Policy on the Use of Lasers for Pediatric Dental Patients

Latest Revision

2022

How to Cite: American Academy of Pediatric Dentistry. Policy on the use of lasers for pediatric dental patients. The Reference Manual of Pediatric Dentistry. Chicago, Ill.: American Academy of Pediatric Dentistry; 2024:135-8.

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 support safe and evidence-based use of lasers through a review of the fundamentals, types, diagnostic and clinical applications, benefits, and limitations of laser use in pediatric dentistry.

Methods

This policy was developed by the Council on Clinical Affairs, adopted in 2013[1], and last revised in 2017[2]. The revision is based on a review of current dental and medical literature related to the use of lasers. This document included database searches using the 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. Expert and/or consensus opinion by experienced researchers and clinicians also was considered.

Background

Medicine began integrating lasers for soft tissue procedures in the mid-1970s. Oral and maxillofacial surgeons incorporated the carbon dioxide (**CO_2**) laser into practice for removal of oral lesions in the 1980s.[3] The first laser specifically for dental use was a neodymium:yttrium-aluminum-garnet (**Nd:YAG**) laser, developed in 1987 and approved by the United States Food and Drug Administration in 1990.[4] Since then, laser technology has advanced significantly. Currently, lasers used in dentistry include Nd:YAG, argon, erbium, (erbium, chromium:yttrium-scandium-gallium-garnet [**Er,Cr:YSGG**] and erbium:yttrium-aluminum-garnet [**Er:YAG**]), diode, and two CO_2 wavelengths. The use of lasers contributes to many areas of dentistry including periodontics[5], pediatrics[5], endodontics, oral surgery[5], restorative dentistry, dental hygiene, cosmetic dental whitening, and pain management.[6-10]

Laser basics

While a detailed description of how lasers work is beyond the scope of this document, the basics of laser physics are important to understand prior to selecting a laser for dental treatment. The term laser is an acronym for light amplification by stimulated emission of radiation. Within a laser, an active medium (e.g., erbium crystal, CO_2 gas, a semiconductor) is stimulated to produce photons of energy that are delivered in a beam of unique wavelength measured in nanometers.[10] The wavelength of a dental laser is the determining factor of the level to which the laser energy is absorbed by the intended tissue.[10,11] Target 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.[10-12] Oral hard and soft tissues have a distinct affinity for absorbing laser energy of a specific wavelength.[10,11] For this reason, selecting a specific laser unit depends on the target tissue the practitioner wishes to treat.

The primary effect of a laser within target tissues is photothermal, meaning the laser energy is transformed into heat.[10] When the temperature of the target tissue containing water is raised above 100 degrees Celsius, vaporization of the water occurs, resulting in soft tissue ablation.[10,11] Since soft tissue is made up of a high percentage of water, excision of soft tissue initiates at this temperature. Dental hard tissue is composed of hydroxyapatite, mineral, and water. Erbium lasers do not ablate hard tissues directly, but vaporization of the water component causes the resulting steam to expand and then disperses the encompassing material into small particles, a process known as spallation.[11,12] The 9300 nanometer (**nm**) CO_2 wavelength targets absorption within the water component, as well as the phosphate and hydrogen phosphate anions of the hydroxyapatite mineral molecule and is, therefore, capable of ablating enamel and dentin.[7,11]

Laser operating parameters such as power, frequency, emission mode, thermal relaxation time, and air and water coolant used affect the clinical abilities of a laser.[10,11] Additionally, the delivery system of laser unit as well as the tissue concentration of the chromophore greatly influence the laser-tissue interactions.[7,10]

ABBREVIATIONS

AAPD: American Academy of Pediatric Dentistry. **CO_2:** Carbon dioxide. **Er,Cr:YSGG:** Erbium, chromium:yttrium-scandium-gallium-garnet. **Er:YAG:** Erbium:yttrium-aluminum-garnet. **Nd:YAG:** Neodymium-yttrium-aluminum-garnet. **nm:** Nanometer. **PBM:** Photobiomodulating.

