Retrospective Evaluation of Two-Implant–Supported Mandibular Overdentures with Radiographic and Clinical Aspects

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Purpose: The aim of this retrospective study was to evaluate the clinical performance of two implants supporting mandibular overdentures by means of clinical and radiologic parameters, and also to explore the relationship of marginal bone loss with implant-/patient-related factors and soft tissue parameters. ***Materials and Methods:*** Data of patients who had undergone insertion of two implants into the interforaminal region between November 2012 and December 2016 using three different implant systems were retrieved from the archival records. Age, sex, implant length, implant diameter, observation period, mobility, and soft tissue parameters were recorded. Marginal bone levels and interimplant distances were measured with computer software on panoramic radiographs obtained at 3 months and at the recall session. ***Results:*** A total of 43 patients with 86 implants were included in the study. Patients were evaluated with an average observation period of 41.79 months. Among the evaluated parameters, Gingival Index, Bleeding Index, and implant diameter were found to have significant effects on the marginal bone loss ($P < .05$). However, no significant effects of sex, age, implant length, observation period, and interimplant distance were observed on the marginal bone loss. No implants showed peri-implantitis or mobility, while eight implants showed peri-implant mucositis. ***Conclusion:*** Within the limitations of this study, it can be concluded that peri-implant soft tissue health and the diameter of the implant have an important effect on the marginal bone loss as well as the success of two-implant–supported mandibular overdentures. *Int J Oral Maxillofac Implants 2021;36:779–786. doi: 10.11607/jomi.8667*

Keywords: edentulous mandible, interforaminal implants, overdenture

Longevity of life has increased proportional to the evolutions in the medical field, and as a consequence of the steady increase in the mean age, the number of edentulous people still remains significant.[1] Edentulism is a major health problem that has an important adverse impact on quality of life by limiting activities like eating and speaking.[2–4] In the past, conventional dentures have been accepted to be the first option for the rehabilitation of edentulism.[1,3,5] However, especially in the mandible, conventional dentures have often been associated with many problems, such as lack of stability and retention and decreased chewing ability.[5–8] These problems can be solved with denture adhesives if satisfactory alveolar support is present.[7,9] However, denture adhesives are not always cost-effective, and in most cases, because of the severe atrophy of the alveolar process, rehabilitation of the mandible becomes a challenge for the clinician.[5,8–10] Treatment solutions have focused on providing denture support by increasing the supporting tissue dimensions with preprosthetic surgical techniques, such as tissue extension procedures and reposition of the muscle attachments in atrophic cases. However, clinically acceptable rehabilitation cannot always be provided by these approaches.[9,11,12]

With the introduction of osseointegration as well as implant-retained prostheses, management of edentulism has been shifted from conventional dentures to the implant-supported mandibular overdenture or a fixed prosthesis in the last 30 years.[5,13–15] Among them, removable implant-supported mandibular overdentures have gained more popularity because of their advantages in terms of cost, maintenance of oral hygiene, technical simplicity, treatment time, and alveolar support.[3,7,9,13] In the current literature, according to the McGill and York Consensus Statements, two-implant–supported mandibular overdentures are accepted as the standard prosthetic care for edentulous patients.[1,16] Two supporting implants, which are placed into the interforaminal region, are reported to increase stability and retention, improve masticatory function, positively

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Submitted May 28, 2020; accepted October 25, 2020.

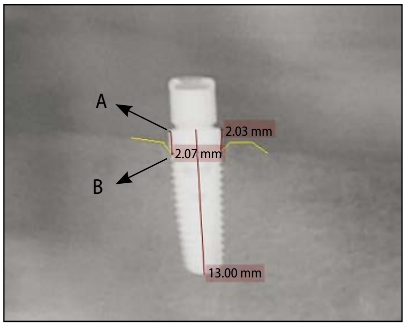

Fig 1 Measurement of marginal bone loss.

affect social life and general health, and thereby serve a better quality of life to healthy as well as medically compromised patients.[4,6,8,9,17]

The success of two-implant–supported mandibular overdentures has been evaluated with several clinical and radiographic parameters mentioned in the literature previously.[6,13,18–21] The aim of this study was to evaluate dental implants supporting two-implant–retained mandibular overdentures by means of clinical and radiologic parameters, and also to explore the relationship of marginal bone loss with implant-/patient-related factors and soft tissue parameters.

