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Lasers in surgical periodontics and oral medicine

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Although the discovery of lasers and research into their applicability for dental use began in the 1960s, it was not until 1985 that the first documented use of a laser in periodontal surgery was published [1]. Early efforts were limited to those soft tissue procedures that could be performed using a straight optical lens/articulated arm delivery system. This limitation meant that only areas accessible by direct vision could be treated [2,3]. A second and equally important limitation was the inability of lasers to interact favorably with calcified tissues such as tooth structure and bone. In 1985, Myers and Myers [4] modified an ophthalmic Nd:YAG laser for dental use. It soon was noted by clinicians that this wavelength could be used for soft tissue surgery [5,6]. Subsequent advances in laser research produced a hollow wave guide delivery system for carbon dioxide (CO_2) lasers [7] and a fiber-optic delivery system for other wavelengths, making access to the entire oral cavity much easier [5,6]. Additional research led to the applicability of other wavelengths such as argon, holmium, diode, and erbium for dental use.

There are several advantages to using lasers in periodontal therapy. These advantages include hemostasis, less postoperative swelling, a reduction in bacterial population at the surgical site, less need for suturing, faster healing, and less postoperative pain [1,2,8–14,102]. Studies on the speed of healing of laser wounds compared with scalpel wounds presently are inconclusive: several studies suggest faster healing [15–17], some suggest slower healing [18–22], and still others report that there is no difference [23,24].

The argon, CO_2, diode, and Nd:YAG lasers all provide what is essentially a bloodless, dry operative field [24,36]. Because the erbium wavelength is

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emitted in a free-running pulsed mode, the thermal energy is not sustained long enough to provide sufficient energy to achieve hemostasis. Secondarily, the erbium wavelength is not absorbed by hemoglobin or similar pigmented blood components. A more complete discussion of the absorption characteristics of the various lasers can be found elsewhere in this issue. Lasers that do provide hemostasis are thought to increase platelet activation at the point of the wound, which leads to sealing the blood vessels [25]. The reduction in swelling following the use of surgical lasers appears to be related to the sealing of the lymphatic vessels [1]. Most surgical lasers used in periodontal therapy also have the ability to significantly reduce the bacterial population at the surgical site [27–32]. This reduction is brought about by the interaction of laser energy with the pigmented portion of the bacteria found in the tissues of the oral cavity. Because these surgical lasers provide such excellent hemostasis, the need for suturing is reduced significantly. Some lasers can be used to weld the edges of tissue together, and this in itself provides less need for suturing [33–35,37]. At this time, the claim that laser surgery results in less postoperative pain cannot be proved with scientific measurements but must rely on anecdotal reports of patients following such surgery and the surgeon's need to provide pain medications for one modality or the other. This subject is discussed in more detail elsewhere in this issue. It also must be kept in mind that patient acceptance of laser treatment is extremely high, thereby giving the patient more confidence in his or her practitioner who is seen as using the most advanced methods of dental treatment [38]. This topic also is discussed in more detail elsewhere in this issue. All of the previously mentioned advantages are mediated by the fact that laser energy has the ability to be absorbed by water or chromophores in tissues. Because the absorption of laser energy into the tissues produces the work necessary to accomplish the desired result, the CO_2 laser is particularly well suited for soft tissue surgery: its wavelength is highly absorbed by the water content of the tissues [40–42]. Because soft tissues contain approximately 90% water, they absorb the CO_2 wavelength easily. A brief description of each laser and how it interacts with soft tissues in periodontal surgery is necessary to understand more completely the advantages of this new modality for treating periodontal disease. More detailed descriptions of the physics of each wavelength can be found elsewhere in this issue.

