Soft-Tissue Augmentation

Treatment Alternative to Autogenous Palatal Graft

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Long-term Case Reports Demonstrating Use of Porcine Collagen Matrix to Augment Width and Thickness of Keratinized Gingiva

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Abstract: Gingival augmentation therapy is intended to create a healthy band of attached keratinized tissue to inhibit further gingival recession, facilitate plaque control, and improve patient comfort. Although an effective treatment for gingival augmentation procedures, the often-used autogenous epithelialized palatal graft has several drawbacks, including the need for a second surgical site to harvest the graft, the risk of such complications as damage to neurovascular tissue and poor healing of the donor site, and potential color and texture discrepancies of the grafted site. The use of a resorbable xenogeneic collagen-based matrix may be considered as a treatment alternative to augment soft tissue. The authors describe the application of such a graft that is made from purified porcine type I and type III collagen and processed without the addition of chemical cross-linkers. Two cases are presented that demonstrate the clinical advantages of this material compared to autogenous palatal grafts when augmenting the width and thickness of attached keratinized gingiva.

The presence of an adequate zone of attached keratinized tissue is generally believed to be conducive to the maintenance of gingival health.[1] The immobile and dense gingival tissue is presumed to act as a barrier that provides better resistance to bacterial and mechanical insults than unattached alveolar mucosa.[2] Exactly how much attached tissue is necessary for the maintenance of gingival health has been a controversial subject in the periodontal literature due to the paucity of well-controlled clinical trials.

Lang and Löe demonstrated that in subjects with effective oral hygiene, areas with less than 2 mm of keratinized gingiva experienced persistent inflammation.[3] Stetler and Bissada found more inflammation and gingival recession in sites with subgingival restorative margins and less than 2 mm of keratinized gingiva.[4] Although numerous studies have shown that periodontal health can be maintained around teeth with minimal keratinized gingiva,[5-9] the consensus from the 2014 American Academy of Periodontology Regeneration Workshop suggested that when plaque control is suboptimal, or when potentially traumatic etiologies like subgingival restorative margins or removable prosthesis clasps are present, at least 2 mm of keratinized tissue (1 mm of which is attached gingiva) is necessary to prevent progressive attachment loss and inflammation.[10] Absence of this tissue dimension in these circumstances may indicate gingival augmentation therapy. Additionally, emerging evidence on peri-implant health also indicates that the absence of sufficient keratinized tissue around implant-borne prostheses may lead to higher plaque and gingival indices as well as the development of mucosal recession.[11-13]

The chief goal of gingival augmentation therapy is to create a healthy band of attached keratinized tissue to facilitate plaque control, improve patient comfort, and prevent further gingival recession.[1] Since its introduction in the 1960s, the autogenous epithelialized palatal graft (ie, free gingival graft) has been considered the "gold standard" treatment for gingival augmentation procedures.[14-18] Transplantation of the graft from either the hard palate or maxillary tuberosity with its keratinized epithelium to the recipient site allows the clinician to increase the width of attached gingiva, deepen the vestibule for hygiene access, eliminate tension from the frenal attachment, relieve brushing

discomfort, and treat gingival recession.[18] A systematic review by Thoma and colleagues that assessed different gingival augmentation techniques concluded that the use of autogenous tissue (epithelialized palatal graft or subepithelial connective tissue graft [CTG]) with an apically positioned flap procedure significantly increases the width of attached gingiva compared to untreated controls and leads to less graft shrinkage compared to the use of allogeneic dermal tissue.[19] A recent long-term study (18 to 35 years) showed that 83% of sites treated with epithelialized palatal graft showed a reduction in gingival recession, whereas 48% of untreated contralateral sites experienced increase in recession.[20] The use of epithelialized palatal graft also has been shown to prevent the development or progression of non-carious cervical lesions over a 25- to 30-year observation period.[21] Soft-tissue augmentation with autogenous tissue grafts around dental implants has also gained recognition in recent years as an important adjunctive therapy to maintain and improve peri-implant tissue health[13,22-24] and marginal bone stability.