MATERIALS AND METHODS

This retrospective cohort study was conducted on the clinical and radiologic data of patients who had undergone insertion of two implants into the interforaminal region, in the Department of Oral and Maxillofacial Surgery of the Faculty of Dentistry of Ordu University between November 2012 and December 2016. The study protocol was approved by the Ethics Committee of the Ordu University (No: 2019-26) and was conducted in accordance with the ethical standards specified in the Helsinki Declaration of 1964 and its subsequent amendments.

Inclusion criteria were as follows:

- Systemically healthy patients
- Patients with complete demographic, clinical, and radiologic data
- Patients with a follow-up period of > 24 months

Exclusion criteria were as follows:

- Patients who have low-quality radiographic images that preclude the measurements
- Patients with severe parafunctional habits or smokers

Surgical Procedure

All surgeries were performed in a standardized manner. Following infiltrative local anesthesia, a crestal incision between the right and left first premolar teeth with releasing vertical incisions was made. The mucoperiosteal flap was rigorously reflected. Mental nerves were controlled to prevent possible paresthesia risk, especially in atrophic cases. Three different implant systems were used (Osstem Implant System, Osstem Global; Implance Implant System, AGS Medical; Nobel Implant System, Nobel Biocare). Osteotomy sites were prepared according to the recommended guidelines given by the manufacturers for each system. Surgeries were performed without using a guide. Two bone-level implants were inserted into the canine areas vertically without inclination. The implants were placed parallel and at the same marginal level to each other by applying a maximum torque of 40 Ncm. After placement of the implants, a closing screw was placed, and the flap was primarily closed with 3-0 silk sutures. Patients were prescribed standard postoperative medication. One week later, the sutures were removed.

Healing caps of all implants were inserted 3 months after the insertion of the implants. To achieve an acceptable emerging profile, the prosthetic stage started 1 week after the insertion of healing caps. The locator system was used for the preparation of the mandibular two-implant–supported overdentures. During the prosthetic stage, the locator attachments to be used in the mouth were selected by considering the gingival heights of the patients, and 35-Ncm torque was applied to the locator attachments. To provide the connection of the prostheses and the implant, pink nylon elements that provide medium force were used. After the necessary adjustments were made during the delivery phase of the prostheses, the metal slots of the locator attachments were placed into the overdenture.

Radiographic Evaluation

The marginal bone levels of all implants were measured on panoramic radiographs obtained with the Kodak 8000C Digital Panoramic Imaging System (Kodak Dental Systems) that were taken at 3 months and a control session from distal and mesial sites of the implants. Measurements were performed with the MicroDicom software (version 0.8.8). The length of each implant was used as a reference to standardize the measurements. To determine marginal bone loss, the distance between the base of the abutment (A) and the first marginal bone-to-implant contact (B) was measured from both mesial and distal sides (Fig 1). The bone-level measurement was performed by an independent examiner (M.A.). The examiner reviewed the radiographs in two separate sessions, 1 week apart. Intraobserver reliability was determined by comparing the first and second measurements. The average of the calculations was accepted as marginal bone loss.