Argon laser

The argon laser is the only soft tissue laser that operates within the visible portion of the electromagnetic spectrum. Its power is delivered through an optical fiber and it is used in a continuous wave in a contact mode. The visible blue-green light of the argon laser is absorbed readily by soft tissues, especially when they are pigmented with melanin [55,105] or hemoglobin

[55,105]. As argon laser energy is converted into heat, there is a thermal effect on soft tissues that first produces coagulation and then vaporization. There is ample evidence that the argon laser is useful in the reduction of pigmented bacteria within the periodontal pocket [23,24,106]. In 1995, Finkbeiner [56] coined the term *laser pocket thermolysis* to describe the reduction of pathogens within the periodontal pocket using an argon laser in conjunction with scaling and root planing. There are reports that this laser is useful in guided tissue regeneration by the de-epithelialzation of the wound margin [43,44,57]. At present, the argon laser is useful in the clinical application of soft tissue welding and soldering. The importance of tissue welding compared with conventional tissue closure methods lies in the fact it can be faster, less traumatic, and easier to apply [36].

Carbon dioxide laser

The CO_2 laser's ability to provide the required power in continuous and gated modes using focused or nonfocused hand-pieces gives this instrument the versatility and precision required for soft tissue surgical procedures. Its uses have been well documented for soft tissue procedures [1,13,39,46,47,77].

The CO_2 laser is absorbed by water rather than chromophores found in cellular tissue elements. In comparison, the Nd:YAG and diode laser wavelengths are absorbed by pigment and are transmissible through water, making them useful in the reduction and possible elimination of the bacteria associated with periodontal disease [27,28]. Anecdotal reports indicate that periodontal dressings seldom are used after surgery with any laser wavelength, with the exception being the recipient site of a free gingival graft. Even in this case, the dressing is used to protect the donor tissue and not to merely cover the wound site.

The CO_2 laser is absorbed by the water component of dental hard tissues, which could lead to thermal damage; therefore, contact with those tissues must be avoided. Any inadvertent char on hard tissue may inhibit the attachment of fibroblasts and delay wound healing [63,64,100,101].

Nd:YAG laser

The first reported use of a fiber-optic–delivered laser in periodontal surgery was the Nd:YAG laser as presented by Myers et al in 1985 [4]. This laser can be used in a contact or a noncontact mode for ablating and cutting soft tissues in the oral cavity. Because the laser energy is delivered through a fiber-optic tip, it can be used within the gingival pocket. Like the diode laser, Nd:YAG has an affinity for chromophores in pigmented tissues, which results in good hemostasis. When the Nd:YAG laser is used in a contact mode, a coating of carbonized tissue forms at the tip of the fiber. When this occurs, the carbonized tissue absorbs the laser energy and there is a significant increase in thermal energy delivered to the tissues. Because this increased thermal energy is absorbed at the surface of the tissue, there is a significant decrease in soft tissue penetration [66]. There is a significant amount of evidence that shows that the Nd:YAG laser wavelength has an affinity for pigmentation [29–31]; it is this characteristic that makes it especially useful in reducing or eliminating the pigmented bacteria commonly associated with periodontitis [27,28]. When this bacterial reduction is coupled to the conventional instrumentation of the root to remove hard and soft deposits, more effective decontamination of the diseased pocket can occur, therefore achieving a greater amount of pocket reduction during the conservative phase of periodontal therapy [26,27,65,67,96,99].

When used in a contact mode, the Nd:YAG laser is useful in gingivectomy and gingivoplasty procedures. It provides excellent hemostasis and, because the pulsed Nd:YAG laser does not cause deep thermal damage, there is a reduction in postoperative pain [69]. There are numerous reports in the literature regarding the Nd:YAG laser's ability to remove hyperplastic gingival tissues without deep thermal damage to the adjacent tissues [68,70,71]. Several Nd:YAG surgical procedures such as a frenectomy may be performed without bleeding and with minimal anesthesia. This results in minimal postoperative pain. In addition to excisional and ablative procedures in the oral cavity, the use of the Nd:YAG laser to provide palliative treatment for oral lesions such as aphthous ulcers has been well documented [54,72,73]. The laser is used in a noncontact mode at extremely low power to denature the proteins of the surface layer of the lesions, thereby providing a biologic bandage created with the patient's own tissues. This process results in the immediate relief of pain and there is evidence that the healing time may be reduced significantly [20].

