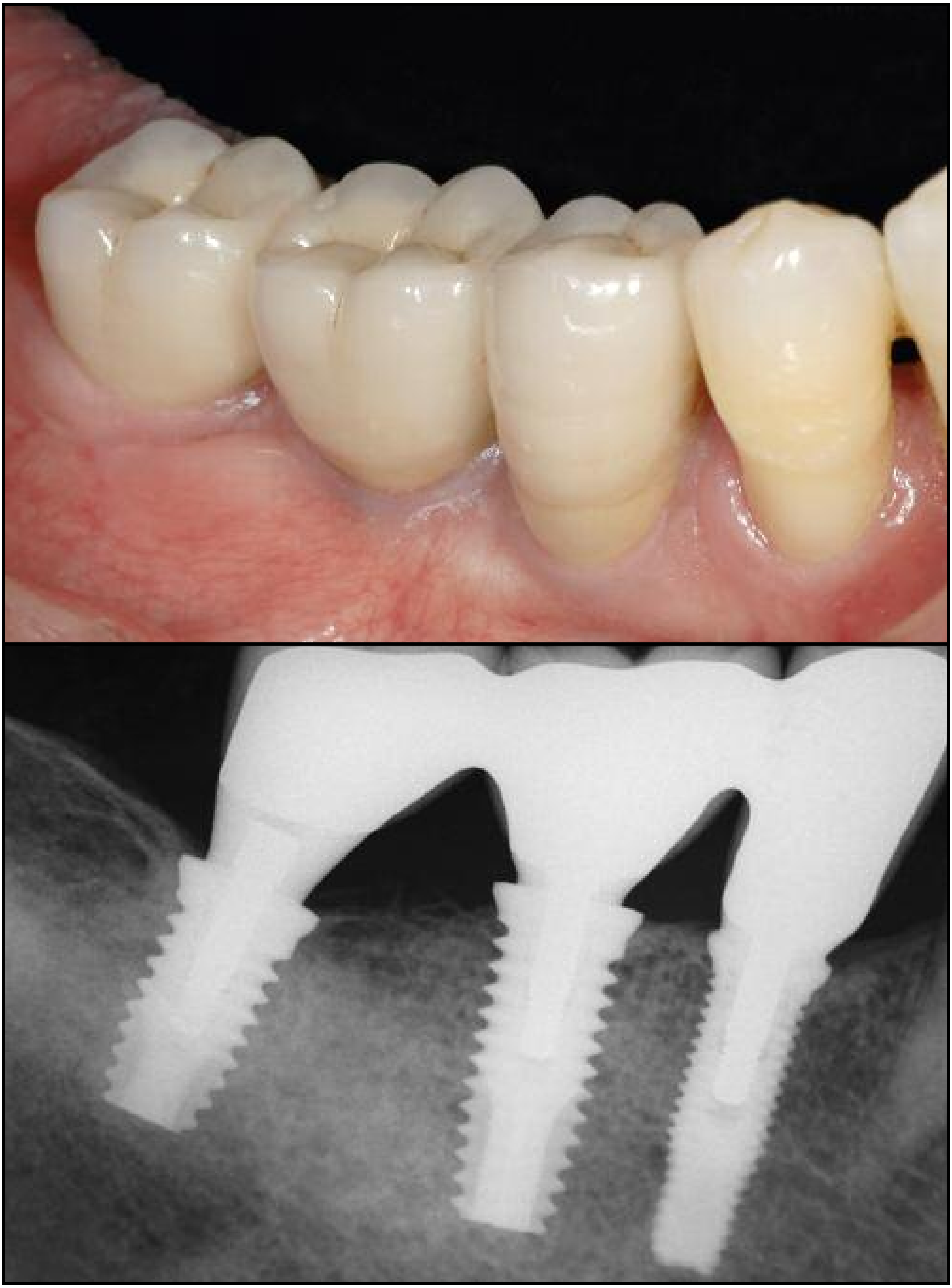
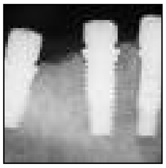


