Successful Root Coverage: A Human Histologic Evaluation of a Case

Connective tissue grafts combined with pedicle grafts (subepithelial grafts) have been shown to be effective in obtaining root coverage. Unfortunately, little is known about the histology of the results in humans. This is a case report of a tooth with a recession defect that was treated with a subepithelial graft. Complete root coverage was obtained. However, at 5 months postoperative the tooth had to be extracted because of a vertical root fracture. With the patient's permission, a small collar of tissue was removed with the tooth. The sample was processed and evaluated histologically. The results revealed areas of regeneration, with new bone, cementum, and connective tissue attachment coronal to the original gingival margin. No bone grafts or guided tissue regeneration membranes were used. This case report confirms that regeneration is possible with subepithelial grafts. (Int J Periodontics Restorative Dent 1999;19:439-447.)

Obtaining predictable and esthetic root coverage has become an important part of periodontal therapy. Over the years various surgical techniques have been shown to be effective in obtaining root coverage. Pedicle grafts, autogenous masticatory mucosa grafts (free gingival grafts), connective tissue grafts combined with pedicle grafts (subepithelial grafts), and guided tissue regeneration have produced good clinical results. Unfortunately, the information concerning the histology of the attachment produced by these procedures is limited.

In spite of the many potential problems, there are published histologic evaluations of the results of root-coverage procedures. Cortellini et al\(^2\) demonstrated new attachment coronal to a gingival margin reference notch when guided tissue regeneration (GTR) was used to obtain root coverage. This included bone, cementum, and connective tissue. The author\(^3\) also used a reference notch at the gingival

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margin. He reported less favorable results when evaluating a connective tissue graft with a partial thickness-double pedicle graft. No new bone, cementum, or connective tissue attachment could be documented coronal to the original gingival margin. Additionally, no new bone could be documented coronal to a second notch that was placed at the bone level.

A different set of reference notches was used by Vincenzi et al. They placed 2 notches, one was 1 mm apical to the adjacent osseous crest and the other was 3 mm apical to the osseous crest. They reported that new attachment (bone, cementum, and connective tissue attachment) was achieved with GTR for root coverage. Similarly, Parmac-Benfenati and Tinti reported on the use of a titanium-reinforced membrane to treat a recession defect. They also placed 2 notches, 2 and 4 mm coronal to the most apical extent of the buccal bone. The apical notch was at the probing attachment level. They reported new connective tissue attachment and new bone formation.

In addition to these block sections (obtained from defects that were planned for extraction from the outset), there are other human histologic evaluations of case reports. These were obtained via a variety of situations. A recession defect may be treated with no intention of extracting the tooth, and it may then need to be extracted for some reason. These cases offer some advantages, as well as disadvantages, over the other block sections. The patient compliance during the postoperative period will probably be higher since it is assumed that the tooth is not going to be lost. Additionally, the prognosis of the tooth would probably be better than if the tooth were scheduled for extraction. The downside of these unplanned histologic evaluations is that no provision is made for a reference notch. Therefore, other methods must be used to determine the original location of the bone and gingival margin.

Pasquinelli reported on a case in which a tooth had to be extracted 10.5 months postoperatively for orthodontics. He reported new attachment (bone, cementum, and connective tissue attachment) with a free gingival graft used for root coverage. His interpretation was based on preoperative clinical findings and the concept of biologic width.

This is a case report of a defect that was treated successfully with a subepithelial graft for root coverage. Unfortunately, the tooth had to be extracted because of a vertical root fracture. This provided a unique opportunity to evaluate a successfully treated root coverage result histologically.

