Marginal bone loss seems to be unavoidable after implant placement. This is especially true after abutments are connected. It has been suggested that a successful implant might lose an average of 1.5 mm of bone during the first year in function and less than 0.2 mm annually in subsequent years. The causes of marginal bone loss are complex, with a combination of mechanical and biologic factors contributing to crestal bone loss. The microgap at the junction of an implant platform and the abutment has been suggested as a contributor. This microgap provides bacteria with an open channel to penetrate into the implant system, leading to inflammation, migration and reestablishment of the biologic width apically, and subsequent bone loss. In vitro studies have confirmed that microbial leakage occurs through the microgap, and the degree of leakage is dependent on the type of implant-abutment connection, the gap size, and the amount of micromovement. This concept was further validated when an inflammatory infiltration zone was identified at the abutment-implant junction. In addition, a band of inflammation-free connective tissue, which was considered a part of the biologic width, was found immediately apical to the inflammatory infiltration zone. Hence, it was further suggested that marginal bone resorption occurred to allow for the reestablishment of the biologic width. This association between the microgap and peri-implant inflammation and bone loss was further confirmed in another animal study. Over the years, attempts have been made to prevent or reduce marginal bone loss through modification of the implant-abutment connection. The concept of platform switching (PS) was introduced by Lazzara and Porter when minimal vertical bone loss was noticed radiographically around implants with mismatched abutments.
abutments (ie, the abutments had a smaller diameter than their respective implant platforms). The reason for this phenomenon is not fully understood, but various biologic and mechanical theories have been proposed.\textsuperscript{15,16} It was suggested that the inward positioning of the implant-abutment interface allowed the biologic width to be established horizontally, since an additional horizontal surface area was created for soft tissue attachment. This meant that less vertical bone resorption was required to compensate for the biologic seal. Furthermore, this design might increase the distance between the inflammatory cell infiltrate at the microgap and the crestal bone, thereby minimizing the effect of inflammation on marginal bone remodeling.\textsuperscript{15,16} Another theory, supported by finite element analyses, suggested that this design reduced the stress at the bone-implant interface and in the crestal region of cortical bone by shifting the stress to cancellous bone during loading.\textsuperscript{17–19}

Preclinical as well as uncontrolled human studies have suggested that PS preserves bone.\textsuperscript{16,20–22} In animal studies,\textsuperscript{20,21} implants restored with abutments of mismatched diameters showed minimal histologic and radiographic bone loss. Histologic examination of implants retrieved from patients revealed minimal bone loss as well as reduced dimensions of inflammatory cell infiltrate, which showed a limited apical extension beyond the platform.\textsuperscript{16,22} Recently, some clinical trials have been conducted to investigate the effect of PS on stabilizing marginal bone and papilla height; however, the results have been controversial and inconclusive. The aim of this systematic review was to critically evaluate the effectiveness of platform switching on preserving implant marginal bone.

**MATERIALS AND METHODS**

The PubMed and MEDLINE databases were searched by one examiner (MA) for relevant English-language articles published prior to June 30th, 2010, to answer the following question: Does platform switching preserve peri-implant marginal bone? The following combinations of key words were used: platform switch, platform switching, mismatched abutment, implant-abutment junction, crestal bone, crestal bone loss, crestal bone preservation, marginal bone preservation, marginal bone loss, marginal bone changes, bone loss, dental implants, and implant design. Additionally, a hand search was carried out in several dental journals, including Clinical Oral Implants Research, Implant Dentistry, The International Journal of Oral & Maxillofacial Implants, The International Journal of Periodontics and Restorative Dentistry, Journal of Clinical Periodontology, Journal of Oral and Maxillofacial Surgery, and Journal of Periodontology. Furthermore, a search of the reference lists of included papers was conducted for publications that had not already been identified electronically.

To be included, studies had to be randomized clinical trials (RCTs) or prospective human clinical trials with a clear aim of comparing marginal bone loss between PS and conventionally restored implants, along with a minimum sample size of 10 subjects and 10 implants with at least 1 year of function. Animal studies and finite element analyses were excluded. Human studies with a retrospective design, insufficient sample size, less than 1 year of functional loading, or without an appropriate control group were also excluded.

The searched articles were screened independently by two examiners (MA and HC). After the screening process was complete, the included articles from both examiners were compared and a final decision regarding inclusion was reached by discussion. Interexaminer agreement was assessed using kappa statistics programmed by commercial software (SPSS, IBM).

