Clinical Coverage of Dehiscence Defects in Immediate Implant Procedures: Three Surgical Modalities to Achieve Primary Soft Tissue Closure

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In 61 patients, 61 consecutive implants were placed immediately after extraction of one anterior or premolar maxillary tooth. One of 3 surgical approaches based on rotated full (RPF) or rotated split (RSPF) palatal flaps, with and without the use of barrier membranes to enable primary soft tissue closure, was applied. A bovine bone mineral graft was used in all cases. At the time of implant placement, the distance between the most apicobuccal alveolar crestal bone and the coronal aspect of the implant body was measured; this was measured again at second-stage surgery. All implants appeared clinically stable. The buccal crestal bone gain was statistically significant for all groups (RPF = 2 mm, RSPF = 1.6 mm, RSPF with membrane = 3.7 mm) (P < .001). Analysis of covariance showed a significant covariant for preoperative measurements; however, this was not significant between groups. (INT J ORAL MAXILLOFAC IMPLANTS 2000;15:843–852)

Key words: *alveolar process, endosseous dental implantation, oral mucosa, oral surgical procedures*

Implant placement immediately after tooth extraction has proven to be a successful treatment modality.[1–9] The number of surgical appointments and the duration of the surgical-restorative procedure are reduced, thus presenting esthetic and functional benefits.[1,3,4]

An occlusive barrier membrane is not always necessary in small bony enveloped defects encountered while placing implants in fresh extraction sites.[8–13] However, larger defects are usually treated with a barrier membrane with or without the use of bone grafting materials.[2,7,14–18] Even a staged approach, in which localized ridge augmentation is performed to obtain proper soft and hard tissue anatomy prior to implant placement, may be indicated.[19–21]

Since many complications can arise because of the lack of complete flap closure over the implant and/or barrier membranes, primary flap closure is important in immediate implant procedures.[3,5,9,12–14,17,18,22,23] Early exposure of implants and/or membranes has a detrimental effect on the bone regeneration process.[12,13,15,17,18,23–29] Several different flap designs have been described to achieve primary closure.[10–14,30–33] Surgical procedures to achieve primary soft tissue closure in immediate implant procedures in the maxillary anterior area, with and without the use of membranes, have recently been reported.[11,12]

The clinical results of 3 surgical approaches based on rotated full-thickness or split-thickness palatal flaps (plus the latter with a barrier membrane) were evaluated and compared for their ability to enable primary soft tissue closure and clinical coverage of dehiscence defects after placement of single implants into maxillary fresh extraction sockets.

MATERIALS AND METHODS

In 61 patients (mean age 46.2 years, SD 10.21), 61 consecutive implants were placed into fresh extraction sites. All patients willing to participate in the study signed an informed consent form. The Ethics Committee of the University approved the study. Criteria for accepting participants included no evidence of

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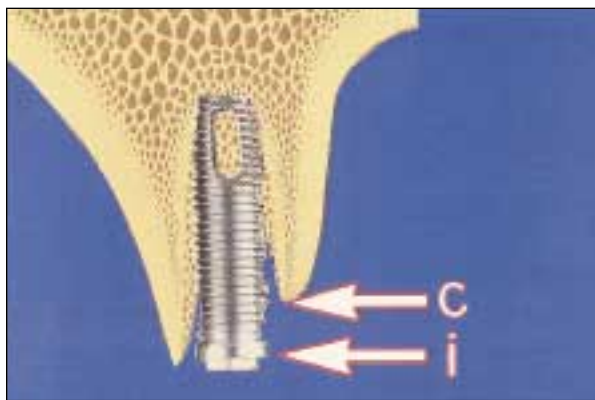
Fig 1 Diagram of buccopalatal view. The distance between arrows, from the most apical aspect of the buccal crest (c) to the top of the implant body (i), was measured.

draining fistulae and/or acute signs of inflammation in the treatment area, no clinical or radiographic signs of active periapical pathosis, and no systemic contraindications for implant surgery. Heavy smokers (more than 10 cigarettes a day) were excluded.

