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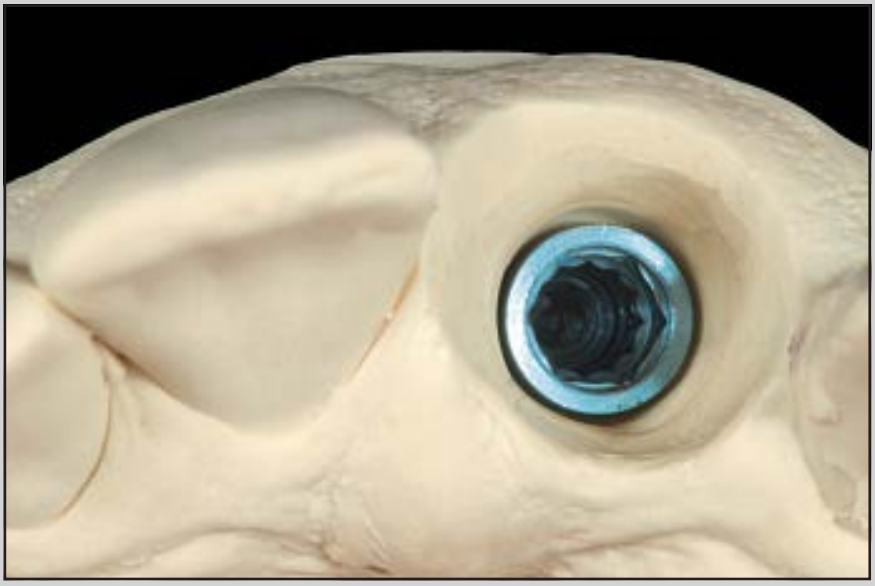
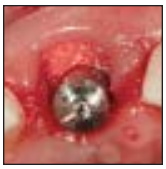


Flapless Postextraction Socket Implant Placement, Part 2: The Effects of Bone Grafting and Provisional Restoration on Peri-implant Soft Tissue Height and Thickness—A Retrospective Study



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This article presents the results of evaluating the changes in peri-implant soft tissue dimensions associated with immediate implant placement into anterior postextraction sockets for four treatment groups: no BGPR (no bone graft, no provisional restoration), PR (no bone graft, provisional restoration), BG (bone graft, no provisional restoration), and BGPR (bone graft, provisional restoration). The vertical distance of the peri-implant soft tissue was greater for grafted sites than for nongrafted ones (2.72 mm vs 2.29 mm, P < .06). The facial soft tissue thickness at the gingival third also was greater for grafted than for nongrafted sites (2.90 mm vs 2.28 mm, P < .008) and for sites with provisional restorations compared to sites without them (2.81 mm vs 2.37 mm, P < .06), respectively. The net gain in soft tissue height and thickness was about 1 mm. The increases in vertical and horizontal dimensions for grafted sites were between 0.5 and 1.0 mm, as compared to sites with no bone graft and no provisional restoration.
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Implant placement into postextraction sockets with a provisional restoration in nonfunctional occlusion in the maxillary anterior region has increased in use and clinical relevance since its introduction in the late 1980s.[1] Treatment procedures are condensed into fewer patient appointments, reducing overall treatment time and increasing patient comfort.[2,3] Survival rates reported for immediate implant protocols are comparable to those for delayed procedures with or without provisional restoration and bone grafting.[4–6] In addition, positive esthetic outcomes have been reported regarding midfacial recession depending on implant position, immediate provisional restoration, and bone grafting.[2,3,5,7–10]

Peri-implant soft tissue thickness, abutment material, and gingival color all must be in harmony to achieve predictable esthetic and restorative outcomes. Several authors have researched the correlation between peri-implant soft tissue thickness and its color-masking ability.[11–17] Even though a consensus does not exist on how much horizontal peri-implant soft tissue thickness is required, there is agreement that it has an important effect on esthetics. This ultimately affects implant-abutment selection from a standpoint of restorative material strength.

