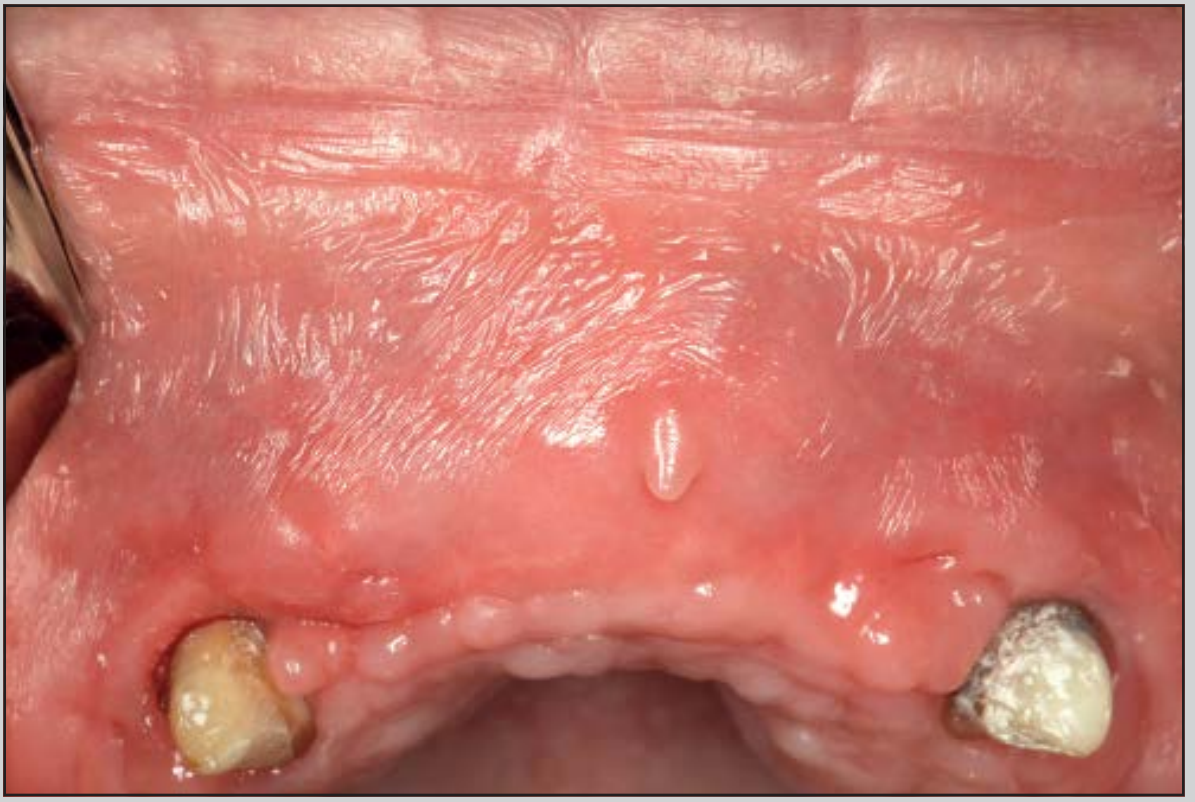
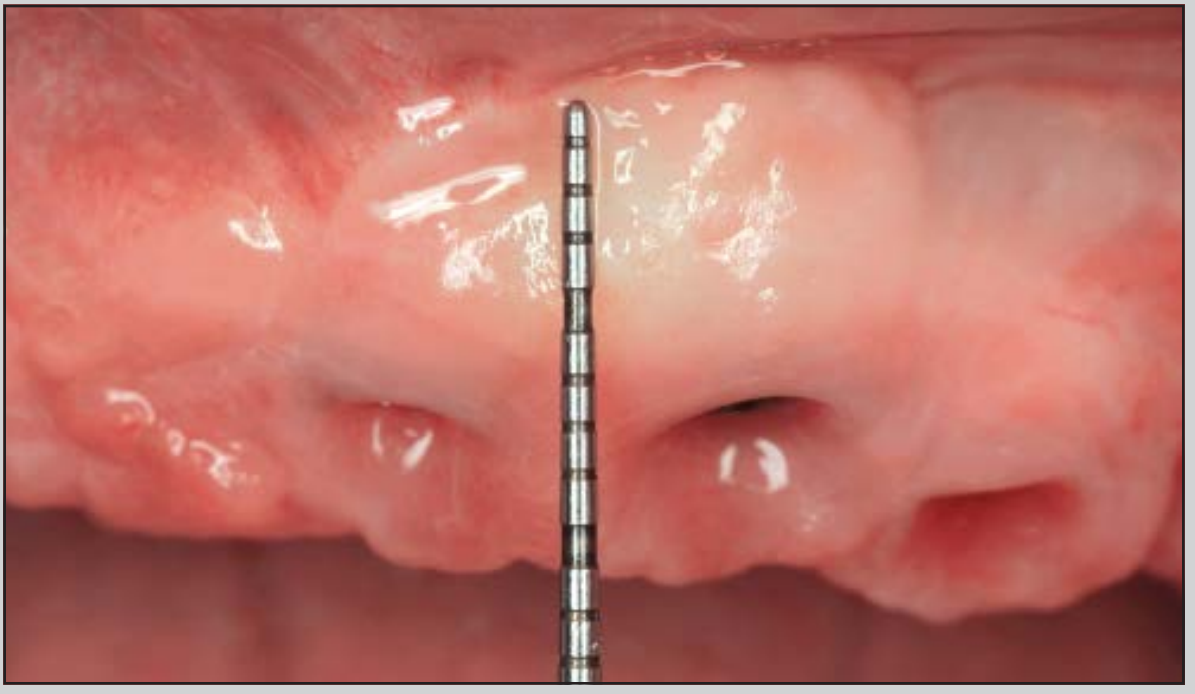
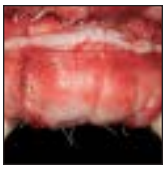




