Efficacy of a New Papilla Generation Technique in Implant Dentistry: A Preliminary Study

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Purpose: *To compare the efficacy of a new uncovering technique with that of the conventional uncovering technique for papilla generation.* ***Materials and Methods:*** *Thirty-three patients with 67 implants were enrolled in the study. Patients were randomly assigned to 1 of 2 treatment groups (test and control). Implants of the test group were uncovered by the new technique and implants of the other group uncovered by the conventional technique (simple midcrestal incision). The height of each papilla after uncovering at baseline, 3 months, and 6 months and the thickness of the tissue covering the implant prior the uncovering were measured. PPD, PI, GI, and BOP measurements were made at 0 and 6 months, and standardized radiographs were obtained at 0, 3, and 6 months. Subject means were used for all statistical analyses.* ***Results:*** *The mean difference between the 2 surgical methods revealed that the new technique provided 1.5 mm greater papilla height (*P < *.001) at all 3 visits (baseline, 3, and 6 months) for implants adjacent to teeth. An overall significant difference for papilla height between the implants was detected between the 2 groups (*P = *.02). There was no significant difference between the 2 groups with regard to PPD, PI, GI, BOP, thickness of soft tissue, or overall bone level measurements during the course of the study.* ***Conclusion:*** *Based on this study, it appears that over the course of 6 months, the new surgical approach for uncovering leads to a more favorable soft tissue response.* Int J Oral Maxillofac Implants 2008;23:926–934

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Many researchers have suggested that papilla height is a predetermined factor,[1,2] thereby challenging whether a soft tissue operation has any effect on the generation of an interproximal papilla.

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The simplest uncovering method is the conventional midcrestal uncovering method.[3,4] Although highly predictable, it is not capable of generating papillae. Current data suggest that papilla generation in implant dentistry is only possible when adequate bone is available to support the soft tissue.[1,2]

Salama et al proposed a method for papilla generation at the first stage of implant surgery in which a healing abutment is buried beneath the gingival flap to produce a dead space. This space is filled by soft tissue, which adds to the height of the future papilla.[5] Other methods that were inspired by periodontal plastic surgery have been introduced for use during second-stage implant surgery.[6–10]

This study introduces a new flap design and a sutureless technique for papilla generation, which can be used for single and multiple implants during second-stage surgery. The goal is to form a natural-looking soft tissue margin buccally and palatally around the implant, and to reconstruct the interproximal papillae between an implant and adjacent implants or teeth. The advantages of this new method are decreased chair time, less postoperative

discomfort, and better esthetics. This method does not require suturing, as using sutures can be traumatic, trigger inflammation, increase the amount of postoperative discomfort, and negatively affect the outcome of the papilla generation procedure.[11]

The purpose of this prospective randomized controlled study was to compare the efficacy of a new uncovering technique for papilla generation with the conventional midcrestal uncovering technique in a 6-month clinical trial.

MATERIALS AND METHODS

Thirty-three patients who had already received 67 implants—37 Biomet 3i (Palm Beach Gardens, FL) and 30 Centerpulse (Zimmer Dental, Carlsbad CA)—were selected for the study. The present investigation was designed as a prospective randomized controlled blinded study at the time of second-stage (uncovering) surgery. All implants were placed 4 months prior to uncovering in the mandible and 6 months prior to uncovering in the maxilla in the Graduate Periodontology Clinic at Boston University. The following selection criteria were used: Inclusion criteria were minimum of 3 mm distance between adjacent implants[12] and 2 mm between an implant and a tooth,[13] adequate keratinized tissue, and a minimum soft tissue thickness of 2 mm over the implant(s). Exclusion criteria were absence of keratinized tissue on the crestal ridge, significant medical history, pregnancy, need for premedication prior to dental procedures, diseases of the soft or hard oral tissues, orthodontic appliances, antibiotherapy within 1 month or during the study period, and participation in another clinical trial.

