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Overcoming Surgical and Prosthetic Challenges

Planning and Implementing a Maxillary Central-Lateral Implant Restoration

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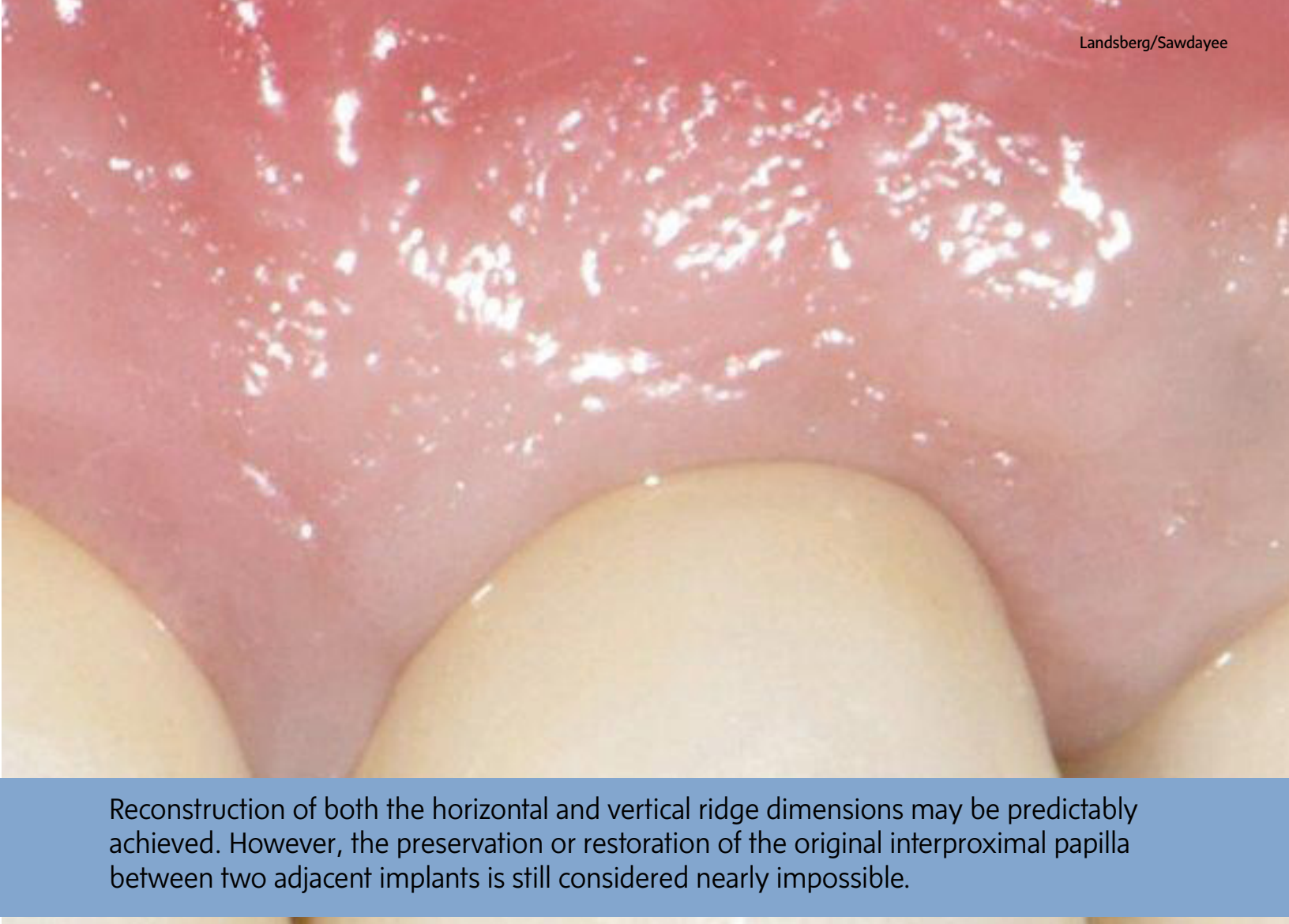
Abstract

The maxillary central-lateral implant restoration presents a unique and multifaceted dilemma for the professional team. Achieving a functional and esthetic implant restoration in this area may become extremely challenging due to its specific anatomical characteristics. This case report emphasizes the importance of detailed planning and use of advanced and challenging surgical and prosthetic procedures to overcome the obstacles typical to this area.