Clinical applications of the lasers commonly used in pediatric dentistry are listed in the Table.

Laser safety

Adherence to safe practices is a duty of every practitioner, but identification of a laser safety officer for a clinical facility can maximize safe and effective laser operations. This person would provide all necessary information, inspect and maintain the laser and its accessories, and ensure that all safety procedures are implemented.[10] Because reflected or scattered laser beams may be hazardous to unprotected skin or eyes, wearing wavelength-specific protective eyewear is required by the dental team, patient, and observers at all times during laser use.[10] Laser plume results from the aerosol byproducts of laser-tissue interaction and may contain particulate organic and inorganic matter (e.g., viruses, toxic gases, chemicals) which may be infectious or carcinogenic.[10]

When using dental lasers, adherence to infection control protocol, including wearing a 0.1 micron (μm) filtration mask, and utilization of high-speed suction are imperative.[10] Sparks from lasers can contribute to patient fire in the presence of an oxidizer-enriched atmosphere and combustible agents (e.g., dry gauze, throat pack, paper, cotton products; hair; petroleum-based lubricants; alcohol-based products; rubber dam, nitrous mask).[13-16] Safe laser practices reduce the risk of fire.[13]

Providing soft tissue treatment of viral lesions in immunocompromised patients has the risk of disease transmission from laser-generated aerosol.[17,18] Palliative pharmacological therapies may be more acceptable and appropriate in this group of patients in order to prevent viral transmission.[18] Many states have well-defined laser safety regulations, and information can be obtained from state boards.

Benefits of lasers in pediatric dentistry

One of the benefits of laser use in pediatric dentistry is the selective and precise interaction with diseased tissues.[10] Less thermal necrosis of adjacent tissues is produced with lasers than with electrosurgical instruments.[10] During soft tissue procedures, hemostasis can be obtained without the need for sutures in most cases.[5,10,11] This may allow wound healing to occur more rapidly with less postoperative discomfort and a reduced need for analgesics.[5,9-12] Little to no local anesthesia is required for most soft-tissue treatments.[5,9-12] Reduced operator chair time has been observed when soft-tissue procedures have been completed using lasers.[5,9] Lasers demonstrate decontaminating and bacteriocidal properties on tissues, requiring less prescribing of antibiotics postoperatively.[5,9,11,12]

Laser therapeutics can occur without a photothermal event, and these effects are known as photobiomodulating (**PBM**) or low-level laser effects.[6] PBM therapy has been used in children for prevention and treatment of oral mucositis associated with immunosuppressive therapy (chemotherapy, radiation, and transplants).[19-22] PMB may reduce postsurgical or traumatic oral pain[6] and pain during cavity preparation.[23] Laser therapy (PBM as well as application of erbium and CO_2 laser energy[24,25]) can provide relief from the pain and inflammation associated with aphthous ulcers and herpetic lesions without pharmacological intervention[5,9,26,27]; however, more studies are needed to establish the laser type and therapeutic parameters (e.g., applied energy, wavelength, power outlet) recommended for children.[25]

Nd:YAG, erbium, and 9300 nm CO_2 lasers have been shown to have an analgesic effect on hard tissues, reducing or eliminating the use of local anesthesia during tooth preparations.[7,12,28-32] The mechanism for laser analgesia is not known; however, proposed explanations include that the photoacoustic effect of laser energy acts within the gate control pathway blocking pain sensations, direct and indirect influences of laser energy on nerves and nociceptors, and modifications of the sodium/potassium pump systems inhibiting nerve transmission.[7,33] During restorative procedures. conventional dental handpieces produce noise and vibrations which have been postulated as stimulating discomfort, pain, and anxiety for the pediatric patient.[12,23,29,34] The noncontact of lasers with hard tissue eliminates the vibratory effects of the conventional high-speed handpiece and may reduce anxiety related to rotary instruments.[35]

Lasers can remove caries effectively with minimal involvement of surrounding tooth structure because caries-affected tissue has a higher water content than healthy tissue.[7,10]

