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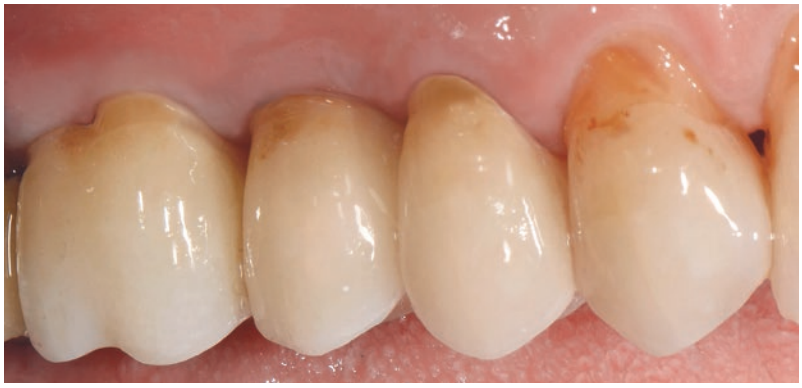

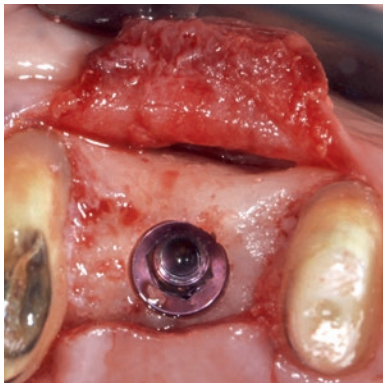

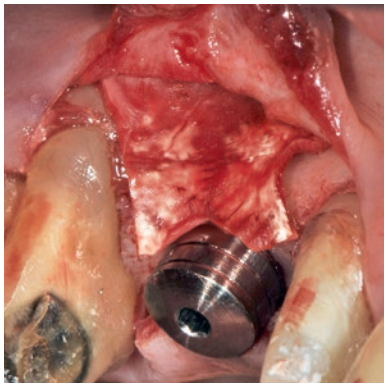

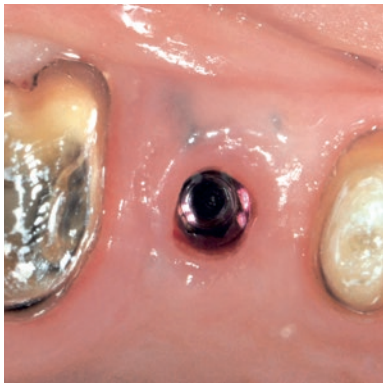

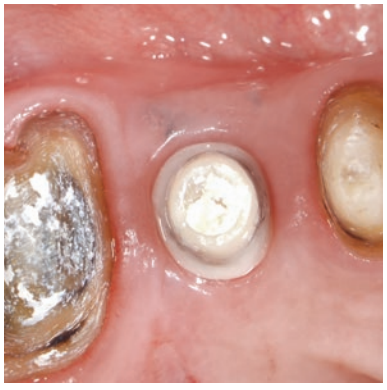

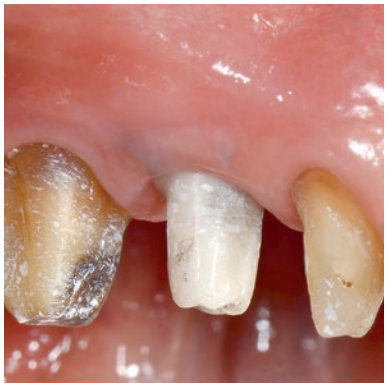

QUINTESSENCE PUBLISHING

A nouveau collagen scaffold to simplify lateral augmentation of deficient ridges between natural teeth