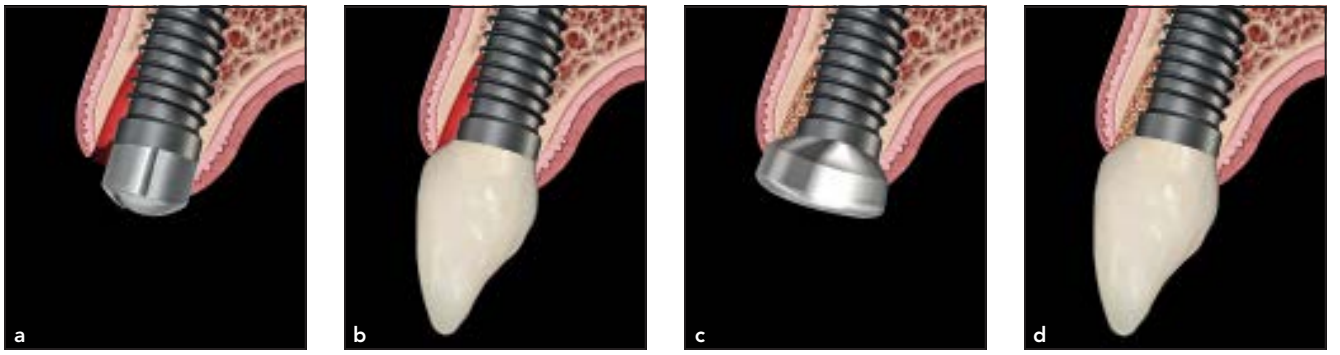

Fig 1 *The peri-implant soft tissue thickness of four treatment groups were evaluated.* (a) *No BGPR = no bone graft/no provisional restoration.* (b) *PR = no bone graft/provisional restoration only.* (c) *BG = bone graft only/no provisional restoration.* (d) *BGPR = bone graft/provisional restoration.*

Furthermore, the vertical soft tissue thickness is critical for not only peri-implant soft tissue stability but also underlying bone crest levels. The trend in this area of research is toward the conclusion that increasing peri-implant soft tissue thickness increases the substrate color-masking ability and bone stability.[18,19]

One recent paper presented the changes in peri-implant soft tissue dimensions after placement of a bone graft contained within the crest of bone and palatal to the facial plate with an autogenous connective tissue graft placed above the bone crest. Compared to a procedure in which no connective tissue graft was provided, the findings showed a 1-mm gain in peri-implant mucosa thickness as measured 2 mm from the free gingival margin (FGM).[20] Little else is known about the effects of different treatment procedures on the vertical and horizontal dimensions of the peri-implant soft tissue of immediate postextraction socket implants in the esthetic zone. Therefore, this article presents the results of a retrospective cross-sectional comparative cohort evaluation of the vertical and horizontal change in peri-implant soft tissue dimensions associated with four different treatment types rendered at the time of implant placement.

Method and materials

As reported in Part 1 of this study, 45 anterior maxillary extraction sockets in 44 patients were treated with immediate implant placement. Of the treated teeth, 70% were maxillary central incisors.[21] The patients ranged in age from 22 to 75 years of age (mean: 48.5 years) and were in good systemic health. Four groups were compared: those receiving *(1)* no bone graft and no provisional restoration (No BGPR), *(2)* a provisional restoration only (PR), *(3)* a bone graft only (BG), and *(4)* both a bone graft and a provisional restoration (BGPR) (Fig 1).

The inclusion criteria for implant replacement were as follows: good systemic health of the patient, maxillary anterior teeth (first premolar to first premolar), no periodontal disease or gingival recession, no restoration on the contralateral natural tooth, and no endodontic lesions with labial plate perforation. Exclusion criteria were general medical or psychiatric contraindications, pregnancy, patients with local or generalized healing limitations, type II or III extraction sockets,[22] bruxism or other destructive parafunctional habits, compromised soft tissue conditions at the surgical or control site, and poor patient compliance.