Despite its predictability and long-term efficacy, the epithelialized palatal graft has some disadvantages. Harvesting the graft requires a second surgical site, which increases chairtime and postoperative discomfort.[25] Anatomical limitations like the shape of the palatal vault and location of blood vessels and nerves dictate and potentially restrict the availability of donor tissue.[26,27] Also, the quality of donor tissue may vary depending on the patient's age, gender, and phenotype. The risk of complications, such as damage to neurovascular tissue, uncontrolled hemorrhage, and poor healing of the donor site, should be strongly considered and weighed against potential benefits, especially in patients with clotting deficiencies or systemic conditions that may compromise healing.[28] After healing, the grafted site often shows a striking color discrepancy and thickness and texture differences compared to adjacent areas,[29-31] possibly leading to an unesthetic result.

Many patients who would benefit from an autotransplantation procedure may be psychologically averse to it because of negative anecdotal reports from friends or relatives, previous pain experienced from the palatal donor site, or the mere thought of the potential discomfort. As a result, they may not seek treatment. In addition, patients who have had autogenous tissue graft treatment in the past and found it uncomfortable may be reluctant to undergo the procedure again.

Soft-Tissue Augmentation Alternatives

The limitations of autogenous tissue grafts have spurred interest in commercially available alternatives, such as allogeneic donor material like acellular dermal matrices, to augment soft tissue. Among newer US Food and Drug Administration–approved alternative materials is a resorbable xenogeneic collagen-based matrix (Geistlich Mucograft®, Geistlich Pharma AG, geistlich-pharma.com) that the authors (RAL, JG) have used extensively in practice. The matrix is made from purified porcine type I and type III collagen and processed without the addition of chemical cross-linkers.[32] Its bilayer structure consists of a thin compact outer layer with cell occlusive and tissue adherence properties and a thick porous inner layer that stabilizes the blood clot and serves as a scaffold for host cellular integration.[32] As an alternative

to autologous soft-tissue grafts, the material has been investigated in the indications of augmenting keratinized tissue around teeth and implants,[29-31,33-38] gingival recession coverage,[39-43] and coverage of grafted extraction sockets.[44-46]

In a pilot study by Herford et al, the material's clinical efficacy to treat various types of intraoral mucosal deficiencies was evaluated, and satisfactory healing with minimal complications was achieved.[33] The authors noted that the tissue of the grafted sites remodeled to match the phenotype (ie, keratinized or non-keratinized) of the surrounding tissue. The apically positioned flap is a common procedure for mucogingival augmentation, and the collagen matrix may be used to cover the periosteal wound bed to improve healing and regeneration. Several clinical studies have demonstrated that the grafted areas heal with minimal inflammation and complications, and the procedure predictably leads to a functional band of attached keratinized tissue of sufficient width.[29-31,33-38] Histologically, the regenerated tissue is indistinguishable from sites grafted with epithelialized palatal graft,[29,30,35-37] presenting physiologically normal keratinized epithelium and connective tissue with minimal inflammatory infiltrate. From an esthetic standpoint, unlike with sites augmented with epithelialized palatal grafts where the augmented tissue may have a characteristic "tire-track" appearance, collagen matrix–regenerated tissue has excellent tissue blend in color and texture with the surrounding mucosa.[29-31] Benefits of the porcine collagen matrix (PCM) are outlined in Table 1.[29,31,33,34]

In a prospective clinical study of long-term outcomes by Schmitt and colleagues, mandibular sites augmented with the collagen

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TABLE 1

Benefits of Porcine Collagen Matrix (PCM)

1. Dry surgical environment enables ease of handling and suturing (infiltration with 1:50,000 lidocaine with epinephrine may be necessary to control hemostasis as in most surgical procedures).

2. Histology is similar to connective tissue graft (CTG) at 4 weeks, and PCM is totally replaced by patient's own connective tissue by 4 weeks.