Key Words: lateral-central restoration, implants, bone regeneration, soft tissue augmentation, esthetics, emergence profile



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Introduction

Extraction of two or more adjacent teeth may cause flattening and narrowing of the alveolar ridge, with almost complete disappearance of the interdental papillae. These changes occur as a result of disruption of attached connective tissue fibers that normally support the function and form of hard and soft tissues around the teeth.[1]

Reconstruction of both the horizontal and vertical ridge dimensions may be predictably achieved. However, the preservation or restoration of the original interproximal papilla between two adjacent implants is still considered nearly impossible.[2,3]

In the maxillary central-lateral tooth area, it is especially difficult to restore the interproximal papilla.[4,5] This is mainly due to inevitable partial resorption of the narrow and mostly cortical interdental septum usually found between the two extracted teeth. Further insult to the interproximal tissues may occur if two standard implants are placed to support the two-unit restoration. This is because the edentulous ridge is usually too short to maintain the minimum 4-mm inter-implant distance necessary to prevent crestal resorption.[1,6]

Several surgical and prosthetic solutions have been proposed to overcome this problem; they include placing narrow[7] or switched platform implants,[8] connecting small diameter concave abutments,[9,10] using scalloped implants,[11,12] or placing a single implant supporting a cantilevered bridge.[4,5,7]

The presented case addresses a variety of surgical and prosthetic considerations and methods to achieve the best possible functional and esthetic outcomes in this challenging central-lateral area.

In the maxillary central-lateral tooth area, it is especially difficult to restore the interproximal papilla.

Case Presentation

A 45-year-old male presented wanting to replace his loose upper front bridge with an esthetic and well-functioning restoration. Clinical examination revealed a skeletal Class II with Angle Class II, Division 1 and 2 occlusion with pronounced overbite and overjet in the anterior dentition. There were no occlusal contacts of teeth ##7-10 in maximum intercuspation, and lateral and anterior movements were canine-protected and anteriorly guided, respectively. Significant deterioration of function and esthetics of the maxillary anterior teeth were noted. The entire sextant was involved, with moderate gingival recession and interdental papillae loss. Tooth #7 was slightly tilted labially. Teeth #8 and #10 displayed darkened roots, which were clearly visible above, and reflected below the recessed gingival margins. A Class I[13] residual ridge defect (i.e., mainly horizontal resorption) was present at site 9 **(Fig 1)**. Radiographic examination revealed early to moderate alveolar bone resorption. A root canal filling had been performed at #8 approximately 15 years previously. A wide radiographic shadow mesial of the tooth suggested the existence of a relatively wide incisive nerve and canal. Severe root decay was found in #10 **(Figs 2a-2e)**.

Treatment Objectives

As the patient rejected correction of the skeletal Class II malocclusion with orthognathic surgery, the remaining treatment goal was to restore function and esthetics to the maxillary front dentition by fulfilling the following objectives:

- extraction of #10
- central and lateral (sites 9 and 10) implant restoration with optimal physiological topography of the gingival margins and interproximal papillae
- crown replacement of #8
- masking of dark-colored root of #8 with a new crown and connective tissue graft
- uprighting of #7
- partial root coverage of #6 and #11.

After discussing the steps necessary to achieve his functional and esthetic goals, the patient agreed to the proposed surgeries, except for the possibility of intervening with the incisive nerve and blood vessels (which might be necessary for safe implant placement in site 9). Therefore, other restorative options limited to a single implant placement in site 10 (i.e., cantilevered bridge, or connecting implant 10 with tooth #8, etc) were considered. The patient also declined any orthodontic treatment. Thus, it was decided to restore the crown with direct composite restoration to blur the misangulation of tooth.[7]

It was also explained to the patient that on #6 and #11, only partial root coverage might be expected due to reduced bone level and papillae heights present interproximally on those teeth.[14,15]

Figure 1: At presentation, the three-unit bridge was loose. Note recessed gingiva of the whole anterior sextant and horizontal ridge defect at site 9.

Figures 2a-2e: At presentation, early to moderate bone loss in the entire anterior sextant, severely decayed root #10, and a radiolucent area apically of pontic #9.

Extraction of #10 and Provisional Bridge

Extraction of #10 necessitated an immediate tooth-supported temporary restoration. To avoid unnecessary preparation of the left canine, the moderately decayed #12 was prepared to support, along with #8 and a metal rest on #11, a metal-reinforced acrylic temporary bridge **(Figs 3-5)**. Immediate preservation of the fresh extraction site by bone and soft tissue grafting was not implemented, because the entire edentulous area was planned for hard and soft tissue augmentation in the subsequent two months.

Implant Placement in Site 10 and Ridge Augmentation in Sites 9 and 10

After two months, marked horizontal concavity of the edentulous area was noted **(Fig 6)**. Wide full thickness labial and palatal flaps with vertical releasing incisions in the distal region of #6 and #12 were elevated, exposing a mostly thin and concave alveolar ridge and a large incisive canal opening **(Fig 7)**. A prefabricated surgical stent **(Fig 8)** clearly indicated that implant (4-mm wide, 3i, Biomet; Palm Beach Gardens, FL) placement was feasible at this stage only in site 10 **(Fig 9)**. It was calculated that placing a relatively wide-diameter implant at site 10 would be advantageous if, despite the efforts to augment the ridge, site 9 would ultimately be found unsuitable for implant placement.