The surgical treatment protocol entailed sharp dissection of the supracrestal gingival fibers with a 15c scalpel blade. This allowed for atraumatic tooth removal without flap elevation, maintaining the periosteal blood supply to the labial bone plate. The extraction socket was debrided thoroughly, and an osteotomy was made with a biased palatal placement of the implant to avoid dehiscence of the labial plate and allow sufficient vertical distance for the development of the proper emergence profile of the prosthetic component in all groups. Palatal implant placement in anterior

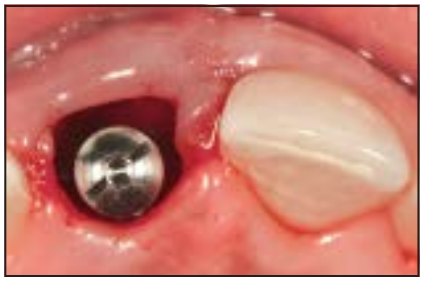

Fig 2 *A patient in the BGPR group after palatal placement of the implant with a straight flat contoured abutment to allow placement of a bone graft into the labial gap.*

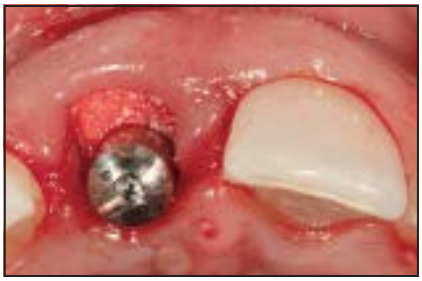

Fig 3 *A bone graft is placed into the labial gap.*

Fig 4 *The straight healing abutment was carefully removed to avoid disturbing the bone graft. Then the provisional restoration fabricated prior to the bone graft was seated to contain, protect, and maintain the graft during the healing phase of treatment.*

extraction sockets also commonly results in a lack of facial bone implant contact, referred to as the gap (Fig 2). Tapered non-platform-switched internal connection implants were placed 3 to 4 mm apical to the FGM. Primary stability was obtained from the macrothread design at the apical third of the implant and confirmed with hand torque (minimum 25 to 35 Ncm) to facilitate immediate full-contour provisional restoration. According to the treatment requirements of each group, the labial gap either contained only the blood clot (No BGPR and PR) or was filled with small-particle bone allograft at the time of implant placement (BG and BGPR) (Fig 3).

Screw-retained provisional restorations were fabricated using autopolymerizing acrylic resin (Super T, American Consolidated) in infraocclusion for the PR and BGPR groups (Fig 4). The subgingval contours of the provisional restorations conformed to support the peri-implant soft tissues and help protect the blood clot as well as any bone graft particles. A straight healing abutment was placed for the No BGPR group, and a stock contoured healing abutment was placed for the BG group. An adhesive resin-bonded prosthesis was adjusted at the (acrylic) pontic portion to avoid contact with the healing abutment. The prosthesis was adhesively bonded to the adjacent natural teeth and adjusted in occlusion. Patients were placed on presurgical antibiotics and an analgesic as needed and seen 7 to 14 days postoperatively for follow-up.