Studies have confirmed the harmful effects of the Nd:YAG laser when used directly on bone and root surfaces. These potentially harmful effects include thermal damage to underlying bone when this laser is used on thin soft tissues to perform gingivectomies [75].

Diode laser

The diode laser wavelength is delivered in a continuous wave or gated pulse in a contact mode. It can cut soft tissue and reduce bacterial counts in periodontal pockets [97]. The ability to use this instrument in a continuous wave or pulsed mode greatly increases its usefulness in soft tissue surgery. There is evidence that this wavelength may cause a reduction in gingival inflammation and a reduced need for local anesthetic during surgical procedures [77,107]. Like the Nd:YAG and CO_2 lasers, diode lasers may be used to cut or vaporize soft tissues. Thermal necrosis zones of less than 1 mm can be achieved, which provides adequate surgical precision and

Fig. 1. A preoperative view of gingival enlargement caused by a calcium channel blocker.

hemostasis for many soft tissue procedures. The laser may be used in a noncontact mode to coagulate soft tissues or to provide hemostasis over an area [76]. As with the CO_2 and Nd:YAG lasers, most soft tissue procedures can be performed with this wavelength [41,76,78,79].

Holmium lasers

Holmium lasers can cut and vaporize soft tissue while providing hemostasis. As with the diode and Nd:YAG lasers, this wavelength is delivered through a flexible, quartz optical fiber. Reasonably good surgical precision and control can be obtained when cutting or vaporizing with a bare fiber in a contact or noncontact mode. As with the CO_2 laser, photothermal interactions of soft tissues with the holmium laser do not rely on hemoglobin or other tissue pigments for the efficient heating of tissue [41].

Shallow penetration depths, combined with the high–peak power characteristic of free running pulsed lasers, allow the holmium laser to ablate hard, calcified tissues. The ablation mechanism for calcified tissue probably is a combination of photothermal and photoacoustic processes

Fig. 2. Immediate postoperative photo of the completed gingivectomy.

Fig. 3. A 4-week postoperative view showing normal gingival contours restored.

rather than true ablation [41]. Charring may be minimized by irrigating the tissue surface. At the present time, the holmium laser has no approval for use on dental hard tissue [45].

Erbium lasers

The erbium family of dental lasers consists of two wavelengths with similar but not identical properties. The erbium:yttrium-aluminum-garnet (Er:YAG) laser produces a wavelength of 2940 nm and the erbium, chromium:yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser produces a wavelength of 2780 nm.

The erbium family of lasers has been used for cavity preparation and caries removal since 1997 [74,80]. These lasers are delivered by a special optical fiber or a hollow wave guide, and all instruments operate in a free-running pulsed mode. These wavelengths have the highest absorption in water and have the most shallow penetration into soft tissue of any dental wavelength. When used in a noncontact mode, minimal hemostasis will

Fig. 4. A preoperative view of gingival enlargement caused by the use of a calcium channel blocker. (Courtesy of Douglas Gilio, DDS, Visalia, CA.)

Fig. 5. Immediate postoperative view of the completed gingivectomy. (Courtesy of Douglas Gilio, DDS, Visalia, CA.)

occur during periodontal surgery compared with the CO_2 and the Nd:YAG lasers [40,41]. As with other soft tissue lasers, there is a proven bactericidal effect when using the Er:YAG laser [61,62]. Erbium lasers can be used to cut and ablate soft tissue precisely. Cuts are scalpel-like and there is almost no healing delay. Erbium lasers sometimes are used with contact-mode accessories to improve their ability to cut soft tissues with hemostasis [45]. The most useful application of these lasers in soft tissue surgery occurs when they are used to trim gingival tissues in preparation for caries removal without the need for analgesia [103]. Because these lasers are well absorbed by hard tissues, the surgeon must protect adjacent tooth structures in the operative field. Local anesthesia may not be necessary depending on the depth of the procedure. Research shows that the Er:YAG laser can remove calculus and lipopolysaccharides from root surfaces without melting, charring, or carbonization of the root surface [62]. The Er:YAG laser may be used not only to remove the diseased hard and soft tissue from root surfaces but also to clean out diseased tissue in root furcations and infrabony pockets without harming root surfaces. Whereas other wavelengths studied (Nd:YAG, CO_2) may leave a char layer on the root surface that prevents attachment of fibroblasts to the root surface, the Er:YAG