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The volume of the bone in a site past an extraction degrades significantly and thus it is imperative to evaluate the situation for implant placement. Besides the need for sufficient bone, the amount and quality of the soft tissue covering the bone in the missing tooth area and nature of the adjacent teeth must be carefully assessed. In anterior sites, reconstructive surgery is usually performed to restore these hard and soft tissues, mainly for esthetic reasons, but it is equally essential in posterior sites to ensure adequate functional support. In guided bone regeneration procedures, barrier membranes block the augmented areas, provide and maintain space for regenerative material, and protect the blood clot, allowing a normal wound stability process. Clinicians prefer using resorbable membranes in most cases, whereas a nonresorbable membrane is selected to correct large defects. This report proposes the use of a collagen scaffold as a core material for guided bone regeneration in the case of a missing tooth between two existing teeth, when there is sufficient bone to place an implant but a horizontal defect is present in the crestal ridge. The tested question is whether a thick, reinforced, resorbable collagen scaffold (Ossix Volumax) can provide a stable basis for restoring the lost volume of a deficient ridge. The regeneration procedure presented with the collagen scaffold resulted in restoration of the lost tissue volume and a favorable lifelike emergence profile for the implant-supported crown. This augmentation procedure is simpler to perform in certain cases than existing procedures with bone substitute material and/or an interpositional connective tissue graft harvested from a remote donor site, the harvest of which is not required. *(Quintessence Int 2019;50:576–582; doi: 10.3290/j.qi.a42652)*

Key words: bone resorption, collagen scaffold, guided bone regeneration, posterior implant, resorbable membrane

As dental implant therapy has become the standard of care in the replacement of missing teeth, discussion has shifted to issues of therapy sequence, materials, and techniques; outcomes; and peri-implant tissue response following years in function.

In partially edentulous cases, single implant-supported crowns demand a clinical approach that supports the surrounding hard and soft tissues, which play a critical role in creating the desired lifelike appearance of the prosthetic unit (ie, emergence profile and the implant-crown interface). Nevertheless, the main question is whether there is sufficient bone at the site. The answer often depends on the amount of time that has passed since the tooth or teeth were lost or diagnosed as congenitally missing. A residual alveolar ridge will rarely maintain its size and may be subject to infections, periodontal disease, or trauma involving the bone unrelated to the extraction.

This physiologic dimensional bone reduction following extraction has been well documented and demonstrated experimentally. In humans, approximately 50% of the residual bone volume is lost after 1 year.[1-5] To avoid this complication, procedures to restore the resorbed alveolar bone prior to or during implant placement are usually performed.[6] According to the literature, lateral bone augmentation procedures for implant placement are considered predictable. High rates of success have been reported for both simultaneous and staged approach procedures, although the latter have achieved better results.

Lateral bone augmentation procedures generally combine bone replacement grafts and barrier membranes.[7,8] Some authors still consider autogenous bone the gold standard of bone replacement materials, but the debate continues over which bone substitutes—allogeneic, xenogenic, or alloplastic—pro-

vide the best outcomes. Although some authors still question their role in regeneration procedures, barrier membranes block the augmented areas, provide and maintain space for the regenerative material, and protect the blood clot and the wound stability process.[9] By isolating the augmentation material from the soft tissues, membranes allow bone to grow over a period of 16 to 24 weeks.[10,11]

In addition to the need for sufficient bone, the second important factor is the amount and quality of the soft tissue covering the bone and the adjacent teeth. Implant-supported restorations demand stable and healthy soft tissues coronal to the implant neck and at the crown-implant interface. The soft tissues in this region have more collagen than the periodontal gingival tissues[12,13] but a relatively smaller blood supply,[14] which helps to explain differences in the behavior and stability of tissues at each site. Collagen, which is naturally distributed throughout the body, constitutes a major component of the gingival connective tissue and the unique implant attachment mechanism at its cervical aspect, very unlike the periodontal ligament and blood vessels that make up the attachment mechanism in teeth.

Reconstructive surgery to restore the hard and soft tissues of a deficient ridge is more often demanded in anterior sites for esthetic reasons yet no less important in posterior areas for functional support. Soft tissue augmentation procedures are indicated when one tooth (or more) is missing between existing teeth. An esthetic outcome of an implant-supported prosthesis means complete integration with the neighboring adjacent teeth but without ignoring function.

The search for the ideal isolating biomaterial for predictable and easy ridge regeneration continues. Clinicians can choose between a nonresorbable membrane designed to correct large defects and the resorbable type of membrane used in most cases today.[15-18] Although the two types of membrane produce similar results, resorbable membranes are preferred by clinicians because they have lower morbidity rates, less risk for exposure,[19-22] lower costs, and no second surgery requirement for removal.[23] The main disadvantage of resorbable membranes is their low tensile strength and poorer performance in maintaining space during healing compared to titanium mesh and expanded polytetrafluoroethylene (ePTFE) membranes.[24]

Today, most guided bone regeneration (GBR) procedures are performed with resorbable porcine- and bovine-derived collagen membranes with or without cross-linking. The membrane is designed to maintain its integrity for protection of the new bone formation process,[9,25-28] to slow down the membrane degradation process by means of cross-linked collagen fibrils,[26-30]