Evaluation of Hard Tissue Response Around Wider Platform–Switched Implants



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The use of a narrower-diameter abutment over a larger-diameter implant platform has been shown to decrease peri-implant bone resorption. This technique, known as platform switching, shifts the implant-abutment microgap inward. The aim of this study was to examine whether shifting the microgap further inward by increasing the discrepancy between the implant platform and abutment diameter would result in a decrease in crestal bone loss. Ten patients requiring mandibular or maxillary implant restorations were included in this study. The inclusion criteria called for an alveolar crest thickness of at least 8.0 mm at the implant placement site. Fifteen Certain PREVAIL implants with a body diameter of 5.0 mm, an expanded platform feature with a maximum diameter of 5.8 mm at the collar, and a prosthetic seating surface of 5.0 mm were used in lengths of 8.5, 10.0, 11.5, or 13.0 mm. The implants were connected to 4.1-mm healing abutments in a single-stage protocol. Periapical radiographs taken before and immediately after surgery, 8 weeks after implant placement, immediately after definitive prosthesis insertion, and at 12 and 18 months after loading revealed an average peri-implant bone loss of 0.30 mm. Increasing the discrepancy between the diameter of the implant platform and the restorative abutment may lead to a decrease in the amount of subsequent coronal bone loss. (Int J Periodontics Restorative Dent 2010;30:163–171.)

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One of the aspects of implant-bone interactions still not completely understood is bone remodeling, which begins at the implant prosthetic platform after abutment connection. Bone resorption is clinically relevant because it is often followed by soft tissue recession, which may compromise the long-term esthetic results of some anterior restorations and reduce the biomechanical bone support in posterior restorations. The amount of crestal bone loss has been used for many years as a criterion for defining implant success.[1]

When the prosthetic platform of a two-piece implant system is placed at the crest level, it has been widely reported that, after prosthetic loading, the peri-implant crestal bone will resorb 1.5 to 2 mm apically from the implant-abutment junction (IAJ).[2] This crater-shaped circumferential defect is more pronounced if the implant platform is located below the bony crest.[3,4]

The etiology of this bone remodeling is unknown.[5] Several theories have attempted to explain it. Some researchers believe it may depend on the mechanical stresses transferred from the implant to the alveolar crest.[6,7] Radiographic observations of Brånemark implants showed that bone loss usually stopped at the implants' first thread. Pillar et al[6] stated that bone remodeling was related mostly to stress on the coronal part of the implant.

Other researchers attribute crestal bone remodeling to a localized inflammation of the peri-implant soft tissue.[8] Berglundh and Lindhe[9] studied peri-implant soft tissue dimensions in beagles and concluded that an adequate biologic mucosal barrier was necessary to protect the bone. This mucosal barrier consists of sulcular epithelium (1.5 to 2 mm) and connective tissue (1 to 2 mm) rich in collagen fibers but poor in cells.[9,10]

The classic two-stage implant surgical protocol typically involves the following sequence of events. During the first surgical step, the implant is placed below the crestal bone to submerge the implant head and cover screw. Primary closure for the soft tissue flap is then obtained. During the second surgical step, the implant head is exposed and a healing abutment is placed to encourage complete soft tissue maturation. Over the next 4 weeks, bone remodeling occurs as the biologic width is established.

If implants are placed with a single-stage surgical protocol, bone remodeling begins right after surgery because the IAJ is exposed immediately to the oral environment.

Hermann et al[11] and Todescan et al[8] stated that when the IAJ is placed more deeply in the bone, vertical bone loss increases. However, the final position of the crestal bone from the IAJ never exceeds 2 mm.

The phenomenon of peri-implant bone resorption has shown the importance of the microgap and its influence on the formation of the biologic width.[12] Hermann et al studied the bone reaction around implants positioned in three different ways: at the crest level, 1 to 1.5 mm below the crest, and 1 to 2 mm above the crest.[3,4] The results demonstrated that if the IAJ is positioned above the bone crest, the resorption of bone is significantly less than if it is positioned below the crest. Histologic analysis has shown inflammatory infiltrate around the IAJ.

