Review Article

The Dawn of Lasers in Paediatric Dentistry

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Abstract: The sun God has been worshipped in many civilizations and has been the source of natural healing from the very start of humanity. In ancient Greece, the sun was used in heliotherapy, or the exposure of the body to the sun for the restoration of health. Now we usher in the new age of lasers in Paediatric dentistry for a bright, healthy and efficient future. Laser-assisted therapy is a modern and effective strategy. Laser technology has a wide application in dental care and treatment, oral traumatology and minor surgical procedures, and is suitable for the treatment both of primary and permanent teeth.

Keywords: Paediatric dentistry; Laser surgery; Frenectomy; Gingivectomy; Dental trauma; Biostimulation.

INTRODUCTION

In 1958, Schawlow and Townes discovered Laser or Light Amplification by Stimulated Emission of Radiation. Laser-supported dental diagnosis and treatment, which allows us to meet the important aim of "filling without drilling," is an excellent approach from the tissue preservation point of view and, as reported by Martens[1] and reiterated by Gutknecht[2], "children are the first in line to receive dental laser treatment." The idea of substituting the drill with a laser instrument which has less impact on the patient as the laser works on hard tissue with no contact, no vibration, no noise and less pain, has brought about the introduction of this device in Paediatric dentistry. Today, laser has found myriad uses in many disciplines of medicine and surgery replacing the scalpel and the whine of the handpiece in dental surgery.This paper will present a review of the international literature that provides scientific evidence (Evidence Based Dentistry) on the use of laser and its various possible applications in Paediatric dentistry, and will attempt a discussion and a correct interpretation of the different results reported. Laser has opened up various applications are possible on both soft and hard tissues using different laser wavelengths.[3]

Soft tissue applications in Paediatric Oral Surgery:

Argon, diode, Nd:YAG (neodymium yttrium aluminium garnet) and CO_2 lasers are useful for cutting, vaporization and decontamination of the soft tissue, performing a very good coagulation and haemostatis, and are ideal for vascular lesions. Laser allows a clean incision and accompanied by limited rise in the temperature, and the absence of peripheral necrotic tissue allows the performance of very accurate biopsies.[4]

The excellent clinical results, quick and easy to use, less use of local anesthesia, excellent control of bleeding during incision, sutureless technique, post-operative recovery often asymptomatic due to the decontaminating effects, and analgesic and biostimulant effects improve the patient acceptance of the therapy over traditional techniques.[5,6] List of the treatable conditions as reported by various authors such as Herpes labialis, Aphthous ulcers, Haemangioma Fibroma Papilloma, Epulis, Pyogenic granuloma, Mucocele, Eruption cyst, Dentigerous cyst. The decontaminating effect of different lasers in the pockets of patients with periodontal disease has been widely documented in adults, but there is little documentation of laser-assisted therapy of periodontitis in young patients.

1. Frenectomies: It has been reported that laser treatment has less postoperative pain, discomfort and fewer functional complications (speaking and chewing) compared to the traditional techniques, where diode, Nd:YAG, Er:YAG, Er,Cr:YSGG and CO_2 lasers were used. Labial upper and lower frenectomies can be performed ,the laser is

extremely simple and effective even in newborns, in cases of severe ankyloglossia or tight maxillary frenum that make breastfeeding difficult.[7] Gingivectomy, gingivoplasty, and operculectomy can be easily performed without anaesthesia.[8,9]

2. Ankyloglossia: On using the, Erbium:YAG laser, revision of the lingual frenum in neonates can be completed without the need to sedate the infant or the use of a local anesthetic agent to numb the soft tissue.[7]

3. Biopsy and lesion removal: Lasers are excellent tools for removing soft-tissue lesions. Bleeding is minimal, and there is little or no post-operative discomfort. Instruments such as Argon, diode, and Nd: YAG is useful for pigmented and vascular lesions, whereas non-pigmented lesions are more effectively removed by an erbium or CO_2 laser.

4. Treatment of pericoronal problems in erupting teeth: It is not uncommon for children whose fist permanent molars are erupting to 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.

5. Treatment of aphthous ulcers and herpetic lesions: One of the easiest and most appreciated procedures using lasers is treatment of single isolated aphthous ulcers or recurrent aphthous stomatitis. The treatment involves low power settings, and the laser energy is directed at the target tissue in a noncontact fashion. In herpes labialis, using the laser when the prodromal signs fist appear has a palliative effect on the area and may prevent the development of a full herpes lesion.

