SCIENTIFIC ARTICLE

Lasers and Soft Tissue Treatments for the Pediatric Dental Patient

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Historically, oral soft tissue surgery on infants and young children was completed in the operating room under a general anesthetic agent. Many children were referred to an oral surgeon and required a physician's physical examination and medical clearance for a hospital admission. This potentially placed a child at risk during the use of a general anesthetic for an elective procedure, which may not have insurance benefits. Traditional methods of oral surgery using scalpels or electrosurgery may produce significant postoperative discomfort and require sutures and prolonged healing. Lasers provide a simple and safe in-office alternative for children while at the same time reducing the chances of infection, swelling, discomfort, and scaring.

In a pediatric practice, there are a variety of surgical and restorative laser wavelengths, such as diode and the Erbium family, and other photobiostimulation or therapeutic lasers which are effective at powers well below those of the surgical lasers.

PHOTOBIOSTIMULATION LASER TREATMENTS

Laser treatments in this article are performed with the Q1000 photobiostimulation unit or the Accupoint laser. Photobiostimulation[3] (also known as therapeutic laser therapy and low level laser therapy) has had limited use in the United States in dental care. The 2 primary diodes used for this therapy are the InGaAIP (indium/gallium/aluminium/phosphide; 660 nm, creating energy of 50 mW) and the GaAlAs (gallium, aluminium, arsenides; 808 nm up to 500 mW).

Pulpal Analgesia

In selected patients, using the 660-nm laser probe can achieve adequate pulpal analgesia[4,5]. Successful analgesia may allow a dentist to use a high speed drill to prepare a class II restoration without the need for any local anesthesia. Success in primary molars varies from 50% to 75%. Success in bicuspids varies but is greater than that found in permanent molars. Analgesia effect may be effected by things such as pigmentation of the patient's gingival tissue, because the diode may react with the pigment in the tissue rather than be absorbed by the pulpal tissue. Treatment consists of placing the laser probe on the occlusal surface of a primary molar for 1 to 2 minutes. In permanent teeth, placing the probe for 1 minute next to gingival tissue over the roots of the treated tooth also contributes to successful analgesia. Using the 808-nm probe may achieve higher success in permanent teeth. Figures 1 through 4 show the laser placed on permanent and primary teeth; shortly thereafter, the carious lesion can be treated (Figure 5).

Maintaining Pulpal Vitality After Trauma

In young patients where an anterior primary central or lateral incisor

Figure 1. Placing the laser tip on the buccal surface of a lower bicuspid for 1 minute to achieve laser analgesia using the 660 nm photobiostimulating laser.

has received a traumatic injury, placing the 808-nm probe over the root may prevent the tooth from devitalizing. Trauma to a primary anterior

Figure 2. Placing the laser tip on the lingual surface of the lower bicuspid.

Figure 3. Placing the laser tip on the occlusal surface of a lower bicuspid.

Figure 4. Placing the 66nm probe on a primary molar to achieve laser analgesia.

tooth may compromise the tooth's vitality and result in requiring either a pulpotomy or extraction in a 4- to 6-week period. A tooth or teeth

Figure 5. Using a high-speed hand piece on a tooth having laser analgesia.

which have been significantly displaced may respond positively if treatment is begun within a few hours of trauma. Treatment consists of placing the laser over the injured tooth for a period of 1 minute on the facial root area and 1 minute on the lingual or palatal root area. Anterior permanent teeth which have been displaced or traumatized may also be treated successfully with similar parameters. An additional treatment in 24 to 36 hours may improve the chance of successfully healing the tooth. Figure 6 shows a partially avulsed primary anterior tooth, and laser therapy was used. Figure 7 is 3 days posttreatment, and Figure 8 is 9 months posttreatment.

Healing of Soft Tissue Trauma

Patients who fall and receive facial lacerations[6,7,14] and swelling benefit from placing the laser/light-emitting diode (LED) unit over the area for approximately 3 minutes and placing the 660- or 808-nm probe over the most injured area for 1 to 2 minutes, helping to heal the lesions more quickly and with less posttrauma discomfort. Additional treatment 24 to 36 hours later may be needed to reduce the discomfort and improve healing. Figure 9

Figure 6. Traumatically displaced lower anterior primary teeth.

