A Modification of the Connective Tissue Graft Procedure for the Treatment of Type II and Type III Ridge Deformities

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Various grafting procedures have been developed for reconstruction of partially edentulous ridge deformities prior to prosthetic rehabilitation. The majority of these procedures have been applicable to reconstruction of Type I (buccolingual) ridge deformities. Type II and Type III defects present a more difficult challenge because of the need for apicocoronal augmentation and replacement of greater volumes of lost tissue. The onlay and subepithelial connective tissue grafts have been predominately used for the treatment of these type of defects, however, each procedure presents certain limitations. This report describes a simple modification of the connective tissue graft that enhances its ability to augment tissue for Type II and Type III deformities. The technique is an effective and predictable procedure for advanced ridge deformities. (Int J Periodontia Rest Dent 1996;16:267-277.)

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Our quest in restorative dentistry and periodontics has always been to restore form, function, and esthetics. Nowhere is this more challenging than in the maxillary anterior region of the high lip-line patient. Replacement of missing teeth in this location is often difficult because of the exposure of the cervical area of the tooth and the surrounding soft-tissue environment. An inadequate alveolar ridge or ridge deformity is a problem that is frequently encountered and can affect esthetics and the restorative outcome.

Localized ridge deformities or inadequate ridge contours are a common fate following the loss of teeth. Traumatic removal of teeth, severe periodontal disease, endodontic failure, implant failure, traumatic accidents, and developmental defects are a variety of causes of ridge deformities. Seibert identified three basic types of ridge deformities: (1) buccolingual loss of tissue contour with
normal ridge height in an apicocoronal dimension; (2) apicocoronal loss of tissue contour with normal ridge width in a buccolinguinal dimension; and (3) a combination of buccolinguinal and apicocoronal loss of tissue. He classified these as Type I, II, and III ridge deformities, respectively.

In the past, ridge deformities were managed by modifying the design of the prosthesis to compensate for the ridge abnormality. However, over the past decade several surgical techniques have been introduced to reconstruct the partially edentulous ridge deformity before the fabrication of the prosthesis. Abrams described a de-epithelized connective tissue pedicle graft or "roll" technique. The roll technique was useful for various types of defects if a sufficient thickness of palatal donor tissue was present and the underlying alveolar bone was of a sufficient width. Langer and Calogna introduced a technique utilizing a subepithelial autogenous connective tissue graft to augment the partially edentulous ridge. This procedure was later modified by Garber and Rosenberg using various pouch designs for the implantation of autogenous connective tissue. Cohen and Allen et al. alternatively described the use of alloplastic graft substitutes for autogenous connective tissue. These techniques were primarily effective for the treatment of Type I deformities.

Treatment of Type II and III ridge deformities present a more difficult challenge because of the need for replacement of greater volumes of lost tissue and reconstruction of alveolar ridge height. The connective tissue and onlay graft have been the most frequently used procedures for these types of defects. Seibert described the use of a thick autogenous free gingival or onlay graft. Utilizing a series of these grafts, he reported successful treatment of Type II and Type III deformities. However, the onlay graft proposes certain drawbacks and limitations, including postoperative necrosis and unpredictable shrinkage of the graft. These two factors increase the likelihood of additional surgery to compensate for the loss. Moreover, postoperative pain and hemorrhaging occur with more frequency. Tissue blanching may also be a potential problem. Langer and Calogna described the use of a subepithelial connective tissue graft sandwiched between a facial pedicle flap and the edentulous ridge. To increase the vertical height, a portion of the graft was intentionally left exposed and allowed to heal. Epithelium was not intentionally included in the graft. The donor tissue was primarily harvested from the inner surface of the
palatal mucosa, which limited the volume of tissue that could be obtained.

The purpose of this study was to describe a modification of the connective graft technique for localized ridge augmentation that intentionally retains and incorporates a wide band of epithelium into the connective tissue graft and increases the size of the graft, enhancing vertical and horizontal augmentation. The effectiveness of this technique will be demonstrated and surgical steps for success will be outlined.

