Clinical Performance of Short Dental Implants Supporting Single Crown Restoration in the Molar-Premolar Region: Cement Versus Screw Retention

Eduardo Anitua, DDS, MD, PhD1/Mohammad Hamdan Alkhraisat, DDS, MSc, EU, PhD2

Purpose: This study assessed the survival and marginal bone loss of single-unit short implants (≤ 8 mm in length) in the premolar-molar area. It also compared cemented with screw-retained restorations. Materials and Methods: In this clinical retrospective study, short implants supporting a single crown in the premolar-molar region were selected. Demographic-, surgical-, implant-, and prosthesis-related data were obtained. The predictor variable was the type of prosthesis retention. The principal variables were survival rate and marginal bone loss. The secondary variables were prosthesis survival and technical and biologic complications. Results: A total of 113 patients (56 ± 11 years of age) with 128 short implants were assessed. The mean follow-up time from implant insertion was 25.47 ± 14.95 months. Fifty-one crowns were cemented and 77 were screw-retained. No failure events were recorded for the implants and the prostheses. The distal marginal bone loss was significantly lower in the screw-retained crowns than in the cemented crowns. Marginal bone loss ≥ 2 mm as a biologic complication was more frequent in the cemented crowns. Two screw-loosening events were observed in the screw-retained restorations. These events were resolved by screw retightening. Conclusion: Short implants could be an effective option to support a single-unit prosthesis in the premolar-molar areas of the maxillae. Int J Oral Maxillofac Implants 2019;34:969–976. doi: 10.11607/jomi.7227

Keywords: cement, crown, screw, screw-retained, short dental implants, single-unit

Several studies have highlighted the importance of avoiding excessive mechanical loading and off-axis mechanical stress if short implants are located in posterior sectors.11,13–15 Splinting the short dental implants with other implants is one of the measures to overcome the impact of nonaxial stress and excessive mechanical loading.16,17 However, when a short dental implant is placed to replace a single missing molar, splinting could not be afforded. Would short dental implants be indicated to support single crowns in posterior regions?

To answer this question, several studies have assessed short implants as a single-unit implant in posterior regions.18–20 The outcomes favor the use of a short implant to replace a missing single premolar or molar tooth.18–20 However, Mezzomo et al,21 in a systematic review with meta-analysis, found that implant length ≤ 8 mm increased the MBL, mean implant failure proportion, and biologic complications. Sailler et al found the 5-year survival rate to be lower in screw-retained single crowns than in cemented crowns.22 In both studies, screw-retained crowns were far less frequent.21,22 Most of the short implants had an external connection. Moreover, Mezzomo et al found insufficient data to compare the MBL in the cemented and
the screw-retained groups. None of the included studies compared screw-retained versus cemented crowns in single-unit short implants.21

Screw-retained single crowns would have the following advantages: retrievability, requiring minimal occlusal space, and can be maintained more easily.23–27 Cement-retained single crowns would be more effective correcting nonideal implant placement, and provide passive fit with improved esthetics,28–31 but carry the risk of leaving residual cement.32,33 In the scientific literature, there is a need to analyze the outcomes of the type of crown retention (screw versus cemented) in short implants with internal connection.

The purpose of this retrospective study was to assess the survival rate and the MBL around single-unit implants (≤8 mm in length) in the posterior regions of the maxillae. Another objective was to evaluate if the type of prosthetic retention affected the treatment outcomes. The null hypothesis was that there is no difference in failure rate and MBL between short dental implants supporting either cemented or screw-retained crowns.

MATERIALS AND METHODS

A retrospective study was implemented in patients who had at least one short implant (length ≤8.0 mm) supporting cement- or screw-retained single crowns placed in posterior areas. The study was conducted in a private dental center in Vitoria, Spain between January 2017 and January 2018. The STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines were followed in the preparation of the article.34 The inclusion criteria were as follows:

- Healthy patients older than 18 years of age
- Men and women
- Short implant (length ≤8.0 mm) placed in the premolar-molar region supporting cement- or screw-retained single crown
- Minimum 12 months of follow-up.

