In the maxillary anterior region, augmentation to correct a soft tissue deficiency is often required for an aesthetic outcome and long-term implant therapy success. This case series of three patients presents a novel approach for soft tissue augmentation using xenogeneic collagen matrix balls in the esthetic zone around the implants. This technique avoids a secondary donor site compared to autogenous connective tissue graft. With this technique, a horizontal soft tissue volume increase (range: 3 to 5 mm) was observed postsurgically and maintained at later follow-ups. The described ball technique offers a viable method for peri-implant mucosal augmentation in the maxillary anterior region.

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Alveolar ridge deficiency is one of the challenges commonly faced during implant therapy in the anterior maxilla. After tooth loss, the alveolar socket heals by resorbing the external socket walls, resulting in reduced vertical and horizontal volume postextraction.1–4 Postextraction alveolar dimensional loss is an inevitable biologic event,1–4 and the edentulous alveolar ridge in the anterior maxilla often has the most pronounced postextraction resorption, with losses of both hard and soft tissue volume due to the thin buccal bone wall.5 The buccolingual width of the ridge can be reduced by 50% in the first year after tooth loss.6 This reduction in the bone volume consequently leads to a reduction in the soft tissue volume,6 which affects the long-term stability and esthetics of the implant restoration. Adequate peri-implant mucosal thickness is associated with higher peri-implant marginal bone stability.7–9 In addition to being a critical factor in marginal bone stability, peri-implant soft tissue thickness is also critical in achieving an esthetic outcome.10

Autogenous subepithelial connective tissue graft (SCTG) has been shown to increase peri-implant soft tissue thickness with a favorable long-term outcome.11 However, harvesting autogenous SCTG has been
associated with increased postoperative pain, increased intraoperative and postoperative bleeding, longer surgical times, and transient palatal sensory dysfunction. In studies that assessed patient-centered outcomes, there was a greater patient preference toward nonautogenous soft tissue augmentation techniques. The use of soft tissue graft substitutes, such as allogeneic and xenogeneic materials, has been proposed frequently in the literature. Previous studies have reported xenogeneic collagen matrix (XCM) to be a viable alternative to autogenous soft tissue graft in peri-implant soft tissue augmentation. When compared to autogenous SCTG, XCM was found to have comparable results in mucosal thickness increase and keratinized mucosa gain around implants, with a significantly reduced surgical time and lowered postoperative patient morbidity.

The use of a porcine-derived XCM has been reported in the literature to have similar esthetic and functional results compared to autogenous grafts for peri-implant soft tissue augmentation, as well as several advantages, including reduced chair time, faster recovery, and avoidance of donor harvesting. However, when attempting to correct a significant peri-implant mucosa deficiency, XCM often lacks volumetric stability due to insufficient thickness of XCM (approximately 1.0 mm when wet). In order to overcome this limitation, an alternative approach is presented herein, utilizing porcine-derived XCMs compressed into balls for correcting a peri-implant soft tissue volume deficiency in the esthetic zone.

Materials and Methods

The following cases demonstrate the use of the collagen ball technique to treat areas of soft tissue volume deficiency in the anterior maxilla at the time of second-stage implant surgery. Informed consent for the procedures was obtained from all patients based on the guidelines of the 1975 Declaration of Helsinki, as revised in 2000.

After administration of local anesthesia (2% lidocaine with 1:100,000 epinephrine), a crestal incision biased toward the palatal aspect was made with a no. 15C blade over the implant sites, and mesial and distal oblique vertical releasing incisions were made on the facial aspect. A full-thickness flap was then elevated to expose the implants. Cover screws were removed and replaced with healing abutments. A porcine-derived XCM material (Mucograft, Geistlich) was manually compressed and condensed into balls ranging 6 to 7 mm in diameter (Fig 1a), then placed over the facial bone and around the implants in areas of soft tissue deficiency (Fig 1b). A periosteal releasing incision was made in the buccal flap to accommodate for the increase in volume (from placing the XCM balls) and to allow for tension-free flap closure. The flap was reapproximated to cover the graft materials using 4-0 Vicryl sutures around the healing abutments (Fig 1c).

Postoperative management included antibiotic therapy (750 mg amoxicillin daily for 1 week) and anti-inflammatory therapy (180 mg loxoprofen daily for 3 days). Postoperative care instructions were given to patients, instructing them to avoid pressure and irritation to the

Fig 1 (a) Porcine-derived xenogeneic collagen matrix (XCM) was compressed and condensed into balls (6- to 7-mm diameter). (b) The balls were grafted and (c) covered by a flap at the time of second-stage implant uncovering surgery.

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Horizontal width was measured (from the maximum protuberance of the buccal soft tissue at the implant site to the palatal aspect) with a caliper and recorded preoperatively at baseline and postoperatively at the time of definitive restoration delivery as well as at follow-up appointments. All treated sites were selected for repeated measurements. Soft tissue volume stability was assessed clinically by caliper measurements at follow-up appointments.