Treatment of Severe Mucogingival Defects with a Combination of Strip Gingival Grafts and a Xenogeneic Collagen Matrix: A Prospective Case Series Study



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Large areas of mucogingival alterations may result from advanced regenerative procedures. This prospective case series study was performed to introduce and evaluate a surgical approach that combines the strip gingival graft technique with the use of a xenogeneic collagen matrix. The primary outcome measurement was the increase in keratinized tissue width from baseline to 12 months postprocedure. Twenty patients were enrolled, and they all completed the 12-month evaluation. All treated sites exhibited a significant gain in keratinized tissue at 12 months, with a mean width of 6.33 mm (SD: 2.16), while there was a 43% contraction of the grafted area at 6 months. Tissue dimensions remained stable between 6 and 12 months. The use of the combination graft was well accepted by the patients, with minimal morbidity according to the patients' low self-reported pain and the low utilization of pain medication. (Int J Periodontics Restorative Dent 2015;35:345–353. doi: 10.11607/prd.2287)

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Although the need for a minimum amount of keratinized tissue around teeth and implants to preserve the health and stability of the gingival and mucosal tissues is still controversial,[1–10] there are certain clinical situations in which soft tissue augmentation by mucogingival surgical techniques can be justified and indicated.[11–15]

Initially, these surgical techniques aimed to increase keratinized tissue width (KTW) and to deepen the vestibule included the apically repositioned flap[16,17] and periosteal fenestration procedures.[18] Although the short-term outcome of these procedures was favorable in many cases, there was a typical rebound within a few months and the achieved tissue gain was lost in most cases.[19,20] To achieve more stable results, soft tissue autografts, either in the form of free gingival grafts (FGGs)[16,21,22] or free connective tissue grafts (FCTGs)[23] were recommended in these indications and provided more predictable results. In well-designed experimental studies, it was clearly shown that the transplanted tissue from the palatal