**Quality Assessment**

The quality of all included RCTs was evaluated with a checklist derived from Montenegro et al.\textsuperscript{23} Definitions of the examined criteria were as follows.

- **Randomization:** Randomization was deemed adequate if generated by a random number table, tossed coin, or shuffled cards. This was designated as unclear if randomization was mentioned in the article but the method was neither reported nor sufficiently explained. **Inadequate** randomization methods included alternate assignment, chart numbers, or odd/even birth dates.
- **Allocation concealment methods:** Adequate refers to central randomization with sequentially numbered or opaque envelopes. **Unclear** was assigned if the study referred to allocation concealment but the method was not reported or was insufficiently reported. **Inadequate** concealment involved unconcealed randomization methods, such as alternate assignment, chart number or odd/even birth date.
- **Masking:** Masking of subjects, providers, and examiners was considered independently. These were recorded as adequate, inadequate, unclear, or, for examiner masking, not applicable if the study design precluded the possibility of masking.
- **Withdrawals and dropouts:** These were assessed by analysis of whether all patients who entered the trial were properly accounted for at the end of the study and, if dropouts occurred, whether the analyses to allow for losses (eg, intention to treat) were noted.
RESULTS

Search Results
The initial screening carried out using the key words yielded 824 and 1,007 articles in the PubMed and MEDLINE databases, respectively. After initial evaluation of their titles and abstracts, the full text of 21 articles was further reviewed\(^24–44\), of these articles, nine articles (six RCTs and three controlled prospective studies) were selected for this systematic review. Interexaminer agreement in selecting the articles was 0.91. The study designs, implant placement techniques, and primary outcomes are summarized in Table 1.\(^{24–32}\) Articles that were excluded after the full text review and the reasons for their exclusion are listed in Table 2.\(^{33–44}\)

This review targeted RCTs and prospective clinical studies that compared the effectiveness of PS implants to conventionally restored (ie, non–platform-switched [NPS]) implants on preserving marginal bone around implants with at least 1 year of functional loading. Because of great heterogeneity among the included publications in terms of platform surface (microthreads or smooth surface), surgical protocols (submerged or nonsubmerged, crestal or subcrestal placement), and loading protocols (immediate or delayed), it was not possible to perform a meta-analysis. Instead, the primary outcomes of the selected articles will be described and compared narratively.

<table>
<thead>
<tr>
<th>Study</th>
<th>Study design</th>
<th>No. of implants (PS/NPS)</th>
<th>Smooth collar?</th>
<th>Microthreads?</th>
<th>Submerged?</th>
<th>Placement level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canullo et al(^25)</td>
<td>RCT</td>
<td>11/11</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Crestal</td>
</tr>
<tr>
<td>Canullo et al(^24)</td>
<td>RCT</td>
<td>17,15, 18/19</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Crestal</td>
</tr>
<tr>
<td>Cappiello et al(^26)</td>
<td>Prospective</td>
<td>73/55</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Subcrestal</td>
</tr>
<tr>
<td>Crespi et al(^27)</td>
<td>RCT</td>
<td>30/34</td>
<td>N (PS), Y (NPS)</td>
<td>N</td>
<td>N</td>
<td>Subcrestal</td>
</tr>
<tr>
<td>Fickl et al(^28)</td>
<td>Prospective</td>
<td>75/14</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Subcrestal (PS), crestal (NPS)</td>
</tr>
<tr>
<td>Kielbassa et al(^29)</td>
<td>RCT</td>
<td>117, 82/126</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Crestal</td>
</tr>
<tr>
<td>Prosper et al(^30)*</td>
<td>RCT</td>
<td>60/60</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Crestal</td>
</tr>
<tr>
<td>Prosper et al(^30)*</td>
<td>RCT</td>
<td>60/60</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Supracrestal</td>
</tr>
<tr>
<td>Trammell et al(^31)</td>
<td>RCT</td>
<td>25</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Crestal</td>
</tr>
<tr>
<td>Vigolo and Givani(^32)</td>
<td>Prospective</td>
<td>97/85</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Crestal</td>
</tr>
</tbody>
</table>

RCT = randomized clinical trial; PS = platform switched; NPS = not platform switched; Max = maxilla; Mand = mandible.

*Both of the two other groups had PS design and could not be compared with each other. As a result, both groups were excluded for comparison.