Figure 7. Three days after laser treatment using the 808 nm laser probe.

depicts a traumatic injury in which the child fell and hit the upper teeth and soft tissue. The treatment consisted of removing the teeth and suturing the gingival tissue (Figure 10) and a 660-nm laser was then used. Six days later, the tissue is healing well (Figure 11).

Figure 8. Nine months after treatment of lower anterior teeth, the teeth remain vital.

Figure 9. Facial trauma to child after treatment of wound and suturing together soft tissue.

Figure 10. Two and a half days after trauma and use of a 660 nm probe and cluster of diodes and LCDs.

Controlling Gag Reflex

During the taking of intraoral radiographs or during an intraoral examination, some patients may gag and in extreme cases vomit. Using the 3 J to 4 J of energy with the 660-nm probe placed over the P-6 acupuncture point on each wrist may prevent the gag[8,9] from occurring. This point is located

Figure 11. Six days post laser treatment.

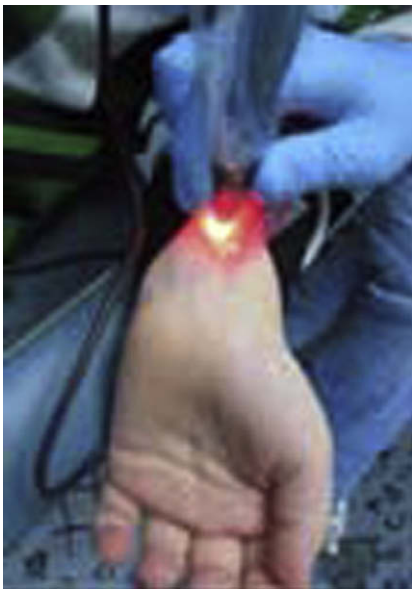

Figure 12. Location and placement of 660nm probe on the p6 acupuncture point on the wrist to prevent gagging.

approximately 1 inch above the wrist crease. The probe is placed on each wrist for 1 to 2 minutes (Figure 12).

Treatment of Herpetic Type Lesions

One of the most painful and debilitating intraoral lesions a child can develop is primary herpes[10,11] or a similar herpetic-like stomatitis. Placing the laser/LED unit in mode 3 for 3 minutes and the 880-nm probe for 1 minute over large lesions reduces the discomfort and reduces the disease outbreak period in many children (Figure 13). More than one treatment over a 24- to 48-hour period may be needed to treat the lesions. Figure 14 shows that the child is pain free 48 hours after this laser therapy.

Orthodontic and Temporomandibular Joint Discomfort

Patients having orthodontic adjustments or having temporomandibular joint discomfort may experience relief using the laser/LED unit[12,13] over the area for 3 minutes using mode 3. More than 1 treatment over a 24- to 48-hour period may be needed to reduce the discomfort.

Pretreatment of Surgical Sites

Pretreating a surgical site may reduce postoperative hemorrhage and discomfort. Treatment involves placing the 660-nm laser over the surgical area for 1 minute before lasing the soft tissue.

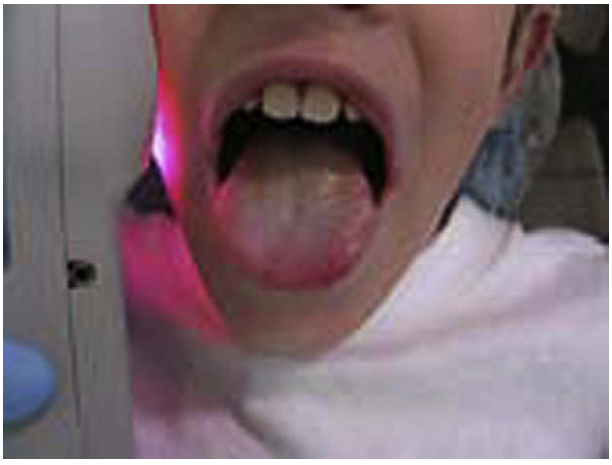

Figure 13. Placement of laser cluster on patient diagnosed with primary herpes intra orally.

