Use Of The CO_2 Laser In Soft Tissue And Periodontal Surgery

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The use of laser energy is by now established in some areas of the medical and dental professions. This article reviews the history of the carbon dioxide laser and discusses the advantages, indications, and contraindications of laser in soft tissue and periodontal surgery. Four clinical cases are presented to illustrate laser techniques in excisional biopsy, gingivectomy, coagulation of graft donor site, and a frenectomy procedure. The learning objective of this article is to familiarize the reader with this relatively new addition to oral surgical procedures.

The carbon dioxide laser was developed approximately thirty years ago in the AT&T Bell Telephone Laboratories. Its utilization in the medical specialties of gynecology, otolaryngology, and dermatology has been well documented in the medical literature since 1976.[1-3] One drawback of the early CO_2 lasers was the inability of the bulky, articulated arm-delivery system to transmit energy along optical fiber. The technological development of the flexible waveguide allowed the operator to perform surgical procedures within the oral cavity with greater ease.[4]

SOFT TISSUE LASER SURGERY

The utilization of carbon dioxide laser in removal of lesions on the buccal mucosa, tongue, and lip has been described in a case report in literature,[5] as has been its use in soft tissue periodontal surgery.[6,7] The major advantage of the CO_2 laser is its wave length of 10.6 microns which is quickly absorbed in a water environment. The soft tissues of the oral cavity have a greater than 90% water content; when the tissue is exposed to a CO_2 laser beam, very little transmission to the adjoining nontarget areas, scattering, or reflection occurs. These important qualities allow the beam to penetrate to a maximum depth of 0.2 mm with minimum damage to the surrounding tissue, permitting the operator precise control in coagulation, vaporization, and cutting.[8] As a result, the CO_2 laser is recognized today as an effective adjunct in soft tissue surgery in the oral cavity. The laser should be viewed not as a replacement but an addition to the present armamentarium.

The possible advantages of the carbon dioxide laser as an instrument in certain periodontal surgical procedures include:

- Control of surgical and postsurgical bleeding.
- Less adjacent tissue damage.
- Reduced postoperative edema.
- Decreased or eliminated wound contraction and scarring.
- Decreased postsurgical pain.
- Better access to some surgical areas.

Indications

The indications of laser use in soft tissue surgery include the following procedures:

- Gingivectomy
- Gingivoplasty
- Frenectomy
- Deepithelialization
- Distal wedges

Figure 1. Case 1. Preoperative view of the raised white nodular lesion in the mandibular area.

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- Coagulation of graft donor sites
- Removal of papillomas
- Treatment of:
  - Fibromas
  - Pyogenic granulomas
  - Lichen planus
  - Keratic lesions
  - Inflammatory papillary hyperplasias
  - Hemorrhagic disorders in dental patients

Contraindications

Laser surgery is contraindicated in the following cases:

- If access to underlying bony defects is necessary (ie, osseous flap surgery). Since the CO_2 laser energy is not readily absorbed by bone, the laser is unable to cut bone efficiently and, therefore, is of minimum use in osseous surgery.
- In procurement of free gingival graft and preparation of recipient site. Since the laser seals off blood vessels for the first 3 days postoperatively, it could jeopardize the initial vascularization of a free gingival graft.
- In soft tissue pocketing where there is a minimum band of attached keratinized gingiva. If a gingivectomy/gingivoplasty is to be performed, the potential for creating a mucogingival involvement is present.

CLINICAL CASES

CASE 1

Clinical History

A 55-year-old healthy white female presented with a white nodule-type lesion approximately 3 mm in diameter in the lower left buccal mucosa (Figure 1). The lesion had been present for several years without a significant increase in dimension. The medical history was noncontributory; the patient was taking two medications — a diuretic for elevated blood pressure and synthroid for hypothyroidism.

