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Laser Applications in Pediatric Dentistry: A Review Article

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Abstract

Light has been used as a therapeutic agent for many centuries. Lasers have grown in scope of treatment and number of dental professionals using them. Lasers are not longer limited to treating soft tissue conditions of periodontics or oral surgery but have wide range of hard tissue applications. Lasers can be utilized for teeth brightening, haemostasis and coagulation, tissue decontamination, melanin depigmentation, hard and delicate tissue removal. This paper will discuss about the applications of lasers in pediatric dentistry.

Keywords: Pediatric Dentistry, Pulp therapy, Lasers

Introduction

The word LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. Einstein first described laser function in 1917, although the actual technology was not developed until the 1960s.[1] Dr Leon Goldman,[2] a dermatologist who had been exploring different avenues regarding tattoo expulsion utilizing the ruby laser, centered two beats of that red light on a tooth of his dental practitioner sibling in 1965.Often the word lasers are associated with the words like "magical" and "lightening quick" with the use of lasers in medical practice. Laser applications for medical science began in the 1970s[3] and the first application in dentistry was as a replacement for scalpels and cautery instruments in oral soft tissue surgery.[4] Laser energy is created by intensified light, which is generated by stimulating a synthetic medium inside a light chamber and are typically named after the active medium that generates the photons.[1] The most commonly used dental laser include neodymium-doped yttrium aluminum garnet (Nd:YAG), neodymium-doped yttrium aluminum perovskite (Nd:YAP) carbon dioxide (CO_2), erbium-doped yttrium aluminum garnet (Er:YAG), , holmium yttrium aluminum garnet (HO:YAG), gallium arsenide (diode), erbium chromium-doped yttrium scandium gallium garnet (Er-Cr:YSGG), and argon lasers. These are Indicated for both adult and pediatric patients, medical and dental lasers have variable wavelengths, and operate in continuous-wave, pulsed or running-pulsed modes.[4]

Laser- Tissue Interaction

When laser light is applied on target tissue, it initiates photothermal reaction which causes heat generation and thereby, rise in temperature within the tissue.[5]When this temperature is above 60°C, it causes protein coagulation within the tissue. However, when the temperature rises above 100°C, it causes vaporization of water molecule and soft-tissue ablation.[6]However,

above 200°C temperature is required for hard tissue procedure.[7] Because of the monochromaticity of laser energy, different laser wavelengths have different absorption coefficients when in contact with dental tissue; laser energy can be transmitted or absorbed based on the composition of target tissue. Water, which is present in all biologic tissue, best absorbs the two Erbium wavelengths, followed by CO2 wavelength. Haemoglobin and other blood components and the tissue pigment melanin absorb the short wavelength lasers.[8] Apatite crystal, readily absorbs CO2 wavelength and however, does not absorb the shorter wavelengths of Argon, diode, and Nd: Yag. Because human dental tissues are composed of a combination of water, apatite crystal, blood, and the tissue pigment, the clinician must choose the best laser for each treatment.

Applications of Lasers in Pediatric Dentistry

Caries Detection by Laser Induced Fluorescence

Conventional methods of diagnosing dental caries such as manual probing and radiographic evaluation are often ineffective in detecting enamel defects as it has the potential of stimulating caries due to the iatrogenic damage caused by the explorer. Laser technology has been developed and studied as an adjunct to clinical and radiographic caries diagnosis. A new era has been began with laser in regard to early caries detection methods such as: Diagnodent, Quantitative laser fluorescence, Optical coherence tomography which are non or minimally invasive method to clinical management of dental caries.[9] Analysis of the light reflected from occlusal surfaces of primary and permanent teeth is used to detect demineralization and changes in tooth structure.

Lasers in Prevention of Enamel and Dentinal Caries

Various mechanisms which suggest caries prevention by lasers are:

Lasers increase the acid resistance in lased enamel by creating structural alterations on ultra level, as a result of melting and re solidifying.