Implants were procured from Calcitek (Carlsbad, CA; n = 23) and Steri-Oss (Yorba Linda, CA; n = 38) and were either cylindric (n = 7) or screw-type (n = 54). Surfaces were microtextured titanium (n = 13), titanium plasma-sprayed (n = 38), or hydroxyapatite-coated (n = 10). Implant diameters were 4 mm (cylindric), 3.75/3.8 mm, or 4.5 mm, and implant length ranged from 12 mm to 16 mm (4 = 12 mm, 10 = 13 mm, 16 = 14 mm, 13 = 15 mm, and 18 = 16 mm). Different implant types and manufacturers were not compared because of the small groups within each treatment modality.

A single implant was placed in the same clinical session in each patient immediately after tooth extraction. Where more than 1 immediate implant was placed, only the first was considered for the study. Implants were placed into the prepared sites, leveled or 1 mm apical to the height of the most coronal wall of the proximal bony housing, but not less than 3 mm apical to the buccal gingival margin of approximal teeth.[34] Primary implant stabilization was achieved for all implants.[35] After implant placement, the location and distance from the most apical aspect of the buccal crestal bone to the top of the implant body were measured (Fig 1). A millimetric periodontal probe (Williams, Hu-Friedy Mfg Co, Chicago, IL), placed parallel to the long axis of the implant, was used.

Three groups were established according to the surgical technique applied for primary soft tissue closure over the implant site. The decision as to which technique was used was based on the thickness of palatal tissues and size of the dehiscence defect.

- Group 1 (n = 18 sites): rotated split palatal flap (RSPF) without membrane
- Group 2 (n = 18 sites): RSPF with membrane
- Group 3 (n = 25 sites): rotated palatal flap (RPF) technique

The thickness of the palatal gingiva in the treatment area was determined by sounding after administering a local anesthetic agent. Patients presenting with more than 4 mm of gingiva were treated with one of the RSPF procedures; otherwise, a technique using an RPF was applied. The decision as to whether to use a membrane (groups 1 and 2) was based on the dimensions of the bony defect around the implant. No membrane was used if the implant was placed within a bony envelope. A resorbable collagen membrane (Bio-Gide, Geistlich Söhne AG, Wolhusen, Switzerland) was used (group 2) for larger defects (exceeding a 4-mm-width dehiscence) and/or where the bony housing was partially missing and more than one-fourth of the implant perimeter was exposed beyond the bone envelope at its final position.

A porous bovine bone mineral (Bio-Oss, Geistlich Söhne AG) was used as the grafting material in all patients. The material was lightly packed to fill only the coronal gap between the implant and the bony walls of the fresh extraction site and to support the membrane (group 2) when used. Second-stage implant exposure was accomplished between 6 and 8 months after the first procedure. At this time, the vertical distance between the implant platform and buccal crestal bone was remeasured. The difference between measurements was calculated and the clinical coverage of the defects was estimated. The distance was considered to be zero even when the new bone covered part of the cover screw of the implant body at second-stage surgery. Since the preoperative values differed between the groups, statistical analysis consisted of 1-way analysis of variance, followed by multiple comparisons, Tukey's method, and analysis of covariance (ANCOVA) (with groups as main effects and preoperative distances as covariates).

Procedures have been presented in detail in previous studies.[12,13]

Surgical Techniques
Group 1. Mean patient age was 46. 2 years (SD 7.45). Teeth were extracted from the maxillary anterior or premolar region: 8 central and 2 lateral incisors, 4 canines, and 2 first and 2 second premolars.

An intrasulcular incision was made around the maxillary tooth to be extracted and the proximal palatal aspect. Maximum soft tissue, including interdental papillae, was preserved. A full-thickness mucoperiosteal palatal flap was raised, extending at least one tooth mesially and distally from the tooth to be extracted. A minimal buccal flap, including only interdental papillae and marginal gingiva, exposing the bone crest, was also reflected. The tooth was carefully extracted, and granulation tissue, epithelium, and bone-inserting Sharpey's fibers were curetted. The receptor site was prepared and the implant was placed, slightly palatally off-centered, according to the aforementioned protocol (Fig 2a).