Publications Showing a Positive Effect
In their preliminary report, Canullo et al\(^25\) included 11 PS and 11 NPS implants (Global Implants, Sweden and Martina), all of which were immediately placed and restored in the maxilla. Significantly less bone resorption was seen around PS implants (0.3 mm) compared to NPS implants (1.19 mm) after an average of 25 months. Subsequently, Canullo et al\(^24\) compared PS and NPS implants using a two-stage approach in the posterior maxilla. Sixty-nine implants were divided into four groups: one NPS group (n = 19, platform diameter of 3.8 mm) and three PS groups (n = 17, 15, and 18 with platform diameters of 4.3, 4.8, and 5.5 mm, respectively). The implants were connected to 3.8-mm-diameter abutments and restored after 3 months. The amount of marginal bone loss was significantly smaller in the PS groups (0.99 ± 0.42 mm, 0.87± 0.43 mm, and 0.64 ± 0.32 mm, respectively) than in the NPS group (1.48 ± 0.42 mm) after 30 months of functional loading. In addition, marginal bone loss was inversely correlated with the amount of platform-abutment mismatch (r = −0.63).
Cappiello et al used a single-stage approach to place implants with PS (n = 73; Osseotite Certain, BIOMET 3i) and NPS (n = 55; Osseotite Certain, BIOMET 3i) subcrestally in 45 patients. After 1 year, the mean peri-implant bone loss was significantly less for the PS group (0.95 ± 0.32 mm versus 1.67 ± 0.37 mm for the NPS group).

Prosper et al investigated two types of implants: platform-enlarged and cylindric (control) implants (BioActive Covering SLA, Winsix). Each was placed with one of three surgical procedures: nonsubmerged, submerged, or submerged with a reduced abutment. After 2 years, control implants with an abutment of the same size as the platform exhibited significantly more bone loss.

### Table 1  Study Designs, Implant Surface Characteristics, and Placement Protocols of Selected Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Restoration protocol</th>
<th>Placement protocol</th>
<th>Arch</th>
<th>Marginal bone loss (mean ± SD) (mm)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canullo et al^25^</td>
<td>RCT</td>
<td>Y</td>
<td>Y</td>
<td>Max</td>
<td>25 mo: 0.3 ± 0.16/1.19 ± 0.38</td>
<td>P &lt; .05 (favored PS)</td>
</tr>
<tr>
<td>Canullo et al^24^</td>
<td>RCT</td>
<td>Y</td>
<td>Y</td>
<td>Max</td>
<td>33 mo: 0.99 ± 0.22/1.49 ± 0.54</td>
<td>P &lt; .005 (favored PS)</td>
</tr>
<tr>
<td>Cappiello et al^26^</td>
<td>Prospective</td>
<td>N</td>
<td>N</td>
<td>Subcrestal</td>
<td>12 mo: 0.95 ± 0.32/1.67 ± 0.37</td>
<td>P = .001 (favored PS)</td>
</tr>
<tr>
<td>Crespi et al^27^</td>
<td>RCT</td>
<td>N</td>
<td>N</td>
<td>Subcrestal</td>
<td>12 mo: 0.78 ± 0.49/0.82 ± 0.4</td>
<td>P &gt; .05</td>
</tr>
<tr>
<td>Fickl et al^28^</td>
<td>Prospective</td>
<td>N</td>
<td>Y</td>
<td>Subcrestal</td>
<td>12 mo: 0.39 ± 0.07/1.00 ± 0.22</td>
<td>P &lt; .01 (favored PS)</td>
</tr>
<tr>
<td>Kielbassa et al^29^</td>
<td>RCT</td>
<td>N</td>
<td>Y</td>
<td>Crestal</td>
<td>12 mo: 0.95 ± 1.37, 0.64 ± 0.97/0.63 ± 1.18</td>
<td>P = .589</td>
</tr>
<tr>
<td>Prosper et al^30^*</td>
<td>RCT</td>
<td>Y</td>
<td>N</td>
<td>Max</td>
<td>1 y: 0/0.272 ± 0.367 2 y: 0/0.275 ± 0.467</td>
<td>1 y, 2 y: P = .0006 (favored PS)</td>
</tr>
<tr>
<td>Prosper et al^30^*</td>
<td>RCT</td>
<td>Y</td>
<td>N</td>
<td>Supracrestal</td>
<td>1 y: 0.021 ± 0.11/0.101 ± 0.274 2 y: 0.055 ± 0.234/0.193 ± 0.474</td>
<td>1 y: P = .018 2 y: P = .0006 (favored PS)</td>
</tr>
<tr>
<td>Trammell et al^31^</td>
<td>RCT</td>
<td>N</td>
<td>N</td>
<td>Crestal</td>
<td>12 mo: 0.6 ± 0.2/0.9 ± 0.3 60 mo: 0.6 ± 0.2/1.1 ± 0.3</td>
<td>1 y: P &lt; .05 (favored PS)</td>
</tr>
</tbody>
</table>