mucosa was able to preserve the tissue specificity, resulting in keratinized mucosa, and the cells responsible for determining this tissue specificity resided in the connective tissue underneath the epithelial basal lamina.[24] In fact, when comparing the use of epithelialized gingival grafts with FCTGs, their ability to promote keratinized epithelium is similar, although the FGGs result in less tissue contraction and shrinkage. These factors can provide an enhanced stability,[25] but the esthetic outcome is usually less favorable. With both techniques, however, there is a need to harvest an autograft large enough to achieve the desired outcome and to compensate for the shrinkage. The harvesting of these soft tissue autografts from the palatal mucosa usually is associated with significant patient morbidity, mainly when there is a need to graft large mucosal areas, such as with advanced ridge bone augmentation procedures. This usually results in a severe translocation of the mucogingival line and loss of vestibule, even limiting the mobility of the lip[15,26–29] (Figs 1a, 1b, 1c, 2a and 2b). To limit the need for such extensive grafting, the strip gingival graft technique was recommended.[30] This technique utilizes thin strips of FGGs placed parallel to one another and fixed to the most apical extension of the prepared periosteal bed, leaving the exposed periosteum between the graft strips to heal by secondary intention. Increases in keratinized tissue extension with a concomitant reduction in patient discomfort were reported, but this surgical approach is technically demanding and time consuming. Moreover, since a large part of the periosteal bed heals by secondary intention, the results may be unpredictable and healing could cause more discomfort to the patient.

Recently, a new xenogeneic collagen matrix was introduced as a soft tissue substitute to increase KTW around teeth and implants. The clinical trials evaluating its efficacy when compared with FCTG resulted in similar outcomes, with a mean increase of 2.5 to 3 mm in the width of keratinized gingiva/mucosa.[31,32] This outcome, although modest, may be considered "adequate" for maintaining gingival/mucosal health and stability in the tissues around individual teeth/implants[3] but may be limited in situations in which severe mucogingival alterations result from advanced flaps used in the course of vertical and horizontal ridge augmentation procedures.

The objective of this prospective case series study was to introduce and evaluate the outcomes from a surgical approach that combines the strip gingival graft technique with the use of a xenogeneic collagen matrix to correct large areas of mucogingival alterations resulting from advanced regenerative procedures.

Method and materials

Patient selection

Patients who fulfilled the following inclusion criteria were selected from a private practice in Budapest, Hungary:

- Presence of at least one site without keratinized tissue (0 mm) in conjunction with loss of vestibular depth as a result of advanced horizontal and vertical ridge augmentation surgeries
- Subjects with good oral hygiene practices, in good periodontal and systemic health, nonsmoking, and willing to comply with the study protocol

The selected patients were informed of the characteristics of this investigation and agreed to participate by signing an informed consent form, previously approved by the Ethics Committee of the University of Szeged, Hungary. All patients were treated by the same experienced surgeon (IU).

Surgical intervention

The surgical intervention tested in this prospective study was called the "combination graft technique" because it consisted of combining an apically placed autogenous strip gingival graft with a xenogeneic collagen matrix (XCM; Mucograft, Geistlich).

In brief, after applying the appropriate local anesthetic (articaine chloride 4% with epinephrine 1:100,000, Novocol Pharmaceuticals), the surgical intervention started with drawing a horizontal incision on keratinized tissue parallel to the mucogingival junction. If the previous regenerative procedure had been done simultaneously with