The palatal flap was split into two. The deeper flap contained periosteum and the inner part of the subepithelial connective tissue, and the superficial flap contained epithelium and the superficial part of the connective tissue. A second incision, involving only the deeper flap, further disconnected these 2 flaps (Fig 2b). The deeper flap was thus transformed into a pediculated one, becoming mobile and easily rotated (Fig 2c). Because of the blood supply, the pedicle should preferably be distal to the midline to receive nourishment from the palatal arteries.

Bovine bone mineral was used to graft the exposed part of the implant. The RSPF was tucked and sutured under the minimally reflected buccal flap, covering the augmented implant site (Fig 2c). The superficial layer of the palatal flap was then repositioned (Figs 2d and 2e) and sutured. Consequently, complete primary soft tissue closure over the implant site was achieved (Figs 2f and 2g).

Group 2. Mean patient age was 45.9 years (SD 13.19). Teeth were extracted from the maxillary anterior or premolar region: 5 central and 3 lateral incisors, 3 canines, and 4 first and 3 second premolars. In these patients, a resorbable collagen barrier membrane was applied.

Incisions were made and the implant site was prepared similar to group 1 (RSPF without membrane). However, in these patients, a larger exposure of the buccal bone was needed. Following preparation of the receptor site and implant placement, an occlusive membrane was adapted and fitted. The implants and bone graft material supported the membrane; therefore, there was no need for fixation or further support. The RSPF was placed covering the membrane and then tucked and sutured under the buccal flap. The superficial layer of the palatal flap was then repositioned and sutured. Complete primary soft tissue closure over the barrier membrane, covering the implant site, was achieved.

Group 3. Mean patient age was 45.7 years (SD 9.99). Teeth were extracted from the maxillary anterior or premolar region: 7 central and 5 lateral incisors, 4 canines, and 5 first and 4 second premolars.

An intrasulcular incision was made around the maxillary tooth to be extracted and the proximal palatal aspect of the adjacent teeth. A minimal buccal flap, including only interdental papillae and marginal gingiva, exposing the bone crest, was reflected. The tooth was carefully extracted, and granulation tissue, epithelium, and bone-inserting Sharpey's fibers were curetted. The implant receptor site was conventionally prepared to allow implant placement slightly off-centered, palatally in the fresh extraction site (Fig 3a). A sharp internal beveled incision delineating a pediculated full-thickness palatal flap was made (Figs 3b and 3c). The extension was sufficient to allow complete coverage of the alveolus and overlapping of the crestal buccal bone. An oblique proximal incision facilitated rotation of the pedicle, which was wider than 5 mm (Fig 3d).

Bone grafting material filled the occlusal part of the gap between the implant and the bony walls of the tooth socket and, when present, dehiscence of the buccal plate causing implant exposure. The RPF was tucked and sutured under the minimally reflected buccal flap covering the grafted implant site, achieving primary soft tissue closure (Fig 3e). The portion of the RPF covered by the buccal flap was de-epithelialized before suturing. Further sutures secured the RPF in the palatal tissues. The donor palatal site, which was left exposed, healed by secondary intention.

RESULTS

Clinical healing of defects was evident at the time of implant uncovering (Figs 4a and 4b). Mean values of crestal bone/implant distance obtained at both measurements for all groups are presented in Table 1 and Fig 5.

Group 1
During follow-up visits, uneventful soft tissue healing was observed, and the pediculated flap esthetically blended with the surrounding tissue as it became secondarily epithelialized. At second-stage surgery, all implants were clinically stable. Additional bone and/or soft tissue augmentation procedures were not necessary.