No specific exclusion criteria were established.

The Helsinki declaration in relation to the investigation with human subjects was followed. Informed consent was obtained.

Demographic-, surgical-, implant-, and prosthesis-related data were obtained from patients’ records. The predictor factor was the type of crown retention. The principal variables were survival rate and MBL. The secondary variables were prosthesis survival and complications (technical and biologic).

Surgery

Before implant placement, all patients received an oral hygiene session. Cone beam computed tomography was done to measure the bone residual height and density at the site of interest. One gram of amoxicillin and acetaminophen were given 1 hour before the surgery, and the antibiotic treatment was continued for the first 5 days after intervention.

Surgical incision was performed after the administration of infiltrative anesthesia to uncover the surgical area. Bone drilling was prepared using the biologic drilling protocol.35,36 PRGF-Endoret was then injected into the prepared alveolus followed by the immediate placement of the dental implant (UnicCa implants, BTI Biotechnology Institute).37,38 According to the loading protocol, the cover screw (delayed loading) or transepithelial abutment (immediate loading) was connected to the implant. Nonresorbable 5-0 monofilament sutures were used for flap closure. Immediate loading was only performed if the implant was placed in bone type I–III and the insertion torque was ≥35 Ncm.39 In delayed loading, the average time between implant insertion and loading was 4 months.

The transepithelial abutment was a titanium abutment in the case of cemented crowns and the Unit abutment (BTI Biotechnology Institute) in the case of screw-retained restorations. The open-tray technique was used for impression making; impression copings of the transepithelial abutment and polyether impression material (Impregum Penta, 3M ESPE) were used.

At the laboratory, the titanium post was trimmed to adapt it to the gingival margins and the occlusal space. It was then screwed to the implant, and the definitive crown was cemented with a radiopaque cement (GC Fuji PLUS, GC Corporation). For screw-retained crowns, the Unit abutment was screwed to the dental implant. The crown was cemented to a metallic interface, and the whole assembly was screwed to the Unit abutment at a torque of 20 Ncm. Teflon and composite resin (Tetric Ceram, Ivoclar Vivadent) were employed to fill the access hole of the screw. The mutually protected articulation concept was used in both types of restorations.

Patients underwent periodic follow-up at 5 to 10 days after intervention, 1 month, 3 months, 6 months, and then once a year. Periodic radiographs were also obtained.

Variable Assessment

Implant survival was verified by its presence in the patient mouth at the last visit. For MBL, a known distance (implant length) was used to calibrate the measurements of the MBL. The marginal bone level was measured by calculating the distance between the top of the shoulder of the implant and the first visible
bone-to-implant contact on a standardized digital radiograph (Sidexis XG, Sirona Dental Systems). Moreover, periapical radiographs were obtained employing the periapical paralleling technique.

The marginal bone position at the radiograph taken at the time of implant loading was the baseline value. The MBL was the difference in the level of the marginal bone between the basal and the last radiograph. Bone loss was represented by negative values. Prosthetic complications were considered as crown detachment, chipping, screw loosening, or material fracture. However, the replacement of the crown due to fracture or loosening was defined as failure. The occurrence of infection, fistula, swelling, mucosal hypertrophy, and MBL ≥ 2 mm were considered as biologic complications.

**Statistical Analysis**

Two independent examiners collected and analyzed the study variables. For demographic variables, age was described by calculating the mean, standard deviation, and range and patient sex by relative frequency. The implant was the statistical unit to calculate the mean, standard deviation, and range of loading time, follow-up time, and MBL. Relative frequency described the implant diameter, length, location, type of crown retention, type of antagonist, bone type, implant survival, and prosthetic survival and complications. The Shapiro-Wilk test was the selected normality test. The \( t \) test analyzed the effect of age, sex, mandible/maxilla, and type of prosthesis retention on MBL. The analysis of variance (ANOVA) test analyzed the effect of antagonist type and implant length. The Kaplan-Meier test gave the survival rate of the implant and the prosthesis. The statistical analysis was done with MacOS statistical software package (GraphPad Prism 7, GraphPad Software). The level of significance was set at 5%.

