Short-Term Bone Level Observations Associated with Platform Switching in Immediately Placed and Restored Single Maxillary Implants: A Preliminary Report

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Purpose: The aim of this study was to evaluate the short-term bone level response around immediately placed and provisionally restored implants using a platform switching concept. ***Materials and Methods:*** Twenty-two implants with a platform diameter of 5.5 mm were immediately placed in healthy maxillary sites in 22 patients. Resultant circumimplant spaces were filled with a mixture of bovine bone matrix and collagen. The implants were randomly divided into two equal groups: 11 implants connected with 3.8-mm-diameter abutments (test group) and 11 with 5.5-mm-diameter ones (control). Provisional crowns were adapted and adjusted for nonfunctional immediate placement on each implant and the final crowns were constructed 2 months later. Posttreatment assessments were carried out by an independent trained observer at the time of implant placement (baseline), at definitive prosthesis insertion, and every 6 months thereafter. These assessments included periapical radiographs, pocket probing depths (PPD), bleeding on probing (BOP), and modified Plaque Index (mPII) on both implants and first proximal teeth. An image analysis software application was used to compare the bone crestal heights at the mesial and distal aspects of the implants. ***Results:*** The mean follow-up observation period was 25 months and all implants were judged to be successfully osseointegrated. In the test group, radiographic analysis showed an average bone reduction level of 0.30 mm (SD = 0.16 mm). This mean value was statistically significantly different ($P \leq .005$) from the average reduction in the control group (mean = 1.19 mm, SD = 0.35 mm). No differences between the two groups in PPD, BOP, or mPII were found. ***Conclusion:*** This preliminary study suggests that immediate single implant restorations in specific maxillary sites with subsequent platform switching may provide peri-implant alveolar bone-level stability. *Int J Prosthodont 2009;22:277–282.*

Provisional restorations on implants placed into fresh extraction sockets are popularly regarded as providing both treatment convenience and advantage. Some authors maintain that this approach helps preserve or retard the otherwise inevitable and variable alveolar ridge reduction, which occurs around implants on a time-dependent basis. Regrettably, the influence of age, gender, systemic health, site specificity, and bone morphology on the outcome of the timing of implant placement, and indeed loading, is far from rigorously documented. Nonetheless, various hypotheses seek to maintain the integrity of circumimplant bone levels. One such interesting proposal[1] suggests that a so-called platform switching protocol could ensure better bone levels, at least in the short term. This concept, if proven to be predictable, would certainly impact the esthetic outcome of implants placed in the esthetic zone and deserves to be tested.

The aim of this preliminary study was to measure traditionally studied bone levels around immediately placed and restored implants in specific maxillary sites using a platform switching protocol. It was designed as a prototype for a longer-term prospective, controlled, randomized, double-blind clinical investigation.

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Materials and Methods

Study Design and Patient Selection

From September to December 2005, two dental implant surgeons in two different private dental offices recruited 22 consecutive patients—12 (seven male and five female) in one office and 10 (six male and four female) in the other—who were scheduled for immediate postextraction implant placement to support single tooth restorations. Inclusion criteria for the selected 22 maxillary teeth (three incisors, three canines, and 16 premolars) were clinically assessed, well-preserved alveolar ridges and teeth morphologic features that precluded their traditional restoration. At the time of implant insertion, patients ranged in age from 32 to 76 years (average age: 50 ± 14.46 years) and all were in good health. They were informed about the procedure and required to sign a consent form.

The exclusion criteria limiting the study to 22 patients were acutely infected teeth, a full-mouth plaque score (FMPS) and full-mouth bleeding score (FMBS) > 25%, resultant implant sites with a interproximal space narrower than 9 mm and ones with interproximal and buccal bone defects, smokers who had more than 10 cigarettes per day, and patients with uncontrolled diabetes (glycemic level > 110 mg/L and HbA1c > 6%) or who were pregnant or lactating.

Since the present study was privately funded and performed, it followed the principles outlined in the Declaration of Helsinki[2] on experimentation involving human subjects. The entire treatment protocol ensured application of the highest standards of professional private practice.