**Technique**

**Recipient site**

A healed edentulous ridge with Type II or III ridge deformity should be present (Fig 1). A partial-thickness pedicle flap is dissected and elevated on the facial aspect of the recipient site requiring augmentation. In most cases a horizontal incision is made slightly facial to the crest of the edentulous alveolar ridge and is connected with either one or two vertical releasing incisions to facilitate flap mobility. The flap may or may not include the region of the interproximal papilla, depending on the extent and requirements for tissue augmentation. The partial-thickness flap dissection leaves connective tissue over the existing bone. The pedicle flap is extended well into the mucobuccal fold without perforations. Concavities and irregularities of the ridge are common and should be taken into consideration during the dissection. The next step includes preparation of the ridge crest. The epithelium covering the connective tissue over the crest of the ridge is removed to expose a bleeding connective tissue base similar to that described by Seibert for the onlay graft. The denudation should extend palatally as far as possible (textured surface in Fig 2) with removal of a 1-mm thickness of surface tissue ensuring complete exposure of the connective tissue. Measurements are taken of the recipient bed in a mesiodistal and buccolingual direction to determine the dimensions of the required graft. A foil template may also be used. The prepared recipient site is covered with surgical gauze moistened with isotonic saline solution while the donor tissue is being procured from the palate.

**Donor site**

A second surgical site is created on the palate to obtain the required donor graft tissue. Palatal tissue in the region of the premolar/first molar area is the most desirable. This site is chosen because the largest volume of
connective tissue is available, and the gingiva from this region is the most pliable and easiest to adapt. In addition, this tissue is loosely organized, allowing for better plasmic circulation during healing. The measurements secured from the recipient site are used to outline the graft to be harvested. Again, a foil template may be preferred.

The dissection of the graft begins with a horizontal incision (parallel to the teeth) 3 to 4 mm palatal to the gingival margins of the maxillary premolar/molar teeth (Fig 3). The length of the horizontal incision should coincide with the previously determined mesiodistal measurement of the recipient site. The incision is extended apically to the underlying bone in a butt-joint fashion (Fig 4). Subsequently, two vertical incisions are made at the periphery of the horizontal incision, extending to the midline of the palate and to the underlying bone (dotted line in Fig 4). The length of the vertical incisions will depend on the buccolingual dimension of the recipient site, which normally averages 6 to 8 mm for large ridge defects.

A second horizontal incision is made connecting the two vertical incisions (Fig 3 dotted line). However, this incision is beveled and is directed toward the center of the palate as described by Langer and Calagna for the subepithelial connective tissue graft technique. It continues apically and obliquely until it meets the underlying bone, averaging 5 to 7 mm from the palatal surface. The beveled incision ensures as much de-epithelialized connective tissue as possible at the base of the graft. During each step of harvesting the graft, effort is made to remove as much palatal tissue as possible. The graft is then completely dissected from the base of the palate until it is free. The final donor graft upon removal will resemble a thick free gingival graft with an accompanying connective tissue tail. Figure 4 diagrammatically depicts a cross-section of a properly harvested graft.

The graft is adapted to the recipient bed and secured with interrupted or a continuous mattress sutures (Fig 5). It is best to secure the palatal aspect of the graft first before suturing the pedicle flap to the graft. The vertical incision(s) are then closed with subperiosteal interrupted fixation sutures.

The donor site should be inspected for undue bleeding and managed accordingly. The provisional fixed partial denture is adjusted, assuming light contact with the surface of the graft. This facilitates formation of ovate pontic sites upon healing, as described by Seibert. The surgical sites should be inspected 1 to 2 weeks post-surgery to assess proper healing.
Fig 1  Diagrammatic representation of a Type III ridge deformity demonstrating buccolingual and apicocoronal loss of tissue.