6. Gingival recontouring and gingivectomies: In instances where gingival tissue has become hypertrophied due to medications such as Dilantin or instances where poor oral care occurs while the patient is wearing orthodontic appliances, the laser can be used to reshape or remove excessive tissue growth. When restoring teeth where caries extend below the gingival tissue, lasers can remove the gingival tissue to allow placement of a restoration without concerns for bleeding.

Hard tissue applications

The studies of this application fall into two broad categories based on the use of different laser wavelengths: Argon laser at 488-514 nm and CO_2 laser at 9300, 9600, 10600 nm. Also the erbium laser 2780 and 2940 nm was investigated in modifying the physical-chemical characteristics of the enamel surface: the results of these studies were assessed by testing cross-sectional micro-hardness and enamel solubility. A study reported that the micro-hardness of the enamel surface was higher when exposed to low Argon laser irradiation only or Argon laser irradiation combined with APF vs. no treatment (control).[10] Sub-ablative use of erbium laser can reduce enamel solubility increasing caries resistance.[11]

Sub-ablative CO_2 laser irradiation of young healthy teeth could be an effective method for **caries prevention**. Further studies are also needed to evaluate the erbium family's ability to increase the acid resistance of permanent teeth.

1. **Laser for carious detection:** This is the application most frequently and extensively investigated in paediatric dentistry. Several studies compared different caries detection methods: visual inspection alone, visual inspection with magnification, bite-wing x-ray and laser fluorescence. Dentists can consider the laser fluorescence system a reliable complementary tool for the visual inspection of occlusal surfaces, both in primary molars and permanent first molars.
2. **Laser application for sealing of pits and fissures:** Laser irradiation may be considered an additional tool in the sealant application procedure, for the overall cleansing and disinfecting effect: care must be taken with the energy applied so as not to over-prepare pit and fissure surfaces.
3. **Laser application for cavity preparation and caries removal:** The

erbium family of lasers may be used for the treatment of any class of caries. Various studies and clinical reports showed how the laser, used by numerous operators as an alternative to rotary instruments in paediatric restorative dentistry, brings an added measure of safety even when used in the treatment of very young children, a new possibility for minimal interventions[12] and an overall better acceptance compared to traditional techniques.[13,14]

4. **Laser application in endodontic treatments**: Lasers are indicated for Pulp capping, Pulpotomy and Root canal disinfection. Olivi and Genovese in 2006 reported the importance of the use of the Er,Cr:YSGG laser with adjustable air-water jet as a single minimally invasive instrument for carious removal and pulp coagulation, with tooth survival of 80% after 4 years. The comparison of the efficacy of two laser systems, Er, Cr:YSGG laser and Er:YAG laser, with conventional calcium hydroxide pulpotomy procedure yielded 80% success in the Er, Cr group, 75% in the Er:YAG group, while the control group had 63% success rate at 2 years.[15]

Pulpotomy is a very common technique in primary teeth: although pulpotomy with formocresol (1:5 dilution) is used with success, there is a tendency today to seek alternative techniques, considering the carcinogenic and mutagenic potential of its formaldehyde component. Lasers have been proposed for pulpotomy, and a study from Pescheck et al. in 2002 compared favorably CO_2 laser treatment to formocresol for pulpotomy in primary teeth, with a survival rate from 91% to 98%.[16] Elliot et al., in 1999 also found a significant inverse correlation between the laser energy applied to the pulp and the degree of inflammation at 28 days and a 99.4% clinical success after 4 years compared to 88.2% of the formocresol control group.[17]

Laser application in dental traumatology:

Dental traumas are frequent in children. They can be complex events, and at times real emergencies in which laser-assisted therapy can offer new treatment possibilities. The advantages correlated to laser applications on hard and soft tissue and on the exposed pulp make laser technology useful in this field.

