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An Epithelial Exclusion Technique Using the CO_2 Laser for the Treatment of Periodontal Defects

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Abstract: *When treating osseous defects associated with periodontitis, the healed result is a compromised regeneration of the attachment apparatus from epithelial downgrowth. This article demonstrates a laser ablation technique for excluding the epithelium from contacting the root surface of the periodontal wound. In accordance with the principles of guided tissue regeneration, the epithelium should be excluded for at least 30 days after surgical therapy. A series of case reports demonstrate the technique and the 6-month results that can be obtained using this approach. The regenerated tissue is confirmed through reentry procedures and radiographs.*

The result of conventional periodontal treatment is often healing of a long junctional epithelium along the root surface and little regeneration of the complete attachment apparatus. Nyman et al[1] and Gottlow et al[2] have shown the ability to predictably obtain periodontal regeneration in animals and humans, provided that epithelium and gingival connective tissue can be excluded from the treated root surface using a semipermeable membrane.

This concept of guided tissue regeneration (GTR), first speculated by Melcher,[3] allows cells emerging from the periodontal ligament and alveolar bone to repopulate that root surface. However, the ability to retard epithelial downgrowth from the mucoperiosteal flap is still a significant variable in treatment. Healing studies have shown that conventional therapy, including GTR, does not exclude all the epithelium.[4] Pritlove-Carson et al[5] demonstrated the importance of epithelial exclusion in GTR therapy because most of the tissue samples (seven of nine) they studied at membrane retrieval indicated the presence of epithelium. They speculated on the importance of early membrane exposure that can allow for more epithelial downgrowth into the newly formed granulation tissue.

Rossmann et al[6] showed that the carbon dioxide (CO_2) laser will precisely and effectively remove epithelium from the gingiva without causing underlying damage to the connective tissue. In further preliminary studies, they have shown its ability to retard epithelial downgrowth after periodontal surgery for up to 14 days.[7]

The delayed epithelialization found in CO_2 laser wounds from previous studies results from a combination of events: (1) the laser wound margins show thermal necrosis and formation of a firm eschar that impedes epithelial migration[8]; (2) the decrease in wound contraction as a result of fewer myofibroblasts, compared to scalpel wounds, leaves a greater surface area remaining to be epithelialized[9]; (3) the thin layer of denatured collagen found on the surface of the laser wound acts as an impermeable dressing in the immediate postoperative period, which reduces the degree of tissue irritation from oral contents[10]; and (4) reduced inflammation in the laser-induced wound can provide less stimulus for epithelial migration.[11]

Israel et al[12] applied the concept of laser de-epithelialization to periodontal surgical procedures in humans. His histologic study revealed the ability to produce a connective tissue attachment on new cementum to a previously infected root surface coronal to the alveolar bone. This method of blocking epithelial downgrowth during the healing phase of surgery would benefit all regenerative procedures whether or not a barrier membrane was used, as found recently by Rossmann et al.[13] Another factor of this laser de-epithelialization technique is the ease of accomplishing complete removal of the epithelium, and the lack of damage to the underlying mucoperiosteal flap during surgery and throughout the healing phase.

The following case reports illustrate the results that can be obtained by using the laser de-epithelialization technique in conjunction with osseous grafting using demineralized freeze-dried bone allografts (DFDBA). The patients were selected from a private practice setting, and the specific technique for laser de-epithelialization will be explained in this article.

Figure 1A—Initial periodontal condition of tooth No. 29 showing probing depths of 12 mm.

Figure 1B—Radiograph at initial presentation of tooth No. 29.

Figure 1C—Facial view of tooth No. 29 showing laser de-epithelialization of gingiva to the mucogingival junction. This was also performed on the lingual gingiva.

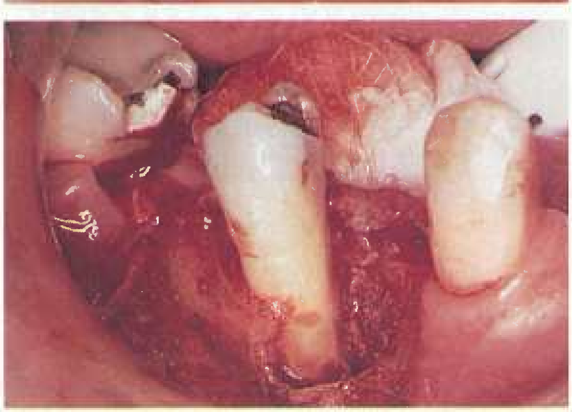

Figure 1D—Osseous defect associated with tooth No. 29. An allograft was placed into the defect.

Case Reports

Case 1

A 45-year-old man presented for periodontal treatment of an intrabony defect on the mesial of tooth No. 29 (Figure 1A). Periapical radiographs exhibited a deep two- to three-wall vertical bony defect (Figure 1B). The patient's medical history was noncontributory.