Disadvantages of lasers in pediatric dentistry

Laser use in pediatric dentistry has some disadvantages. Since different wavelengths are necessary for various soft and hard tissue procedures, the practitioner may need more than one laser.[10] Laser use requires additional training and education for the various clinical applications and types of lasers.[9,10,29,30] High start-up costs are required to purchase the equipment, implement the technology, and invest in the required education and training.[9,10] Laser manufacturers provide training on their own units, but most laser education is obtained through continuing education courses. Few dental schools and graduate programs currently provide comprehensive laser education. Most dental instruments are both side- and end-cutting; lasers are exclusively end-cutting, and lasers are unable to ablate metallic restorations.[7,10] Cavity preparations are slower to make with a laser than with a highspeed handpiece.[7] Modifications in clinical technique along with additional preparation with handpieces may be required to finish tooth preparations.[10,29]

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 patients.

Table. LASER BASICS IN PEDIATRIC DENTISTRY

Laser type	Wavelength	Applications
Diode	450 - 655 nm‡	1. Laser fluorescence – diagnostic applications, detection of occlusal caries, detecting calculus in periodontal pockets, detection of dysplastic cells during oral cancer screening[7,10]
Diode	810 - 980 nm	1. Soft tissue ablation – gingival contouring for esthetic purposes, frenectomy, gingivectomy, operculectomy, biopsy[5,10] 2. Photobiomodulation – proliferation of fibroblasts and enhancing the healing of oral lesions (mucositis, aphthous ulcers, herpetic lesions) or surgical wounds[6,25] 3. Periodontal procedures – laser bacterial reduction, elimination of necrotic epithelial tissue during regenerative periodontal surgeries[36] 4. Enamel whitening[8]
Er, Cr:YSGG*	2,780 nm	1. Hard tissue procedures – enamel etching, caries removal and cavity preparation in enamel and dentin[5,7,10] 2. Osseous tissue procedures – bone ablation[5,10] 3. Soft tissue procedures – incision, excision, vaporization, coagulation and hemostasis; gingival contouring for esthetic purposes, frenectomy, gingivectomy, operculectomy, biopsy[5,10] 4. Endodontic therapy – pulp cap, pulpotomy, pulpectomy, root canal preparation[37] 5. Periodontal procedures – laser bacterial reduction, elimination of necrotic epithelial tissue during regenerative periodontal surgeries[36] 6. Treatment of oral ulcerative lesions[24]
Er:YAG**	2,940 nm	1. Hard tissue procedures – caries removal and cavity preparation in enamel and dentin[5,7,10] 2. Endodontic therapy – root canal preparation[37]
CO_2†	9,300 nm	1. Hard tissue procedures – caries removal and cavity preparation in enamel and dentin[11] 2. Osseous tissue procedures – bone ablation 3. Soft tissue procedures – gingival contouring for esthetic purposes, frenectomy, gingivectomy, operculectomy, biopsy[5,10]
CO_2	10,600 nm	1. Soft tissue procedures – gingival contouring for esthetic purposes, frenectomy, gingivectomy biopsy[5,10,37] 2. Treatment of oral ulcerative lesions[25,37] 3. Periodontal procedures – elimination of necrotic epithelial tissue during regenerative periodontal surgeries[37]

* Er, Cr:YSGG – erbium, chromium, yttrium, scandium, gallium, garnet. ** Er:YAG – erbium, yttrium, aluminium, garnet. † CO_2: Carbon dioxide.
‡ nm – nanometer.

- encourages dental professionals to research, implement, and utilize the appropriate laser specific and optimal for the indicated procedure. Understanding the technology and clinical implications is necessary before practitioners utilize lasers in patient care.
- encourages additional research regarding the safety, efficacy, and application of lasers for dental care for pediatric patients.
- supports patient, visitor, and staff safety through identification of a laser safety officer, supplementation of infection control practices, and use of wavelength-specific protective eyewear when a dental facility employs laser technology.

