Review

Comparison of Crestal Bone Loss Around Dental Implants Placed in Healed Sites Using Flapped and Flapless Techniques: A Systematic Review

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**Background:** The aim of the present systematic review is to compare the crestal bone loss (CBL) around dental implants placed in healed sites using flapped and flapless surgical techniques.

**Methods:** The focused question was, “Does flapped and flapless surgical technique influence CBL around dental implants placed in healed sites?” Databases were searched from 1975 up to and including May 2014 using different combinations of the following keywords: “crestal bone loss”; “dental implant”; “surgery”; “flap”; and “flapless.” Unpublished data, experimental studies, letters to the editor, review articles, case reports, commentaries, and articles published in languages other than English were excluded. In all studies, the test group comprised implants placed using flapless surgery, and the control group, implants placed after reflection of a full-thickness mucoperiosteal flap.

**Results:** Ten clinical studies were included. In five studies, CBL around implants was comparable between the test and control groups. In four studies, implants in the test group showed significantly less CBL compared with the control group. In one study, CBL was significantly higher in the test group than the control group.

**Conclusion:** CBL around dental implants placed in healed sites using flapped and flapless techniques is comparable. J Periodontol 2015;86:185-191.

**KEY WORDS**
Alveolar bone loss; dental implants; gingiva; gingival recession; review; surgical flaps.

A traditional implant placement protocol involves exposure of the alveolar ridge using a full-thickness mucoperiosteal flap; then implants are placed in bone and the flaps are repositioned using sutures. Flap elevation facilitates visibility and access at the operating site and is considered advantageous in the esthetic zone since flaps can be repositioned to desired locations. However, reflection of the mucoperiosteal flap compromises the vascular supply of bone, which may lead to crestal bone loss (CBL) and long-term esthetic complications.

Studies have shown that a flapless procedure during implant placement has a positive effect on the alveolar bone remodeling process. For example, in the study by Sunitha and Sapthagiri, 40 patients selected for conventional implant therapy were assigned to two treatment groups, flapped and flapless. The amount of CBL was measured at baseline and ≤2 years after implant placement using conventional two-dimensional radiographs. The results showed that CBL was significantly higher around implants placed after flapped surgery compared to flapless implants. Similar results were reported by Tsoukaki et al., Job et al., and Tonetti and Schmid. An explanation of this may be derived from the fact that using a flapless approach during implant placement preserves the

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periosteal vascular supply to bone, thereby minimizing the possibility of future CBL. However, controversial results have also been reported. In the studies by Froum et al.\textsuperscript{10} and De Bruyn et al.,\textsuperscript{11} CBL around implants placed in healed sites using flapped and flapless surgery were comparable.

To the current authors’ knowledge from indexed literature, there is one recently published systematic review that compared the effect of flapped and flapless surgical techniques on CBL around dental implants.\textsuperscript{12} The results showed that the implant survival and radiographic CBL between flapped and flapless interventions were comparable. It is noteworthy, however, that studies on both immediate and conventionally placed implants were included in that systematic review.\textsuperscript{12} In addition, in one study bone augmentation procedures were also performed.\textsuperscript{13} It has been reported that a significant correlation exists between CBL and flapless immediate implants, compared to implants placed in healed sites using flapless technique.\textsuperscript{12} This suggests that factors such as implant placement protocol (immediate or conventional) and surgical technique (flapped, flapless, and/or bone augmentation procedures) influence the overall CBL around implants. Therefore, it is speculated that a systematic review primarily focusing on implants placed in either healed sites or fresh extraction sockets would clearly show the influence of flapped and flapless surgical technique on CBL.

With this background, the aim of the present systematic review is to compare CBL around dental implants placed in healed sites using flapped and flapless surgical techniques.

**MATERIALS AND METHODS**

**Focused Question**
The focused question was, “Does flapped and flapless surgical technique influence CBL around dental implants placed in healed sites?”

