# Assessment of the Effect of Clinical Independent Risk Factors on Marginal Bone Loss in 2-Implant–Supported Locator-Retained Mandibular Overdentures

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The objective of this study is to evaluate the effect of clinical parameters of gender, age, implant length, implant diameter, interimplant distance, and locator height on marginal bone loss in 2-implant–supported locator-retained mandibular overdenture prostheses in 6, 12, and 24 recall sessions after loading. Clinical and radiographic data of patients who were treated between January 1, 2014, and January 4, 2018, were retrieved from the archives. The clinical data of gender, age, implant length, implant diameter, and locator height were recorded. The mesial and distal marginal bone levels of all implants and interimplant distances were determined at baseline and at 6-, 12-, and 24-month recall sessions on panoramic radiographs in a computer program. Statistical analysis was used to evaluate the effect of implant length, implant diameter, gender, age, interimplant distance, and locator height on marginal bone loss at the 6-, 12-, and 24-month control evaluations. A total of 57 patients with a mean age of 59.2 ± 9.8 years and 114 implants were included in the study. Among the aforementioned parameters, only the locator height had a major effect on the distal and mesial marginal bone loss ($P < .05$). A locators with a 4-mm height showed statistically significant distal and mesial marginal bone loss compared with locators with 2- and 3-mm heights in all control periods ($P < .05$). The locator with a 4-mm height generated more stress compared with locators with 2- and 3-mm heights, leading to marginal bone loss. The absence of oral hygiene evaluation was identified as a limitation of the study. Clinical parameters of gender, age, implant length, implant diameter, and interimplant distance did not seem to affect marginal bone loss in the study population of the current study.

***Key Words: abutment, implant-supported dental prosthesis, locator, overdenture***



## Introduction

Mandibular ridge atrophy is an obstacle for optimal prosthetic reconstruction with acceptable retention and stability in elderly patients. Treatment with a conventional prothesis in patients with mandibular edentulism and ridge atrophy may be challenging, and an implant-supported prostheses fabricated with attachment systems are proposed to overcome the retention and stability problems of conventional prostheses.[1] A mandibular overdenture prosthesis supported with dental implants that are inserted in the interforaminal region is considered a reliable treatment modality in the rehabilitation of mandibular edentulism.[2,3]

A locator system (Zest Dental Solutions, Carlsbad, Calif) is an intermediate attachment system frequently used with an overdenture prosthesis to provide better retention and stability compared with other retention systems, such as ball and magnets.[4,5] Mandibular overdentures retained with locator attachments show predictable results while improving oral health and quality of life.[6] Locator attachments have become well known and popular in the past decade; however, there are not many studies that focus on clinical risk factors that affect the prognosis and marginal bone loss.

In this study, the effect of locator height as well as gender, age, implant diameter, implant height, and interimplant distance on distal and mesial marginal bone loss at 6-, 12-, and 24-month recall sessions after loading in mandibular 2-implant–supported mandibular overdentures was evaluated.

## Materials and Methods

The study protocol was approved by the Local Research Ethics Committee (approval number 17/04/2018-17) and performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments. All clinical and radiographic data of patients who were treated with locator-retained mandibular overdentures between January 1, 2014, and January 4, 2018, were retrieved from the archives. The inclusion criteria of the study were (1) intact demographic information of the patient and (2) complete preoperative, immediate postoperative, and 6-, 12-, and 24-month recall sessions after loading of clinically and radiographically success-

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ful implants. A clinical examination was performed at each recall session. The examination evaluated prosthetic parameters such as occlusion, tissue adaptation, condition of the retentive mechanism, and condition of the denture-bearing tissues. All necessary measures were taken in case of complaints or complications.