Clinical Procedure

An excisional biopsy was taken of the lesion, including a surrounding margin of healthy tissue, using CO_2 laser:

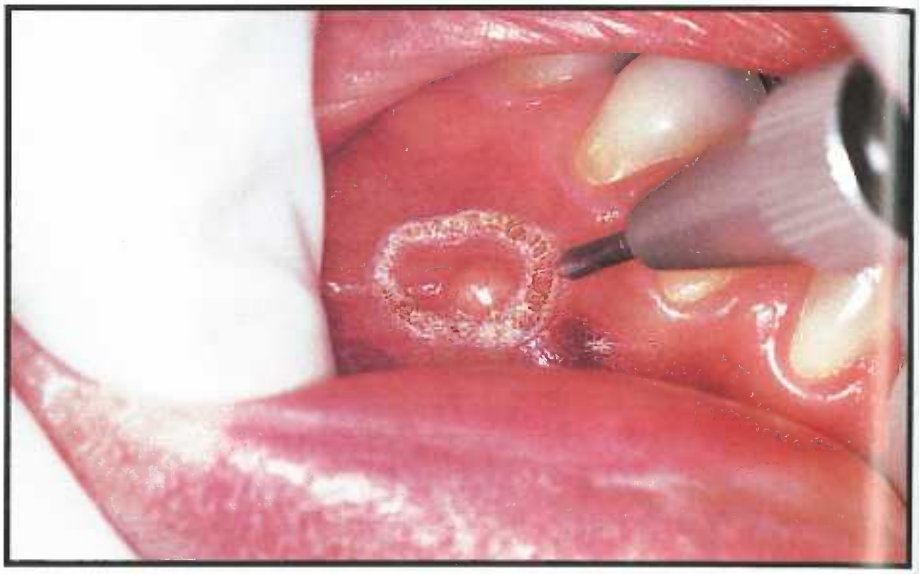

Figure 2. Laser is used to outline the lesion, including an adequate border of healthy tissue.

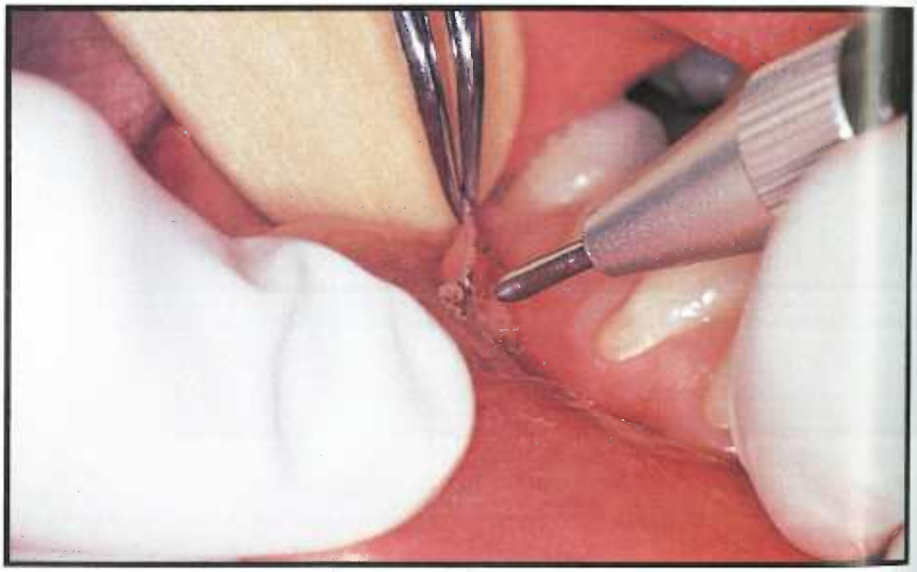

Figure 3. The lesion is laser-excised, using a traction-countertraction technique.

Figure 4. A char layer is placed, in a defocused mode.

