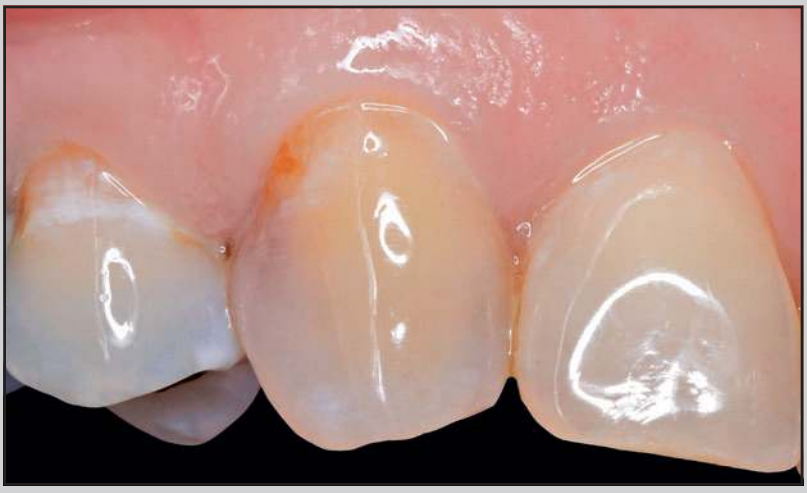

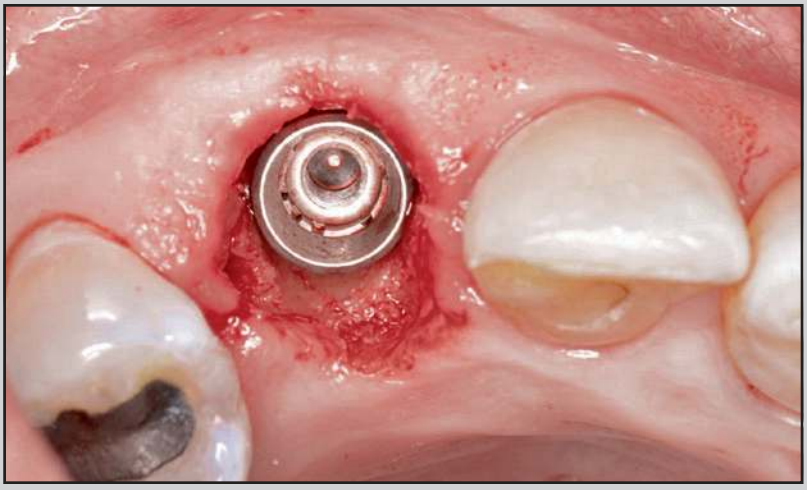

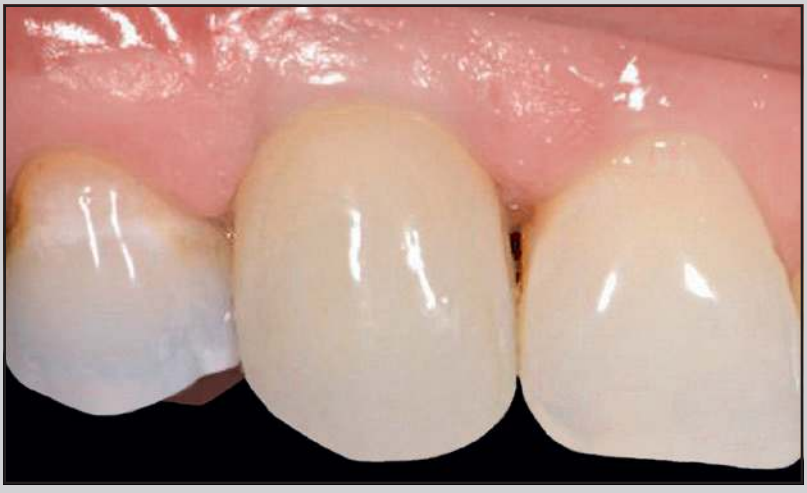

Changes in Peri-implant Soft Tissue Thickness with Bone Grafting and Dermis Allograft: A Case Series of 15 Consecutive Patients