Ericsson et al[13] explained how the microgap causes bone loss. The author carried out a histologic analysis in dogs implanted with two-component implant systems. Two different zones were identified in the peri-implant soft tissue. One zone could be seen around the IAJ and spread 1.1 mm apical to the mucosal edge and was infiltrated by many inflammatory cells. This infiltrated connective tissue (ICT) has been observed both in sites subjected to plaque control and in those where oral hygiene is poor, suggesting that ICT is not correlated to plaque in the peri-implant mucosa. A second zone of uninfiltrated connective tissue that acted as a buffer was positioned apical to the ICT and 0.8 mm above the bone.[10,13]

It has also been suggested that the craterlike bone loss around implants could be related to the bone microvasculature. In another study in dogs, Traini et al[14] reported the presence of many thick blood vessels inside the crestal bone around implants. This was interpreted as evidence of a high degree of metabolic activity. It was also postulated that during inflammation, the blood vessels in the bone are unable to completely swell as they do in soft tissue, producing increased vascular resistance and ischemic necrosis that results from occlusion of either the arterial supply or venous drainage.[14]

Jensen et al[15] demonstrated that there is always a microgap of about 10 µm between the abutment and the implant, irrespective of the implant system used. Moreover, all these microgap-related phenomena have been demonstrated in cases restored following the original Brånemark protocol, and in which the implant platform and prosthetic components have the same diameter. According to Ericsson et al[13] and Abrahamsson et al,[16] the ICT zone is usually located at or below the bony crest and triggers bone resorption.

In 1991, 3i Implant Innovations began producing wide-diameter (5- and 6-mm) implants with larger-diameter restorative platforms than standard implants (3.75 mm). For some time, however, corresponding prosthetic components were not available, and standard prosthetic abutments (4.1 mm diameter) were used instead of abutments that matched the 5- and 6-mm implant diameters.[17] The result was an unintentional "change of platform," which came to be known as *platform switching*.[17]

Long-term radiographic follow-up of these first platform-switched implants revealed less vertical bone loss than that observed around conventionally restored implants.[17] This result was attributed to the horizontal shift of the IAJ inward, a shift that distanced the ICT from the crestal bone. When 4.1-mm abutments were used on 5-mm implants, the circumferential lateralization of the ICT was 0.45 mm. When 4.1-mm abutments were used on 6-mm implants, the lateralization was 0.95 mm. The latter is referred to as *wide platform switching*.

In 2005, Biomet 3i introduced the PREVAIL implant. This implant has a full Osseotite (ie, dual acid-etched) surface, an extended platform measuring 4.8 mm, a 4.0-mm body, and an internal connection 4.1 mm in diameter. The transition from the extended part measuring 4.8 mm to the attachment platform measuring 4.1 mm is fabricated with a 16-degree chamfer approximately 0.35 mm long. This implant design is also available with a body of 5.0 mm, an expanded platform with a maximum diameter of 5.8 mm at the collar, and a prosthetic seating surface of 5.0 mm.

The lateralization of the ICT when using PREVAIL implants with a 4.8-mm platform (standard platform switching) is 0.35 mm. The lateralization is 0.85 mm when using implants with a maximum collar dimension of 5.8 mm (wide platform switching). If shifting the ICT inward and away from the bone reduces crestal bone loss, it seems reasonable to imagine that shifting the ICT further inward might decrease crestal bone loss even more. To the authors' knowledge, no systematic study has previously sought to verify whether such a correlation exists.

The aim of this study, therefore, was to examine the peri-implant crestal bone loss that results when using wide platform switching.

Method and materials

Ten consecutive patients requiring an implant-supported restoration in either the mandible or the maxilla and having a minimum alveolar crest thickness of 8 mm were included in this study. A buccolingual dimension at the implant site of at least 8 mm, as identified by a diagnostic computed tomography scan, also was required to allow for placement of an implant with a maximum collar diameter of 5.8 mm.

