



A Prospective Clinical and Radiographic Assessment of Platform-Switched Laser-Microchannel Implants Placed in Limited Interimplant Spaces

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This multicenter clinical trial of platform-switched laser-microchannel implants supports findings from a previous preclinical trial. Previous information indicated that an interimplant distance narrower than 3 mm would result in decrease in the crestal bone level, but the results of this investigation suggest that a more optimistic clinical result can be anticipated for implants and abutments with a laser-microchannel surface. Int J Periodontics Restorative Dent 2017;36:33–38. doi: 10.11607/prd.3109

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Prevailing contemporary evidence suggests a die-back effect or loss of crestal bone when two-piece dental implants are placed adjacent to each other.[1] There is evidence that inflammatory infiltrate due to the microgap at the implant-abutment junction drives the connective tissue element apically, resulting in bone loss.[2] Preclinical trials using a canine model confirmed a 3-mm dimension of soft tissue and 1 mm of crestal bone loss to accommodate the connective tissue element of the biologic width.[2–5] Abrahamsson et al demonstrated that repeated removal and reconnection of healing abutments compromised the protective mucosal barrier and resulted in a more apically positioned zone of connective tissue.[6] A subsequent animal study revealed that the abutment portion of the implant influenced the location and quality of the attachment between the peri-implant mucosa and the implant.[7] Three recent clinical case reports testing the use of laser-microchannel surface treatment on the apical portion of the abutment confirmed that a connective tissue attachment resulted in crestal bone stability.[8–10] Reattachment was also demonstrated when the healing abutment was replaced with a permanent abutment with a laser-microchannel finish.[9]

Investigations have found surprisingly little change in crestal bone with platform-switching techniques.[11–16] The implant industry has continued to refine the roughened surface in an effort to promote osteoblast differentiation to prevent bone loss.

Nevins evaluated whether the roughened surface of an osseointegrated titanium implant can be mechanically altered to result in a physical attachment of the supracrestal connective tissue fibers to the implant, emulating the attachment apparatus of a tooth.[17] This proof-of-principle human histology investigation demonstrated supracrestal connective tissue attachment to the laser microchannels of the dental implant. A more recent preclinical investigation demonstrated that placement of the laser-microchannel finish on an abutment resulted in bone preservation on implants that were placed 2 and 4 mm apart.[18] This proof-of-principle preclinical study result confirmed that hard and soft tissue preservation is enhanced with laser-microchannel finish on the abutment. A similar clinical study was conducted by Koutouzis et al.[19] The objective of the present prospective clinical study was to investigate the hard and soft tissue result when implants are placed < 3 mm apart to emulate the interproximal space between teeth in the esthetic zone.

Materials and methods

This multicenter, prospective, clinical and radiographic study investigated the effect of laser-microchannel permanent abutment/platform-switch implant assemblies (BioHorizons) on the maintenance of soft and hard tissues when placed < 3 mm apart. This laser-microchannel implant has buttress implant threads close to the implant platform, incorporates a beveled interface as opposed to a butt joint connection, and has a circumferential platform shift of 0.3 mm.

Patient treatment was performed in eight private periodontal practices. All patients signed an informed consent form based on the Helsinki Declaration of 1975, as revised in 2000. A total of 38 implants were placed in 18 patients and evaluated at 1 year or longer after restoration. The patients requiring implant surgery were enrolled and prepared for surgery in accordance with accepted dental practice guidelines, including informed consent. The appropriate demographic and medical histories and radiographic surveys were recorded. Each patient presented with a localized edentulous ridge site requiring two dental implants placed 2 to 3 mm apart. This situation allowed evaluation of soft and hard tissue behavior. Periapical radiographs and clinical photographs were made 1 year after restoration.