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Immediate implant placement and provisional restoration has become a popular and well-supported method of tooth replacement in the maxillary anterior dentition. Aside from achieving osseointegration, esthetic demands have grown with better understanding of the behavior of hard and soft tissues following this mode to therapy. Stability of gingival contours, texture of the surrounding tissues, and blending of prosthetic components with the natural dentition are critical for successful outcomes to be maintained long-term. Increasing soft tissue thickness at the time of therapy plays an important role in this regard. A technique combining the proven principles of immediate implant placement and provisional restoration with hard and soft tissue augmentation using nonautogenous materials is demonstrated with comparisons to nongrafted, temporized historical controls.
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Immediate implant placement in the anterior dentition is a technique-sensitive procedure.[1] Many factors influence the physiologic and esthetic outcome.[2–4] Implant placement within the extraction socket plays a major role in the way hard and soft tissues model and remodel during healing.[5,6] The concept of implant insertion preserving the pre-extraction alveolar socket and its dimensions has been refuted.[7,8] Due to these negative changes, various modalities have been advocated to augment and preserve hard and soft tissue topography. One of the most critical areas of concern is the supracrestal facial keratinized tissue. The height of the gingival margin must be in harmony with the contralateral tooth to avoid esthetic compromise. Additionally, the thickness of this soft tissue has the ability to preserve the underlying bone as biologic width is established around the implant and submucosal abutment.[9,10] It also may or may not mask the gray color of the submarginal prosthetic components, reducing or eliminating a gray shadow, affecting the esthetic outcome of therapy.[11,12]

Several investigators advocate the use of subepithelial connective tissue grafts to increase the peri-implant soft tissue thickness and prevent recession.[13,14] Although this method is often effective, morbidity associated with procurement of

autogenous tissue grafts can be significant.[15] Using allografts can successfully increase soft tissue dimension, resulting in bone preservation and increasing the zone of keratinized peri-implant tissue.[16] Recently, one of the present authors demonstrated a technique using dermis allograft at the time of immediate implant placement to provide particulate bone graft containment, barrier function, and gingival thickening.[17]

The management of the void or gap between the implant and the internal aspect of the facial socket wall is another critical area of concern. Implants inserted in close proximity to the facial bone result in more bone loss compared to those placed at a greater distance from the internal socket cortex.[18] Placing a bone graft into this space has also been shown to limit the diminution of the alveolar contour post–immediate implant placement.[19]

Recently, the concept of obturating the gap and the supra-alveolar space between the soft tissue and submucosal portion of the temporary crown was introduced.[20] This dual-zone grafting concept demonstrated superior ridge dimensional stability compared to nongrafted controls.[21] It has also shown the ability to increase marginal peri-implant soft tissue thickness equivalent to connective tissue grafting.[22] Considering the unpredictability and dynamic nature of peri-implant tissue topography, it is reasonable to develop a strategy to minimize these negative changes at the inception of immediate implant therapy. Performing both hard and soft tissue augmentation is recommended in these types of cases. Exploiting the beneficial properties of allogeneic and/or xenogeneic connective tissue allografts eliminates the morbidity of autogenous tissue procurement while achieving long-lasting, positive outcomes. One method is the dermal apron technique.[23] This technique uses flapless implant placement, palatal implant positioning, and dual-zone bone grafting combined with a dermal allograft.

The purpose of this case series was to validate the efficacy of the dermal apron technique regarding its ability to increase the thickness of the facial peri-implant soft tissue. The thickness of the facial peri-implant gingiva is compared to historical nongrafted, and nontemporized controls to demonstrate the efficacy of using allogeneic hard and soft tissue grafts in the peri-implant soft tissues.

