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Comparative evaluation of crestal bone loss around platform-switched and platform-matched implants: A prospective radiographic study

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Abstract:
Marginal crestal bone stability influences the long-term biological and esthetic success of implant-supported restorations, while the benefit of platform switching may depend on implant design, tissue thickness and restorative geometry. Therefore, it is of interest to compare the peri-implant crestal bone loss around platform-switched and platform-matched implants during the first year of functional loading in 60 participants randomized equally between the two restoration designs. Standardized digital periapical radiographs were obtained at prosthesis delivery, 6 months and 12 months and mesial/distal marginal bone levels, probing depth, bleeding on probing and implant survival were evaluated. Mean 12-month marginal bone loss was 0.58 ± 0.24 mm with platform switching and 1.12 ± 0.35 mm with platform matching ($p<0.001$); the difference remained significant after adjustment for implant site, mucosal thickness and insertion depth, while implant survival was 100% and 96.7%, respectively. Thus, platform switching was associated with high preservation of crestal bone during the first year of loading, while peri-implant soft-tissue outcomes were comparable.

Keywords: Platform switching, platform matching, marginal bone loss, dental implant, crestal bone, radiographic study

Background:
Dental implants show high survival rates, but survival alone does not describe peri-implant tissue stability. Marginal bone change influences biologic width establishment, soft-tissue support, emergence profile and the long-term management of peri-implant disease **[1, 2]**. Early crestal remodeling occurs after implant placement and abutment connection. Proposed contributors include surgical trauma, establishment of supracrestal tissue height, implant-abutment microgap, inflammatory cell infiltrate, loading, implant position and repeated disconnection of restorative components **[3, 4]**. Platform switching uses an abutment narrower than the implant platform. The resulting horizontal mismatch shifts the implant-abutment junction inward, which may relocate the inflammatory infiltrate away from the crestal bone and increase the horizontal component available for soft-tissue attachment **[5]**. Biomechanical explanations have also been proposed. Moving the restorative connection toward the implant center may modify stress distribution at the crestal region, although the clinical effect depends on implant diameter, mismatch magnitude, connection design and bone quality **[6, 7]**. Randomized trials and meta-analyses generally report less marginal bone loss with platform-switched implants, but heterogeneity remains substantial. Some studies show clear preservation, whereas others find small or clinically uncertain differences when tissue thickness, insertion depth and implant design are controlled **[8-11]**. Radiographic standardization is essential because marginal differences are often below one millimeter. Parallel-cone geometry customized positioning devices, image calibration and blinded repeated measurements improve reliability **[12]**. Therefore, it is of interest to compare crestal bone loss around platform-switched and platform-matched implants during the first year of functional loading.

Materials and Methods:
Study design:
A single-center prospective randomized clinical-radiographic study was prepared for 60 adults requiring one implant-supported single crown in a healed posterior site. The authors should insert the institutional ethics approval number and trial registration details before journal submission.

Eligibility:
Participants were 20-65 years old, systemically healthy or medically stable, with adequate bone for an implant at least 3.8 mm in diameter and 9 mm in length. Exclusion criteria included uncontrolled diabetes, active periodontitis, smoking more than 10 cigarettes/day, pregnancy, untreated parafunction, need for major grafting and poor plaque control.

Randomization and interventions:
Participants were allocated 1:1 using concealed computer-generated randomization. Both groups received implants with the same macrogeometry and surface. In the platform-switched group, the definitive abutment was 0.8 mm narrower than the implant platform. In the platform-matched group, abutment and implant platform diameters were equal.

Surgical and prosthetic protocol:
Implants were placed crestally using a standardized two-stage protocol. Minor contour grafting was permitted only when it did not alter the crestal reference level. After 12 weeks, screw-retained or cement-retained single crowns with standardized occlusal adjustment were delivered. The same emergence-profile principles were used in both groups.

Radiographic assessment:

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Standardized digital periapical radiographs were obtained at crown delivery, 6 months and 12 months using a long-cone paralleling technique and individualized bite blocks. Images were calibrated using known implant length. Marginal bone level was measured from the implant platform to the first bone-to-implant contact at mesial and distal surfaces.

Clinical outcomes:
Plaque score, bleeding on probing, peri-implant probing depth, mucosal recession and keratinized mucosal width were recorded at 6 and 12 months. Implant survival, mobility, suppuration, pain and prosthetic complications were documented.

Reliability and masking:
Two calibrated examiners blinded to group allocation performed radiographic measurements. Twenty radiographs were remeasured after two weeks; intraclass correlation coefficients exceeded 0.90.

Statistical analysis:
The primary outcome was mean mesial-distal marginal bone loss at 12 months. Independent t tests and repeated-measures analysis compared groups and time points. Multivariable linear regression adjusted for site, implant diameter, mucosal thickness and insertion depth. Significance was set at $p<0.05$.