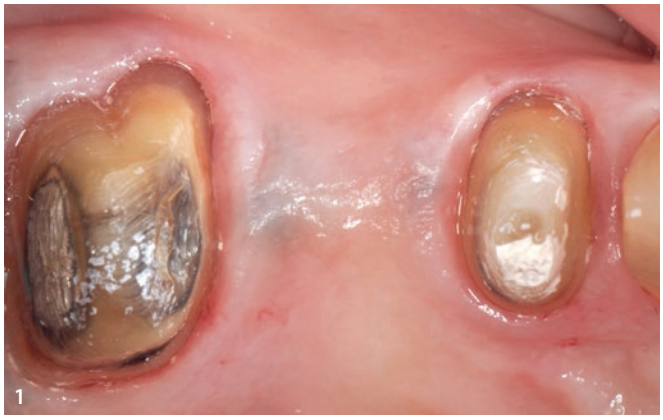
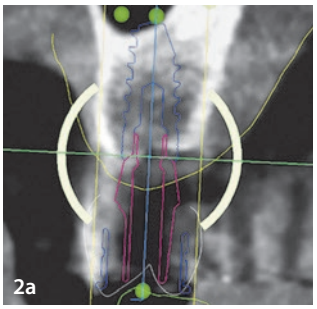


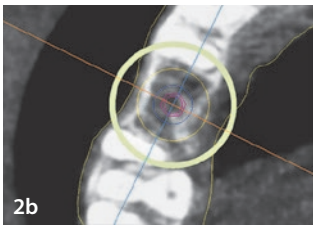
Fig 1 Occlusal view prior to treatment showing evidence of a lateral bone deficiency.

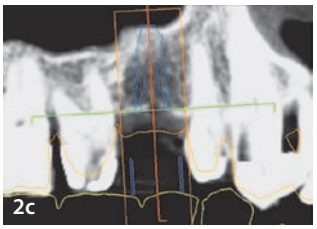
and to remain uncovered with no dehisences.[31,32] Cross-linked resorbable membranes have been found to be prone to exposure during healing, resulting in significantly less bone regeneration.[33,34] The addition of a ribose-linking agent to a porcine-derived collagen membrane has demonstrated the ability to maintain a barrier for over 4 months without being exposed.[35]

A clinical classification system described by Studer et al,[36] based on the Seibert system[37,38] and another proposed by Allen et al,[39] relates to the quantity and quality of alveolar bone defects in both horizontal and vertical dimensions. The deficiency characteristics and the planned future restoration define the nature of the surgical intervention and type of augmented tissues needed. Adding soft tissues improves the quantity and quality of the mucogingival tissue and the anatomical aspect of the results. As a general rule, excess soft tissue augmentation is recommended for achieving optimal function and esthetics. The soft tissue surgery can be performed during implant placement or at the time of the stage-two implant surgery (if planned) and allows the surgeon to seal and sculpt the anatomy.[40]

The same functional difficulties associated with missing teeth restored with pontic teeth (phonetic problems, food impaction, cleansability of the prosthetic unit) occur with implant-supported restorations. They are caused by the specific arrangement of soft tissue around the cylindrical implants and the unavoidable spaces resulting from differences in the shape of implants relative to teeth and the loss of tissues following extractions. As with teeth, correction of these problems and alveolar deficiencies can be achieved by prosthetic means (enlarging, elongating, or augmenting the missing gingiva with pink porcelain), but the results do not appear natural







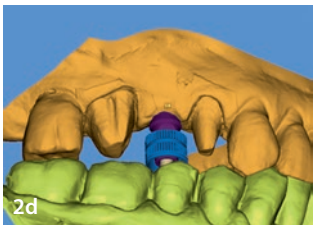


Fig 2a to 2d Implant placement planning software (MGuide, MIS Implants Technologies). *(a)* Sufficient bone for implant placement in the buccopalatal aspect. *(b)* The concave nature of the buccal plate (occlusal view) with negative effect on the future emergence profile. *(c)* Lateral view showing suffiient bone height and mesiodistal space. *(d)* The final placement plan is seen with insufficient soft tissue support and profile.

and are easily recognized, especially in the anterior region of the mouth.