3. Less surgical time for the patient is needed (approximately one-third to one-half the time versus conventional CTG).

4. There is less morbidity for the patient, as only one surgical site is required.

5. PCM serves as an excellent carrier of biologics to the surgical site, promoting soft-tissue healing.

6. The use of a periodontal surgical dressing is usually unnecessary, because the PCM acts as a surgical bandage over the partial-thickness wound.
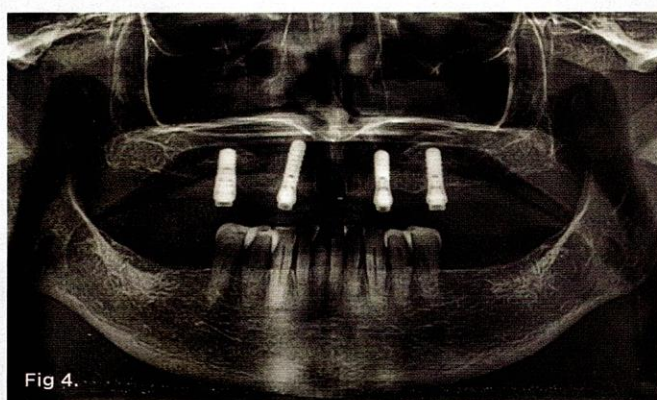
Fig 1. Case 1: Preoperative (December 20, 2012). At sites Nos. 20 through 22 and 27 through 29 facial attachment loss had measurements of 5 mm to 6 mm mid-buccal and was progressing in a very thin gingival phenotype. These areas were noted to be Miller class III recession. The patient's restorative dentist had completed a patient-removable four-implant locator case in the maxilla in January 2011. **Fig 2 and Fig 3.** Preoperative (December 20, 2012), sites Nos. 20 through 22 (Fig 2) and 27 through 29 (Fig 3). **Fig 4.** Preoperative panoramic x-ray taken in December 2011. The location of the inferior alveolar nerves and mental foramina must be noted presurgery.

matrix experienced 52.89% loss of width of keratinized mucosa, compared to 40.65% in the sites grafted with epithelialized palatal graft.[31] The investigators observed that the greatest loss of vestibular depth occurred during the first 90 days postoperatively in both the collagen matrix and the epithelialized palatal graft groups, with minimal graft contraction occurring between 1 and 5 years. Despite the statistically significantly greater loss of keratinized mucosa in the collagen matrix group, a clinically sufficient width of keratinized tissue remained after 5 years (mean: 6.15 mm ± 1.23 mm). Based on extensive clinical experience, the present authors estimate a long-term 50% shrinkage of augmented tissue using the collagen matrix, compared to 35% to 40% when using epithelialized palatal grafts.

Two case reports are presented herein in which the collagen-based matrix material was used for soft-tissue augmentation.

Clinical Case 1

The first case involved a healthy, nonsmoking 60-year-old woman whose medical history included American Society of Anesthesiologists (ASA) II classification, penicillin allergy, gastroesophageal reflux disease, and asthma. She presented by referral from her restorative dentist to the primary author (RAL) with concerns of progressive facial gingival recession of her remaining mandibular teeth (Nos. 20 through 29). She had been wearing a maxillary complete denture for many years and was highly concerned about losing her remaining lower dentition. She presented with fair plaque control and no root sensitivity. Her immediate desire was to complete treatment of her maxillary implant-retained removable overdenture with partial palatal coverage.

Taking the patient's financial concerns into consideration, her case was treatment-planned in three phases. The first phase entailed completion of a maxillary prosthesis using a restorative-driven team approach that would include placement of four dental implants (Straumann® Tissue Level, Straumann, straumann.com) using a surgical guide for a locator-retained overdenture; the implants were placed on January 26, 2011. The second phase involved periodontal plastic surgery to increase the width and thickness of attached keratinized gingiva at Nos. 20 through 22 and 27 through 29 with no attempt at root coverage since esthetics were not a concern to her and complete root coverage was unattainable because the recession defects were classified as Miller class III or recession type 2.[47,48] Even though esthetics were not an issue, increasing the zones and thickness of the attached keratinized gingiva was indicated because there was documented increased gingival recession noted in periodontal maintenance on several of the teeth that were to be treated. Presurgery, the amount of remaining keratinized gingiva present on the teeth to be treated was 0 mm to 2 mm. Lastly, the third phase of treatment included restorative-driven single implants to replace missing teeth Nos. 19 and 30 to create first-molar occlusion against the maxillary overdenture.