Materials and Methods

All 15 patients were treated in a private periodontal practice. They were referred by their restorative dentists for immediate implant therapy in the anterior sextant of the maxilla. Prior to treatment, all of the patients gave signed informed consent. Natural teeth bordered all immediate implant sites mesially and distally. The maxillary teeth included one canine, eight lateral incisors, and six central incisors. All teeth were extracted in a flapless manner following sulcular incisions with a 15C blade. Sockets were debrided with ultrasonic and manual instruments to remove any soft tissue remnants and irrigated with sterile saline. Implant placement was performed with a palatal bias. All implants were threaded, root-form implants with a moderate roughness, fluoride-modified, TiO blasted surface (OsseoSpeed EV, Astra Tech, Dentsply). The head of the implant was positioned approximately 3.0 to 4.0 mm apical to the mucosal zenith (free gingival margin) and 2.0 mm palatal to the point of emergence of the adjacent natural teeth. Implants demonstrating rotational stability via insertion torque and axial stability via resonance frequency analysis were deemed eligible for immediate temporization.

The selected implant diameter ensured a gap existed between the internal facial socket wall and implant body, facilitating a dual-zone placement of a particulate bone graft. This graft is a composite of mineralized, cortical allograft (MTF) and deproteinized, bovine bone mineral (DBBM) (Geistlich) or porous carbonate apatite of porcine origin (PCA) (Symbios, Dentsply). A 4:1 ratio was selected so that the majority were allografts capable of viable bone substitution; the 20% xenograft was exploited for its slow-resorbable nature and space maintenance. A dermal allograft (PerioDerm, Symbios) with a prehydrated thickness of 0.4 to 0.8 mm was adapted around the submucosal portion of a screw-retained, temporary crown. It was inserted into a subperiosteal pouch created immediately prior to its insertion. The pouch was about 5.0 to 7.0 mm in coronal-apical dimension from the free gingival margin, minimizing the surface area of separation of the periosteum from the facial bone.

The basement membrane portion of the dermis was oriented toward the facial cortex, and the connective tissue side contacted the periosteum. This orientation was meant to improve the integration of the dermal allograft with the overlying soft tissues. The purposes of this step included soft tissue thickening, particulate graft containment, and membrane function.

Screw-retained titanium temporary abutments were hand-tightened to the implants, and the void between the implant and internal socket walls was obturated with the particulate mineralized bone graft previously described. A vacuum-formed template made from pre-extraction models or diagnostic wax-ups was adapted and filled with bisacryl temporary resin to lute the template to the temporary abutment. The abutment screw was loosened and removed from the implant and affixed to a laboratory analog. Voids between the bisacryl resin and temporary abutment were filled with light-cured flowable composite resin. The provisional restoration was contoured and polished extraorally. The submucosal portion of the restoration was intentionally undercontoured to avoid pressure on the facial mucosa and allow for adaptation of the soft tissues. A biopsy punch was used to pierce the dermal allograft and adapt it over the metallic collar and apical portion of the temporary crown. The particulate bone graft was reapplied to a supracrestal level, as described by Chu et al.[20] The temporary restoration was hand-tightened, and the apron portion of the dermal allograft was tucked into the preformed pouch. A radiograph was obtained to confirm the provisional crown was completely seated prior to tightening the abutment screw to 15 Ncm. The access channel was filled with Teflon tape, and flowable composite resin sealed the access. A resorbable monofilament (Monocryl, Ethicon), figure-8 suture was used to gently compress the soft tissues and aid in hemostasis. Occasionally, additional interrupted sutures were used mesially and distally to better adapt the soft tissues. The occlusal design of the temporary crown was always nonfunctional. There was no contact between the provisional crown and the mandibular teeth in maximum intercuspation or excursions.

Patients were instructed to maintain a soft diet and avoid mastication in the anterior dentition for at least 8 weeks. Tooth brushing was avoided in favor of chlorhexidine mouthrinses until the first postoperative appointment at 10 days. After that time, an extra-soft postsurgical toothbrush was provided and patients were instructed in the roll brushing technique, to be used for approximately 6 weeks. Patients were referred back to their restorative dentists to start definitive restorative treatment at no earlier than 12 weeks after surgery.