Clinical Parameters

At the control session, the patients were evaluated for Bleeding Index, Gingival Index, mobility, peri-implantitis, and peri-implant mucositis, and the results were recorded. Measurements were performed as follows:

Bleeding Index.[19]

- Score 0: No bleeding when using a periodontal probe
- Score 1: Isolated bleeding spots visible
- Score 2: A confluent red line of blood along the mucosal margin
- Score 3: Heavy or profuse bleeding

Gingival Index.[22]

- Score 0: Normal peri-implant mucosa
- Score 1: Mild inflammation, slight change in color, slight edema
- Score 2: Moderate inflammation, redness, edema, and glazing
- Score 3: Severe inflammation, marked redness and edema, ulceration

Mobility.

- Scored as (+) if present, (–) if absent

Peri-implantitis and Peri-implant Mucositis.[23]

Peri-implantitis.

- (+) ≥ 4-mm probing depth, presence of bleeding and/or suppuration at two or more sites around the implant, and bone loss was at least 25% over the length of the implant.
- (-) When these conditions were not met, it was recorded as absent.

Peri-implant mucositis.

- (+) Soft tissue inflammation without bone loss was noted as present.
- (–) When these conditions were not met, it was recorded as absent.

Statistical Analysis

Statistical analyses were performed with the IBM SPSS Statistics for Windows software (version 23.0, IBM). The Shapiro-Wilk test was used to assess the normality of the data. To compare marginal bone level changes, interimplant distance, Gingival Index, Bleeding Index, and the observation periods among the implant systems after loading (3 months) and in the control session, the Kruskal-Wallis test was used. The difference between marginal bone at 3 months and the control session among implant systems were compared with the Wilcoxon and paired *t* tests. Total marginal bone loss, marginal bone loss at 3 months and the control session, Gingival Index, and Bleeding Index among the sexes were explored with the Mann-Whitney *U* test or independent-samples *t* test as appropriate. Spearman correlation was used to explore the relationship between age, interimplant distance, Gingival Index, Bleeding Index, the observation period, and marginal bone loss. The difference between marginal bone loss and diameter/length of the implants were evaluated with the Mann-Whitney *U* test. Baseline characteristics were analyzed with the Kruskal-Wallis test for continuous data and the chi-square test for categorical variables. The intraobserver reliability was estimated with intraclass correlation coefficients (ICC). All tests were two-tailed and were based on a .05 significance level.

RESULTS

A total of 43 patients with a mean age of 63.88 ± 7.3 years and 86 implants were included in the study. Twenty-one of the patients were women, and 22 of them were men. No significant differences were observed regarding age and sex between the implant systems (Table 1). The diameter of the implants was ranged from 3.3 to 5 mm, and the length of the implants from 10 to 14 mm (Table 2). Significant differences were observed regarding marginal bone levels at 3 months and control measurements among the implant systems. No significant differences were observed in terms of interimplant distance (P = .66), Gingival Index, Bleeding Index, and marginal bone loss at the control session between the implant systems. However, significant differences were observed between implant systems regarding observation period, 3 months, and total marginal bone loss (Table 3, Fig 2). No significant differences were observed at 3 months, control, and total marginal bone loss between implants with a length of > 12 mm and < 12 mm (Fig 3a). Regarding diameter, significant differences were observed at 3 months, control, and total marginal bone levels between implants > 4 mm and < 4 mm in diameter (Fig 3b). Significant correlations were found between total marginal bone loss and Gingival Index (P = .000, r = 0.495) and Bleeding Index (P = .000, r = 0.435), while no significant correlations were found between total marginal bone loss and interimplant distance (P = .589), age (P = .267), and observation period (P = .287). Among sexes, no significant differences were observed regarding marginal bone loss, Gingival Index, and Bleeding Index (Fig 4). None of the implants showed mobility or peri-implantitis during the follow-up period. However, eight implants in eight patients showed peri-implant mucositis and were treated during the follow-up period (Table 4). ICCs for the first and second measurements of marginal bone loss at 3 months from mesial and distal sides were 0.988 (0.981 to 0.992) and 0.987 (0.979 to 0.991), respectively.