All participants completed the informed consent form approved by the internal review board of Boston University and were operated on by the same clinician (PS).

Using the randomized controlled stratified blinded clinical study protocol for uncovering, patients were distributed into a test and a control group. All patients required partial arch replacement, except for 1 who received a complete maxillary arch replacement. Two clinicians performed all procedures and measurements at the baseline after random distribution of the patients. Preoperative intraoral and postoperative photographs were taken at baseline (prior to second-stage surgery) and repeated at the 3- and 6-month follow-up visits. Periodontal pocket depth (PPD), Plaque Index (PI),[14] Gingival Index (GI),[15] and bleeding on probing (dichotomous score of 0 or 1 indicating whether or not the site bled on probing) were measured at baseline prior to the second-stage surgery and repeated at the 6-month follow-up visit. Oral hygiene maintenance was reinforced at each visit. Standardized periapical radiographs were taken to assure the proper positioning of the healing abutments and enable evaluation of any bone-level alterations around implants. To standardize the geometry, a vinyl polysiloxane impression material (GC America, Alsip, IL) was used. All radiographs were obtained with an x-ray unit (Gendex) operating at 70 KV, 7 mA, 1.4 seconds. After the induction of local anesthesia, the position of the submerged implant was determined using a periapical radiograph and ridge mapping.[16]

Following the initial incision(s), the thickness of the tissue was recorded by applying a plastic probe (Biomet 3i, Palm Beach Gardens, FL) and a tissue gauge caliper. Implants were uncovered based on the following protocol.

- *The conventional uncovering technique (control group):* The implants in the control group were uncovered with a conventional uncovering technique. In this procedure the implants at edentulous locations were simply uncovered using a midcrestal incision only. At locations with adjacent dentition, a midcrestal incision with proximal intrasulcular incision(s) at the adjacent tooth or teeth were used. Flaps were raised and proper healing abutments were placed. Flaps were sutured with 4-0 silk sutures. Patients then received postoperative instructions and were scheduled for a follow-up visit within 7 to 10 days.
- *The new surgical uncovering technique (test group):* The new technique (Figs 1 to 9) was used to uncover the implants in the test group. In this procedure the goal was to guide the soft tissue that formerly covered the implant over to the sides of the implant and to plump up this piece of tissue after inserting the healing abutment. This was done to provide enough soft tissue interproximally to allow for papilla generation.

  - *Single implant model (Figs 10a to 10d):* From the occlusal view, a small "U"-shaped flap was created to allow mobilization of the tissue in the mesial direction. Another U-shaped flap, mirroring the first and sharing in common the buccolingual incision, permitted mobilization of the tissue distally. Combined, these side-by-side full or partial thickness U-shaped flaps formed an "H"-shape design from the occlusal view.
  - *Multiple implant model (Figs 11a to 11d):* The covering tissue of the most mesial implant provided the mesial papilla of that implant utilizing the U-shape design. The second implant pro-

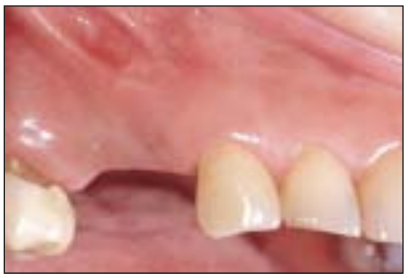


Fig 1 Preoperative buccal view.

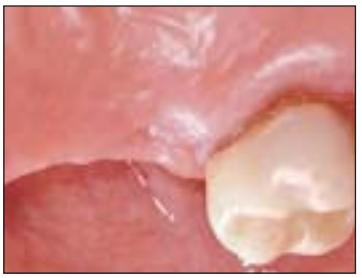


Fig 2 Preoperative palatal view.

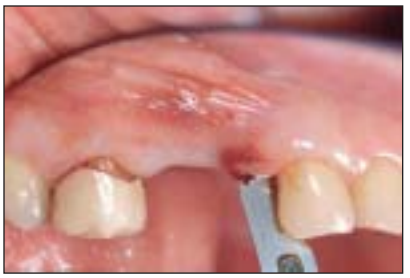


Fig 3 Entry mesiobuccal incisions.