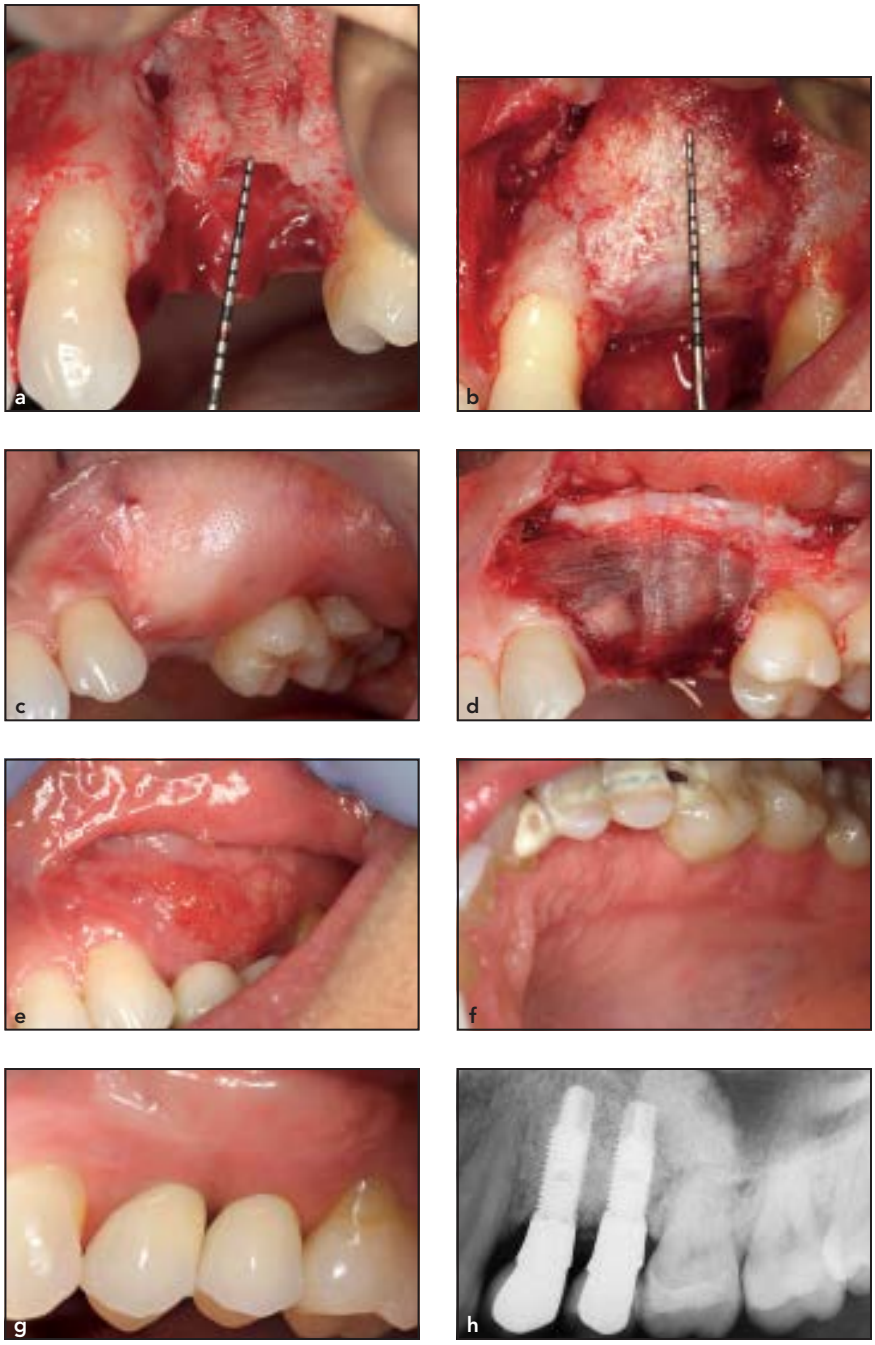

Fig 1 *Representative case of combination graft treatment of a severe mucogingival distortion after vertical augmentation.* (a) *Buccal view of a vertical defect in the maxillary premolar region.* (b) *Buccal view of the regenerated ridge 8 months postoperatively.* (c) *Buccal view of the mucogingival distortion after placement of the implants into the newly formed bone.* (d) *Buccal view of the combination graft (strip gingival graft and XCM) sutured over the recipient site.* (e) *Buccal view of the graft after 1 week of healing.* (f) *Occlusal view of the palatal wound. Note the almost complete healing of the wound 1 week postoperatively.* (g) *Vestibular view of the regenerated tissue with the definitive restorations in place after 1 year of healing. Note the excellent color match at the coronal region and some discrepancy at the apical area where the strip graft was placed.* (h) *Periapical radiographs after 1 year of loading.*

implant placement and the dental implants were still submerged, the horizontal incision was on the palatal side of the ridge. In situations when implants were already restored, the horizontal incision was done intrasulcularly to preserve the maximum thickness of the peri-implant mucosa. The flap was then elevated with a split thickness dissection to reposition the mucogingival line apically to its original position before the bone regenerative surgery and sutured in this apical position with the use of T-mattress sutures (5-0 Monocryl, Ethicon). The resulting recipient site consisted of a periosteal bed that was smoothed using

