Socket Shield Technique for immediate implant placement – clinical, radiographic and volumetric data after 5 years

Daniel Bäumer*Otto Zuhr*Stephan RebeleMarkus Hürzeler

Key words: alveolar bone preservation, buccal bone, esthetic zone, extraction socket, immediate implant, socket shield

Abstract

Objectives: Implant placement immediately after tooth extraction is often accompanied by resorption of surrounding tissues. A clinical technique was developed where the buccal portion of the root is retained to preserve the periodontal ligament and bundle bone. This technique is based on animal studies showing the potential to preserve the facial tissues utilizing this approach. The purpose of this study was to gain more insight regarding the safety of the technique with regard to biological and implant-related long-term complications and to observe the clinical appearance of the peri-implant tissues. Another objective was to evaluate volumetric changes of the affected facial contours in long-term and the esthetic outcomes.

Material and Methods: This study is a retrospective case series of 10 consecutive patients with implant replacement between the maxillary first premolars. Impressions were made prior to extraction (t1) and 5 years post-implant placement (t2). 3D-surface scans of the casts were digitally superimposed for quantitative evaluation of alterations of the facial peri-implant tissue contours and soft tissue recessions. Additionally, clinical data were collected (PPD, BOP, peri-apical radiographs and photographs).

Results: All implants healed without adverse events. Peri-implant probing revealed healthy conditions. The comparison of radiographic images showed physiologic bone remodeling at the implant shoulders. Mean tissue loss on the facial side in oro-facial direction was $0.21 \pm 0.18$ mm. Average recession at implants was $0.33 \pm 0.23$ mm and at neighboring teeth $0.38 \pm 0.27$ mm. Mean loss of the marginal bone level at the implant shoulder amounted to $0.33 \pm 0.43$ mm at the mesial and $0.17 \pm 0.36$ mm at the distal aspect of the implants. A mean pink esthetic score of 12 was recorded.

Conclusion: Volumetric analysis showed a low degree of contour changes from extraction and implant placement to the follow-ups. Mucosal recession at the implant restoration was comparable to that of the neighboring teeth. Within the limitations of this descriptive study, the socket shield technique offers reduced invasiveness at the time of surgery and high esthetic outcomes with effective preservation of facial tissue contours. This technique should not be used in routine clinical practice until a higher level evidence in the form of prospective clinical trials is available.

The complete preservation or reconstruction of the peri-implant soft tissues in areas of esthetic importance remains one of the biggest challenges in implant dentistry and can often only be achieved in select cases. Esthetic compromise can manifest itself in vertical recession in the mid-facial or interdental area, loss of facial contours in the horizontal dimension and also with differing tissue color and surface texture (Furhauser et al. 2005).

These changes can be the consequence of several influencing factors resulting from tooth extraction, such as mechanical trauma, microorganisms in the socket exposed to the oral cavity, disruption of the periosteal blood supply after flap elevation and patient-related risk factors such as smoking or plaque accumulation (Tan et al. 2012). Two very important etiologic factors also identified in this context are the thickness of the buccal bone...
To overcome the defect formation that negatively influences the esthetic appearance and the osseointegration of the implant, ridge preservation techniques and supportive measures have been considered, and a big effort is made under their use to reach the best possible esthetic result (Lin et al. 2014). These include hard and soft tissue augmentation procedures, immediate provisionalization, flapless implant placement, a more palatal orientation of the implant in the socket and possibly the use of platform switching. Despite the positive effect of all these techniques, it needs to be realized that an optimal esthetic result can only be reached in selected cases (Khazam et al. 2015) as the tissue changes cannot be completely prevented or compensated [Esposito et al. 2012; Chen & Buser 2014; Lin et al. 2014].

The loss of the periodontal ligament and bundle bone plays a major role influencing the resorption process resulting in subsequent peri-implant soft tissue recession and esthetic deterioration. As they will be lost, the buccal bone plate and the covering soft tissues will be thinned out and even reduced in height as the bundle bone extends into the tip of the buccal bone wall. In the upper front, the coronal part of the buccal lamella often consists solely of bundle bone, and therefore, its loss will not only lead to a thinning out but to a complete resorption of the buccal bone in this area (Araujo & Lindhe 2005).

