REVIEW ARTICLE

LASER-ASSISTED DENTISTRY "MIGHTY TOOL IN PEDODONTICS" – A REVIEW

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ABSTRACT

Pediatric laser dentistry is a promising field in minimally invasive dentistry, which enables the provision of better care for children and adolescents. Laser technology in pediatric dentistry has led to a massive expansion of different treatment possibilities for children as it has begun to be more popular based on the nature of pediatric dentistry which requires the need to deal with children from birth through adolescence along with parent's compliance. Prior to the application of the laser beam, careful selection of patients, and special attention to the reliable scientific literature regarding the safety, efficacy, and effectiveness of the technology are desired. Laser has opened new horizons in the treatment of both soft and hard tissue procedures because of their numerous benefits in soft tissue surgeries, reducing or completely eliminating the need for local anesthesia, providing a bloodless field during cutting, and eventless healing period due to the bactericidal and bio-stimulant effects of laser.

KEY WORDS

Laser, DIAGNOdent, Lowlevel laser application

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INTRODUCTION

Modern notions of dentistry today have shifted to more micro- Invasive techniques such as chemo-mechanical techniques, kinetic (air abrasion), and hydrokinetic (laser) cavity preparation systems[1].

The concept of "Laser" in dentistry has already been established, acknowledging the fact that it has several implications in different domains of dentistry. Laser technology in paediatric dentistry has led to a massive expansion of different treatment possibilities for children as it has begun to be more popular based on the nature of pediatric dentistry.

The term "LASER" is an acronym formed out of the initials "Light amplification by stimulated emission of radiation" which was first described by Einstein in 1917[1]. In 1965 sognaes and stern first suggested the use of laser for caries prevention[2,3], the first laser specifically for dental use was the neodymium- yttrium-aluminium-Garnet (Nd:YAG) laser developed in 1987 and approved by the Food and drug administration in 1990, Oral and maxillofacial surgeons included the carbon dioxide (CO_2) laser into practice for soft tissue lesions[4,5,6]. The laser acts by concentrating high energies into a narrow beam of electromagnetic radiation. Laser light can have possible interactions with the target tissue depending on its optical properties-absorption, transmission, reflection, or scattering[1]. Absorption is the most important for hard tissue treatment as it will regulate the final ablation (e.g., cutting enamel and dentin)[7], reflected Dental therapy can be influenced by different absorption coefficients of tissues for each particular wavelength. The most important is carbon dioxide (co2λ=9.6um) for oral surgery, the neodymium:yttrium-aluminum-garnet (Nd:YAG, λ =1030nm) for endodontic and/or periodontal procedures, and potassium -titanyl phosphate (KTP λ=532 nm) for bleaching and soft tissue surgery, diode lasers for diagnosis, disinfection, low-level lasers (LLL) for bio stimulation.

Laser application in Diagnosis –

Based on emitted fluorescence of organic components of teeth and the difference between

sound and carious enamel Argon laser of wavelength 488nm is used for the detection of occlusal caries and interproximal lesions[8].Techniques such as qualitative light-induced (QLF) or Dye enhanced laser fluorescence if a fluorescing dye was used, both techniques appear adequate for the quantitative determination of caries as well as for occlusal and interproximal lesions[9,10,11]. A QLF method of quantification and detection of mineral loss in early carious lesions in primary teeth was somewhat more precise than in permanent teeth[12].

Laser fluorescence is used in addition to conventional methods for the diagnosis of occlusal caries in questionable case scenarios after visual inspection[13]. And it was found that at an excitation frequency of 655 nm the fluorescence intensity of caries can exceed that of the sound tooth which contributed to Developing a portable diode laser-based system (eg DIAGNOdent (kavo)[14].

Studies have reported that DIAGNOdent for the diagnosis of occlusal caries in deciduous teeth shows accurate results in comparison to traditional clinical methods but shows reduced efficacy in the presence of plaque or alterations in organic content, none the less, diagnosis tends to overscore discolored fissures.[15,16,17,18]

One of the main obstacles to the treatment of younger patients is fear so early detection of caries in primary teeth would allow greater use of simple adhesives restorations or directed preventive treatment thus carrying out procedures not requiring Local anaesthesia.