The ridge was augmented using bovine bone mineral (Bio-Oss, Geistlich Pharma GA; Wolhusen, Switzerland) and a resorbable x-linked collagen membrane (Ossix-Plus, Datum Dental; Lod, Israel) **(Figs 10 & 11)**. To further increase the overall dimensional changes of the ridge, a subepithelial soft tissue graft harvested from the palate was placed and sutured on top of the membrane using resorbable 4-0 polyglactin sutures (Vicryl Rapide, Ethicon/Johnson & Johnson; Somerville, NJ) **(Fig 12)**. The labial flap was coronally advanced and sutured using nonresorbable 6-0 polyamide sutures (Ethilon, Ethicon/ Johnson & Johnson) to the palatal flap for complete coverage of the grafted tissues.[16] Root coverage of #6 and #11 was carried out concomitantly **(Fig 13)**. Healing was uneventful, and at six months marked vertical and horizontal ridge augmentation had been achieved **(Fig 14)**. However, the dimensions necessary to obtain the desired soft tissue topography around the future crowns had not been reached **(Fig 15)**. CT scans of the area revealed an appreciable horizontal gain of hard tissue, which seemed suitable for implant placement at site 9 **(Fig 16)**.

It was predicted that additional bone gain, both horizontally and vertically for improved soft tissue support, would be unachievable mainly due to anatomic limitations (reduced crest level mesially of #11 and a wide incisive canal).

Figure 3: Tooth #12 was prepared. Note vertical fracture of #10 and moderate gingival recession of #11.

Figure 4: A transitional bridge composed of acrylic crowns for #8 and #12, a metal rest on #11, and two pontics for sites 9 and 10.

Figure 5: The left lateral tooth was removed. A transitional bridge is supported by #8 and #12, and a metal rest on #11.

Figure 6: After two months, a marked horizontal ridge deficiency was noted in the area of pontics #9 and #10.

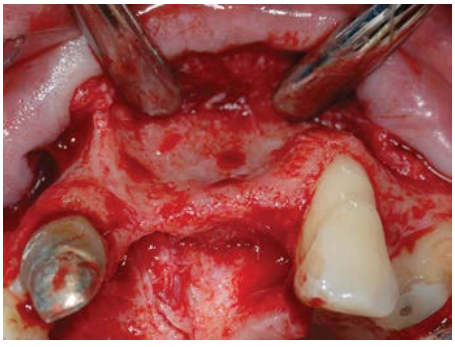


Figure 7: Wide flaps are elevated showing severe horizontal bone defect and wide incisive canal, significantly compromising future implant placement in site 9.

Figure 8: The surgical stent that mimics the planned screw-retained final crowns is well situated.

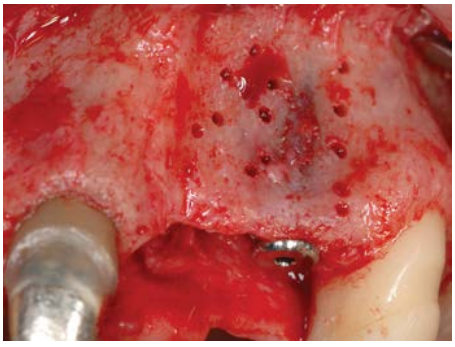


Figure 9: Residual bone is decorticated by multiple drill penetrations. A standard-diameter (4.1 mm) implant is placed at site 10 close to the labial bony plate.

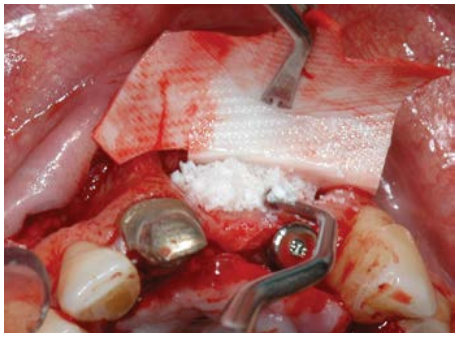


Figure 10: Bovine bone particles are placed underneath an x-linked resorbable collagen membrane to increase buccal bone volume.

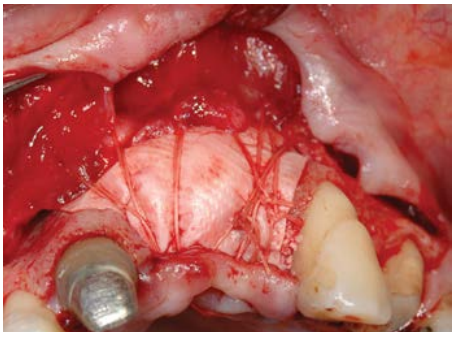


Figure 11: The membrane is fixed by 4-0 resorbable sutures anchored to the deep periosteum buccally and to the palatal flap.