**Eligibility Criteria**
The following eligibility criteria were imposed: 1) original studies; 2) clinical studies; 3) intervention: CBL around dental implants placed in healed sites using flapped and flapless techniques; 4) presence of a test group (implants placed using flapless surgery) and a control group (implants placed using conventional full-thickness mucoperiosteal flaps) in healed sites; and 5) only articles published in English language. Letters to the editor, case reports, commentaries, review articles, and unpublished articles were excluded.

**Search Strategy**
PubMed/Medline (National Library of Medicine, Bethesda, Maryland), Google Scholar, EMBASE, and ISI Web of Knowledge databases were searched from 1975 up to and including May 2014 using different combinations of the following key words: “crestal bone loss”; “dental implant”; “surgery”; “flap”; and “flapless.” Titles and abstracts of studies that fulfilled the eligibility criteria were individually assessed by the authors (FV, AK, KA, and FJ) and checked for agreement. Full texts of the relevant studies were then independently read and assessed with reference to the selection protocol. As a next step, reference lists of original and review studies were manually searched to identify any articles that could have been missed during the initial search. Any disagreements regarding study selection were resolved by discussion (Fig. 1).

The initial search yielded 36 studies. Twenty-six studies that did not fulfill the eligibility criteria were excluded (see supplementary Appendix A in the online Journal of Periodontology). In total, 10 studies were included and processed for data extraction.
RESULTS

General Characteristics of the Studies
All studies 6-8,10,11,14-18 had a prospective design and were performed at either universities or health care centers. The total number of patients ranged from six to 60. Seven studies 7,8,11,15-18 reported the mean age of study participants, which was from 39.2 years to 61 years (age range, 20 to 79 years). Nine studies 7,8,10,11,14-18 reported the number of female participants, which ranged from seven to 35 individuals (Table 1). In the studies by Katsoulis et al. 15 and De Bruyn et al., 11 three and 10 smokers, respectively, were included. In all studies, 6-8,10,11,14-18 it was unclear whether soft tissue biotype was assessed before implant placement.

Surgical Technique and Implant-Related Characteristics
In all studies, 6-8,10,11,14-18 rough-surfaced titanium implants were placed in healed sites, with diameters and lengths ranging from 3.3 to 5 mm and 7 to 18 mm, respectively. The number of implants placed ranged from 10 to 195. In four studies, 7,11,14,17 implants were placed in both arches. In three studies, 15,16,18 all implants were placed in the maxilla. In three studies, 5,8,10 the location of implants was not reported. Five studies 11,14,15,17,18 reported the implant insertion torque, which ranged from 20 to 35 Ncm. Immediate and conventional loading was performed in three 6,16,17 and four 7,10,11,18 studies, respectively. In three studies, 8,14,15 implant loading was not performed (Table 1). The follow-up period ranged from 6 weeks to 48 months.

In five studies, 10,11,14-16 CBL was comparable around implants placed using flapped and flapless techniques. In four studies, 6-8,18 implants placed using flapless techniques showed significantly less CBL compared to those placed using a flapped technique. In the study by Maló and Nobre, 17 implants placed using flapless techniques showed significantly higher CBL than those placed using flapped surgery.

DISCUSSION

The present study is based on the hypothesis that implants placed in healed sites using flapless technique undergo significantly less CBL compared to those placed using conventional surgical flap procedures. An explanation may be derived from the fact that compared to flapped surgical procedures, flapless surgery allows minimum disruption of peri-implant tissues, thereby reducing changes in crestal bone levels, probing depth, and inflammation. 19 In addition, flapless surgery has also been reported to preserve circulation of the peri-implant tissues and accelerate recuperation, thereby allowing the patient to resume regular oral hygiene maintenance immediately after implant placement. 7 The findings of the present systematic review are comparable to those reported in the study by Lin et al. 12 However, Lin et al. 12 included studies on implants placed in healed sites, fresh extraction sockets, and augmented sites. Therefore, the present systematic review was performed using strict eligibility criteria to assess CBL around dental implants placed in healed sites using flapped and flapless surgical procedures.

