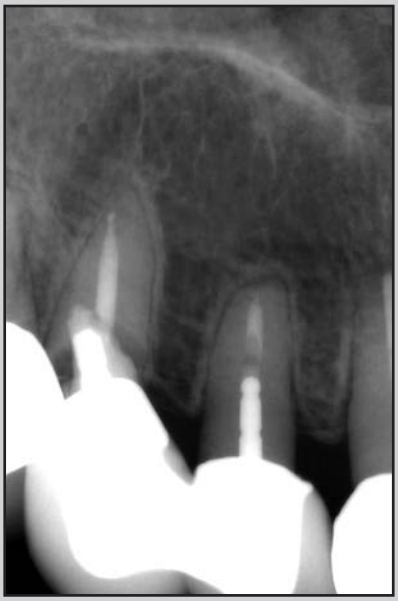

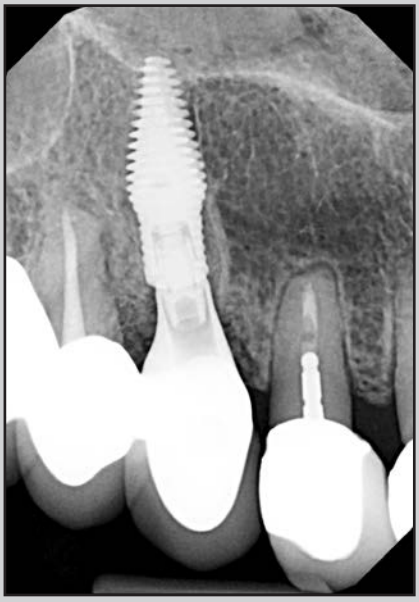

Changes in Peri-Implant Soft Tissue Thickness with Bone Grafting and Dermis Allograft. Part III: A Case Series Using a Novel, Hybrid Implant Design with a Subcrestal Angle Correction

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This comparative case series presents 16 consecutively placed and temporized immediate implants in the maxillary esthetic zone. The implants have a novel, inverted body-shift design, intended to achieve high levels of primary stability via the tapered apical portion. The coronal narrow cylinder provides greater space between the implant platform and facial socket wall and adjacent teeth/implants, allowing a greater opportunity for augmentation. The restorative platform also features a subcrestal angle correction, which facilitates screw retention. The wider, facial platform-shift thus creates more room for augmentation via dual-zone bone grafting and the application of a dermal allograft, which yields greater soft tissue thickness after initial healing. This case series aimed to evaluate soft tissue thickness and compare the results to two previously published cohorts where implant design served as the only variable between groups. Int J Periodontics Restorative Dent 2022;42:723–729. doi: 10.11607/prd.6333

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Over the last two decades, immediate tooth replacement therapy (ITRT) has become a desired method for replacing hopeless anterior teeth.[1,2] However, certain limitations exist. With limited bone volume in many extraction sites, surgeons rely primarily on bone beyond the socket walls for implant engagement. Commonly, wide-diameter, tapered implants are used to achieve higher levels of primary stability. Unfortunately, these implants are widest at their coronal dimension, reducing distance between the implant platform and the adjacent tooth roots and facial bone. Implants with labial angulations result in more soft tissue recession and thinner soft tissues.[3,4] Facially inclined implants are often necessary to avoid perforating the apical aspect of the facial cortex.[5] Recently, angle-correction abutments have been introduced, changing the trajectory of abutment screws to emerge through the cingulum aspect of implant-supported crowns. These angle-correction abutments must emerge in a linear direction from the implant platform, with the angle correction existing coronal to the facial bone crest. This may induce pressure in the subcritical and critical contours of restorations,[6] resulting in recession.