Case report

The patient in this case report was a 38-year-old woman in good general health. She was taking no medications and had no contraindications for periodontal therapy. There was a history of a traumatic injury to the area of the maxillary right lateral incisor 15 years earlier. After the injury the patient had multiple endodontic procedures, including 4 surgical procedures, and 6 years ago the lateral incisor was extracted. Since that time the patient has worn a removable partial denture. The periodontal condition in all areas of her mouth was within normal limits. All probing depths were less than 4 mm and there was minimal bleeding on probing. The patient's oral hygiene was good to excellent. She had never had any periodontal therapy, except routine maintenance therapy in her general dentist's office. There was ridge collapse in the area of the maxillary right lateral incisor and 4 mm of recession on the buccal aspect of the right central incisor. The probing depth on the buccal aspect of the central incisor was 1 mm, with no bleeding on probing; there was 2 mm of keratinized tissue in the area. There was a slight loss of papilla height on the distal aspect of the central incisor (Fig 1). The treatment plan was to augment the ridge in the area of the right lateral incisor and cover the exposed root surface of the central incisor with a subepithelial...
graft. A 3-unit fixed bridge was then to be constructed from the right canine to the right central incisor.

An informed consent form was explained, and it was signed by the patient. A subepithelial graft was performed to augment the ridge and cover the exposed root of the maxillary right central incisor. After obtaining anesthesia the exposed root surface was planed to flatten the root surface and remove any surface contaminants. This was done with large curettes and back-action chisels. No rotary, sonic, or ultrasonic instruments were used. Since there was no periodontal disease in the area, subgingival instrumentation was not performed to preserve any existing connective tissue attachment. The root surface was treated with a tetracycline solution (125 mg tetracycline/1 mL of saline) with cotton pledgets for 3 minutes. The area was rinsed with water and dried with a 3-way syringe. Incisions were made starting at the cementoenamel junction of the central incisor and extending mesially and distally across the space between the right lateral incisor and canine. A vertical incision was added at the mesial extent of the incision. A partial-thickness flap was reflected as close to the periosteum as possible (Fig 2). The dissection was continued until the flap could be positioned over the defect at the central incisor without requiring support. The papilla mesial to the central incisor was dissected to create a recipient bed. A 1.5-mm-thick connective tissue graft was obtained with a scalpel with parallel blades (Harris Double Blade Graft Knife, H & H), as previously described. The epithelial border was discarded. The connective tissue graft was sutured over the recession defect at the central incisor and into the edentulous ridge area at the lateral incisor with 5-0 gut sutures (Fig 3). The pedicle flap was sutured over the connective tissue graft with 5-0 gut sutures (Fig 4). Isobutyl cyanoacrylate (Isodent, Ellman) and a periodontal dressing (Barricaid, Dentsply/ Caulk) were applied.

The patient was seen at 2, 4, 8, and 12 weeks postoperative for routine postoperative care. The healing was uneventful. There was complete root coverage of the right central incisor and a slight augmentation of the edentulous ridge at the lateral incisor. In the area of the original defect there was a 1-mm probing depth, no bleeding on probing, and 4 mm of keratinized tissue. There was a groove in the soft tissue on the buccal aspect of the central incisor and the edentulous space at the lateral incisor. At 12 weeks postoperative the patient developed pain that seemed to be of pulpal origin. Endodontic therapy was accomplished, but the pain continued. With time the pain seemed to mimic that of a cracked tooth. At 5 months postoperative (Fig 5), the decision was made to extract the central incisor. Clinically, there was no periodontal change between the 12-week and 5-month evaluations. The patient did not desire additional surgery or therapy to attempt to save the tooth.

With the patient's consent a small collar of tissue was removed in the area of the original defect. After obtaining anesthesia, the collar was outlined with a scalpel. With a high-speed bur the outline was continued into the tooth. The tooth and the small collar of tissue were gently extracted with elevators. A vertical fracture was found on the palatal surface. The tooth was placed in 10% formalin, decalcified, serial sectioned at 7- to 8-μm intervals, and stained with hematoxylin-eosin. The sections from the deepest portion of the recession defect were evaluated. The extraction site was grafted with a xenograft (Bio-Oss, Osteohealth) to preserve and augment the ridge at the time of the extraction. Later, the area was treated with a frenectomy and an acellular dermal matrix (AlloDerm, Lifecore) to improve the soft tissue contour. The healing was uneventful.

