients who received implants in oral and maxillofacial surgery clinic.

**Material and Methods:** Two hundred and fifty-three implant surgeries that were performed in the period from 2016 to 2017 were included in this study. The panoramic X-rays taken immediately after implantation and before prosthetic loading at 3 months were evaluated. The marginal bone resorptions around the implants were measured and these values were compared with respect to the gender of the patient and the size of the jaw areas.

**Results:** Implant surgeries were performed on a total of 91 patients (50 females and 41 males). The mean age of the patients was  $46.03 \pm 12.13$  years. One hundred and forty-four implants were evaluated in male patients, while 109 implants were evaluated in females. Marginal bone resorption around the implants in males was observed to be statistically significantly higher than in females ( $p=0.00$ ). There was no statistically significant difference ( $p=0.76$ ) between the resorption values of mandible and maxilla. Resorption values in the molar region in the jaws were significantly higher than the amount of resorption in the anterior region ( $p=0.17$ ).

**Conclusion:** In this study, the marginal bone resorption around the implant was assessed between the implant surgery and the prosthetic loading, where it was found to be 0.24 mm in mandible and maxilla. In addition, both jaws were observed to have the lowest resorption amount in the anterior region and the highest resorption amount in the molar region.

**Keywords:** Bone Resorption; Dental Implant; Bone Level Implant.

## INTRODUCTION

The use of dental implant applications for the treatment of partial or complete absence of teeth has been more frequently used in the last decades. Currently, the production of implants in the world is estimated to be around 12 million units annually. One of the most important factors in the success of implants is the attachment of bone tissue around the implants. For this reason, analysis of the marginal bone resorption around the implant is the most important indicator in assessing the long-term success of the endosseous implants (1,2).

Resorption in the jaw bones starts after tooth extraction and continues throughout life. It has been reported that the presence of stimulants in implant applications after tooth extraction reduces resorption in the jaw bones around the implant. Despite this treatment, the life-long

bone resorption continues even after implant surgery (3). The exact cause of these bone resorptions is unknown. However, it was suggested that it may depend on patient-related factors, implant surface characteristics, and prosthetic loading (4). Following implant surgery, a marginal bone resorption of 1.5-2 mm in the first year and an annual resorption of 0.2 mm in the following years were accepted within the physiological limits (5,6). In the 2008 Oral Implantology Congress, it has been reported that the bone resorption around the implant should be less than 2 mm within the first year following implant surgery for the surgery to be successful (7).

In several studies, the bone around the implant was evaluated during the early healing period. In these studies, marginal bone loss and implant stability were evaluated at the 4th, 6th and 12th weeks after implant surgery during the unloaded healing period (8,9). The aim of this study was

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to investigate the amounts of marginal bone resorption around the implant that occurs after the implant surgery before the prosthetic loading.

## MATERIAL and METHODS

Two hundred and fifty-three implant surgeries which were performed in Adiyaman University Faculty of Dentistry, Department of Oral and Maxillofacial Surgery between November 2016 and November 2017 were included in the study. In this study, the panoramic X-rays taken immediately after implant surgery and before prosthetic loading at 3 months were evaluated.

Individuals who required advanced bone regeneration for implant treatment, patients with systemic diseases, the patients with bone discrepancies and patients who do not use any medication were not included in the study. The other exclusion criteria were smoking habits, alcohol consumption, and poor oral hygiene. Patients with D1, D2 and D3 bone quality in terms of Misch classification (10) based on the tactile sense of the surgeon included the study. All implant surgeries were performed by the same surgeon following the manufacturer's operating manual and using the same brand implant (Bredent OCS blueSKY, Bredent Medical, Senden, Germany). XL drill in D1 bone, cortical finisher drill in D2 bone and final drill in D3 bone were used in line with the manufacturer's instructions. All implants were inserted at the bone level by applying 30-35 Newtons of torque.

Panoramic X-rays of all patients were taken with a Planmeca Promax Dental Panoramic X-ray device (Planmeca, Helsinki, Finland). All images were taken by the same technician according to a standardized protocol for patient positioning. The measurement of marginal resorption around the dental implants was performed based on the method used by Lee et al. (11). For the measurement of all implants, the Romexis 2.9.2 program and its digital scale were used. Calibration of the digital ruler was made in the Romexis program and the calculation was made according to the following criteria:

1. An implant with a known size was measured with the Romexis digital ruler on a radiograph, confirming the accuracy of the digital ruler (Figure 1).