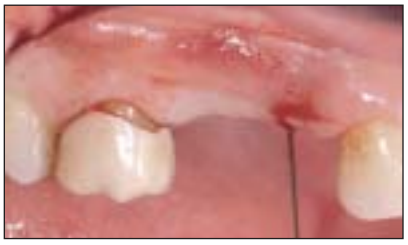


Fig 4 Buccolingual incisions.

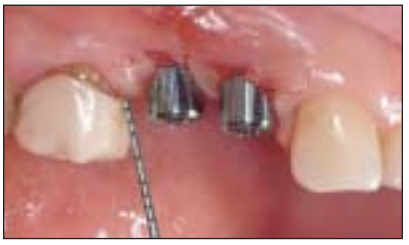


Fig 5 Healing abutments in place.

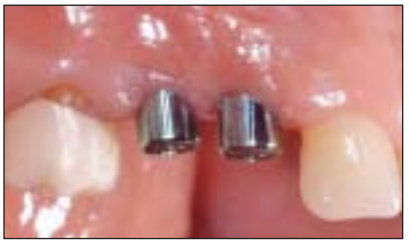


Fig 6 Two weeks postoperation.

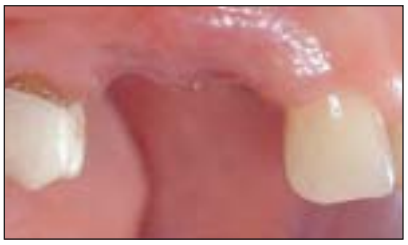


Fig 7 Five months postoperation, buccal view.

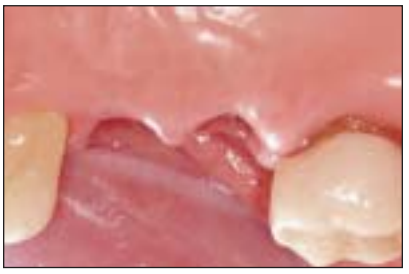


Fig 8 Five months postoperation, palatal view.

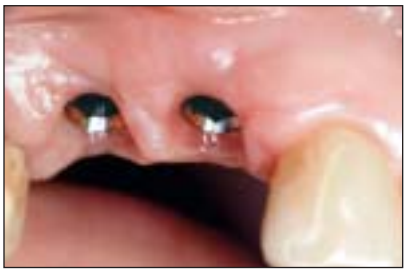
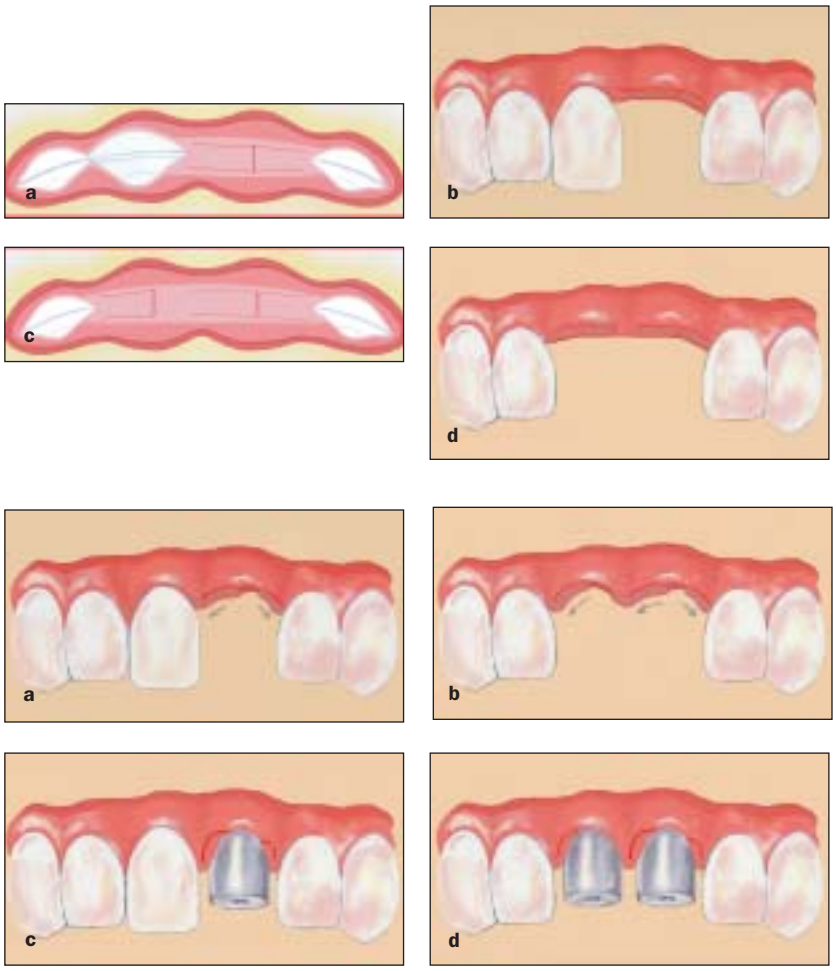