**Table 2  Excluded Studies and Reasons for Exclusion**

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Reason(s) for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilhan et al^33^</td>
<td>2010</td>
<td>Retrospective study</td>
</tr>
<tr>
<td>Calvo-Guirado et al^34^</td>
<td>2007</td>
<td>Insufficient follow-up period (6 mo), no control group</td>
</tr>
<tr>
<td>Calvo-Guirado et al^35^</td>
<td>2008</td>
<td>No control group</td>
</tr>
<tr>
<td>Calvo-Guirado et al^36^</td>
<td>2009</td>
<td>No control group</td>
</tr>
<tr>
<td>Canullo and Rasperini^37^</td>
<td>2007</td>
<td>No control group</td>
</tr>
<tr>
<td>Cocchetto et al^38^</td>
<td>2010</td>
<td>No control group</td>
</tr>
<tr>
<td>Donovan et al^39^</td>
<td>2010</td>
<td>No control group</td>
</tr>
<tr>
<td>Hurzeler et al^40^</td>
<td>2007</td>
<td>Insufficient sample size (eight implants in the control group)</td>
</tr>
<tr>
<td>Linkevicius et al^41^</td>
<td>2010</td>
<td>Insufficient sample size (six implants in test group, six implants in control group)</td>
</tr>
<tr>
<td>Romanos and Nentwig^42^</td>
<td>2009</td>
<td>No control group</td>
</tr>
<tr>
<td>Vela-Nebot et al^43^</td>
<td>2006</td>
<td>Insufficient follow-up period (6 mo)</td>
</tr>
<tr>
<td>Wagenberg and Froum^44^</td>
<td>2010</td>
<td>No control group</td>
</tr>
</tbody>
</table>

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loss compared to their platform-enlarged counterparts ($P < .001$) or control implants with a reduced abutment ($P < .001$).

Fickl and coworkers$^{28}$ observed significantly less bone loss ($0.39 \pm 0.07 \text{ mm}$) in a PS group ($n = 75$; wide-diameter Osseotite Certain, BIOMET 3i) compared to an NPS group ($n = 14$; Osseotite Certain, BIOMET 3i) ($1.00 \pm 0.22 \text{ mm}$) ($P < .01$).

In another study,$^{31}$ a total of 25 implants were divided into two groups—PS (Osseotite Certain NTXP, BIOMET 3i) and NPS (Osseotite Certain, BIOMET 3i)—and placed in 10 patients. Less bone loss was detected in the PS group ($0.99 \pm 0.53 \text{ mm}$) than in the NPS group ($1.19 \pm 0.58 \text{ mm}$) at the 2-year follow-up.

The study$^{32}$ of Vigolo and Givani had the longest follow-up period (5 years). Wide-neck, external-hexagon implants (Osseotite, Parallel Walled, BIOMET 3i) were restored with ($n = 97$) or without ($n = 85$) PS. At 1 year, PS implants had significantly less bone loss ($0.6 \pm 0.2 \text{ mm}$) than NPS implants ($0.9 \pm 0.3 \text{ mm}$). At 5 years, the mean bone loss values were $0.6 \text{ mm and}$ $1.1 \text{ mm}$ for PS and NPS implants, respectively.

**Publications Showing No Positive Effect**

Crespi et al$^{27}$ investigated marginal bone loss around 30 PS implants (Ankylos Plus, Dentsply-Friadent) and 34 NPS implants (Sweden and Martina) that were placed 1 mm below the crestal bone in fresh extraction sockets and loaded immediately. Mean bone loss values at 2 years were $0.73 \pm 0.52 \text{ mm}$ and $0.78 \pm 0.45 \text{ mm}$ in the PS and NPS groups, respectively ($P > .05$). However, care should be exercised when interpreting these results, because the abutment-platform connections (Morse cone connection in PS implants and external-hexagon connection in NPS implants) and the implant macrostructure (rough-surface platform in PS implants and 0.8-mm smooth collar on the platform in NPS implants) were different in the two groups.