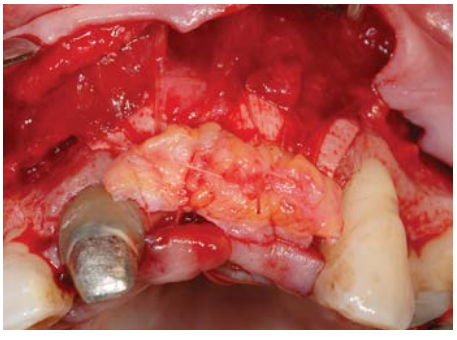


Figure 12: A subepithelial soft tissue graft harvested from the palate is placed on top of the membrane and fixed by 4-0 resorbable sutures.

Figure 13: The augmented area is completely covered by the coronally advanced labial flap and the palatal flap using 6-0 polyamide sutures.

Figure 14: At six months, the ridge demonstrates horizontal and vertical gain.

Figure 15: Pontics #9 and #10 are shortened to accommodate the increased vertical ridge dimension. However, insufficient horizontal ridge width was noted.

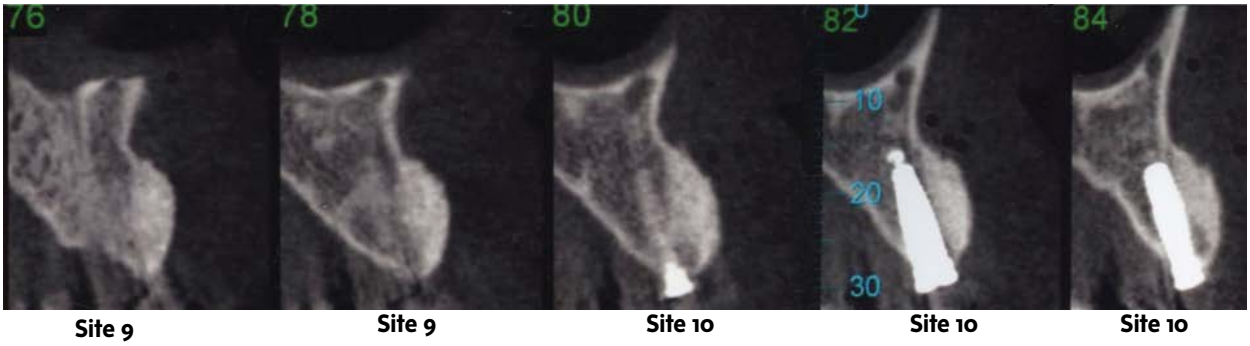


Figure 16: At six months, CT scans show a significant gain in bone volume horizontally. Note site 9 is suitable for narrow implant placement.

Implant Placement at Site 9 and Soft Tissue Enhancement

After six months, buccal and palatal full thickness flaps were elevated, exposing newly sound regenerated bone and a well-integrated implant at site 10. A narrow-diameter (3.25 mm) implant was placed at site 9 using the original surgical guide. As a 4-mm wide implant had previously been placed at site 10, the achieved inter-implant distance was only 3.2 mm **(Figs 17 & 18)**. A large soft tissue graft, harvested from the same donor site in the palate, was placed to augment the ridge both horizontally and vertically, and to partly increase the marginal gingiva width of #11 **(Figs 19 & 20)**. The labial flap was advanced once again to completely cover the augmented ridge **(Fig 21)**. Healing was uneventful, and three months after surgery the tissue topography in both vertical and horizontal dimensions seemed adequate for surgical implant exposure **(Fig 22)**. However, significant coronal advancement of the less desired non-keratinized mucosa was evident **(Fig 23)**.

Restoration of two missing maxillary central and lateral teeth with a functional and esthetic implant-supported prosthesis is still one of the most challenging procedures in implant dentistry.

Figure 17: Using the original surgical stent, site 9 is suitable for implant placement six months after guided bone regeneration.

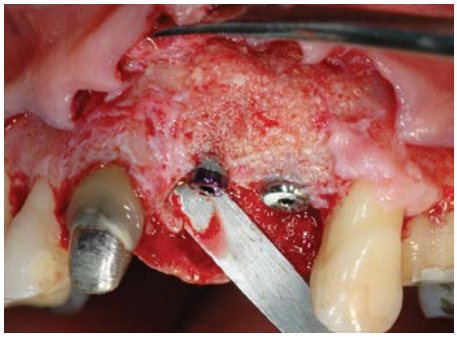


Figure 18: A narrow-diameter (3.25 mm) implant is placed at site 9.