An implant with a subcrestal angle correction (SAC) design eliminates this compromise, as the

abutment screw often emerges through the cingulum region of the crown, while the long axis of the implant emerges through the incisal edge of the planned restoration.[7] Another feature of SAC implants is the wider offset between the implant platform and implant-abutment junction, known as variable platform switch (VPS). Canullo et al[8] demonstrated that the greater this disparity, the more favorably the marginal bone is maintained. This implant design allows implants to be positioned with a palatal bias, where bone usually exists more apically.[9,10] All of these elements result in predictable prosthetic screw access without supracrestal pressure on the soft tissues from SAC abutments. When the present authors compared facial soft tissue thickness between uniaxial and SAC implants in ITRT scenarios,[11] approximately 1.0 mm of increased soft tissue thickness was seen in sites receiving SAC implants when both groups received identical augmentation procedures around immediately placed and restored implants. In a similar study, Chu et al[12] demonstrated significantly thicker soft tissues in sites receiving SAC implants compared to conventional platform-switched implants. Recently, a novel, inverted body design (INV) macrohybrid implant has been introduced with the aim of achieving greater primary stability via the wide, tapered apical part (60%) of the implant body. The narrower, cylindrical coronal portion allows for greater gap distance at the crest and also features an SAC design.[13,14] The narrower cylindrical coronal portion provides space for augmentation with hard and/or soft tissue grafting and the restoratively increased space for seating of prosthetic components. This allows for the maximum preservation of hard and soft tissue volume. This is possible due to the larger gap between the implant platform and facial wall of sockets and between the implant and adjacent teeth/implants.

In the present case series, peri-implant soft tissue thickness (recorded 2.0 mm apical to the facial gingival margin) is measured at 3 to 4 months postoperative to demonstrate increased mucosal thickness. Thickened peri-implant facial soft tissue is clinically relevant, as it allows for greater concealment of underlying abutments that can cause an unwanted esthetic compromise.[15,16] There have been limited studies evaluating the biologic advantages of this INV + SAC implant. The purpose of this case series is to measure facial soft tissue thickness and demonstrate the synergy between the INV and SAC macrohybrid implants combined with dual-zone bone grafting and dermal allograft application. To confirm or refute the efficacy of this implant design, the results were compared to two previously published studies utilizing identical surgical and restorative procedures that also measured soft tissue thickness.

Materials and Methods

Fourteen patients receiving 16 consecutively placed immediate implants in the maxillary anterior sextant (canine to canine) were treated with INV/SAC implants and dual-zone bone grafting combined with a dermal allograft (the Dermal Apron Technique). All 16 implants received either temporary crowns placed out of occlusion or customized healing abutments to support the soft tissues and grafting materials.

Two previously published studies had an identical treatment method,[17,18] and the present study's only variable is the utilization of the novel INV/SAC implant design.

The surgical protocol involved flapless, minimally traumatic extraction, meticulous socket debridement, and positioning the INV/SAC implant with its long axis emerging through the incisal edge of the planned restoration. Chairside fabrication of customized healing abutments or screw-retained provisional crowns was performed to be delivered out of occlusal contact with the opposing mandibular teeth. A dual-zone bone graft, as described by Chu et al,[14] was performed; rather than utilizing a bone graft consisting exclusively of cancellous bone allograft, a composite bone graft comprised of 80% mineralized cortical bone (particle size: 250 to 810 μm; Symbios Allograft Particulate, Dentsply Sirona) and 20% xenograft (particle size: 250 to 1,000 μm; ZenGro, Southern Implants) was applied in the bone and tissue zones around the implants. A dermal allograft (0.4 to 0.8 mm thick; Symbios PerioDerm, Dentsply Sirona) was adapted around the internal component of the one-piece temporary crowns. This allograft was secured within a small subperiosteal pouch and oriented so that the basement membrane side faced inward,

against the facial bone and graft particulate, and the connective-tissue side faced the periosteum and sulcus. A resorbable, monofilament suture (Monocryl, Ethicon, Johnson & Johnson) was used in a figure-eight configuration to gently compress the overlying soft tissues and graft material.

