Resilient Stud Versus Bar Attachments for Immediately Loaded Implants Supporting Mandibular Overdentures: 1-year Randomized Controlled Clinical Trial

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Purpose: This study aimed to examine clinical and patient-centered outcomes of resilient stud and stress-free bar attachments used for immediately loaded implants supporting mandibular overdentures. Materials and Methods: Thirty edentulous patients with sufficient bone mesial and distal to the mental foramen received new dentures. The patients were randomly assigned into two groups. After 3 months of adaptation, four implants were placed in the canine and second premolar areas of the mandible using computer-guided surgery and the flapless surgical approach. Overdentures were connected immediately to the implants using either resilient stud (Locator) or stress-free implant bar (SFI-Bar) attachments. Marginal resorption of bone, plaque and gingival indices, pocket depth, and implant stability were evaluated for both groups at baseline (prosthesis delivery) and 6 and 12 months thereafter. Implant survival and patient satisfaction were calculated after 12 months. Results: For both groups, marginal bone loss (P < .043), plaque scores (P < .001), and probing depth (P < .002) increased significantly with time. SFI-Bar recorded lower marginal bone loss (P = .048) and higher plaque scores (P = .021) and probing depth (P = .001) than Locator after 12 months of denture insertion. The implant survival was 96.6% and 98.3% for Locator and SFI-Bar, respectively. No significant difference was found in the survival rate between groups (P = .56). Locator showed significantly higher general satisfaction, satisfaction with retention, comfort, and cleaning of overdentures compared with SFI-Bar (P < .001). Conclusion: Within the limits of this investigation, both resilient stud and stress-free bar attachments can be used successfully with mandibular four-implant overdentures subjected to an immediate loading protocol. However, studs may be preferred regarding peri-implant soft tissue health, patient satisfaction with retention, cleaning, and comfort, and stress-free bar attachments could be more effective in terms of marginal bone preservation. Int J Oral Maxillofac Implants 2021;36:346–354. doi: 10.11607/jomi.8472

Keywords: attachment, bar, immediate loading, implant, Locator, overdentures, SFI

The use of four implants to support mandibular overdentures has several merits compared with standard two-implant–retained overdentures, such as reduction of mucosal support, stabilization of mandibular dentures, reduction of posterior mandibular bone resorption, and creation of a stable occlusal plane. Moreover, the rigid anchoring improves satisfaction and masticatory efficiency of the patient, decreases the need for prosthodontic maintenance, and avoids prominent mylohyoid ridges and high muscle attachments. It is well documented in the literature that the placement of implants in the interforaminal area of the mandible to assist mandibular overdentures is associated with a high success rate. However, placing implants distal to the mental foramina to assist mandibular overdentures has been reported to improve electromyographic activity and chewing efficiency compared with two-implant–retained overdentures. Moreover, this approach eliminates overdenture rotation, increases psychologic comfort, and improves masticatory performance similar to fixed prostheses. Compared with fixed prostheses, overdentures have several merits, such as enhanced aesthetics, ease of performing oral hygiene, and reduced cost. Also, it can reduce the harmful effect of mandibular flexure on implants if nonrigid attachments are used. However, this design may not be possible due to anatomical limitations and mandibular deformation, which exerted a high load on posterior implants when a rigid splinted superstructure was used. The Locator attachment (LOCATOR Legacy, Zest Dental Solutions) is a stud attachment that is resilient, self-aligning, and has double retention cylinders with...
different retention forces. Moreover, it has a low profile, provides limited lateral movements, and contains some built-in angulation compensation.

Bar attachments contribute to the sharing of load between the implants, can overcome the problem of implant divergence, have a lower incidence of prosthetic complications, and provide horizontal stability with marked alveolar atrophy. Moreover, bars are suitable for immediately loaded implants, as they decrease micromotion at the bone-implant interface. Stress-free implant bar (SFI-Bar, Cendres+Métaux) connects implants with no soldered or laser-welded joints. This provides a passive-fit bar. SFI-Bar is prefabricated, can be adjusted chairside, and is appropriate for an immediate loading protocol. Also, SFI-Bar may eliminate transmission of harmful stresses to implants during mandibular deformation compared with rigid splinted superstructures.