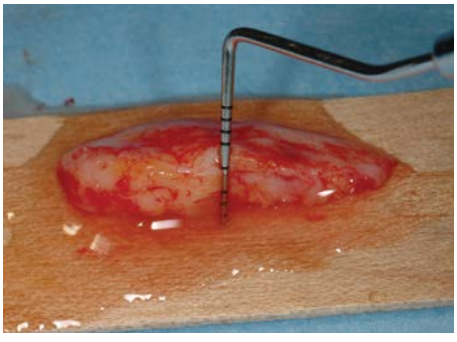


Figure 19: An additional large soft tissue graft is harvested from the same donor in the palate.

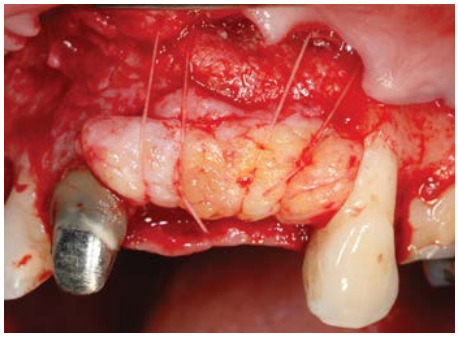


Figure 20: The soft tissue graft is placed at the occluso-labial aspect of the ridge and fixed with 4-0 resorbable periosteal sutures.

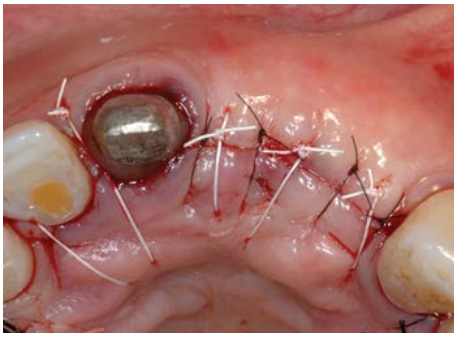


Figure 21: The labial flap is coronally advanced to achieve complete coverage of the grafted tissues.

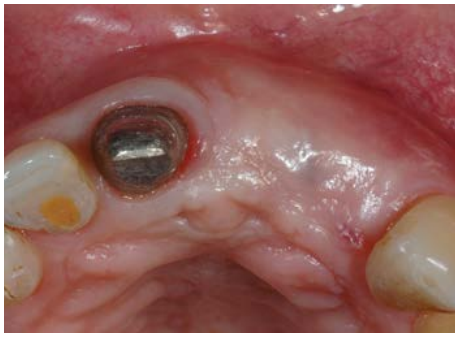


Figure 22: After three months, there is a significant increase in ridge volume, both in coronal and labial dimensions.

Figure 23: The pontics at sites 9 and 10 are shortened. Note lack of adequate keratinized band at the labial aspect due to labial flap coronal advancements.

Healing Abutment Connection and Transmucosal Tissue Profile Development

After three months, a palatal horizontal incision was made that enabled healing abutment connection and transposition of a significant amount of keratinized tissue, both buccally and coronally **(Fig 24)**. Small pieces of connective tissue harvested from the palate filled the created interproximal soft tissue gaps. Semicircular small pedunculated labial flaps were rotated to protect these tissue grafts and to further enhance the interproximal tissues **(Figs 25-27)**.[17] After three months of healing, individual screw-retained temporary acrylic crowns were connected to the implants. Initially, these interim crowns were prepared to be narrow in their transmucosal part to avoid pressure on the peri-crown soft tissues that presented typical cylindrical long and narrow profiles. However, every few weeks, light pressure on the surrounding tissues was exerted gradually by adding small acrylic increments circumferentially on the cervical portions of the crowns. This achieved a gradual improvement in proportions and appearance of the crowns and the tissues around them **(Fig 28)**. The desired crown designs with "all-around" concave transmucosal profiles were finally achieved six months after they were first connected to the implants **(Figs 29-31)**.

Figure 28: After two months, provisional crowns during the process of redesigning the transmucosal tissue profiles.

Figure 24: At implant exposure, a palatal straight horizontal incision enables further corona-labial positioning of the labial flap.

Figure 25: Small soft tissue grafts harvested from the palate are placed in the interproximal gaps created upon flap elevation. Mini pedunculated flaps are prepared in the labial flap.

Figure 26: The mini-flaps are rotated to fully cover the grafted soft tissue and to further augment the interproximal tissues.

Figure 27: After one week, there is significant increase in ridge volume and reestablishment of adequate band of keratinized tissue with a straight mucogingival line.

Figure 29: After five months, ultimate provisional restoration of #9 before its connection to the implant (buccal view). Note concave emergence profiles.

Figure 30: After five months, ultimate provisional restoration of #9 before its connection to the implant (lateral view). Note concave emergence profiles.

