# PLATFORM SWITCHING AND BONE PLATFORM SWITCHING

*Francesco Carinci, MD; Giorgio Brunelli, MD; Matteo Danza, MD*

Bone platform switching involves an inward bone ring in the coronal part of the implant that is in continuity with the alveolar bone crest. Bone platform switching is obtained by using a dental fixture with a reverse conical neck. A retrospective study was performed to evaluate the effectiveness of conventional vs reverse conical neck implants. In the period between May 2004 and November 2007, 86 patients (55 females and 31 males; median age, 53 years) were operated and 234 implants were inserted: 40 and 194 were conventional vs reverse conical neck implants, respectively. Kaplan-Meier algorithm and Cox regression were used to detect those variables associated with the clinical outcome. No differences in survival and success rates were detected between conventional vs reverse conical neck implants alone or in combination with any of the studied variables. Although bone platform switching leads to several advantages, no statistical difference in alveolar crest resorption is detected in comparison with reverse conical neck implants. We suppose that the proximity of the implant abutment junction to the alveolar crestal bone gives no protection against the microflora contained in the micrograph. Additional studies on larger series and a combination of platform switching and bone platform switching could lead to improved clinical outcomes.

**Key Words: Kaplan-Meier algorithm, Cox regression analysis, dental implant, bone remodeling, alveolar crest**

## INTRODUCTION

In 2006, Lazzara and Porter introduced the concept of platform switching (ie, an inward metal ring in the coronal part of the implant that is in continuity with the alveolar bone crest). Platform switching is obtained by restoring the dental fixture with an abutment of smaller diameter.[1]

Preliminary radiologic studies demonstrated a smaller than expected vertical crestal bone loss around platform switching implants than around implants restored conventionally with prosthetic components of matching diameters. This was attributed to a greater distance between implant abutment junction and alveolar crestal bone, which leads to protection from the microflora contained in the micrograph.[1,2]

Additional studies demonstrated that mechanical stress in the crestal alveolar bone is greatly reduced in cases of platform switching,[3] and that a microrough titanium surface extending to the implant shoulder in conjunction with platform switching provides osseous integration along the entire length of the implant.[4]

The concept of platform switching can be applied successfully, together with immediate loading, as demonstrated in case series[5] and in histomorphometric evaluation in man.[6]

Starting from the platform switching idea, we elaborated the concept of bone platform switching. Bone platform switching involves an inward bone ring in the coronal part of the implant that is in continuity with the alveolar bone crest. Bone platform switching is obtained by using a dental fixture with a reverse conical neck (Figures 1 and 2). This type of implant produces increased residual crestal bone volume around the implant neck and carries several advantages: (1) reduced

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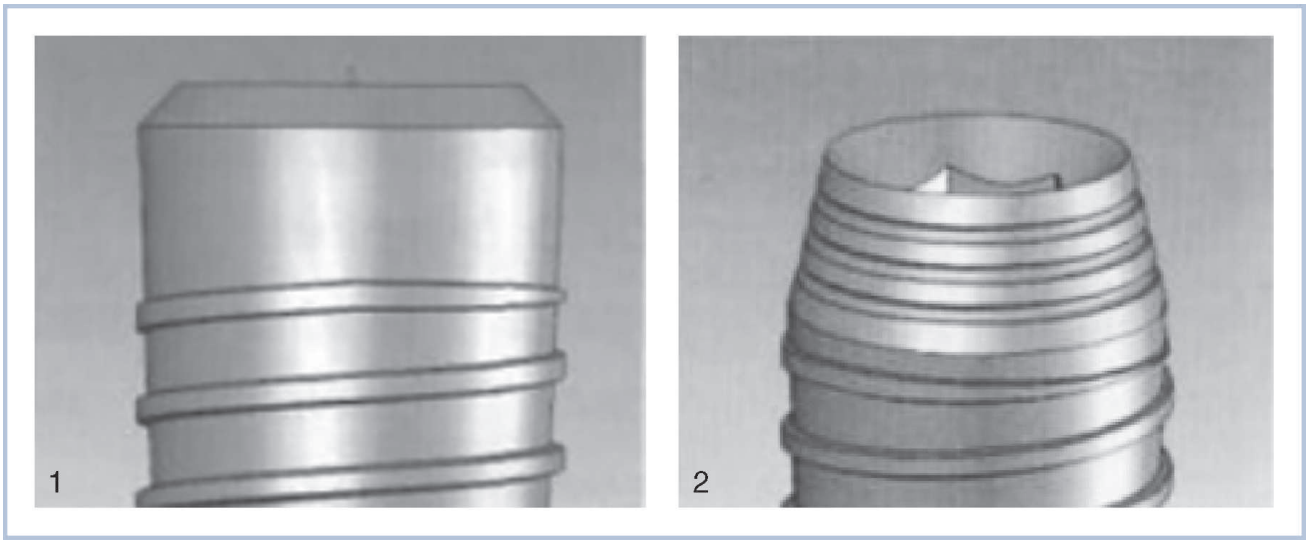