Patients were administered systemic antibiotic therapy (amoxicillin, or clindamycin for patients allergic to penicillin); a 6-day tapering course of methylprednisolone (Medrol Dosepak); nonsteroidal, anti-inflammatory medication (400 mg; etodolac); and chlorhexidine rinses in lieu of toothbrushing for the first 10 to 14 days postoperative. After suture removal at 10 to 14 days, patients were given an extra-soft toothbrush and instructed to perform the "roll technique" of brushing for at least 3 months. Patients were also advised to avoid all mastication with the anterior dentition for at least 3 months.

Temporary crowns were removed at approximately 3 to 4 months to assess implant stability via implant stability quotient measurements, and patients were referred back to their restorative dentist for fabrication of definitive crowns. Soft tissue models were fabricated via implant-level conventional impressions at 3 to 4 months postoperative. These models were then scanned (Trios, 3Shape), allowing soft tissue thickness (measured 2 mm apical to the direct facial free gingival margin) to be quantified.

The soft tissue thickness values were analyzed by analysis of variance (Prism 5.0 software, GraphPad), using Tukey test for post-hoc comparisons. The results were considered significant when $P < .05$. Soft tissue thickness measurements from two previously published cohorts[17,18] were compared to the present measurements and evaluated for significant differences.

Case Examples

Case 1

A 76-year-old woman presented with a hopeless vertical root fracture of the maxillary right canine associated with an endodontic post (Figs 1a and 1b). Following flapless extraction and socket debridement, the tooth was replaced with a 4.5/3.6 × 13.0–mm INV/SAC implant (Inverta, Southern Implants) with a 12-degree SAC. The implant was palatally positioned, and dual-zone bone grafting was performed at the facial gap as previously described.

A screw-retained provisional crown was fabricated with a titanium temporary abutment and bis-acryl and flowable composite resin. A dermal allograft (0.4 to 0.8 mm thick) was trimmed, and a biopsy punch was used to allow the allograft to be draped over the temporary crown/abutment (Fig 1c).

The allograft was oriented with the connective tissue side facing outward, towards the periosteal surface of the facial mucosa, and the basement membrane side facing inward, against both the facial bone and graft particles residing within the tissue zone (Fig 1c). Resorbable sutures (5-0 Vicryl Rapide, Ethicon) were placed for hemostatic purposes and to gently compress the site, minimizing the clot between the layers of hard and soft tissues and grafting materials (Fig 1d). A postoperative radiograph was taken to confirm complete seating of the provisional crown (Fig 1e).

No mobility, inflammation, or discomfort were present during healing (Fig 1f). The final screw-retained crown was delivered approximately 16 weeks after surgery (Figs 1g and 1h). A digital scan was performed (Trios) on the soft tissue model containing the implant analog to measure soft tissue thickness on the direct facial aspect of the model (approximately 6 months postsurgery). In this particular case, the mucosa thickness was 4.87 mm (Fig 1i).

Case 2

A 79-year-old woman presented with a failing maxillary left central incisor. Both central incisors were recently restored with all-ceramic crowns, with the endodontic post losing retention in the left central incisor site (Figs 2a and 2b).

Following flapless extraction and meticulous socket debridement, a 4.5 × 15.0–mm INV/SAC implant (Inverta) was placed with a palatal bias, whereby the long axis of the implant coincided with the incisal edge of the future restoration. The 12-degree SAC results in a screw access emerging through the cingulum region of the provisional and definitive crown. Dual-zone bone grafting was performed as previously