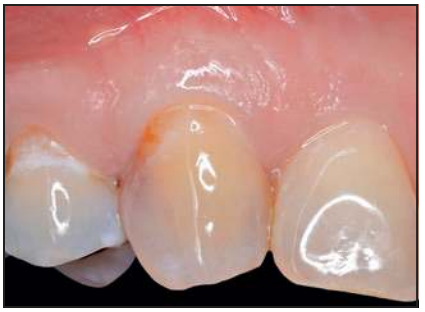
At the first disconnection of the provisional crowns, implant-level impressions were performed and soft tissue models used for fabrication of the final abutments and crowns (screw- or cement-retained) were produced. These models were scanned with a digital scanner (CAD-Blu, 3Shape), and digital measurements were performed to evaluate soft tissue thickness. Measurements of the direct facial soft tissue were taken at 1.0 mm (incisal), 2.0 mm (middle), and 3.0 mm (apical) from the free gingival margin. Measurements was performed on hard models rather than intraorally to avoid compression of the soft tissue with calipers. The measurements for the 15 cases in this series were compared to the 13 cases of nongrafted implants but with provisional restoration, reported in a separate study,[19] which served as historical controls.

Experimental Case

A 66-year-old woman presented for immediate implant therapy for the maxillary right canine. Clinically, severe external root resorption was present on the palatal aspect (Fig 1). Radiographically, root resorption was evident palatally, to the level of the osseous crest (Fig 2).

Following flapless extraction, the alveolus was treated as described. A cylindrical/conical, fluoride-treated, blasted implant (Astra Tech EV, Dentsply Sirona) with an apical diameter of 3.1 mm and a restorative platform 4.8 mm wide and 11.0 mm in length was placed with a palatal bias (Fig 3). The space or gap between the facial implant surface and the oral aspect of the facial socket wall was obturated above the facial osseous crest with a particulate bone graft.

A titanium temporary abutment was used to fabricate a screw-retained provisional crown. The seating, contours, and occlusion were verified clinically and radio-



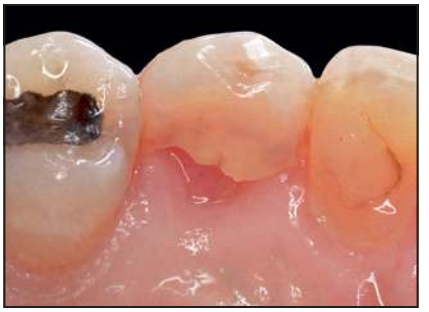


Fig 1 *The clinical situation reveals a healthy facial periodontium on the facial aspect of the maxillary right canine. Palatally, the severity of the external root resorption is evident, with soft tissue invasion into the affected palatal root surface.*

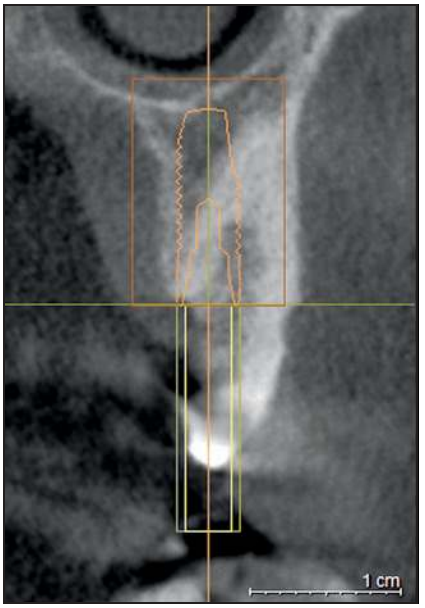


Fig 2 (left) *Cross-sectional view of the maxillary right canine, obtained with a CBCT scan, reveals the resorptive lesion extending into the pulp at the level of the palatal osseous crest.*

Fig 3 (below) *Implant placement was performed, achieving primary stability toward the palatal aspect of the extraction socket.*