Fig. 6. Three-week postoperative view of the surgical site with normal tissue contours restored. (Courtesy of Douglas Gilio, DDS, Visalia, CA.)

Fig. 7. A preoperative view of gingival enlargement caused by poor home care during orthodontic treatment and a mouth-breathing habit. (Courtesy of Douglas Gilio, DDS, Visalia, CA.)

leaves a smooth char-free surface, with no smear layer and the collagen matrix exposed [62]. There currently are no reports in the scientific literature that validate the use of the Er,Cr:YSGG wavelength in periodontal osseous surgery.

De-epithelialization

The successful treatment of periodontal defects requires new attachment of the periodontal ligament fibers into the newly forming cementum of the root surface. Apical proliferation of epithelium from the adjacent surfaces of the wound along a healing surface interfere with the formation of a new connective attachment between the root surface and the supporting alveolar bone [79].

Many techniques have been suggested to retard the downward growth of epithelium [43,78,81]. More recently, various types of materials have been placed between the edge of the healing wound and the root surface in an

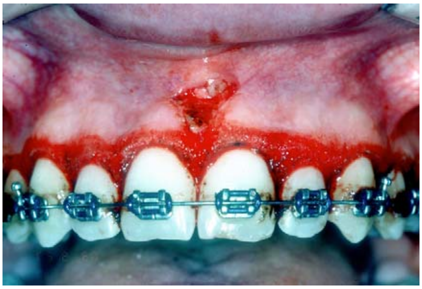

Fig. 8. Immediate post operative photo of a gingivectomy using an Er:YAG laser. (Courtesy of Douglas Gilio, DDS, Visalia, CA.)

Fig. 9. A preoperative photo of a surgical site requiring soft tissue crown lengthening for improved cosmetics following orthodontic treatment. (Courtesy of Janet Hatcher-Rice, DDS, Bristol, TN.)

attempt to retard epithelial migration [43]. These techniques had significant flaws in their application: the materials that were used dissolved rapidly when exposed to the oral environment following soft tissue recession or did not dissolve at all, requiring a second surgical procedure to remove them [84,85].

Until the advent of resorbable barrier membranes that would maintain their integrity for a long enough period of time for attachment to occur, a method of epithelial exclusion using a CO_2 laser was suggested [87–93,98]. The absorption of CO_2 energy by gingival tissue can be controlled in such a manner that vaporization of the intracellular fluid occurs, leading to the disruption of the entire cell. Because the interaction between the CO_2 wavelength and gingival tissues is shallow in depth (0.1–0.3 mm), it results in less wound contraction and a reduced inflammatory response [86]. Animal and human studies have shown that the CO_2 laser can remove epithelium effectively from gingival tissues without damaging the underlying connective tissue. These studies show that when CO_2 energy is applied to a

Fig. 10. Laser gingivectomy in progress using a diode laser set at 2 W. (Courtesy of Janet Hatcher-Rice, DDS, Bristol, TN.)

Fig. 11. Immediate postoperative view of the completed gingivectomy. (Courtesy of Janet Hatcher-Rice, DDS, Bristol, TN.)

full-thickness mucoperiosteal flap, the underlying connective tissue is not damaged despite the complete removal of the epithelium [86].