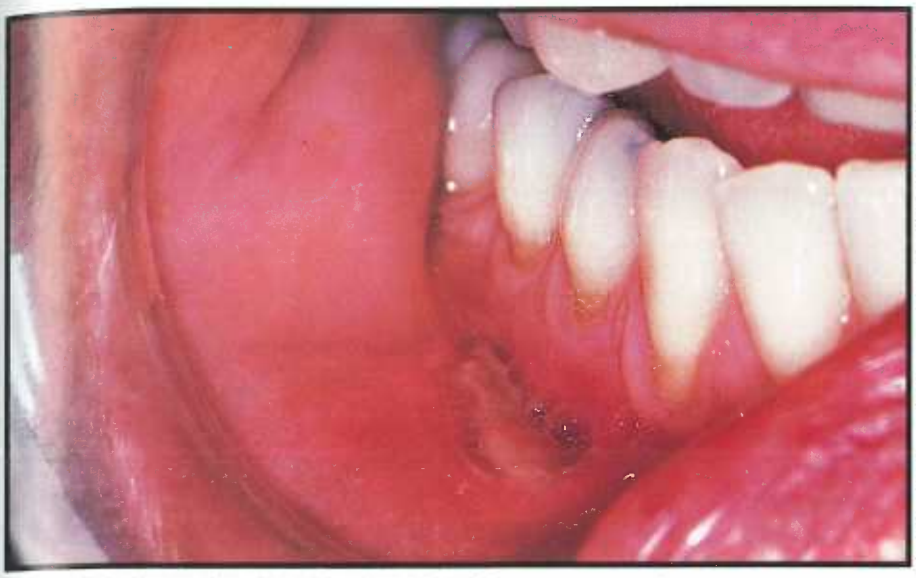

Figure 5. Postoperative view of healing at 1 week.

Figure 6. View of completed healing at 4 weeks postoperatively.

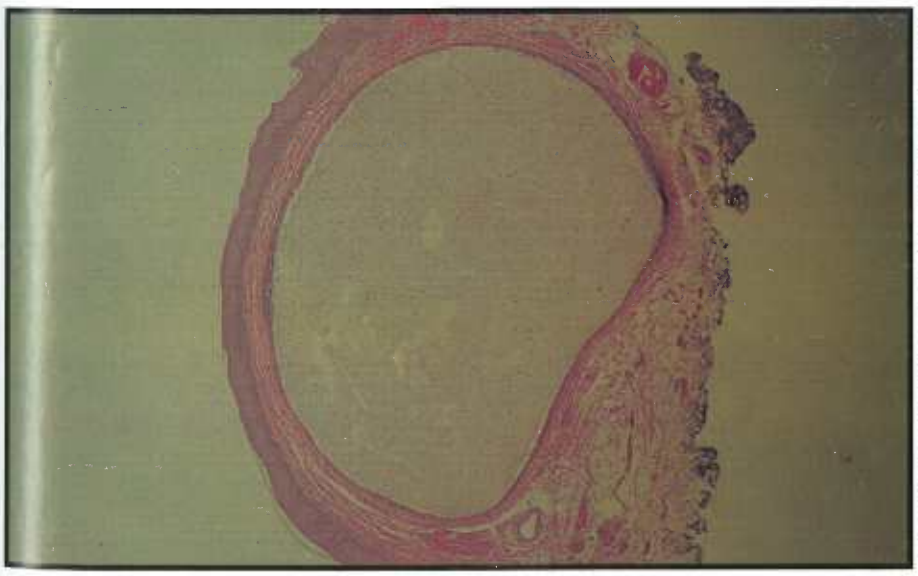

Figure 7. Histopathologic specimen, showing removal of the mucocele in toto with a clean boundary of healthy tissue.

- A local anesthetic was administered in the mucobuccal fold region in close proximity to the lesion.
- The CO_2 laser was used at 5-watt pulsed cutting mode (20 milliseconds exposure at a repetition rate of 20 times per second) with a .35 mm diameter tip.
- The area to be dissected was first outlined with the laser (Figure 2).
- Using the traction-countertraction technique, the lesion was excised (Figure 3).
- A char layer was placed, using the 4-watt continuous defocused mode, to act as a dressing for the exposed wound (Figure 4).
- The patient was evaluated postoperatively at 1 week and again at 4 weeks (Figures 5 and 6).
- The specimen was fixed in formalin and sent for histopathologic examination.

Pathology

The specimen revealed a mucosal wedge with mild parakeratosis and acanthosis of surface epithelium; maturation was essentially normal. The underlying tissue revealed the presence of a circumscribed cavity, producing an elevation of the mucosa (Figure 7). The cavity was filled with an eosinophilic coagulum, containing mainly leukocytes and mononuclear phagocytes. This appeared to be consistent with a diagnosis of a retention cyst (mucocele).

Discussion

Mucoceles are commonly occurring lesions of the oral mucous membrane and are the most common lesion involving minor salivary glands. They are usually the result of trauma to the mucosa, with the majority located on the lower lip.[9] Even though these lesions have a distinctive clinical appearance, they must be differentiated microscopically from benign and malignant neoplasms which closely resemble them.