Patients were randomly assigned to one of the two following protocols: restoration using the platform switching concept (abutments 3.8 mm in diameter: test group) or standard restoration (abutments 5.5 mm in diameter: control group) and were blinded regarding their inclusion in either group.

Random assignment was performed by a professional statistician according to predefined randomization tables, and a balanced random permuted block approach was used to prepare the randomization tables to avoid an unequal balance between the two treatments. In order to reduce the chance of unfavorable splits between test and control groups in terms of key prognostic factors, the randomization process took into account the variables of sex, age, biotype, and tooth position.

Clinicians were also blinded regarding use of the selected abutment diameter until after the implant was inserted. Once the surgical procedure was completed, the surgeons' assistants opened a sealed envelope that identified the choice of abutment.

Surgical Protocol

Each patient was scheduled for a full-mouth professional prophylaxis appointment before the surgical appointment. Patients took antibiotics (Augmentin 1 g, GlaxoSmithKline) 1 hour prior to surgery and every 12 hours for 6 days afterwards.

All extractions were performed atraumatically without raising a flap and using a periotome. The sockets were thoroughly debrided and the presence of any bone defects were explored using a periodontal probe. Thirteen-millimeter Global Implants (Sweden and Martina) with a platform diameter of 5.5 mm were inserted. All postextraction sites presented well-preserved bone walls and the absence of acute infection in the anterior and premolar regions of the maxilla. The premolar region implant osteotomy sites were prepared along the long axis of the extracted teeth but were slightly inclined palatally to the long axis in the anterior sites.

The root-shaped implant used in this study presented a 0.3-mm-high machined neck surface and microthreads in the coronal portion. Moreover, the whole surface of the implant was sand-blasted and acid-etched and incorporated a double internal abutment connection. The edge of the implant platform was placed at the margin of the buccal bone wall. To obtain adequate primary stability, implants were inserted at least 3 mm beyond the tooth apex, which permitted an initial torque value of 32 to 45 N/cm.

When the distance between the implant and the buccal bone wall (so-called jumping distance) exceeded 1 mm, it was recorded as such and filled with a mixture of collagen bovine bone matrix (Bio-Oss Collagen, Osteohealth) and blood. A bucco-oral jumping distance was detected in 14 sites (seven in the test group and seven in the control).

Abutment Connection

Temporary abutments were then connected to the implants (torque: 20 N/cm) using a titanium post with a diameter of 3.8 mm in the test group (1.7 mm narrower than the implant platform) and a titanium abutment with a diameter of 5.5 mm in the control.

A gelatin sponge (Cutanplast Dental) saturated with tranexanic acid was plugged around the abutment into the alveolar socket as part of a protocol that is presumed to promote and improve the mucosal healing. A provisional custom-made acrylic resin crown was contoured for an optimal marginal fit and immediately placed over the post. Occlusal centric and eccentric contacts were not permitted on the provisional restorations and this was verified using a 200-μm articulating paper. The crown was then adapted by means of an antiseptic gel (Corsodyl gel,

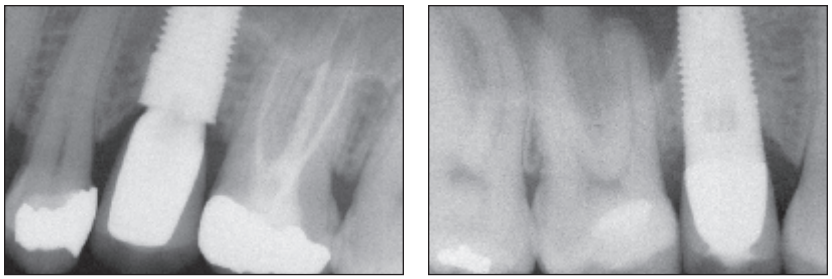

Fig 1a *(left)* Periapical radiograph of a restored premolar in the test group after 24 months of loading.

Fig 1b *(right)* Periapical radiograph of a restored premolar in the control group after 24 months of loading.

GlaxoSmithKline) so as to avoid contamination of the healing process by cement.