Fig 9 Five months postoperation, occlusal view.

vided the distal papilla of the first (which was also the mesial of the second), also utilizing the U-shape design. The third implant provided the distal papilla of the second implant (also the mesial papilla of the third) in the same manner, and so on.

For both models the initial incisions were made using a no. 15 blade and were as follows:

1. The entry incision was in a mesiodistal direction on the buccal side. By inserting the blade at almost a 45-degree angle, the tip of the blade could be used to feel the occlusobuccal line angle of the alveolar ridge. The incision continued in a slight parabola buccally when there was adequate keratinized gingiva on the buccal side to create a gingival margin around the implant. The incision continued in a slight parabola palatally if there was not enough amount of the keratinized gingiva on the buccal aspect. Precautions were taken to preserve buccal keratinized tissue. The incision passed the mesial or distal platform of the implant and ended halfway between the platform and the adjacent implant or tooth (Drawing Figs 10a, 10b, 11a, and 11b).
2. A mesiodistal incision on the lingual (palatal) aspect in the same manner as described parallel to the incision on the buccal side was placed. The incision for the anterior implants curved slightly off buccally in the middle, as the top of the papilla should be smaller than its base in the buccolingual direction. In posterior implants, the incision was also placed slightly palatally, since the width of the platform of a posterior implant is usually smaller than the width of its crown. This was essential in gaining an adequate buccolingual (palatal) papilla to cover the interproximal space (Figs 10a, 10b, 11a, and 11b).



Figs 10a and 10b Single implant model, incision outlines.

Figs 10c and 10d Multiple implant model, incision outlines.

Fig 11a Single implant model, mini-flap elevation.

Fig 11b Multiple implant model, mini-flap elevation.

Fig 11c Single implant model, healing abutment placement.

Fig 11d Multiple implant model, healing abutment placement.

3. A buccolingual incision was made for each implant perpendicular to the 2 first incision lines (mesiodistal incisions). The location ranged from the mesial or distal edge of the platform of the implant to the middle of the platform, depending upon the amount of tissue needed between implants or between the implant and the adjacent tooth (Figs 10a, 10b, 11a, and 11b).
4. Flaps were elevated using the side of the scalpel and an Orban's knife. First, the soft tissues were reflected from the underlying implant, then each mini-flap was undermined with the no. 15 blade and the Orban's knife, and the full- or partial-thickness mini-flap was extended to about 1 mm away from the adjacent implant or tooth (Figs 10c and 11c).