Interestingly, 50% of the studies 10,11,14-16 included in the present systematic review showed that CBL was comparable among implants placed using either flapped or flapless surgical technique. It is possible that additional factors that may have influenced crestal bone levels were overlooked in the studies that fulfilled the eligibility criteria. For example, it is well known that regular oral hygiene maintenance plays an essential role in the overall success of periodontal surgical interventions. 20,21 Although two 11,16 of these five 10,11,14-16 studies clearly stated that oral hygiene status was satisfactory in their study populations, it is speculated that all patients in these studies had acceptable pre- and postoperative oral hygiene status. This could have yielded comparable results in terms of CBL between the groups. Likewise, studies 22,23 have also shown that CBL is significantly higher in smokers compared with non-smokers. Among the studies 10,11,14-16 showing comparable CBL between flapped and flapless implants, only one 16 had participants who were all non-smokers. In the studies by Katsoulis et al. 15 and De Bruyn et al., 11 nearly 7% and 20% of the population, respectively, were smokers. However, the group allocation (flapped and flapless) of smokers remained unclear. It is possible that the comparable outcomes reported in these studies 11,15 could have been influenced by the distribution of smokers within their respective study groups. Moreover, clinical experience and skill of the surgeon are considered a prerequisite in overall treatment success. 3,24,25 In 60% of these studies, 11,15,16 surgical procedures were performed by a single skilled operator. Therefore, the operator’s skill seems to be an additional factor that governed CBL around dental implants regardless of the surgical techniques (flapped or flapless) used in these studies. 10,11,14-16 Furthermore, peri-implant soft-tissue biotype, implant abutment interface, depth of implant placement (crestal or subcrestal), and occlusal loading are additional factors that could have biased the results of the studies included in the present review. 26-29 It is noteworthy that none of the studies included in this review addressed the relationship of crestal bone levels with implant–abutment interface,
### Table 1. Characteristics of Studies That Fulfilled Eligibility Criteria

<table>
<thead>
<tr>
<th>Reference and Study Group</th>
<th>Implants Placed (n)</th>
<th>Patients (n)</th>
<th>Mean Age in Years (range)</th>
<th>Females (n)</th>
<th>Total Implants (n)</th>
<th>Implant Dimensions (width-length in mm)</th>
<th>Implant Surface</th>
<th>Loading Protocol</th>
<th>Follow-Up</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job et al.6</td>
<td>6</td>
<td>NA</td>
<td>3-8/10-15</td>
<td>10</td>
<td>3.8/10-15</td>
<td>Rough</td>
<td>Immediate, non-functional</td>
<td>12 weeks</td>
<td>Bone loss significantly higher in FG compared with FLG</td>
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<tr>
<td>Sunita and Sapthagiri7</td>
<td>40</td>
<td>39.2 (25 to 62)</td>
<td>15</td>
<td>40</td>
<td>3.7-4.8/13-16</td>
<td>NA</td>
<td>Conventional</td>
<td>≤24 months</td>
<td>FLG showed significantly less CBL than FG</td>
<td></td>
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<tr>
<td>Tsoukaki et al.8</td>
<td>20</td>
<td>11</td>
<td>3.5-4/NA</td>
<td>30</td>
<td>47.4 (30 to 62)</td>
<td>NA</td>
<td>Unloaded</td>
<td>≤12 weeks</td>
<td>CBL higher in FG than FLG</td>
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<tr>
<td>Froum et al.10</td>
<td>60</td>
<td>NA</td>
<td>35</td>
<td>60</td>
<td>4.3-5.0/10-16</td>
<td>Rough</td>
<td>Conventional</td>
<td>12 months</td>
<td>Bone loss comparable between FG and FLG</td>
<td></td>
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<tr>
<td>DeBruyn et al.11</td>
<td>49</td>
<td>53 (20 to 79)</td>
<td>27</td>
<td>53</td>
<td>3.3-5.0/7-18</td>
<td>Rough</td>
<td>Conventional</td>
<td>≤48 months</td>
<td>Both groups showed mean bone loss of 1.35 mm</td>
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</table>