When sites treated by laser de-epithelialization combined with osseous grafts are compared with nonlased sites in split-mouth experimental designs, the CO_2 sites show better gain of clinical attachment level and increased osseous fill of infrabony defects [82,83,90]. The benefit of using the Er:YAG laser in combination with CO_2 laser in a combined surgical technique now becomes apparent: the Er.YAG laser may be used to remove diseased tissue from the root surface. This process leaves the root surface smooth, with no char layer and the collagen matrix exposed. The next step in the periodontal surgical procedure is de-epithelialization of the flap. This procedure permits the connective tissue to form new attachment onto the smooth root surface. This double–laser wavelength surgical technique shows tremendous potential in periodontal regenerative surgery. More split-mouth studies are needed with larger numbers of patients to validate what has been shown in two animal models and small human studies.

Fig. 12. Two-week postoperative view showing normal gingival contours restored. (Courtesy of Janet Hatcher-Rice, DDS, Bristol, TN.)

Fig. 13. A preoperative view of a thick gingival graft requiring recontouring.

Soft tissue laser surgery using various wavelengths

Gingivectomy

A patient presented to the office with gingival enlargement due to the use of calcium channel blockers (Fig. 1). Note the edematous finger-like projections of the interproximal papillae. This type of enlargement differentiates this tissue reaction from the bulkier and more fibrotic enlargements caused by phenytoin and cyclosporine. The patient was premedicated with 800 mg of ibuprofen, taken with food 1 hour before the surgery. This premedication regimen is routine for all surgical procedures, whether performed by scalpel or laser. The patient was then anesthetized with 2% lidocaine with 1:100,000 epinephrine. A periosteal elevator was placed between the tissue and the tooth to protect the hard tissue from the effects of the CO_2 wavelength. Lasing was performed with a CO_2 laser in a 7-W continuous wave mode. Fig. 2 shows an immediate postoperative view following the completion of surgery. Note the slight amount of interproximal bleeding, which was due to the fact that the finger-like projections of the hyperplastic tissue contained capillaries that were larger than the diameter of the lasing beam. A biologic bandage (char layer) was placed

Fig. 14. Immediate postoperative view of a gingivoplasty completed with a CO_2 laser.

Fig. 15. The 3-week postoperative view shows the graft tissue blended into the adjacent attached gingiva.

over the surgical site, eliminating the need for a periodontal dressing. The procedure took approximately 45 minutes from injection to completion. The patient was given a prescription for chlorhexidine gluconate 0.12%, as is normal for all surgical procedures, and dismissed with the usual postoperative instructions. Fig. 3 shows a 1-month postoperative view, with normal tissue contours restored.

A patient presented for treatment to remove hyperplastic gingiva caused by the use of a calcium channel blocker (Fig. 4). The surgical site was anesthetized with 2% lidocaine containing 1:100,000 epinephrine. The procedure was performed with an Er:YAG laser set at 150 mJ of energy, with a repetition rate of 20 Hz for a total of 3 W of power. Fig. 5 shows an immediate postoperative view. The patient was dismissed with the usual postoperative instructions and returned in 3 weeks for a final evaluation. Normal tissue contours were restored (Fig. 6). The primary disadvantage of using an Er:YAG laser for soft tissue applications is minimal hemostasis compared with other wavelengths, which could lead to mild bleeding or

Fig. 16. A preoperative photo of an aberrant frenum positioned between two maxillary central incisors. The tissue is to be removed prior to starting orthodontic treatment.

Fig. 17. Immediate postoperative view of the frenum removed with a CO_2 laser.

oozing before hemostasis is achieved. Postoperative recovery usually is uneventful, with little discomfort. Healing is comparable to scalpel incisions.