References

1. American Academy of Pediatric Dentistry. Policy on use of lasers for pediatric dental patients. Pediatr Dent 2013;35(special issue):75-7.
2. American Academy of Pediatric Dentistry. Policy on use of lasers for pediatric dental patients. Pediatr Dent 2017;39(6):93-5.
3. Frame JW. Carbon dioxide laser surgery for benign oral lesions. Br Dent J 1985;158(4):125-8.
4. Myers TD, Myers ED, Stone RM. First soft tissue study utilizing a pulsed Nd:YAG dental laser. Northwest Dent 1989;68(2):14-7.
5. Boj JR, Poirer C, Hernandez M, Espassa E, Espanya A. Review: Laser soft tissue treatments for paediatric dental patients. Eur Arch Paediatr Dent 2011;12(2):100-5.
6. Fornaini C, Arany P, Rocca J, Merigo E. Photobiomodulation in pediatric dentistry: A current state-of-the-art. Photomed Laser Surg 2019;37(12):798-813.
7. Parker S. Lasers in restorative dentistry. In: Convisar RA, ed. Principles and Practice of Laser Dentistry. 2nd ed. St. Louis, Mo.: Elsevier Mosby; 2016:162-77.

References continued on the next page.

8. Suresh S, Navit S, Khan S, et al. Effect of diode laser office bleaching on mineral content and surface topography of enamel surface: An SEM study. Int J Clin Ped Dent 2020;13(5):480-5.
9. Olivi G, Genovese MD, Caprioglio C. Evidence-based dentistry on laser paediatric dentistry: Review and outlook. Eur J Paediatr Dent 2009;10(1):29-40.
10. Coluzzi DJ, Convissar RA, Roshkind DM. Laser fundamentals. In: Convissar RA, ed. Principles and Practice of Laser Dentistry. 2nd ed. St. Louis, Mo.: Elsevier Mosby; 2016:12-26.
11. Parker S, Cronshaw M, Anagnostaki E, Mylona V, Lynch E, Grootveld M. Current concepts of laser-oral tissue interaction. Dent J (Basel) 2020;8(3):61. Available at: "https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7558496/". Accessed May 31, 2022.
12. Martens LC. Laser physics and review of laser applications in dentistry for children. Eur Arch Paediatr Dent 2011; 12(2):61-7.
13. American Academy of Pediatric Dentistry. Policy on patient safety. The Reference Manual of Pediatric Dentistry. Chicago, Ill: American Academy of Pediatric Dentistry; 2022:176-80.
14. Chen JW. Fire during deep sedation and general anesthesia-urban myth or real nightmare? Pediatr Dent Today 2019;LIV(6):32. Available at: "https://www.pediatricdentistrytoday.org/2019/November/LIV/6/news/article/1304/". Accessed March 11, 2022.
15. Bosack R, Bruley M, VanCleave A, Weaver J. Patient fire during dental care: A case report and call for safety. J Am Dent Assoc 2016;147(8):661-7.
16. Weaver JM. Prevention of fire in the dental chair. Anesth Prog 2012;59(3):105-6.
17. Parker S. Laser regulation and safety in general dental practice. Br Dent J 2007;202(9):523-32.
18. Garden JM, O'Bannon MK, Bakus AD, Olson C. Viral disease transmitted by laser-generated plume (aerosol). Arch Dermatol 2002;138(10):1303-7.
19. American Academy of Pediatric Dentistry. Dental management of pediatric patients receiving immunosuppressive therapy and/or head and neck radiation. The Reference Manual of Pediatric Dentistry. Chicago, Ill.: The American Academy of Pediatric Dentistry; 2022: 507-16.
20. Elad S, Cheng KKF, Lalla RV, et al; Mucositis Guidelines Leadership Group of the Multinational Association of Supportive Care in Cancer and International Society of Oral Oncology (MASCC/ISOO). MASCC/ISOO clinical practice guidelines for the management of mucositis secondary to cancer therapy. Cancer 2020;126(19): 4423-31.