This had led to the revival of root retention in a different indication than it was once introduced for in the 1970s [Casey & Lauricello 1980]. In its original intention, the preservation of roots was propagated for alveolar bone preservation in the context of treatment solutions with full dentures. In many cases, it has been used as a successful measure to maintain the denture-supporting tissue. Recently root submergence has also been used as a method to preserve the alveolar ridge in pontic sites under fixed partial dentures [Salama et al. 2007]. Whatever aim is being followed by root retention, it works due to one principle: maintenance of the periodontal attachment including cementum, periodontal ligament and bundle bone.

A technique called “socket shield” that makes use of this principle has been made up to keep the periodontium in the marginal area on the buccal side of the implant by partial root retention [Hurzeler et al. 2010]. In the context of preclinical studies, the preservation of the buccal periodontal tissues, and in particular that of the buccal bone plate, could already be documented on a histological level as well as the volumetric stability of the involved buccal periodontal structures when using the socket shield concept. These results as well as first clinical case reports from clinical application (follow-up 6 months and 1.5 years) have recently been published (Hurzeler et al. 2010; Baumer et al. 2015).

Based on these positive first results, the next step was now to (i) gain more insights regarding the safety of the socket shield technique regarding biological implant-related long-term complications and observe the clinical appearance of the peri-implant soft and hard tissues as well as to (ii) evaluate volumetric changes of the affected buccal contours in the long-term [5 years] and (iii) the resulting esthetic outcomes.

Material and methods

Patient population
The patient group was evaluated retrospectively. It consisted of subjects who were consecutively treated with immediate implant placement using the socket shield technique in a dental office between July 2009 and October 2010. All patients participated in a dental hygiene maintenance program during the follow-up time with a 4-month recall interval. The subjects were adults with one front tooth (from the first premolar to the first premolar in the upper front) no longer worth maintaining with adjacent teeth being present and to be replaced with an implant. A history of periodontal surgery resulted in exclusion from the study. All patients were informed about the clinical procedure, possible alternative treatments, the novelty of the technique and especially possible risks and complications.

Inclusion criteria
- medically healthy adult (ASA classification I-II, age ≥ 25 years old)
- non-smoker
- hopeless anterior tooth with neighboring teeth on the mesial and distal intact buccal periodontal tissues as far as preoperatively diagnosable any periodontal phenotype (thin, normal or thick)
- single immediate implant in the maxilla using socket shield
- good oral hygiene (FMPS & FMBS ≤ 25%)
- written informed consent

Exclusion criteria
- teeth with present/past periodontal disease
- teeth with vertical root fractures on the buccal aspect
- teeth with horizontal fractures at/below bone level
- teeth with any other pathologies affecting the buccal part of the root, for example, external or internal resorptions, except apical pathology
- patients who are pregnant, intending to conceive or breast feeding
- no written informed consent

The clinical outcomes of 10 consecutive patients (5 males, 5 females) treated during the time period [July 2009 to October 2010] were retrospectively evaluated. All patients gave their written consent to participate in the investigation. The experiments were undertaken with the understanding and written consent of each subject and according to the World Medical Association Declaration of Helsinki. The study was independently reviewed and approved by the ethical board of the Albert-Ludwigs-University of Freiburg.

Surgery & prosthetics
Treatment prior to surgery included therapy of gingivitis and if necessary instructions in oral hygiene. After extra-oral disinfection of the surgical site, the patient was instructed to rinse with 0.12% chlorhexidine solution for 1 min. After the application of local anesthesia, the clinical crown of the tooth was cut off with a diamond bur 1 mm above the gingival level, and implant bed preparation was performed according to the manufacturer’s guidelines, but through the root still in the alveolar socket. Utilizing new implant drills, the resistance when drilling through dentine is similar to bone class D1. The osteotomy was performed with special attention to keep the drills stable in vertical direction in order to reduce the risk for dislodgement of the root segment although the risk seems to be very low according to the authors’ experience.