The dimensions of the peri-implant mucosa (gingival biotype) were identified, and digital periapical standardized radiographs were taken using an individualized mouthpiece to ensure a parallel technique and used for baseline recordings. Exposure parameters were conducted according to the manufacturer's recommendations by standard clinical protocols.

Patients were instructed to maintain a soft diet and to avoid chewing in the treated area until the time of final restoration. Oral hygiene in the surgical site was limited to soft brushing for the first 2 weeks and regular brushing in the rest of the mouth. Rinsing with 0.12% chlorhexidine was prescribed for 2 weeks. Thereafter, conventional brushing and flossing were permitted.

After 1 week, the provisional crown was cemented with temporary cement (Temp Bond, KerrHawe). All surgical procedures were uneventful.

Two months after implant placement an impression of the implant head was taken with an appropriate impression coping (3.8 mm in the test group and 5.5 mm in the control). The status of the peri-implant tissue was observed, and the coping transfer was modified to avoid a collapse of the mucosa over the implant head.

Titanium abutments and metal-ceramic crowns were used for the final restorations. The latter were optimally designed to match the contours and contact areas of the adjacent teeth permitting optimal soft tissue contours. New films were made at the time of the final abutment and crown connection appointment.

A full-mouth prophylaxis was carried out and the following parameters were recorded every 6 months: bleeding on probing (BOP), probing pocket depth (PPD), and modified Plaque Index (mPII) at both implants and neighboring (mesial and distal) teeth.The aggregate measurements were compared to baseline.

Radiographic Evaluation

Periapical standardized digital radiographs were repeated every 6 months using the same protocol (Figs 1a and 1b). Peri-implant marginal bone changes were evaluated with a computerized measuring technique applied to digital radiographs. Each radiograph was previously modified with a digital filter in order to hide the abutment diameter before it was given to the operator.

The distance from the mesial and distal margins of the implant neck to the most coronal point where the bone appeared to be in contact with the implant was measured. Evaluation of the marginal bone level around implants was performed using image analysis software (Scion Image 4.02 Win, Scion) that was able to compensate for radiographic distortion. The software calculated bone remodeling at the mesial and distal aspects of the implants.

All measurements (periodontal indices, esthetic parameters, radiographic measurements) were made and collected by the same trained examiner who was not one of the implant surgeons.

Statistical Analysis

Data distribution was plotted with a box plot and characterized by mean value and standard deviation (SD). The Student *t* test ($P \leq .005$) was selected to detect differences between test and control groups, while correlation between gingival biotype and marginal bone loss was examined by the F test ($P \leq .05$).

The F test was used to test the hypothesis that the standard deviations of two groups of patients with different gingival biotypes (thick or thin) are equal and of comparable origin.[3]

Results

No patient dropped out of this study; the mean follow-up uneventful observation period was 25 months (range: 24 to 27 months). At the time of impression taking and crown placement, dense fibrotic tissue overlying the part of the implant platform not covered by the abutment was observed in the test group (Figs 2 to 4).

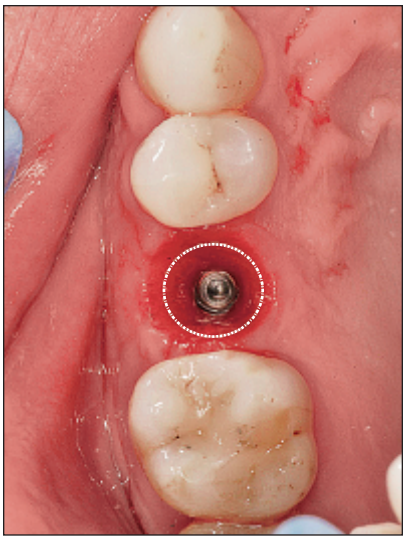

Fig 2 Soft tissue healing 2 weeks after surgery of a premolar site in the test group. A dense fibrotic soft tissue band around the uncovered horizontal aspect of the implant head was observed. The actual implant diameter is outlined.