Figure 31: After six months, ultimate provisional restorations of #9 and #10, having all-around concave profiles, are screw-retained as single units.

Final Crown Restorations

The final transmucosal profiles achieved around the provisional restoration were perfectly transferred to the laboratory using a technique recently developed by the secondary author **(Figs 32 & 33)**. In this technique, the provisional restoration is mounted on the working model, thereby allowing accurate fabrication of a soft tissue replica.

Cast gold abutments exactly matching the concave transmucosal profiles of sites 9 and 10 were fabricated and tested in situ **(Fig 34)**. Using dual-cured adhesive resin cement (Panavia F 2.0 CT, Kuraray; Tokyo Japan), zirconia crowns were bonded to the gold abutments to become one-piece prosthetic units **(Fig 35)**, which were screw-retained separately to implants 9 and 10. A single zirconia crown was cemented (Panavia) to the existing gold post of #8. Choosing identical prosthetic materials (zirconia cemented to gold) for the three crown restorations defined their desired similar esthetic characteristics. Therefore, other options (e.g., porcelain-fused-to-gold screw-retained crowns) for the implants were not considered. Teeth #6 and #11 regained almost natural anatomic proportions by combining partial root coverage and cervical composite restorations. Tooth #7 received a bonded composite restoration in an attempt to blur its labial angulation. Well-aligned esthetic crowns were achieved in healthy tissue housing with nicely contoured soft tissue margins **(Fig 36)**.

Radiographically, the implants demonstrated proper "implant-tooth" distances; however, there was less than ideal "implant-implant" space with bone profiles typically found around straight, wide-headed implants **(Figs 37a & 37b)**.

After one month, the patient received a new composite restoration to enhance the appearance of #7. At six months, a slight vertical eruption of #8 was discovered. Therefore, the tooth was intruded back to its natural position utilizing a transparent acrylic plate and finally splinted with orthodontic wires and a composite.

The patient has been seen in both periodontal and prosthetic clinics every three to four months since completing active treatment. At the three-year follow-up it was evident that both bony and soft tissue housings around the implant restoration remained completely stable **(Figs 38-39b)**. A slight marginal gingiva edema on #7 and #8 was noted. This was related to possible inefficient plaque control and compromised connective tissue attachment to the imperfect darkened treated root #8. Subgingival curettage under local anesthesia was performed and the need to improve adherence to the oral hygiene instructions and maintenance program was emphasized to the patient.

Figure 32: At removal of ultimate provisional restorations of #9 and #10, the transmucosal tissues show the maximum desired morphology.

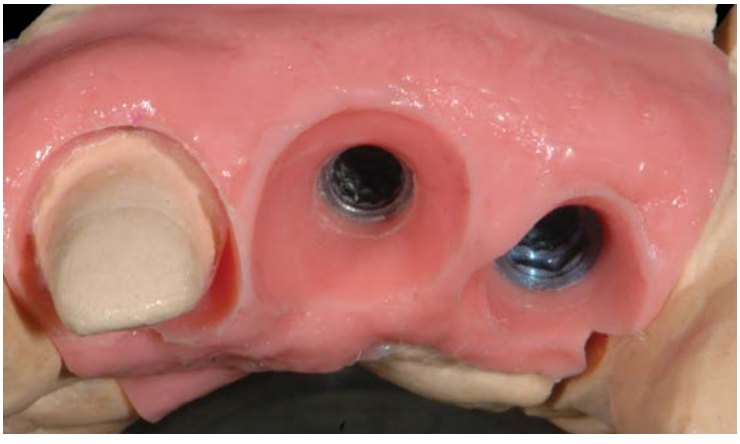
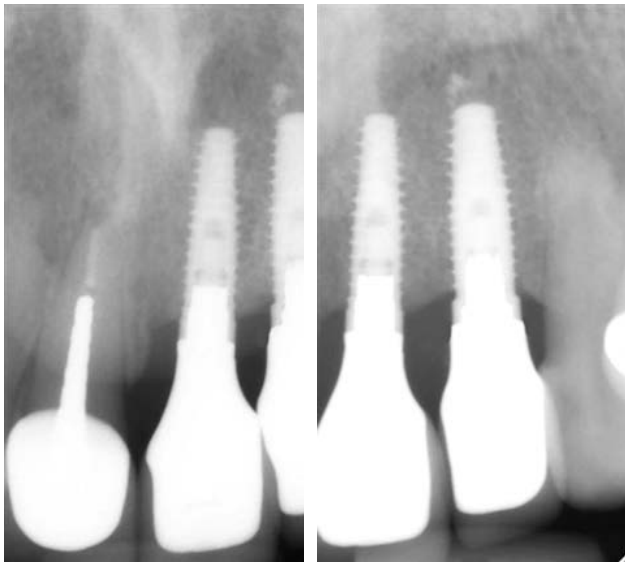


Figure 33: The transmucosal tissue profiles are accurately transferred to the laboratory using a silicone-based material.