After a minimum of 4 months, the resin-bonded prosthesis was removed for the first time for the No BGPR and BG groups, and a screw-retained polyether-ether-ketone (PEEK) abutment with contoured acrylic was joined to the implant. Nonsurgical soft tissue sculpting was performed to shape the peri-implant soft tissues. The tissues were allowed to heal for at least 3 additional weeks for these groups before final impressions were made. For the PR and BGPR groups, a minimum of 5 months of healing was allowed before the first removal (disconnection) of the provisional restoration (Fig 5). Subsequently, patients returned for implant-level impression making with a monophase impression material (Flexitime, Heraeus Kulzer) and an open-tray technique for the fabrication of a definitive restoration. Implant-level transfer copings were seated, and GC pattern resin (GC America) was used within 1 minute of provisional restoration disconnection to capture the subgingival soft-tissue mucosa profile (Fig 6). The dental laboratory fabricated a gypsum cast that allowed construction of a screw-retained noble metal alloy abutment or cement-retained subframe (Fig 7). Custom abutment and metal-ceramic or all-ceramic crowns were fabricated and delivered approximately 3 months after the final impression. The definitive crowns were either cement-retained with temporary cement (TempBond NE, Kerr) or screw-retained.[23]

The facial peri-implant soft tissue thickness (labiopalatally) was measured coronoapically from the FGM to the implant-abutment junction using a periodontal probe (Fig 8), and the peri-implant soft tissue dimensions were measured (Fig 9). The vertical distance from the FGM to the implant shoulder was divid-

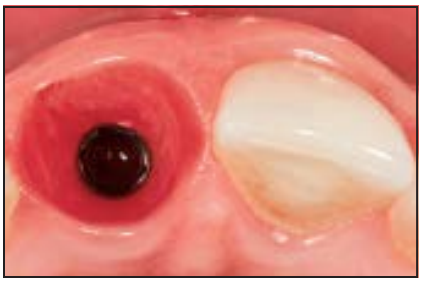

Fig 5 *After adequate healing to allow the implant and bone graft to integrate (5 months), the provisional restoration was disconnected for the first time. Notice the shape of the ridge contour as well as the peri-implant soft tissue.*

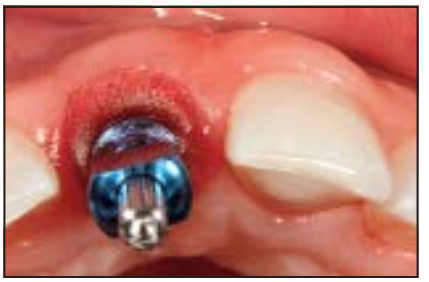

Fig 6 *An implant-level impression was made with pattern (acrylic) resin to capture the subgingival profile of the peri-implant sulcus.*

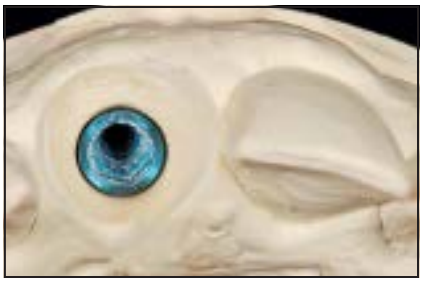

Fig 7 *A gypsum (stone) cast was poured to allow fabrication of the definitive restoration. The gypsum cast was used to measure the peri-implant soft tissue thickness at the G, M, and I zones.*

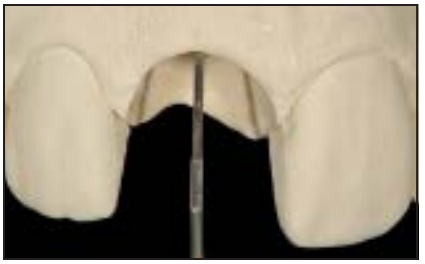

Fig 8 *The coronal-apical dimension or vertical mucosal tissue height was measured using a periodontal probe from the implant head to the free gingival margin on each gypsum cast.*