Flaps were mobilized and pushed in the mesial and distal directions to open a window for uncovering. Application of gauze in the area for a few minutes facilitated molding of the tissue while pushing the tissue to the sides. In some cases, the resiliency of the flaps to be accommodated in the interproximal space was inadequate. In those cases, the middle of the flap, the epithelium, was incised across the flap parallel to the buccolingual incision. This increased the flexibility of the flaps, since connective tissue is quite maleable. After removing the cover screw, a healing abutment with a proper height, width, and shape was placed onto the implant. This shaped the future papilla by pushing the tissues to the sides and holding them upright. The same technique was repeated for implant(s) distal to the first mesial implant, until the most distal implant or tooth adjacent to implant(s). No sutures were required, since healing abutments held the tissue in the proper position (Figs 10d and 11d).

Patients then received postoperative instructions and were scheduled for a follow-up visit within 7 to 10 days.

Following the uncovering procedure, the distance from the highest point of the papilla to the top of the healing abutment was measured by placing a plastic probe (Biomet 3i, Palm Beach Gardens, FL) vertically

on the 4 corners of each healing abutment (mesiobuccal, mesiolingual, distobuccal, and distolingual). Then, the height of the papilla relative to the platform of the implant was calculated by adding that number to the height of the healing abutment provided by the manufacturer. If the implant was situated at the end of the arch, the distal papilla was excluded. Healing abutments were used in all cases, and no provisional restorations were used during this study.

Subsequently, during the 3- and 6-month follow-up visits, a separate examiner (KB) who was blinded to the uncovering techniques removed the healing abutments and made all measurements. All papilla measurements (from the tip of the papilla to the platform of the implant buccally and lingually) were rounded off to the nearest millimeter. In the case of 2 adjacent implants, each papilla was measured against the contralateral side of the implant platform.

Following evaluations at intervals of 3 months that included standardized radiograph(s) and papilla height measurements, patients were referred to the prosthodontic department for fixed prosthetic construction.

At 6 months, the final evaluation of all patients was repeated. PPD, GI, PI, and bleeding on probing were measured, and standardized radiographs were obtained. Papilla height measurements were performed in the same manner at the 3- and 6-month follow-ups.

Subject means were used for all analyses. Summary statistics were computed for papillae height by location (between implant and tooth versus between implant and implant) and treatment group. Initial testing was conducted using independent sample *t* tests at each time point. Further analysis was conducted using repeated-measures analysis of variance. Summary statistics for clinical measures (PI, GI, bleeding on probing, probing depth) were also computed at baseline and after 6 months. Mean clinical measures, calculated by treatment group at baseline and 6 months, were compared using independent sample *t* tests. Similarly, summary statistics for bone levels (mesial, distal, and overall) and healing abutment (mesial, distal, and overall) at 3 and 6 months were computed by treatment group and compared at each time point using independent sample *t* tests. $P < .05$ was considered to indicate statistical significance.

RESULTS

Thirty-three subjects, 12 female and 21 male, age range 18 to 78 years, with 67 implants to be exposed were enrolled in the study. Forty implants in 17 subjects were exposed using the standard technique while the remaining 27 implants in 16 subjects were exposed using the new technique. Of the 40 implants exposed using the standard technique, 32 were multiple implants in 9 subjects. Of the 27 implants exposed using the new technique, 20 were multiple implants in 9 subjects. The average age of subjects was 55.3 years (median, 56 years; SD, 16.6; range, 18 to 78 years). The average age of subjects with implants exposed using the standard technique was 57.9 years (median, 56 years; SD, 15.9; range, 27 to 78 years), while the average age of subjects with implants exposed using the new technique was 52.6 years (median, 58.5 years; SD, 17.4; range, 18 to 77 years). An independent sample *t* test revealed no significant difference in age between the 2 treatment groups ($P = .366$).

Three patients with 7 implants at 3 months and 2 subjects with 4 implants at 6 months dropped from the study.