Immediate loading with implant-supported prostheses reduces surgical and prosthetic visits, increases patient satisfaction, and improves mastication and esthetics, as the prosthesis is inserted immediately after surgery. Immediate loading of two implants in the mandible by Locator and Dolder bar–retained overdentures have been reported. However, the use of these attachments with four-implant–supported overdentures was not sufficiently investigated. Moreover, the clinical evaluation of the SFI-Bar attachment for immediately loaded four-implant overdentures is still scarce. The purpose of this study was to assess peri-implant bone resorption (primary outcome) and clinical and patient parameters (secondary outcomes) of immediately loaded implants assisting overdentures with resilient stud and stress-free bar attachments.

MATERIALS AND METHODS

Participants
Forty completely edentulous participants, aged between 43 and 64 years, were selected from the outpatient clinic of the Removable Prosthodontic Department, Faculty of Dentistry, Mansoura University, Egypt. This sample size was performed to give 80% power based on the findings of another study in which the authors found a significant difference (effect size = 1.14 mm, SD = 1.61) in vertical bone resorption between groups after 1 year (2-tailed α = .05). The power analysis was made by the G*Power program (version 3.1.5). The sample was increased 33% to increase the power to 97% and to account for possible dropouts. The inclusion criteria were as follows: healthy mucosa, abundant bone volume (class III-V of Cawood and Howell), and density (classes I-III according to Lekholm and Zarb) mesial and distal to the mental foramen of the mandible to place implants with a minimum 11-mm length and 3.75-mm diameter and a minimum of 15-mm restorative space to accommodate all types of tested attachments. Participants with osteoporotic bone, diabetes mellitus, immune deficiency, anticoagulant medication, head and neck radiotherapy, and habit of smoking were excluded. Informed consent was obtained after describing the study protocol to all candidates. The protocol of the study was approved by the ethical committee of the institute. The participants were stratified by age, sex, old denture number, remaining bone height, and years of edentulousness. Randomization and allocation of the participants to groups were done using the computerized balanced randomization method to ensure a comparison between groups regarding baseline characteristics (Table 1). Patients were assigned to one of two groups: (1) Locator group, which consisted of 20 patients who had Locator-retained mandibular overdentures; and (2) SFI-Bar group, which included 20 patients who had SFI-Bar–retained mandibular overdentures. Randomization and allocation were performed by a blind dentist. Patients and operators were not blinded to treatment groups.

Surgical and Prosthetic Steps
For all participants, mandibular and maxillary dentures were fabricated and worn for 1 month before surgery to enhance neuromuscular adaptation. A tissue-borne stereolithographic template was fabricated using CBCT (i-CAT Vision, Imaging Sciences International) and used for placement of implants. Implant positions were planned at canines and second premolar areas of the edentulous mandible using the software (OnDemand3D). The plan was used to construct the surgical template using rapid prototyping (In2Guide). Four implants (Neoss) were inserted using the surgical guide and the universal surgical kit (In2Guide). The insertion of implants was done by the same oral and maxillofacial surgeon at a minimum torque of 40 Ncm to give the high initial stability required for immediate loading.

All implants were immediately loaded by the mandibular dentures after implant placement. For the Locator group, sufficient relief spaces opposite the Locator abutments were made in the inner surface of the mandibular dentures. Blocking white rings were attached to the Locator abutments, and metal housings with black processing inserts were seated over the abutments. Self-cure acrylic resin was used to pick up the metal housings to the mandibular denture while the patients held the dentures in centric occlusion. Blue inserts (extra-light retention, 0.68 kg) were used, and the dentures were delivered to the patients (Fig 1). For the bar group, the SFI-Bar (Cendres+Métaux) implant adapters were tightened to the implants, and tube bars were screwed to the implant adapter using a screwdriver. The ball joints were aligned...
to the implants, and fixation screws were slightly loosened to align the pins. The tube bar with the tube bar gauge was slid onto the pin of the ball joint until the convex part of the tube bar gauge could be fitted onto the implant adapter, and the retaining screws were retightened. The tube bar was sectioned with a cutting disk. The shortened tube bar was slid onto the two ball joints and retightened tension-free. The procedure was repeated for the other two segments of the bar. The metal housings with retaining plastic clips were positioned on bar segments. With the aid of disclosing media, sufficient relief was provided in the inner surface of the denture until no contact was observed between the acrylic resin and the bar or the housings. The space under the bar was blocked out with wax, and the metal housings with retaining plastic clips were fastened to the denture using autopolymerizing acrylic resin (Fig 2). All patients were instructed to chew soft food, perform oral hygiene, and attend regular follow-up visits to perform necessary adjustments (modifications of flanges, adjustment of occlusion, and relining if necessary).