The laser offers some distinctive advantages in the excisional biopsy technique over conventional methods:

- Reduced operating time.
- No suturing is generally required.
- Less wound contraction and scarring.
- Reduced bleeding in vascular sites (ie, lip, cheek, mucosa, and tongue).
- Less postsurgical discomfort.

CASE 2

Clinical History

A 30-year-old female was referred for periodontal therapy. Initial therapy was instituted, comprising root planing and oral physiotherapy instruction. Upon clinical reevaluation, soft tissue pocket depths, ranging from 4 to 6 mm, were found on teeth #11 to #15 (Figure 8). Radiographic examination and clinical probing revealed no underlying osseous involvement, and an adequate zone of attached gingiva was present.

Clinical Procedure

A laser gingivectomy and gingivoplasty were performed to reduce the soft tissue pocketing and achieve proper gingival architecture:

- Local infiltration anesthesia was given for patient comfort and management.
- The CO_2 laser was used in a 5-watt continuous mode, in focussed and defocussed mode, to vaporize the tissue and achieve the desired gingival height and contour.
- When working interproximally or near the teeth, the laser was used in pulsed mode (20 millisecond exposure at a repetition rate of 20 times per second).
- A periosteal elevator or #7 wax spatula was placed between the tooth and the gingival margin for protection against accidental exposure to the laser beam.
- At the end of the procedure, a char layer was placed, using 4 watts in a continuous defocused mode (Figure 9).
- The patient was seen at 2 and 4 weeks postsurgically (Figures 10 and 11).

Figure 8. Case 2. Preoperative view of maxillary site prior to gingivectomy and gingivoplasty.

Figure 9. Immediate postoperative view of gingivectomy and gingivoplasty with char layer in place. Bleeding occurred during root planing with a curette.

Figure 10. Postoperative view at 2 weeks after completed laser procedure.

Figure 11. Postoperative view at 4 weeks exhibits complete healing with proper gingival architecture. Note tissue health.

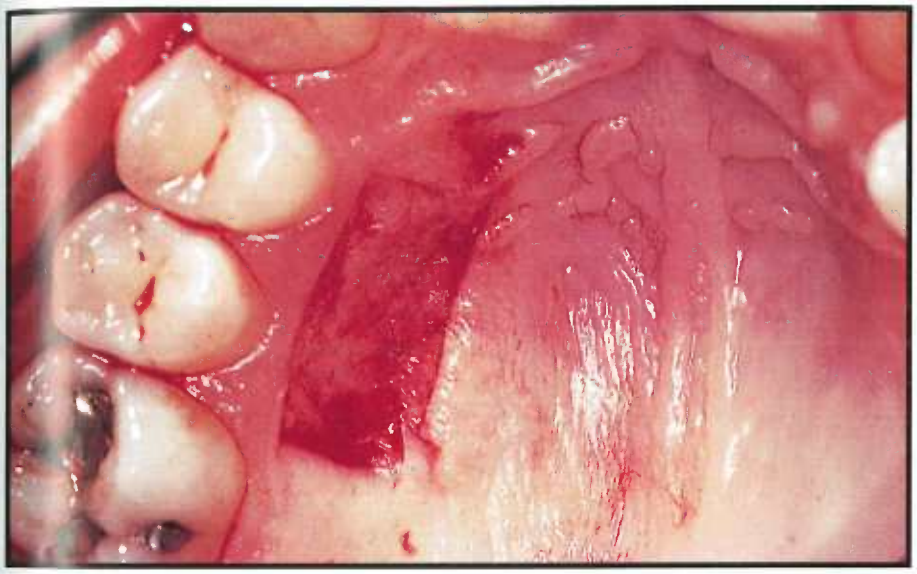

Figure 12. Case 3. View of the free gingival graft donor site following dissection.