Partial sloughing of the palatal flaps was observed at 4 sites (22%). During healing, there was spontaneous exposure of the cover screws of 2 of

Fig 2a After tooth extraction and preparation of the site, an implant was placed extending apically to the end of the alveolus. A small buccal dehiscence is present, and the implant perimeter is smaller than the fresh extraction site. Note minimal reflection of buccal flap.
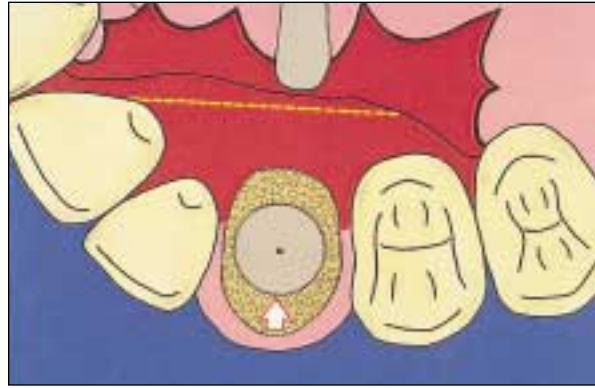

Fig 2b Diagram of full-thickness palatal flap raised and subsequently split into superficial and deep flaps. Another incision involving only the deep flap *(dotted line)* creates a pediculated flap. An implant is then placed *(arrow)*.

Fig 2c The pediculated split-thickness deep palatal flap is mobile and easily rotated in the direction of the curved arrows, covering the implant (and bone graft, if applied), which is placed into the fresh extraction socket *(arrow)*.

Fig 2d The pediculated deep split-thickness palatal flap is rotated to cover the implant.
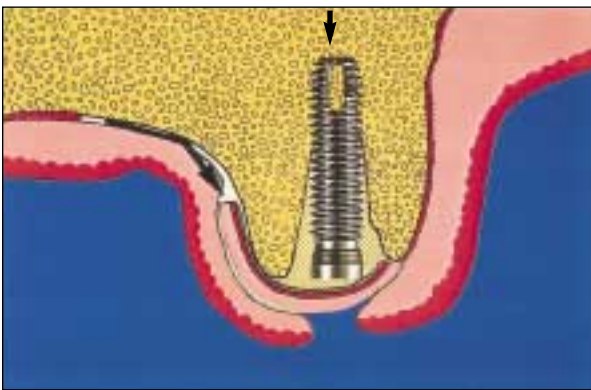
Fig 2e Sagittal view in center of alveolus. The implant is placed in a prepared site in the fresh extraction socket. The palatal flap is split into superficial and deep components. The deep palatal flap is transformed into a pediculated flap and rotated *(arrow)*, covering the occlusal portion of the implant.

Fig 2f Occlusal aspect postsurgically. The superficial layer of the palatal flap has been repositioned and sutured. The implant cover screw is covered by the deep split palatal flap to allow primary soft tissue closure over the implant site.
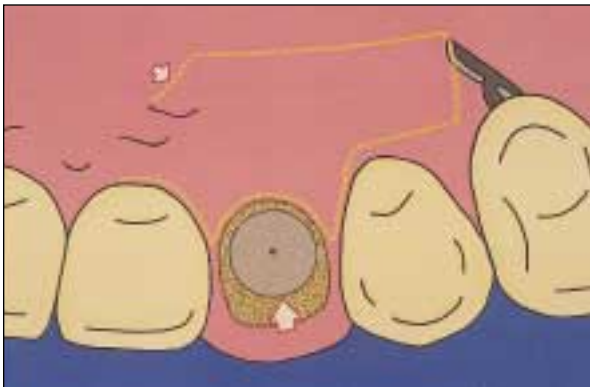
Fig 2g Aspect of the alveolar ridge at time of implant uncovering. Complete soft tissue coverage over the implant was maintained during this time.


Fig 3a Implant in place (group 3 site). Note buccal dehiscence. A minimal buccal flap, including only interdental papillae and marginal gingival, exposing the bone crest, was reflected.

Fig 3b Diagram of implant in place *(large arrow)*. A sharp, deep, internal beveled incision was made, delineating a pediculated full-thickness palatal flap. An oblique proximal incision facilitated rotation of the pedicle *(small arrow)*.