* Flap

* Flapless

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Table 1. (continued)
Characteristics of Studies That Fulfilled Eligibility Criteria

<table>
<thead>
<tr>
<th>Reference and Study Group</th>
<th>Implants Placed (n)</th>
<th>Patients (n)</th>
<th>Mean Age in Years (range)</th>
<th>Females (n)</th>
<th>Total Implants (n)</th>
<th>Implant Dimensions (width-length in mm)</th>
<th>Implant Surface</th>
<th>Loading Protocol</th>
<th>Follow-Up</th>
<th>Outcome</th>
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<tr>
<td>Al-Juboori et al.¹⁴</td>
<td>10</td>
<td>7</td>
<td>22</td>
<td>4.1-4.8/10</td>
<td>Rough</td>
<td>Unloaded</td>
<td>≤12 weeks</td>
<td>No significant difference seen in CBL between groups</td>
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<tr>
<td></td>
<td>Flap</td>
<td>11</td>
<td>NA (27 to 62)</td>
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<tr>
<td></td>
<td>Flapless</td>
<td>11</td>
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<td>Katsoulis et al.¹⁵</td>
<td>40</td>
<td>61 (47 to 78)</td>
<td>16</td>
<td>195</td>
<td>3.5-4.3/10-13</td>
<td>NA</td>
<td>Unloaded</td>
<td>≤36 months</td>
<td>Both FG and FLG showed mean bone loss of 1.5 mm</td>
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<td></td>
<td>Flap</td>
<td>110</td>
<td>23</td>
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<td></td>
<td>Flapless</td>
<td>85</td>
<td>17</td>
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<tr>
<td>Van de Velde et al.¹⁶</td>
<td>14</td>
<td>55.7 (39 to 75)</td>
<td>10</td>
<td>70</td>
<td>4.1-48/8-12</td>
<td>Rough</td>
<td>≤18 months</td>
<td>Both FG and FLG showed mean bone loss of 1.9 mm</td>
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<td></td>
<td>Flap</td>
<td>34</td>
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<tr>
<td></td>
<td>Flapless</td>
<td>36</td>
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<tr>
<td>Maló and Nobre ¹⁷</td>
<td>41</td>
<td>45.5 (19 to 79)</td>
<td>22</td>
<td>72</td>
<td>4.0/10-15</td>
<td>Rough</td>
<td>Immediate</td>
<td>12 months</td>
<td>FLG showed more marginal bone loss than FG</td>
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<tr>
<td></td>
<td>Flap</td>
<td>40</td>
<td></td>
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<tr>
<td></td>
<td>Flapless</td>
<td>32</td>
<td></td>
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<tr>
<td>Bashutski et al.¹⁸</td>
<td>24</td>
<td>14</td>
<td>24</td>
<td>3.5-4/NA</td>
<td>Rough</td>
<td>Conventional</td>
<td>15 months</td>
<td>FLG showed significantly less CBL than FG</td>
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<tr>
<td></td>
<td>Flap</td>
<td>12</td>
<td>52.8 (27 to 78)</td>
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</table>

NA = not available; FG = flap group; FLG = flapless group.  
* Number of implants assessed in the group was not reported.
depth of implant placement, and occlusal loading independent of the surgical technique used (flapped or flapless). Also, in four studies, it was unclear whether the soft tissue biotype before implant placement was investigated.

A limitation of the studies included in the present review is that all study participants were presumably healthy individuals. It is well known that periodontal inflammatory conditions are worse in immunocompromised patients (such as patients with poorly controlled diabetes and prediabetes) and elderly patients compared with systemically healthy and younger individuals. It may therefore be speculated that the outcomes of implant surgical procedures (regardless of the technique used) are compromised in immunosuppressed and elderly individuals compared with systemically healthy counterparts. However, further studies are needed in this regard.

CONCLUSION

Within the limits of the present systematic review, CBL around dental implants placed in healed sites using flapped and flapless techniques is comparable.

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