Table 1 Demographic Characteristics of the Patients

	Implance n = 32	Osstem n = 26	Nobel n = 28	*P* value
Age				.45*
Mean ± SD	65.63 ± 6.43	63.85 ± 7.68	61.93 ± 7.40	
Median (Min–Max)	67 (53–76)	64 (54–86)	62 (47–80)	
Sex				.111†
Female (%)	12 (37.5)	12 (46.2)	18 (64.3)	
Male (%)	20 (62.5)	14 (53.8)	10 (35.7)	
Follow-up (mo)				< .001*
Mean ± SD	49.50 ± 9.38	29.69 ± 4.79	44.21 ± 6.79	
Median (Min–Max)	49.50 (34–65)	30 (24–36)	41 (38–56)	

*Kruskal-Wallis test; †chi-square test.

Table 2 Distribution of the Implants Regarding Sex, Diameter, and Length

	Length (mm)									
Diameter (mm)	**10**	**11.5**	**12**	**13**	**14**	**10**	**11.5**	**12**	**13**	**14**
Implance n = 32	**Female (12)**					**Male (20)**				
3.3								2		
3.5										
3.7	2		4					4	2	
4		2								
4.3	2							2		6
4.5										
4.8		2						4		
5										
Osstem n = 26	**Female (12)**					**Male (14)**				
3.3										
3.5		4				2	2		2	
3.7						4				
4		4	2							
4.3										
4.5							2		2	
4.8										
5	2									
Nobel n = 28	**Female (18)**					**Male (10)**				
3.3										
3.5										
3.7	4	2		8			2		4	
4										
4.3										
4.5		4							4	
4.8										
5										

Table 3 Marginal Bone Loss Among Implant Systems

	Implance n = 32	Osstem n =26	Nobel n = 28	*P* value
MBL-3rd month				< .001*
Mean ± SD	0.69 ± 0.29	0.67 ± 0.33	1.68 ± 0.71	
Median (Min–Max)	0.67 (0.15–1.60)	0.58 (0.25–1.58)	1.65 (0.40–3.40)	
MBL-control				.314*
Mean ± SD	1.2 ± 0.47	1.18 ± 0.46	1.44 ± 0.64	
Median (Min–Max)	1.17 (0.35–2.10)	1.17 (0.63–2.38)	1.32 (0.60–2.98)	
***P* value**	< .001†	< .001‡	.016‡	
MBL-total				< .001*
Mean ± SD	0.94 ± 0.36	0.92 ± 0.38	1.56 ± 0.63	
Median (Min-Max)	0.93 (0.25–1.85)	0.84 (0.45–1.98)	1.46 (0.50–2.99)	

*Kruskal-Wallis test; †Paired *t* test; ‡Wilcoxon test.

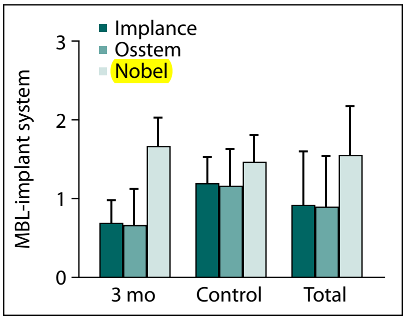

Fig 2 Marginal bone loss among implant systems.

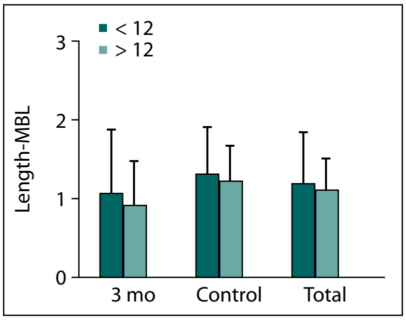

Fig 3a Marginal bone loss regarding length.