**RESULTS**

One hundred thirteen patients (age: 56 ± 11 years [range: 32 to 77 years]) with 128 single implants (≤ 8.0 mm in length) were assessed. Among the 113 patients, 56% were female. Table 1 describes the implant dimensions. Two patients had no radiographs at the last visit and were considered as missing data for MBL.

### Short Implant as Single-Unit Implant

The implants had a follow-up time after insertion of 25.47 months (SD: 14.95; range: 12.0 to 108.9 months). Seventy-three short implants were placed in the maxilla and 55 in the mandible. No implant failures were reported. The mesial MBL was 0.17 ± 0.69 mm, and the distal bone loss was 0.28 ± 0.70 mm. The bone loss was not significantly different between the mandible (mesial: 0.16 ± 0.76 mm; distal: 0.21 ± 0.68 mm) and the maxilla (mesial: 0.18 ± 0.66 mm; distal: 0.33 ± 0.72 mm). Moreover, the differences in the bone loss were not significant (\( P = .34 \) for mesial; \( P = .27 \) for distal) between 5.5-, 6.5-, and 7.5-mm implants (Fig 1). The effect of the type of the antagonist, age, and sex on the MBL also was not significant (\( P = .96 \)). However, the type of prosthesis retention (cement- and screw-retained) had a significant effect (\( P = .03 \)) on the bone loss as will be discussed in the next section.

### Cement- Versus Screw-Retained Restoration

Table 2 shows a comparison of the clinical outcomes between cement- and screw-retained crowns. Figures 2 and 3 show clinical cases restored with screw- and cement-retained single crown restorations.

Both groups were statistically equal in all parameters except the follow-up time and the MBL (Table 2). However, the follow-up time was significantly higher in the screw-retained crown (mean difference: 6.5 months). The distal bone loss was statistically higher (\( P = .03 \)) in the cement-retained single crown implants compared with the screw-retained implants. More bone loss was observed mesially in the cement-retained single crown implants without being statistically significant (\( P = .13 \)) (Table 2).

Neither group demonstrated prosthesis failure. No technical complications occurred in the cement-retained prostheses; however, the screw was loosened in two screw-retained crowns. The screw was retightened, and no more screw loosening events were reported.

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Length (mm)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>3.75</td>
<td>1.0</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>5.0</td>
<td>12</td>
</tr>
<tr>
<td>4.25</td>
<td>7.0</td>
<td>18</td>
</tr>
<tr>
<td>4.5</td>
<td>2.0</td>
<td>32</td>
</tr>
<tr>
<td>5</td>
<td>8.0</td>
<td>23</td>
</tr>
<tr>
<td>5.5</td>
<td>11.0</td>
<td>33</td>
</tr>
<tr>
<td>6</td>
<td>11.0</td>
<td>18</td>
</tr>
<tr>
<td>6.25</td>
<td>2.0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>128</td>
</tr>
</tbody>
</table>