**Peri-implant Tissue Outcomes**

Evaluation of peri-implant tissues was done after overdenture delivery (T0) and 6 (T6) and 12 (T12) months after delivery. Marginal bone loss was measured on digital periapical radiographs (Digora, Soredex). Standardization of radiographs was made using an acrylic jig placed between maxillary and mandibular teeth.29,33 The images were digitally traced, and marginal bone loss was measured as recommended by Elsyad et al.29,33–35 The distance between the implant platform (A) and first bone contact (B) was recorded as the marginal bone level (Fig 3). Measurements were made at the mesial and distal aspects of each implant. Secondary outcomes include plaque and gingival scores, pocket depth, and implant stability. Plaque Index and Gingival
Pocket depth was measured in millimeters using a periodontal probe. Implant stability was evaluated using Osstell device (Integration Diagnostics) and implant stability quotient (ISQ). Plaque Index, Gingival Index, and probing depth were evaluated at the midfacial, midlingual, midmesial, and middistal aspects of each implant. An implant was considered to have survived if it fulfilled survival criteria suggested by Albrektsson and Isidor, which include no symptoms (suppuration, pain, and mobility) and limited bone resorption during the first year of loading (≤ 1.5 mm).

**Participant Satisfaction**
Participant satisfaction was measured using a visual analog scale (VAS) in which answers to supplied questions ranged from zero (not satisfied at all) to 100 (totally satisfied). The VAS questionnaire validity for edentulous participants with complete dentures and implant overdentures was proven in several studies. The questionnaire was given to the patients in Arabic and validated in a previous study.

**Statistical Analysis**
The data were analyzed using SPSS software version 22 (SPSS) by a statistician blinded to treatment groups. Since baseline data were not normally distributed, Mann-Whitney and Fisher exact tests were used for comparing baseline criteria between groups. The Mann-Whitney test was used for comparisons of all outcomes between groups. The difference between observation times was detected using the Friedman test followed by the Wilcoxon signed-rank test for multiple comparisons between observation times using Bonferroni correction. The Kaplan-Meier test was used to evaluate implant survival, and the log-rank test was utilized for between-group comparison of survival. P values < .05 were significant.

**RESULTS**
There was no significant difference in baseline criteria between groups (Table 1). Five patients in each group were lost to follow-up due to several reasons such as medical problems, inconvenience to the patient, unclear expectations, and patient satisfaction with new dentures without need for further implant treatment. The patients did not complete the follow-up visits and were excluded from further analysis. The intention-to-treat principle in clinical trials was followed. Therefore, the data for 30 patients (15/group) were presented.

Table 1: Comparison of Baseline Characteristics Between Groups

<table>
<thead>
<tr>
<th></th>
<th>Locator</th>
<th>SFI-Bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>60.38</td>
<td>61.48</td>
</tr>
<tr>
<td>Height of the mandibular bone in the canine region (mm)</td>
<td>27.18</td>
<td>26.51 ± 2.32</td>
</tr>
<tr>
<td>Period of mandibular edentulism (y)</td>
<td>2.55</td>
<td>3.41</td>
</tr>
<tr>
<td>Sex (male/female), no.</td>
<td>13/7</td>
<td>13/7</td>
</tr>
<tr>
<td>No. (frequency) of previous mandibular dentures, Mean ± SD</td>
<td>1 denture = 7</td>
<td>1 denture = 8</td>
</tr>
<tr>
<td></td>
<td>2 dentures = 9</td>
<td>2 dentures = 9</td>
</tr>
<tr>
<td></td>
<td>3 dentures = 4</td>
<td>3 dentures = 3</td>
</tr>
</tbody>
</table>

Table 2: Vertical Bone Loss (mm)

<table>
<thead>
<tr>
<th></th>
<th>T0</th>
<th>T6</th>
<th>T12</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locator</td>
<td>–</td>
<td>0.74 ± 0.10a</td>
<td>0.83 ± 0.10c</td>
<td>.005*</td>
</tr>
<tr>
<td>SFI-Bar</td>
<td>–</td>
<td>0.68 ± 0.08b</td>
<td>0.74 ± 0.13a</td>
<td>.042*</td>
</tr>
</tbody>
</table>

*Mann-Whitney test; *Fisher exact test.