Figures 1–2. Figure 1. Standard implant neck. Figure 2. Reverse conical neck.

mechanical stress in the crestal alveolar bone area, (2) repositioning of gingival papillae on the bone ring (that is the physiologic condition), and (3) a proper vascular supply to hard and bone tissue, also in cases of reduced interimplant space. However, the distance between implant abutment junction and alveolar crestal bone is not increased, and thus no protective effect against the microflora contained in the micrograph can be expected.

To verify whether the concept of bone platform switching really provides some advantages vs reverse conical neck implants, a retrospective analysis is performed on a cases series of spiral family implants (SFIs). SFIs comprise the spiral implant (SPI) and the spiral flare bevel (SFB). They are identical in all parts except for the fact that the SFB has a reverse conical neck.

## Materials and Methods

### *Patients*

In the period between May 2004 and November 2007, 86 patients (55 females and 31 males) with a median age of 53 years were operated and 234 SFIs (3D Alpha Bio, Pescara, Italy) were inserted: 40 SPI and 194 SFB. The last check-up was performed in October 2008, with a mean follow-up of 13 months.

Subjects were screened according to standard inclusion criteria[7–9]: controlled oral hygiene and absence of any lesions in the oral cavity; in addition, patients had to agree to participate in a postoperative check-up program.

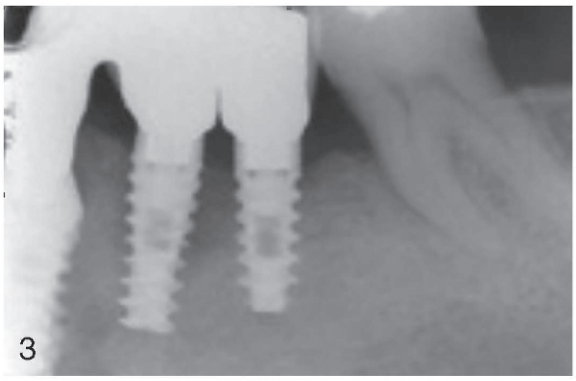
Exclusion criteria were as follows: bruxism; smoking more than 20 cigarettes/d; localized radiation therapy of the oral cavity; antitumor chemotherapy; liver, blood, and kidney diseases; immunosuppressed patients; patients taking corticosteroids; pregnant women; inflammatory and autoimmune diseases of the oral cavity; and poor oral hygiene.