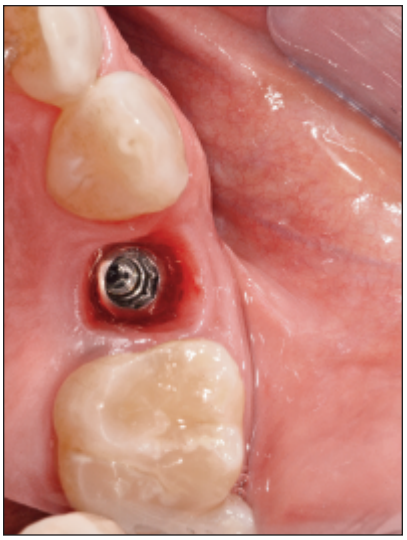

Fig 3 Soft tissue healing 2 weeks after surgery of a premolar site in the control group. The entire horizontal component of the implant head is visible.

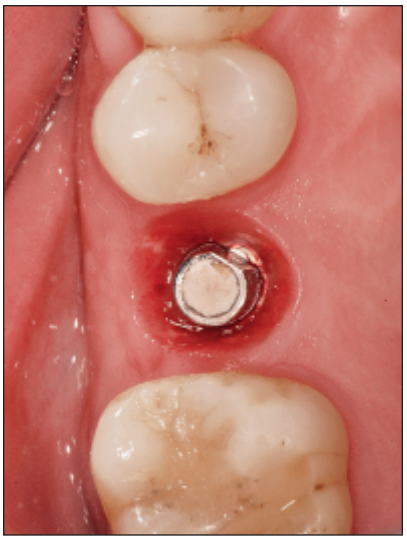

Fig 4 Soft tissue appearance of a premolar site in the test group at the time of definitive restoration.

Table 1a Patient Demographics and Implant Characteristics in the Test Group

No.	Sex	Biotype*	Age at implantation (y)	Implant position†	Bone loss (24 mo postloading) Mesial	Distal
1	M	T	72	12	0.29	0.79
2	M	T	41	4	0.35	0.42
3	M	T	42	13	0.07	0.40
4	F	t	70	12	0.47	0.32
5	M	t	41	9	0.30	0.30
6	F	t	40	11	0.20	0.30
7	M	T	36	6	0.09	0.37
8	M	t	62	4	0.20	0.09
9	F	T	63	9	0.30	0.42
10	M	T	37	12	0.14	0.12
11	M	T	40	12	0.36	0.40

*T = thick; t = thin.
†Implant position based on FDI tooth numbering system.

Table 1b Patient Demographics and Implant Characteristics in the Control Group

No.	Sex	Biotype*	Age at implantation (y)	Implant position†	Bone loss (24 mo postloading) Mesial	Distal
1	M	T	38	5	0.99	0.99
2	F	t	41	13	1.30	1.69
3	F	t	37	4	1.04	1.20
4	F	T	76	12	1.27	1.65
5	F	T	45	4	1.08	0.82
6	M	T	34	13	1.85	1.80
7	M	t	59	13	0.58	0.62
8	M	t	32	4	0.69	1.30
9	M	T	63	8	1.08	1.13
10	F	t	65	6	1.22	1.31
11	F	t	66	4	1.32	1.28

*T = thick; t = thin.
†Implant position based on FDI tooth numbering system.

Radiographic Results

In the test group, the postoperative radiographs at the last follow-up (24 months after definitive prosthesis insertion) demonstrated an average bone loss of 0.25 mm on mesial surfaces (range: 0.07 to 0.47 mm, SD = 0.123) and 0.36 mm on distal surfaces (range: 0.09 to 0.80 mm, SD = 0.183). Overall mean bone loss was 0.30 mm (SD = 0.157) (Table 1a).

In the control group, the postoperative radiographs showed an average bone loss of 1.13 mm on mesial surfaces (range: 0.58 to 1.85 mm, SD = 0.337) and 1.25 mm on distal surfaces (range: 0.62 to 1.80 mm, SD = 0.404). Overall mean bone loss was 1.19 mm (SD = 0.384) (Table 1b).