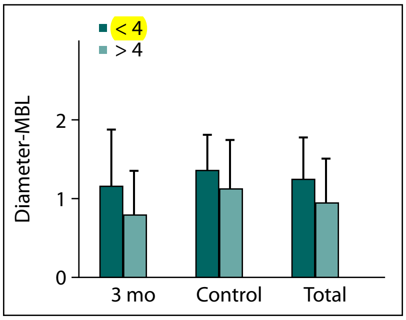

Fig 3b Marginal bone loss regarding diameter.

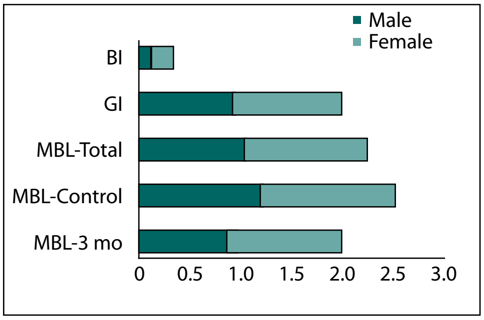

Fig 4 Marginal bone loss, Gingival Index (GI), and Bleeding Index (BI) among sexes.

Table 4 Peri-implant Soft Tissue Parameters and Mobility

	Implance n = 32	Osstem n = 26	Nobel n = 28	*P* value
Gingival Index				.535*
Mean ± SD	1.09 ± 0.58	0.92 ± 0.48	1 ± 0.66	
Median (Min–Max)	1 (0–2)	1 (0–2)	1 (0–2)	
Bleeding Index				.296*
Mean ± SD	0.22 ± 0.42	0.08 ± 0.27	0.21 ± 0.41	
Median (Min–Max)	0 (0–1)	0 (0–1)	0 (0–1)	
Peri-implant mucositis	6	1	1	
Peri-implantitis	–	–	–	
Mobility	–	–	–	

*Kruskal-Wallis test.

ICCs for the first and second measurements of marginal bone loss at the control session from mesial and distal sides were 0.993 (0.989 to 0.995) and 0.994 (0.990 to 0.996), respectively.

DISCUSSION

Currently, two-implant–supported mandibular overdentures are considered as the first treatment of choice for rehabilitation of edentulous patients, and the reported survival rates of two-implant–supported mandibular overdentures are high among the reported studies with different follow-up periods.[1,3,5,16] Bakker et al,[6] in their prospective 20-year follow-up study on 53 patients, reported 92.5% survival rate for two-implant–supported mandibular overdentures. In another clinical study with a retrospective design, Vercruyssen et al[13] showed a survival rate of > 95.5% after 23 years of loading of two-implant–supported mandibular overdentures. Meijer et al[24–26] reported that the 5- and 10-year survival rates were 93% to 100% for different implant systems. In the present study, the average follow-up was 41.79 months, and the survival rate was 100% without failure of any implant.

The success of the implants was strongly influenced by the marginal bone level changes. Albrektsson et al[18] proposed criteria for the assessment of implant survival and success and reported that marginal bone level changes in the first year should be < 1 to 1.5 mm, and ongoing annual bone loss should be < 0.2 mm. It has been reported that because of the maturation and adaptation of the bone to withstand functional forces, the bone level around the implant becomes stable after 3 years, and minimal changes are seen afterward.[24,27] Meijer et al[24] reported that mean marginal bone loss over a period of 5 years was 0.7 to 1.4 mm for different implant systems. Visser et al[28] reported a bone loss of 0.4 mm in the first year and an annual bone loss of < 0.2 mm for two-implant–supported mandibular overdentures. Meijer et al[29] reported that the average annual bone loss over 10 years was 0.14 mm. Vercruyssen and Quirynen[30] reported that the mean annual bone loss was 0.08, 0.07, 0.06, 0.04, and 0.05 mm/year after 3, 5, 8, 12, and 16 years of loading, respectively. In the present study, mean marginal bone loss of 1.14 mm was observed in an average 41.79-month follow-up period. Compared with the other studies, the marginal bone loss in the present study was relatively high in a short follow-up period. The authors think that the possible reason for this may be the strict oral hygiene regimens performed in the reported studies and the relatively high Gingival Index score of the patients in the present study. Also, the difference in terms of implant systems, surgical-prosthetic procedures, and aftercare regimens between the studies may be considered as the other possible factors.