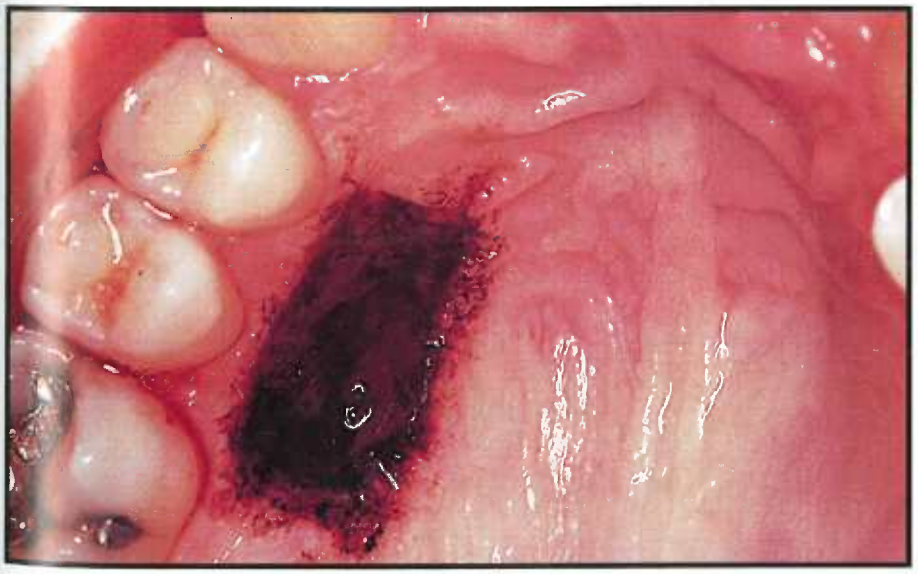

Figure 13. View of char layer placed on the free gingival graft donor site using the laser procedure.

Discussion

There still exists a lack of larger controlled studies to provide scientific documentation. However, drawn from the author's experience and observations, some of the advantages of the laser gingivectomy, as compared to conventional gingivectomy procedures, are listed:

- Bloodless operating field due to the coagulating effect of the CO_2 laser on vessels less than 1 mm in diameter.
- Better access in areas such as distal of second and third molars.
- Less postoperative discomfort.
- Even though there is virtually no swelling in conventional gingivectomy, the chances even for that are reduced, as a result of the "sealing" effect on the local lymphatic vessels.

One of the disadvantages of using the laser in this procedure is the slower healing that occurs within the first week. This is attributed to the delayed migration of the epithelium on the surface of the wound.[10]

CASE 3

Clinical History

A 37-year-old white female was referred for a mucogingival procedure. Periodontal examination revealed a localized area of gingival recession on the buccal aspect of tooth #22 with a lack of attached keratinized gingival zone.

Clinical Procedure

A coronally positioned free gingival graft was placed on the buccal aspect of tooth #22;[11] (the graft donor site was coagulated with the CO_2 laser):

- Using a #15 blade, two horizontal incisions were made at the interproximal papillae of the recipient site to create a margin against which the graft could be abutted. Vertical incisions were made at the line angle of the adjacent teeth, and a split thickness dissection was performed.
- An outline of the graft was made with a blade at the donor site on the palate, and the graft was subsequently removed by sharp dissection (Figure 12).

- The graft was placed on the recipient bed and sutured in place using 5-0 silk.
- Hemostasis was accomplished using moistened gauze packs on the donor site.
- The laser procedure involved the use of a 4-watt continuous mode with a ceramic .8 mm tip to place a char layer. This was accomplished by applying a defocused beam (4 to 6 mm from the target tissue) to the exposed wound in a sweeping back and forth motion from the periphery of the donor site to the center (Figure 13).
- Postoperative healing was evaluated at 2 and 4 weeks following the surgical procedure (Figures 14 and 15).

Discussion

In the classic approach, the free gingival graft donor site is sometimes covered with a COE-pak, but retention is often a problem. Another technique involves the fabrication of a stent to cover the donor site; this creates an added expense and discomfort for the patient. In contrast, the laser has the following advantages:

- The char layer acts as a dressing and reduces postoperative discomfort for the first 3 days.
- Hemostasis is maintained following the surgical procedure at the donor site.

CASE 4

Clinical History

A 13-year-old child was referred by orthodontist for evaluation of prominent frenulum (Figure 16). The patient had been in active orthodontic therapy for 2 years and was approaching completion of treatment.