Once the patient was ready to commence phase 2 of her treatment plan (February 7, 2013), two surgical options were discussed with her: (1) augmentation of the tissue using her palate bilaterally as donor sites in one to two surgical visits, which the authors

considered a viable option given her new removable partial palatal coverage overdenture; or (2) use of what was at the time a recently introduced PCM (Geistlich Mucograft) to complete treatment in one surgical appointment. Given her low esthetic demands, with root coverage not being a treatment objective, along with her history of compliance of home care and periodontal maintenance every 3 months (alternating with her restorative dentist), she was a candidate for both surgical approaches. On teeth Nos. 20 through 22 and 27 through 29, facial recessions as measured from the cementoenamel junction (mid-buccal) of the teeth to the apical extent of the sulci ranged from 5 mm to 6 mm (Figure 1 through Figure 4).

The patient decided that she wanted to avoid the morbidity involved with the donor surgical site and that completing the procedure in two visits was undesirable to her given her busy work schedule. She opted to have the procedure completed in one visit using the PCM. Based on a discussion with the clinician of the available literature at the time in 2012 she was pleased that the PCM could be incorporated and totally replaced by her own tissue in 4 weeks along with less operative time and morbidity (Table 1).

In one surgical appointment, bilateral inferior alveolar nerve blocks and long buccal infiltrations were administered. Beveled incisions were performed just coronal to the mucogingival junction at the level of the depth of the recessions. Partial-thickness reflection was completed using sharp dissection with a #15c blade from site Nos. 19 through 23 and 25 through 30 so as to incorporate at least one additional tooth on either side of the most anterior and posterior tooth being treated. It should be noted that the surgeon must be fully aware of the location of the mental foramen with regard to incision design coronal to the mental foramen. For both surgical and medico-legal purposes, a full-mouth x-ray examination, panoramic x-ray (as in the present case), or site-specific cone-beam computed tomography scan is necessary presurgically to locate the mental foramina.

Upon completion of partial flap reflection, a new #15c blade is used to scribe the apical border of the reflection through the periosteum to the osseous cortex. The PCM comes in two sizes with the larger being 20 mm width x 30 mm length. Trimming the material length-wise in half, as was done in this case, typically allows one full piece of the material to treat most patients from teeth Nos. 20 through 29. The PCM was sutured easily to

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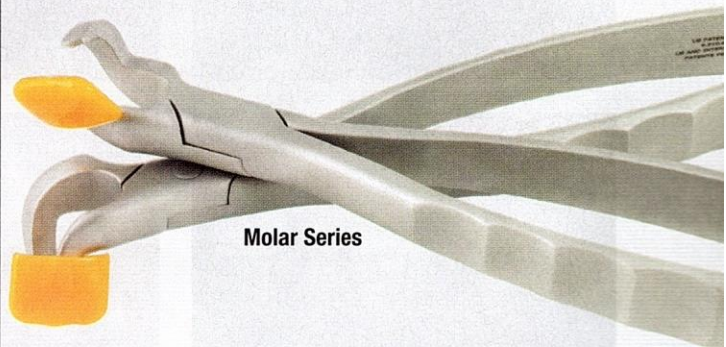
the existing interproximal papillae with resorbable 6-0 plain gut suture. No attempt was made to stabilize the PCM to the periosteum with apical or lateral suturing, as it was deemed unnecessary in this case. Nor was the apical extent of the flap sutured, as this is not needed in most cases. The PCM acts as a postsurgical bandage, therefore the use of periodontal dressing
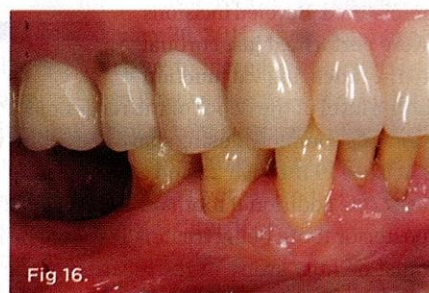
Fig 5. Day of surgery (February 7, 2013). Partial-thickness flaps via sharp dissection were extended from Nos. 19 through 23 and 25 through 30. Future dental implant placement was anticipated in edentulous sites Nos. 19 and 30. The incisions that are at or just coronal to the mucogingival junction must be extended at least one tooth anterior and posterior to blend the PCM. Depending on the location of the mental nerves, once the sharp dissection is completed, a line is scribed through the periosteum to help prevent the mucosa from rebounding. The PCM was sutured with resorbable 6-0 plain gut suture. **Fig 6 and Fig 7.** Day of surgery, sites Nos. 19 through 23 (Fig 6) and 26 through 30 (Fig 7). **Fig 8 through Fig 10.** First postoperative visit at 2 weeks (February 20, 2013), buccal (Fig 8), lower left quadrant (Fig 9), lower right quadrant (Fig 10). Root coverage was not a goal. Light brushing with a two-row toothbrush was reviewed with the patient. Note coronally excellent healing with apical healing via secondary intention. **Fig 11 through Fig 13.** Second postoperative visit at 8 weeks (April 18, 2013), buccal (Fig 11), lower left quadrant (Fig 12), lower right quadrant (Fig 13). Complete healing was noted with scarring of the apical border due to scribing of the periosteum prior to PCM placement and suturing. The position of the mental foramina must be known to avoid an iatrogenic insult and postoperative non-repairable numbness. **Fig 14 through Fig 16.** Six-year postoperative follow-up (May 16, 2019), buccal (Fig 14), lower left quadrant (Fig 15), lower right quadrant (Fig 16). The patient had maintained excellent plaque control and compliance to an alternating periodontal maintenance schedule every 3 months. Note significant increase in the zone and thickness of the attached keratinized gingiva, with "creeping attachment" observed on the treated teeth on each side (Nos. 20 through 22 and 27 through 29).