### *Surgical approach*

Surgical operations were performed by the same operator (O.D.). A crestal incision between the left and right premolar regions as well as releasing vertical incisions were made, and the mucoperiosteal flap was carefully reflected to expose the native bone. In some cases with advanced bone atrophy in the interforaminal region, nerve exploration was made with a blunt periosteal elevator to identify the exact location of the egress of the nerve in order to adjust the safe position of the implant. Osteotomy sites were prepared in accordance with the instructions of the implant manufacturer. Dental implants (Astra Tech Implant System, The OsseoSpeed TX implants, Dentsply Sirona Corporate, Salzburg, Austria) were using a handpiece with a maximum torque of 50 N/cm$^2$. The interimplant distance was measured over the residual ridge crest linearly between the widest supracrestal part of the collar region of the implant immediately after insertion. Dental implants were exposed with a small crestal incision, and healing caps were inserted 3 months after the healing period. The prosthetic stage started 1 week after gingival formation for an acceptable emerging profile.

Oral antibiotics (2 g/d amoxicillin with clavulanic acid), nonsteroidal anti-inflammatory drug (1100 mg/d naproxen sodium), and oral mouth rinses (0.12% chlorhexidine digluconate $\times$ 3) were prescribed for postoperative use for at least 5 days.

### *Radiographic evaluation*

The marginal bone levels of the distal and mesial aspects of all implants were measured at baseline, and control evaluations using panoramic radiographs (Planmeca ProMax; Planmeca, Helsinki, Finland) were taken immediately after loading and at every control session. Images of panoramic radiographs were transferred to the software program CorelDraw 11.0 (Corel Corporation and Coral Ltd, Ottawa, Canada), and measurements were obtained at $\times$20 magnification.

The manufacturer's dimensions for the diameter of each implant at the collar region were used as reference point. The measurement of the distance from the widest supracrestal region of the implant to the present crestal bone level was performed on the magnified images. To explain variability, the implant width was measured and a comparison with the documentation dimensions was made. Ratios were calculated to adjust for distortion. A distortion coefficient was applied to determine bone levels. True bone height was calculated by multiplying the true implant width by the bone height measured on the radiograph, which was then divided by the implant diameter measured on the radiograph. The interimplant distance was measured over the residual ridge crest linearly between the widest supracrestal part of the implants.

The actual bone-level measurement was performed by 2 independent examiners, a prosthodontist and a specialist in oral and maxillofacial radiology, neither of whom had participated in the treatment of the selected patients or knew the placement of the implants. Each examiner reviewed the radiographs on 2 separate occasions, 1 week apart. The radiographs were not available to any of the examiners between the first and second viewings. In addition, the examiners' measurements made at the first testing were not available during the second testing. During the first review, the observers did not know they would be retested.

Intraobserver reliability was determined by comparing the measurements made by each individual observer for the first and second testing sessions. Interobserver reliability was assessed by comparing the measurements made by the 2 different examiners. The average of both examiners' calculations was used as the marginal bone-level value. The level at which the marginal bone seemed to be attached was assessed by visual evaluation at the distal and mesial surfaces of all implants.

### *Statistical analysis*

The methodology and results of the study were reviewed by an independent statistician. SPSS version 21.0 Statistical Software (IBM, Chicago, Ill) was used for statistical analysis of the results. Two-way repeated-measures analysis of variance with 1-factor repetition was used to evaluate the effect of gender, age, implant length, implant diameter, interimplant distance, and locator height on marginal bone loss during the 6-, 12-, and 24-month recall periods. In a post hoc evaluation, Bonferroni test was used. The results were assessed at the 95% confidence interval, at a significance level of .05.

## Results

A total of 57 patients with a mean age of 59.2 $\pm$ 9.8 and 114 implants were included in the study. Among 114 locators, 27 were 2 mm, 65 were 3 mm, and 22 were 4 mm in height. Forty-two of the patients were female, and 72 were male. The mean interimplant distance was 33.5 $\pm$ 4.4 mm. The diameter of 48 implants was 3.5 mm, and 66 implants were 4 mm. Thirty implants were 9 mm, 73 implants were 11 mm, and 11 implants were 13 mm in length. Between the parameters of gender, age, implant length, implant diameter, and interimplant distance, only locator height had a major effect on the distal ($P = .042$) and mesial ($P = .012$) marginal bone loss (Tables 1 and 2).