A 15-year-old girl presented for a cosmetic evaluation at the completion of orthodontic therapy. A clinical examination revealed that she was a mouth breather and her home care was extremely poor (Fig. 7). Instruction in proper home care was given and the patient was advised to coat the buccal marginal tissue with a thin layer of petroleum jelly before retiring for the evening. Both suggestions did little to correct the situation. The patient agreed to a surgical procedure to correct the cosmetic problem. The site was anesthetized using lidocaine with 1:100,000 epinephrine. An Nd:YAG laser with a 300-μm fiber-optic cable connected to a quartz tip was used in a contact mode with power set at 4 W. The quartz tip allows for ideal positioning and precise tissue removal around orthodontic appliances. The coagulative properties of this wavelength provide excellent hemostasis. A traditional scalpel procedure would result in bleeding, which would obscure the surgical site, making it more difficult to provide an ideal cosmetic result. Fig. 8 shows an immediate postoperative view of the procedure. The patient was dismissed with the usual postoperative instructions.

Fig. 18. A 4-week postoperative view showing that the frenum has been eliminated.

Fig. 19. A preoperative view of a surgical site ready for stage 2 implant recovery.

A 16-year-old girl presented for a consultation regarding the uneven appearance of the maxillary anterior gingival margin following completion of orthodontic treatment. It was decided to correct the esthetic problem using a diode laser. A preoperative photograph was taken (Fig. 9) and the surgical site was anesthetized with one half carpule of articaine with 1:200,000 epinephrine. A diode laser with a 360-μm fiber set at 2 W was used for the surgery. After probing the area to determine bone height, the soft tissue was sculpted to its maximum depth without invading the biologic width of the sulcus (Fig. 10). The laser fiber was aimed at the free gingival margin parallel to the tooth surface and was moved apically with a horizontal reciprocating motion until the desired cosmetic result was obtained (Fig. 11). Vitamin E was placed over the surgical site and the patient was dismissed with the usual postoperative instructions. The patient returned in 2 weeks for a postoperative evaluation and photos (Fig. 12).

Fig. 20. The head of the implant fixture has been exposed using a CO_2 laser.

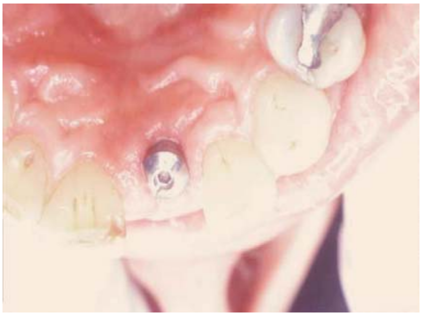

Fig. 21. A 10-day postoperative view of the healed surgical site that is ready for final impressions.

Gingivoplasty

Fig. 13 shows a mature free gingival graft that is much thicker than the surrounding tissues. The area was anesthetized with 2% lidocaine with 1:100,000 epinephrine. A CO_2 laser was set at 4 W in a continuous wave. Fig. 14 shows an immediate postoperative view of the procedure. Note that the fibrotic tissue of the graft has been blended into the surrounding attached gingiva. The patient was given a prescription for chlorhexidine gluconate 0.12% and was dismissed with usual postoperative instructions. Fig. 15 shows a 3-week postoperative view in which normal gingival contours have been restored.

Frenectomy

Fig. 16 shows a preoperative view of a frenum that was placing excessive tension on the marginal gingiva between the two maxillary central incisor teeth. The attending orthodontist suggested removal of this frenum pull before the start of orthodontic therapy. The area was anesthetized with one

Fig. 22. The permanent restoration is in place.

Fig. 23. A preoperative view of a lower incisor region showing a muscle pull that has resulted in the absence of attached gingiva. A free gingival graft is to be placed.

half carpule of 2% lidocaine with 1:100,000 epinephrine. The frenum was removed with a CO_2 laser set at 5 W, continuous wave. Fig. 17 shows an immediate postoperative view of the surgical site. A biologic bandage (char layer) was placed over the attached gingival portion of the surgical site. Fig. 18 shows a 3-week postoperative view, with the marginal gingival problem resolved.