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implants was noted between time intervals or attachments (Table 4). The implant survival rate was 96.6% and 98.3% for Locator and SFI-Bar groups, respectively (Fig 6). The difference in survival rate between groups was not significant (log-rank test, \( P = .56 \)).

A comparison of VAS between groups is presented in Table 5. There was no significant difference between groups regarding satisfaction with overdentures compared with natural dentition, the stability of overdentures, occlusion of maxillary dentures and overdentures, satisfaction with speech, satisfaction with mastication, satisfaction with the quality of food, satisfaction with esthetics, ease of handling the overdenture, feeling that the overdenture is a part of the patient, satisfaction with surgery and healing, and feeling of embarrassment. The Locator attachment showed significantly higher general satisfaction with overdentures, satisfaction with retention, comfort with overdentures, and cleaning of overdentures compared with SFI-Bar.

DISCUSSION

The marginal loss of bone in this study ranged from 0.68 to 0.83 mm after 12 months. This finding agreed with the normal range of vertical bone resorption observed in the literature that is 1 mm during the first year.\(^41,42\) The mean bone loss after 1 year for the Locator group (0.83 ± 0.10 mm) was higher than the values obtained in another study (0.23 ± 0.44)\(^43\) with single implants but similar to that obtained in a different study (0.87 ± 0.13 mm) in which the conventional loading protocol was used.\(^44\) The vertical bone loss for the bar group was 0.76 ± 0.13 mm after 1 year. A similar value was also obtained for a bar attachment (0.84 ± 0.34 mm) retaining two-implant overdentures with an immediate loading protocol.\(^35\) However, bone loss was higher than the values of bar/implant-retained overdentures (0.59 mm) in another study\(^45\) after conventional loading. This could be attributed to the immediate loading, which increases implant micromotion\(^20\) and may result in greater bone turnover.\(^46\) Zou et al\(^47\) found 0.6 to 1.0 mm bone resorption in the bar group and 0.5 to 0.9 mm in the Locator group after 3 years of using four-implant–supported maxillary overdentures. The reduced bone loss in the study of Zou and colleagues could be due to the delayed loading of implants compared with the immediate loading of the implants in the present study.

For both groups, vertical bone loss was significantly higher at T12 compared with T6. Similarly,
Elsyad et al\textsuperscript{29,33} reported an increased marginal bone loss after 1 year compared with values at 6 months. The authors justified the increased bone resorption to the bone response to overdenture loading and bone maturation combined with functional forces. The increased bone loss with Locators compared with SFI-Bar could be attributed to the splinting of the implants and greater surface area provided by the bar attachment, which is very effective in the prevention of implant micromotion in case of immediate loading.\textsuperscript{48} The resilient clips transmit the load indirectly to the implants through bar segments. In contrast, the unsplinted nature of the Locator attachment may subject the implants to higher forces that may interfere with early healing of immediately loaded implants.\textsuperscript{49,50} Another explanation could be attributed to implant parallelism. Perfect parallelism between anterior and posterior implants in the buccolingual direction is difficult to achieve due to the anatomy of the mandibular bone. Therefore, implants may be inclined buccally or lingually. The implant angulation is not a problem with bar attachments since the overdentures are inserted and removed from clips. However, with Locators, the external and internal flanges of the nylon components behave like guiding planes that restrict lateral movement of the prosthesis and may transmit moment loads to the implants during denture insertion and removal.\textsuperscript{21–53}

The increased plaque scores with time for both groups concur with Zou et al,\textsuperscript{47} who found the same observation for bar and Locator anchors used for four-implant maxillary overdentures. Bar overdentures recorded significantly higher plaque scores than Locator

![Table 3 Results of Plaque and Gingival Scores](image1)