**Clinical Cases**

**Case A**

A 35-year-old woman with osseointegrated implants replacing maxillary right central and lateral incisors received soft tissue augmentation with the XCM ball technique at the time of second-stage healing abutment placement to correct peri-implant soft tissue volume deficiency (Fig 2a). Porcine-derived XCM was manually compressed into balls and placed over the facial bone of the implant areas during implant uncovering surgery. A peri-implant soft tissue volume increase of 5 mm was noted 4 months postoperatively (Fig 2b, Table 1). This soft tissue volume increase remained stable at the 18-month (Fig 2c) and 33-month (Fig 2d) follow-ups. Shallow peri-implant probing depths and healthy peri-implant tissue were noted.

**Case B**

A 51-year-old woman with implants in the anterior maxilla at the right lateral incisor and left central and lateral incisor sites (replacing all four maxillary incisors) had a significant soft tissue volume deficiency (Fig 3a). Porcine-derived XCM balls were placed over the facial bone of the implant areas during implant uncovering surgery. A soft tissue volume gain of 3 mm was noted 5 months later (Fig 3b, Table 1). No significant soft tissue volume change was observed between 8 months (Fig 3c) and 12 months (Fig 3d) follow-ups.
3c) and 25 months postoperatively (Fig 3d). The peri-implant tissue was healthy without deep probing depths.

Case C

A 49-year-old woman had a soft tissue volume deficiency around implants placed at both maxillary central incisor sites (Fig 4a). Porcine-derived XCM (Avitene, BD) compressed balls were placed over the facial bone at the areas of peri-implant soft tissue deficiency during the second-stage implant uncovering procedure. A postaugmentation soft tissue volume increase of 5 mm was noted 8 months later (Fig 4b, Table 1). From 12 months (Fig 4c) to 40 months (Fig 4d) following soft tissue augmentation, peri-implant soft tissue gain remained stable without shrinkage. The peri-implant tissue was healthy without deep probing depths.

Discussion

Soft tissue augmentation is often indicated around dental implants in the esthetic region to compensate for the deficiencies in hard and soft tissue often observed in the edentulous anterior maxilla. In the past several years, various biomaterials have been available to clinicians and have increasingly gained popularity due to their advantages when compared to autogenous grafts, such as reduction of surgical time,
unlimited availability, avoidance of a secondary donor harvest site, decreased postsurgical morbidity, and increased patient preference.\textsuperscript{12,13} In recent years, materials such as acellular dermal matrix and porcine collagen matrix have been available as alternatives to autogenous graft in the augmentation of peri-implant mucosa and have achieved successful results in experimental and clinical studies.

An average horizontal soft tissue volume gain of 4.33 mm was noted in the present case series. These positive results merit further controlled research with this technique. Cairo et al reported a peri-implant mucosa thickness gain of 0.9 ± 0.2 mm utilizing porcine collagen matrix.\textsuperscript{17} Schallhorn et al reported a 0.7-mm gain in soft tissue thickness when porcine-based collagen matrix was utilized around implants.\textsuperscript{18} When Thoma et al utilized porcine collagen matrix, a 1.6-mm gain in horizontal soft tissue volume was reported.\textsuperscript{19} Compared to other studies that also utilized porcine collagen matrix, one possible reason for the greater horizontal soft tissue volume increase reported in the present study may be related to the dense compression of the XCM material into ball shapes prior to placement. Studies that reported increases of 0.7 to 0.9 mm in horizontal soft tissue volume utilized the porcine collagen matrix in a single layer, while the study that reported a 1.6-mm gain used a folded matrix with a double-layer thickness, without compression, to increase density of the XCM material. Postoperative shrinkage of soft tissue augmentation over time is commonly reported, ranging from 0.20 to 3.06 mm and up to 50.7%, but it is subjected to individual variations depending on the graft material used and the surgical technique.\textsuperscript{20} In the present case series study, stable soft tissue augmentation results were documented and maintained during the follow-up periods (up to 25 months in case B, 33 months in case A, and 40 months in case C), which suggested that the soft tissue volume gain remained stable even after resorption of the placed porcine XCM.

Some limitations with the present case report include the lack of repeatability, accuracy in measurements (due to the manual caliper), and comparison to a control group grafted with a conventional approach using collagen matrix. Future digital volumetric studies using reverse-engineering software are being planned to compare the results and long-term stability of peri-implant soft tissue volume enhancement utilizing the compressed ball technique described vs the conventional technique.

Conclusions

The ball technique described in the present case series provides a viable method for augmenting soft tissue volume around dental implants in the anterior maxilla by using porcine collagen matrix compressed into balls. Some additional areas of interest for future research may include utilization of the ball technique with a minimally invasive tunneling approach and the potential synergistic effect of combining the ball technique with growth factors.

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References