Clinical Procedure

A frenectomy was performed on the labial frenum between teeth #8 and #9, in conjunction with a gingivoplasty to achieve proper gingival contour interproximally:[12]

- A small amount of local anesthetic was infiltrated into the mucobuccal fold area in proximity to the frenulum.

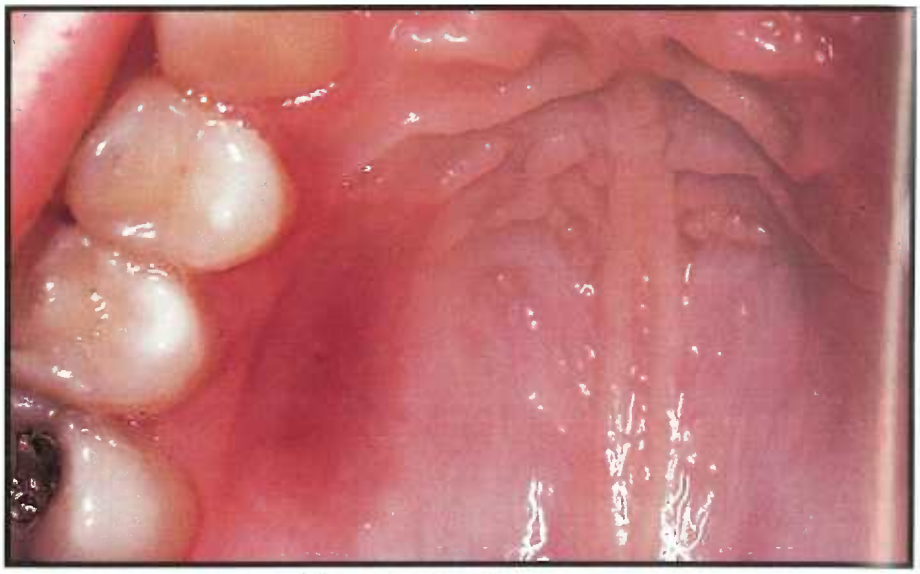

Figure 14. Healing of the recipient site at 2 weeks postoperatively.

Figure 15. Complete epithelialization of wound site at 4 weeks postoperatively.

Figure 16. Case 4. Preoperative facial view of aberrant maxillary frenulum present on the labial between teeth #8 and #9.

Figure 17. Immediately postoperative view of completed laser frenectomy with placement of char layer.

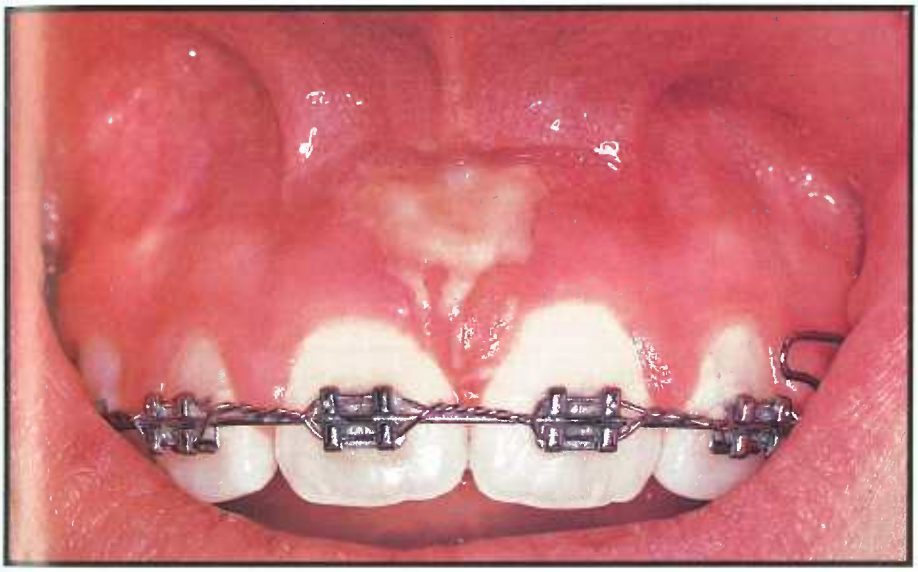

Figure 18. Facial view of the progress of healing at 1 week postoperatively.

Figure 19. Completed healing of laser frenectomy 1 month postoperatively. Note tissue health.