In a multicenter study,$^{29}$ 177 patients received one of three implant designs: NobelActive, NA Internal ($n = 117$), NA External ($n = 82$), or Nobel Replace Tapered ($n = 126$) (all Nobel Biocare); the first two types had PS. After 1 year of functional loading, the mean marginal bone loss values, which were not statistically significantly different ($P = .589$), were $0.95 \text{ mm,}$ $0.64 \text{ mm,}$ and $0.63 \text{ mm}$, respectively.

**Quality Assessment**

Quality assessment of the RCTs included in this systematic review is summarized in Table 3. Six articles were randomized trials,$^{24,25,27,29–31}$ of which four had clearly described methods for randomization and allocation concealment.$^{24,25,30,31}$ Most studies did not disclose whether examiners and/or subjects were masked.$^{24,25,27,29,31}$ In three studies, all subjects completed the experiment,$^{25,27,31}$ whereas the other three studies$^{24,29,30}$ had subject dropouts and any statistical methods accounting for the dropouts were not described.

**DISCUSSION**

This systematic review summarized current evidence regarding the effectiveness of PS on maintaining marginal bone around implants. All the selected studies assessed radiographic peri-implant marginal bone changes as their primary outcome. Of the nine articles chosen, seven concluded that PS was beneficial in reducing marginal bone loss around implants, and two studies did not find significant differences in PS as compared to NPS.

All nine selected publications enrolled subjects who were healthy and had adequate alveolar bone dimensions for implant placement and proper plaque control. However, the exclusion criteria varied among studies; these included the presence of dehiscence or

<table>
<thead>
<tr>
<th>References</th>
<th>Canullo et al$^{25}$</th>
<th>Canullo et al$^{24}$</th>
<th>Crespi et al$^{27}$</th>
<th>Kielbassa et al$^{29}$</th>
<th>Prosper et al$^{30}$</th>
<th>Trammell et al$^{31}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Described as randomized</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Randomization methods</td>
<td>Yes</td>
<td>Yes</td>
<td>Unclear</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Allocation concealment</td>
<td>Yes</td>
<td>Yes</td>
<td>Unclear</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Provider masked</td>
<td>Yes</td>
<td>N/A</td>
<td>No</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Examiner masked</td>
<td>Yes</td>
<td>Unclear</td>
<td>No</td>
<td>Unclear</td>
<td>Yes</td>
<td>Unclear</td>
</tr>
<tr>
<td>Subject masked</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Unclear</td>
<td>Yes</td>
<td>Unclear</td>
</tr>
<tr>
<td>All patients accounted</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Analysis accounted</td>
<td>N/A</td>
<td>No</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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fenestration\textsuperscript{25,27}; acute infection at the implant site\textsuperscript{24–27,31}; patients with a history of radiation therapy within the previous year,\textsuperscript{31} psychiatric disease,\textsuperscript{29} current lactation or pregnancy,\textsuperscript{24,25,31} uncontrolled periodontal disease,\textsuperscript{26,30} or uncontrolled diabetes\textsuperscript{24,25,29}; subjects who were alcoholics\textsuperscript{27,29,30} and/or heavy smokers (> 10 cigarettes/day)\textsuperscript{24,25,27,31}; and patients with a history of bisphosphonate therapy\textsuperscript{24} or parafuncional habits.\textsuperscript{27,29–31}

Standardized digital or conventional periapical radiographs were used to evaluate marginal bone loss in all included articles. The accuracy and reliability of these radiographic tools has been investigated. In a cadaver study, absolute and corrected radiographic measurements of mean bone level differences around implants taken from digital and conventional intraoral films were found to be within a range of 0.2 mm, thus indicating that standardized periapical radiographs were precise.\textsuperscript{45} The reliability, as determined by the standard deviation (SD) of the measurements, ranged between 0.2 and 0.4 mm.\textsuperscript{36–48} In other words, a minimal value of 0.5 mm, which is 2.5 times the SD, must be present to account for true differences rather than a random effect. In this regard, when interpreting the results of the included studies, the inherent measurement variability in periapical radiographs should be considered, especially in some of the selected articles,\textsuperscript{30–32} where a small positive effect in preserving marginal bone via PS was observed.