Figure 1: DIAGNOdent pen

Laser application in oral surgery –

Laser wavelength with an optical affinity for hemoglobin and water (chromophores contained in the gingiva and mucosa) can be used for these applications such as Nd:YAG, argon, Co_2, and diode lasers are used for cutting, coagulation, and decontamination of soft tissue[19,20]. Laser indications in pediatric dentistry include - Removal of the fibroma (Figure 2A to D), pyogenic granulomas (Figure 3A to D), frenectomies (lingual frenum, the maxillary labial frenum) (Figure 4A to C), Gingivectomy, exposure of unerupted tooth for orthodontic purposes (Fig 5A to C).

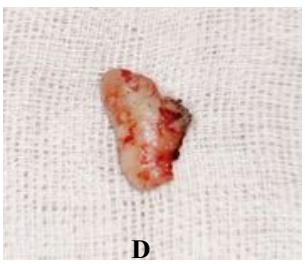
With the introduction of Erbium lasers, the paediatric dentist has a safe and efficient laser to treat hard and soft tissue of the oral cavity. Erbium laser permits a clean incision due to the air-water jet delivered through the handpiece and also causes vaporization of the soft tissues with a limited rise in the temperature[21] although the coagulating ability of their wavelength is not as effective as the wavelengths of Nd:YAGor co2. There are two wavelengths, Er,Cr:YSGG at 2790nm and Er: YAG at 2940nm, that are similarly effective in treating soft-tissue and hard-tissue lesions.

CLINICAL CASES

A

B

C



D

1. Fibroma

Figure 2A to D: (A) and (B) Preoperative pictures showing fibroma in relation to lower anteriors; (C) Postoperative picture after removal of fibroma using Laser; (D) excised fibromatous tissue.

A

B

C

D

2. Pyogenic granuloma

Figure 3A to D: (A) and (B) preoperative pictures showing pyogenic granuloma in relation to upper anteriors; (C) excised tissue (D) postoperative picture after removal of pyogenic granuloma using laser

A

B

C

3. Frenectomy

Figure 4A to C: (A) preoperative picture showing enlarged labial frenum; (B) perioperative picture after removal of frenum using laser (C) postoperative picture after suturing

A

B

C

4. Exposure of unerupted Tooth for orthodontic traction

Figure 5A to C: (A) perioperative picture showing the exposure of unerupted tooth using Laser; (B) postoperative picture after removal of the tissue; (C) CO_2Laser

Laser application in hard tissue-

A) Laser application for cavity preparation and caries removal –

An approach for the treatment of Early childhood caries by selective removal of surface enamel caries with the Nd:YAG laser, which is absorbed by carious but not by healthy enamel has proved to deliver several clinical advantages such as reduction of dentin permeability and hypersensitivity[22]. Another study was carried out where laser therapy assists in the removal of surface enamel caries but not the sound enamel below the lesion and it has been demonstrated to be both safe and effective with both clinical and histological evaluations of pulp vitality displaying no abnormalities[23]. The idea of substituting the drill with a laser instrument which has less impact on the patient has introduced this device to paediatric dentistry, and additionally delivers new possibilities for minimum interventions and overall, a better acceptance compared to conventional techniques[24,25,26].

A study carried out by celiberti et al has established the efficacy of laser in treating primary teeth by comparing the performance of four different dentin excavation methods- steel bur, polymer bur, Er:YAG laser, and manual excavator among which laser-produced instant results with low chances of over-preparation as per minimally invasive concepts[27]. Many authors have stated in their study that Er:YAG laser-ablated dentin surfaces have no smear layer and are open with clearly visible dentinal tubules[28,29]. A morphological study by Kohara et al. has presented that cavity preparation of primary teeth by Er:YAG laser is irregular and that the microleakage of such cavities after filling with composite resin is less when compared with mechanical bur by dye penetration method[30]. The use of laser technology seems to improve children's clinical behaviorand cooperation during treatment Besides comfort during cavity preparation is mostly influenced by vibration and cavity preparation by Er:YAG laser produces less or almost no sound, less vibration, and no administration of local anaesthesia. Similarly, Kato et al. define that Ablation with Er: YAG in enamel and dentin in both deciduous and immature permanent teeth in children confirms patient cooperation with almost no pain and could be a useful alternative method for composite resin restoration method in children[31].

Laser application in Endodontics –

1. Pulp capping:

Many studies have used lasers in adjunct with conventional methods to stimulate the exposed pulp to form reparative dentin formation. A systematic review done by F. Javed et al. shows that treatment of exposed dental pulp with lasers can improve the outcome of direct pulp capping procedures[32]. A study by Jayawardena et al., reported increased tertiary dentin formation when direct pulp capping was performed using $Ca(OH)_2$ with adjunct Er:YAG laser as compared to when $Ca(OH)_2$ was used alone[33]. Another study by Moritz et al. showed a 93% success rate in terms of tooth vitality among the teeth that received laser therapy in adjunct with conventional therapies for direct pulp capping[34].