This dilemma led to the development of procedures to restore the alveolar ridge to its original dimensions prior to or during a prosthetically driven implant placement surgery.[35,41] In many cases, the soft tissue deficiency is the primary concern and a connective tissue graft often is the only needed solution, especially when the deficiency is between teeth. The interpositional connective tissue graft is an effective and predictable surgical procedure, but it is technically sensitive and demands a remote donor site for harvesting soft tissues, increasing the morbidity of the procedure.[42] Marzadori and colleagues[43] recently identified the need for a simplified one-stage soft tissue correction technique that could be used even for Seibert Class 3 defects. Until now, no connective tissue substitute has been developed that will reduce the morbidity associated with surgery and avoid the need to harvest soft tissue from a donor site.[43]

This report proposes the use of a collagen scaffold as a core material for GBR in the case of a missing tooth between two existing teeth, in situations where there is sufficient bone to place an implant but a horizontal defect is present in the ridge. The tested question is whether a thick, reinforced, resorbable collagen scaffold can provide a stable basis for restoring the lost volume of a deficient ridge. As a secondary aim, a positive result could present an option to replace the connective tissue interpositional graft procedure.

The material used in this report is Ossix Volumax (Datum Dental), a biodegradable and biocompatible collagen membrane designed for use during GBR and guided tissue regeneration. The collagen is extracted from porcine tendons in an approved, controlled, standardized procedure. According to the manufacturers, this innovative regeneration material is based on the same Glymatrix technology used to produce the Ossix Plus membrane.[44] The collagen scaffold is 1.5 to 2.0 mm thick, expands when wet, and adapts and adheres to the bone. If exposed, the device resists degradation, which is allowed to occur slowly over a period of up to 6 months in its progress toward mineralization and into ossification.

The aim of this clinical presentation is to introduce the use of this nouveau material in the restoration of buccal and labial ridge defects to support better functional and anatomical outcomes in implant-supported restoration procedures.

Clinical case

A 60-year-old woman presented at the clinic after she lost a porcelain-fused-to-metal prosthesis from the maxillary right first premolar to first molar (teeth 14 to 16 according to FDI notation) that replaced a missing maxillary right second premolar. A provisional acrylic restoration was prepared and fitted chairside, the abutments were evaluated, and the patient was referred for a cone beam computed tomography (CBCT) scan. The abutment teeth had good bone support and sufficient tooth material for crowning. The first molar tested vital and the first premolar had previously undergone root canal therapy. The treatment plan accepted by the patient was to restore the first molar and first premolar with crowns and to place an implant that would support a crown in the area of the missing second premolar. The CBCT scan demonstrated that the amount of bone in the second premolar region was sufficient for placing an implant, but a transverse evaluation at the crestal level revealed a buccolingual deficiency (Fig 1).[36]

Implant surgery was planned virtually with a software planning system (MSoft, MIS Implants) (Fig 2), and a software-designed surgical template (Seven, MIS Implants) was fabricated. For the implant placement, a midcrestal incision was made, and a full-thickness flap was raised buccally (Fig 3). To obtain tension-free adaptation of the flap margins, the buccal

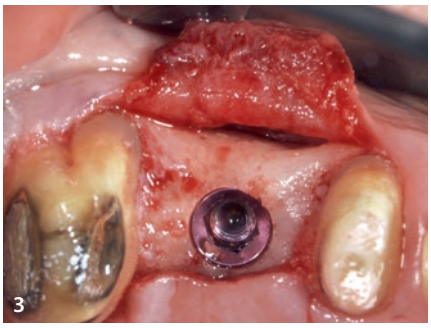


Fig 3 At the implant placement surgery, the deficiency in the crestal area is revealed under the full-thickness flap.

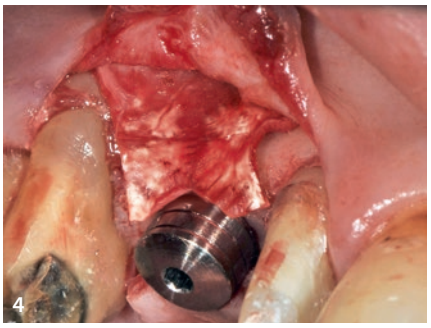


Fig 4 Adaptation of the collagen scaffold in the buccal aspect of the ridge and around the buccal aspect of the healing abutment.