- The laser was used in the 5-watt continuous mode, in a focused and defocused manner, to incise and vaporize the frenum.
- A gingivoplasty was performed interproximally, using 7-watt pulsed mode (20 millisecond exposure at a repetition rate of 20 times per second).
- At the completion of the procedure, a char layer was placed using a 4-watt continuous defocused mode (Figure 17).
- The patient experienced minimal discomfort postoperatively and was seen at 1 and 4 weeks for evaluation (Figures 18 and 19).

Discussion

Some of the advantages of the CO_2 laser in this procedure are as follows:

- No suturing.
- Less operating time; the procedure can be performed in 5 to 10 minutes.
- Bloodless field.
- Significantly reduced postsurgical discomfort.

One of the drawbacks of using the laser is the slower clinical healing evident the first week postoperatively, but at 3 to 4 weeks the difference in comparison to conventional techniques becomes minimal.

CONCLUSION

Four cases have been presented where the carbon dioxide laser was used in soft tissue periodontal surgery. It is important to note that the laser should be viewed as an addition to the present armamentarium, not as a replacement for the established surgical techniques. In the future of periodontics, the use of the laser may offer some exciting possibilities, such as root conditioning, guided tissue regeneration, connective tissue attachment,[13,14] and sterilization of pockets. However, these procedures should be pursued only after substantial scientific research and documentation.

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PRACTICAL PERIODONTICS & AESTHETIC DENTISTRY

The 10 multiple choice questions for this exercise are based on the article "Use of the CO_2 laser in soft tissue and periodontal surgery" by Michael Israel, DDS. This article is on Pages 57-63. Answers for this exercise will be published in the September, 1994, issue of *PP&A*.

Self-Instruction Exercise No. 67

LEARNING OBJECTIVES:

The purpose of this exercise is to demonstrate the use of the CO_2 laser in soft tissue and periodontal surgery. At the conclusion of this exercise, the clinician will have a better understanding of the following:

- The limitations and benefits of the carbon dioxide laser in periodontal surgery.
- The interaction relationship between laser and soft tissue.

1. Prior to the development of the flexible wave guide, the 10.6 micron CO_2 laser beam was transmitted by:
   a. Fiberoptics.
   b. An articulated arm mirror delivery.
   c. A HeNe aiming beam.
   d. All of the above.

2. The 10.6 micron wavelength gives the CO_2 laser the following properties when used on soft tissue:
   a. Minimal scattering, transmission, and reflection.
   b. High absorption by water.
   c. A penetration depth of 0.2 mm.
   d. All of the above.

3. Advantage(s) of the carbon dioxide laser is/are:
   a. A precise coagulation of deep blood vessels.
   b. Surface absorption in soft tissue.
   c. A precise cutting ability with minimum damage to surrounding tissue.
   d. b and c.

4. Indication for the use of the CO_2 laser in soft tissue is:
   a. Osteotomy.
   b. Osteoplasty.
   c. Gingivectomy.
   d. Curettage.

5. When using a laser to perform an excisional biopsy, the following is true:
   a. Primary closure with sutures should be obtained.
   b. No anesthetic is needed.
   c. The laser should be used in a "vaporization" mode.
   d. Traction/countertraction technique is used in a cutting mode to excise lesion.

6. Advantage(s) of using the laser in a free gingival graft procedure is/are:
   a. Char layer acts as a dressing.
   b. Hemostasis is maintained at the donor site.
   c. Reduced postoperative discomfort for the first 3 days.
   d. All of the above.

7. A laser gingivectomy is indicated in which of the following cases?
   a. Adequate band of attached keratinized gingiva.
   b. 2 to 3 wall intrabony defects.
   c. Grade II furcation involvement in the mandibular molars.
   d. a and c.

8. A laser versus scalpel wound heals at:
   a. A faster rate.
   b. Slower rate.
   c. Same rate as with the scalpel.
   d. None of the above.

9. In a laser frenectomy there is:
   a. Reduced operative time.
   b. No suturing.
   c. Minimal bleeding
   d. All of the above.

10. The residual char layer following lasing:
    a. Should be wiped down following completion of the procedure.
    b. Acts as a dressing.
    c. Reduces postoperative discomfort for 3 days.
    d. c and d.