Osseointegrated dental implants have become the standard of care for tooth replacement in selected cases (1). In fact, the survival rates of implant-supported single and multiple tooth restorations are comparable to that of implant-supported prostheses in totally edentulous patients (2-5).

The goals of modern implant therapy entail more than just the successful osseointegration of the implant. The final result must also include a restoration with stable soft and hard tissue levels. Maintenance of soft tissue has been shown to depend on preservation of bone surrounding the implant (6).

In order to achieve this goal, each step of the treatment must be managed carefully. This requires knowledge of pre-surgical treatment planning, site development, implant positioning, soft tissue management, provisionalization, and prosthetic management (7-9).

New implant designs have appeared in the literature with claims that certain modifications may be helpful for maintaining crestal bone levels and consequently preserving normal soft tissue contours. Placement of a smaller diameter abutment on a large diameter implant platform (platform switching) has been proposed as an effective way to control circumferential bone loss around dental implants (10). By altering the horizontal position of the microgap, the horizontal bone loss after abutment connection may be reduced (11). Also, scalloped and one-piece implants represent other design changes that have been advocated for maintaining proximal osseous contour (12, 13).

The purpose of this review was to evaluate the literature from an evidence based point of view regarding implant design modifications for preserving crestal bone levels.

**INTRODUCTION**

When the scalloped implants were placed adjacent to existing natural dentition, the average bone level at placement and at 6, 12, and 18 months was -1.7, -3.5, -3.8, and -3.9mm, respectively, compared with -1.0, -3.6, -4.3, and -4.4mm respectively, when placed adjacent to other scalloped implants. However, mean crestal bone loss of conventional implants was reported to be 1.5 mm (Table 1). According to this review mean bone loss around one-piece implants was -1.2(±1.3) mm and mean bone loss around two-piece implants was -0.2(±0.8)mm (Table 2). The mean crestal bone loss of larger platform

**MATERIAL AND METHODS**

The research includes a review of 4681 articles from peer reviewed journals published in English from January 1986 to January 2008 and has been performed by using Medline at the Waldmann Library of the New York University College of Dentistry Kriser Dental Center. The keywords utilized are “dental implant” and “implant design”(3075), “implant design” and “bone resorption” (910), “implant design” and “alveolar bone loss” (515), “platform switching” (58), “scalloped implant” (22), and “one piece implant” and “bone resorption” (19). Criteria for inclusion were articles that combined implant design modifications and measurement of crestal bone changes. The specific implant design features included those that discussed scalloped implant, one versus two piece implants, and unequal diameters of abutment and implant (platform switching).
implants with smaller diameter abutments was 0.76mm on the mesial aspect and 0.77mm on the distal aspect. The mean crestal bone loss of implants with equal diameter abutments was 2.53mm on the mesial aspect and 2.56mm on the distal aspect (Table 3).

One-piece implant systems (OPIs) were designed to minimize crestal bone loss based on the theory that contamination of the implant–abutment junction (the microgap) and violation of the biological width are the causes for the initial bone loss (Fig 3-4) (13). Ostman et al concluded that a one-piece implant(Nobel Direct) and a scalloped one-piece implant (Nobel Perfect) showed lower success rates and more bone resorption than two-piece implant systems after 1 year in function. One feature of both of these designed implants was the use of a moderately rough, oxidized surface as the part of the implant that faced the soft tissues, which, according to the manufacturer, was believed to result in ‘soft tissue integration’ and better long-term aesthetics (Table 2) (26). A pilot histological study on the general perception demonstrated that endothelial cells and fibroblasts prefer smooth surfaces (27). Although surface roughness may have a positive effect on the submucosal tissue response, any soft tissue retraction and exposure of the rough surface to the oral cavity, as seen in the present study, will facilitate plaque accumulation, which in turn may lead to soft and bony tissue pathology (28).

Another attempt to preserve crestal bone involved the concept of platform switching. Lazzara et al suggested that platform switching would alter the inflammatory cells pathway, shifting it inward and away from the adjacent crestal bone thereby limiting the bone resorption around the implant (Fig 5-9)(11). A recent study by Vela-Nebot et al evaluated the implant platform modification, shifting the implant-abutment interface medially to minimize invasion of the biological width. The study assessed 30 control cases and 30 study cases using platform-modification technique. Proximal bone resorption on the medial and distal aspects of each implant was assessed using digital radiography at 1, 4, and 6 months. The mean value of bone resorption observed in the mesial measurement for the control group was 1.5mm (T able 1) (24-25).