The coronal facial root segment was separated from the rest of the root using a linde-mann surgery bur with the aid of light and ×6 magnification loupes. The remaining pieces of the root were removed using a desmotome without putting stress on the buccal tissues. This resulted in a lamella of the former root in the area of the buccal bony socket (Figs 1, 2 and 3) that was thinned out to a thickness of 2–3 mm using round diamond burs. It was also beveled toward the
implant in order to create more space for soft tissue between abutment and dentine. In vertical direction, the coronal aspect of the segment was placed 1 mm above the buccal bone level.

In the unlikely event that the root segment yet dislodged or loosened during preparation, it would have been removed and not replaced, and a conventional approach for implant placement would have been performed. The same applied when a fracture of the root would be observed on the buccal aspect. In case of apical pathology, granulation tissue was removed carefully. In the same manner, thin facial bone or even a buccal fenestration did not change the surgical protocol.

On the inside of the root segment, an enamel matrix protein (Emdogain™, Straumann®, Basel, Switzerland) was applied in order to try to initiate new cementum formation which could aid in the prevention of root resorption in long term. Then, a conventional parallel-walled implant (SPI®, ELEMENT, Thommen Medical, Waldenburg, Switzerland) was placed immediately exerting as little pressure on the root segment as possible. Augmentations or reconstructive surgical treatment measures, for instance the application of demineralized bovine bone mineral, a resorbable membrane and/or a soft tissue graft were omitted. As no flap was raised, the implants were left for non-submerged healing with either an individualized healing abutment [six of the cases] or an immediate provisional [four of the cases]. The patient was given comprehensive postoperative instructions and was advised to take the prescribed medication which included an antibiotic [Clinda-saar 600 mg, MIP Pharma®, Blieskastel, Germany; 1 x 1 h before surgery], an analgesic [Ibuprofen Gra600®, Actavis®, Steinhausen, Switzerland; 3x daily for 4 days] and a chlorhexidine mouth rinse [GUM® Paroex® 0.12%, Sunstar®, Etoy, Switzerland; 3x daily for 14 days].

Five months after implant placement, implant impressions were made. The final crowns, made of lithium disilicate, were inserted with screw retention [six crowns] or cemented on custom zirconia abutments with glass ionomer luting cement [four crowns].

Data acquisition & follow-up
Patients were followed up from 51 to 63 months (mean 58 months). All of the following steps were the routine part of the procedures in the dental office. Prior to extraction and immediate implant placement, an impression was made for preoperative diagnostics. To assure peri-implant health, clinical measurements were taken as follows: probing depths, bleeding on probing, buccal width of keratinized mucosa measured with a periodontal probe [PCPUNC15, Hu-Friedy®, Chicago, IL, USA] after coloring with lugol’s iodine. A scale was used to calibrate the examiner to a probing force of 25 g, and clinical measurements were confirmed in a second attempt. A radiograph was taken after insertion of the final crown using the parallel cone technique and a Rinn film holder to adjust the radiographic beam perpendicular to the implant. At the follow-up visits, the same measurements were repeated. Extra measures taken for the study were an impression and clinical pictures 5 years after surgery.

Volumetric, radiographic and esthetic analysis
Volumetric analysis was performed according to a previous study [Baumer et al. 2015]. Polyether impressions were made with Perma-dyne® (3M, St. Paul, MN, USA) prior to extraction and 5 years after delivery of the definitive restoration. Plaster casts were made with a type IV die stone (esthetic base gold®, dentona AG, Dortmund, Germany) and optically scanned with a structured light 3D scanner [D104®, Imetric 3D, Courgenay, Switzerland]. The obtained STL-data were compared regarding volume alterations of the buccal soft tissues by digital superimposition in a matching software [SMOP Volume Compare®, Swissmeda, Zurich, Switzerland]. The volume alterations were measured as the mean loss in distance (Δd [mm] = Δvol [mm³]/area [mm²]) in labial direction according to animal studies by Fickl et al. and a clinical study by Schneider et al. [Fickl et al. 2008; Schneider et al. 2011] [Figs 4 and 5].

Besides volumetric evaluation, recession of the soft tissues was measured at the apical zenith of the mucosal margin on the implants and the gingival margin on the
neighboring teeth after superimposing the models as the vertical distance change between the former and the new position of soft tissue margins.