© 2019 BY QUINTESSENCE PUBLISHING CO, INC. PRINTING OF THIS DOCUMENT IS RESTRICTED TO PERSONAL USE ONLY. NO PART MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM WITHOUT WRITTEN PERMISSION FROM THE PUBLISHER.
Fig 1  (a) Mesial and (b) distal bone loss comparing 5.5-, 6.5-, and 7.5-mm implant lengths.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Cement-retained crown</th>
<th>Screw-retained crown</th>
<th>P &lt; .05</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of implants</td>
<td>51</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>57 ± 13</td>
<td>61 ± 11</td>
<td>Noa</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>62%</td>
<td>53%</td>
<td>Noa</td>
</tr>
<tr>
<td>Male</td>
<td>38%</td>
<td>47%</td>
<td></td>
</tr>
<tr>
<td>Smokers</td>
<td>8</td>
<td>14</td>
<td>Noa</td>
</tr>
<tr>
<td>Implant position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>21</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Mandible</td>
<td>30</td>
<td>25</td>
<td>Noa</td>
</tr>
<tr>
<td>Immediate loading</td>
<td>9</td>
<td>18</td>
<td>Noa</td>
</tr>
<tr>
<td>Follow-up time (mo)</td>
<td>21.64 ± 15.74</td>
<td>28.14 ± 13.96</td>
<td>Yesb</td>
</tr>
<tr>
<td>Bone type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>11.8%</td>
<td>5.3%</td>
<td>Noa</td>
</tr>
<tr>
<td>II</td>
<td>52.9%</td>
<td>35.0%</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>31.5%</td>
<td>58.4%</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>1.9%</td>
<td>1.3%</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>1.9%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Implant failure</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Antagonist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural</td>
<td>35</td>
<td>56</td>
<td>Noa</td>
</tr>
<tr>
<td>Crown</td>
<td>8</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Prosthesis</td>
<td>8</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>MBL ≥ 2 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mesial</td>
<td>5.88%</td>
<td>2.59%</td>
<td>Yesa</td>
</tr>
<tr>
<td>Distal</td>
<td>5.88%</td>
<td>1.29%</td>
<td>Yesa</td>
</tr>
<tr>
<td>Mesial bone loss (mm)</td>
<td>−0.2731 ± 0.83</td>
<td>−0.1053 ± 0.60</td>
<td>Nob</td>
</tr>
<tr>
<td>Distal bone loss (mm)</td>
<td>−0.4746 ± 0.80</td>
<td>−0.1517 ± 0.59</td>
<td>Yesb</td>
</tr>
</tbody>
</table>

χ² test.

Student t test.

MBL = marginal bone loss.
Both groups were free of infection, fistula, swelling, and mucosal hypertrophy. For cement-retained crowns, 5.88% had mesial and distal bone loss ≥ 2 mm, while for screw-retained crown implants, 2.59% and 1.29% had mesial and distal bone loss, respectively (Table 2, \( P < .05 \)).

**DISCUSSION**

The use of short (≤ 8.0 mm in length) implants to support single crown restorations in the molar and premolar regions was successful regarding survival rate and MBL. The null hypothesis of this study could be partially rejected, as screw retention resulted in lower MBL than crown cementation.

No implant failure was observed in this study. In a recent randomized controlled trial (RCT), 6-mm and 10-mm-long implants were inserted to support single crown restorations (screw-retained) in the posterior region. Both implants performed equally regarding survival and MBL at 3 years of follow-up. In the posterior maxilla, Guljé et al described the absence of differences in the survival of 6-mm and 11-mm implants (associated with maxillary sinus floor augmentation) supporting a cement-retained crown. The mean MBL in the present study varied from 0.17 to 0.28 mm. These values were similar to those reported by Sahrman et al and Villarinho et al describing tissue-level short implants. However, Villarinho et al reported an inferior survival rate. The authors described implant failure being more likely to occur in the mandible. This is probably due to the vulnerability of the rigid supporting bone to fracture. However, implant failure could be related to mechanical and/or biologic factors.

Statistically significantly less MBL was observed in the screw-retained single crown. This observation was not related to either the type of antagonist or the implant length. Several factors could influence the MBL. These factors could be host-, surgery-, and implant-related factors. In this study, the anatomical location, the bone type, the surgical technique, the abutment material, the implant design, and the occlusal scheme were the same in both groups. Thus, the differences between the groups could be related to the type of prosthesis retention.