The Effect of Implant Design on Crestal Bone Levels


discussion

Table and durable integration of implants has long been advocated as the goal in dental implant treatment. Successful endosseous implant therapy requires osseointegration and preservation of crestal bone. The amount of crestal bone loss around an implant may be affected by such factors as biologic width, the effect of the microgap on biologic width, proximity of implant to an adjacent tooth or implant, and quality of the alveolar mucosa (15, 19, 20). Many technical advancements in implant design have been introduced. A better understanding of bone behavior and cellular activities has led to the invention of new designs. These changes include implant surface treatments, various interface connections, versatile unique implant sizes and shapes, and new implant-related prosthetic components (16). These newly introduced dental implant designs have led to a dramatic improvement in clinical outcomes of dental implant treatment from a functional standpoint. Thus, selection of the optimum implant design is now an integral part of treatment planning when considering crestal bone preservation following implant restoration (17).

Crestal bone levels are typically located approximately 1.5 to 2.0mm below the implant-abutment junction (IAJ) at 1 year following implant restoration (18). Additionally, Berglundh et al and Ericsson et al observed in histologic sections of crestal bone and soft tissue that crestal bone is always separated from the base of the abutment inflammatory cell infiltrate(aICT) by an approximately 1mm wide zone of healthy connective tissue (Fig 1-2)(19,20).

One proposed design modification was the scalloped implant which mimicked the cementoenamel junction on the mesial and distal aspects of the implant. The purpose of the scalloped design was to keep or create interdental bony peaks that could support the hard and soft tissue (12, 21, 22). Nowzari et al reported that this design exhibited no differences in crestal bone levels compared to conventional flat shoulder implants. In fact, bone loss around scalloped implants was notably greater than that compared to traditional implant placement (23). Aalam A et al and Rocci A et al reported that mean crestal bone loss around conventional implant was 1.5mm (Table 1) (24-25).
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to the control group (p<0.0005), thus showing a clinical advantage in the platform switching group (Table 3) (29).

The ability to reduce or eliminate crestal bone loss can result in major esthetic and clinical benefits. In that aspect, altering the horizontal position of the microgap or “platform switching” may be a more predictable alternative to control crestal bone levels when compared to other methods of bone maintenance such as one-piece implants or scalloped implants. However, “platform switching” is a technique that requires additional retrospective and long term studies because of limited scientific research.

**CONCLUSION**

**Table 1. Mean bone loss of scalloped implant**

<table>
<thead>
<tr>
<th></th>
<th>One-piece implants (n=104)</th>
<th>Two-piece implants (n=350)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean marginal bone loss [mm (SD)]</td>
<td>-1.2(±1.3)mm</td>
<td>-0.2(±0.8)mm</td>
</tr>
<tr>
<td>Bone loss of 25% best [mm (SD)]</td>
<td>-0.3(±0.5)mm</td>
<td>0.6(±0.2)mm</td>
</tr>
<tr>
<td>Bone loss of 25% worst [mm (SD)]</td>
<td>-3(±1)mm</td>
<td>-1.5(±0.3)mm</td>
</tr>
<tr>
<td>Bone loss ( &gt;2mm )</td>
<td>25%</td>
<td>4.60%</td>
</tr>
<tr>
<td>Bone loss ( &gt;3mm )</td>
<td>7.70%</td>
<td>1.10%</td>
</tr>
</tbody>
</table>

**Table 2. One-piece implant vs Two-piece implant**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum (mm)</th>
<th>Maximum (mm)</th>
<th>Mean (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified plarform mesial</td>
<td>30</td>
<td>0.4</td>
<td>1.2</td>
<td>0.76</td>
</tr>
<tr>
<td>Modified plarform distal</td>
<td>30</td>
<td>0.3</td>
<td>1.3</td>
<td>0.77</td>
</tr>
<tr>
<td>Nonmodified plarform mesial</td>
<td>30</td>
<td>2.1</td>
<td>3.1</td>
<td>2.53</td>
</tr>
<tr>
<td>Nonmodified plarform distal</td>
<td>30</td>
<td>2.2</td>
<td>2.9</td>
<td>2.56</td>
</tr>
</tbody>
</table>

**Table 3. Platform switching vs Non-platform switching**
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REFERENCES