Marginal bone levels were compared in available intraoral radiographs (Fig. 6) taken after insertion of the definitive restoration and at the follow-up visit. The implant shoulder was used as a reference point, and the distance to the first bone contact mesially and distally was measured digitally with a measuring software (Trophy®, Kodak®, Rochester, NY, USA). If the preserved root segment encroached the proximal aspect of the implant, the first bone to dentine contact was used as reference point.

Soft tissue esthetics were evaluated by an independent observer (dentist) using photographs and the pink esthetic score by Furhauser (Furhauser et al. 2005) (Figs 7–16).

Results

All implants healed without complications. Until the final follow-up visit, no adverse events were registered or reported by the patients. Probing depths were physiologic, and no signs of peri-implant mucositis were visible (Table 1). A sufficient amount of keratinized mucosal width of 3–5 mm buccal of the implants was present in all patients. Mean loss of buccal tissue in oro-facial direction was $-0.37 \pm 0.18 \text{ mm}$ (Table 2). Average mid-facial recession at the implant was $-0.33 \pm 0.23 \text{ mm}$ and at neighboring teeth $-0.38 \pm 0.27 \text{ mm}$ (Table 3).

Mean loss of marginal bone level amounted $0.33 \pm 0.43 \text{ mm}$ at the mesial and $0.17 \pm 0.36 \text{ mm}$ at the distal aspect of the implants.

Pink esthetic score evaluation from photographs showed positive results in all cases with a mean score of 12.

Discussion

Treatment protocols for delayed implant placement are well documented and provide predictable outcomes with high survival and success rates in the posterior and anterior zones (Buser et al. 1997, 2012; Lindh et al. 1998; Belser et al. 2004; Fischer & Stenberg 2012), but they can often demand more treatment time and multiple surgical procedures. To streamline the process and reduce treatment time, immediate implant protocols have been introduced, which report a similar survival rate (Lang et al. 2012). They can also provide a pleasing esthetic result with good function in selected situations, but not on a predictable basis and have a higher risk for mucosal recession and volume loss (Evans & Chen 2008; Chen & Buser 2014). This is where the socket shielding technique was introduced in an effort to make a positive difference: Although scientific evidence is still lacking, one can speculate that it offers the advantages of immediate implant placement like comparably low morbidity and a rather favorable cost-benefit ratio and at the same time comes along with less risk regarding the esthetic outcome. Additionally, the case spectrum, in which predictable esthetic success can be achieved, might be extended by more complex situations which could not predictably be solved so far such as the need for multiple adjacent implants.

Presumably, this is why other professionals have also focused on the technique during the last 5 years: Kan et al. have reported a case with a modified shield technique for interimplant papilla preservation with good success in maintaining the bone level and the periodontium, where the shield was located more in the interproximal than the buccal area (Kan & Rungcharassaeng 2013). A
similar approach was presented by Cherel et al. for the replacement of two neighboring central incisors without adverse events at 11 months after implant placement. They could observe complete preservation of the papilla (Cherel & Etienne 2014).

Also using the technique for a situation with two implants besides each other, Gluckman et al. reported a case without adverse events and with a pleasing esthetic result (Gluckman et al. 2015). This correlates with the authors experience: the esthetic potential for two implants next to each other seems to be much higher compared to conventional implant placement (Table 4).

Abadzhiev et al. have described a clinical study with 25 patients comparing the conventional approach for immediate implant placement including soft and hard tissues grafting with the socket shield technique. In their report, the conventional approach was clearly inferior regarding the esthetic outcomes and tissue changes (Abadzhiev et al. 2014).

Several other authors have also reported positive experiences with the technique or modifications thereof (Glocker et al. 2014; Troiano et al. 2014; Al Dary & Al Hadidi 2015; Engelke et al. 2015; Lagas et al. 2015). Siormpas et al. retrospectively followed 46 patients for 24–60 months (median 40 months) with 100% survival rate and a
low rate for crestal bone loss with 0.18 ± 0.09 mesial and 0.21 ± 0.09 on the distal (Siormpas et al. 2014). In that publication, cone-beam CTs also show the retained piece of the root buccal of the implant. Only in one case, apical resorption of the shield was reported which might be due to microbiological leftovers in the root apex, which is indicative of the technique sensitivity of this approach which is described by most authors. Special care has to be taken that the apex of the root is completely removed and that there is no vertical fracture staying within the shield. With increasing experience in the application of the technique, a consensus in the recommended step-by-step procedure will come up and first step-by-step descriptions are already being published (Mitsias et al. 2015) [Table 5].