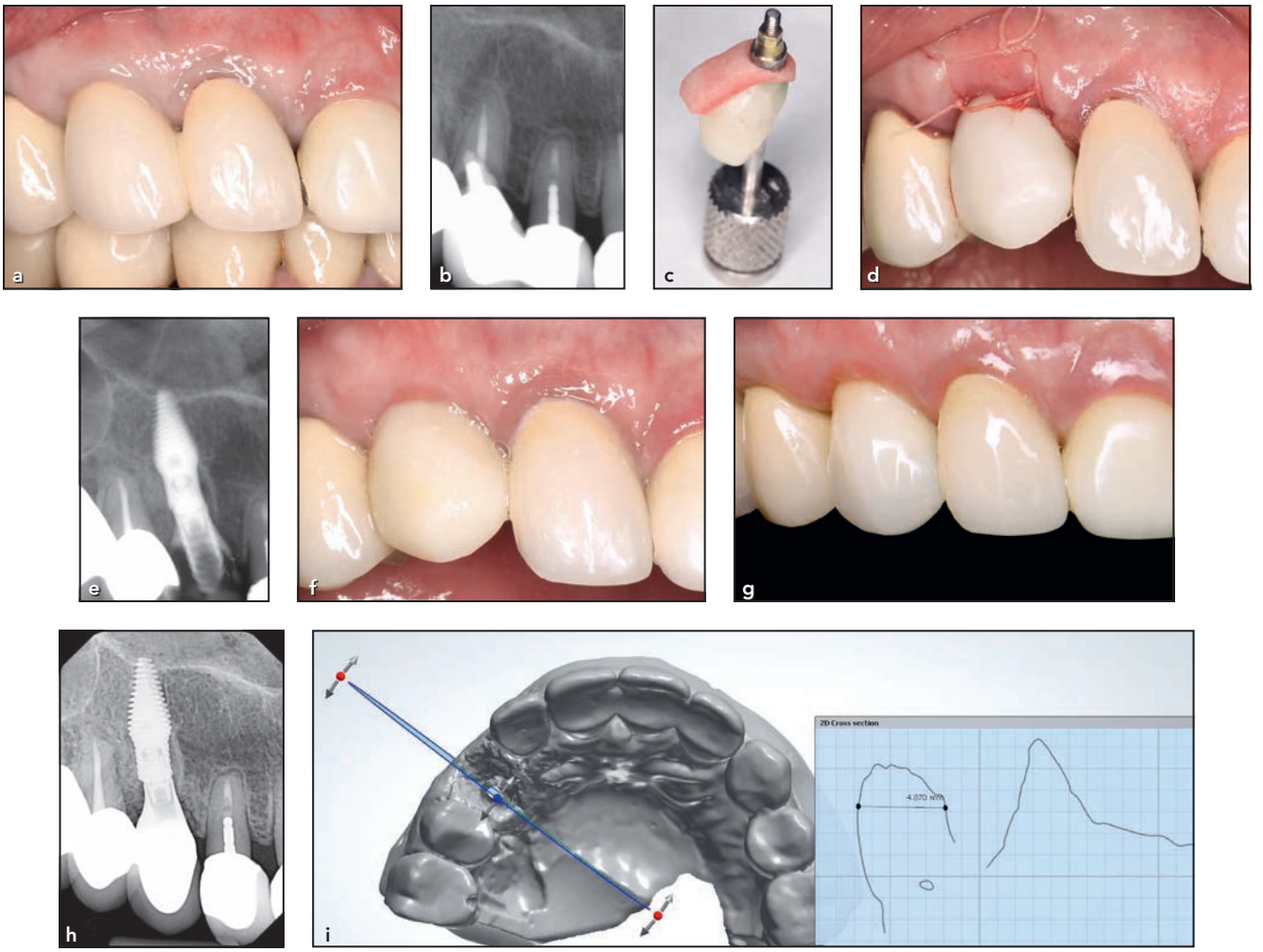

Fig 1 *Example Case 1.* (a) *Fractured root of tooth 13 (FDI tooth-numbering system), which is splinted to tooth 12.* (b) *The radiograph view shows the fractured canine root associated with the prosthetic post.* (c) *A screw-retained provisional crown with dermal allograft was adapted. At adaptation, the connective tissue surface was oriented against the temporary crown, and the basement side of the membrane was placed against the facial bone and bone graft in the tissue zone.* (d) *An immediate temporary restoration was placed with resorbable compression sutures for hemostasis and clot stabilization.* (e) *Radiographic view at the time of ITRT for the maxillary right canine.* (f) *Post-operative conditions 7 weeks after ITRT.* (g) *Clinical and* (h) *radiographic views at delivery of the final, screw-retained, porcelain-fused-to-metal crown on tooth 13.* (i) *Digital scan of the soft tissue model at time of restorative therapy (14 weeks postsurgery). The facial soft tissue thickness was 4.87 mm (measured 2 mm apical from the free gingival margin).*