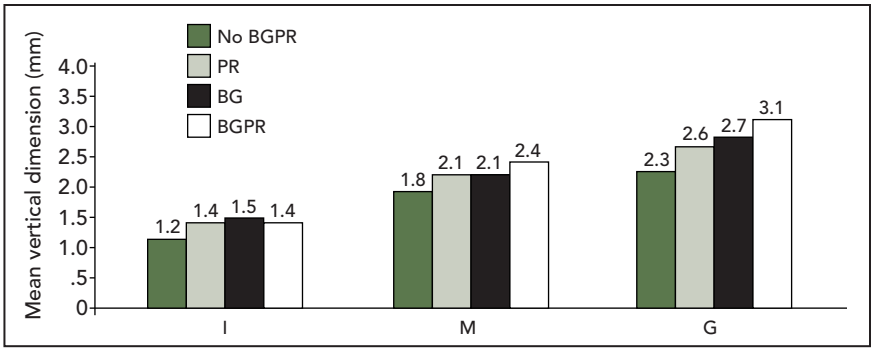

Fig 9 *The mean values for peri-implant soft tissue for each treatment and zone were recorded and compared. The greatest positive change was noted for the BGPR group and the least for the No BGPR group.*

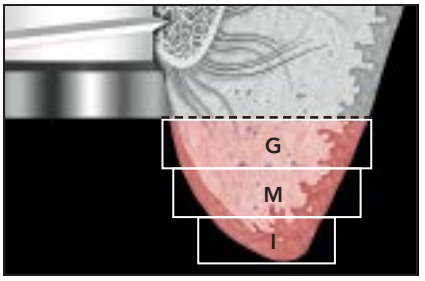

Fig 10 *With a default implant depth of 3.0 mm at the time of placement, 3 zones approximately 1.0 mm in vertical height could be measured in its mid-most region.*

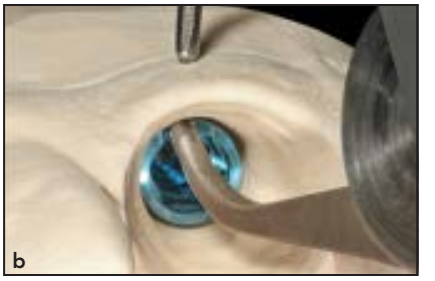

Fig 11 *Spring-loaded calipers were used to measure the gingival zone of the peri-implant soft tissue thickness.*

ed into three labial-palatal points of reference designated as the gingival (G), middle (M), and incisal (I) zones, respectively (Fig 10). The middle point of each vertical zone on the gypsum casts (Figs 11a and 11b) was measured with a spring-loaded dental caliper (Iwanson Decimal Caliper, Asa Dental) sensitive to 0.1 mm. Mean values were calculated for each peri-implant soft tissue measurement at each

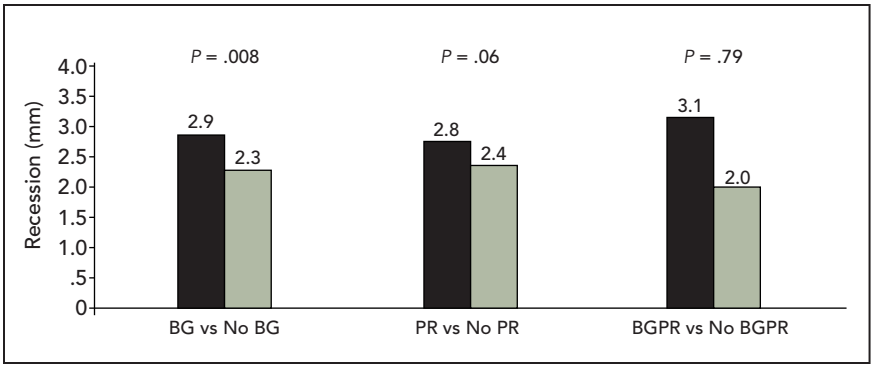

Fig 12 *Summary of change in peri-implant soft tissue dimension (recession).*

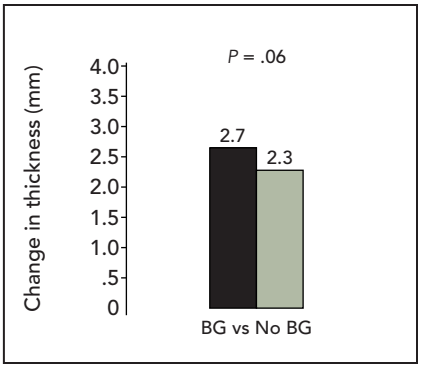

Fig 13 *Summary of change in peri-implant soft tissue labial-palatal dimension (thickness).*