At the time of the 3-month follow-up examination, 1 of the test patients with 2 implants had moved to a different country, another patient from the same group with 2 implants was excluded because of a previously undetected infection around the implants, and 1 of the control patients with 3 implants withdrew from the study for personal reasons. At 6 months, 1 of the control patients with 2 implants dropped out for personal reasons and another with 2 implants from the same group dropped out because of an infection caused by the proximity of an endodontically compromised tooth.

One patient had received his definitive fixed partial prosthesis at 6 months; it was removed and papillae measurements were performed. All other patients still had the healing abutments in place at the 6-month recall appointment.

The mean difference between the test and control groups for papillae height between implant and tooth was 1.41 mm ($P = .001$) at baseline, 1.76 mm ($P < .001$) at 3 months, and 1.71 mm at 6 months ($P < .001$).

Average papillae heights were calculated for each subject by location (adjacent to tooth versus adjacent to implant) and by surgical technique (standard versus new). The summary statistics were then computed from subject means, and comparisons were conducted using independent sample *t* tests (Table 1). A significant difference in papillae height between the 2 treatment groups was detected for implants adjacent to teeth ($P < .001$). However, no change in papillae height was detected over time ($P = .856$) or by treatment group over time ($P = .788$). Repeated-measures analysis of variance was also conducted for papillae height for implants adjacent to implants over time. A

Table 1 Average Papilla Height by Location and Surgical Method

Location and method	n	Mean	Median	SD	Range	*P*
Baseline						
Implant and tooth						
Control	14	3.32	3.33	1.13	1.0 to 5.5	.001
Test	14	4.73	5.00	0.94	2.5 to 6.0	
Implant and implant						
Control	12	2.90	2.69	1.13	1.5 to 4.5	.01
Test	9	4.04	4.00	0.79	3.1 to 5.6	
3 months						
Implant and tooth						
Control	12	3.12	3.46	1.08	1.0 to 4.3	< .001
Test	13	4.88	5.00	1.04	3.5 to 6.5	
Implant and implant						
Control	9	2.39	2.50	0.71	1.0 to 3.2	.012
Test	8	3.50	3.38	0.89	2.5 to 5.0	
6 months						
Implant and tooth						
Control	11	3.02	3.00	1.11	1.0 to 4.0	< .001
Test	12	4.73	4.63	0.75	4.0 to 6.0	
Implant and implant						
Control	8	2.66	2.50	0.78	1.8 to 4.3	.138
Test	8	3.44	4.00	1.15	1.8 to 4.5	

Table 2 Average PI, GI, Bleeding on Probing (%), and Clinical Probing Depth Over Time by Treatment

	n	Mean	Median	SD	Range	*P*
Average PI						
Baseline						
Control	17	1.39	1.29	0.84	0.23 to 3.98	.87
Test	16	1.35	1.39	0.77	0.25 to 3.10	
6 months						
Control	14	0.80	0.70	0.33	0.36 to 1.58	.81
Test	14	0.77	0.75	0.30	0.35 to 1.31	
Average GI						
Baseline						
Control	17	1.03	1.00	0.36	0.50 to 1.69	.78
Test	16	1.00	0.97	0.30	0.57 to 1.66	
6 months						
Control	14	0.73	0.73	0.15	0.48 to 1.09	.90
Test	14	0.74	0.74	0.16	0.40 to 0.92	
Average bleeding on probing (%)						
Baseline						
Control	17	5.5	0	12.0	0 to 48	.25
Test	16	13.0	0	22.7	0 to 73	
6 months						
Control	14	6.3	5	4.3	0 to 13	.05
Test	14	10.8	8.5	7.1	1 to 26	
Average probing depth						
Baseline						
Control	17	2.27	2.22	0.25	1.83 to 2.92	.37
Test	16	2.17	2.12	0.38	1.74 to 3.34	
6 months						
Control	14	2.02	2.03	0.40	1.23 to 3.06	.82
Test	14	2.04	2.04	0.17	1.69 to 2.30	

significant difference in papillae height between the 2 treatment groups was detected for implants adjacent to other implants ($P = .020$). However, the change in papillae height between adjacent implants over time did not achieve statistical significance ($P = .062$), and no significant change in papilla height over time by treatment group was detected ($P = .445$). There is a possibility that these statistically significant results are in direct correlation with the small number of subjects used in this preliminary study.