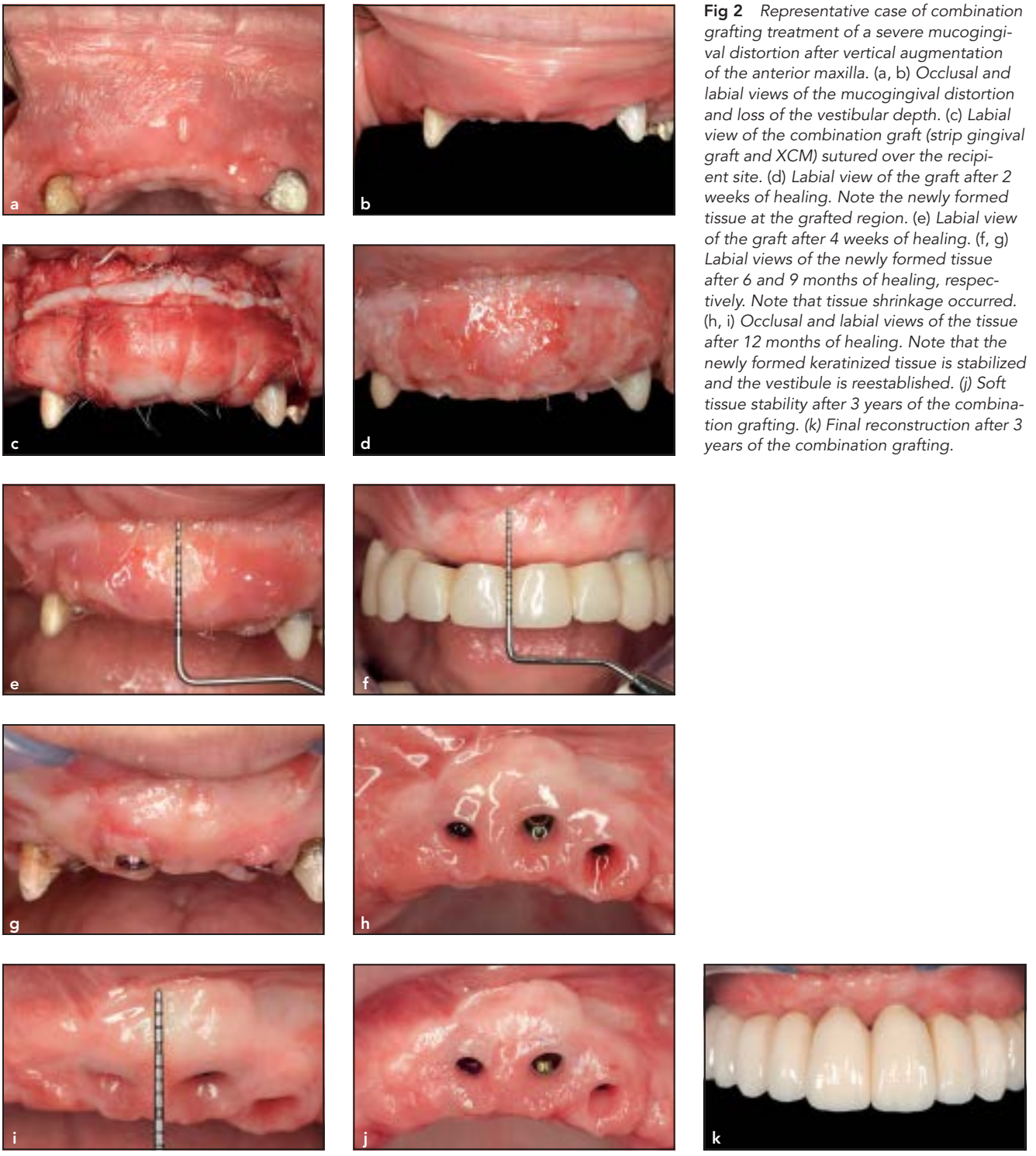

Fig 2 *Representative case of combination grafting treatment of a severe mucogingival distortion after vertical augmentation of the anterior maxilla.* (a, b) *Occlusal and labial views of the mucogingival distortion and loss of the vestibular depth.* (c) *Labial view of the combination graft (strip gingival graft and XCM) sutured over the recipient site.* (d) *Labial view of the graft after 2 weeks of healing. Note the newly formed tissue at the grafted region.* (e) *Labial view of the graft after 4 weeks of healing.* (f, g) *Labial views of the newly formed tissue after 6 and 9 months of healing, respectively. Note that tissue shrinkage occurred.* (h, i) *Occlusal and labial views of the tissue after 12 months of healing. Note that the newly formed keratinized tissue is stabilized and the vestibule is reestablished. (j) Soft tissue stability after 3 years of the combination grafting. (k) Final reconstruction after 3 years of the combination grafting.*