Fig 2  Split-thickness pedicle flap and exposure of a connective tissue base on the facial aspect, and the removal of epithelium from the crest of the ridge defect (textured surface).

Fig 3  Diagrammatic representation of the outline incisions of donor site.

Fig 4  Cross-sectional view of the modified connective tissue graft before its removal from the palate.

Fig 5  Diagrammatic representation of modified connective tissue graft adapted and secured to the recipient site.
**Case report 1**

The patient shown in Fig 6a was a 29-year-old man who presented with a Type III ridge deformity. A temporary acrylic prosthesis had been constructed following the loss of the maxillary right lateral and central incisors 6 months previously as a result of chronic endodontic failures. Considerable buccolingual and apicocoronal tissue loss accompanied the extraction (Figs 6b and 6c show the extent of the ridge defect). The loss of root eminence and papilla form prompted the patient's dentist to request a ridge augmentation procedure prior to fabrication of a fixed partial denture. The deformity was judged to be too large to reconstruct with a single graft, and the decision was made to augment the defect utilizing two consecutive grafts. Palatal donor tissue was evaluated, and sufficient thickness was found to be present. The recipient site was prepared by removal of surface epithelium from the crest of the ridge and dissection of a partial-thickness pedicle facial flap with a single releasing incision near the cuspid (Fig 6d). The pedicle flap was carefully dissected and undermined at the left central incisor to facilitate adequate mobility (Fig 6e). A modified connective tissue graft was harvested from the palate conforming to the dimensions of the recipient bed (Fig 6f). Figure 6g demonstrates positioning and securing of the graft to the recipient site. The graft was lightly compressed to conform to the edentulous ridge before suturing. The palatal donor site was appropriately dressed with a suitable hemostatic material. An identically designed second-stage graft was performed approximately 8 weeks later. The final edentulous ridge healed with adequate buccolingual and apicocoronal contours (Figs 6i and 6j). Illusions of root eminences and papilla forms were achieved in the final result (Fig 6k).
Fig 6d (left)  Preparation of recipient site. Crestal epithelium has been removed and pedicle flap incisions have been made.

Fig 6e (right)  Partial-thickness dissection and reflection of facial pedicle flap.

Fig 6f (left)  Mirror view of the right side of the palate, showing the modified connective tissue being harvested from the palate.

Fig 6g (right)  Incisal view of the donor tissue adapted to recipient site. Notice the connective tissue portion of the graft is located on the facial aspect of the defect and will be covered by the pedicle flap.

Fig 6h (left)  Facial view of graft sutured in place.

Fig 6i (right)  Facial view of final healed edentulous ridge following two consecutive modified connective tissue graft procedures.

Fig 6j (above)  Incisal view shows the dramatic increase in the buccolingual dimension following ridge augmentation and ovate pontic formations.

Fig 6k (right)  Final fixed partial denture 8 months after ridge augmentation surgery. Mild blanching of the graft can be noticed.
Case report 2

A 24-year-old man was evaluated for possible ridge augmentation of the maxillary right and left central and left lateral incisor region. The patient had the three teeth traumatically avulsed during an altercation. Following initial emergency care and 2 months of healing, the patient presented with a severe Type III ridge deformity (Figs 7a and 7b). He strongly desired replacement of the teeth with a fixed prosthesis. The entire ridge architecture had been severely obliterated, preventing any type of fixed prosthetic replacement. Originally, an autogenous corticocancellous osseous graft, harvested from the hip, was recommended to the patient before soft tissue augmentation, but he declined because of concerns over postoperative problems. A decision was made to reconstruct the ridge with multistage modified connective tissue grafts as described above. No oral-nasal communication could be detected at the initial evaluation. A series of three modified connective tissue grafting procedures as described above were performed, after which the restorative dentist was able to construct a fixed partial denture (Figs 7c and 7d).
Fig 7a  Pretreatment facial view of severe Type III ridge deformity.

Fig 7b  Incisal view showing complete loss of ridge architecture.

