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Policy on the Use of Lasers for Pediatric Dental Patients

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Purpose

The American Academy of Pediatric Dentistry (**AAPD)** recognizes the judicious use of lasers as a beneficial instrument in providing dental restorative and soft tissue procedures for infants, children, and adolescents, including those with special health care needs. This policy is intended to inform and educate dental professionals on the fundamentals, types, diagnostic and clinical applications, benefits, and limitations of laser use in pediatric dentistry.

Methods

This policy is based on a review of current dental and medical literature related to the use of lasers. This document included database searches using key terms: laser dentistry, dental lasers, laser pediatric dentistry, laser soft tissue treatments, and laser restorative dentistry. Articles were evaluated by title and/or abstract and relevance to pediatric dental care. ~~Twenty-six citations were chosen from this method and from references within selected articles.~~ When data did not appear, sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians.

Background

Medicine began integrating lasers in the mid 1970's for soft tissue procedures (~~Coluzzi 2004;~~). Oral and maxillofacial surgeons incorporated the carbon dioxide (**CO_2**) laser into practice for removal of oral lesions in the 1980s[1,2]. ~~(Frame 1985; Coluzzi 2005).~~ The first laser specifically for dental use was a neodymium-yttrium-aluminum-garnet (**Nd:YAG**) laser, developed in 1987 and approved by the

Food and Drug Administration in 1990[3]. (~~Coluzzi 2004;~~ Since then, laser technology has advanced significantly. The use of lasers is contributing to many areas of dentistry including periodontics, pediatrics, endodontics, oral surgery, restorative dentistry and dental hygiene, cosmetic dental whitening and management of TMJ pain to name a few.

Laser Basics

While a detailed description of how lasers work is beyond the scope of this document, it is important to understand the basics of laser physics prior to selecting a laser for dental treatment. The term **laser** is an acronym for light amplification by stimulated emission of radiation. Lasers are classified by the active medium that is used to create the laser energy. Within a laser, an active medium is stimulated to produce photons of energy that are delivered in a beam of unique ~~with an exact~~ wavelength ~~unique to~~ that ~~medium~~ is measured in nanometers (nm)[4]. (~~Fasbinder 2008).~~ ~~Lasers typically are classified by the active medium that is used to create the energy~~. ~~The energy radiated by the laser is basically a light of one color (monochromatic) and thus a single wavelength (Fasbinder 2008). Oral hard and soft tissues have a distinct affinity for absorbing laser energy of a specific wavelength.~~ The wavelength of a dental laser is the determining factor of the level to which the laser energy is absorbed by the intended (target) tissue. Target ~~or identified~~ tissues differ in their affinity for specific wavelengths of laser energy depending on the presence of the "chromophore" or the laser absorbing elements of the tissue [4-6] ~~.(Coluzzi 2004; ; Fasbinder 2008; Green, Weiss, and Stern 2011; Martens 2011~~). Oral hard and soft tissues have a distinct affinity for absorbing laser energy of a specific wavelength. For this reason, selecting a specific laser unit depends on the target tissue that the practitioner wishes to treat. The primary effect of a laser within target tissues is photothermal[7]. ~~(Coluzzi 2004; ; White et al 1992).~~ When the temperature of the target tissue containing water is raised above 100 degrees centigrade, vaporization of the water occurs, resulting in ablation of soft tissue (~~Coluzzi 2004;~~). Since soft tissue is made up of a high percentage of water, excision of soft tissue initiates at this temperature. Hard tissue composed of hydroxyapatite crystals and minerals are not ablated at this temperature, but the water component is vaporized, the resulting steam expands and then disperses the encompassing material into small particles [6].(~~Coluzzi 2004;~~ Laser operating parameters such as power, frequency, emission mode, thermal relaxation time, air and water coolant used affect the clinical abilities of a laser. Additionally, the delivery system of laser unit as well as the tissue concentration of the 'chromophore' greatly influence the laser tissue interactions.

Various types of lasers have been used in dentistry. Clinical applications of the commonly used lasers in pediatric dentistry are listed in Table 1.

~~The CO_2 laser is well absorbed by water, and therefore effective in incising, excising, and coagulating soft tissue (Coluzzi 2004; ; Boj 2011). The CO_2 is primarily a soft tissue laser, as its wavelength is poorly absorbed by hydroxyapatite (Convissar and Goldstein 2003). The diode lasers (810-980 nm) contains a solid active medium and is are composed of semiconductor crystals of aluminum or iridiumk, gallium, and arsenic (Coluzzi 2004; ; Convissar and Goldstein 2003). This laser effectively is absorbed by pigmented tissues and has a good depth of penetration in soft tissues containing hemoglobin and melanin. The diode laser is relatively unable to be absorbed by hard tissue. For this reason, soft tissue surgery can be completed safely without affecting adjacent hard tissue structures (Coluzzi 2004; ; Boj 2011; Convissar and Goldstein 2003). The Nd:YAG laser consists of neodymium ions and crystal of yttrium, aluminum, and garnet (Green, Weiss, and Stern 2001). This laser energy is absorbed well by pigmented tissues and only minimally absorbed by hard tissue (Coluzzi 2004;). Soft tissue surgery can be completed adjacent to the tooth accurately and safely (Convissar and Goldstein 2003; Kotlow 2004). Pigmented surface carious lesions can be removed without affecting healthy tooth structure (Coluzzi 2000; White et al 1993). The Nd:YAG wavelengths are absorbed by hemoglobin and are effective in coagulation and hemostasis during soft tissue procedures (Coluzzi 2004; ; Kotlow 2004). Erbium lasers consist of two separate wavelengths. The 2,940 nm **Er:YAG** consists of erbium ions and a solid active medium of crystals of yttrium, aluminum, and garnet; the 2,780 nm **Er,Cr:YSGG** contains erbium, chromium ions, and a crystal of yttrium, scandium, gallium, and garnet (Coluzzi 2004; ; van As 2004). In addition to facilitating soft tissue procedures, the erbium lasers effectively can remove caries and prepare enamel, dentin, cementum, and bone (van As 2004; Olivi and Genovese 2011).~~