A 4-unit fixed bridge was placed by the patient's general dentist from the right canine to the left central incisor.
Histologic evaluation

At the time of the root coverage surgery it was not known that the tooth was going to be extracted. Therefore, no reference notches were placed. However, the root planing was aggressive and was completed prior to the elevation of a flap. Therefore, the terminal edge of the root planing could be used as a histologic marker for the original gingival margin. A representative section from the area of the original defect is shown in Figs 6 to 12.

Figure 6 shows the gingival margin area, where there was an invagination of the epithelium that extended into the connective tissue at about the midpoint of the tissue. The junctional epithelium adjacent to the tooth extended the entire distance shown in Fig 6. The view in Fig 7 continues further apically and includes the apical extent of the junctional epithelium and epithelial invagination. Connective tissue could be observed inserting into cementum and dentin. The apical extent of this view showed areas where resorption of the root had occurred. Figure 8 shows a 160× magnification of the resorption that can be seen in the apical portion of Fig 7. Figure 9 shows the area apical to Fig 7, starting at the resorptive area in the apical portion of that view. The coronal aspect of the bone is shown. Additional resorptive areas can be seen in the root. Some of these seemed to be filled with new cementum. The connective tissue fibers inserted into the cementum, dentin, and bone. The bone is discontinuous in this view, but more bone was apparent in the apical extent of this view. The terminal edge of the root planing was visible. Figure 10 shows a higher magnification (100×) of the coronal bone and...
Fig 6. Gingival margin area. i = epithelium invagination. (Original magnification × 40; hematoxylin-eosin stain.)

Fig 7 (left). Area apical to that shown in Fig 6. i = epithelium invagination; e = apical extent of junctional epithelium; r = root resorption. (Original magnification × 40; hematoxylin-eosin stain.)

Fig 8 (right). Root resorption in apical portion of area shown in Fig 7. r = root resorption. (Original magnification × 160; hematoxylin-eosin stain.)

Fig 9 (left). Area apical to that shown in Fig 7. 1 = coronal bone; 2 = apical bone; c = new cementum; r = root resorption; t = terminal edge of root planing. (Original magnification × 40; hematoxylin-eosin stain.)

Fig 10 (right). Coronal bone (1) and root shown in Fig 9. c = new cementum; t = terminal edge of root planing. (Original magnification × 100; hematoxylin-eosin stain.)
root. Cells could be seen in the lacunae of the bone. New cementum was on the root adjacent to the bone. Fibers inserted into the bone and the cementum. The terminal edge of the root planing was visible. Figure 11 shows a 160x magnification of the bone seen in Figs 9 and 10. The cells in the lacunae were apparent and therefore it can be assumed that the bone was vital. Figure 12 is a higher magnification of the root surface adjacent to the bone in Figs 9 to 11; connective tissue fibers could be seen inserting into the new cementum.

Discussion

The results of this case report support the theory that a root coverage procedure with a subepithelial graft may produce regeneration. New bone, cementum, and connective tissue could be seen coronal to the presumed location of the original gingival margin. This is unquestionably apparent in Figs 9 and 10. The regeneration in this case occurred without bone grafts or GTR membranes. However, there are areas where the results would best be classified as repair.

It is unfortunate from an academic standpoint that there were no reference notches. However, the terminal edge of the root planing served as an acceptable reference point for the original gingival margin. The terminal edge of the root planing could not have been used if the root planing had been accomplished after the pedicle was elevated.

The most obvious problem with this study is the lack of reference notches. However, this was impossible to control because when the defect was treated it was assumed that the tooth was
going to be retained. It is possible that the root planing may have extended slightly below the gingival margin. However, the distance instrumented must be minimal and less than the preoperative probing depth of 1 mm. Since the exposed root surface was instrumented predominately with large instruments, such as back-action chisels and large curettes and no rotary, sonic, or ultrasonic instruments, it is highly unlikely that the subgingival area was instrumented significantly during the surgery. Another possibility for the marks on the root surface could have been a previous periodontal procedure such as scaling and root planing or periodontal surgery. However, this is not possible in the present case because the patient had never had periodontal therapy in the area. Certainly, the terminal edges of the root planing do not provide an exact location of the gingival margin; only a reference notch would do that.