2. Measurements were made from the apex of the implant to mesial and distal bone heights (Figure 2).

3. These measurements were then subtracted from the original length of the implant to find the marginal resorption around the implant.

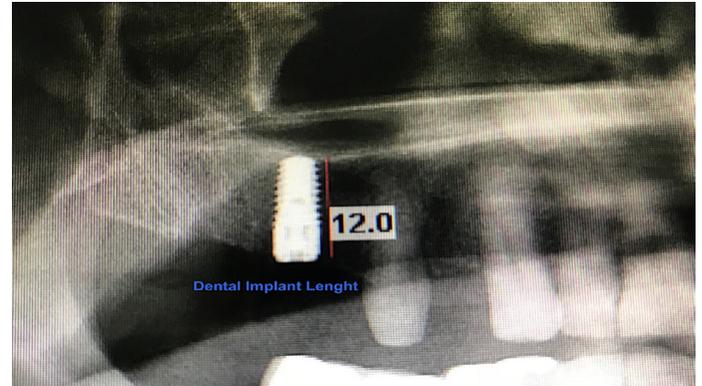
4. Finally, the arithmetic mean of resorption from mesial and distal measurements was calculated.

### The following formula was applied for the calculation:

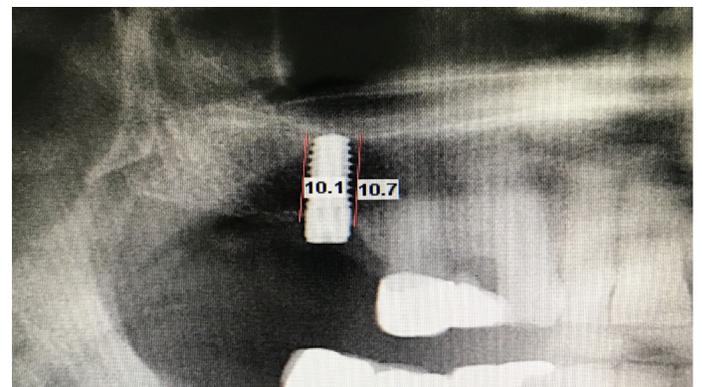
Implant size - size of implant adjacent bone = marginal resorption

$$\frac{(\text{Mesial marginal resorption} + \text{distal marginal resorption})}{2} = \text{Mean marginal resorption}$$

The application of this formula is illustrated in Figures 1 and 2.



**Figure 1.** An implant with a known size was measured with the Romexis digital ruler on a radiograph, confirming the accuracy of the digital ruler



**Figure 2.** Measurements were made from the apex of the implant to mesial and distal bone heights

The study protocol was approved by the Ethics Committee of Adiyaman University (2018 / 3-4) and was performed in accordance with the Declaration of Helsinki. Furthermore, informed written consent was obtained from all patients.

### Statistical Methods

The data obtained in this study were analyzed using IBM SPSS Statistics Version 22 package program. Shapiro-Wilk test was used because the unit numbers show normal distribution. The results were interpreted with a significance level of 0.05, where for  $p < 0.05$ , the variables were assumed not to come from a normal distribution, while for  $p > 0.05$ , the variables were assumed to come from a normal distribution. Since the variables did not have a normal distribution, the Mann-Whitney U Test was used for the analysis of different groups. Kruskal Wallis multiple comparisons were used to compare multiple groups (more than 2). Chi-square analysis was applied when relations between groups of nominal variables were examined. The results were interpreted at a significance level of 0.05 where it was accepted that there is a significant relationship for  $p < 0.05$  and no significant relationship for  $p > 0.05$ .

## RESULTS

Implant surgeries were performed on 91 patients (50 females, 41 males). The mean age of the patients was  $46.03 \pm 12.13$  years (males  $47.5 \pm 12.51$  years, females  $45.1 \pm 11.87$  years). A total of 253 implants were used where 109 implants were applied to male patients, and 144 were applied to female patients (Table 1).

The marginal bone resorptions around the implants were higher in males compared to females, and this difference was statistically significant ( $p = 0.00$ ) (Table 2).