Table 3 Average Bone Level Over Time by Treatment

Average Probing Depth	n	Mean	Median	SD	Range	*P*
Mesial bone level						
3 months						
Test	14	−0.08	0.00	0.21	−0.66 to 0.25	.38
Control	15	−0.16	−0.17	0.29	−0.63 to 0.49	
6 months						
Test	14	−0.27	−0.10	0.51	−1.32 to 0.25	.99
Control	14	−0.28	−0.16	0.35	−0.99 to 0.33	
Distal bone level						
3 months						
Test	12	−0.09	0.00	0.15	−0.49 to 0.00	.22
Control	12	−0.22	−0.16	0.33	−0.99 to 0.25	
6 months						
Test	12	0.00	0.00	0.68	−1.07 to 1.92	.79
Control	12	−0.06	−0.12	0.39	−0.50 to 0.99	
Overall bone level						
3 months						
Test	14	−0.10	−0.06	0.20	−0.66 to 0.16	.18
Control	15	−0.20	−0.16	0.21	−0.50 to 0.08	
6 months						
Test	14	−0.17	−0.07	0.57	−1.32 to 1.08	.91
Control	14	−0.19	−0.16	0.32	−0.74 to 0.50	

Table 4 Tissue Thickness at Baseline by Surgical Method

Tissue thickness	n	Mean	Median	SD	Range	*P*
Implant and tooth						
Control	14	3.43	3.38	0.96	2.0 to 5.5	0.22
Test	14	2.96	2.75	1.03	2.0 to 4.5	
Implant and implant						
Control	12	2.60	2.53	0.77	1.8 to 4.5	0.60
Test	9	2.44	2.50	0.62	1.5 to 3.8	

Summary statistics of measured periodontal indices over time by treatment group are presented in Table 2. Based on independent samples *t* tests, no significant differences were detected for any of these clinical measures.

Summary statistics for bone level at 3 and 6 months were calculated by treatment group and are presented in Table 3. No significant differences in bone level were detected.

Average preoperative tissue thickness by location and surgical technique was also calculated. The summary statistics with corresponding *P* values from independent samples *t* tests are presented in Table 4.

Generally, the surgical procedures were uneventful, and patients did not have any specific postoperative complications at any time during the study.

DISCUSSION

The new surgical uncovering technique yielded significantly better results compared to the conventional midcrestal implant uncovering technique (Figs 12 and 13). This is the first study that provides data comparing papilla generation between implants and teeth and between 2 adjacent implants. The study also shows that papilla generation between an implant and a tooth is more predictable than between 2 adjacent implants. This finding is in accordance with other studies about the soft tissue margins. In a study of 53 single-tooth replacements,[17] a majority of the implant-supported crowns (75%) showed soft tissue margin stability during a 5-year follow-up period. These results were different from other studies in which the soft tissue alterations in subjects with multiple implants were investigated.[18,19] Such findings may lead one to conclude that, overall, soft tissues around single implants are more stable and predictable than soft tissues around multiple implants. Avivi-Arber et al,[20] in a study of single implants, proposed that the soft tissue positioning in proximal sites of an implant-supported single crown restoration is likely influenced by the level of periodontal support of the adjacent teeth. It was also noticed that generated papillae between implants were more stable and had better shapes

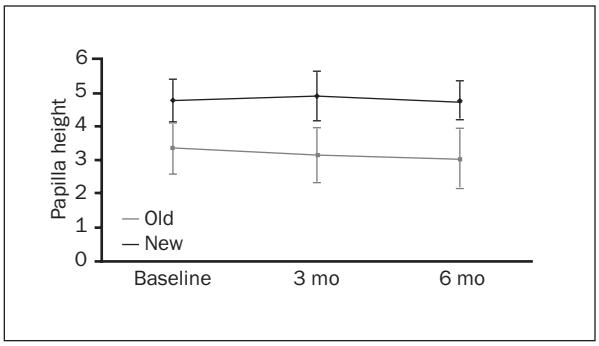


Fig 12 Papilla height between implant and tooth over time by surgical method.