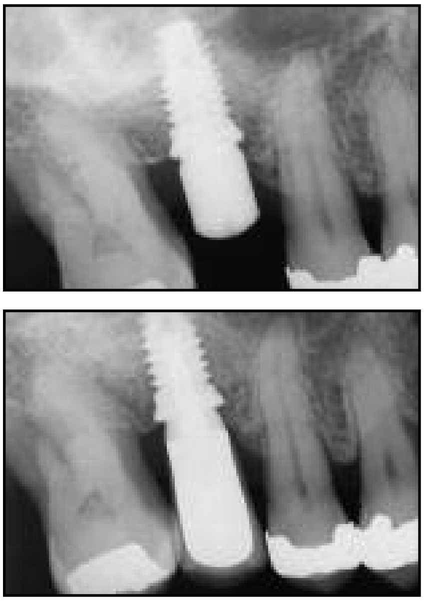
A single-stage protocol was used for each surgery. Following the manufacturer's recommendation, the implant sites were prepared to allow for subcrestal positioning of the prosthetic platform.

To ensure that all implants were positioned at exactly the same distance from the alveolar crest, a specially calibrated countersinking drill was used.

Five patients received two 5/6/5 Certain PREVAIL implants, while five received one 5/6/5 Certain PREVAIL implant. The 5/6/5 Certain PREVAIL design has a 5.0-mm body, an expanded platform feature with a maximum diameter of 5.8 mm at the collar, and a prosthetic seating surface of 5.0 mm. The entire surface is treated with dual acid etching (Osseotite). Implant lengths of 8.5, 10.0, 11.5, and 13.0 mm were used.

Several patients also received standard implants and PREVAIL 4/5/4 implants simultaneously, but for this study, only the PREVAIL 5/6/5 implants were evaluated.

After implant placement, 4.1-mm-diameter healing abutments were immediately secured to the 5/6/5 Certain PREVAIL implants using a



Figs 1a to 1d *Patient 1. Radiographs taken* (top left) *at the time of implant insertion,* (top right) *after 2 months of healing,* (bottom left) *12 months after loading, and* (bottom right) *18 months after loading.*

20-Ncm calibrated torque wrench. Surgical flaps were sutured around the abutments. Impressions were taken after an 8-week healing period. To promote soft tissue healing and avoid bone loss resulting from disconnection and reconnection of the abutment, a double abutment technique was used.[18] This technique involves duplicating the definitive titanium abutment in polyurethane resin. The definitive titanium abutment is then inserted in the implant, allowing the laboratory to use a perfect polyurethane resin copy for fabrication of the definitive prosthesis. In every case, the definitive porcelain-fused-to-metal restoration was delivered within 6 months of the initial surgery.

All patients were followed for at least 18 months after loading. To evaluate the peri-implant crestal bone levels, periapical radiographs were obtained prior to surgery, immediately following surgery, 8 weeks after implant placement, at the time of definitive prosthesis insertion, and at 12 and 18 months after loading.

To ensure standardization of the measurements, the same operator took all radiographs using a standard positioning device (Dentsply/Rinn). Furthermore, after the first radiograph was taken of each implant site, all subsequent radiographs were immediately compared to it to verify that the implant dimensions were exactly the same. Radiographs that showed any sign of deformation, darkness, or other problems were retaken.

All radiographs were converted to 640 × 480-pixel digital images using a calibrated video camera. The resorption was calculated using computer-aided design software (AutoCAD), according to the method used by Alomrani et al.[19]

Figures 1 and 2 illustrate the treatment of two patients.

Fig 2a *Patient 3. Three implants were inserted. The implants in the center and to the right were wide platform–switched, while the implant on the left was regular platform–switched.*