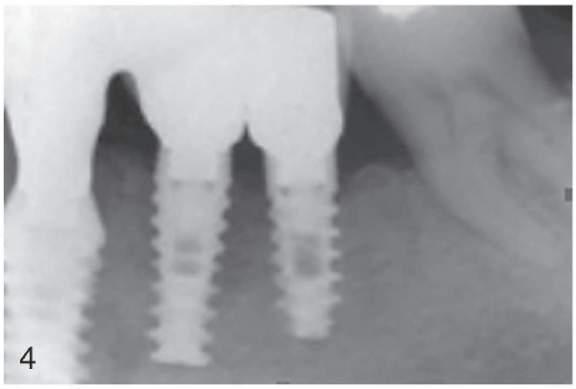
### *Data collection*

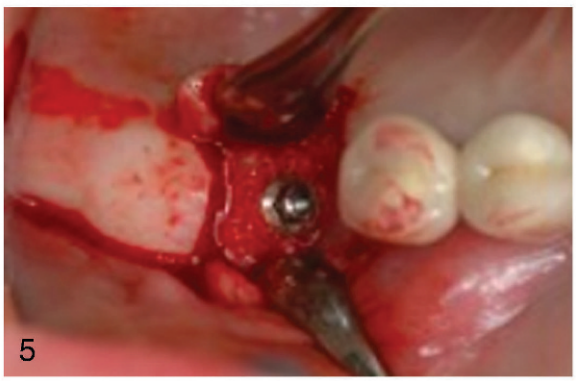
Before surgery and in the follow-up period, radiographic examinations were done (Figures 3 and 4). In each patient, peri-implant crestal bone levels were evaluated by calibrated examination of periapical X rays. Measurements were recorded after surgery and at the end of the follow-up period. These measurements were carried out mesially and distally to each implant; the distance between the coronal edge of the implant and the most coronal point of contact between the bone and the implant were calculated. The bone level recorded just after surgical insertion of the implant was the reference point for measurements, which were rounded off to the nearest 0.1 mm. A peak scale loupe with a magnifying factor of seven times and a scale graduated in 0.1 mm was used.

Peri-implant probing was not performed because controversy is ongoing regarding the correlation between probing depth and implant success rates.[10,11]

Implant success rates were evaluated according to the following criteria: (1) absence of persistent pain or dysesthesia, (2) absence of peri-implant infection with suppuration, (3) absence of mobility, and (4) absence of persistent peri-implant bone resorption greater




FIGURES 3–5. FIGURE 3. One spiral flare bevel and 2 spiral implants after the final prosthetic restoration. FIGURE 4. The control after 12 months. FIGURE 5. The bone platform is seen around the most cranial and narrow part of the reverse conical neck implant.

than 1.5 mm during the first year of loading and 0.2 mm/y during the follow-up years.[12]

### *Implants*

A total of 234 SFIs (40 SPIs and 194 SFBs) were inserted in 86 patients: 88 (37.6%) in the mandible and 146 (62.4%) in the maxilla. Implant diameter was 3.75 mm, 4.2 mm, 5.0 mm, and 6.0 mm in 24 (10.7%), 112 (49.9%), 65 (27.8%), and 33 (11.6%) SFIs, respectively. Implant length was less than 13 mm, 13 mm, and 16 mm in 94 (40.2%), 76 (32.5%), and 64 (27.3%) SFIs, respectively. Implants were inserted to replace 50 incisors (21.4%), 26 cuspids (11.1%), 91 premolars (38.9%), and 67 molars (28.6%). One hundred one fixtures were inserted in postextractive sockets and the remaining 133 in healed bone. Flapless surgical technique was used in 97 cases.

### *Surgical and prosthetic technique*

All patients underwent the same surgical protocol. An antimicrobial prophylaxis was administered with 500 mg amoxicillin twice daily for 5 days, starting 1 hour before surgery. Local anesthesia was induced by infiltration with articaine/epinephrine, and postsurgical analgesic treatment was performed with 100 mg nimesulid twice daily for 3 days. Oral hygiene instructions were provided.

After a crestal incision was made, a mucoperiosteal flap was elevated. In 97 cases, a mucotomy was performed. Implants were inserted according to the procedures recommended. The implant platform was positioned at the alveolar crest level. Sutures, if used, were removed 14 days after surgery. In cases of delayed loading, the provisional prosthesis was provided after 8 weeks from implant insertion, and in all cases, the final restoration usually was delivered within an additional 12 weeks. One hundred forty-eight implants were loaded immediately, whereas 86 patients underwent two-stage surgery. The number of prosthetic units (ie, implant/crown ratio) was about 0.8. Fifty-one patients were totally edentulous in the jaw receiving implants. The antagonists were natural teeth and prosthetic crowns in 115 and 119 cases, respectively. All patients were included in a strict hygiene recall.

### *Statistical analysis*

Because only 9 in 234 implants were lost (ie, survival rate = 96.2%) and no statistical differences were detected among the studied variables, no or reduced crestal bone resorption was considered an indicator of success rate when the effects of several host-, implant-, and occlusion-related factors were evaluated. To calculate the success rate, the nine failed implants were dropped out.