may be a case-by-case decision; in this case no periodontal dressing was needed (Figure 5 through Figure 7). Because the objective of the case was to create a barrier of at least 2 mm to 3 mm of keratinized gingiva to prevent further facial attachment loss, and not root coverage, treatment of sites Nos. 24 and 25 was not necessary as adequate zones and thickness of keratinized gingiva were present.

Postoperative care included rinsing with chlorhexidine gluconate (CHG) twice per day for 2 weeks and use of a cotton tip to clean the buccal cervical areas, with no toothbrushing or flossing for 2 weeks. At 2 weeks, toothbrushing and flossing could be reinstated, which is approximately 4 to 6 weeks sooner than when a CTG is used for root coverage. A water irrigation device can also be reinstated at this time.

The patient was seen for her first postoperative visit at 2 weeks, at which she received a full-mouth prophylaxis. She was introduced to the use of a soft two-row toothbrush, flossing was reinstated, and the CHG rinse was discontinued (Figure 8 through Figure 10). Another postoperative visit took place at 2 months to review healing and plaque control (Figure 11 through Figure 13). The patient has been in an alternating 3-month periodontal maintenance frequency with her restorative dentist.

Photographs taken during her 6-year postoperative follow-up, which was her most recent alternating 3-month maintenance visit under the authors' care, demonstrated significant increase in zone and thickness of attached keratinized gingiva (Figure 14 through Figure 16). At 6 years, the attached gingiva gained was as follows: 2 mm gain at No. 20, 3 mm gain at No. 21, 2 mm gain at No. 22, 3 mm gain at No. 27, 2 mm gain at No. 28, and 3 mm gain at No. 29. The authors no longer use CHG in their practice and over the past 3 years have incorporated an oral antioxidant, antibacterial, antifungal non-alcohol mouthwash that the patient uses twice daily and is given routinely to patients presurgically.

Clinical Case 2

A healthy, nonsmoking 28-year-old woman (ASA I) presented for evaluation to the periodontal private practice of one of the authors (JG). She was concerned that her dentist had advised that a frenectomy and gingival graft from her palate were necessary to maintain her mandibular anterior teeth. The patient had a previous history of orthodontic treatment as an adolescent. She had no specific chief complaint other than anxiety about gingival surgery, and she also was highly averse to palatal harvesting for the autogenous gingival graft that was recommended.