Fig 4 *After the dermal allograft was hydrated in sterile saline for approximately 3 minutes, it was trimmed and pierced to be adapted around the apical portion of the screw-retained provisional crown.*

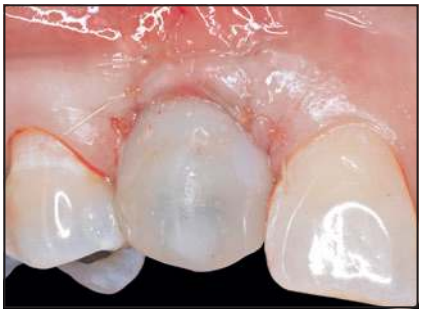


Fig 5 *The soft tissues were adapted around the provisional crown after the soft tissue graft was placed in the prepared subperiosteal recipient regions. Resorbable sutures were placed to provide gentle compression between the mucosal, allograft, and osseous layers.*

graphically. A dermal allograft 0.4 to 0.8 mm in thickness (Fig 4) was trimmed, punched, and positioned as described in Materials and Methods. The provisional restoration was attached via a facially oriented screw access, concealed with Teflon tape and composite resin (Fig 5). A postoperative radiograph confirmed seating of the provisional crown and the peri-implant bone levels at baseline.

At 10 weeks, the implant site appeared clinically and radiographically healthy, with soft tissue preservation and no signs of inflammation (Fig 6). The provisional crown was detached for the first time (Fig 7), revealing minimal bleeding and soft tissue architecture consistent with the shape of the temporary crown.

The patient was restored with a computed-aided design/computer-assisted manufacture gold-coated, titanium custom abutment (Atlantism Dentsply Sirona) and a cement-retained, porcelain-fused-to-metal crown (Fig 8). At time of cementation, there was no visible evidence of apical bone level change radiographically (Fig 9).

The soft tissue model created for restorative purposes was digitally scanned (CADBlu, 3Shape). The soft tissue thickness was 1.6 mm, 1.8 mm, and 2.2 mm at the incisal, middle, and apical points, respectively (Fig 10).

Results and Statistical Analysis

This case series demonstrates soft tissue thickness measured at 1.0 mm, 2.0 mm, and 3.0 mm apical

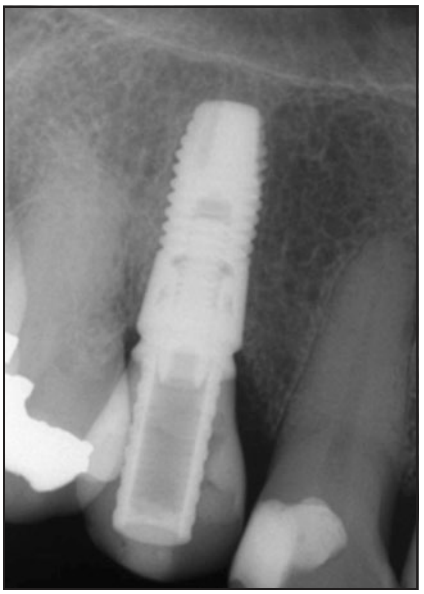
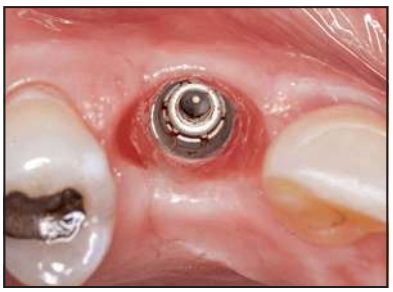
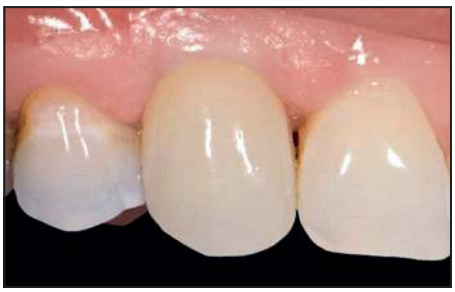