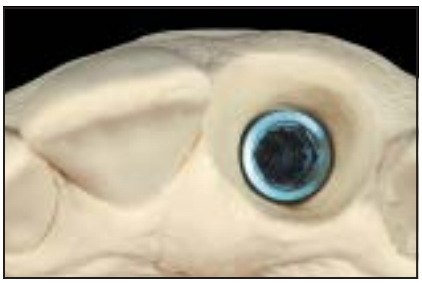

Fig 14 (left) *Gypsum cast of a patient in the BGPR group. The ridge contour as well as the peri-implant soft tissue thickness was robust.*

Fig 15 (right) *Gypsum cast of a patient in the No BGPR group. The ridge contour as well as the peri-implant soft tissue thickness was collapsed and thin. The only area greater than 2.0 mm in thickness was zone G by the head of the implant interface.*

reference point for zones G, M, and I. One operator at each study site measured each patient's cast using 2.5× magnification optical loupes.

Data were submitted to regression analysis and analysis of covariance (JMP Version 10, SAS Cary). Stability of the postextraction implant site was estimated using the contralateral tooth. Statistical significance was set at an α level of .05.

Results

The average vertical distance (peri-implant soft tissue height) of the implant-abutment junction from the FGM was 2.5 mm. The labial-palatal soft tissue dimensions for zones G, M, and I were 2.7 mm, 2.1 mm, and 1.3 mm, respectively.

In all treatment groups, an average of 0.5 mm of vertical collapse or recession of the peri-implant soft tissues was recorded from the time of implant placement to measurement (Fig 12). The peri-implant soft tissue thickness decreased from zones G and M to zone I. At the most apical extent of the peri-implant mucosa, indicative of the implant-abutment interface or connection, the facial-palatal thickness was always greater than 2 mm in all treatment groups. However, when moving more coronally toward the FGM (0 mm), the tissue thickness always decreased.

The vertical distance, or height, of the peri-implant soft tissue was greater for the grafted sites (BG and BGPR) than for the nongrafted sites (No BGPR and PR) (2.72 mm vs 2.29 mm, $P < .06$). The facial soft tissue thickness (labiopalatally) at the gingival level was also greater for the grafted versus the nongrafted groups (2.28 mm vs 2.90 mm, $P < .008$) and for the sites with provisional restorations (2.81 mm for the PR and BGPR groups vs 2.37 mm for the No BGPR and BG groups, $P < .06$) (Fig 13). In addition, the facial soft tissue thickness (labiopalatally) was greater at sites that received a bone graft and a provisional restoration (Fig 14) compared to sites without either grafts or restorations (Fig 15) (3.09 mm vs 2.03 mm, $P < .79$, respectively). No statistically significant association was observed between bone graft and provisional restoration on the vertical or horizontal dimension at the incisal and middle levels.

Discussion

This study demonstrated that placing a bone graft and provisional restoration at the time of immediate postextraction implant placement results in greater peri-implant soft tissue height and thickness in a facial-palatal dimension. The net gain in soft tissue height and thickness was about 1 mm in the BGPR group.

The buccolingual peri-implant soft tissue increase was most evident in zones G and M. This increase was most notable in the BG, PR, and BGPR groups. The increase was above the 2.0 mm tissue-thickness threshold and thus enough to have a color-masking impact regarding implant abutments.[14,16]

Many confounding factors can influence soft tissue thickness, including periodontal phenotype, implant position, and adjacent restorations. The new point to consider is that tissue thickness is a function of not only the implant position, socket anatomy, and shape, but also the extent of collapse of the labial plate resulting from the clinical procedure (Figs 2 to 7). In this study, the provisional restorations mirrored contralateral nonrestored natural teeth to provide support.