Inclusion criteria were as follows:

1. Men or women, 20 to 70 years of age, who had requested dental implant treatment options for rehabilitation
2. Subjects who signed an informed consent, participated, and returned for follow-up visits
3. Subjects without a significant medical history and currently not on medications that might complicate the results

Subjects were excluded from the study if they met the following exclusion criteria:

1. Did not meet all the inclusion criteria or who would not cooperate with the protocol schedule
2. Experienced implant failure
3. Required a ridge augmentation procedure to achieve adequate bone volume for the placement of implants
4. Significant untreated periodontal disease, caries, or infection in the oral cavity
5. Used nicotine-containing products within 3 weeks prior to surgery
6. Insulin-dependent diabetic or had HbA_{1c} levels > 6.5%
7. History of malignancy within the past 5 years (except for basal or squamous cell carcinoma of the skin or in situ cervical carcinoma)
8. Nursing or pregnant
9. Taking medications (except estrogen/progesterone therapy) or undergoing treatment known to have an effect on bone turnover
10. Diseases that affect bone metabolism (excluding idiopathic osteoporosis)
11. History of an autoimmune disease
12. Requiring immediate implant placement

Fig 1 *The patient presented with two missing maxillary premolars and requested dental implant rehabilitation.*

Fig 2 *An assembly of laser-microchannel dental implant and healing abutment was placed. The interimplant distance was < 3 mm.*

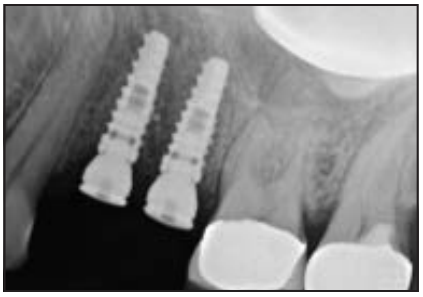


Fig 3 *A periapical radiograph was taken immediately after the surgery.*

Surgical and restorative phases

Preoperative periapical radiographs and appropriate clinical photographs were taken. Two laser-microchannel implants were placed with a maximum interimplant spacing of < 3 mm and the implant platform at the level of the osseous crest (Figs 1 and 2). A laser-microchannel healing abutment was then inserted. The gingival flaps were adapted for a tension-free wound closure with interrupted and horizontal mattress sutures. A periapical radiograph and clinical photographs were made immediately; the patients underwent the standard postsurgical infection and pain control (Fig 3). Patients were then recalled for restoration of these implants using laser-microchannel final abutments.

Fig 4 *Clinical photograph taken 1 year postrestoration, demonstrating intact interproximal papilla and preservation of crestal bone level.*

Fig 5 *Radiograph taken 1 year postrestoration, demonstrating very good interproximal bone level between two implants with limited interimplant space.*

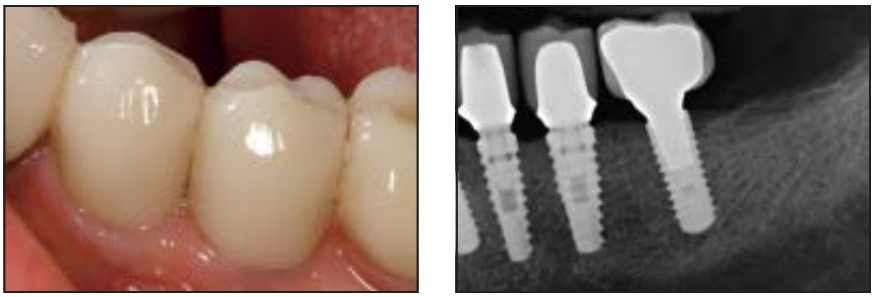


Fig 6 *Clinical photograph* (left) *and radiograph* (right) *of mandibular left premolar case taken 1 year postrestoration, demonstrating healthy soft tissue and preservation of crestal bone level between two implants.*

Clinical and radiographic evaluations

All patients participating in this study returned for their routine postoperative visit after the implant surgery and for 6-month and 1-year postoperative restoration visits. One case was followed up for 3 years.

Results

Radiographic observations

After 1 year of loading, the interproximal bone appeared to be at the level of the implant abutment junction for most of the implants (Figs 4 to 6). No significant osseous dieback was seen around 31 implants, but 4 implants lost bone to the first thread and 1 implant to the second thread.