described. A screw-retained temporary crown was fabricated in the same manner as the previous case, and a dermal allograft was trimmed and adapted around the provisional crown (Fig 2c). The provisional crown was seated, and the dermal allograft was inserted into the shallow subperiosteal pouch created facially and palatally, with no occlusal contact with the mandibular incisors (Fig 2d).

Restorative therapy began 4 months after ITRT and included refabrication of the crown on the adjacent central incisor for a matching, esthetic appearance. A soft tissue model (Figs 2e and 2f) was digitally scanned to measure the facial soft tissue dimension. In this case, the soft tissue thickness was 3.212 mm. The definitive screw-retained crown on the implant and the new all-ceramic crown on the adjacent central incisor were delivered about 6 months after initiating treatment (Fig 2g).

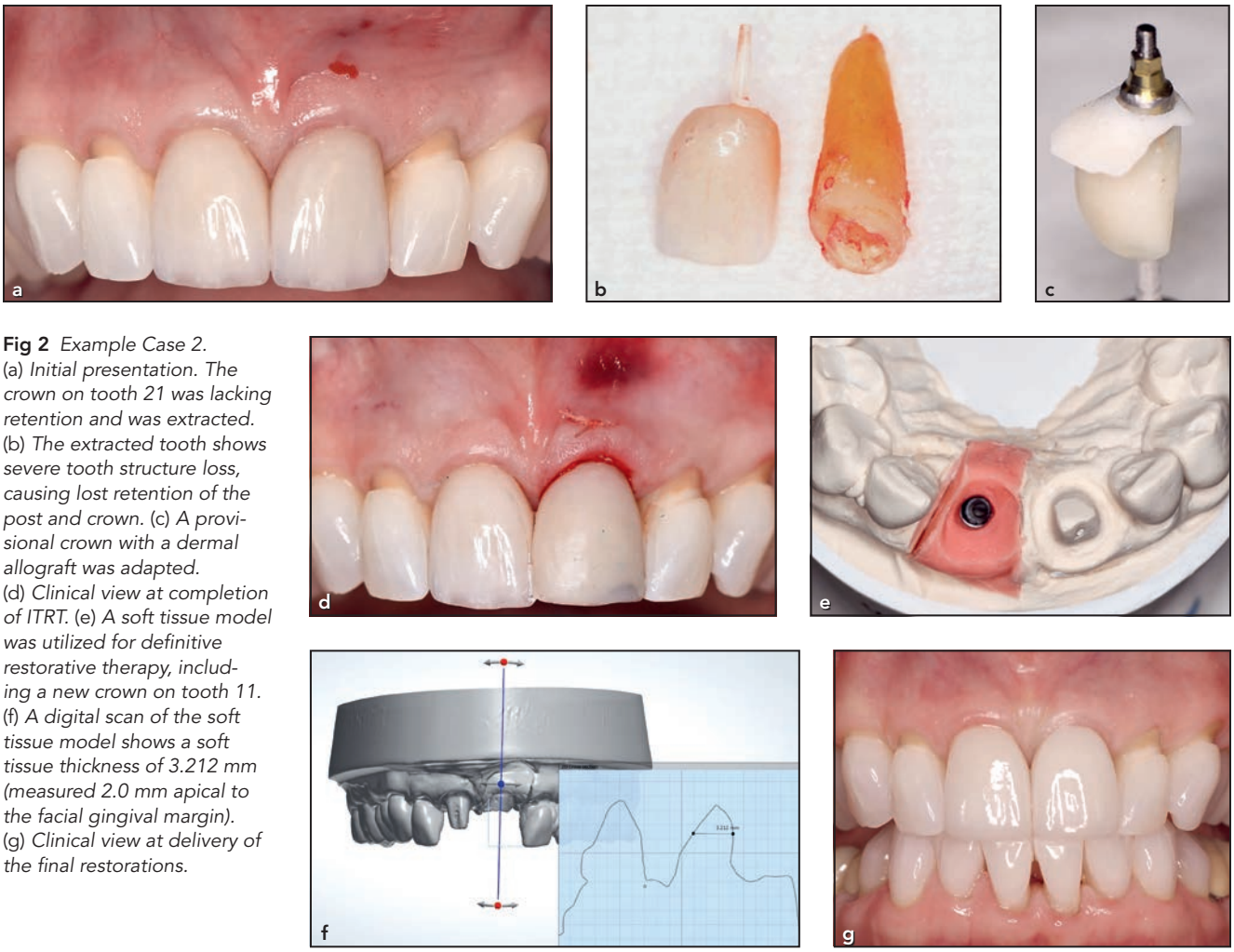

Fig 2 *Example Case 2.* (a) *Initial presentation. The crown on tooth 21 was lacking retention and was extracted.* (b) *The extracted tooth shows severe tooth structure loss, causing lost retention of the post and crown.* (c) *A provisional crown with a dermal allograft was adapted.* (d) *Clinical view at completion of ITRT.* (e) *A soft tissue model was utilized for definitive restorative therapy, including a new crown on tooth 11.* (f) *A digital scan of the soft tissue model shows a soft tissue thickness of 3.212 mm (measured 2.0 mm apical to the facial gingival margin).* (g) *Clinical view at delivery of the final restorations.*

Results