sharp dissection to avoid any loose fibers or irregularities. It was then measured with a sterile foil stent to clearly define the boundaries of the graft necessary to fully cover its apical dimension. An autogenous FGG of appropriate length to cover the full apical extension of the recipient gingival bed was harvested from the

palatal mucosa. This graft was only 2 to 3 mm wide and 1 to 1.5 mm thick (strip graft) and was sutured immediately after its retrieval to the apical end of the recipient bed with resorbable monofilament sutures (6-0 PDS-II, Ethicon). The remainder of the periosteal bed not covered with the strip graft was covered with the collagen matrix (trimmed and customized for the available space) and sutured in place using the same resorbable suture by means of single interrupted and cross-mattress sutures (Figs 1d and 2c). The combination graft was left exposed for healing. The palatal wound was then closed using cross-mattress sutures, and, due to the limited width of the obtained grafts, approximation of the palatal wound margins was easily achieved (Gore-Tex CV-5 Suture, W. L. Gore & Associates or 5-0 Monocryl Suture, Ethicon). Patients were instructed to rinse twice a day with 0.2% chlorhexidine solution (eg, Corsodyl) for 1 minute. Appropriate systemic anti-inflammatory medication (50 mg diclofenac, Cataflam, Novartis) was prescribed, and patients were instructed to comply with the prescribed regimen and to return at 7 and 14 days postsurgery (Figs 1e, 1f, 2d).

Outcome measurements

The primary outcome measurement was the increase in the width of keratinized tissue between baseline and 1-year postsurgery (Figs 1g, 1h, 2h, 2i). The baseline reference was established by the free mucosal margin around the implants, or when the implants were still submerged, the mucogingival line projected from the adjacent teeth. Immediately after surgery the augmented tissue was assessed with a calibrated periodontal probe rounded up to 0.5 mm (UNC, Hu-Friedy) from the apical extension of the strip graft to the established baseline reference point. The changes in this extension (width) were evaluated at 1, 3, 6, 9, and 12 months (Figs 1g and 2e to 2i).

As secondary outcome measurements, the degree of graft shrinkage, expressed in percentage, was calculated by measuring the graft contours from standardized clinical photographs taken with the probe in place. The images were then digitized and analyzed with image analysis software (ImageJ, National Institutes of Health).

The patient morbidity was evaluated at 1 and 2 weeks postsurgery by measuring the amount of pain medication needed and by assessing the patient's pain through a visual analog scale (VAS) with which patients registered the intensity of their perceived pain using a numerical score from 0 (no pain at all) to 10 (maximum pain).[31] The occurrence of postoperative complications, such as infection of the graft, bleeding, or disturbances in chewing also was recorded.

Data analysis

Descriptive statistics of the outcome measurements assessed in this clinical study are presented as means, medians, SDs, and 95% confidence intervals (CIs) of the means.

Results

The study population consisted of 20 consecutive patients treated with the combination graft from January 2011 through October 2012. All patients completed the 12-month postoperative evaluation, although 1 patient missed the 1- and 6-month follow-up visits, and another patient missed the 1- and 9-month follow-up visits. The mean age of the patients was 51 and most of them (85%) were female (n = 17). Most of the surgeries (85%) were carried out in the maxilla (n = 17), with 9 in the posterior and 8 in the anterior areas. In the mandible, two surgeries were carried out in the anterior and one in the posterior area.