Clinical examination showed excellent oral hygiene and virtually no inflammation. It also confirmed the observation of a near total lack of attached keratinized tissue and thin scalloped biotype on teeth Nos. 22 through 27. Incipient recession was observed on these teeth and was classified as Miller class I or recession type 1.[47,48] Additionally, a prominent labial frenum pull was noted between teeth Nos. 24 and 25 (Figure 17). Because the patient was adamantly opposed to consenting to autogenous graft harvesting, the PCM was proposed and accepted.

Preoperatively the patient was given 2 g amoxicillin and 1 mg lorazepam orally. Local anesthesia was obtained by infiltration using
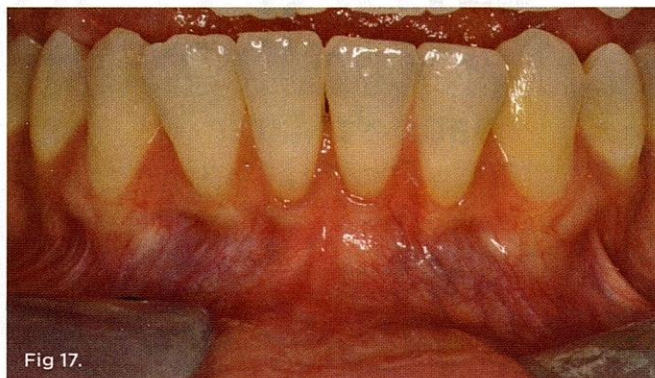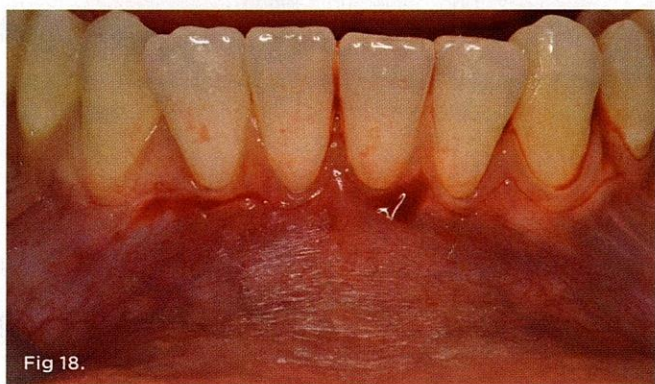
Fig 17.

Fig 18.

Fig 19.

Fig 17. Case 2: Patient exhibited a very thin phenotype. No inflammation or pocket depth was present, and very minor recession was noted on teeth Nos. 23 through 26. There was no attached gingiva on teeth Nos. 22 through 27, and a prominent midline frenum was observed. **Fig 18.** A submarginal partial-thickness incision was made slightly coronal to the mucogingival junction, with an effort to incorporate some keratinized tissue into the flap and leave marginal tissue intact. **Fig 19.** The partial-thickness incision was fully developed into the vestibule, with careful removal of all loose connective tissue. Tissue fenestration over teeth Nos. 22 and 23 was observed.

articaine and bupivacaine with epinephrine 1:200,000. A partial-thickness incision was created just coronal to the mucogingival junction from teeth Nos. 22 through 27 using a #15 scalpel blade and continued to the depth of the vestibule (Figure 18 and Figure 19). Remnants of the labial frenum and fibers from the mentalis muscle were removed to bone. The periosteum was scored to bone near the base of the incision. Mucosal margins of the incision were sutured

apically to the periosteum using 5-0 chromic gut sutures (Figure 20).

A piece of collagen matrix was shaped to cover the periosteal bed. It was placed on the bed dry and allowed to rehydrate from tissue fluid and blood before being stabilized into the bases of the papillae with interrupted 6-0 polyglactin sutures (Ethicon, ethicon.com). Additional circumferential sutures anchoring apically to the periosteum, looping around teeth Nos. 24 and 25, were placed to adapt the collagen matrix material against the bed (Figure 21). Periodontal surgical dressing (Barricaid° VLC, Dentsply Sirona, dentsplysirona.com) was then adapted against the teeth and material and cured with a bonding light to further stabilize and isolate the surgical site from the rest of the mouth (Figure 22). Although as noted earlier the PCM acts as a postsurgical bandage, periodontal dressing, though not essential, may be used if the clinician believes it will enhance patient comfort and further stabilize the collagen matrix.