	Female (n:50)	Male (n:41)	Total (n: 91)
Implant number	144	109	253
	Mean $\pm$ StDev	Mean $\pm$ StDev	Mean $\pm$ StDev
Age	$45.1 \pm 11.87$	$47.5 \pm 12.51$	$46.03 \pm 12.13$

StDev: Standard deviation

	N	Min	Max	Mean	StDev	P value Mann Whitney Test
Female	144	0	8	0.14	0.75	
Male	109	0	9	0.37	1.20	0.00*
Total	253	0	9	0.24	0.97	

StDev: Standard deviation

A total of 129 implants were applied to the maxilla and 124 implants were applied to the mandible. Seventy-four of the implants were placed in the anterior region, while 78 were applied to the premolar region, 101 were placed in the molar regions. Marginal resorption around the implants placed in the maxillary area was 0.12 mm (anterior 0.1 mm, premolar 0.12 mm, posterior 0.12 mm), and the marginal resorption around the mandibular implants was 0.36 mm (anterior 0.07 mm, premolar 0.44 mm, posterior 0.55 mm).

There was no statistically significant difference ( $p = 0.76$ ) between the resorption values in the mandible and the maxilla. The value of marginal resorption was determined to be as 0.24 mm in total implants. When the anterior, premolar and molar regions were compared in the mandibular region, there was a statistically significant difference between the molar region and the anterior region ( $p = 0.01$ ). The amount of resorption in the molar region was significantly higher than in the anterior region. There was no statistically significant difference between the other regions of the mandible. The differences between the anterior, premolar, and molar regions of the maxillary region were also not statistically significant. When the anterior, premolar, and molar regions were compared, there was a statistically significant difference between the anterior and molar regions ( $p = 0.17$ ). Resorption values in the molar region were significantly higher than

the amount of resorption in the anterior region. Tables 3 and 4 summarize the marginal resorption measurements according to zones.

Two hundred fourthy six of the implants were successful (97%) in this study, because more than 2 mm bone resorption was found around 7 out of 253 implants. Three of the 7 failing implants were removed because of excessive bone resorption.

Table 3. The comparison of marginal resorption between the mandible and the maxilla

	N	Min	Max	Mean	StDev	P value Mann Whitney Test
Mandible	124	0	9	0.36	1.33	
Maxilla	129	0	2.4	0.12	0.37	0.076
Total	253	0	9	0.24	0.92	

StDev: Standard deviation

Table 4. The bone resorption values with respect to the placement of the implants in the mandible and the maxilla

	Mandible Mean $\pm$ StDev	Maxilla Mean $\pm$ StDev	Total Implants Mean $\pm$ StDev
Anterior Region	$0.07 \pm 0.31$ mm* n:40	$0.10 \pm 0.25$ mm n:34	$0.10 \pm 0.31$ mm** n:74
Premolar Region	$0.44 \pm 1.62$ mm n:25	$0.12 \pm 0.37$ mm n:53	$0.20 \pm 0.95$ mm n:78
Molar Region	$0.55 \pm 1.59$ mm* n: 59	$0.12 \pm 0.45$ mm n:42	$0.36 \pm 1.26$ mm** n:101
All Region	$0.36 \pm 1.33$ mm n:124	$0.12 \pm 0.37$ mm n:129	$0.24 \pm 0.92$ n=253

StDev: Standard deviation

\* The marginal resorptions were statistically significantly different between anterior and molar regions in the mandible.

\*\* There was a statistically significant difference between anterior and molar regions in terms of marginal resorptions of total implants

## DISCUSSION

Dental implant applications in prosthetic rehabilitation of one or more tooth defects or complete edentulous have become common in the last decades. After implant application, the crestal bone enters the resorption and remodeling phases, and the radiographic marginal bone level is considered to be an important parameter in assessing the peri-implant health and the long-term clinical outcomes (1,6,11). In this study, the resorption of the marginal bone around the implant immediately before the prosthesis construction was evaluated clinically and radiologically.

One of the most important criteria that determine the success of an implant surgery is the bone texture around the implant. Bone loss in different quantities has been reported in the studies on the amount of resorption of the supporting bone around the implant (12-14). In these studies, it has been emphasized that the long-term success of the implant depends on the marginal resorption around the implants in the first 12-months period after implant surgery (15). The implant surgery was accepted

to be successful if bone resorption around the implant is less than 2 mm in the first year after implant surgery (7). In one study, Gatti et al. (12) reported that the marginal bone resorption was 0.22 mm at the end of the first year and the success rates were 100% for 54 implants. Lee et al. (11) found that marginal bone resorption was 0.52 mm and the success rate was 100% in the first 6 months of 32 implants. In the literature, there are also studies evaluating the marginal bone resorption of the implants in the early healing period. In a study of 22 implants, Al-Juboory et al. (8) reported that the mean marginal bone resorption rate in the first 3 months was 0.97 mm and the implant success rates were 100%. Yang et al. (9) reported that the amount of bone resorption at the 12 weeks after implant surgery was 1.28 mm and 1.32 mm in the mesial and distal sides, respectively. In the present study, the marginal resorption of 253 implants was 0.24 mm in the first 3 months and 97% of bone resorption were within physiological limits.