No perceptible difference was found in the radiographic controls after first follow-up (6 months after definitive prosthesis insertion) in both groups. The mean values of the test group were statistically significant ($P \leq .005$) compared to control group mean values (Fig 5). No changes in bone levels adjacent to abutment teeth were noted in either group.

Periodontal Parameters

Throughout the study's observation period, neither BOP nor PPD exceeding 3 mm were detected in either group. The mean mPII was 0.57 (SD = 0.32) in the control group and 0.74 (SD = 0.34) in the test group.

The Student paired *t* test was selected to detect differences between test and control groups. There was no statistically significant difference ($P > .005$) regarding periodontal indices when test and control sites were compared to baseline and last follow-up.

Absence of inflammatory signs was verified in the inner peri-implant soft tissues.

Biotype Correlation

The observed F of the test applied to gingival biotype and bone loss was $F_{calc} = 0.00031$. The critical F, at a 95% significance level, was $F_{1,20} = 4.35$. Therefore $F_{calc} < F_{1,20}$ and we accept the null hypothesis that the two standard deviations are equal. The confidence level was 95% that any difference in the sample standard deviations was due to random error.

There is no evidence that gingival biotype (thick or thin) influences bone loss in patients. No different result was found using the same test with test and control groups.

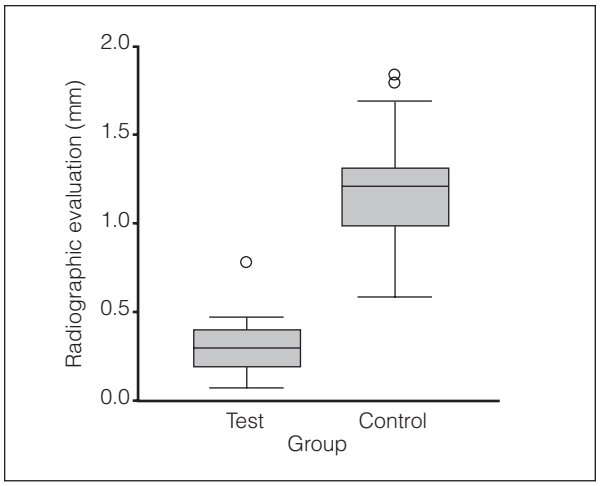

Fig 5 Box plot of mean values and SDs of bone resorption in the test and control group after 24 months of loading. Statistically significant differences were found between the two groups.

Discussion

In the present study, postextraction immediately provisionalized wide-diameter implants (5.5 mm) were restored using the platform switching technique (3.8 mm abutment) compared to a matched abutment restoration (5.5 mm abutment). After 25 months of follow-up, the mean bone resorption was 0.30 mm in the test group and 1.19 mm in the control.

The rationale for the use of a wide-diameter implant in both patient study groups was to make sure that this was a blind protocol, to increase implant primary stability, and to amplify implant/abutment mismatching. Surgeons were directed to use a specific abutment diameter only after preparation of the osteotomy site to eliminate bias in abutment selection.

In addition, a 5.5-mm implant diameter presumably permitted an increase in contact between the bone and screw thread. In fact, in the present study, the sockets often presented a conical morphology with a mesiodistal distance of about 5.5 mm mainly in the premolar sites. In doing such, high primary stability was readily obtained—one of the most important prerequisites for immediately restored implants. Moreover, the use of these wide-diameter implants enabled a larger implant/abutment diameter mismatch than has been previously reported. It was considered that this would amplify differences in crestal bone level changes in the two groups. An additional presumed rationale was to cancel out variable implant diameter marginal bone stress. Isidor[4] stated that a wide-diameter implant could better distribute stress at the implant-abutment interface and consequently minimize microdamage resulting in bone resorption.

The recorded levels of crestal bone loss appeared to be slightly lower than results reported for similar short-term clinical studies, which may be related to the completely rough surface of the implant used in this study. It has also been reported that some roughened titanium surfaces and microthreads are associated with the formation of a superficial fibrin network, which could hypothetically enhance the initial stability of the bone-implant interface.[5]

Furthermore, the measurable bone resorption observed in the test group was statistically lower than in the control group. It is tempting to believe that the longer soft tissue contact area (presumed to be similar to the so-called biologic width popularly described as occurring around natural teeth) for the implants restored with a platform switching protocol may actually play a role in this subtle initial difference (Figs 6 and 7).