Factors that might have influenced the primary outcome include implant design, the level of implant placement (at/coronal to/apical to the crest), the timing of implant placement and restoration, the locations of the implants, the extent of PS, and the duration of the follow-up period. With respect to implant design, three of the selected articles\textsuperscript{24,25,29} used implants with microthreads. This might be a confounding factor, as some studies\textsuperscript{49–51} have shown that microthreads help to preserve peri-implant marginal bone. In addition, the location of the microthreads on the implant platform may have influenced the degree of marginal bone loss encountered. Song et al\textsuperscript{52} indicated that the closer the microthreads were to the top of the implant, the less marginal bone loss would occur. As a consequence, the presence of microthreads might mask the true effect of PS on marginal bone preservation.

Another factor influencing peri-implant bone loss is the level of placement in relation to the alveolar crest. In most of the selected articles,\textsuperscript{24,25,29–32} implants were placed at the level of the bone crest; however, in three studies,\textsuperscript{26–28} the implants were positioned subcrestally. In one article,\textsuperscript{28} the PS implants were placed subcrestally but the NPS implants were placed at the level of the crest. The depth of implant placement could have confounded this effect. Hammerle et al\textsuperscript{53} and Hartman et al\textsuperscript{54} investigated the effect of subcrestal implant placement on peri-implant tissue changes; both studies concluded that the deeper the implants were placed, the more bone loss would occur over time. Both groups used one-piece implants with a 2.8-mm smooth collar and coronal flare (Standard Implant, Institut Straumann). More bone loss has also been observed around deeply placed two-piece implants.\textsuperscript{55} Histomorphometric analysis of peri-implant tissues showed that subcrestal implant-abutment interfaces promoted a greater density of neutrophils than supracrestal interfaces, and the resulting inflammation might lead to more bone loss.\textsuperscript{56} Barros et al,\textsuperscript{57} on the other hand, found that subcrestally placed implants with rough surfaces at the implant collars yielded less marginal bone loss in an animal study. As such, the apicocoronal level of the implant platform should be taken into consideration when evaluating the efficacy of PS on the maintenance of marginal bone.

The placement and immediate restoration of implants, in certain clinical situations, have been proven to be safe and predictable.\textsuperscript{58,59} Two RCTs compared marginal bone loss after PS and NPS implants were placed and restored immediately.\textsuperscript{25,27} Interestingly, a positive effect of PS on preserving bone was found by one study\textsuperscript{25} but not the other.\textsuperscript{27} Whether PS exerts a positive effect on marginal bone loss around immediately placed and restored implants requires further research.

Implants were placed in both arches in most studies,\textsuperscript{27–30,32} whereas two studies\textsuperscript{24,25} included implants placed only in the maxilla and one study\textsuperscript{31} examined mandibular implants only. It was found that marginal bone loss was identical regardless of arch location.\textsuperscript{32} Therefore, PS had the same positive effect on marginal bone preservation in either arch.

The effect of PS on marginal bone level seemed to be “dose dependent.” Canullo et al\textsuperscript{24} demonstrated that the greatest platform-abutment mismatch resulted in the least marginal bone loss and concluded that the degree of PS might significantly influence peri-implant marginal bone remodeling.

The concept of PS evolved recently; as such, results of the selected studies with follow-up periods of 12 to 60 months can be regarded only as short-term findings. Vigolo et al\textsuperscript{32} reported the longest follow-up period (5 years), with a positive effect of PS on bone preservation after 1 year; at 5 years, the marginal bone change was insignificant compared to that seen at 1 year around both PS and NPS implants. These results suggest that under normal circumstances, the pattern of marginal bone loss associated with PS implants was identical to that of conventional implants, where the greatest amount of bone changes occurred between surgery and crown/abutment placement, after which the changes were minimal.
CONCLUSIONS

Nine articles were included in this systematic review, which investigated the effect of platform switching on marginal bone loss. A meta-analysis was not conducted because of the heterogeneity of study designs and implant characteristics in these studies. Seven articles demonstrated marginal bone preservation as a result of platform switching. Various factors, for example, the depth of implant placement, implant microstructure, the amount of platform switch, and the reliability of examination methods, might influence the interpretation of the research data. Platform switching appears to be a promising tool in preserving peri-implant bone, and more research to validate its application would be of substantial value.

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