The mean distal and mesial marginal bone loss of implants with 3 types of locators at the 6-, 12-, and 24-month recall sessions are demonstrated in the Figure. The locator with 4-mm height showed statistically significant mesial marginal bone loss compared with locators with 2-mm and 3-mm heights in all recall sessions (Table 3; $P < .05$). The locator with a 4-mm height also showed statistically significant distal marginal bone loss compared with other locator types in all recall sessions ($P < .05$), with an exception of a nonsignificant difference in the marginal bone loss between locators with 2-mm and 4-mm heights at the 6-month recall session ($P > .05$; Table 4). There was no statistically significant difference between 2-mm and 3-mm locators in all recall sessions ($P > .05$). There was also a

TABLE 1

Independent risk factors that affect distal marginal bone loss (D) at 6-, 12-, and 24-month recall sessions evaluated with repeated-measures analysis of variance (stepwise)

| | Pillai's Trace | | |
|---|---|---|---|
| | Statistical Value | *F* | Significance |
| First step* | | | |
| Time _D | .04 | 0.993 | .378 |
| Time _D – gender | .071 | 1.832 | .171 |
| Time _D – age | .029 | 0.705 | .499 |
| Time _D – implant diameter | .033 | 0.806 | .452 |
| Time _D – implant length | .099 | 2.639 | .082 |
| Time _D – interimplant distance | .001 | 0.001 | 1.000 |
| Time _D × locator height | .199 | 2.707 | .035 |
| Last step† | | | |
| Time _D | .937 | 394.376 | <0.001 |
| Time _D × locator height | .173 | 2.562 | 0.042 |

*Step 1.
†Step 5.

TABLE 2

Independent risk factors that affect mesial marginal bone loss (M) at 6-, 12-, and 24-month recall sessions evaluated with repeated-measures analysis of variance (stepwise)

| | Pillai's Trace | | |
|---|---|---|---|
| | Statistical Value | *F* | Significance |
| First step* | | | |
| Time _M | .198 | 5.932 | .005 |
| Time _M – gender | .012 | 0.289 | .750 |
| Time _M – age | .061 | 1.563 | .220 |
| Time _M – implant diameter | .005 | 0.125 | .883 |
| Time _M – implant length | .017 | 0.420 | .659 |
| Time _M – interimplant distance | .021 | 0.518 | .599 |
| Time _M – locator height | .169 | 2.257 | .068 |
| Last step† | | | |
| Time _M | .948 | 480.018 | <.001 |
| Time _M – locator height | .155 | 2.269 | .012 |

*Step 1.
†Step 5.