Local anesthesia, using 2% xylocaine with 1:100,000 epinephrine, was administered to the patient; for hemorrhage control, local infiltration with 1:50,000 epinephrine was given. Before reflection of a mucoperiosteal flap, a de-epithelialization using the CO_2 laser was performed on the outer aspect of the gingiva extending from the free gingival margin to the mucogingival junction on both the buccal and lingual sides (Figure 1C). A power setting of 8 W was used in a pulsed mode with a repetition rate of 20 times per second at an exposure of 20 Msec. An 0.8 mm spot size in a focused mode was used to remove all visible epithelium from the outer aspect of the gingiva. The resultant char layer was totally removed with moist gauze.

After the laser de-epithelialization, a reverse bevel incision was made, extending one tooth laterally from the surgical site, along with a vertical-releasing incision one tooth mesial to the bony defect. An effort was made at the time of the initial incision to remove the crevicular epithelium. A facial and lingual full-thickness mucoperiosteal flap was reflected, and all granulation tissue was removed to expose the intrabony defect (Figure 1D). The roots were then planed using hand instruments and a rotary carbide finishing bur and treated with a saturated tetracycline solution in an attempt to achieve root biomodification. A laser de-epithelialization, as previously described, was performed on the inner aspect of the flap. Care was taken to avoid any laser contact to the root surface or the alveolar bone by placing a periosteal retractor between the hard and soft tissue and aiming the beam at a 90-degree angle to the flap.

Figure 1E—Ten days postsurgery, after the second de-epithelialization procedure by laser has been performed.

Figure 1F—Six-month postsurgery view showing probing depth of 3 mm at tooth No. 29.

Figure 1G—Reentry procedure performed at 6 months to demonstrate osseous fill of the original defect.

Figure 1H—Radiograph taken at 8 months postsurgery showing osseous changes.

DFDBA mixed with tetracycline in a 5:1 ratio was placed in the defect before closure of the flap. The flaps were readapted, and primary closure was obtained. The patient was placed on tetracycline 250 mg 4 times a day for 7 days after the surgery.

The patient was seen 10 days postoperatively for suture removal. A laser de-epithelialization procedure was again performed on the outer gingival surface, as described previously, using topical anesthesia (Figure 1E). The patient was then seen at 20 days and 30 days postsurgery for a repeat of the laser de-epithelialization procedure to the outer gingival surface.

The patient was followed monthly over the next 6 months, at which time a reentry procedure was performed. A radiograph was also taken for documentation purposes. This procedure was done after obtaining the patient's informed consent. Significant osseous fill was noted on the mesial and labial surfaces when compared to the original defect (Figures 1F through 1H). It was also noted that 1 mm to 2 mm of gingival recession on the buccal surface of tooth No. 29 had occurred during this healing period.

Case 2

A 47-year-old woman presented with a periodontal defect associated with tooth No. 24. She had a negative medical history. Before periodontal treatment, the tooth tested positive for vitality, and a surgical procedure was performed in the same manner as described in Case 1. The defect presented as a one-walled intrabony lesion with an osseous dehiscence on the labial surface (Figures 2A and 2B). After thorough debridement and root preparation, an osseous graft was placed using DFDBA (Figure 2C). The de-epithelialization technique was applied on the day of surgery and 10, 20, and 30 days after surgery.

After 6 months of supportive therapy, the area was reentered to document the results of the treatment. At this time, a radiograph was made to verify the osseous fill before reentry. The clinical attachment gain and bone fill are seen in Figures 2D and 2E.

Figure 2A—Pretreatment condition of tooth No. 24 showing probing depth of 7 mm.

Figure 2B—Osseous defect and dehiscence associated with tooth No. 24.

Figure 2C—Tooth No. 24 treated with DFDBA.

Figure 2D—Six-month postsurgery view showing probing depth of 2 mm at tooth No. 24.

Figure 2E—Reentry procedure at 6 months to visualize osseous changes.

Case 3

A 64-year-old woman presented with a periodontal lesion at tooth No. 31 (Figures 3A and 3B). A laser de-epithelialization, in conjunction with osseous surgery and placement of DFDBA into the intrabony defect, was performed (Figure 3C). The area was reentered at 6 months for clinical documentation (Figures 3D and 3E). Another radiograph was taken 3 years after treatment, and it shows the osseous fill obtained in this area (Figure 3F).

Discussion

The rationale for laser de-epithelialization stems from the attempt to block the downgrowth of epithelium into the healing periodontal wound after surgery, and thus prevent formation of a long junctional epithelial attachment. Numerous techniques have been used to accomplish the blockage of epithelium.[14-17] The advent of GTR was an offshoot of this concept and led Gottlow to examine the effects of selectively blocking certain cell types from contacting the root surface during periodontal wound healing.[2] The use of a CO_2 laser to de-epithelialize the gingival flaps is an attempt to exclude this cell type from the healing wound and has been used with and without the benefit of GTR membranes.[13] In the Rossman et al[13] study on beagle dogs, the histologic results of using membranes and the laser procedure enhanced the wound healing and regeneration of new bone, cementum, and connective tissue attachment when compared to paired defects using the membranes alone. The results from the present case reports, combined with the animal studies, would indicate a positive benefit in wound healing as a result of the laser de-epithelialization technique.