Figure 34: Cast gold abutments are connected to implants #9 and #10 and tested for their adequate relationship with the peri-implant mucosa.

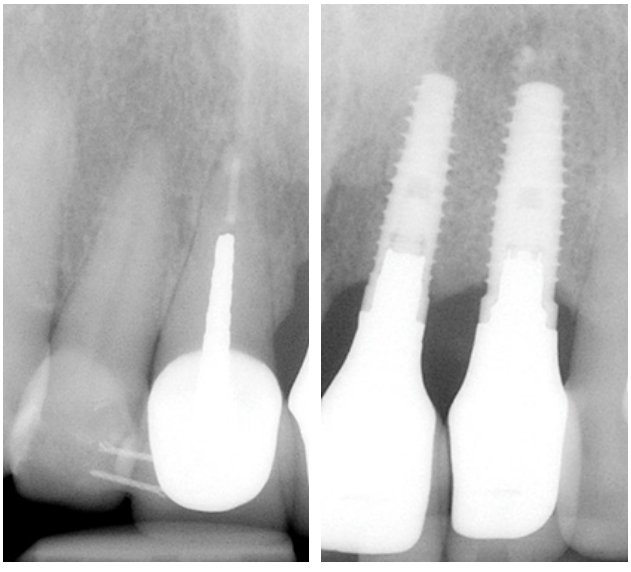
Figure 35: Zirconia crowns are bonded to the gold abutments to become one-piece screw-retained crowns.

Figure 36: At the end of treatment, the final crowns appear to be surrounded by healthy and well-contoured soft tissue.



Figures 37a & 37b: At the end of treatment, both concave abutment transmucosal profiles and solid interproximal bone profiles are shown.

Figure 38: At the three-year follow-up, stable soft tissue topography is evident. Note slight marginal tissue cyanosis at #7 and #8.



Figures 39a & 39b: At the three-year follow-up, radiographic views demonstrate stable hard tissue profiles around the teeth and implants. Note splinting between #7 and #8.

Discussion

Restoration of two missing maxillary central and lateral teeth with a functional and esthetic implant-supported prosthesis is still one of the most challenging procedures in implant dentistry. The reasons are threefold: the usually too-short ridge span, the multiple differences in the three-dimensional position of the implants, and the expectation that the implant-supported restoration would mimic its neighboring counterpart across the midline. The following surgical and prosthetic clinical guidelines were used when planning the presented case.

Implant Placement Must be Prosthetically Driven

A clinician may find it very frustrating when trying to calculate and plan the correct three-dimensional implant positioning in this area. The generally known and accepted implant-to-implant[2,6] and implant-to-teeth[2,18,19] distances (> 4 mm and > 1.5 mm, respectively), as well as other pertinent dimensions, are calculated mainly for two-dimensional implant placement situations. In the central-lateral area, which is unique and different in its three-dimensional morphology for each patient, poor esthetics may result if these measurements are arbitrarily applied. To overcome this difficulty, it is necessary to use a prosthetically driven surgical stent, which should give almost no freedom of interpretation as to the exact positioning of the implants.[20] The acrylic surgical stent chosen for this case was fabricated as an exact copy of the provisional bridge. For stabilization, palatal rests were prepared on existing proximal #8 and #11. The surgical stent was planned for screw-retained crowns, while providing guidance for the desired three-dimensional positioning of the implants. During surgery, this stent design may allow for minute changes in final implant positioning. This is in contrast to a fully computerized surgical stent, which rigidly dictates only one implant position.

Two Implants are Better Than One to Support a Central-Lateral Implant Restoration

Sufficient load-bearing capacity is usually provided by placing two medium-diameter (3.3 to 3.5 mm) implants in both a lateral and central incisor tooth position or, preferably, by a standard-diameter (3.7 to 4.1 mm) implant in the central tooth position and a medium-diameter implant in the lateral incisor tooth position. Additionally, the authors have experienced that recapturing an interproximal papilla of reasonable height is more predictably achieved between two adjacent implants, rather than between an implant and a pontic, provided bone level and quality are similar in both clinical situations. This is likely due to the ability of the prosthetic transmucosal parts to push and support the interproximal soft tissues significantly better than the supramucosal pontic.

> For an esthetic implant-supported restoration mainly in the maxillary anterior area, both its bony and soft tissue housing should be of premium quality and sufficient quantity.

