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Review Article

Diode Laser Applications in Pediatric dentistry

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ABSTRACT

A replacement for conventional methods or in conjunction, laser technologies are expected to become an essential component of contemporary pediatric dental practice. Understanding the various uses of laser is simply to accept the cutting edge of present day pedodontics. Lasers are commonly used in efficient diagnosis of dental caries, preventive and restorative dentistry and in pulp therapy treatment in children.
Oral hard and soft tissues have a distinct affinity for absorbing laser energy of a specific wavelength. Diode laser has one of the most versatile ranges of wavelengths available due to the number of different therapies that can be performed in several tissues. They offer a comfortable and stress-free environment to the pedodontist and child by offering an excellent haemostatic effect, easy application, reduced pain, swelling and the use of post-operative antibiotics. The aim of this paper is to review the various diode laser applications in pediatric dentistry.

Introduction

In the present scenario, lasers provide a safe and uncomplicated alternative for dental treatment in children. The dental lasers of today have benefited from decades of laser research and have revolutionized several areas of treatment in the last three and a half decades of 20th century[1]. The most commonly used lasers in dentistry include holmium yttrium aluminium garnet (HO:YAG), neodymium-doped yttrium aluminium garnet (Nd:YAG), carbon dioxide laser (CO2), erbium-doped yttrium aluminium garnet (Er:YAG), neodymium doped yttrium aluminium perovskite (Nd:YAP), gallium arsenide (GaAs) (diode), erbium, chromium doped yttrium scandium gallium gar- net (Er-Cr:YSGG) and argon lasers. Out of these, Diode, neodymium, erbium, and CO2 lasers are approved by the Food and Drug Administration (FDA) for use in oral surgery[2].

Innovative technologies, such as diode lasers, have provided considerable benefit to dental patients and dentists[3]. The Diode Laser can be used for a multitude of dental procedures which are predominantly soft tissue surgery, periodontal pocket therapy, peri-implantitis, but can also be used in endodontics for root canal disinfection, and in laser-assisted tooth whitening[4,5].

The exemplary properties of diode lasers makes them more convenient and ideally suited for pediatric dental treatment. Absorption of energy gives diode lasers their ability to precisely cut, coagulate, ablate or vaporize the target soft tissue[6]. The laser energy is absorbed by pigmentation in the soft tissues, and this establishes the diode laser an excellent tool to haemostatic agent. Henceforth, on the grounds of efficacy and safety of diode laser in different wavelengths for specific procedures, this review article elaborates on its clinical applications in pediatric dentistry.

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Discussion

The Diode laser was introduced in dentistry and oral surgery in the mid-90s[7]. The diode laser contains a solid active medium and is composed of semiconductor crystals of aluminum or iridium, gallium, and arsenic[8]. They are soft tissue lasers with wavelengths ranging from 810 nm to 1064 nm (in the near infra red region of the spectrum).

As its wavelength is poorly absorbed by hard dental tissue, diode laser is safe and well indicated for soft oral tissue surgeries in regions near the dental structures for cutting, vaporization, curettage, blood coagulation and hemostats in the oral region[9]. The chromophore of diode lasers is pigmented (or coloured) tissues, specifically melanin, hemoglobin and oxyhemoglobin[10]. The diode is efficient for treating the patients soft tissues because the gingival tissues have a concentration of these chro-mophores; as a result, a diode photon has a high affinity for gingival tissues. The exclusive use of this laser by contact or at an extremely close distance avoids damage, due to 'beam escape,' in an open field, which makes it much safer than other laser sources[9]. It's use in contact mode provides tactile feedback during surgical procedure. The advantages of the laser over scalpel surgical procedures on oral tissues. include greater precision, a relatively bloodless surgical and postsurgical course, sterilization of the surgical area, minimal swelling and scarring, coagulation, vaporization, cutting, minimal or no suturing, and less or no postsurgical pain[10,11]. Also, they are procedure specific, easy to operate, portable and cost effective[12].

Therefore, the diode lasers can provide a paradigm shift in pediatric dentistry by working as a replacement or a tool in conjugation with the conventional methods for providing a stress-free and comfortable treatment to the children. The various clinical procedures in which diode laser is used in paediatric dentistry are as follows:

1. Caries Detection and diagnosis

Hibst and Paulus discovered that bacterial metabolites within caries produce fluorescence that can be enhanced by a laser light[13]. Based on this, DIAGNOdent (Kavo, Biberach, Germany, a portable laser diode based device was developed[14]. DIAGNOdent's accuracy has been studied both in vitro and in vivo for occlusal caries in primary and permanent teeth[15,16].

The DIAGNOdent unit contains a laser diode (655nm, modulated, 1 mW peak power) as the excitation light source, and a photo diode combined with a band pass filter (transmission > 680 nm) as the detector. Recently a new version of DIAGNOdent, the DIAGNOdent pen, was introduced. The device is cordless and handy to operate and is based on the same principle as the original DIAGN-Odent.