Fig 2b *Healing abutments were placed on the implants.*

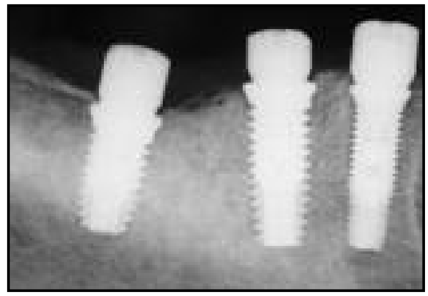
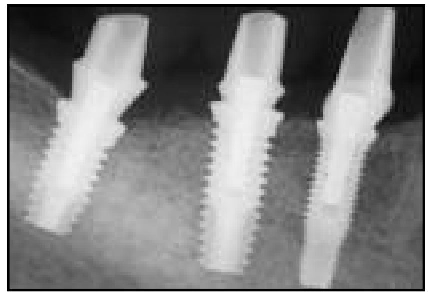
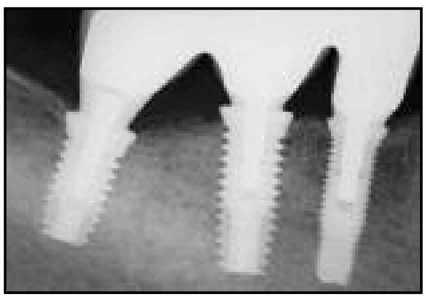


Fig 2c *Radiograph taken at the time of implant insertion.*

Fig 2d (left) *Prosthetic abutments in place.*

Fig 2e (right) *Radiograph taken 8 weeks postinsertion with provisional acrylic crowns.*





Figs 2f (left) **and 2g** (right) *Clinical and radiographic views at definitive prosthesis insertion.*

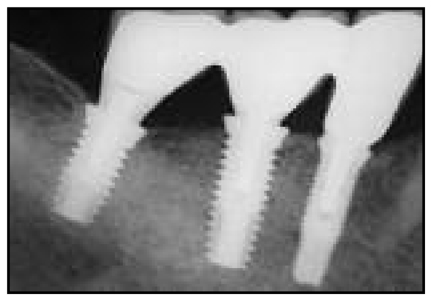


Fig 2h *Radiograph taken after 2 years of loading. Note the bone level stability.*

Results

All patients were followed for a minimum of 18 months. No implant failures were reported. All patients demonstrated an average amount of plaque control with no peri-implant inflammation.

The radiographic analysis revealed that peri-implant bone loss around the 15 wide-diameter implants ranged from 0.05 to 1.63 mm. The average peri-implant bone loss for 14 of the implants after 18 months of function was 0.20 mm. For 1 implant, bone loss at 6 months was 0.5 mm; it was 1.63 mm at 18 months (Table 1).

Table 1	Bone loss measured at 18 months
Implant no.	**Bone loss (mm)**
1	0.24
2	0.18
3	0.20
4	0.05
5	0.15
6	0.22
7	0.19
8	0.28
9	0.22
10	1.63
11	0.20
12	0.22
13	0.19
14	0.28
15	0.24

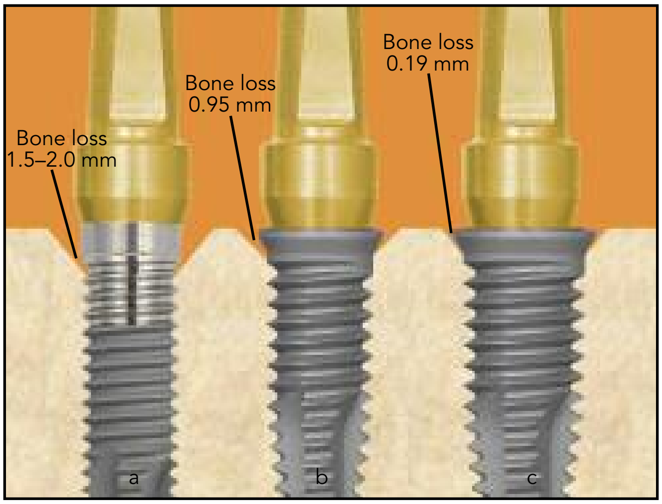


Fig 3 *Bone loss associated with three different implant-abutment geometries:* (a) *standard, non–platform-switched,* (b) *regular platform–switched, and* (c) *wide platform–switched.*

Discussion

For 14 of 15 implants, the results using the wide platform–switching technique show a high degree of bone preservation (0.19 mm bone loss). This compares with an average crestal bone loss of 0.95 mm found around implants for which a standard platform-switching technique was employed.[20] Average bone loss around standard, non–platform-switched implants has been widely reported as 1.5 to 2 mm (Fig 3).

