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Evaluation of Clinical and Radiographic Signs of Implants in Patients With Implant Retained Mandibular Overdentures

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Abstract

Background: The minimum standard treatment plan for the reconstruction of an edentulous mandible, according to York, is an overdenture supported by two implants.
Objectives: The aims of this study were to evaluate and compare the clinical outcomes and peri-implant marginal bone loss around implants in patients treated with mandibular overdentures supported by 1, 2, 3, 4, and 5 implants.
Materials and Methods: A total of 25 patients with a mean age of 62.7 years old, who were treated with implant supported mandibular overdentures at Hamedan's faculty of dentistry, were enrolled in this cross-sectional study. Among these patients, 6 had overdentures supported by one implant, 9 had overdentures supported by two implants, 2 had overdentures supported by three implants, 5 had overdentures supported by 4 implants, and 3 had overdentures supported by 5 implants. The clinical and radiographic parameters around the implants were assessed, including: probing depth, width of keratinized gingiva, bleeding on probing, peri-implant inflammation, calculus formation, implant mobility, adverse events, and radiographic signs of peri-implant bone loss (distance between the implant shoulder and the level of the mesial and distal proximal bone). The ANOVA and the Fisher's Exact test were used to evaluate the significant differences among the groups.
Results: None of the implants had loosened and no adverse events were seen around the implants. Additionally, the clinical variables did not show significant correlation with the number of implants. Overall, the bone resorption showed an inverse and significant relationship with the number of implants ($P = 0.001$).
Conclusions: With mandibular overdentures supported by 1, 2, 3, 4, and 5 implants, favorable clinical outcomes can be achieved. However, when increasing the number of implants, marginal bone loss decreases. For example, the patients with five implants showed less marginal bone loss than those with a lesser number of implants.

Keywords: Bleeding on Probing, Calculus, Keratinized Gingiva, Mandibular Overdenture, Probing Depth

1. Background

Although nowadays edentulous situations seem to be decreasing, edentulism is still one of the challenges many communities are facing, due to the increased life expectancy of the population. Most often, edentulous situations involve the low-income parts of the community (1-3). Fortunately, most people who use complete dentures adapt effectively, without any significant problems in the quality of their lives (2, 4). However, among the existing prosthesis for the reconstruction of the edentulous areas, most of the complaints with regard to the retention and stability occur with complete dentures. Under these conditions, according to York, the minimum standard of treatment is an overdenture supported by two implants (5). There are numerous studies supporting overdentures retained by 1 to 8 implants, and the number of implants for supporting the overdenture usually depends on the economic situation of the patient (6). It has been shown that even overdentures supported by one implant in the midline of the mandible have favorable results (2, 7-9).

Overdentures have greater retention and stability when compared to complete dentures. In addition, the mandibular anterior bone is preserved, but the posterior bone loss continues. Therefore, in cases in which the patient cannot afford the cost of an implant-supported complete fixed partial denture, an overdenture is the choice. Even years later, additional implants can be added to the treatment plan. Moreover, less soft tissue is covered, which is especially important for those who just want to use dentures (1, 10-14). The first advantage of overdentures, when compared to complete fixed prostheses, is the lower cost of the treatment. Furthermore, with overdentures, the need

for complicated surgical treatment before implant placement can be eliminated. In cases in which there is a need for the reconstruction of soft tissue contours, overdentures are better than implant-supported complete fixed partial dentures. In cases with nocturnal parafunction, the stress on an implant is reduced by removing the overdenture. Furthermore, home health care is easier and hygiene is greater than in fixed treatment (3, 10, 11, 15).

Several studies have examined overdentures, and success rates of 94% - 97% have been reported for mandibular overdentures (16). Depending on the number of implants, there are several treatment plans for overdentures, and the financial condition of the patient is the main determining factor of the treatment plan. Several studies have examined the results of different numbers of implants for supporting overdentures (6). In some of these studies, the results of the clinical and radiographic assessments with regard to different numbers of implants were different (17, 18). Moreover, some studies have shown that they were not significantly different (19-21). Although there have been many studies on this topic, there are controversies (22, 23), and few studies are available related to the hard and soft tissue evaluation of the different numbers of implants. Therefore, more studies with regard to the effects of the number of implants on the treatment outcomes are needed (6).

2. Objectives

The aim of this cross-sectional study was to determine and compare the clinical outcomes and the amount of bone resorption adjacent to the implants in subjects treated with mandibular overdentures supported by 1, 2, 3, 4, and 5 implants.