Diminution in the size of the apatite crystal, due to loss of water and CO_2, and that the hydroxyapatite crystal could be made more compact after laser irradiation, thus increasing to enamel resistance.[10]

Organic blocking theory: Partial denaturation of organic matrix may block the diffusion pathway in enamel, resulting in retardation of enamel demineralization.[11]

Laser can alter the chemical composition and morphology of the highly mineralized (96%) dental enamel. Frequencies <450Mj/cm^2 resulted in an increased Ca/P ratio, decreased amount of carbonate and protein and the formation of tri calcium phosphate and tetra calcium phosphate, suggesting the involvement of photo thermal mechanism[12]

Soft Tissue Applications

Lasers are excellent tools for removing soft-tissue lesions. There are many applications for pediatric soft tissue laser procedures in oral surgery, oral pathology, periodontology and orthodontics-including frenectomie s,frenotomies, operculectomies, gingivectomies, and treatment of aphthous and herpetic lesions.[13] Procedure is simple, efficient with minimal bleeding, and there is little or no post-operative discomfort . Ankyloglossia of the infant is a common condition in which the attachment of the lingual frenum is at the tip of the tongue and is most common in boys, with a reported incidence of 4% to 5%.[14] A scalpel, laser or electrosurgical knife is used to make a V-shaped incision separating the attachment. Advantages of using a laser include the specific interaction of the laser with treated tissue, rapid hemostasis, reduced postoperative discomfort and fast wound healing. The laser also has a

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decontaminating and antibacterial effect.[15]Removal of benign, diseased oral soft tissue, such as mucocele, gingival fibroma, and pyogenic granuloma, can also be achieved with a diode or Nd:YAG laser. Laser labial frenectomy is completed in a similar fashion, but can also include surgical repositioning of the frenum attachment.

Treatment of Aphthous Ulcers and Herpetic Lesions

Aphthous ulcers and herpetic ulcers treated with laser therapy, resulting in reduced healing time. The treatment involves low power settings, and the laser energy is directed at the target tissue in a noncontact fashion. The involved area is lased in 15-30 s intervals, without local anaesthesia and the procedure is repeated three or four times until the patient reports relief. In herpes labialis, laser has a palliative effect when the prodromal signs first appear and may prevent the development of a full herpes lesion. The infusion of laser energy disrupts the progress of viral activity, arresting lesions progression.

Treatment of Pericoronal Problems in Erupting Teeth

It is common for children when first permanent molars are erupting it develop discomfort, swelling, or infection in the tissue overlying the emerging tooth. Lasers can be used in a noncontact mode to ablate the involved tissue and expose clinical crown of the involved tooth. To expose a unerupted or partially erupted tooth for orthodontic bracket or button placement laser is used. As the laser-assisted surgical field is relatively bloodless, immediate placement of bracket or button can be done. Er: YAG, Nd:YAG, and Er-Cr: YSGG are mainly used for this purpose.

Pit and Fissure Sealants

Laser can be used for fissurotomy, cleaning, and conditioning of pits and fissures before sealant application.[16] Erbium laser is mostly used for this procedure. The laser allows the dentist to clean, sterilize, and clearly visualize the enamel grooves. The formation of enamel cracks and resulting microleakage at sealant enamel interface are the disadvantages of this technique which can be prevented by curing the sealant material using argon laser.[17] In primary teeth, surface conditioning with Er-Cr: YSGG laser does not have any effect in reducing microleakage at sealant enamel interface Furthermore, studies have shown that the erbium-etched enamel has similar properties to acid etched enamel.

Pulpal Therapy

Laser Doppler flowmetry is a noninvasive method of diagnosing pulp vitality. It uses helium, neon, and gallium aluminum as a semiconductor diode laser at a power of 1–2 mW which measures the changes in red blood cell flux in the pulp tissue[18]

In pediatric dentistry, pulpotomy is a common vital pulp procedure that seeks to maintain a tooth by removing infected coronal pulp tissue and preserving radicular pulp tissue.[19] During Laser pulpotomy in vital primary teeth, the laser cleans the pulp chamber in 10-20 s. The laser seems to provide adequate hemostasis and allows some vital tissue to remain at the apex. In non-vital teeth, the laser's success rates seem equal to conventional pulpotomy procedures, if a fistula is present, the success rate falls significantly.

Policy statement The AAPD:[20]

- 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

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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.

Conclusion

Lasers are a beneficial tool in providing dental restorative and soft tissue procedures for infants, children, and adolescents, including those with special health care needs. Due to its minimal invasiveness patients of pediatric age group show cooperative behaviour during dental procedure. With wide range of lasers applications from soft tissue surgery to caries preparation, the advantages include faster healing after trauma and surgery, and reduced pain following procedures.

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