<table>
<thead>
<tr>
<th></th>
<th>T0 Median (minimum–maximum)</th>
<th>T6 Median (minimum–maximum)</th>
<th>T12 Median (minimum–maximum)</th>
<th>Freidman test (P value)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plaque Index</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locator</td>
<td>0.00\textsuperscript{a}(0.00–0.00)</td>
<td>0.00\textsuperscript{a}(0.00–1.00)</td>
<td>1.00\textsuperscript{a}(0.00–2.00)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>SFI-Bar</td>
<td>0.00\textsuperscript{a}(0.00–0.00)</td>
<td>1.00\textsuperscript{a}(0.00–1.00)</td>
<td>1.00\textsuperscript{b}(0.00–3.00)</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Mann-Whitney (P value)</td>
<td>1.00</td>
<td>.014*</td>
<td>.021*</td>
<td></td>
</tr>
<tr>
<td><strong>Gingival Index</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locator</td>
<td>0.00\textsuperscript{a} (0.00–0.00)</td>
<td>0.00\textsuperscript{a}(0.00–1.00)</td>
<td>0.00\textsuperscript{a}(0.00–1.00)</td>
<td>.68</td>
</tr>
<tr>
<td>SFI-Bar</td>
<td>0.00\textsuperscript{a} (0.00–0.00)</td>
<td>0.00\textsuperscript{a}(0.00–1.00)</td>
<td>1.00\textsuperscript{b}(0.00–1.00)</td>
<td>.075</td>
</tr>
<tr>
<td>Mann-Whitney (P value)</td>
<td>1.00</td>
<td>.08</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

\*P is significant at .05 level. Different superscript letters show a significant difference between each two observation times (Wilcoxon signed-ranks, P < .05).

![Table 4 Results of Probing Depth and Stability of Implants](image2)

<table>
<thead>
<tr>
<th></th>
<th>T0 Mean ± SD</th>
<th>T6 Mean ± SD</th>
<th>T12 Mean ± SD</th>
<th>Freidman test (P value)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Probing depth</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locator</td>
<td>0.64 ± 0.17\textsuperscript{a}</td>
<td>0.95 ± 0.25\textsuperscript{b}</td>
<td>0.98 ± 0.23\textsuperscript{a}</td>
<td>\textsuperscript{.001*}</td>
</tr>
<tr>
<td>SFI-Bar</td>
<td>0.68 ± 0.15\textsuperscript{a}</td>
<td>1.63 ± 0.47\textsuperscript{b}</td>
<td>2.46 ± 0.45\textsuperscript{c}</td>
<td>&lt;\textsuperscript{.001*}</td>
</tr>
<tr>
<td>Mann-Whitney test (P value)</td>
<td>\textsuperscript{.55}</td>
<td>&lt;\textsuperscript{.001*}</td>
<td>&lt;\textsuperscript{.001*}</td>
<td></td>
</tr>
<tr>
<td><strong>Implant stability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locator</td>
<td>66.43 ± 2.01\textsuperscript{a}</td>
<td>65.78 ± 1.64\textsuperscript{a}</td>
<td>66.40 ± 1.42\textsuperscript{a}</td>
<td>.52</td>
</tr>
<tr>
<td>SFI-Bar</td>
<td>66.24 ± 1.75\textsuperscript{a}</td>
<td>65.17 ± 1.29\textsuperscript{a}</td>
<td>65.09 ± 1.48\textsuperscript{a}</td>
<td>.083</td>
</tr>
<tr>
<td>Mann-Whitney test (P value)</td>
<td>\textsuperscript{.68}</td>
<td>.22</td>
<td>.053</td>
<td></td>
</tr>
</tbody>
</table>

\*P is significant at .05 level. Different superscript letters show a significant difference between each two observation times (Wilcoxon signed-ranks, P < .05).