Laser application in dental traumatic injuries - Crown fracture involves the enamel and dentin and may involve exposure of the pulp. Erbium lasers can be used to perform the entire procedure: tooth margin preparation and finishing, coagulation of the exposed pulp, pulpotomy or pulpectomy (if needed) [18], as well as soft tissue procedures. Crown fracture exposes a large number of dentinal tubules: erbium-chromium and erbium 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 4 um), resulting in a reduction of the tissues's permeability to fluids, thus reducing dentinal hypersensitivity. The other laser wavelengths (diode, Nd:YAG, CO_2) also have this beneficial therapeutic action for this application. They can also be applied:

1.To perform indirect or direct pulp capping.
2.To decontaminate infected root canals.
3.To treat soft tissue defects.

Laser application in soft tissue traumatic injuries

Indirect traumas are lesions to the supporting structures, in particular the alveolar bone, the gum, the ligament, the frenum and the lips. Lasers can be used for the treatment of dental soft tissue and, they provide good coagulation (with extremely clean working area), effective decontamination, photo-biostimulation and pain reduction effect for the treatment of traumatic injuries, with no suture, good and rapid healing by second intention and minor discomfort for the patient . The improvement in these procedures by using lasers in the following applications:

1. Decontamination of the alveolus following traumatic avulsion.
2. Treatment of a periodontal defect following dental
3. Luxation or sub-luxation.

4. Microgingival surgery for the treatment of traumatic dental injury.
5. Gingivectomy and gingivoplasty.
6. Surgical cutting (e.g. To remove a tooth fragment)

Bio-stimulation and pain control

A non-traumatic introduction to dentistry can be represented by Low Level Laser Therapy (LLLT) or soft laser therapy. The LLLT has an important pain-reducing and bio-stimulating effect with acceleration of the reparative processes that have a considerable clinical importance, especially in those patients with a compromised immune system like young patients affected by insulin dependent diabetes, history of endocarditis, cardiac dysfunction or malformations or cardiac surgical and prosthetic valves reconstruction, oncological patients undergoing chemotherapy or radiation). In short, LLLT stimulates the tissue repair processes, influencing a large number of cell systems (fibroblasts, macrophages, lymphocytes, epithelial cells, endothelium), and can also have a series of benefits on inflammatory mechanism, reducing the exudative phase and stimulating the reparative process.[19, 20, 21] After 3-5 days of bio-stimulation, it is already possible to observe a considerable reduction of swelling and an acceleration of the epithelization and collagen deposition phase.

The LLLT has a number of applications in dentistry, both at the soft tissue level (bio-stimulation of lesions, aphthous stomatitis, herpetic lesions, mucositis, pulpotomy), and the hard tissue level (acceleration of orthodontic movement) as well as neurally (analgesia, neural regeneration, temporomandibular pain, post-surgical pain, orthodontic pain). According to Tuner and Hode (2004), and Gutknecht et al. (2005), LLLT has five main indications in paediatric dentistry.[22, 2]

a. Post-traumatic treatment after lip and front-tooth trauma to reduce swelling and pain can be achieved by applying a laser radiation dose of 3 to 4 Joules.
b. A laser radiation dose of 2 Joules has a brief anaesthetic effect of the mucosa, allowing painless injection with a needle.
c. Direct application of a laser radiation dose of 4 to 6 Joules into an exposed cavity of a deciduous tooth can be used for pain reduction.
d. Post-traumatic treatment after lip and front-tooth trauma to reduce swelling and pain can be achieved by applying a laser radiation dose of 3 to 4 Joules.
e. A laser radiation dose of 1 to 2 Joules as an additional treatment in pulp capping improves treatment outcome.

CONCLUSION: Many modern medical and dental discoveries were byproducts of innovative minds thinking “outside the box.” It is rightly said that science is not orthodox. Embracing new technology may usher a new dawn of treatment modality. Laser enables optimal preventive, interceptive, and minimally invasive interventions for both hard and soft tissue procedures. It is important for the professional to understand the physical characteristics of the different laser wavelengths and their interaction with the biological tissues to ensure that they are used in a safe way, in order to provide the benefits of this technology to young patients. However, the most appealing aspect of LASERs is this that it, actually is a pain free approach to dental treatment.

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How to cite this article: Singh G, Kohli A, Katiyar A, Gupta K, Sarkar B. The Dawn of Lasers in Paediatric Dentistry. Rama Univ J Dent Sci 2015 Sept.;2(3):21-25.

Sources of support: Nil **Conflict of Interest**: None declared