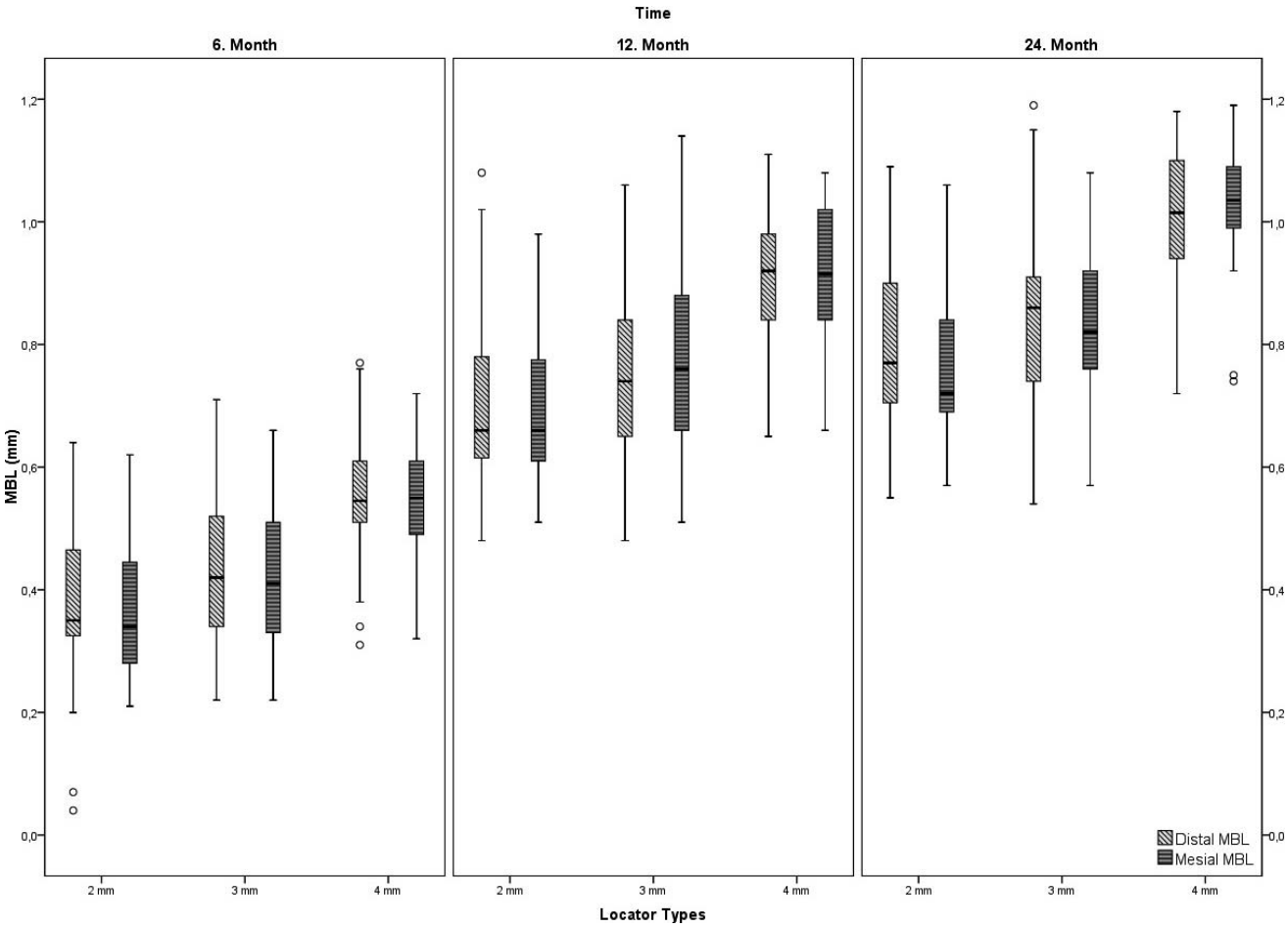


FIGURE. Box plot of the distal and mesial marginal bone loss values of locators with 2-mm, 3-mm, and 4-mm heights at 6-, 12-, and 24-month recall sessions.

Table 3

Mean mesial marginal bone loss of implants with 3 types of locators at 6-, 12-, and 24-month recall sessions†

| | Recall Session (Mean ± Standard Deviation) | | | |
|---|---|---|---|---|
| | a: 6 mo | b: 12 mo | c: 24 mo | *P* |
| Locator type | | | | |
| 2 | 0.373 ± 0.116 | 0.695 ± 0.132 | 0.759 ± 0.127 | a-b: .001*<br>a-c: .001*<br>b-c: .008* |
| 3 | 0.423 ± 0.119 | 0.764 ± 0.141 | 0.826 ± 0.116 | a-b: .001*<br>a-c: .001*<br>b-c: .001* |
| 4 | 0.542 ± 0.117 | 0.902 ± 0.122 | 1.024 ± 0.111 | a-b: .001*<br>a-c: .001*<br>b-c: .001* |
| *P* | 2–3: .970<br>2–4: .001*<br>3–4: .002* | 2–3: .872<br>2–4: .001*<br>3–4: .004* | 2–3: .826<br>2–4: .001*<br>3–4: .001* | a-b: .001*<br>a-c: .001*<br>b-c: .001* |

†2 indicates 2-mm locator abutment; 3, 3-mm locator abutment; 4, 4-mm locator abutment. *P* values in the columns show the statistical significance of the marginal bone loss between recall sessions. *P* values in the rows demonstrate the statistical significance of the bone loss between locator types in control periods separately. *$P < .05$ was considered statistically significant.

