Policy on the Use of Lasers for Pediatric Dental Patients

Originating Council
Council on Clinical Affairs
Adopted
2013

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.[1] Oral and maxillofacial surgeons incorporated the carbon dioxide (CO_2) laser into practice for removal of oral lesions in the 1980s.[2,3] 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.[1,4]

The term **laser** is an acronym for light amplification by stimulated emission of radiation. Within a laser, an active medium is stimulated to produce photons of energy that are delivered in a beam with an exact wavelength unique to that medium.[5] 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.[5] 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 tissue. Target or identified tissues differ in their affinity for specific wavelengths of laser energy.[1,5-7] For this reason, selecting a specific laser depends on the target tissue the practitioner wishes to treat. The primary effect of a laser within target tissues is photothermal.[1,8] When the target tissue containing water is raised above 100 degrees centrigade, vaporization of the water occurs, resulting in soft tissue ablation.[1] 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.[1,7]

Various types of lasers have been used in dentistry. The CO_2 laser is well absorbed by water, and therefore effective in incising, excising, and coagulating soft tissue.[1,9] The CO_2 is primarily a soft tissue laser, as its wavelength is poorly absorbed by hydroxyapatite.[10] The diode laser contains a solid active medium and is composed of semiconductor crystals of aluminum or iridium, gallium, and arsenic.[1,10] This laser effectively is absorbed by pigmented tissues and has a good depth of penetration. 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.[1,9,10] The Nd:YAG laser consists of neodymium ions and crystal of yttrium, aluminum, and garnet.[6] This laser energy is absorbed well by pigmented tissues and only minimally absorbed by hard tissue.[1] Soft tissue surgery can be completed adjacent to the tooth accurately and safely.[10,11] Pigmented surface carious lesions can be removed without affecting healthy tooth structure.[12,13] The Nd:YAG wavelengths are absorbed by hemoglobin and are effective in coagulation and hemostasis during soft tissue procedures.[1,11] Erbium lasers consist of two separate wavelengths. The **Er:YAG** consists of erbium ions and a solid active medium of crystals of yttrium, aluminum, and garnet; the **Er,Cr:YSGG** contains erbium, chromium ions, and a crystal of yttrium, scandium, gallium, and garnet.[1,14] In addition to facilitating soft tissue procedures, the erbium lasers effectively can remove caries and prepare enamel, dentin, cementum, and bone.[14,15]

Diagnostic applications

Laser fluorescence (**LF**) can be used as an additional tool combined with conventional methods for detection of occlusal caries.[16] The portable diode laser-based system interprets the emitted fluorescence on the occlusal surface which correlates with the extent of demineralization in the tooth.[7,11] 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.[7,16] 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.[16]

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.[7,9,11] CO_2, diode, and Nd:YAG lasers all have the capability of effectively incising tissue, coagulating and contouring tissues.[7,9] 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.[1,10,12]

Hard tissue clinical applications

The Nd:YAG, Er:YAG, and Er,Cr:YSGG lasers have all been used successfully for removal of caries and preparation of teeth for restorative procedures in children and adolescents.[11,14-16] Lasers also have been used effectively for indirect and direct pulp capping treatments.[15,16] The erbium lasers are the predominant lasers used for hard tissue procedures.[11,14,15] Dental lasers have been utilized for endodontic procedures such as primary tooth pulpotomies and root canal disinfection.[11,14-16] Success rates of laser pulpotomies have been comparable to those of formocresol pulpotomies.[11,17,18]

Lasers in pediatric dentistry

One of the benefits of laser use in pediatric dentistry is the selective and precise interaction with diseased tissues.[3] Less thermal necrosis of adjacent tissues is produced with lasers than with electrosurgical instruments.[1,11] During soft tissue procedures, hemostasis can be obtained without the need for sutures in most cases.[3,9] 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.[7,9,11,16] Little to no local anesthesia is required for most soft-tissue treatments.[7,9-11,16] Reduced operator chair time has been observed when soft tissue procedures have been completed using lasers.[9,11,16] Lasers demonstrate decontaminating and bacteriocidal properties on tissues, requiring less prescribing of antibiotics post-operatively.[7,9,11,16] Lasers can provide relief from the pain and inflammation associated with aphthous ulcers and herpetic lesions without pharmacological intervention.[6,9,16]

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.[1,3,12] 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.[7,15,19,20] 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.[7,11,15,20] 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.[7,11,14,15,21-23]

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.[3,14,15,16] High start up costs are required to purchase the equipment, implement the technology, and invest in the required education and training.[3,16] Since different wavelengths are necessary for various soft and hard tissue procedures, the practitioner may need more than one laser.[3] 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.[3,15] 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.[1,3] 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.[3,11,24] 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.[25,26] To prevent viral transmission, palliative pharmacological therapies may be more acceptable and appropriate in this group of patients.

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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