Moreover, radiographically assessed differences in crestal bone loss were noted after the first follow-up appointment. This may also be attributable to a slightly faster tissue maturation in the clinical circumstances described here. The differences in measured bone level changes in the two groups may be related to the observed formation of dense fibrotic tissue on the uncovered horizontal part of the implant

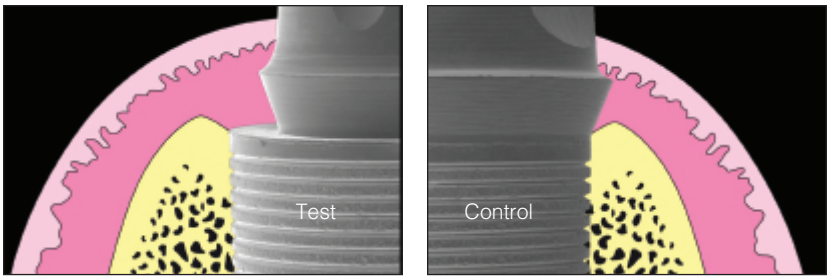

Fig 6 Figurative representation comparing soft and hard tissues in the test and control groups at the time of implant insertion (mesiodistal section).

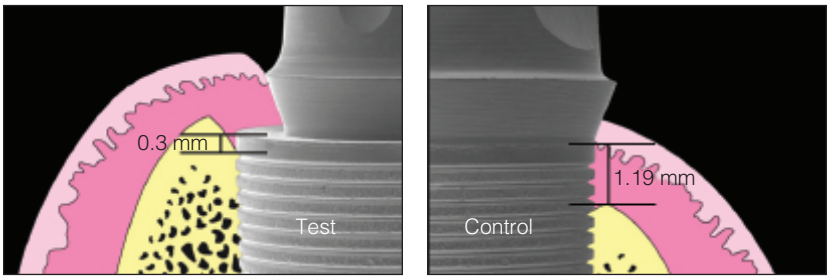

Fig 7 Figurative representation comparing soft and hard tissues in the test and control groups after definitive restoration showing the difference in bone levels.

head. Hypothetically, this occurrence could limit the extension of the soft and hard tissues down the vertical walls of the implants in order to establish an effective biologic barrier to the oral environment (see Figs 2 to 4).

Unsurprisingly, no statistically significant differences were found between the sites where alloplastic bone materials were used when compared to the sites where they were not. It was concluded that the alloplastic material could not affect radiographic measurements since the bone filler was used exclusively in buccal or palatal defects. The radiographic assessments only recorded mesial and distal changes. The biometric evaluation in the present study must be considered with caution since bone levels were evaluated only by means of digital standardized periapical radiographs with a consequent risk of minor assessment errors, particularly when seen in the context of the numerical size of the patient sample employed in this study.

These results concur with the observations of Lazzara and Porter,[1] whose recently published long-term radiographic follow-up of platform switched implants suggests a minimal crestal bone loss when compared to traditionally restored implants, at least for the specific duration of the study. No substantial differences were noted between test and control groups regarding the periodontal indices—even if the relevance of this assessment remains unclear.

This preliminary, numerically limited, and short-term clinical study also demonstrates comparable impressive successful outcome results to other reports for immediately placed implants that are occlusally loaded relatively early, albeit without the platform switching protocol. It is therefore tempting to conclude that the protocol per se does not appear to compromise presumed optimal outcomes. Moreover, it may actually contribute to better bone level maintenance, as least in the short term.

Conclusions

The limitations of this study's design preclude any definitive conclusions regarding the merits of routinely using long-term platform switching protocols. However, given the recorded successful osseointegration outcomes and maintained bone levels, clinical researchers should be encouraged to consider the merits of more comprehensive clinical investigations.

Acknowledgments

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