Fig 3c The palatal flap is delineated with a sharp incision. Note flap extension to achieve full coverage of the gingival socket.
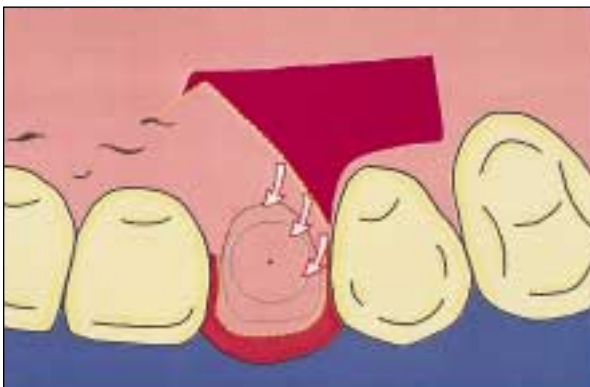
Fig 3d The palatal flap is rotated *(arrows)* and tucked and sutured under a minimally reflected buccal flap, covering the grafted implant site.

Fig 3e The RPF is sutured to the buccal flap. The portion of the RPF covered by the buccal flap was de-epithelialized prior to suturing. Complete primary soft tissue closure over the implant site was achieved.

Fig 4a Occlusal aspect of group 1 implant at time of uncovering. Bone fill around implant is noted.

Fig 4b Healed group 3 bone defect present at time of implant placement.

Table 1 Mean Values of Distance from Buccal Crestal Bone to Top of Implant Body for the 3 Treatment Groups (in mm)

Group	n	Mean	SD	Min	Max
Preoperative					
1	18	2.0	1.14	0	4
2	18	4.5	1.20	2	7
3	25	2.6	1.76	0	7
Postoperative					
1	18	0.4	0.51	0	1
2	18	0.8	0.61	0	2
3	25	0.6	0.71	0	2
Difference					
1	18	1.6	0.98	0	3
2	18	3.7	1.03	2	5
3	25	2.0	1.72	−1	7
Percent difference					
1		80%			
2		82%			
3		77%			

Group 1 = RPF; Group 2 = RSPF with membrane; Group 3 = RPF.
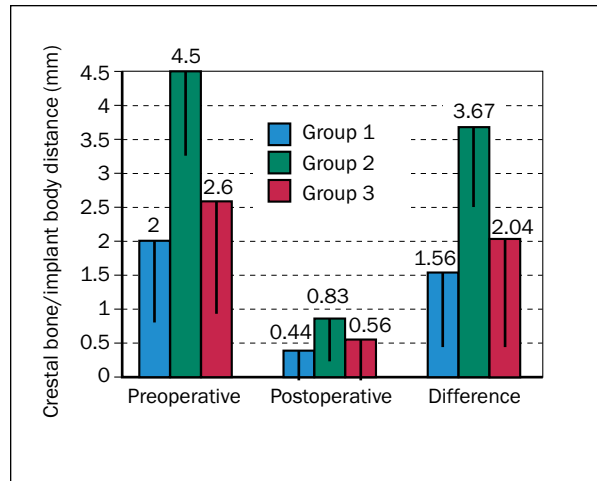
Fig 5 Mean pre- and postoperative distances in mm (and their difference) from the buccal crestal bone to the top of implant body, in the 3 groups. Group 1 = RSPF without membrane, Group 2 = RSPF with membrane, and Group 3 = RPF. Vertical lines represent standard deviations.

these implants (11%), one titanium plasma-sprayed and one hydroxyapatite-coated.

The measurement of crestal bone/implant distance postoperatively was adjusted with ANCOVA because of the preoperative differences between the groups. The mean distance was 0.60 mm. The mean crestal gain was 1.6 mm (SD 0.98), which was statistically significant ($P < .001$; paired t test). Where there was spontaneous exposure of the implant body cover screw, complete crestal bone healing did not occur. A decrease in the apical bone crest/implant platform distance was recorded at 15 sites, and at the remaining 3 sites, there was no change.