A total of 14 patients (2 men, 12 women; aged 24 to 89 years old) underwent ITRT of a single maxillary anterior tooth utilizing the Dermal Apron Technique with placement of an INV macrohybrid implant (Inverta, Southern Implants). Two patients received ITRT in two adjacent sites.

All 16 implants clinically osseointegrated and received definitive restorations. All single crowns were screw-retained. Soft tissue models were obtained from the restorative dentists and digitally scanned (Trios) after delivery of the final crown. The soft tissue thickness on the direct facial aspect was measured 2 mm apical to the free gingival margin, and the average thickness was 3.70 mm (range: 2.37 to 5.71 mm).

This soft tissue thickness was compared with that of the two sets of cases[17,18] that received ITRT with the Dermal Apron Technique in conjunction with different implant designs: a conventional uniaxial implant (UA) and a VPS implant with an SAC. The data collected in these groups were published previously,[17,18] and the average soft tissue thickness for each group is shown in Fig 3. Both SAC and INV/SAC groups showed statistically significant increases in soft tissue thickness compared to the UA group ($P = .0165$ and $P = .021$, respectively), but no significant difference was seen between SAC and INV/SAC groups.

Discussion

The present sites were treated with a protocol identical to that of the 15

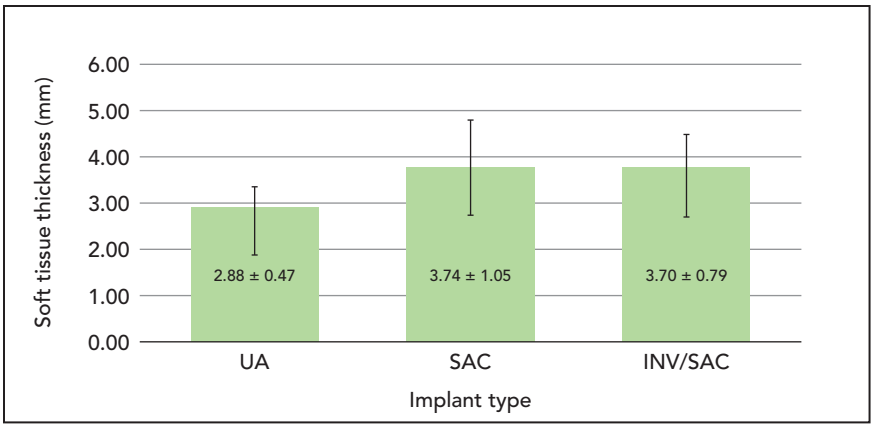

Fig 3 *Comparison of soft tissue thickness outcomes at 3 to 4 postoperative months for uniaxial (UA[17]), subcrestal angle correction (SAC[18]), and inverted-body design (INV) implants across the present study and previously published studies.[17,18]*