In comparison to delayed implant placement with and without bone and/or autogenous or allograft soft tissue grafting as reported in the literature, the values of labial-palatal dimension for the BG group reported in Fig 7 were generally less than those reported by van Brakel et al.[16] This is because measurements were made at 0.5 mm vs 1.0 mm intervals; the thickness of the caliper tip (0.8 mm diameter) was the limiting factor. Consequently, tissue measurements at similar reference points were greater, although this may not be clinically relevant or reflective of proper contours accompanying definitive abutments and restorations.

No BGPR implants placed appeared to be more labially positioned in the socket than they actually were. The labial tissue collapses created a false appearance or illusion of labial implant placement.

Data in this study, measured at 2.5 mm from the FGM in the BG group (3.1 mm), were very similar to those reported by Nozawa et al (3.2 mm), though the latter study included only three subjects with anterior implant sites.[24] Jung et al reported the greatest value at 1.0 mm from the FGM (3.1 mm), using an endodontic file for measurement, though patients with peri-implant soft tissue thickness of less than 2.0 mm received a connective tissue graft prior to definitive measurement.[13]

Araújo et al showed that xenograft particulate material could be incorporated and encapsulated into the peri-implant mucosal tissues with bone grafting and immediate implant placement.[25] These particles may act as a benign foreign body where a localized inflammatory response is absent. The question is whether they will be assimilated into the peri-implant mucosa tissues, thereby increasing their volume, specifically the labial-palatal thickness. This volume increase can create a masking effect that would counteract gray-colored abutments and enhance the esthetic outcome without the use of a subepithelial connective tissue graft. What remains unknown are the effects of subepithelial connective tissue grafting alone on the peri-implant soft tissue dimensions. Grunder showed the dimensional changes of ridge contour around anterior immediate postextraction socket implants with and without connective tissue grafting, with a gain of 0.3 mm and a loss of 1.0 mm, respectively.[26] Measurements were made intraorally at one reference point 3 mm from the FGM representative of the implant-abutment interface, using a periodontal probe, though peri-implant soft tissue changes were not compared in the study.

Limitations of the present study include the retrospective cohort study design and the lack of long-term follow-up. There was also no measurement of the preimplant labial soft tissue thickness. Peri-implant labial tissue dimensions differ from those of the unattached gingiva around natural teeth. For the present study, peri-implant soft tissue dimensions could only be ascertained from the stone casts. Six months has been reported to be a sufficient time for peri-implant soft tissue healing to occur after placement of implants and provisional restorations into extraction sockets immediately after flapless extraction procedures.[20]

The effect of provisional restoration alone or bone grafting and provisional restoration at the time of immediate placement were assessed in this study. The effect of soft tissue grafting (ie, subepithelial connective tissue grafting or allograft) or dermis

allografts with provisional restoration or the combination of bone and soft tissue grafting with provisional restoration need further investigation through future research.

The results of the present study are consistent with the net gain of 1 mm, measured 2 mm from the FGM, previously reported.[20] The key difference is the use of a free subepithelial connective tissue graft to augment the peri-implant soft tissues (in the previous study) versus bone grafting the peri-implant soft tissue zone in the present study.

Conclusions

Placing a bone graft and provisional restoration at the time of anterior tooth extraction increases both the vertical and labial-palatal dimensions by between 0.5 and 1.0 mm, as compared to placing neither a bone graft nor a provisional restoration at the time of flapless immediate postextraction implant placement. Increases were most frequently noted in the gingival and middle zones, where thickness gains were above the critical soft tissue threshold of 2.0 mm.

Further research is required to assess the long-term stability of peri-implant soft tissue around provisional restoration supporting implants placed immediately in the flapless postextraction socket.

Acknowledgments

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The authors reported no conflicts of interest related to this study.

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