DIAGNOdent showed higher sensitivity and accuracy as compared with other conventional methods for detection of enamel caries, whereas for detection of dentinal caries, even though the sensitivity was high, accuracy of the DIAGNOdent device was similar to other conventional caries diagnostic methods[17]. It can also be used as an alternative diagnostic method in detection of proximal caries in primary teeth[18].

2. Pulpotomy

Laser use in pulpotomies was first reported by Shoji in 1985[19], who used CO2 laser. The main advantages of laser-assisted pulpotomies were: less chair side time and painless procedure thus increasing pediatric patient's co-operation. The Diode laser is the most frequently used

due to its reliability, versatility and convenience, together with its handiness and simple set-up[20]. The human clinical trials that compare laser pulpotomies with existing pulpotomy techniques have shown conflicting results. Any variation in laser application parameters, including the power, frequency, exposure time, and water/air dry-mode, causes different results in pulp tissue. These facts might differentiate the laser-assisted pulpotomy results from each other.

The 810nm wavelength shows an increase in DNA synthesis[21] proliferation of human gingival fibroblasts[22] and completion of root formation in an immature rat tooth following pulpotomy[23]. In a comparison of pulpotomy using MTA, Laser and Biodentine, in diode laser group, hemostasis was achieved by exposing root canal orifices to Diode Laser (Picasso) of 810 nm with the pulsed contact mode of application for 2 seconds delivered by optical fiber tip and 1.5 watt power[24]. Pulpotomies performed with MTA, Laser or Biodentine were proved to be equally efficient whereas in a another study, Saltzman et al[25], used a diode laser with 3W until hemostasis was achieved and reported less radiographic success compared to formocresol pulpotomy but diode laser pulpotomy with mineral trioxide sealing (L-MTA) can be an alternative to formocresol pulpotomy.

3. Apexogenesis

The management of pulpally exposed immature teeth often proves to be challenging to the clinician. In young patients with immature teeth, it is desirable to maintain pulp vitality so as to ensure continued root development[26]. This can be achieved by either pulp capping or pulpotomy depending upon the size of exposure[27]. According to American Academy of Pediatric Dentistry (AAPD) guidelines, partial pulpotomy for traumatic exposures is a procedure, in which the inflamed pulp tissue beneath an exposure is removed to a depth of 1-3 mm or more to reach the deeper healthy tissue[28].

A diode laser (940 nm, Ezlase, Biolase Technology Inc. USA) in a young permanent tooth with traumatically exposed pulp has proved to be an effective technique for Pulpotomy in an immature tooth[29]. Therefore, the use of soft-tissue diode lasers can influence the treatment outcome and should be seen as a predicable tool for vital pulp therapy.

4. Labial Frenectomy

The labial frenum is an anatomical landmark that joins the lips and cheeks to the alveolar processes of maxillary and mandibular bones. This fold contains vascular structures with thin peripheral nervous ramifications that is covered by stratified layered epithelium and their high attachment may involve orthodontic, prosthodontics and prosthodontics discrepancies as well as speech inability. Hypertrophic, fibrotic, ample, fan-shaped or bifid ending construction are described as an abnormal frenum whose development is not dependent upon its point of insertion[30].

With regard to functional aspect, the labial frenectomy is indicated when the presence of frenum poses negative impact on the child's life. It is suggested that optimal treatment outcomes are achieved when the procedure is performed between 8 and 18 months of age[31]. Frenectomy that once was rejected in very young patients because it is necessitated general anesthesia can now be safely and quickly performed with lasers in outpatient settings[32]. Among the various lasers present, diode laser wavelengths approximate the absorption coefficient of pigmented tissues containing haemoglobin, melanin and collagen chromophores and thus are

indicated for for soft tissue surgeries in regions near dental structures[33].

The frenectomy performed in an infant patient using a diode laser with a wavelength of 980 nm, operated at a power of 3.0 watt in continuous wave mode with a 320-micron quartz optical fibre proved to be a successful method and advocated the use of diode laser as a comparably simple and safe procedure without the need for general anaesthesia[34]. Therefore, Diode laser surgery may be considered a useful tool for the clinician in performing pediatric labial frenectomy. However, the need for a randomized controlled trial is emphasized in order to establish the exact efficacy of this technique if compared to other methods. It is obvious that diode laser frenectomy may be performed without infiltrated anasethesia with the optimum healing post-surgically. In severe cases of soft tissue excision the need of anaesthesia may be essential[35].

5. Lingual Frenectomy

During the 18th century, midwives used to divide the lingual frenulum with their sharp fingernail-s[36]. For over a century, a grooved tablespoon was created specifically to release the tongue-ties[36]. Pediatricians used similar devices over decades, but recurrence was common. Nowadays, several surgical techniques have been described to correct an abnormal frenulum. The following techniques are of particular interest in Pediatric Dentistry: frenotomy and frenectomy with the use of one hemostat, two hemostats, a groove director or laser.