Fig 6 (left) *Radiographically, the proximal bone levels at 10 weeks were relatively unchanged and no peri-implant radiolucencies were evident.*

Fig 7 (below center) *The first disconnection of the provisional crown revealed minor bleeding and sculpted soft tissue contours created by the temporary restoration.*

Fig 8 (below right) *Delivery of the final cement-retained crown. Physiologic soft tissue and ridge contours were preserved throughout the course of therapy. Final restoration by Dr H. Rosenthaler, Philadelphia, Pennsylvania.*





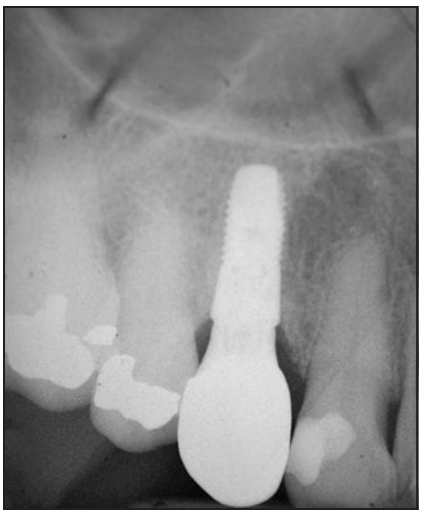


Fig 9 *Periapical radiograph taken at the time of final restoration. Marginal bone levels remained unchanged relative to the proximal surfaces of the adjacent teeth and at the top of the implant platform.*

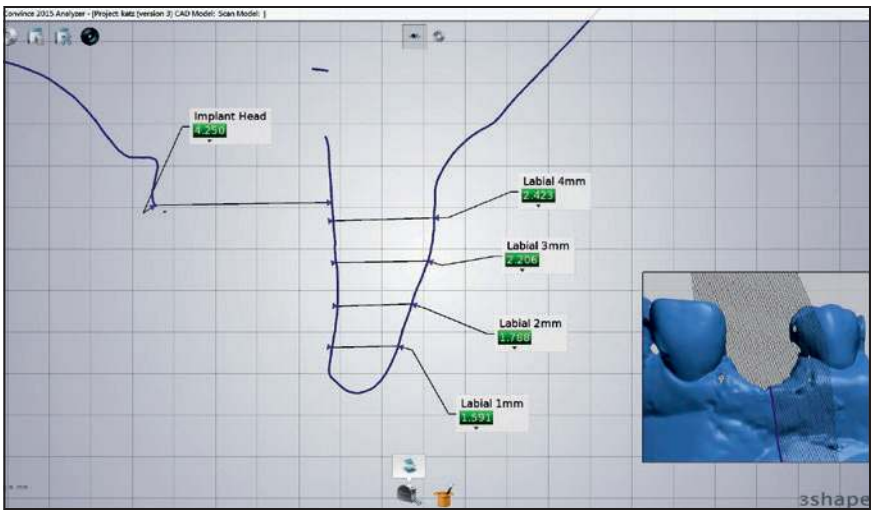


Fig 10 *The digital mucosal measurements of soft tissue thickness at 1.0 mm, 2.0 mm, and 3.0 mm apical to the free gingival margin were recorded. Soft tissue thickness was 1.6 mm, 1.8 mm, and 2.2 mm at the incisal, middle, and apical points, respectively.*

to the direct facial mucosal margin. A total of 15 soft tissue models obtained from restorative dentists, used for fabrication of definitive restorations, were digitally scanned and measured.

The average soft tissue thickness at 1.0 mm apical to the facial margin was 1.89 mm (range 1.36 to 2.71 mm; SD 0.38). At 2.0 mm from the margin, the average thickness was 2.79 mm (range 1.79 to 3.57 mm; SD 0.53), and at 3.0 mm, the mean thickness was 3.25 mm (range 2.21 to 4.33 mm; SD 0.59). The measurements for all 15 models are presented in Table 1.