None of the patients had any relevant postoperative complications, such as intense pain, infection, or bleeding. At 1 week, the grafted and donor sites exhibited good healing conditions without sloughing either the strip graft or the collagen matrix (Figs 1e and 1f). Table 1 depicts the results of the primary outcome variable. All treated sites exhibited a significant gain in KTW, with an average width at 12 months of 6.33 mm (SD: 2.16 mm and 95% CI ranging between 5.31 and 7.34). Between day 1 and 12 months, there was a mean contraction of the graft of 43.0% (SD: 11.0% and 95% CI ranging between 37.9% and 48.2%). Figure 3 shows the differences in the magnitude of keratinized tissue gain between the anterior and posterior maxillary sites, resulting in higher gains in the anterior maxilla

Table 1 Results of primary outcome measure: Keratinized tissue width (KTW)

KTW (mm)	Presurgery	Postsurgery	1 mo	3 mo	6 mo	9 mo	12 mo	Shrinkage (%) 12 mo postsurgery
Median	0.00	11.00	8.00	6.50	6.00	6.00	6.00	43.7
Mean	0.00	11.07	8.49	6.88	6.45	6.46	6.33	43.0
SD	0.00	3.10	3.11	2.57	2.41	2.34	2.16	11.0
Lower 95% CI	0.00	9.62	6.95	5.67	5.28	5.33	5.31	37.9
Upper 95% CI	0.00	12.52	10.04	8.08	7.61	7.59	7.34	48.2

CI = confidence interval.

Table 2 Morbidity of perceived pain experienced by the patients*

Morbidity	VAS 1 wk postoperatively	VAS 2 wk postoperatively	Total medication (mg)
Median	2.00	0.00	25.0
Mean	2.35	0.00	215.0
SD	1.90	0.00	332.5
Lower 95% CI	1.46	0.00	59.4
Upper 95% CI	3.24	0.00	370.6

VAS = visual analog scale; CI = confidence interval.
*Patients registered the intensity of perceived pain using a VAS ranging from 0 (no pain at all) to 10 (maximum pain).

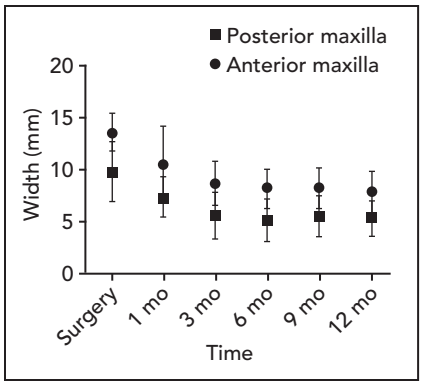

Fig 3 *Comparison of the magnitude of keratinized tissue gain between the anterior and posterior maxillary sites. There was a mean 43% shrinkage from baseline to 12 months postsurgery.*

at 12 months (7.81 versus 5.50 mm). The shrinkage, however, was similar (43.1% in the anterior versus 44.9% in the posterior).

An evaluation of the patients' perceived pain is shown in Table 2. Most patients had mild pain at the grafted area and only one patient complained of pain on the donor site. Ten out of 20 patients did not take any pain medication, although 2 patients required continuous pain medication during the first postoperative week, and 8 patients required pain medication intermittently during this week. None of the patients reported pain or the need for pain medication after 1 week. None of the patients reported any difficulties in chewing.

Clinically, the regenerated soft tissue demonstrated a good match in color with the neighboring tissues (Figs 1g and 2i), except the area corresponding to the strip graft at the apical end, which was clearly noticeable with a distinct consistency and color.

Discussion

This prospective case series study clearly showed that the combination of a xenogeneic collagen matrix and a free single strip gingival graft can be utilized safely and effectively to restore severe mucogingival defects resulting from advanced vertical and horizontal ridge augmentation procedures. These defects consisted of severe loss of keratinized tissue and vestibular depth, together with displacement of the mucogingival line, which was usually located in a palatal/lingual position in relation to the submerged implants (Figs 1a to

1c, 2a and 2b). In these clinical situations, there is a clear indication for a mucogingival surgical procedure aimed at increasing the amount of keratinized tissue. Recent clinical studies have concluded that a wider zone of keratinized tissue may better preserve soft and hard tissue stability around dental implants as well as their long-term maintenance.[33,34] On the other hand, lack of keratinized tissue may result in poorer oral hygiene and greater soft tissue recession.[35]

A recent systematic review[36] evaluated the efficacy of surgical procedures to augment KTW around dental implants. Seven studies reported on various techniques and materials and in all studies KTW was successfully augmented. In three of the included studies, collagen matrices were evaluated and compared with autogenous grafts.[31,32,37] The reported increase in KTW indicated a successful use of both collagen matrices, even though the gain of KT was slightly less compared to sites augmented with autogenous tissue (mean gain between 2.2 and 2.5 mm).