![Fig 6 Kaplan-Meier analysis of survival rate. LOD = locator overdentures; BOD = bar overdentures.](image3)
overdentures. It was expected that the smooth surface of the prefabricated SFI-Bar will reduce the plaque accumulation. However, this did not occur, as patients with bars usually face difficulties in cleaning the gingiva under and around the bar. On the other hand, Locators have a smooth surface, which is easy for elderly patients to clean. In this study, the increased plaque scores with time did not cause a significant increase in gingival indices. Moreover, no difference in gingival scores was observed between groups. In line with this observation, Zou et al found low gingival scores at all evaluation points for bar and Locator attachments used to assist maxillary overdentures. They added that the Gingival Index did not significantly differ between groups. In contrast, Krennmair et al found a time-dependent increase of Gingival Index for milled bar attachments of mandibular overdentures after 3 years of follow-up. The difference in the results may be attributed to the different bar designs used in each study. Krennmair et al used a milled bar with a rectangular cross section that covered a large area of the peri-implant mucosa and could be responsible for increasing gingival inflammation. However, in this study, the SFI-Bar had a smooth surface, circular cross section, and covered a small area of mucosa, which may reduce gingival inflammation and proliferation.

The increased probing depth with time was also noted in other studies. This may be attributed to increased bone loss and soft tissue proliferation around implants. Similarly, Elsyad et al found that pocket depths increased with the progress of time for two interforaminal implants that were immediately loaded by Locator and magnetic overdentures. Bars recorded higher probing depth than Locators. Similarly, Cordaro et al reported significantly higher peri-implant probing depths in the CAD/CAM bar group than the Locator group for four-implant–supported mandibular overdentures. This may be attributed to the gingival hyperplasia around the implants. Implant stability decreased at T6 and increased again at T12, but the difference was not significant. Similarly, Elsyad et al found that implant stability significantly reduced after 6 months and increased after 12 months again. The decrease in implant stability indicates reduced implant attachment to the bone due to the remodeling process. No significant difference in the stability of implants was noted between attachments. A similar finding was also seen in other studies.

The survival rate was high in both groups. A comparable survival rate was noted for CAD/CAM bar and Locator attachments used for four-implant–supported overdentures. This is not surprising since the anterior and posterior mandible are two of the best areas for implant insertion due to good bone quantity and quality. However, the limitations of this study include the small sample size, the lack of measurement of intraexaminer reproducibility, and the short follow-up period.

The increased general satisfaction and comfort with Locator overdentures compared with bar overdentures could be attributed to the unsplinted nature of the attachments, which minimizes restriction of tongue space. In contrast, SFI-Bar was reported to increase the satisfaction with overdentures.
size of the lingual surface of the mandibular denture, which may affect tongue space. Albrecht et al. reported that SFI-Bar was associated with increased lingual contouring of the mandibular denture without a negative impact on either self-perceived oral function or patient satisfaction. The difference in the results may be due to Albrecht et al. using SFI-Bar on two canine implants. However, in the present study, SFI-Bar was used on four widely distributed implants, which may restrict the posterior tongue space and affect patient comfort compared with two implants only. It was not surprising to find reduced patient satisfaction with cleaning in the bar group compared with the Locator group, as bars are usually associated with increased mucosal coverage, which complicates oral hygiene, especially with posterior implants, as stated previously. In contrast, Locator attachments do not cover the mucosa and therefore have circular cleaning ability. The increased satisfaction with retention of Locator overdentures compared with bar overdentures could be attributed to the double retention feature of Locator inserts, which comes from the internal and external frictional flanges of the male nylon components. Moreover, the lack of parallelism between anterior and posterior implants in a buccolingual direction would create undercuts between nylon inserts and Locator abutments. These undercuts are responsible for increased retention of Locator attachments. In agreement with this observation, Elsyad et al. in a recent study, noted that Locator attachments are associated with high retention and stability with minimal retention loss compared with bar attachments when used for implant overdentures. The limitations of the study include reduced patient sample, short follow-up period, the inclusion of patients with several excluding criteria, and matching of some criteria that increase the risk of missing important outcomes. Therefore, conclusions should be made with caution. Future studies with an increased number of patients are recommended to measure other patient-reported outcomes (as oral health–related quality of life), prosthetic complications, and chewing functions.

**CONCLUSIONS**

Within the limitations of this study, both SFI-Bar and Locator attachments can be used successfully with mandibular four-implant overdentures subjected to an immediate loading protocol. However, Locators may be preferred regarding peri-implant soft tissue health and patient satisfaction with retention, cleaning, and comfort, and SFI-Bar attachments may be recommended to preserve marginal bone.

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**REFERENCES**