A point of further investigation is the function and especially the long-term stability with the incidence of biologic long-term complications. Even if the technique is performed to the best knowledge, possible risk factors can still not be excluded as missing long-term data have to be addressed. These relate mostly to the question how the root segment is integrated. It would be favorable if it would be incorporated by tissue free of inflammation or maybe even processed by controlled resorption and replaced by bone, although this is purely hypothetical and the real consequences are unknown. An unfavorable situation would be resorption of the segment accompanied by an inflammatory process. The idea behind the application of
Table 1. Values for pocket depth and bleeding on probing

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Surface (mm²)</th>
<th>Mean orofacial recession (mm)</th>
<th>Max (mm)</th>
<th>Min (mm)</th>
<th>Volume (mm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31.1</td>
<td>0.62</td>
<td>−0.9</td>
<td>−0.19</td>
<td>17.33</td>
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<td>2</td>
<td>34.02</td>
<td>0.08</td>
<td>−0.52</td>
<td>0.59</td>
<td>7.14</td>
</tr>
<tr>
<td>3</td>
<td>46.26</td>
<td>0.13</td>
<td>−0.47</td>
<td>0.13</td>
<td>5.29</td>
</tr>
<tr>
<td>4</td>
<td>44</td>
<td>0.56</td>
<td>−0.91</td>
<td>0.91</td>
<td>22.1</td>
</tr>
<tr>
<td>5</td>
<td>45.49</td>
<td>0.31</td>
<td>−0.74</td>
<td>0.72</td>
<td>11.64</td>
</tr>
<tr>
<td>6</td>
<td>30.39</td>
<td>0.34</td>
<td>−0.7</td>
<td>0.03</td>
<td>10.29</td>
</tr>
<tr>
<td>7</td>
<td>51.18</td>
<td>0.43</td>
<td>−0.77</td>
<td>0.13</td>
<td>21.18</td>
</tr>
<tr>
<td>8</td>
<td>33.07</td>
<td>0.02</td>
<td>−0.73</td>
<td>0.52</td>
<td>8.05</td>
</tr>
<tr>
<td>9</td>
<td>29.97</td>
<td>0.18</td>
<td>−0.69</td>
<td>0.05</td>
<td>4.84</td>
</tr>
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<td>10</td>
<td>33.35</td>
<td>0.24</td>
<td>−0.14</td>
<td>0.65</td>
<td>5.95</td>
</tr>
</tbody>
</table>

Overall mean: 37.88, −0.37, −0.66, −0.16, 11.38

Overall median: 33.69, −0.34, −0.72, −0.16, 9.17

Table 2. Results of volumetric measurements

<table>
<thead>
<tr>
<th>Patient #</th>
<th>Recession mesial tooth (mm)</th>
<th>Recession implant (mm)</th>
<th>Recession distal tooth (mm)</th>
<th>Width of keratinized gingiva (pre/post-op)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>−0.43</td>
<td>−0.53</td>
<td>−0.54</td>
<td>3.5/4</td>
</tr>
<tr>
<td>2</td>
<td>−0.3</td>
<td>0</td>
<td>−0.32</td>
<td>5/5</td>
</tr>
<tr>
<td>3</td>
<td>−0.42</td>
<td>−0.24</td>
<td>−0.28</td>
<td>5/5</td>
</tr>
<tr>
<td>4</td>
<td>−0.3</td>
<td>−0.67</td>
<td>−0.17</td>
<td>5/4.5</td>
</tr>
<tr>
<td>5</td>
<td>−0.54</td>
<td>0.21</td>
<td>−0.73</td>
<td>5/5</td>
</tr>
<tr>
<td>6</td>
<td>−0.11</td>
<td>0.46</td>
<td>−0.14</td>
<td>5/5</td>
</tr>
<tr>
<td>7</td>
<td>−1.11</td>
<td>−0.46</td>
<td>−0.21</td>
<td>4.5/4.5</td>
</tr>
<tr>
<td>8</td>
<td>−0.49</td>
<td>−0.25</td>
<td>−0.2</td>
<td>5/5</td>
</tr>
<tr>
<td>9</td>
<td>−0.05</td>
<td>0.74</td>
<td>−0.77</td>
<td>5/5</td>
</tr>
<tr>
<td>10</td>
<td>0.44</td>
<td>0.44</td>
<td>0.49</td>
<td>3/3</td>
</tr>
</tbody>
</table>