It is a shame that the bone shown in Fig 9 is discontinuous. This probably occurred during processing. If one could evaluate the area between the coronal and apical bone a great deal of information could be obtained. The coronal bone seemed to be woven and therefore would be new bone, while the more apical bone had reversal lines and was probably more mature bone. It seems highly unlikely that such mature bone would form coronal to the gingival margin in just 5 months. However, since it is unknown what the healing dynamics are after a subepithelial graft, no possibilities should be overlooked or excluded. Additional study in this area is needed.

The results of this case report are significantly better than a previous case report by the author that evaluated a connective tissue graft with a partial thickness-double pedicle graft. In that study there was no evidence of regeneration, while in the present study there was significant regeneration. One reason might be that the defect was deeper in the present case report; possibly the greater recession depth provided a greater opportunity for regeneration. Additionally, patient factors such as compliance and oral hygiene were better in the present case. This occurred because it was assumed that the tooth in the present study was not going to be lost. In fact, the tooth evaluated in this study was scheduled to be a fixed bridge abutment. In the previous study it was known that the tooth was going to be extracted and oral hygiene and compliance were not ideal.

The present study compares well with previous GTR root coverage histologic case reports. All of those studies, as well as this one, produced new bone, new cementum, and new connective tissue attachment. The present study also compares well with Pasquinelli's case report. In both that study and the present study the teeth evaluated were not scheduled to be extracted. Therefore, they both probably had higher oral hygiene and patient compliance levels. In the Pasquinelli study 4.0 mm of new bone was reported. However, this was based on biologic width assumptions. In the present study the exact amount of bone that was formed was unknown.

There are certainly other options available to achieve root coverage. High rates of root coverage (more than 97% mean root coverage) have been demonstrated with pedicle grafts by Allen and Miller, Harris and Harris, and Wennstrom and Zucchelli. Additionally, Sugarman and Common and McFall have shown new connective tissue attachment with laterally positioned pedicles in humans. It is possible that a similar result may have been possible with simply a pedicle graft. However, it has been suggested that pedicle grafts should be generally used in the treatment of shallow recession defects. That, and the fact that ridge augmentation of the maxillary right lateral incisor area was desired, is the reason a connective tissue graft was used in this case.

The clinical finding of the groove on the buccal surface correlates well with the histologic findings. The invagination of the epithelium was in the same location as the clinical groove. The cause of this is unknown. Similar findings were not reported in any of the other studies discussed in

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this case report. One possible reason the groove may have developed is that the connective tissue graft may have had a barrier function and stopped the epithelium from migrating down the side of the tooth. The epithelium may have migrated on the buccal surface of the connective tissue graft. Conversely, the connective tissue graft may have served no barrier function and the epithelium may have simply migrated down both sides of the connective tissue graft. Another possibility could be that remnants of epithelium that were not removed when the epithelial border was removed may have been in the connective tissue graft. Figure 3 shows that epithelium was probably remaining in the graft. The epithelium may have survived and grown, expanding until it was continuous with the external layer of epithelium. Additionally, other possibilities may have caused the groove. Further study will be required to determine the etiology of the groove.

It is well known that subepithelial grafts can be an effective method to obtain root coverage. However, little is known about the type of attachment that these procedures produce. Additional human block sections will be needed to determine the amount of regeneration that occurs, how often regeneration occurs, and what factors affect regeneration. The value or lack of value of tetracycline treatment of the root surface will need to be addressed. Additionally, the question of whether a couple of millimeters of regeneration on the buccal surface of a tooth is even important will need to be answered. Does the regeneration on the buccal surface improve the stability of the result? Does it improve the long-term prognosis? However, the answers to these questions were not the intent of this case report. The goal of this report was to evaluate histologically a successful root coverage result. Based on this evaluation, regeneration is possible when a connective tissue graft is combined with an overlying pedicle graft to achieve root coverage.

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