Fig 7 *Initial clinical photograph. Patient was a 52-year-old woman referred for clinical crown lengthening. She was recommended for new crowns by her general dentist.*

Fig 8 *Clinical photograph demonstrating inadequate tooth structure for crown lengthening. The teeth were deemed nonrestorable and replacement with dental implants was advised.*

Clinical observation

Healing proceeded uneventfully for all 18 patients, and none of the 38 implants were compromised or lost. Of the implants, 22 were placed in the maxilla and 16 in the mandible. There was minimal clinical inflammation and no evidence of postoperative infection. All implants and abutments were stable and restored (Figs 4 to 6). No soft tissue recession was observed for any implants, but 3 cases did not have 100% interdental papillae. For the cases that did not experience radiographic evidence of bone loss, interproximal papillae were healthy and, for the most part, completely occupied the interdental space between the crowns.

Discussion

The appropriate investigative process should be initiated with a preclinical study to test a hypothesis before a clinical study is attempted. A preclinical, proof-of-principle canine investigation was performed to examine this novel implant-abutment system design, which combines platform switching with precisely configured laser-ablated abutments and implants at interimplant distances of 2 and 4 mm.[18] The result of that preclinical study determined that interimplant crestal bone can be maintained for implants only 2 mm apart.[18] The current study provides results of the same construct and procedure in a clinical study with similar clinical and radiographic outcomes.

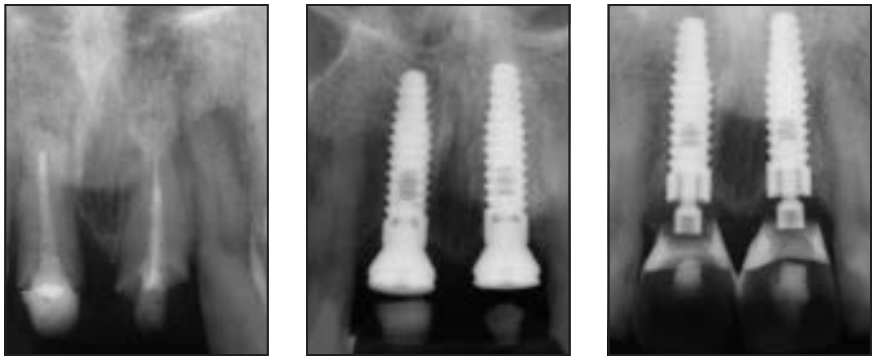
Patients are aware of and demand esthetic results from their restorative therapy. Focus on intact interimplant papillae is required to produce excellent prosthetic results. The gingival position is a reflection of intact crestal bone and a minimal sulcular depth. Deep sulcular pockets are difficult for the patient and oral hygienist to maintain. It has been demonstrated that crestal bone resorption can be related to the microgap between the implant and the new abutment.[20] Interimplant crestal bone loss has also been identified as a result of implant distance < 3 mm.[1] The previously mentioned preclinical study provided optimism that application of the laser-microchannel surface will result in a stable crestal bone level; this contradicts previous thinking. It appears that the addition of the laser-microchannel surface to the abutment and implant collar plus the platform switching can create sustained bone-to-implant contact coronal to the first thread and often to portions of the implant collar.

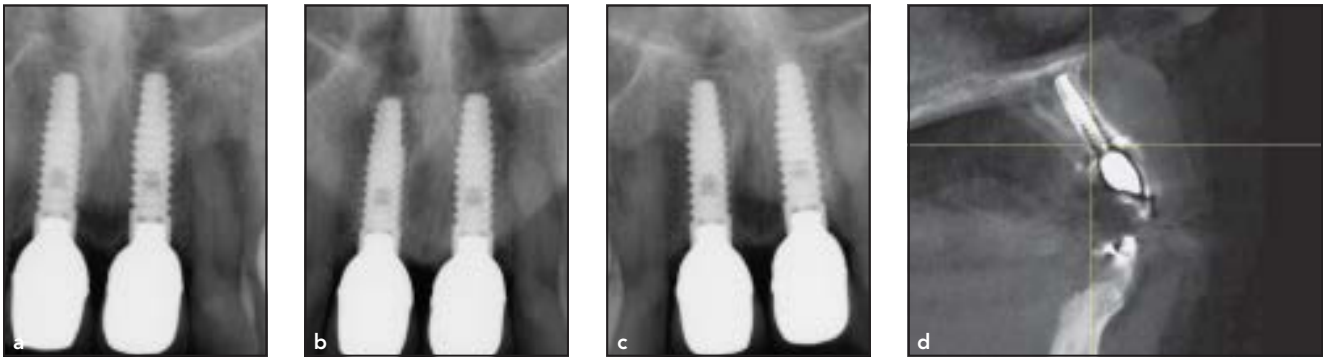
Natural teeth have Sharpey fiber attachment superficial to the interproximal bone as transseptal fibers and the gingival fiber apparatus that prevent apical migration of the junctional epithelium. It is possible that these fibers, perpendicular to the implant surface in a physical attachment, fulfill a similar protection for the vertical level of interimplant crestal bone. Placing