Overall mean: −0.42, −0.33, −0.34, 4.6/4.6

Overall median: −0.42, −0.25, −0.28, 5/5

Table 3. Results of clinical measurements

<table>
<thead>
<tr>
<th>Patient #</th>
<th>Recession mesial tooth (mm)</th>
<th>Recession implant (mm)</th>
<th>Recession distal tooth (mm)</th>
<th>Width of keratinized gingiva (pre/post-op)</th>
</tr>
</thead>
<tbody>
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<td>0</td>
<td>0.0</td>
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</tr>
<tr>
<td>2</td>
<td>1.1</td>
<td>0.0</td>
<td>1.1</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>0.3</td>
<td>0.5</td>
<td>0.3</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>0.0</td>
<td>0.1</td>
<td>0.0</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>0.8</td>
<td>1.1</td>
<td>0.8</td>
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<td>7</td>
<td>0.3</td>
<td>0.0</td>
<td>0.3</td>
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<td>0.0</td>
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<tr>
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<td>0.0</td>
<td>0.0</td>
<td>12</td>
</tr>
<tr>
<td>10</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>11</td>
</tr>
</tbody>
</table>

Mean: 0.33, 0.17, 0.33, 12

Median: 0.15, 0.0, 0.15, 12

PES, pink esthetic score.
and with positive results, simpler treatment protocols have to be developed as its clinical application is still difficult to perform and technique sensitive.

References


Table 5. Detailed information on indication, implant characteristics and prosthetics

<table>
<thead>
<tr>
<th>Patient #</th>
<th>Reason for extraction</th>
<th>Implant length (mm)</th>
<th>Implant diameter (mm)</th>
<th>Immediate provisional (yes/no)</th>
<th>Crown cemented/screw-retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Endodontic failure</td>
<td>12.5</td>
<td>4.0</td>
<td>No</td>
<td>Cemented</td>
</tr>
<tr>
<td>2</td>
<td>Vertical fracture</td>
<td>14.0</td>
<td>4.0</td>
<td>No</td>
<td>Cemented</td>
</tr>
<tr>
<td>3</td>
<td>Endodontic failure</td>
<td>17.0</td>
<td>4.0</td>
<td>No</td>
<td>Screw-retained</td>
</tr>
<tr>
<td>4</td>
<td>Post &amp; tooth fracture</td>
<td>11.0</td>
<td>5.0</td>
<td>Yes</td>
<td>Cemented</td>
</tr>
<tr>
<td>5</td>
<td>Endodontic failure</td>
<td>14.0</td>
<td>5.0</td>
<td>Yes</td>
<td>Cemented</td>
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<tr>
<td>6</td>
<td>Horizontal fracture</td>
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<td>Yes</td>
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<tr>
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<td>Cemented</td>
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<td>8</td>
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<td>4.0</td>
<td>No</td>
<td>Screw-retained</td>
</tr>
<tr>
<td>9</td>
<td>Horizontal fracture</td>
<td>12.5</td>
<td>3.5</td>
<td>No</td>
<td>Cemented</td>
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<tr>
<td>10</td>
<td>Endodontic failure</td>
<td>11.0</td>
<td>4.0</td>
<td>Yes</td>
<td>Screw-retained</td>
</tr>
</tbody>
</table>

Conclusion

The results of this retrospective pilot study and the increasingly available documentation in the literature, the socket shield technique is a promising treatment approach for implants in the esthetic zone. It is still too early for routine clinical application as well-designed clinical studies with long-term follow-up periods have to be performed before a general treatment recommendation can be given.

Conflict of interest

No conflict of interest by any author.
Bäumer et al. Socket shield technique


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