Because all 15 patients were treated in a private practice, controls were not used. Instead, nongrafted, temporized cases otherwise treated similarly were used for comparison. These were obtained from an independently published study in which maxillary anterior teeth were

Table 1 Study Model Measurements (in mm)

Implant site	Incisal soft tissue thickness (1.0 mm apical to gingival margin)	Middle soft tissue thickness (2.0 mm apical to gingival margin)	Apical soft tissue thickness (3.0 mm apical to gingival margin)
Maxillary right lateral incisor	1.94	2.96	3.46
Maxillary right lateral incisor	2.71	3.01	3.44
Maxillary left central incisor	2.16	2.69	2.94
Maxillary left lateral incisor	2.01	2.58	3.04
Maxillary right lateral incisor	2.05	3.26	3.49
Maxillary right central incisor	2.07	2.70	2.92
Maxillary right lateral incisor	2.16	3.57	4.11
Maxillary right canine	1.59	1.79	2.21
Maxillary right lateral incisor	2.32	3.36	4.33
Maxillary right central incisor	1.73	2.19	2.36
Maxillary left central incisor	1.36	1.92	2.62
Maxillary right lateral incisor	1.53	2.48	3.36
Maxillary left lateral incisor	2.51	3.25	3.73
Maxillary left central incisor	2.31	3.11	3.34
Maxillary right central incisor	2.46	3.03	3.39
Average soft tissue thickness	1.89	2.79	3.25
Range	1.36–2.71	1.79–3.57	2.21–4.33

extracted and immediate implants were placed in an identical fashion.[22] Comparatively, for the sites treated identically with the exception of no hard or soft tissue augmentation being performed, Chu et al[22] achieved mean soft tissue thickness values of 1.4 mm, 2.1 mm, and 2.6 mm at 1.0 mm, 2.0 mm, and 3.0 mm apical to the mucosal margin, respectively. A two-tailed *t* test revealed significant differences compared to the 15 cases in this series at all three measurements, with $P = .003$.

Discussion

Immediate implant placement provides several advantages to staged therapy. When appropriate, it reduces the number of surgical procedures, shortens overall treatment time, and maintains preoperative soft tissue architecture. Although short-term advantages are appreciated, the long-term success of treatment as it relates to physiologic and esthetic stability is one of concern. Over time, mucosal recession can result in esthetic failure and require additional, unpredictable surgical and restorative procedures. Non-grafted sites continue to lose soft tissue height beyond the first year after treatment is completed,[24] suggesting that peri-implant hard tissues continue to remodel after immediate implant placement and restoration, and soft tissue levels migrate apically, more so in patients with thin periodontal phenotypes, after treatment. Therefore, it is logical to strategize methods of tissue stabilization at the onset of immediate implant therapy. This involves not only undercontoured submucosal regions of abutments and crowns[25,26] but also augmentation of hard and soft tissues at the time of immediate implant placement and provisional restoration.

Esthetic success is not only related to gingival height and contour, but also to blending prosthetic tooth replacement with the natural frame of hard and soft tissues. Often, implant abutments alter the color of the peri-implant soft tissue, negatively affecting esthetics. Recently, Ferrari et al[27] demonstrated that peri-implant soft tissue with a thickness of ≥ 2.0 mm was capable of

preventing color changes induced by metallic and ceramic abutments. In a study by Jung et al, intentional soft tissue grafting was performed after implant placement when soft tissue thickness was < 2.0 mm for the purpose of masking underlying abutments.[11] This was done after bone xenograft was placed into the socket gap and a resorbable collagen membrane was used in a flapped approached. The objective of using the dermal apron technique is not only to stabilize peri-implant soft tissue levels, but also to thicken the gingiva and aid in masking the underlying prosthetic components. Compared to historical controls, this technique achieves the second objective. The use of a dermal allograft in conjunction with bone grafting of the hard and soft tissue zones enhances and increases the peri-implant soft tissue thickness, especially in the incisal third. This is of clinical significance since the most coronal zone adjacent to the free gingival margin is the first line of defense against recession. Therefore, an increased peri-implant soft tissue thickness at the incisal area has potentially greater effects on long-term stability of the free gingival margin. More research is necessary on the stability of the free gingival margin with such augmentation techniques.