2. Pulpotomy:

Conventional methods of pulpotomy involve the use of mummifying materials such as formocresol or using electro surgery to clean up the chamber. The usage of formocresol is strongly criticized in the literature for its side effects and carcinogenic potential and it has several disadvantages such as the smell, which disturbs the children and it may cause necrosis and ulcers when they come in contact with oral mucosa. Nowadays the use of lasers has been gaining popularity as an alternative to formocresol pulpotomy because of its advantages such as hemostasis, and preservation of vital tissues near the apical region of the tooth, etc., An in vivo study done by Elliot et al., found that the clinical success rate and radiographic success rate as 91.8% and 98.1% respectively when CO_2 laser is used for pulpotomy[35]. A study by Pescheck et al., showed the usage of a CO_2 laser for pulpotomy gained a higher success rate in comparison with the conventional formocresol pulpotomy[36]. A study by K S Uloopi et al., concluded that the usage of LLLT for primary tooth pulpotomy had a success rate comparable to that of MTA pulpotomy[37].

Laser application in trauma-

About 20% of children suffer a traumatic injury to their primary teeth and over 15% to their permanent teeth[38]. At present Pedodontists for traumatic dental injuries prefers two types of lasers – Er:YAG and the Er, Cr:YSGG along with that, KTP laser, Nd:YAG laser, the diode laser, and CO_2 laser13. Laser doppler flowmetry is emerging as a promising method, as Yet in the experimental stages for ascertaining the state of pulp revascularization[39]. Although limited attention is given to this concept in the international literature and no well-codedguidelines for laser application in these traumatic clinical event seven though the potential of laser technology in the dental field is considerable acknowledging its advantages correlated to laser application on hard and soft tissue and on the exposed pulp.

When the crown of a tooth is traumatized, the enamel only or dentin may be involved in the fracture, while sometimes if complicated the pulp is exposed. Erbium lasers are beneficial in this aspect to establish complete treatment including marginal preparation of the tooth and pulp coagulation if exposed[13,40].

Crown fracture exposes a large number of dentinal tubules: Erbium – chromium lasers, when used with only a little amount or no water jet, have the capacity to produce fusion and sealing of the dentinal tubules (depth up to 4um), resulting in a reduction of the tissue's permeability to the fluid's thus reducing dentinal hypersensitivity[13].

b) Laser application in soft tissue traumatic injuries –

Indirect traumas are lesions to the supporting structures, in particular the alveolar bone, the gum, and the ligament. As lasers provide good coagulation and offer a clean working area other application includes decontamination of the alveolus following traumatic avulsion, treatment of a periodontal defect following dental luxation or subluxation, mucogingival surgery for the treatment of traumatic dental injury, surgical cutting (e.g. removal of a tooth fragment), photobiostimulation and pain reduction effect for the treatment of traumatic dental injuries, with no suture, good and rapid healing by second intention and minor discomfort for the patient[13].

Low-level laser application (LLLT) – also known as 'soft laser therapy' and 'Bio-stimulationrepresents a non-invasive technique in the dental field. Helium-neon lasers were used chiefly although at the present time the semiconductor diode lasers 635-830nm are used mostly. The LLLT has a significant pain-reducing and bio-stimulating effect with the acceleration of the reparative processes that have considerable clinical importance, especially in immune-compromised patients[41].

LLLT stimulates the tissue repair process, influencing a large number of cell systems and can also have a series of benefits on inflammatory mechanisms, reducing the exudative phase and stimulating the reparative processes[42,43].

The LLLT has a number of applications in dentistry, both at the soft tissue level and hard tissue level as well as in neural regeneration, temporomandibular pain, and orthodontic pain.

CONCLUSION

Laser has been evidenced to be an effective tool in paediatric dentistry. It permits Preventive and minimally invasive interventions for both hard and soft tissue procedures with a much more conservative approach. Laser-assisted refined diagnosis of caries combined with suitable preventive adhesive dentistry after laser-assisted cavity preparation will be a leading a new wave of micro dentistry based on "filling without drilling". It is also important for the professional to understand the physical characteristics of the different laser wavelengths and their interaction with biological tissues to ensure that they are used in a safe and effective way in order to provide the benefits of this technology to young patients.

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