The use of an osseous graft in treatment of the periodontal defects has been shown to

Figure 3A—Preoperative condition of tooth No. 31 showing 8-mm probing depth.

Figure 3B—Radiograph taken at initial presentation of tooth No. 31.

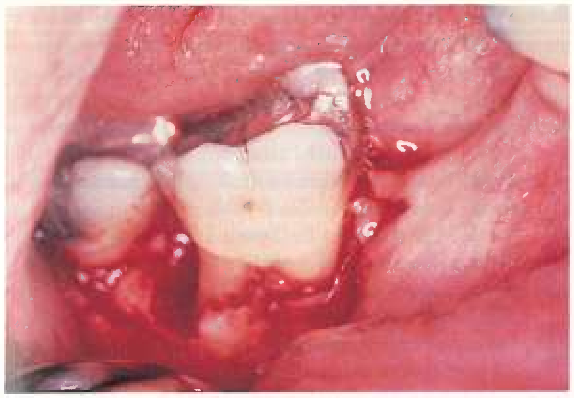

Figure 3C—Osseous defect associated with the distal of tooth No. 31.

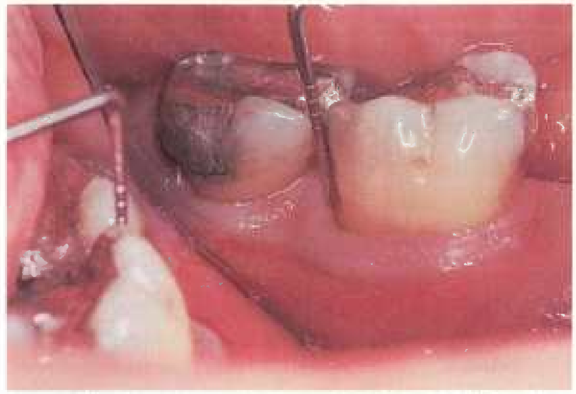

Figure 3D—Six-month postsurgery view showing probing depth of 2 mm.

Figure 3E—Reentry procedure at 6 months demonstrating osseous fill at tooth No. 31.

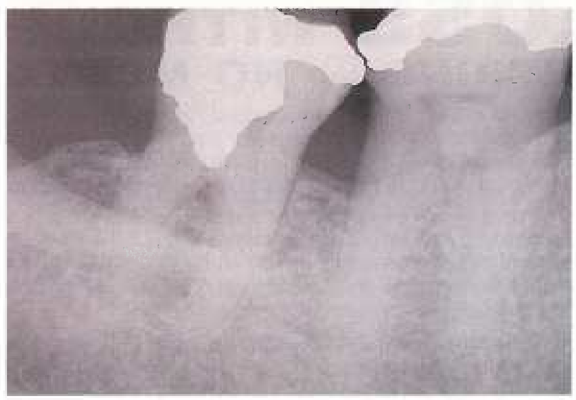

Figure 3F—Radiograph taken 3 years after treatment of tooth No. 31.

effectively stimulate new bone growth and regenerate new attachment.[18,19] Recently, it has been speculated that the additional benefit of an osseous graft in GTR procedures is the organization of the blood clot at initial healing, which may tend to maintain the space needed for regeneration and provide a matrix for the fibrin clot to retard epithelial downgrowth. Studies comparing the results of osseous grafting to flap debridement have consistently shown that the amount of new bone formation and clinical new attachment favors the grafted sites vs paired nongrafted sites.[20-23]

The effect of removal of the pocket epithelium at the time of periodontal surgery has been studied by several authors and generally shows an incomplete removal of the sulcular epithelium by the inverse bevel incision.[24-26] This was recently studied by Centty et al,[27] who compared the removal of sulcular epithelium by the CO_2 laser technique (as described in this article) to conventional methods. Their results confirm that: (1) a more complete removal of sulcular epithelium was obtained by laser than by knives; and (2) that the technique will effectively remove the oral and sulcular epithelium from a gingival flap without damaging the viability of the flap during wound healing. The technique described in this article was used by Israel et al[12] to verify the ability to maintain a viable gingival flap during multiple laser de-epithelialization procedures in humans during the first 30 days of healing.

These case reports have shown the ability to obtain clinical new attachment with bone fill in previously diseased sites. The concept of laser de-epithelialization as an adjunct to regenerative periodontal procedures is currently being studied in a multicentered university setting using a parallel study in controlled clinical trials. The authors believe that this technique has shown significantly better results than those obtained through conventional osseous grafting alone and appears to be comparable to the results reported for GTR procedures with barrier membranes.

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