PHOTOTHERMAL LASER TREATMENTS (ERBIUM:YAG, ERBIUM:CR; YSGG, AND DIODE)

Treatment of soft tissue procedures[27] are completed using the VersaWave Erbium:YAG laser (2940 nm) or the Power Lase AT Spa Er:YAG laser (distributed by Lares Research Chico, CA), or the Diodent (810 nm) diode laser (both from Hoya Dental Lasers, Fremont, CA), but are equally able to be completed by the other manufacturers of lasers within diode and the Erbium family of lasers. The Erbium:YAG and Erbium:Cr; YSGG at 2780 nm are useful in treating most soft tissue lesions where absolute hemostasis in not required. Diodes in the 810- to 980-nm range are excellent lasers for treatment where hemostasis is an absolute necessity. There is one major difference in these 2 groups of wavelengths: first, the Erbium family of lasers is relatively shallow in laser energy penetration; therefore, what you see is exactly what you are doing. Second, when using a diode, the result of treatment may initially be unobserved because of deeper penetration of the laser energy. This may result in more collateral damage and more postoperative discomfort. For all soft tissue treatments, it is very important to remember that when using the Erbium laser you can observe the direct effect of the laser on the tissue; however, when using the diode, the tissue must heat up first and the laser penetrates deeper into the tissue. If you increase the laser energy to increase the speed of the treatment, more collateral damage and postoperative discomfort may result.

Lingual Frenum Revisions

Revision of an abnormal lingual frenum attachment is one of the

Figure 14. Forty-eight hours post treatment without pain or discomfort.

most undertreated developmental anomalies of the oral cavity.[15–18,22,24,26] A short lingual frenum may result in newborns failing to be able adequately nurse and result in failure to thrive. Mothers attempting to nurse may find nursing too painful and difficult to continue. Gagging may occur when infants are beginning to eat solid foods because of the inability of the restricted tongue to clear food from the palate. A short frenum may also contribute to speech or periodontal problems as children mature. Traditional methods of correcting this anomaly consist of using scalpels or electrosurgery and often result in extended periods of patient discomfort and usually require suturing of the surgical site. A diode laser or the Erbium family of lasers significantly reduces postoperative discomfort, and sutures may not be required in some cases, especially in infants and toddlers.

Figure 15. Class 1 classification of lingual frenum 12-16 mm.

Figure 16. Class II classification of lingual frenum 8-12 mm.

In order to assist in the diagnosis and treatment of the frenum, I created a classification system based on the distance from the tip of the tongue and the insertion of the frenum to the base of the tongue. Normal frenum attachment was determined to be more than 16 mm of distance from the tip of the tongue to the insertion of the frenum.[19,20] The classification is as follows: class I, 12 to 16 mm (Figure 15); class II, 8 to 12 mm (Figure 16); class III, 4 to 8 mm (Figure 17), and class IV 0 to 4 mm (Figure 18). When the frenum insertion is less than 8 mm, I will usually recommend that the frenum be revised. Whether the patient is a few days old or in his or her teens, the revision of the lingual frenum is a simple procedure easily completed using lasers.

Figure 17. Class III classification of lingual frenum 4-8mm.

Revision consists of initially placing a topical anesthetic on the tissue. The frenum is then stretched using an instrument known as a grooved tongue positioner (Miltex, York, PA; Figure 19). When the frenum tissue is primarily a thin fibrous attachment, no local anesthesia is normally required. Place the laser 2 to 3 mm away from the tissue and allow

Figure 18. Class IV classification of lingual frenum 0-4 mm.

Figure 19. Grooved tongue positioner available through Miltex.

the laser energy to ablate the frenum (Figure 20). If the tissue is thick and fibrous, the use of local anesthesia may be required, and it may be necessary to place a single gut suture at the end of the lased area to prevent frenum reattachment. The recommended settings for an Er:YAG laser for a new or inexperienced user are 30 Hz and 55 mJ. As the dentist acquires more experience, the hertz can be increased to 45 Hz and 55 mJ. No water is required for this treatment. Figure 21 shows a preoperative view of complete anklyoglossia; Figure 22 shows the immediate postoperative successful revision.

Figure 20. Er:YAG laser treating an abnormal lingual frenum attachment without a local anesthetic.