The difference between the implant abutment junction and the bone crestal level was defined as the abutment-bone level and was calculated at the time of operation and during follow-up. The delta abutment-bone level is the difference between the abutment-bone level at the last check-up and the abutment-bone level recorded just after the operation. Delta

TABLE 1

Distribution of 225 fixtures still in place at the end of the follow-up period*

| Implant Type | Implant Site | Implant Diameter | Implant Length | Post-extractive | Flapless | Immediate Loading | Prosthetic Type | NPU | Antagonist | Edentulism | Site |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SPI†, 36 (0.8) | Incisors, 48 (0.9) | 3.75, 22 (1.8) | <13, 89 (1.9) | No. 99 (1.0) | No. 93 (1.0) | No. 99 (1.0) | None 0 | ≤.5, 41 (1.1) | Natural teeth, 111 (1.0) | Total, 50 (1.2) | Maxilla, 139 (1.0) |
| SFB†, 189 (1.1) | Cuspids, 25 (0.9) | 4.2, 109 (1.8) | 13, 75 (1.9) | Yes, 126 (1.0) | Yes, 132 (1.0) | Yes, 126 (1.0) | Fixed prosthesis, 214 (1.0) | >.5, 184 (1.0) | Prosthesis, 114 (1.0) | Partial, 175 (1.0) | Mandible, 86 (1.1) |
| – | Premolars, 87 (1.2) | 5.0, 62 (1.8) | >13, 61 (1.4) | – | – | – | Removable dentures, 11 (1.4) | – | | | |
| – | Molars, 65 (1.0) | 6.0, 32 (1.7) | – | – | – | – | – | | | | |

*The number of cases is outside of parentheses, whereas the median delta abutment-bone level is within parentheses. NPU indicates number of prosthetic units; SFB, spiral flare bevel; and SPI, spiral implant.

abutment-bone level medians were stratified according to the variables of interest.

Disease-specific survival curves were calculated according to the product limit method (Kaplan-Meier algorithm).[13] Time zero was defined as the date of insertion of the implant. Implants that have no or ''standard'' bone resorption were included in the total number at risk of loss only up to the time of their last follow-up. Therefore, the success rate changed only when implant ''failure'' occurred. The calculated success rate was the maximum estimate of the true survival curve. Log-rank testing was used to compare success rate curves generated by stratifications for a variable of interest.

Cox regression analysis then was applied to determine the single contribution of covariates to the success rate. Cox regression analysis compares ''survival'' data while taking into account the statistical value of independent variables, such as age and sex, in terms of whether or not an event (eg, implant failure) is likely to occur. If the associated probability was less than 5% ($P < .05$), the difference was considered statistically significant. As part of the process of doing the regression analysis, odds ratio and 95% confidence bounds were calculated. Confidence bounds did not have to include the value «1».[14] Stepwise Cox analysis allowed us to detect the variables most associated with implant success.

## RESULTS

Because only 9 in 234 implants were lost (ie, survival rate = 96.2%), no statistical differences were detected among the studied variables by using survival rate. Table 1 reports the median delta abutment-bone level according to the studied variables calculated on 225 fixtures still in place at the end of the follow-up.

In univariate analysis (Table 2; Kaplan-Meier algorithm) and in multivariate analysis (Table 3; Cox regression), none of the studied variables has a statistical impact on the clinical outcome.

## DISCUSSION

Following exposure to the oral environment of two-piece dental implants and the connection with matching-diameter restorative components, some vertical repositioning of crestal bone and the subsequent soft tissue attachment to the implant usually is reported.[7–9]

Historically, two-piece dental implant systems have been restored with prosthetic components that locate the interface between the implant and the attached component element at the outer edge of the implant platform. In 2006, Lazzara and Porter introduced the concept of platform switching.[1] They reported that in 1991, Implant Innovations introduced wide-diameter implants with matching wide-diameter platforms. When introduced, however, matching-diameter pros-

TABLE 2

Kaplan-Meier logarithm output*

| Variable | Log-Rank | df | *P* Value |
|---|---|---|---|
| Imp type | 1.96 | 1 | .1617 |
| Imp length | .45 | 2 | .7984 |
| Imp diameter | 1.36 | 3 | .7147 |
| Imp site | 1.98 | 3 | .5771 |
| Postextractive | .38 | 1 | .5397 |
| Flapless | 1.68 | 1 | .1945 |
| Immediate loading | .14 | 1 | .7082 |
| Prosthesis | 1.48 | 1 | .2233 |
| NPU | 4.66 | 3 | .1984 |
| Antagonist | 2.78 | 1 | .0952 |
| Edentulism | .43 | 1 | .5140 |
| Mandible/maxilla | 2.53 | 1 | .1114 |

*df indicates degrees of freedom; Imp, implant; and NPU, number of prosthetic units.