Fig 9 (left) *Initial radiograph.*

Fig 10 (center) *Immediate placement of implants following extraction (radiographic pins in place). Intrasocket grafting required.*

Fig 11 (right) *Screw-retained provisional crowns placed and shaped using Lexan plastic provisional abutments (restorations by Dr Jeffrey O'Connell, Bridgeport, Connecticut, USA).*





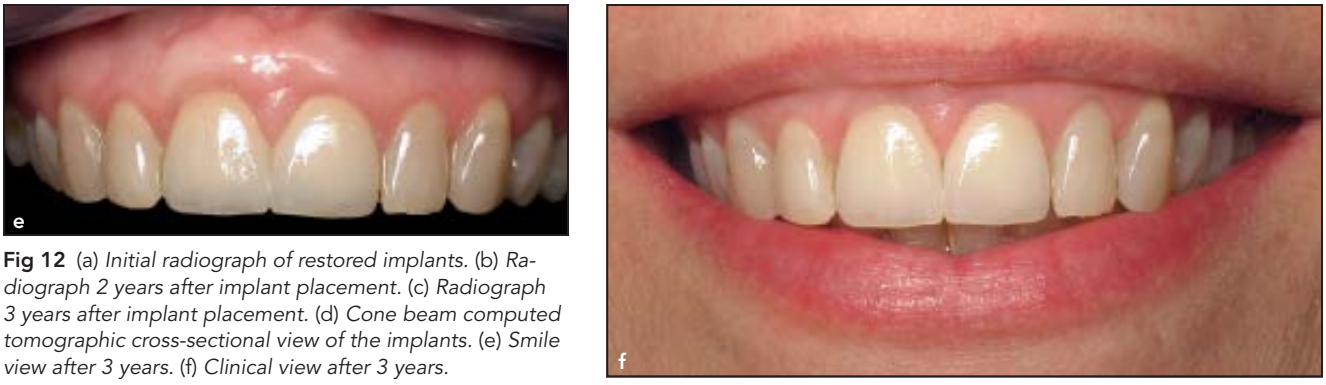


Fig 12 (a) *Initial radiograph of restored implants.* (b) *Radiograph 2 years after implant placement.* (c) *Radiograph 3 years after implant placement.* (d) *Cone beam computed tomographic cross-sectional view of the implants.* (e) *Smile view after 3 years.* (f) *Clinical view after 3 years.*

the laser microchannels on the abutment surface reduces or eliminates inflammatory infiltrates normally associated with the implant-abutment junction microgap. Thus, the laser-microchannel abutment together with platform switching may act synergistically to preserve the bone.

The 3-year results of the case shown in Figs 7 to 12 demonstrated radiographic stability of cervical bone and the competent position of the interproximal papilla.

Conclusions

The results of this prospective clinical and radiographic assessment study reflect and support the histologic findings of the preclinical investigation with the laser-microchannel finish on the implant-abutment complex. Radiographic and photographic evidence provide an optimistic outlook for this system. Most cases demonstrated intact interdental papillae and no loss of bone apical to the collar of the implant. There was a minor loss of

bone to the first thread of four implants and to the second thread of one implant. No recession was evident in any of the implants. There was a lack of total interproximal soft tissue papillae in 3 of the 38 cases.

Acknowledgments

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