Second-stage implant surgery

Fig. 19 shows the site of a dental implant that was ready for second-stage surgery. The area was anesthetized on the buccal and palatal aspects of the site with 2% lidocaine with 1:100,000 epinephrine. The tissue over the implant was ablated using a CO_2 laser set at 6 W continuous wave. Because the surgical site is so small, the area tends to form a char layer quickly. This char must be removed during surgery so that additional lasing can occur deeper into the tissues until the head of the implant is exposed. If the char is not removed during surgery, then absorption of the laser energy will cease and scattering of the laser beam will occur, possibly heating up the tissue

Fig. 24. To prepare the recipient site, a vestibuloplasty has been performed using a CO_2 laser.

Fig. 25. The graft tissue has been secured in place.

surrounding the implant, and possibly damaging the implant. After the implant is exposed, the cover screw can be removed and a healing abutment placed as shown in Fig. 20. Fig. 21 shows a 4-week postoperative view, with healing complete and the implant ready for restoration. The advantage of using a laser to uncover the implant is that it avoids an incision that would extend through the interproximal papillae located next to the adjacent teeth. By avoiding this incision, a better cosmetic result can be assured. Fig. 22 shows the implant restored.

Free gingival graft

Fig. 23 shows a preoperative view of a mucogingival problem that involves the mandibular central incisor teeth. A broad muscle pull was present and a significant amount of gingival recession had occurred. The patient was premedicated in the usual manner, and the area was anesthetized with 2% lidocaine containing 1:100,000 epinephrine. A vestibuloplasty was performed by placing the laser tip parallel to the mandible in a focused mode and separating the vestibular tissue, leaving the periosteum attached to the bone (Fig. 24). After the surface of the periosteum was freshened with

Fig. 26. Four-week postoperative view.

Fig. 27. Immediate preoperative view of typical donor site.

a scalpel to produce bleeding, the area was ready to receive the graft. This bleeding allows for plasmatic circulation to occur during the first 14 days of healing before capillaries can form to nourish the graft tissue. The more apical portion of the vestibular mucosa does not require suturing (Fig. 25). Following its placement, the graft was covered with a layer of telfa and then a periodontal dressing was placed. Treatment of the donor site began by achieving hemostasis with an injection of 1 carpule of 2% lidocaine with 1:100,000 epinephrine. The area was then lased to create a biologic bandage. The laser was set at 5 W continuous wave in a defocused mode. In addition to the usual postoperative instructions for swelling and discomfort, the patient was given instructions regarding the consistency of her diet and was advised to contact the office if the dressing covering the graft became loose. Fig. 26 shows the postoperative view 4 weeks after the surgery. Figs. 27 and 28 show the donor site of a different case immediately before and after placement of the biologic bandage.

Laser peel

Fig. 29 shows a preoperative view of the mouth of a female Caucasian patient who developed severe pigmentation of the buccal-attached gingiva at

Fig. 28. Donor site covered by biologic bandage.

Fig. 29. A preoperative view of severe oral pigmentation that is to be removed using a laser peel.

22 years of age. This type of endogenous pigmentation occasionally develops during pregnancy [94]. The entire maxillary arch was anesthetized with 4 Carpules of 2% lidocaine containing 1:100,000 epinephrine. A CO_2 laser was used at 4 W continuous wave in a defocused mode. By using the laser in this manner, it is possible to separate the epithelium from the underlying connective tissue by creating a blister (Fig. 30). Because the melanocytes are found in the basement membrane of the epithelium, they will be permanently eliminated with the tissue that is removed. The procedure took approximately 45 minutes. The patient was dismissed with a prescription for chlorhexidine gluconate 0.12%, and the usual postoperative instructions were given. Fig. 31 shows a 3-week postoperative view, with the buccal-attached gingiva now exhibiting normal color and contour.

Soft tissue crown lengthening

Soft tissue crown lengthening can be accomplished easily with a laser when two conditions exist. First, there must be no need to contour the

Fig. 30. Blister has formed over entire surgical site.