Group 2
Primary closure over the membrane was obtained in all patients. No adverse tissue reactions were noted, aside from partial sloughing of the palatal flap at 3 sites (16%). At the 1-week postoperative examination, there was premature exposure of 2 of the membranes and subsequently of 2 implant body cover screws (11%) from titanium plasma-sprayed implants; however, healing progressed uneventfully and early surgical implant uncovering was not necessary.

The apical crestal bone/implant postoperative distance was adjusted with ANCOVA because of preoperative differences between the groups. The

mean was 0.59 mm. Mean crestal bone healing was 3.7 mm (SD 1.03), which was statistically significant versus baseline (*P* < .001). Complete bone healing was not recorded where there was spontaneous exposure of the cover screw. Crestal bone healing was recorded in all 18 sites.

Group 3

At second-stage surgery, all implants had clinically achieved stability. A small superficial cleft between the RPF and buccal flap could be seen during the first few weeks; however, it filled in. Eventually, there were a few granules of grafting material exfoliating at this position during the first weeks of healing in 10 patients (40%). No signs of infection were noted in any patient. Partial sloughing of the palatal flap was observed at 3 sites (12%). In one of these, there was spontaneous exposure of the cover screw. At the remaining 24 sites (96%), complete soft tissue coverage was maintained until second-stage surgery. The pediculated flap blended with the surrounding tissue.

The postoperative distance between the most apical crestal bone and the coronal aspect of the implant body was adjusted with ANCOVA because of preoperative differences between the groups. The mean was 0.62 mm. Thus, the mean difference (crestal bone gain) was 2.0 mm (SD 1.72), which was statistically significant versus baseline (*P* < .001). Of 25 sites, bone formation was recorded at 21. At the only site where there was early exposure of the implant cover screw, crestal bone loss of 1 mm occurred. No crestal bone formation was seen in 3 sites.

Statistical Analysis

Mean age was similar for all groups (difference not statistically significant). ANCOVA (the main effects were the treatment groups, and the covariate was the preoperative measurements of crestal bone to implant distance) showed a significant (*P* = .005) covariant for preoperative measurements; however, it was not significant between the groups (*P* = .98). After the correction related to different preoperative measurements between groups, no difference in postoperative measurements was found between groups. Preoperative measurements influenced the postoperative result.

DISCUSSION

Implants placed directly into fresh extraction sites with and/or without the use of barrier membranes have been predictably successful in clinical trials and experimental models.[1–9,12,13,17,18,23,36,37] In the present study, all 61 implants appeared clinically stable at the time of their uncovering. A bone graft was used around the implants.

In the presented procedures, bleeding and discomfort were only occasional complications (in approximately 10% of the patients). Primary soft tissue healing was achieved with the use of rotated palatal flaps, which preserved part of their blood supply. A maximum of soft tissue, including proximal papillae, was preserved, thus contributing to rehabilitation esthetics. The need for coronal repositioning of the marginal gingiva was avoided, the mucogingival junction remained unchanged, and vestibular depth was preserved. Potential gingival recession at adjacent donor sites was avoided. A minimal buccal flap was raised when a membrane was not used; consequently, periosteum adherence to bone was not disrupted. Therefore, the osseous surface was not exposed, which presumably reduced or eliminated bone plate resorption. When a membrane was applied, a buccal flap was raised, usually with no releasing incision, since it was not coronally displaced.

In the present study, the buccal bony plate usually appeared damaged following tooth extraction. Implants were placed in a slightly off-centered, palatal position in the fresh socket. This created a space between the buccal bony wall and implant where bone could grow.[38,39] Implants were placed not more than 1 mm below the proximal crestal bone to avoid creating an intrabony defect and, in certain cases, to allow placement of longer implants. Bone grafts were used to fill the coronal gap between the implant and the bony walls and provide support for a resorbable collagen membrane (when used). Porous bovine bone mineral has been shown, clinically and histologically, to be an effective biocompatible, osteoconductive filler with slow degrading capability.[40,41]

Primary flap maintenance over immediate implants was important to the final results, since decreased bone regeneration was observed where cover screws became prematurely exposed. Previous clinical and histologic studies have reported similar findings in short-term and long-term delayed implantation.[5,12,13,42,43]

Three surgical methods were used to achieve primary soft tissue closure in single-tooth immediate implant procedures. However, the present study was not a randomized trial. Instead, each approach was targeted toward a different patient group defined by specific criteria. Therefore, differences between groups cannot be attributed entirely to the surgical approach.