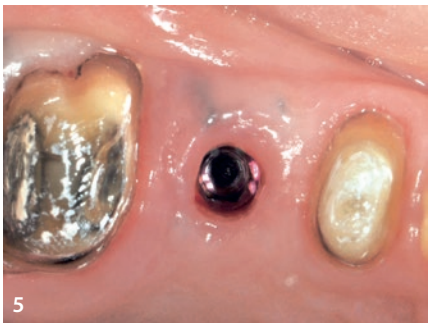


Fig 5 Removal of the healing abutment following the healing period. Note the improved tissue contour of the buccal aspect.

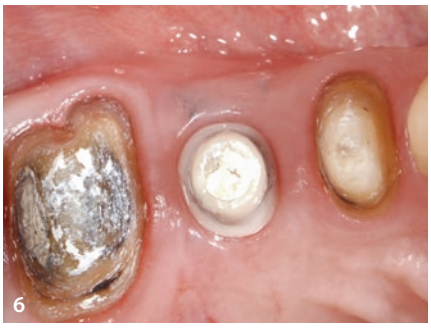


Fig 6 Occlusal view of the natural tooth abutments and the implant-borne zirconia abutment. Note the tissue contour and the excellent adaptation of the tissues.

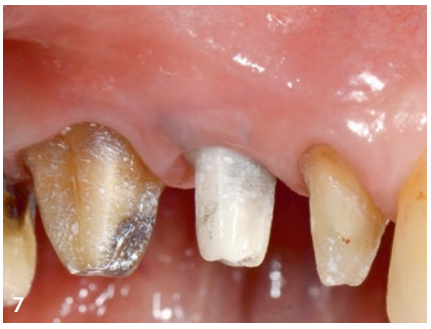


Fig 7 Lateral view of the augmentation results demonstrating restoration of the tissue volume.

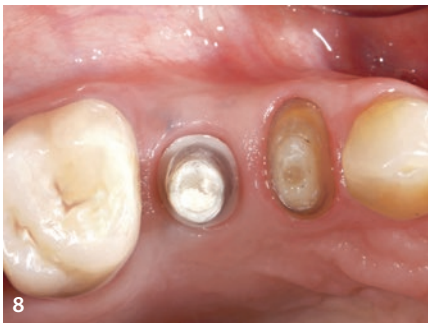


Fig 8 Occlusal view 3 months after delivery of the crowns and prior to cementation of the final implant-supported crown and the first premolar crown.

flap was released by horizontal superficial cuts. For augmentation of the deficient ridge, a cross-linked collagen scaffold (Ossix Volumax) was cut and adapted to the buccal wall and ridge around the buccal aspect of the healing abutment (Fig 4). This regeneration material is designed to expand and ossify over time and restore the lost buccal volume.

The manufacturer recommends placement of a second layer of the scaffold material close to the crest of the ridge to increase the volume of regenerated bone, although that was not performed in the present case. Stabilization of the collagen scaffold was achieved with internal resorbable horizontal mattress sutures from the palatal aspect to a split inner tissue in the buccal flap and then back around the healing abutment. The tension-free flap margins were adapted per primum around the healing abutment with simple interrupted resorbable sutures. The provisional acrylic restoration was modified to leave room for the healing abutment screw to stay protected, and unloaded.

After a healing period of 6 months, the integration of the implant was confirmed, and evaluation of the regenerated ridge revealed a significant buccal increase in tissue volume that was sufficient to support the prosthetic restoration (Fig 5). Conventional impressions of the abutment teeth and the implant platform level were taken simultaneously. A zirconia abutment was prepared to fit and support the soft tissue and secured to the implant (Figs 6 and 7). Three individual zirconia-based porcelain crowns were fabricated to fit the abutment teeth and the implant (Figs 8 and 9).

The regeneration procedure with the collagen scaffold resulted in restoration of the lost tissue volume and a favorable lifelike emergence profile for the implant-supported crown. This augmentation procedure can be considered simpler to perform, in certain cases, than existing procedures and relatively easy as in this case it required no bone substitute material or harvesting of an interpositional connective tissue graft from a remote donor site.

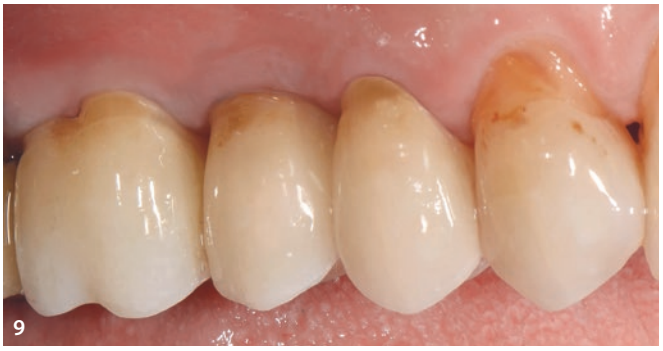


Fig 9 Appearance of the three bilayered zirconia-based crowns after 2 years in the mouth. Note the favorable emergence profile and the positive support and stability of the augmented tissues.