In many cases, however, because the ridge is relatively short, the clinician may find it necessary to place only small-diameter implants (3.0 to 3.25 mm), use platform-switched abutment connections, place only one implant to hold a cantilevered bridge, or connect between a tooth and an implant. Only a few case reports have shown successful results, although short-term, using the above imperfect solutions.[4,5,7,8] The use of small-diameter implants or platform switching, and definitely cantilevering a single implant, may hold the potential risk of implant or abutment fractures. A well-thought-out clinical solution was recently suggested[21] in which the canine tooth is moved to the lateral position, thereby converting the "central-lateral dilemma" to a single incisor implant case. Also suggested was the maintenance of a root submerged under a single implant cantilevered pontic to enhance the soft tissue morphology.[21] In the presented case, the decision to place a standard-diameter implant in the lateral tooth position was based on the concerns that implant placement in the central tooth position would become unachievable (due to the challenging ridge anatomy), and that a cantilevered two-unit bridge would have to be constructed. In retrospect this approach was mistaken, as augmenting the ridge first might have allowed placement of a medium- or small-diameter implant, as is the preferred implant size in the lateral tooth position. This eventually would have resulted in delivery of separated central and lateral crowns supported by small- to medium-diameter implants.

Soft Tissue May Significantly Compensate for Partially Missing Bone

For an esthetic implant-supported restoration mainly in the maxillary anterior area, both its bony and soft tissue housing should be of premium quality and sufficient quantity.[1,22-28] Reconstruction of both horizontal and vertical ridge dimensions around properly placed prosthetically driven dental implants may be predictably achieved. Nevertheless, to date, one of the most challenging goals of implant dentistry is the preservation or restoration of inter-implant papillae. Research has shown that, with or without special surgical manipulations, tissue thickness on top of the inter-implant crestal bone ranges from 2 to 4 mm.[3] This is because current implant designs may not allow for the reestablishment of a collagen fiber system similar to that normally found between adjacent teeth. Thus, support and maintenance of the inter-implant papilla may be dependent upon the physical support gained from the underlying bone and the approximating artificial crown surfaces, as well as on the physical properties of the papilla.[1]
In the presented case, the regenerated bone height was definitely limited by the reduced peak of crestal bone at the mesial aspect of the left canine, the undesired resorption pattern around the wide and straight-

headed implants,[29] and other possible weaknesses of materials or methods in the bone regenerative procedure, as had been implemented. To compensate for the missing ideal configuration of the regenerated bone, it was necessary to augment the soft tissue component of the ridge more than is usually needed. Indeed, harvesting of the palatal connective tissue graft was performed three times, and together with flap advancements and other manipulations, adequate soft tissue ridge topography was finally achieved. No recession of the peri-implant tissues was noted three years after final crown connection and approximately three and a half years after final soft tissue augmentation. Evidently, the reduced crestal height was significantly compensated long term by the increased volume and quality of augmented soft tissue. Of special interest was the fact that a supracrestal 7- to 8-mm long central-lateral inter-implant papilla formed and was maintained at the three-year follow-up.

Transmucosal Profiles Should be Gradually Developed

The implant head is completely round and narrow when compared to the natural root of a given tooth. Consequently, the tissue around the healing abutment attains a similar round and narrow transmucosal configuration. However, the desired emerging tissue profiles must follow the natural tooth anatomy, which is mostly elliptical and wider.[22,23] This may be achieved with gradual pressure on the surrounding tissues by the provisional acrylic restorations.[22,23,30] The desired tissue profiles may be reached by adding small acrylic increments at two- to three-week intervals, taking care not to cause permanent tissue ischemia. These tissue profiles should remain supported and unchanged for at least two months by the final configuration of the provisional restorations to achieve advanced tissue maturation and stability before impression-taking for the final prosthesis.

Transmucosal Emergence Profiles Should be Accurately Transferred to the Laboratory

Once the desired topography of the peri-implant mucosa has been achieved, it is advisable to transfer the exact tissue profiles to the dental laboratory. This may become problematic, as the peri-implant soft tissues tend to partially collapse once the provisional restorations are removed for impression-taking. Advanced impression techniques have been proposed to overcome this tissue collapse.[31-39] In the presented case, a simplified method was used in which a precise soft tissue replica was achieved, leaving no place for guesswork in fabricating the emergence profiles of the final prosthesis.

Summary

In implant dentistry, restoring the lateral-central edentulous ridge with implant-supported porcelain crowns may well be considered a unique esthetic challenge. It necessitates a variety of prosthetic and surgical considerations, many of which are unique to this area—and, of course, to the individual patient. Meticulous occlusal and prosthetic analysis, together with thorough periodontal assessment, must precede the treatment plan. The treatment plan, in turn, must include advanced bone and soft tissue regenerative procedures and laboratory techniques (and, obviously, well-constructed and designed implant surgical and prosthetic parts). The case presented demonstrates the difficulties that characterize the central-lateral area and ways to optimally overcome them. In these cases, the professional team's dedication and the patient's utmost cooperation are necessary to achieve satisfactory results.

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