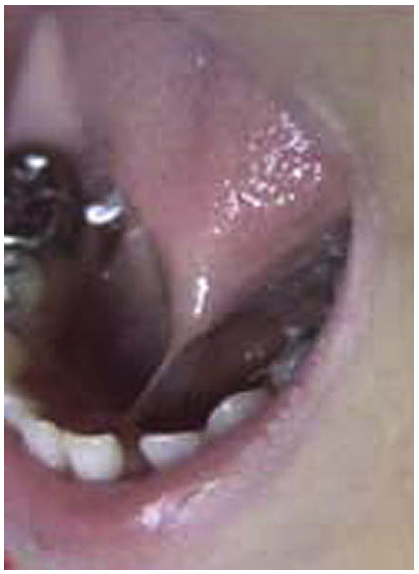

Figure 21. Er:YAG laser treating class IV lingual frenum attachment.

When the frenum is dense or muscular, after the tissue is anesthetized, grasp the frenum using a hemostat (Figure 23). The hemostat is placed as close to the base of the tongue as possible. The laser is used on the exposed side of the hemostat using the chisel tip, not on the surface of the hemostat touching the tongue. It is prudent to stay away from the floor of the mouth and avoid any treatment lingual to the lower incisors. The procedure takes approximately 15 to 30 seconds to complete (Figure 24). A suture can be placed to prevent reattachment (Figure 25). Postoperative care involves the use of over the counter pain medications if discomfort occurs. To prevent reattachment, the parent is instructed to have the child exercise the tongue and to stretch the area daily. Follow-up observations are scheduled in 6 to 7 days. Figure 26 is a 6-day postoperative view.

Figure 22. Er:YAG laser treatment immediately after using the laser.

Figure 23. Er:YAG laser treating an abnormal lingual frenum attachment with a local anesthetic and being held using a hemostat to control tongue movement.

When using the diode 810-nm laser, the laser tip is first initiated using a piece of articulating paper to

Figure 24. Er:YAG laser treatment immediately after frenum revision.

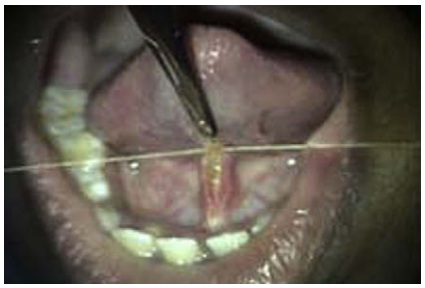

Figure 25. Placing suture to prevent frenum reattachment.

Figure 27. Class IV maxillary frenum on infant.

prevent it from becoming a hot tip, which would heat the tissue above the desired temperature. Unlike the Erbium laser, the diode tip is used in direct contact with tissue at a power of 1.0W CW using a 400 u fiber. The procedure usually takes more time and requires the use of a local anesthetic.

Maxillary Frenectomy Revisions

Many oral conditions can be intercepted or prevented by examining children by 1 year of age or approximately 6 months after the first teeth erupting to the oral cavity.[21,23] During an examination, it may appear that there is an extension of the maxillary frenum into the palatal area or inserting into the interproximal area between the upper central incisors. This degree of frenum attachment may contribute to nursing difficulties, mother discomfort during nursing, the development of facial caries on the upper anterior teeth, bleeding gingival tissue between the incisors, preventing healing of trauma to the frenum area, and causing a diastema to form between the 2 central incisors. Intercepting or preventing these problems associated with the abnormal placement of frenum may require revision of this abnormal attachment at an early age.

Treatment in infants and in the primary dentition involves placing a topical anesthetic over the area, and then lasing the area to get the desired detachment and repositioning of the frenum. Figure 27 shows an abnormal frenum, lasing is beginning in Figure 28, and Figure 29 is the immediate postoperative view. The recommended settings when using the Erbium laser are 30 to 45 Hz and 55 mJ and the chisel tip. Water is not required unless the process includes cutting away interproximal bone. In permanent dentition, if bone removal is required interproximally, water should be turned on when lasing the bone. Settings remain the same. Bleeding is usually controlled; however, occasionally a small area in this highly vascular area continues to seep blood. When this occurs, pressure for 1 to 2 minutes usually resolves the problem. If bleeding remains uncontrolled, placing a small moist teabag over the area for 2 minutes will create good hemostasis.

The diode laser will usually prevent any bleeding, because it is a better laser for hemostasis. When using a diode, the settings are 1.0W, CW using a 400 u fiber. Healing using the diode usually takes longer with the potential of more post perative discomfort than when using the Erbium laser. More care is required to prevent photothermal collateral damage of adjacent tissue.