consecutive cases in two previous studies,[17,18] with the implant design as the only variable. When comparing the results between studies, a significant difference was found between the average soft tissue thickness in the present study compared to the study utilizing UA implants[17] (3.70 mm vs 2.79 mm, respectively). In the present study, traditional implants with an SAC design yielded a soft tissue thickness of 3.74 mm at a distance of 2 mm apical to the facial free gingival margin. This increase in soft tissue thickness was equally accomplished with the INV implant in the present study.

It is noteworthy that the platform of the INV implant used in the present study featured a VPS, with a greater distance between the abutment connection and the implant platform facially compared to UA implants. The standard 4.0-mm–diameter SAC implant possesses a 0.86-mm VPS compared to a 0.60-mm platform-switch on the UA implant, and the 3.5-mm–diameter SAC implant has a 0.99-mm VPS compared to the 0.36-mm platform-switch of the UA version. This unique feature (VPS) can contribute to thicker facial soft tissues when compared to identical ITRT methods using UA implants.[20] The present study used the INV/SAC version of the Inverta implant, featuring a VPS. The INV implants have a 0.52-mm VPS compared to a 0.40-mm platform switch for the straight version with a 4.5/3.6-mm diameter, and a 0.72-mm VPS compared to a 0.60-mm platform switch for the straight version with a 5.0/4.0-mm diameter. Although the difference between INV/SAC and straight implants is less than the difference between SAC implants and straight implants, both diameters of the INV/SAC implant have a 20% to 30% greater platform-switch compared to straight versions, which may be partly responsible for the comparatively equal soft tissue thicknesses found for INV/SAC compared to SAC implants.[11] One of the advantages of the INV/SAC implant over its predecessor is the wider, tapered apical half of the macrodesign. This apical portion allows the operator to achieve significantly higher primary stability, as quantified by insertion torque and resonance frequency analysis.[19] This lends itself to greater versatility and predictability when performing immediate temporization and immediate loading. Furthermore, the narrower coronal portion increases the gap distance between the implant and the facial and interproximal socket walls, resulting in preservation of papillae and alveolar contours.

In a multicenter study evaluating the clinical performance of this novel INV+SAC implant (Inverta), where a dual-zone bone graft consisted of exclusively mineralized cancellous bone allograft, the average soft tissue thickness was measured from 48 cases.[14] The overall soft tissue thickness was 3.29 ± 0.73 mm when measured 2 mm apical to the free gingival margin.[14] The present study confirms those findings: This novel implant design, when combined with simultaneous soft and hard tissue augmentation and temporization, results in thickened facial soft tissues. Robust soft tissue dimensions have been associated with maintained hard tissue support around the implant.[21,22] With the near-doubling of established minimal thickness for esthetic results, the outcomes of the technique demonstrated in the present study should be viewed as encouraging. These preserved biologic dimensions ultimately result in optimized esthetic results that are stable over time.

Conclusions

This comparative case series demonstrates that when a novel INV implant with an SAC is combined with a specific hard and soft tissue grafting technique, in conjunction with immediate implant placement and provisionalization, the facial soft tissue thickness is favorable. When comparing the results to those of UA implants in other studies, the INV/SAC implants achieved an increased tissue thickness. The VPS appears to play a significant role in increasing soft tissue thickness compared to standard platform-switched implants. Ultimately, the thickened soft tissue dimensions allow for greater esthetic results and tissue support for the implant's longevity. The high degree of primary stability and increased coronal gap space make this implant a viable option for ITRT. Long-term follow-up studies are necessary to demonstrate the stability of these outcomes.

Acknowledgments

The authors declare no conflicts of interest.

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