Fig. 31. A 16-day postoperative view.

underlying bone; second, there must be sufficient attached gingiva so that there will be an adequate zone of attached gingiva after the soft tissue has been ablated. Fig. 32 shows a preoperative view of the maxillary anterior teeth where a new fixed bridge is anticipated. The existing bridge was used as a temporary prosthesis; soft tissue crown lengthening is required. The patient was premedicated in the usual manner and anesthetized with 2% lidocaine containing 1:100,000 epinephrine. Fig. 33 is an immediate postoperative view showing the resection completed. During the surgical procedure, a periosteal elevator was inserted between the gingival tissues and the teeth so that the hard tissue would not be damaged inadvertently by the CO_2 wavelength. The patient was dismissed with a prescription of chlorhexidine gluconate 0.12%, and the usual postoperative instructions were given. Fig. 34 shows a 1-month postoperative view, with normal tissue tone and contours restored.

Lasers in oral medicine

The successful treatment of ulcerative lesions in the oral cavity depends on a knowledge of the etiology of the lesion and its histopatholgy. Although

Fig. 32. Preoperative view of the surgical site.

Fig. 33. Immediate postoperative view.

the treatment of aphthous lesions, hyperkeratosis, and lichen planus can be accomplished with a laser [48–53,58–60,72,73,76,95,103,104], other conditions such as candidiasis and erythema multiforme cannot. The goal of treating aphthous ulcers with a laser is to create a palliative effect on the lesion so that it will remain comfortable while normal healing occurs. There is no attempt to remove the lesion by excision or ablation. Most wavelengths can be used for this treatment. The laser energy is directed at the lesion in a defocused mode and brought slowly toward the tissue with a circular motion. The treatment time is approximately 2 to 3 minutes. Low powers are used. The surface of the lesion may show a change in appearance from a glossy to a matte surface. Because the procedure is performed without anesthesia, the patient is able to provide feedback to indicate when the area is comfortable. Typical power settings are approximately 0.5 W for diode in a continuous wave, 1.0 to 1.5 W for Nd:YAG, 2 W for erbium, and 1.5 to 3 W for CO_2. Power higher than these examples may result in ablating the surface of the lesion, leaving a raw surface exposed to the oral environment. The patient is dismissed with the usual postoperative instructions and advised to rinse twice daily with 0.12% chlorhexidine gluconate.

Fig. 34. One-month postoperative view.

Lichen planus may be treated successfully by performing a laser peel. The area to be treated is anesthetized with a local anesthetic. When using a CO_2 laser, the power is set at 3 W continuous wave and the tip is positioned in a highly defocused mode. The laser tip is brought toward the tissue until a blister begins to form. This blister indicates that the epithelium containing the lesion is separating from the underlying connective tissue. After the entire lesion is raised, it can be peeled off of its connective tissue base easily. The patient is given the usual postoperative instructions, including rinsing with chlorhexidine gluconate until the operative site is comfortable.

Lichen planus also can be removed by using an erbium laser in a manner similar to the CO_2 laser. The laser is set to 50 to 75 mJ at 30 Hz in a defocused mode using a water spray.

Leukoplakia can be removed easily using a Nd:YAG laser at 4 W. A similar procedure can be performed with a CO_2 laser set at 5 W continuous wave in an ablative mode. Both procedures require local anesthetic. Recently, an article was published that described the use of lasers to treat the oral manifestations of HIV infection, including HIV-associated periodontal diseases (linear gingival erythema and necrotizing ulcerative periodontitis), human papillomavirus–induced focal epithelial hyperplasia, and Kaposi's sarcoma [99]. Many other soft tissue lesions that may be treated with a laser are discussed in other articles in this issue. A more complete list of soft tissue lesions treated with a laser and laser biopsy technique may be found in an article elsewhere in this issue.

Summary

The use of lasers in periodontal therapy has evolved since a laser for dental applications was first introduced in 1985. Initially, most articles that advocated the use of lasers for soft tissue surgery were anecdotal. With the discovery of newer wavelengths, it appears that research in soft tissue applications is increasing exponentially. Previous anecdotal claims of decreased bleeding, swelling, pain, and bacterial populations now are being referenced in leading refereed medical and dental publications.

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