When the frenum is not corrected in children before 3 years of age, the next best time to revise the frenum occurs when the maxillary permanent central incisors begin to erupt. Revising the frenum when a large gap appears or when the central incisors appear to be erupting distally can prevent diastema formation or periodontal problems in the frenum area. A diastema as wide as 4 to 5 mm may close without orthodontic intervention. No scar tissue has been observed interproximally when the frenum is revised. The frenum should be revised before the beginning of any orthodontic care.

Figure 26. Patient six days after surgical revision.

Figure 28. Frenum being revised using Er:YAG with local anesthetic.

Biopsies

Fibrotic lesions, gingival growths, mucoceles, and other nonhemangioma type lesions can be quickly and safely removed using the Erbium laser. Lesions usually require a local anesthetic, but in some instances, a topical anesthetic may be adequate. Each child and lesion

Figure 29. Area immediately after lasing.

must be treated on its own characteristics. Erbium settings range from 15 to 45 Hz and 55 mJ either with or without water. Tips may include the chisel tip or any one of the hard tissue tips. Diode settings using the 400 u fiber are 1.0 to 1.5W CW. The diode is especially useful if the lesion contains a vascular area which could result in posttreatment hemorrhaging. Fibrotic lesions or lesions which do not contain any pigment may be more effectively removed using the Erbium laser. This is because of the target tissue characteristics of Erbium and diode lasers. Figure 30 shows a preoperative view of a mucocele, which is excised by first outlining the lesion with the Erbium laser (Figure 31) The immediate postoperative view shows complete removal (Figure 32) and healing is progressing at 1 week (Figure 33).

Figure 30. Mucocele requiring removal.

Figure 31. Removal of lesion using Er:YAG laser.

Figure 32. Surgical site immediately after lesion removal.

Figure 33. Surgical site one week post surgery healing.

Herpes Labialis and Recurrent Aphthous Ulcers

Two of the most debilitating oral lesions children may experience are recurrent herpes labialis or aphthous ulcers. The Er:YAG or the Diode laser can bring instant relieve to the aphthous ulcer lesion and often abort or shorten the duration of the herpes labialis lesion. Treatment of the aphthous ulcer using the Er:YAG laser involves settings of 15 Hz and 35 mJ in a noncontact mode. Extend the treatment area about 1 mm beyond the lesion's boundaries. Water is not required. Place the laser tip above the lesion until small white

Figure 34. Child with Herpes Labialis.

areas are seen on the tissue. Allow the laser to remain over the lesion for 15 seconds, moving the tip in a circular area over the entire lesion. Repeat the process 2 to 3 times until the child indicates that the lesion no longer feels uncomfortable. Large lesions may need a second treatment in 24 hours.

Herpes labialis is treated similarly; however, the tip should slowly be passed over the entire portion of the lip that is affected just short of observing the white change in tissue color. This usually involves treating the entire half of the lip involved. The process takes 1 to 2 minutes. The diode settings are 0.500 mw, 400 u fiber for approximately 1 minute for aphthous ulcers and 2 minutes for herpes labialis lesions. The diode fiber does not need to be initiated and is kept defocused 2 to 3 mm above the lesion. Because of the photothermal reaction of the diode, there will be no visual indication that the lesion is being treated. The nature of the diode laser allows for deeper penetration of the laser energy and may be more effective than the Er:YAG laser when treating herpes labialis lesions. No local anesthesia is required for either laser during treatment. Figure 34 shows the lesion, and the 810-nm diode is used for treatment in Figure 35. Forty-eight hours later, the patient is comfortable, and the lesion is resolving (Figure 36).

Figure 35. Lasing the area using diode laser.

Figure 36. Forty-eight hours after laser treatment.

Pulpotomies

Lasers eliminate placing chemicals (such as pulpotomies formocresol) into the tooth chamber to complete the pulpotomy. The Erbium laser is the laser of choice for this treatment. Treatment consists placing the laser tip into the coronal portion of the tooth at settings of 30 HZ, 55 mJ with water or without water for approximately 15 seconds or until adequate hemostasis is achieved, this may require 2 to 3 treatment intervals. The pulpotomy is completed by placing zinc oxide and eugenol (ZOE b & T cement) into the chamber. In teeth where the dentist anticipates that a pulpotomy is needed, local anesthesia is recommended; however, there are instances when treating a tooth—when the nerve is exposed unexpectedly during caries removal—that a local anesthesia may not be required. This is because of the analgesic effect of using the laser on the tooth.