The patient was maintained on amoxicillin 500 mg four times per day for 7 days and instructed to rinse with CHG twice daily. Nonsteroidal anti-inflammatory drugs were prescribed for management of pain.

One week after surgery, the patient returned for postoperative assessment. She was concerned that the surgical area was still quite tender; therefore, the wound dressing was removed and the site gently cleaned with chlorhexidine. A new dressing was placed and light-cured. Eleven days later (18 days after surgery), the patient returned for removal of the second dressing. The area was again cleaned with chlorhexidine and observed (Figure 23). Most of the sutures were loose, and all of them were then removed. Healthy pink tissue proliferation and ingrowth was observed throughout the graft. Maintenance of the vestibuloplasty was confirmed with no indication of the pre-existing frenum pull. The patient was given appropriate instructions to gradually increase intensity of oral hygiene procedures over the next month.

She returned for semiannual routine periodontal supportive care for the next 5 years. At her 5-year examination, a new photograph was taken showing continued health of the site with approximately 50% loss of the vestibular extension depth (Figure 24). A denser, whitish band of scar tissue was noted apically, which was analogous to a new mucogingival junction. There was 3 mm to 5 mm of attached tissue, which appeared to be immobile, keratinized, and healthy. This tissue was somewhat more reddish in color compared to the paler gingiva around the more posterior teeth but had no inflammation. Creeping attachment occurred on teeth Nos. 22 through 27, eliminating the previously observed minor recession. All of the goals of the surgical procedure, including vestibular deepening, creation of an adequate band of attached tissue, and correction of recession, were achieved without harvesting palatal tissue. Color and texture match of the tissue were good, and the patient was very pleased with the result.

Conclusion
There is growing evidence of the importance of soft-tissue dimensions around teeth and dental implants in preventing long-term complications, as the absence of sufficient keratinized tissue and tissue thickness can contribute to persistent inflammation around teeth and implants[3,4,11-13,49] and may eventually lead to recession
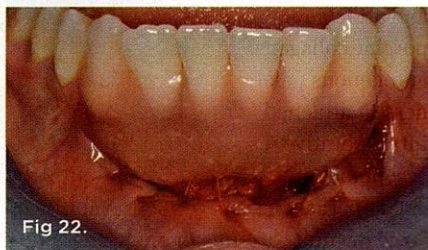
Fig 20. The flap was sutured apically with 5-0 chromic sutures to maintain the vestibuloplasty. **Fig 21.** PCM material was trimmed to fit the prepared site and stabilized in place using 6-0 polyglactin sutures interproximally and as vertical "strap" sutures. The PCM was placed with the smooth side out, per manufacturer's instructions. **Fig 22.** Periodontal surgical dressing was adapted over the surgical site and cured into place to protect the wound. **Fig 23.** At 18 days postoperative, excellent incorporation of the PCM into the underlying tissue bed was evident. Vestibular extension was noted. The interproximal sutures were still in place. **Fig 24.** At 5 years postoperative, an adequate band of 3 mm to 4 mm of keratinized tissue was evident on teeth Nos. 22 through 27, as was creeping attachment on Nos. 23 through 26. Scar formation at the "new mucogingival junction" was noted. Color of the new tissue appeared somewhat erythematous compared to the paler mucosa but was consistent with marginal tissue around the posterior teeth.

and attachment loss. The use of evidence-based alternatives like porcine collagen matrix has many clinical advantages compared to autogenous palatal grafts when augmenting the width and thickness of attached keratinized gingiva. Benefits include decreased intraoperative discomfort and postoperative pain,[36] high patient acceptance and favorable esthetic outcomes,[30,31] significantly shortened operation time,[31,36] and the ability for clinicians to augment large or multiple sites in one visit.[31,35,36] These patient-centered attributes are especially important given that mucogingival defects oftentimes do not cause any symptoms and patients frequently are unaware of them. The option to treat these patients in fewer and shorter visits while minimizing discomfort and disruption to quality of life may be a valuable asset for clinicians to increase patient acceptance. Long-term clinical trials are needed to evaluate PCM stability over time.

DISCLOSURE

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