In this study, the combination of a strip graft with a xenogeneic matrix resulted in a mean gain in KT of 8.49 mm at 1 month following surgery, which was 6.33 mm at 1 year.

In a previous systematic review, Thoma et al[38] compared the outcomes of the FGG to FCTG and allografts demonstrating a significant superiority for gaining KTW. The use of allografts consisting of an acellular dermal matrix[39] or the use of bioengineered constructs using allogeneic fibroblasts[40] resulted in extensive shrinkage (more than 50%), although they rendered less morbidity and higher comfort for the patient. Similarly, this FGG procedure resulted in less shrinkage of the graft when compared with the FCTG, but at the expense of an unesthetic appearance. In this clinical investigation, the use of the combination graft resulted in a contraction of 43.0% at 12 months, which is similar to that reported with the use of FGGs[11] and inferior to the use of FCTGs and xenogeneic collagen membranes, which have reported consistently more than 50% shrinkage.[25,31,32,41] The lower rate of graft contraction reported in the present investigation may be related to the strip graft, which may stabilize the apical portion of the recipient bed, thus preventing the rebound of the alveolar mucosa, as it was clearly shown when xenogeneic collagen matrices were used in the treatment of large mucosal defects.[42]

The expected mechanism of action of the collagen matrix was to stabilize the blood clot, providing a scaffold where cells and vessels from the adjacent tissues may migrate in and form healthy KT, while the strip graft on the apical end of the surgically created bed would act as a barrier to the apical tissues from the alveolar mucosa, which do not have the capability to keratinize. In this manner, the tissues from the lateral borders would migrate and differentiate within this three-dimensional scaffold into keratinized mucosa. In fact, when this xenogeneic biomaterial has been tested in experimental models, it has shown good biocompatibility and excellent porosity with immediate ingression of fibroblasts and vascular elements in absence of a significant inflammatory reaction.[43,44]

The combination of a strip graft with a xenogeneic matrix resulted in a good healing response with no postoperative complications, such as infection or loss of the autogenous strip graft or the collagen matrix. Similar outcomes have been reported with the use of the same soft tissue substitute for the treatment of small size areas lacking KT around teeth and implants.[31,32] In all patients treated in this consecutive case series, the most apical area corresponding to the strip graft was clearly noticeable with a distinct consistency and color different from adjacent tissues. The rest of the grafted area, corresponding to the area covered with the collagen matrix, showed a good color match and integration with the adjacent tissues. The use of the combination graft was well accepted by the patients, with minimal morbidity according to the patients' low self-reported pain and the low utilization of pain medication. This fact may be an advantage to the use of other surgical techniques, such as FGGs or FCTGs, which have shown increased morbidity associated with the harvesting of the donor site.[31,45] This observation, however, must be tested with the appropriate clinical trials.

The surgical technique described in this prospective case-series study is simpler than the techniques used previously for similar indications, such as large FGGs,

FCTGs, or the harvesting and placement of several strip autografts. The harvesting of the single strip graft and its placement to the recipient site were not difficult, and the handling of the collagen matrix was excellent.

The nature of the design of this clinical study (prospective case series) did not allow the authors to draw any firm conclusions because there was no control group and, therefore, the authors could only generate the hypothesis that this combined intervention may help to increase the amount of KT in these clinical situations after extensive hard tissue grafting. This hypothesis must be validated in well-designed clinical trials using the appropriate controls.

Conclusions

This prospective case series study has shown that the combination of a xenogeneic collagen matrix and a free single strip gingival graft safely and effectively restored severe mucogingival distortions after advanced vertical and horizontal ridge augmentation procedures. These positive results, however, must be tested in well-designed clinical trials.

Acknowledgments

This study was partially funded by Geistlich Pharma, Wolhusen, Switzerland. The authors reported no conflicts of interest related to this study.

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