Figure 37. Cleft palate patient requiring removal of soft tissue followed by caries removal and tooth restoration.

Figure 38. Removal of hyperplastic tissue using Er:YAG laser without a local anesthetic.

Gingival Recontouring

Children undergoing orthodontic treatment or taking medications such as Dilantin (Pfizer US, New York, NY) may develop gingival hyperplasia. This may be a contributing cause for facial or buccal dental caries formation or enamel decalcification within the deep gingival pocket. This overgrowth of tissue can be reshaped or removed using

Figure 39. One week post treatment healing.

Figure 40. Exposure of permanent tooth under soft tissue using Er:YAG laser without local anesthetic.

either the Erbium or diode laser. Post-orthodontic treatment may result in the desire to improve aesthetics by exposing more available tooth enamel to eliminate the short tooth appearance of anterior teeth. This gingival recontouring is painless in most instances. Using either the Erbium or the diode laser, the tissue can often be reshaped without the need for local anesthesia. The Erbium laser settings are 30 to 45 Hz and 55 mJ. No water is usually needed. Using a 400 u initiated fiber, a diode laser would be used at 1 to 1.5W CW, depending on the density and amount of pigment in the tissue. In some patients, a local anesthetic may be required. The Erbium laser was used for the following excision: Figure 37 shows the preoperative excessive tissue; the laser excision is shown in Figure 38; and the 1-week postoperative view depicts good healing (Figure 39).

Figure 41. Lasing and exposing tooth.

Figure 42. Immediate post surgery ready for band placement.

Removal of Soft Tissue

To expose permanent teeth under just gingival tissue or in pericoronal discomfort over erupting molars, either laser can be used with settings similar to those used in gingival recontouring. Care must always be taken when using the Erbium laser to stay parallel to the tooth's surface to prevent enamel etching, and using the diode may require using local anesthesia. Figure 40 shows the Erbium laser in position, and Figure 41 shows layer by layer tissue removal. The completed exposure of the cuspid is shown in Figure 42.

Surgical Treatment of Patients with Bleeding Disorders

Patients who have bleeding disorders where hemostasis is a vital requirement for soft tissue surgery should be treated primarily using the diode laser. Those wavelengths target blood and pigment to provide excellent hemostasis, whereas the Erbium laser is not always successful in controlling bleeding. Patients with hemophilia or von Willebrand's diseases can often be treated without medical intervention. This saves the patient from complications and the cost of medications to control bleeding. Patients on blood thinners for reasons such as organ transplants or cardiac valve replacements can also be effectively treated with the diode and not have to have their blood thinner medications altered. Figure 43 shows the diode laser beginning to incise the frenum of a patient with von Willebrand's disease, and Figures 44 and 45 show the excellent hemostasis immediately following the laser surgery.

Figure 43. Maxillary frenectomy on patient with von Willibrauns disease using diode laser.

Figure 44. Immediately after surgery without any medical intervention for bleeding.

Venous Lake Lesions

A venous lake or pool often appears at the site of an injury to the lower lip. A venous lake or pool presents as a bluish soft, discrete, painless nodule beneath the epithelium of the lower lip. Although it is usually seen after 40 years of age, this case shown is an 8-year-old

Figure 45. One week healing of surgical site.

Figure 46. Venous lake lesion on lower lip.

patient (Figure 46). The source of lesion is a feeder vessel that has extended an appendage into the epithelium of the lip. The diode can ablate and seal the extension of the feeder vessel without damaging the lip, collateral damage, or scarring at the area of the lesion. Topical anesthetic was placed, and the 810-nm diode with a 400 u noninitiated fiber at 0.6W CW was used for 60 seconds (Figure 47) and then out of contact for an additional 30 seconds. The immediate postoperative result is shown in Figure 48, and complete healing is shown in Figure 49.

Figure 47. Lasing of the lesion using the Diode.

Figure 48. Immediately after surgery.

Figure 49. One week post surgery lesion not longer present.

DISCUSSION

The settings suggested above have been developed after years of successful laser treatments, and are both a safe and effective and a continuously evolving part of laser care. Other wavelengths, such as Nd:YAG and carbon dioxide, may also be used. Lasers are an exciting new technology which provides pediatric patients with optimal care without many of the "fear factors" found in conventional dental care.

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