~~**Diagnostic applications**~~

~~Laser fluorescence (**LF**) can be used as an additional tool combined with conventional methods for detection of occlusal caries (Olivi, Genovese, and Caprioglio 2009). The portable diode laser-based system interprets the emitted fluorescence on the occlusal surface which correlates with the extent of demineralization in the tooth (Martens 2011; Kotlow 2004). Laser digital readings can indicate the~~

~~proportional amount of caries present. LF may be used as a complementary instrument when diagnosing occlusal caries in cases of questionable findings after visual inspection (Martens 2011; Olivi, Genovese, and Caprioglio 2009). LF caries detection is not recommended under dental resins or sealants due to a high probability of unreliable readings as a result of the intrinsic fluorescence from the sealant material (Olivi, Genovese, and Caprioglio 2009).~~

Laser Type	Wavelength	Applications
Diode	450 - 655 nm	1. Laser Fluorescence (LF) – Diagnostic applications, Detection of occlusal caries, Detecting calculus in periodontal pockets, detection of dysplastic cells during oral cancer screening
Diode	810 - 980 nm	1. Soft tissue ablation - gingival contouring for esthetic purposes, frenectomy and gingivectomy, operculectomy 2. Photobiomodulation - Proliferation of fibroblasts and enhancing the healing of oral lesions (Mucositis) or surgical wounds 3. Periodontal procedures – Laser bacterial reduction, elimination of necrotic epithelial tissue during regenerative periodontal surgeries 4. Whitening
Er, Cr: YSGG	2780 nm	1. Hard tissue procedures - Enamel etching, Caries removal and Cavity preparation in enamel and dentin 2. Osseous tissue procedures - Bone ablation 3. Soft tissue ablation - gingival contouring for esthetic purposes, frenectomy and gingivectomy, operculectomy 4. Endodontic Therapy - Pulp cap, Pulpotomy, Pulpectomy and Root canal preparation 5. Periodontal procedures - Laser bacterial reduction, elimination of necrotic epithelial tissue during regenerative periodontal surgeries 6. Treatment of oral ulcerative lesions
Er: YAG	2940 nm	1. Hard tissue procedures - Caries removal and cavity preparation in enamel and dentin 2. Endodontic Therapy - Root canal preparation
CO_2	9300 nm	1. Hard tissue procedures - Caries removal and cavity preparation in enamel and dentin 2. Osseous tissue procedures - Bone ablation 3. Soft tissue procedures - Incision, excision, vaporization, coagulation and hemostasis 4.
CO_2	10600 nm	1. Soft tissue ablation - gingival contouring for esthetic purposes, frenectomy and gingivectomy 2. Treatment of oral ulcerative lesions 3. Elimination of necrotic epithelial tissue during regenerative periodontal surgeries

~~Soft tissue clinical applications~~

~~Dental lasers have been used for numerous clinical soft tissue procedures in pediatric dentistry. Clinical applications include maxillary and lingual frenectomies, operculectomies, exposure of teeth for orthodontic purposes, gingival contouring/ gingivectomies, removal of mucosal lesions and biopsies, and treatment of aphthous ulcers and herpetic lesions~~ and laser bacterial reduction in periodontal pocket ~~(Martens 2011; Boj 2011; Kotlow 2004).~~

~~CO_2, diode, and Nd:YAG lasers all have the capability of effectively incising tissue, coagulating and contouring tissues (Martens 2001; Boj 2011). Erbium lasers also have the capability of providing soft tissue procedures; however, the hemostatic ability of these wavelengths is not as effective as CO_2, diode, and Nd:YAG wavelengths (Coluzzi 2004; ; Convissar and Goldstein 2003; Coluzzi 2000).~~

~~Hard tissue clinical applications~~

~~The~~ 1064 nm ~~Nd:YAG,~~ 2,780 nm Er,Cr:YSGG , 2,940 nm ~~Er:YAG, and~~ 9,300nm CO_2 ~~lasers have all been used successfully for removal of caries and preparation of teeth for restorative procedures in children and adolescents (Kotlow 2004; van As 2004; Olivi and Genovese 2011; Olivi, Genovese, and Caprioglio 2009). Lasers also have been used effectively for indirect and direct pulp capping treatments (Olivi and Genovese 2011; Olivi, Genovese, and Caprioglio 2009). The erbium lasers are the predominant lasers used for hard tissue procedures (Kotlow 2004; van As 2004; Olivi and Genovese 2011).~~