In the case of implant 10 (the implant experiencing 1.63 mm of bone loss), the implant was inserted immediately after an extraction that was performed surgically implementing a mucoperiosteal flap reflection. The buccal plate was very thin (approximately 7 mm) and consisted entirely of cortical bone. This was an inadvertent violation of the study protocol and probably explains the significantly greater bone loss. Bone resorption in this situation was inevitable, but this amount of bone loss is acceptable by the standards put forth in the literature and the implant can still be considered a success. Moreover, when this patient's bone loss is averaged with that of the other patients, the overall average crestal bone loss is still only 0.30 mm—roughly one-third that of standard platform-switched implants and 17% to 22% that of standard, non–platform-switched implants.

Although placement of the implants crestally might have made it slightly easier to assess any subsequent bone loss, the manufacturer recommends placing the platform 1 mm below the crest, and this recommendation was followed.

Supracrestal positioning may reduce peri-implant bone resorption but it can also lead to esthetic problems with the restoration. While subcrestal placement can reduce such prosthetic problems, the bone resorption resulting from standard, non–platform-switched implants and abutments can change the profile of the soft tissue. However, subcrestal placement of the platform-switched implants minimizes both prosthetic problems and bone loss with its consequences for the soft tissue profile. The clinical relevance of this study's findings can be seen in different situations. In posterior quadrants, use of the PREVAIL implant with platform switching, and especially wide platform switching, offers several advantages. In situations where anatomical structures such as the mandibular nerve or maxillary sinus limit insertion of long implants, the use of shorter implants with wide diameters can minimize bone stress. Also, through use of the wide or regular platform switching, the original peri-implant crestal level can be maintained, improving the final biomechanical support for the implant and almost eliminating the bone loss commonly seen when using traditional prosthetic protocols.

In the anterior maxilla, oral implant rehabilitation represents a special challenge to the clinician. Even though the osseointegration of dental implants has been widely demonstrated, predictable esthetic results are not always achieved, especially when mplants are placed immediately after extraction.[21]

The success of placing implants immediately postextraction depends on several factors, including the dimensions of the residual vestibular plate, the ability to obtain primary stability, and the appropriateness of the implant placement. If the extraction has been carried out carefully and the implant has been properly positioned, with primary stability achieved, bone preservation becomes even more critical to maintaining the stability of the gingival buccal margin, which all too often tends to move apically. The use of wide platform switching can help to achieve the goal of maintaining the soft tissue profile. Use of a wide-diameter implant reduces the distance between implant and bone, promoting primary stability.

In the esthetic zone, when implants are placed close to each other and the interimplant bone height resorbs below the implant-abutment connection level, support for the interimplant papilla is reduced, affecting the clinical result. For this reason, placing two adjacent implants in the anterior maxilla is usually contraindicated.[22,23] However, using wide platform switching in the esthetic zone appears to promote a high degree of bone preservation.

Preservation of the residual bone height via wide platform switching was used for the rehabilitation of two central incisors in a study by Baumgarten et al.[24] The conclusion from that research was that wide platform switching helped to preserve crestal bone and ensure more predictable long-term soft tissue levels. Grunder et al[25] used the platform-switching technique in the esthetic zone to preserve the buccal cortical plate and reduce cervical cratering.

Although the results obtained in the present study are promising, use of platform switching on wide-diameter implants requires a crestal bone thickness of at least 8 mm, as well as adequate soft tissue.[26] Without these, there may be no esthetic or other advantage to using either regular or wide platform switching.

A histologic evaluation in experimental models is currently ongoing at the University G d'Annunzio, Chieti-Pescara, Italy, to further analyze the effects of wide platform switching in minimizing or preventing further bone loss in implant dentistry.

Conclusion

The aim of this study was to evaluate both clinically and radiographically the biologic effect of using a wide platform–switching restorative protocol in humans. The results of this preliminary study indicate that when properly selected, patients receiving wide platform–switched implants may experience less crestal bone loss than that resulting from the use of regular platform switching or traditional non–platform-switched approaches.

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