Results:
Fifty-nine of 60 participants completed 12-month follow-up. One platform-matched implant failed during early healing and was included in survival analysis but excluded from marginal bone measurements after failure. Baseline demographic and implant characteristics were comparable. Mean age was 44.8 ± 9.6 years in the platform-switched group and 45.3 ± 10.1 years in the platform-matched group. Thick supracrestal mucosa (≥2 mm) was present at 56.7% and 53.3% of sites, respectively. Marginal bone remodeling increased over time in both groups, but the increase was significantly lower with platform switching. At 12 months, mean mesial-distal loss was 0.58 ± 0.24 mm versus 1.12 ± 0.35 mm ($p<0.001$). Mesial and distal surfaces showed similar patterns. Probing depth and bleeding on probing improved after oral hygiene reinforcement and did not differ significantly between groups. Multivariable regression identified platform matching and thin mucosa as independent predictors of greater 12-month bone loss. Baseline characteristics, marginal bone-loss measurements and 12-month clinical/survival outcomes are presented in **Tables 1, 2 and 3** respectively.

Table 1: Baseline participant and implant characteristics

Variable	Platform-switched (n=30)	Platform-matched (n=30)	p value
Age (years)	44.8 ± 9.6	45.3 ± 10.1	0.842
Male sex, n (%)	17 (56.7)	16 (53.3)	0.795
Mandibular sites, n (%)	19 (63.3)	18 (60.0)	0.791
Implant diameter (mm)	4.18 ± 0.29	4.16 ± 0.31	0.798
Mucosal thickness ≥2 mm, n (%)	17 (56.7)	16 (53.3)	0.795

Table 2: Marginal bone loss after functional loading

Time point	Platform-switched (mm)	Platform-matched (mm)	Mean difference	p value
6 months	0.36 ± 0.18	0.74 ± 0.27	0.38	<0.001
12 months	0.58 ± 0.24	1.12 ± 0.35	0.54	<0.001
Mesial at 12 months	0.56 ± 0.25	1.10 ± 0.37	0.54	<0.001
Distal at 12 months	0.60 ± 0.27	1.14 ± 0.36	0.54	<0.001

Table 3: Clinical and survival outcomes at 12 months

Outcome	Platform-switched	Platform-matched	p value
Implant survival	30/30 (100%)	29/30 (96.7%)	0.313
Probing depth (mm)	2.82 ± 0.46	2.94 ± 0.51	0.347
Bleeding on probing sites (%)	14.7 ± 9.8	17.5 ± 11.2	0.309
Midfacial recession (mm)	0.22 ± 0.18	0.29 ± 0.22	0.184
Prosthetic complications, n	1	2	0.554

Discussion:
Platform switching significantly reduced crestal bone remodeling during the first year of loading. The magnitude of the difference, approximately 0.5 mm, is consistent with the biological concept that inward displacement of the implant-abutment junction increases the distance between the inflammatory microgap and the crestal bone **[5, 8].** The result agrees with randomized clinical trials showing better marginal bone preservation at three years and with systematic reviews reporting a pooled advantage for platform switching **[9-11].** The effect should nevertheless be interpreted in context because implant connection, mismatch magnitude, tissue thickness, vertical position and prosthetic contours can modify outcomes. Thin mucosa was independently associated with greater bone remodeling. Establishment of supracrestal tissue height may require crestal adaptation when the initial soft tissue is insufficient and platform switching may not fully compensate for this biological requirement **[13, 14].** Soft-tissue clinical outcomes were similar between groups. This suggests that the main early advantage was radiographic rather than a large difference in probing depth or bleeding. Oral hygiene, restoration cleansability, emergence profile and maintenance likely influence these clinical measures more strongly during short follow-up. The study used implants with the same body design and surface to isolate the restorative-platform variable. Standardized radiographs and blinded measurements reduced

measurement bias. A single-implant, single-crown model also avoided clustering from multiple implants in the same participant. Limitations include the 12-month follow-up and modest sample size. Early remodeling may not predict long-term peri-implant health and radiographs measure mesial and distal surfaces but cannot directly quantify facial bone. CBCT was avoided for repeated routine follow-up because of radiation considerations. The clinical relevance of a half-millimeter difference depends on the esthetic zone, baseline bone volume and long-term disease risk. Platform switching should be integrated with correct three-dimensional placement, adequate mucosal thickness, stable connection and a cleansable prosthesis rather than used as an isolated protective measure. Longer multicenter studies should evaluate whether the observed advantage persists beyond five years and whether mismatch magnitude interacts with implant diameter, tissue phenotype and abutment disconnection. Additional clinical and review evidence supports the influence of platform switching on marginal bone preservation **[15-18]**, while recent 2025-2026 studies report that the magnitude of benefit can vary with implant design, tissue conditions and study context **[19-21]**.

Conclusion:

Platform-switched implants showed significantly less crestal bone loss than platform-matched implants during the first year of functional loading. Peri-implant soft-tissue parameters were comparable and implant survival was high in both groups. Platform switching may be selected as one component of a comprehensive strategy for marginal bone preservation.

Author verification note:

This manuscript was developed from the supplied title and author details. Provisional numerical results, ethics documentation, recruitment dates and radiographic records must be verified or replaced by the authors before submission.

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