There are different results related to the influence of implant- and patient-related factors on implant success. Mumcu and Dereci[14] reported that longer and wider implants increase the bone-to-implant contact and result in increased osseointegration. Geckili et al[31] reported that implants longer than 10 mm have higher success rates. However, Vercruyssen et al[13] reported that short implants are able to support an overdenture. In the present study, no significant difference was observed among the implants with < 12-mm and > 12-mm length in terms of marginal bone loss. However, the implants with < 4 mm in diameter were found to show significantly more marginal bone loss compared with the implants > 4 mm in diameter.

Regarding age and sex, Hoeksema et al[32] reported that the clinical success of two-implant–supported mandibular overdentures is the same in younger and older patients. Bakker et al,[6] in their study on patients aged > 80 years, reported 92.5% survival rates for two-implant–supported mandibular overdentures. Garg et al[33] reported that age and sex were not important variables for implant health in their study. Mumcu and Dereci[14] found that sex and age have no major effect on marginal bone loss. Interimplant distance is also another parameter in question in terms of marginal bone loss and patients' satisfaction.[2,14,34] Tokar et al,[35] in their in vitro study that explored the stress in three different interimplant distances of three-implant–retained overdentures, found the lowest stress in the shorter interimplant distance. Kan et al,[36] in another study conducted with finite element analysis, suggested that placing implants into the lateral incisor area provides better results in terms of stress and fracture risk than placement into the canine area. Mumcu and Dereci[14] found that interimplant distance did not affect marginal bone loss. In the present study, age, interimplant distance, and sex were found to have no significant effect on marginal bone levels as well as the success of the implants.

Peri-implant soft tissue parameters were also considered to be an indicator for implant success. In a study by Meijer et al,[24] low Gingival Index and Bleeding Index scores were observed in all five evaluation periods. Similarly, in other studies by the same authors,[25,26] lower Gingival Index and Bleeding Index scores were observed. It is suggested that these results originated from the strict oral hygiene regime applied in these studies. In another study, Roman-Torres et al[37] reported no significant difference in terms of marginal loss and peri-implant health. Elsyad et al[38] found no correlation between Gingival Index and other clinical parameters, except pocket depth with marginal bone loss. Significant correlations were observed between marginal bone loss and the Gingival-Bleeding Indexes in the present study.

Panoramic radiography is a practical and cost-effective imaging method used to evaluate the marginal bone level.[39] Although intraoral radiographs are considered to be the standardized approach to measurement of marginal bone loss, in particular, the atrophic edentulous mandible may preclude the use of intraoral radiographs.[14,40] Persson et al[41] reported that panoramic radiography can be used as a standard diagnostic approach for periodontal radiographic imaging. Also, Akesson[42] suggested that if increased image quality is achieved, panoramic radiographs should be preferred for the evaluation of marginal bone changes. Therefore, in the present study, panoramic radiography was preferred.

The retrospective nature is a limitation of this study in terms of control and accuracy of past clinical and radiologic records. Clinical parameters, such as plaque and calculus index and pocket depth, could not be evaluated because of the retrospective design. The changes in the surgical skills of the surgeon in the study period and the height of the locator attachments may be considered as other limitations that can affect the outcomes. Also, follow-up periods were not homogenous among the patients and were relatively short. This period may lead to misinterpretation of the marginal bone loss.

CONCLUSIONS

Within the limitations, the results of this study suggest that the peri-implant soft tissue health and the diameter of the implant have an important effect on the marginal bone loss as well as the success of two-implant–supported mandibular overdentures in a short follow-up period.

ACKNOWLEDGMENTS

The authors declare that there is no conflict of interest.

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