~~Endodontic applications~~

~~Dental lasers have been utilized for endodontic procedures.~~ ~~For eg.~~ ~~2,780 nm Er,Cr:YSGG , 2,940 nm Er:YAG can be used for primary tooth pulpotomies and root canal disinfection (Kotlow 2004; van As 2004; Olivi and Genovese 2011; Olivi, Genovese, and Caprioglio 2009). Success rates of laser pulpotomies have been comparable to those of formocresol pulpotomies (Kotlow 2004; Elliott et all 1999; Pescheck, Pescheck and Moritz 2002).~~

Laser safety

Laser 'plume' which is mixture of gases as well as debri is generated during the use of lasers. When

using dental lasers, it is imperative that the doctor and auxiliaries adhere to infection control protocol and utilize high-speed suction as the vaporized aerosol may contain infective tissue particles [2,8]. The practitioner should exercise good clinical judgment when providing soft tissue treatment of viral lesions in immunocompromised patients; as the potential risk of disease transmission from laser-generated aerosol exists [9,10]. To prevent viral transmission, palliative pharmacological therapies may be more acceptable and appropriate in this group of patients. Reflected or scattered laser beams may be hazardous when exposed to unprotected skin or eyes. Wavelength-specific protective eyewear should be provided and consistently worn at all times by the dental team, patient, and other observers in attendance during laser use [2]. Many states have well defined laser safety regulations and practitioners should contact their specific state boards to obtain this information.

Lasers in pediatric dentistry

One of the benefits of laser use in pediatric dentistry is the selective and precise interaction with diseased tissues [2].Less thermal necrosis of adjacent tissues is produced with lasers than with electrosurgical instruments [11].During soft tissue procedures, hemostasis can be obtained without the need for sutures in most cases [2,12].With the benefit of hemostasis during soft tissue treatments, wound healing can occur more rapidly with less post-operative discomfort and a reduced need for analgesics[6,11-13]. Little to no local anesthesia is required for most soft-tissue treatments [6,12-14]. Reduced operator chair time has been observed when soft tissue procedures have been completed using lasers[12, 13]. Lasers demonstrate decontaminating and bactericidal properties on tissues, requiring less prescribing of antibiotics post-operatively [6,12,13].Lasers can provide relief from the pain and inflammation associated with aphthous ulcers and herpetic lesions without pharmacological intervention [5,12,13].

~~The erbium~~ Lasers can remove caries effectively with minimal involvement of surrounding tooth structure because caries-affected tissue has a higher water content than healthy tissue [11]. The noise and vibration of the conventional high-speed dental handpiece has been postulated as stimulating discomfort, pain, and anxiety for the pediatric patient during restorative procedures [6,15-17].The non-contact of erbium lasers with hard tissue eliminates the vibratory effects of the conventional high-speed handpiece allowing tooth preparations to be comfortable and less anxiety provoking for children and adolescents [6,15,17]. Nd:YAG and erbium lasers have been shown to have an analgesic effect on hard

tissues, eliminating injections and the use of local anesthesia during tooth preparations [6,15,18-20].

Limitations of lasers in pediatric dentistry

There are some disadvantages of laser use in pediatric dentistry. ~~Laser use requires additional training and education for the various clinical applications and types of lasers (Coluzzi 2005; van As 2004; Olivi and Genovese 2011; Olivi, Genovese, and Caprioglio 2009). High startup costs are required to purchase the equipment, implement the technology, and invest in the required education and training (Coluzzi 2005; Olivi, Genovese, and Caprioglio 2009).~~ Since different wavelengths are necessary for various soft and hard tissue procedures, the practitioner may need more than one laser [2].~~Most dental instruments are both side and end-cutting. When using lasers, modifications in clinical technique along with additional preparation with high-speed dental handpieces may be required to finish tooth preparations (Coluzzi 2005; Olivi and Genovese 2011).~~ Laser use requires additional training and education for the various clinical applications and types of lasers [2,13,15,18]. High startup costs are required to purchase the equipment, implement the technology, and invest in the required education and training [2,13].Most dental instruments are both side and end-cutting. When using lasers, modifications in clinical technique along with additional preparation with high-speed dental hand-pieces may be required to finish tooth preparations [2,15].There are a variety of resources such as the Academy of Laser Dentistry, available to assist dentists in the training and education for safe and effective use of lasers.

Policy statement

The AAPD:

- Recognizes the use of lasers as an alternative and complementary method of providing soft and hard tissue dental procedures for infants, children, adolescents, and persons with special health care needs.
- Advocates the dental professional receive additional didactic and experiential education and training on the use of lasers before applying this technology on pediatric dental patients.
- Encourages dental professionals to research, implement, and utilize the appropriate laser specific and optimal for the indicated procedure.
- Endorses use of protective eyewear specific for laser wavelengths during treatment for the dental team, patient, and observers.

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