Marginal bone resorption in the implant periphery has been evaluated in several studies in terms of gender. Wyatt and Zarb (16), Moy et al. (17), Kim et al. (18), and Naert et al. (19) reported that there is no difference between men and women in terms of resorption values. Lee et al. (11) reported that marginal bone resorption values were higher in women than in men. Unlike these studies, the present study observed that this value was higher in men than in women. Researchers believed that it may be related to the fact that females engage in better oral hygiene behavior and are more interested in oral health than males.

In a study by Hof et al. (2), the marginal bone resorption around implants at 1 year was found to be 0.98 mm, in a group of 200 implants. It was also found that the bone resorption was 0.93 mm in the mandible and 1.04 mm in the maxilla, and there was no statistically significant difference between maxillary and mandibular resorptions. In another study, Takuma et al. (20) determined that the marginal bone resorption around 66 posterior (premolar and molar) implants was 0.82 mm in the mesial and 0.62 mm distal, and the difference between these regions was not statistically significant. In the present study, the amount of bone resorption was found to be higher in the mandibular area compared to the maxillary area but this difference was not statistically significant.

Naert et al. (20) stated that there was no difference between the anterior and posterior regions in the jaws in terms of marginal bone loss. Avanojik et al. (21) placed 36 maxillary and 52 mandibular implants and observed that the maxillary anterior implants showed more marginal resorption than the maxillary posterior implants, and the mandibular anterior implants displayed more marginal resorption than the mandibular posterior implants. In the present study, it was observed that the amount of resorption around the implants in the mandibular molar region was greater than the ones in the mandibular anterior region. It was also found that the most resorbed region in both the mandible and the maxilla was the molar region.

The present study showed several limitations. Firstly, the marginal resorption around dental implants was not evaluated by periapical radiography and computerized dental tomography. Periapical radiographs are useful for the diagnosis and monitoring of marginal bone levels, but they have disadvantages especially when there is lack of standardization between serial radiographs, due to low reproducibility. Also, uncomfortable film holders for standardized periapical radiographs are usually very painful for patients with atrophic mandibles (22). Panoramic radiographs are an alternative technique to periapical radiographs for evaluating marginal bone loss in cases where this type of edentulous mandible makes periapical radiography difficult or impossible (22,23). Panoramic radiographs are used for radiation protection when multiple implant evaluations are required per patient (24). Panoramic radiographs were selected for radiation protection reasons because of the need to evaluate multiple implants per patient. Analysis by using computerized dental tomography will give better results since these values can be measured in three dimensions. However, it should be kept in mind that the computerized dental tomography is not economical, it is time-consuming, and radiation is used in the process. In the literature, it should be noted that in routine practice periapical radiographs and computerized dental tomography are too impractical and present difficulties for patients. In this study, marginal resorption at mesial and distal regions of the implants was measured vertically by using panoramic radiography. However, frequent distortions to mesial-distal measurements on panoramic radiography are observed, limiting a more precise evaluation mainly to the anterior segment and maxillary molars areas. Secondly, the levels of resorption occurred over a period of about 3 months until prosthetic loading were determined. In the future studies, authors suggest to measure the marginal bone resorptions after prosthetic loading and compare them with the values before prosthesis production. In addition, it is recommended to evaluate more implants and longer follow-up results in future studies.

## CONCLUSION

In the present study, the marginal resorption of the bone surrounding the implant after surgery until loading the prosthetics was evaluated and was found to be 0.24 mm in the mandible and the maxilla. In addition, both jaws had the lowest resorption in the anterior region and the highest resorption in the molar region. In this study, mesial and distal vertical bone resorption levels have been investigated, and further studies are recommended for the analysis of resorption in vestibular/buccal and lingual/palatal walls.

*Competing interests: The authors declare that they have no competing interest.*

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