3. Materials and Methods

Those patients treated with mandibular implant supported overdentures and complete maxillary dentures, according to their files as registered patients from February of 2011 through February of 2014 at the Hamadan faculty of dentistry, were included in the study. This study was approved by the ethical committee of the Hamadan University of Medical Sciences. For this study, only those patients fulfilling the following selection criteria were enrolled: patients with complete implant files that were available, patients having dental implants with at least two years of oral function after prosthetic rehabilitation, and regular plaque control every 24 hours. Those patients who were not systemically healthy, received antibiotics and/or anti-inflammatory therapy within the previous 3 months, received periodontal treatment within the previous 6 months, with a smoking history, and with alcohol, tobacco, or drug abuse were excluded from this study. After the patients were given a complete detailed explanation about the study, informed consents were obtained.

A total of 25 patients with ages ranging from 52 to 75 years old (mean age of 62.7 years) were included in the study. Among these patients, 6 had mandibular overdentures supported by one implant, 9 patients had overdentures supported by two implants, 2 had overdentures supported by three implants, 5 had overdentures supported by four implants, and 3 patients had overdentures supported by five implants. For all of the patients, there were periapical radiographs with paralleling techniques taken immediately after surgery.

3.1. Clinical Examination

The clinical situation of the soft tissue around the implants, including the following criteria, was examined. The probing depths (PDs) and the width of the keratinized gingiva were measured on six sites per implant, on all of the implants, and the average PD and width of the keratinized gingiva for each group were recorded.

The presence or absence of bleeding on probing (BOP) of six sites per implant, on all of the implants (until 30 seconds after probing), and the calculus and inflammation (changes in gingival color and shape) at the buccal or lingual surfaces (in 2 locations around each implant) of the implants were assessed. These data were used to calculate the percentage of sites with BOP, calculus, and inflammation in each group. Furthermore, the implant mobility was also recorded (24, 25). The clinical examinations were carried out three times by one examiner, and the findings were recorded.

3.2. Radiographic Evaluation

At the time of this study, new radiographs were obtained under standard conditions, and a digital caliper was used for the evaluation of the radiographs. The evaluation of the bone resorption was performed by measuring the distance from the implant shoulder to the level of the mesial and distal proximal bone (24). Then, the measurements at the baseline and the follow up radiographs were compared. The radiographic magnification could not be determined; so, for matching the magnification of the initial and final radiographs, the distances between the implant threads in the initial and final radiographs were measured and considered. The measurements were performed three times by one examiner, and the average of the measurements in each group was reported.

3.3. Statistical Analysis

The descriptive statistics, including the means and standard deviations, were calculated for describing the data in all of the study groups. The results were then analyzed by a one-way ANOVA and Fisher's test to detect the significant differences among all of the groups. The statistical significance level was set at $P < 0.05$.

4. Results

The results showed that none of the implants had loosened and no adverse events occurred around the implants. The ANOVA analysis of the mean probing depth and the width of the keratinized gingiva around the different numbers of implants did not show any significant differences between the groups (P = 0.276, 0.648). In addition, the differences in the percentages of the calculus, BOP, and inflammation at the buccal and lingual surfaces between the groups were analyzed using the Fisher's Exact test, and revealed that there was no relationship between the number of implants and the mentioned clinical features (P = 0.498, 0.934, 0.934). Therefore, none of the clinical variables showed significant correlations with the number of implants.

The bone resorption showed an inverse and significant relationship with the number of implants (P = 0.001). The minimum amount of marginal bone loss was 0.49 ± 0.119 mm, and was seen in the overdentures supported by five implants. The maximum amount of marginal bone loss was 1.51 ± 0.099 mm, and was seen in the overdentures supported by one implant (Table 1).

Table 1. The Mean Marginal Bone Loss and the ANOVA Test Results[a]

Criteria	Mean ± SD
Marginal Bone Loss	
Group 1	1.51 ± 0.099
Group 2	1.036 ± 0.141
Group 3	0.75 ± 0.47
Group 4	0.66 ± 0.064
Group 5	0.49 ± 0.119

[a] P value is 0.648.

5. Discussion

With the help of an implant supported overdenture, greater retention and stability can be achieved (10). The effectiveness of overdentures supported by implants compared to dentures, with respect to patient satisfaction and clinical efficacy, has been previously demonstrated (17). The present cross-sectional study evaluated the clinical and radiographic outcomes in the subjects treated with mandibular overdentures supported by 1, 2, 3, 4, and 5 implants. However, none of the clinical features showed significant correlations with the number of implants; although the results of the clinical evaluations were consistent with those of Batenburg et al., Visser et al., and Meijer et al. (19-21).

The bone resorption showed an inverse and significant relationship with the number of implants in the present study; but this was inconsistent with the results of Batenburg et al., Visser et al., Meijer et al., and Burn et al., which showed no significant differences between the marginal bone loss and the number of implants (18-21), and Stoker et al., which showed more marginal bone loss with an increasing implant number (17).