Fig 7c  Facial view of augmented edentulous ridge following three consecutive modified connective graft procedures.

Fig 7d  Final fixed partial denture 1 year postsurgery.
Discussion

Significant progress has taken place in reconstruction of the deformed partially edentulous ridge since the introduction of ridge augmentation by Abrams. With the advent of the various grafting techniques now available, treatment of ridge deformities is more predictable. This has been achieved through the use of different surgical approaches and the application of available knowledge of mucogingival surgical principles to ridge augmentation. The goal of this report was to introduce a modification of the subepithelial connective tissue graft technique for ridge augmentation surgery that enhances the ability to treat Type II and Type III defects.

Langer and Langer described the use of the subepithelial connective graft for successful root coverage of deep wide recessions. The success of the grafts was attributed to the dual blood supply of the recipient site derived from the underlying connective tissue base and the overlying recipient flap. Increases of 2 to 6 mm of root coverage over avascular root surfaces were achieved in many cases. In addition, the technique had the advantage of a better blend of the graft with the adjacent tissue, avoiding the "keloid" healing effect common to traditional free gingival grafts. Healing accompanying this technique resulted in a graft which tended to maintain original thickness compared to the typical shrinkage encountered with conventional onlay grafts. Langer and Calagna reported similar findings using the subepithelial connective tissue graft for ridge augmentation as well.

The modified connective tissue graft described in this report receives vascular nourishment from two sources. One source is the underlying connective tissue base on the bone, and the second is the pedicle flap. As a result, there is minimal risk of slough and loss of tissue. Also, contraction or shrinkage of the graft appears to be minimal with time. A significant feature of the modification introduced is the simultaneous expansion of the buccolingual and apicocoronal dimensions of the ridge with the same graft. The pedicle flap is displaced in a buccal direction as a result of the wide epithelial bond on the graft located at the crest of the ridge. Incorporation of the epithelial collar allows the graft to function as a thick onlay graft facilitating vertical augmentation, while the connective tissue enhances vascularity. The onlay graft has been shown as an effective grafting procedure for vertical augmentation in large Type II and Type III defects. Collectively, the modification results in a graft that functions as an onlay graft but has the healing capacity of a subepithelial connective tissue graft.

Retention of epithelium increases the overall dimension of the graft compared to the subepithelial connective tissue graft described by Langer and Calagna. This results in the use of fewer grafts for augmentation of the larger defects encountered in Type II and III deformities. Case 2 clearly demonstrates this effect, as three grafts were required to reconstruct a combined 7-mm vertical and 5-mm horizontal defect.

The graft becomes more fibrotic with the passage of time and blends with the adjacent tissue in color when compared to the onlay graft. The blanched or "keloid-like" healing is minimal, and slight changes in color of the epithelialized portion of the graft occur over time (see Figs 6k and 7d). This type of healing is consistent with previously reported subepithelial connective tissue grafts. The addition of blood source probably improves the capillary survival rate of the donor graft, thus diminishing the amount of blanching.

Finally, the graft procedure does not appear to be technique sensitive. It has been used successfully for the past 6 years in 15 cases which have remained stable over this period.

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of time. Most Type III ridge deformities have required two or fewer grafts. Increases in vertical height have ranged from 2 to 7 mm in many cases. This “user-friendly” quality seems to be a universal healing principle of subepithelial graft designs.

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**Conclusion**

Repair of the deformed edentulous ridge preceding prosthetic rehabilitation can provide the restorative dentist with a more ideal gingival contour and preclude the need for modifications or compromises in the final prosthesis. The technique described in this report can be used to reconstruct large edentulous ridge cavities, irregularities, and deformities of Type II and III defects where esthetics is of prime importance or in which the deformed ridge interferes with function of speech or the ability to perform efficient oral hygiene. The resulting gingival contour and form can closely mimic a normal ridge relationship. This procedure is a useful adjunct for correcting esthetic and functional problems in fixed prosthodontics.

**References**