Better results appeared to be obtained in crestal bone healing in group 2 (membrane used) compared with groups 1 and 3; however, after the correction with ANCOVA related to different preoperative measurements, results were similar. A membrane was used only when large defects (exceeding a 4-mm dehiscence) were evident and a large portion of the bony housing around the implants was missing (wider defects). In the present study, successful bone healing was achieved in small defects placed within a full or partial bony envelope (space making), similar to those found in groups 1 and 3 without a membrane. However, cell-occlusive membranes favor bone healing in patients with advanced bone loss.[27,38,44]

The present short-term study refers only to clinical observation, since no histologic evaluation of the bone-implant interface was conducted.[39] It is possible that when clinical bone healing is apparent, the tissue is not necessarily bone. Even in cases where bone has regenerated, it should not be assumed that this has resulted in osseointegration at the defect site.[39]

There was a positive effect on crestal bone fill with the use of membranes. At the time of implant placement, crestal bone formation, relative to the initial bone crest/implant distance, was approximately 82% in group 2, 79% in group 3, and 78% in group 1. Healing of implant dehiscence defects with and without the use of non-resorbable membranes was compared in humans.[39] The clinical results suggested complete or nearly complete regeneration of a bone-like tissue in most of the dehiscence defects covered with a membrane, compared to those seen in nearly identical control defects. However, these clinical findings were not statistically significant, partly because of the overall variability in response. The histologic measurements of bone area percentage and bone-to-metal contact also failed to show significant differences. Although the implant shoulder/bone margin distance improved in implants placed with a membrane, it only approached statistical significance.[39] Histologically, bone fill around implants has been shown even in extreme cases with little or no bone-to-implant contact.[45,46]

Another histologic study,[43] in which immediate implant placement was carried out in humans, showed that for small peri-implant defects not exceeding 1.5 mm in horizontal dimension, the use of barrier membranes was not necessary, as long as the socket walls were intact and a favorable defect morphology was present. In previous dog and rabbit studies, an even smaller bone-to-implant distance was critical to achieve early bone-to-implant contact.[35,47,48] In immediate implantation, where a gap between the implant and the bony walls exists, soft tissue collapse may impede population of the implant surface with cells of bony origin. The use of membranes and/or bone grafting material[35,47] and longer healing periods after implant placement[35] have been recommended. The results of the present study were similar to other clinical reports in which delayed implants were placed in combination with guided bone regeneration procedures.[44,49]

The RPF approach does not allow for the use of a membrane. It differs from the RSPF, creating a surgical wound in the palate that heals by secondary intention. However, the RPF procedure is easier to perform than the RSPF since there is no splitting of the palatal flap. The RPF is advised especially when the thickness of palatal gingiva in the treatment area is 4 mm or less (as determined through preoperative sounding) and implants can be placed within a partial or full bony envelope. Otherwise, an RSPF procedure with or without the use of a barrier membrane is the technique of choice for single-tooth immediate implant procedures.

CONCLUSIONS

1. Immediate implant placement with a bone graft and soft tissue coverage was successful in the short term.
2. Primary soft tissue maintenance over immediate implants may be significant for improved crestal bone healing.
3. The use of a barrier membrane in immediate implant procedures probably is not mandatory, provided the implants are placed within a bony envelope, even if partially missing.
4. The techniques presented in this study, using pediculated palatal flaps, can provide an effective treatment approach to achieve primary soft tissue coverage and clinical crestal bone healing (approximately 80% relative to the initial bone crest/implant distance) over implants placed immediately after extracting single anterior or premolar maxillary teeth, with or without the use of barrier membranes.

ACKNOWLEDGMENT

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