Table 4

Mean distal marginal bone loss of implants with 3 types of locators at 6-, 12-, and 24-month recall sessions†

| | Recall Session (Mean ± Standard Deviation) | | | |
|---|---|---|---|---|
| | a: 6 mo | b: 12 mo | c: 24 mo | *P* |
| Locator type | | | | |
| 2 | 0.383 ± 0.151 | 0.717 ± 0.153 | 0.788 ± 0.133 | a-b: .001*<br>a-c: .001*<br>b-c: .001* |
| 3 | 0.439 ± 0.126 | 0.745 ± 0.130 | 0.826 ± 0.129 | a-b: .001*<br>a-c: .001*<br>b-c: .001* |
| 4 | 0.548 ± 0.118 | 0.905 ± 0.128 | 1.012 ± 0.119 | a-b: .001*<br>a-c: .001*<br>b-c: .001* |
| *P* | 2-3: 1.00<br>2-4: .059<br>3-4: .009* | 2-3: 1.00<br>2-4: .003*<br>3-4: .001* | 2-3: 1.00<br>2-4: .001*<br>3-4: .001* | a-b: .001*<br>a-c: .001*<br>b-c: .001* |

†2 indicates 2-mm locator abutment; 3, 3-mm locator abutment; 4, 4-mm locator abutment. *P* values in the columns show the statistical significance of the marginal bone loss between control periods. *P* values in the rows demonstrate the statistical significance of the bone loss between locator types in control periods separately. *$P < .05$ was considered statistically significant.

statistically significant difference in the marginal bone loss between all recall sessions for 2-, 3-, and 4-mm locators, separately ($P < .05$; Tables 3 and 4).

## Discussion

Locator retainers brought a new sight into implant-supported overdentures, improving the stability and retention of the overdentures. In the study by Schincaglia et al,[7] 2 groups containing 60 implants were created. One group was loaded with locator-retained overdentures immediately, and the other group was loaded with locator-retained overdentures with a 3-month delay. In the delayed group, there was a mean radiographic bone loss of 0.54 (0.5) mm at the end of the 12-month follow-up period. In a short-term clinical trial conducted in 36 patients, it was reported that an immediate loading protocol with locator-retained overdentures demonstrated higher marginal bone loss compared with the delayed loading protocol.[8]

The independent factors of gender, age, implant length, implant diameter, and interimplant distance were found to have no major effect on marginal bone loss in the current study. Interimplant distance has been a topic of interest lately, especially in overdenture prostheses, and in some studies, it is associated with patient satisfaction, quality of life, and retention properties in implant-supported overdentures.[9–11] Interimplant distance seemed to have no effect on marginal bone loss in the current study, even if it may have had an effect on the retention that may influence the long-term prognosis of the implant. Geckili et al[9] reported that patient age and implant length are important factors that influence the success and failure of dental implants and that the success rates of dental implants longer than 10 mm are higher. Increasing the diameter and length of the implant simultaneously increases the surface area, forming a better implant-bone contact and creating a more stable implant with increased osseointegrated surface. Age and gender are demographic properties, and it has been reported in several studies that they have no effect on implant prognosis.[12–14] Marginal bone loss is a predictive factor for implant success; however, it is not the only factor and does not directly affect prognosis. There were no implant failures in this study, and a focus on marginal bone loss rather than implant success was established. There are variable results extracted from studies that focused on the effect of implant- and patient-related independent parameters on implant success, but in this study, the effect of these parameters was evaluated only on the marginal bone loss, and, except for locator height, there were no associations found between these parameters and marginal bone loss.

In the current study, locator height was the only parameter that affected marginal bone loss. A 4-mm locator abutment was associated with higher distal and mesial marginal bone loss compared with the 2- and 3-mm locator abutments. In the study by Ying et al,[15] 3 different types of locator attachments were used in an in vitro model to observe the effect of lateral forces, and they reported that the greatest denture displacement occurred with attachments of 4-mm height. The annual implant marginal bone loss was less than 0.2 mm for all locator abutments after 1 year of service, which was consistent with the criteria of Albrektsson et al.[16] There were no statistically significant differences in marginal bone loss between the 2- and 3-mm locator abutments ($P > .05$). This result may indicate that these abutments generate similar stress in the peri-implant bone tissue, whereas stress accumulation on peri-implant tissues was higher for the 4-mm locator abutment. When the locator abutment is higher, the prosthesis tends to rotate on an axis, which connects 2 implants. This fulcrum axis results in a less stabile prosthesis, and higher retainer elements bear much more load in chewing function. The height of the locators in

implant overdentures significantly affects the lateral force on the implants and subsequently constitutes denture displacement.[15] The reduction in the stability may generate unfavorable stress on the implant and increase marginal bone loss.