Two studies in which soft tissue thickness was measured have provided values to be anticipated when no augmentative steps are performed. In both studies, similar cases were grafted and provisional crowns were affixed at the time of surgery. However, control sites included cases with no hard or soft tissue grafting. In the study by Chu et al,[22] for sites receiving immediate implants only without any augmentation or provisional restoration, the measurements at 1.0 mm, 2.0 mm, and 3.0 mm apical to the gingival margin were 1.2 mm, 1.8 mm, and 2.3 mm, respectively. A second study with immediate temporization but without any augmentation, where soft tissue thickness was only measured 2.0 mm apical to the mucosal margin, demonstrated that untreated peri-implant soft tissue thickness measured an average of 1.42 ± 0.36 mm.[28] This was after a mean follow-up time of 8.6 months (range of 6 to 17 months). This study demonstrated a mean soft tissue thickness at 2.0 mm apical to the margin for 31 sites grafted with autogenous connective tissue grafts of 2.61 ± 0.57 mm, ranging from 1.50 to 4.10 mm. Sites in the current series of 15 cases compared quite favorably (mean thickness 2.0 mm apical to the margin = 2.79 mm), to the second study's cases grafted with autogenous soft tissue.

In the present study, the range of soft tissue thickness at the critical 1.0-mm incisal level of soft tissue was 1.36 to 2.71 mm. Of the 15 cases in this study, 10 (67%) demonstrated soft tissue thickness of at least 2.0 mm. This thickness, according to Ferrari et al,[27] would be favorable in terms of concealing the underlying abutments at the most critical level of soft tissue height, enhancing the esthetic outcome. In addition to the absence of implant failures or complications related to osseointegration, none of the 15 patients included in this study experienced failure of the dermal graft to incorporate into the existing mucosa or sloughing of the overlying soft tissue. The authors have experienced varying degrees of soft tissue sloughing when thicker dermal allografts (0.8 to 1.4 mm) are used in the same manner. It is hypothesized but not proven that the limited elastic nature of keratinized gingiva did not allow for adaptation of the thicker allograft without vascular compromise. Therefore, the thinner material was selected for the technique presented in this case series.

The effect of the patient's periodontal phenotype was not taken into account in this study. As has been demonstrated by Eghbali et al,[29] correct identification of the periodontal biotype is inconsistent. The same group[30] also suggests a third, "thick, scalloped" biotype may exist. Misdiagnosing this characteristic may increase the risk of gingival recession after immediate implant therapy is completed, warranting further treatment. The routine necessity for soft tissue augmentation in every immediate implant placement and provisionalization situation is not universally accepted. As previously stated, one of the functions of the dermal allograft is for bone graft containment. Sequestration of particulate bone was rarely experienced in this study. Though the argument opposed to routine soft tissue augmentation for the purposes of increasing gingival thickness for every case may be reasonable, the procedure described serves several other functions, such as guided bone regeneration and graft containment. The clinician

must consider each individual site, risks for adverse physiologic and esthetic complications, and experience when approaching these types of situations.

Conclusions

The use of a dermis allograft in conjunction with bone grafting in the hard and soft tissue zones enhances and increases the peri-implant soft tissue thickness, especially in the incisal third, close to 2.0 mm in horizontal thickness. Therefore, an increased peri-implant soft tissue thickness at the incisal area has potentially greater effects on long-term stability of the free gingival margin and resistance to midfacial recession. By reducing postoperative morbidity and eliminating a secondary donor site, this procedure is less invasive and may be as efficacious in achieving a satisfactory increase in soft tissue thickness pending further, well-controlled randomized human clinical trials.

Acknowledgments

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

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