21. Miranda-Silva W, Gomes-Silva W, Zadik Y, et al. Mucositis Study Group of the Multinational Association of Supportive Care in Cancer/International Society for Oral Oncology (MASCC/ISOO). MASCC/ISOO clinical practice guidelines for the management of mucositis: Sub-analysis of current interventions for the management of oral mucositis in pediatric cancer patients. Support Care Cancer 2021;29(7):3539-62.
22. Zadik Y, Arany P R, Fregnani ER, et al. Systematic review of photobiomodulation for the management of oral mucositis in cancer patients and clinical practice guidelines. Supp Care in Cancer 2019;27(10):3969-83.
23. Tanboga I, Eren F, Altinok B, Peker S, Ertugral F. The effect of low level laser therapy on pain during dental tooth-cavity preparation in children. Eur Arch Paediatr Dent 2011;12(2):93-5.
24. Yilmaz HG, Albaba MR, Caygur A, Cengiz E, Boke-Karacaoglu F, Tumer H. Treatment of recurrent aphthous stomatitis with Er,CR:YSGG laser irradiation: A randomized controlled split mouth clinical study. J Photochem Photobiol B 2017;170:1-5.
25. Suter VGA, Sjolund S, Bornstein MM. Effect of laser on pain relief and wound healing of recurrent aphthous stomatitis: A systematic review. Lasers Med Sci 2017;32 (4):954-63.
26. Green J, Weiss A, Stern A. Lasers and radiofrequency devices in dentistry. Dent Clin North Am 2011;55(3): 585-97.
27. Bardellini E, Veneri F, Amadori F, Conti G, Majorana A. Photobiomodulation therapy for the management of recurrent aphthous stomatitis in children: Clinical effectiveness and parental satisfaction. Med Oral Patol Oral Circ Bucal 2020;25(4):e549-e53.
28. Caprioglio C, Olivi G, Genovese MD. Pediatric laser dentistry. Part 1: General introduction. Eur J Paediatr Dent 2017;18(1):80-2.
29. Olivi G, Genovese MD. Laser restorative dentistry in children and adolescents. Eur Arch Paediatr Dent 2011; 12(2):68-78.
30. van As G. Erbium lasers in dentistry. Dent Clin North Am 2004;48(4):1017-59.
31. Matsumoto K, Hossain M, Hossain MM, Kawano H, Kimura Y. Clinical assessment of Er,Cr:YSGG laser applications for caries removal and cavity preparation in children. Med Laser Appl 2002;20(1):17-21.
32. DenBesten PK, White JM, Pelino JEP, Furnish G, Silveira A, Parkins FM. The safety and effectiveness of an Er:YAG laser for caries removal and cavity preparation in children. Med Laser Appl 2001;16(3):215-22.
33. Poli R, Parker S, Anagnostaki E, Mylona V, Lynch E, Grootveld M. Laser analgesia associated with restorative dental care: A systematic review of the rationale, techniques, and energy dose considerations. Dent J 2020;8(4):128. Available at: "https://www.ncbi.nlm.nih.gov/pmcarticles/PMC7712922/". Accessed May 31, 2022.
34. Takamori K, Furukama H, Morikawa Y, Katayama T, Watanabe S. Basic study on vibrations during tooth preparations caused by highspeed drilling and Er:YAG laser irradiation. Lasers Surg Med 2003;32(1):25-31.
35. Merigo E, Fornaini C, Clini F, Fontana M, Cella L, Oppici A. Er:YAG laser dentistry in special needs patients. Laser Therapy 2015;24(3):189-93.
36. Low S. Lasers in surgical periodontics. In: Convissar RA, ed. Principles and Practice of Laser Dentistry. 2nd ed. St. Louis Mo.: Elsevier Mosby; 2016:51-66.
37. Nazemisalman B, Farsadeghi M, Sokhansanj M. Types of lasers and their applications in pediatric dentistry: A review. J Lasers Med Sci 2015;6(3):96-101.