Panoramic radiography is an easy and affordable imaging method frequently used in outpatient dental clinics and in dental implant studies to evaluate the bone loss around the loaded implant.[17–19] Marginal bone loss evaluation is a reproducible and reliable procedure in high-quality panoramic radiographs.[20,21] Chiapasco and Gatti[22] suggested that intraoral radiography could be a difficult imaging method in edentulous patients because of the interference of the superficial location of the muscles of the mouth floor. After considering the aforementioned advantages, we decided to use panoramic radiography in the current study.

The selection of the height of the retainer attachment becomes an important factor in the overdenture prosthesis to reduce marginal bone loss.[15] In a finite element study, it was reported that shorter attachments located parallel to each other showed less stress and better stability.[23] Ebadian et al[24] reported that ball attachments with reduced collar height and locator attachments with increased restorative space provided favorable biomechanical results. The height differences between locator abutments in 2-implant–supported overdentures significantly affect the retention ability of the prosthesis.[19]

The limitations of the current study are as follows:

1. The marginal bone loss associated with the locator abutments with 2-, 3-, and 4-mm heights were evaluated individually in a retrospective fashion, and the absence of the clinical data accounting for the main indication for the use of different types of locators in each patient is a limitation of this study. Locator abutments with variable heights are used to overcome the host soft-tissue thickness and provide sound retention.[25] They are also used for compensation for ill-inserted implants with angulation or misleveling.[26] It is suggested that soft-tissue thickness did not have an influence on marginal bone loss.[27] However, soft-tissue thickness and locator height might have a combined effect on marginal bone loss and should be evaluated in further studies. The angulated implants are more prone to destructive forces compared with implants with no angulation. Therefore, marginal bone loss is more likely to occur with these implants. To overcome this limitation, the exclusion of angulated or misleveled implants may be considered in future studies.
2. Recall sessions up to 24 months are relatively short. Marginal bone loss measurement in the short term may be misleading because of the insufficient time given for the function of the implant. The evaluation of marginal bone loss at long-term follow-up of more than 2 years may be a more suitable and accurate approach.
3. The diets and oral hygiene behaviors of patients are important factors in marginal bone loss, and there was no record of the oral hygiene status of the patients included in this study population. Negligence of oral hygiene may result in the formation of bacterial biofilm and subsequent periodontal infection, leading to marginal bone loss apart from the biomechanical condition of the implant-prosthesis system. Periodontal index measurements can be employed from dental implants in all recall sessions, and the periodontal status of the dental implants should be adapted in the statistical analysis to understand the effect of oral hygiene on marginal bone loss in the existence of patient- and implant-related parameters in the future studies.

## Conclusions

This study evaluated patient- and implant-related parameters in a limited population in a retrospective manner. The results obtained from the retrospectively evaluated study population revealed no clear effects of patient-related and implant-related parameters of gender, age, implant length, implant diameter, or interimplant distance, whereas the parameter of locator height had an influence on marginal bone loss in 2-implant–supported locator-retained mandibular overdentures. Locators with 4-mm height showed higher marginal bone loss compared with locators with 2- and 3-mm heights in 6-, 12-, and 24-month follow-up controls. There were no statistically significant differences between locators with 2- and 3-mm heights, suggesting that locators higher than 3 mm may hamper the stability of the prosthesis by changing the fulcrum axis and increasing stresses that affect the bone-implant interface. Further studies with larger sample sizes should be designed in a prospective manner to better understand the effect of the locator height on marginal bone loss and to obtain more definite results.

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## Note

The authors report no conflicts of interest.

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