In the clinical evaluation, there were no signs of the loosening of the implants and none of the implants were lost, which may be due to the dense cortical bone of the anterior mandible, standard operating procedures, and acceptable hygiene (in most cases). All of these factors contribute to the good condition of the implant supporting bone. This finding is consistent with the results of Cune et al. (26) in a 10-year study and Cordioli et al. (7) in 5-year study; but in studies done by Chiapasco et al. (27), Walton et al. (8), Bressan et al. (24), and Visser et al. (20), some of the implants were lost.

Calculus formation at the buccal and lingual surfaces of the implants was seen in all of the groups (with the exception of the overdentures supported by 3 implants). Although the presence of calculus can be attributed to poor oral hygiene, the role of prosthesis connections cannot be ignored, but was not considered due to the limitations of this study. Since healthy soft tissue around the implant is important for the long-term success of the treatment, it was evaluated in this study (17). Based on the results of a systematic review that recommended the use of clinical features for evaluating implant soft tissue health, it was assessed by measuring the PD, presence or absence of BOP, and inflammation (26). The PD was normal in all of the patients (the pocket depths were lower than 4 mm), which was the same as the results of the case report studies by Vafaee et al. (28) that evaluated the clinical outcomes of overdentures supported by one implant, Cordioli et al. (7) in a 5-year study of overdentures supported by one implant, Cune et al. (26) in a 10-year study of overdentures supported by two implants, and Chiapasco et al. (27) in a study of overdentures supported by 4 implants. In this study, the mean PD showed no significant difference between the 5 groups, which is consistent with the study by Visser et al., who demonstrated no significant difference

in the PDs between the overdentures supported by 2 and 4 implants (20). However, this is inconsistent with the results of Stoker et al., which showed that the PD was greater in those overdentures supported by 4 implants than 2 implants. The deep pockets in this study could be explained by gingival hyperplasia (17).

The examination of the inflammation around the implants did not show significant differences among the groups. We expected that with an increasing number of implants, plaque control would be more difficult and more inflammation would be seen, but we could not show any relationship between the inflammation and the number of implants. Therefore, we should consider other factors contributing to inflammation, such as prosthesis connections and a proper maintenance recall program with patient compliance, in addition to a patient's ability for adequate oral hygiene, which was not mentioned in our study.

BOP was seen in all groups in this study; however, it was not associated with the number of implants. This can be attributed to poor plaque control in the patients. In other studies, including the studies of Cune et al. (26), Chiapasco et al. (27), and Visser et al. (20), the bleeding index was used, which could not be compared with our study. The mean width of the keratinized gingiva in the groups with 2, 3, and 5 implants was greater than 2 mm. Although the low width of the keratinized gingiva can lead to the irritation and inflammation of the soft tissue around the implant, only one of the patients with overdentures was supported by 2 implants, which had a complete lack of keratinized gingiva around the implants, and showed inflammation. With respect to the width of the keratinized gingiva, the analysis did not reveal a significant relationship with the number of implants. This was similar to the results of the study by Burn et al. (18).

Since the hardness of a titanium or titanium alloy implant is greater than that of cortical bone, when stress is transferred to the bone it is distributed to the most coronal portion of the supporting bone of the implants, and can lead to marginal bone loss (29). In this study, standard periapical radiographs were used to assess the marginal bone loss, and the mean marginal bone loss was measured in each of the five groups in this study. A comparison of the marginal bone loss between the groups showed that with an increasing numbers of implants, the marginal bone loss was reduced. We can attribute this finding to the fact that when occlusal loads are distributed over increasing numbers of implants, the bone stresses surrounding the individual implants are reduced. However, in the studies by Batenburg et al. (19), Visser et al. (20), and Burn et al. (18), the marginal bone loss showed no significant differences between the different numbers of implants. In addition, Stoker et al. showed that with an increasing number of implants, the marginal bone loss increased (17). It is worth noting that besides the number of implants, there are other factors that might be involved in marginal bone loss, such as the type of prosthesis connections, loading time, implant length and diameter, type of implant system, effect of maxillary occlusal conditions, bone density, and angle of the implant placement (2). However, in the present study they were not considered.

While interpreting the results of this study, it is important to keep the limitations in mind. Overall, the results of this study showed favorable clinical outcomes for overdenture treatment. Additionally, it was shown that while increasing the number of implants supporting the overdenture, the marginal bone loss decreases. Therefore, based on the findings of the present study, it can be concluded that an overdenture supported by implants, even with the lowest number of implants, could be a successful treatment. However, in order to prevent marginal bone loss, it is better to increase the number of implants for supporting the overdenture.

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Footnotes

Authors' Contribution: Massoumeh Khoshhal developed the original idea and the protocol, abstracted and analyzed the data, and is the guarantor. Fariborz Vafaee, Oranous Moradi, Neda Rastegarfard, Erfan Abbasi, and Shahram Sharifi contributed to the development of the protocol and abstracted the data, while Neda Rastegarfard prepared the manuscript.

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