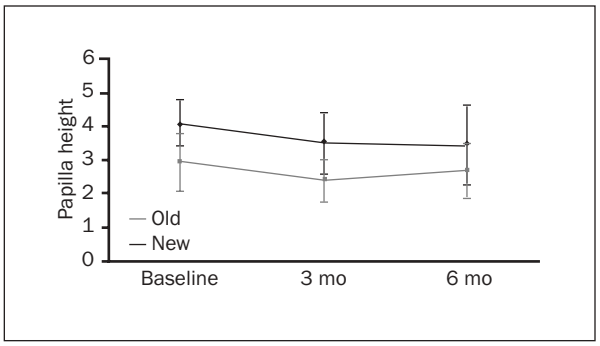


Fig 13 Papilla height between implants over time by surgical method.

when they had a broader keratinized tissue. Therefore, it seems that the presence of abundant keratinized tissue plays a large role in papillae development. Further investigations are necessary to confirm this hypothesis.

A potential drawback of the study was the inclusion of 2 different types of implants. The bone level at the neck of the 3i external-hex implants is determined by the microgap between the implant and the abutment, while with the Zimmer internal hex it is determined by the rough/smooth border.[21,22] The inclusion of 2 different implant systems may have played a role in the outcomes of the study. Further studies are necessary to elucidate this possibility.

One of the determining factors when restoring an implant-supported crown is the thickness of the covering tissue before implant placement. The thickness of the tissue can be influenced by several factors: the previous height of the alveolar bone, the relationship to the adjacent teeth,[20] the type of periodontal biotype before extraction,[23] and the pattern of bone loss pre- or postextraction. Surgical indexing of the implants during stage-1 surgery is preferable. This approach has the benefit of immediate insertion of fixed prosthetics after uncovering to provide better esthetics, increase the patient's comfort, and facilitate better oral hygiene. In addition, it allows for a better control of the provided space with which to accommodate generated papilla.[24,25]

A survey of the literature shows 3 main surgical methods aimed at papilla generation. Palacci et al suggested that a full-thickness flap be raised from the buccal and palatal side of the implant on the ridge and rotated 90 degrees to accommodate the interproximal space of the implant.[7] Adriaenssens et al introduced the "palatal sliding strip flap" to form papillae between implants and between natural teeth on the anterior area of the maxilla. In this technique the palatal mucosa slides in a labial direction.[8] Nemcovsky et al made use of a U-shaped incision.[6] The nature of this design was essentially the same as the surgical approach introduced earlier by Adriaenssens, but with some minor differences.

Temporization of the implant at uncovering has the benefit of providing better esthetics and improving patient comfort and oral hygiene. In addition, there is more control of the provided space to accommodate the generated papilla. Furthermore, by adding acrylic resin on a weekly basis, the generated papilla may be molded until it reaches a favorable form.[26,27]

Some authors have suggested that the reason for papilla growth between implant and tooth may be related to postoperational persistent inflammation.[9,28,29] This has been challenged by Cooper et al in a 3-year prospective multicenter investigation of 1-stage single implants. They demonstrated that despite the fact that the surfaces with inflammation decreased, a mean gain in papilla length of 0.61 mm occurred.[30]

CONCLUSION

In the present preliminary study, the efficacy of a new uncovering technique was compared to the conventional uncovering technique for papilla generation between implants and between implants and teeth. The results showed that the mean gain in papilla height favored the new technique and was statistically and clinically significant at 6 months. The results also suggested that a papilla between an implant and a tooth is more stable and predictable than a papilla between implants.

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