The lower MBL in the screw-retained crowns may apparently contradict the outcomes of other studies that assess the impact of the prosthesis retention type on the MBL. Cemented and screw-retained prostheses have been globally compared (not individualized according to the type of prosthesis). In a systematic review with meta-analysis, Lemos et al reported that cement-retained restorations had less MBL than screw-retained restorations. However, of the five studies that reported on the MBL, only three assessed single-unit implants (one in the premolar region [Vigolo et al] and two in the anterior region). In the studies by Vigolo et al, no statistically significant differences in MBL at 10 years of follow-up were found, although at 4 years these differences were statistically significant (favoring the cemented crowns). Nissan et al showed that MBL tends to be lower in the cemented restorations. However, the results were not detailed.
according to the prosthesis type (single crown and fixed partial prosthesis). De Brandão et al concluded in a systematic review that there is no evidence to support the differences in MBL between cemented and screw-retained prostheses. In fact, only two studies included both screw-retained and cemented restorations in their design.

In the present study, transepithelial abutments were also used in the cemented single crown. These elevated the prosthetic platform away from the marginal bone, and the abutment-restoration interface was positioned close to the gingival margin (tissue level) for cement- and screw-retained crowns. Thus, the repeated connection/disconnection of the abutment was avoided. This would favor the stability of the marginal bone. Recent findings have appointed the importance of abutment height in minimizing the MBL. Minimum MBL could be expected when the abutment height is 2 mm. In the present study, the height of the abutments in both groups was ≥ 2 mm. Moreover, the quality of sealing at the implant-abutment would enhance the stability of peri-implant bone. This would prevent the accumulation of microorganisms, inflammation, and bone loss. The fit discrepancy at the implant-abutment significantly affected mechanical stress received by bone. Excessive stress may provoke bone loss.

The screw-retained restoration in the present study is a two-piece restoration. The Unit abutment has its own screw to be connected to the implant, and the restoration is connected to the abutment by another screw. In other studies, the screw-retained crown was a one-piece restoration. One long screw held the restoration connected to the implant. In a systematic review, Wittneben et al showed that two-piece restorations but not one-piece restorations had a significantly lower failure rate than cemented restorations. The estimated failure rate and the estimated technical complication rate were higher in the one-piece restoration than the two-piece restoration.

In the present study, two events of screw loosening were observed in screw-retained single crowns (2.5%). Villarinho et al observed a higher frequency of screw loosening (28.3%). Screw loosening could be related to excessive loads that overcome the screw preload or to screw settling. The failure to deliver a sufficient preload to the screw (during tightening) may also increase the risk of loosening. In the present study, screw loosening would probably be related to the failure of the application of optimum preload. No further events were observed after screw retightening.

Regarding biologic complications, in the systematic review by Sailer et al, MBL ≥ 2 mm was observed to be more frequent in the cemented single crown than in the screw-retained crown. This is in agreement with the present study, where the cemented group showed a higher frequency of MBL ≥ 2 mm.

This study was a retrospective study with dependency on data availability in the reviewed records of the patients. The two groups compared were fairly well balanced for the main confounders like sample size, age, sex, implant location, bone type, and antagonist type. The effect of systemic diseases could not be assessed in this study. Prospective controlled clinical studies are needed to get more evidence of the predictability of short implants to support single-tooth restorations in the premolar-molar areas and to confirm the findings of the present study. In particular, long-term studies are necessary, as contradictory results have been reported for short implant performance at 5 years.

CONCLUSIONS

On the basis of this retrospective study of 113 patients with 128 single implants of ≤ 8 mm length, the following observations can be made: short (≤ 8 mm) dental implants could be an effective option to support a single-tooth restoration in the premolar-molar regions, and the clinical outcomes of the cement- and screw-retained crowns demonstrated no significant differences.

ACKNOWLEDGMENTS

E.A. is the Scientific Director of BTI Biotechnology Institute (Vitoria, Spain). He is the head of the Foundation Eduardo Anitua, Vitoria, Spain. M.H.A. is a scientist at BTI Biotechnology Institute (Vitoria, Spain).

REFERENCES