Discussion

The success of an implant-supported restoration to replace a single missing tooth depends on its integration with the adjacent teeth, from both a functional and an esthetic point of view.[41] Placement of the implant must be planned and carried out according to the prosthetic needs for optimal esthetics and function.[45] The quantity and quality of the alveolar bone as well as the surrounding soft tissues are key factors in achieving a good clinical outcome.

The overall goal is to restore the hard and soft tissues in the area in preparation for placement of an implant-supported prosthesis with a lifelike result. This is true not only for anterior teeth but for posterior teeth as well, where functional demands are greater. Therefore, prosthetic planning should include an evaluation of the ridge deficiency and the grafting procedures needed for a prosthetically driven implant placement.

Bone availability is a critical factor for achieving a predictable result. In most cases, bone loss will occur around a missing tooth even in the absence of pathology, infection, periodontal lesions, or trauma to the socket. According to the literature, these resorptive changes most often occur during the first year following tooth loss.[1-5] When implants are placed into sites with ridge deficiencies, complications such as dehiscence around the implants and fenestrations often develop.

The literature shows that lateral bone augmentation procedures to support implants are highly predictable and are associated with high implant survival rates.[7,8] In these procedures, a bone substitute xenograft and a bioresorbable membrane are typically combined with implant placement in a single-stage procedure or placed separately in a two-stage approach as indicated.[46]

Even if the bone volume at the site is sufficient for implant placement, occasionally the resorptive process will create the need for a prosthetic correction in the abutment angle or in the anatomy of the crown. In such cases, lateral augmentation will provide a better foundation and conditions for favorable placement of the implant and restorative unit. Thus, it is important to examine and evaluate the transverse aspect of the missing tooth area at the ridge level.[47] The ridge between two teeth will reveal a lateral deficiency that can be augmented, even with a connective tissue graft, to improve all aspects of the integration results, including esthetics.[48]

Ossix Volumax, the nouveau material used in the present case to restore a ridge deficiency between adjacent teeth, greatly simplifies the procedure. Comprised of a biodegradable and biocompatible cross-linked collagen scaffold, this material was created with the same Glymatrix technology used in the Ossix Plus membrane.[44] The collagen scaffold is designed to expand and ossify during healing as part of the augmentation process. When placed in one or two layers, it may obviate the need for a bone substitute material or a connective tissue graft, although adding a bone substitute material is a valid option when indicated.

In the reported case, the Ossix collagen scaffold restored the deficient volume and resulted in an anatomically correct emergence profile. Because of its expansion qualities, this material may serve as a substitute for connective tissue harvested from a donor site, simplifying the surgical procedure and simultaneously reducing morbidity.[43] A laterally augmented ridge will improve appearance[48] and function during chewing and allow for better daily hygiene. Function and hygiene take on greater importance in posterior implant cases as color and anatomical issues attract less attention from patients. Single posterior implants generally earn patient approval when function and maintenance are uneventful. When the laterally deficient ridge between teeth is overlooked during implant therapy, food accumulation and patient inconvenience often result.

Today, the process from diagnosis to treatment planning is streamlined with the use of digital tools to visualize what is missing and to present the proposed treatment to the patient. Once the prosthetic plan is approved, an evaluation of the ridge deficiencies and the grafting procedures needed to support a prosthetically driven implant placement should be performed.[41,42,45,47,49-51] The soft tissue appearance in the buccal aspect around implants is a major concern, and dehiscence is a common esthetic complication.[48,52-55] Many of the factors that contribute to soft tissue recession are well documented,[56] and the goal of gaining more soft tissue than is needed is often recom-

mended as a preventive measure.[40] In posterior areas, good function is imperative, and soft tissue stability in the buccal aspect is a critical component.

As demonstrated by the case reported in this paper, Ossix Volumax resulted in a favorable and stable clinical outcome for lateral augmentation of a deficient ridge between existing teeth. Further studies are needed to prove long-term stability in similar cases and to explore other potential applications for this promising collagen scaffold.

Acknowledgment

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