TABLE 3
Cox regression output

| Variable | df* | *P* Value | Exp (B) | 95% CI for Exp (B) Lower | Upper |
|---|---|---|---|---|---|
| Age | 1 | .9154 | .9970 | .9436 | 1.0535 |
| Gender | 1 | .4140 | 1.7746 | .4481 | 7.0285 |
| Imp* type | 1 | .9740 | 4.454E-06 | .0000 | – |
| Imp diameter | 1 | .6630 | .7735 | .2436 | 2.4558 |
| Imp length | 1 | .8724 | 1.1083 | .3160 | 3.8873 |
| Imp site | 1 | .5165 | 1.3460 | .5485 | 3.3031 |
| Postextractive | 1 | .8273 | .8361 | .1675 | 4.1737 |
| Flapless | 1 | .4963 | 1.7035 | .3671 | 7.9036 |
| Immediate load | 1 | .6873 | 1.4209 | .2568 | 7.8607 |
| Prosthesis | 1 | .0889 | 17.1379 | .6490 | 452.5332 |
| NPU* | 1 | .7985 | .7650 | .0979 | 5.9792 |
| Antagonist | 1 | .3453 | .3796 | .0508 | 2.8375 |
| Edentulism | 1 | .9908 | .9738 | .0109 | 86.8662 |
| Maxilla/mandible | 1 | .1406 | 3.1191 | .6869 | 14.1627 |

*df indicates degrees of freedom; Exp, exponent; Imp, implant; and NPU, number of prosthetic units.

thetic components were not available, and many of the early 5.0- and 6.0-mm-wide implants received "standard"-diameter (4.1-mm) healing abutments and were restored with "standard"-diameter (4.1-mm) prosthetic components. Long-term radiographic follow-up of these "platform-switched" restored wide-diameter dental implants demonstrated a smaller than expected vertical change in crestal bone height around these implants than is typically observed around implants restored conventionally with prosthetic components of matching diameters. This radiographic observation suggests that the resultant postrestorative biologic process resulting in the loss of crestal bone height is altered when the outer edge of the implant-abutment interface is repositioned horizontally inwardly and away from the outer edge of the implant platform.

In 2007, Maeda et al[3] examined the biomechanical advantages of platform switching using three-dimensional finite element models. The stress level in the crestal bone area around the implant neck was greatly reduced when the narrow diameter abutment was connected compared with the regular-sized one. Investigators concluded that the platform switching configuration has the biomechanical advantage of shifting the stress concentration area away from the cervical bone-implant interface, but it also has the disadvantage of increasing stress in the abutment or abutment screw.

Starting from the platform switching idea, we elaborated the concept of bone platform switching. Bone platform switching involves an inward bone ring in the coronal part of the implant that is in continuity with the alveolar bone crest (Figure 5). Bone platform switching is obtained by using a dental fixture with a reverse conical neck.

Several variables were investigated in our series; they can be grouped as follows: 1, surgery-, 2, host-, 3, implant-, and 4, occlusion-related factors.[9]

With regard to surgery-related factors, postextractive, flapless, and immediate loading techniques are compared with implants inserted in healed bone by using mucosal flap and loaded in a second time, respectively. Type of rehabilitation, number of prosthetic units per implant, type of edentulism, and type of antagonist element are evaluated among the occlusion-related factors. Tooth site and upper or lower jaws are considered host-related factors because the bone quality significantly changes in these areas. Finally, length, diameter, and overall neck type are investigated among the implant-related factors.

When conventional and reverse conical neck implants in our series are compared, no statistical differences are detected in terms of survival and success rates, neither between the 2 implant types nor by evaluating the confounding variables.

Thus one could infer that reverse conical neck has no impact on clinical outcome. However, reverse conical neck implants give an increased residual crestal bone volume around the implant neck and carry several advantages: (1) reduced mechanical stress in the crestal alveolar bone area, (2) repositioning of gingival papillae on the bone ring (that is the physiologic condition), and (3) a proper vascular supply to hard and bone tissue, also in case of reduced interimplant space. On the contrary, distance between implant abutment junction and alveolar crestal bone is not increased, and thus no protective effect against the microflora contained in the micrograph can be expected.

## CONCLUSION

Reverse conical neck by itself is not sufficient to reduce alveolar crest bone resorption. Probably, the greater distance between implant abutment junction and alveolar crestal bone (which leads to protection from the microflora contained in the micrograph) is the major determinant of the platform switching effect. We believe that additional studies on larger series will help to demonstrate whether reverse conical neck has any clinical relevance, especially if a combination of platform switching and bone platform switching will be performed.

## ACKNOWLEDGMENT

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