Frenectomy corresponds to the complete excision of the frenulum. This procedure is more invasive and difficult to be performed in young children, although the results are more predictable, decreasing the recurrence rate[37]. However, surgery should be performed before the child develops abnormal swallowing and speech patterns. When the procedure is performed in older children, they should be referred to a speech therapist to reestablish the normal functions of the tongue[37].

Laser technique is an excellent alternative to traditional surgery. It is simple and rapid to perform, well accepted and tolerated by patients[38,39], requires a minimal anaesthesia, with an asymptomatic postoperative period, without relapse. Different wavelengths can be utilised for this procedure and the principal concept to remember for all wavelengths is that the minimum effective energy must be used because the lower the energy applied, the less the damage on the targeted tissue and the faster the healing process.

A Frenectomy carried out with diode laser at a wavelength of 800 nm and power of 2 W in non-contact mode proved that the laser can be considered as a simple and safe alternative for children while reducing the amount of local anesthetics, the bleeding and the chances of infection, swelling and discomfort[39]. Also, lingual frenectomy using a Diode laser (830nm) proved to be a successful method for management of ankyloglossia or tongue tie[40].

6. Gingivectomy

The Gingival tissue may appear normal at birth but, hyperplastic gingival fibromatosis may become evident with the eruption of primary or permanent dentition, suggesting a trauma-induced tissue reaction during the eruption.

The treatment of gingival fibromatosis is essential because it causes difficulties with mastication, speech problems, mispositioning of teeth, aesthetic effects, and psychological difficulties for the patient. The appropriate time of the removal of gingival enlargement varies. Emmerson recommended that the best time is when all the permanent teeth have erupted[41]. Alternatives for gingival tissue removal include the use of a scalpel, electrosurgery, and lasers.

Lasers offer the potential of increased operator control and minimal collateral tissue damage. Diode lasers specifically, operate at a wavelength that is easily absorbed by the gingival tissues, while posing little risk of damaging the tooth structure[42]. The laser wound in the soft tissue has unique characteristics of being a very superficial wound; it is not a burn, and the thermal damage caused by the irradiation is only a few tenths of a millimeter in depth. The cellular disintegration caused at the impact does not allow for the release of chemical mediators of inflammation, which leads to a reduced acute inflammatory response compared with scalpel-created wounds. Additionally, there is very little wound contraction[43].

The prime rationale for the use of laser in this pediatric patient is to give a painless and bloodless substitute for the scalpel-facilitated surgical procedures and reduce the perception of fear and anxiety in the patient, thus instilling a positive attitude toward the dental treatment[44]. Also, a comparison of the use of laser in treating gingival enlargement with the conventional method showed good re-sults[45].Thus, the laser may be considered as a novel alternative to the other well-established treatment modalities in pediatric patients**.**

Treatment of Pyogenic Granuloma

Pyogenic granuloma (PG) is an inflammatory hyperplasia which occurs in the oral cavity or on the skin. Although, PG is common on the skin, it rarely occurs in the gastrointestinal tract except for the oral cavity, where it is often found on keratinized tissue[46]. Agulio et al (2002)[47] reported formation of PG as a result of injury to a primary tooth and Milano et al (2001)[48] reported a case of PG associated with aberrant tooth development._It has been stated that even eruption of teeth can be a precipitating factor of pyogenic granuloma development[46].

Various treatment techniques have been described for pyogenic granuloma. Conservative surgical excision and removal of the causative irritant or source of trauma are the usual treatments. Also cryosurgery, cauterization with silver nitrate, sclerotherapy, Nd: YAG (Neodymium-Doped Yttrium Aluminium Garnet) and CO2 (Carbon Dioxide) laser as well as laser photocoagulation have been proposed as treatment options[46].

The use of lasers in a variety of surgical procedures has been well documented. Diode laser with 810-980 nm wavelengths has been used for soft tissue cutting in pediatric patients. Advantages of lasers in removal of soft tissue lesions in pediatric patients include less hemorrhage and post-surgical discomfort[49]. Diode laser with a wavelength of 808 nm, output energy 0.1-7.0 W, and input power of 300 VA was also introduced as a powerful tool for treatment of pyogenic granuloma by Rai et al (2011)[50]. Also, removal of pyogenic granuloma by diode laser in a pediatric patient with 810 nm wavelength, a continuous wave mode, a power output of 3 watt and a 0.4-mm diameter fiber optic offered a new tool for treatment of oral lesions as

comfortable as possible in pediatric patients and resulted in less stress and fear in children[51].

Conclusion

The use of lasers diode lasers in pediatric dentistry is now an accepted treatment aid with a wide range of applications in oral soft tissue surgery. A diode laser can be used in pediatric dentistry as a tool needed to reach a therapeutic result and a helping device to complete conventional therapy. With advantages of easy and faster application, better coagulation, no need for suturing, less swelling and pain and better de-epithelialization, diode lasers can be used as an effective aid in pae-diatric dental treatments.

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