International Journal of Dental Research
www.dentaljournal.net
Online ISSN: 2664-9055, Print ISSN: 2664-9047
Received: 11-02-2022, Accepted: 26-02-2022, Published: 12-03-2022
Volume 4, Issue 1, 2022, Page No. 27-31

Laser therapy in pediatric dentistry-Mini review and case report

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Abstract
Laser therapy have become the latest advent which provides a wide range of treatment prospective in Pediatric Dentistry. It's high acceptability rate among children as well as their parents have embedded in designing and formulating stress free environment in Pediatric Dentistry. Diode laser predominates in possessing variable wavelengths hence facilitating its applications on numerous surgical procedures. The advantages of the laser assisted surgeries over the conventional surgical procedures are well determined precision of the surgical technique, lack of bleeding sites, lack of edematous surgical areas, no visible scar formation and negligible postoperative pain for the patient. Pediatric dentistry is an age defined dental specialty which includes assimilation of all aspects of child development. However pediatric treatment modalities differ in greater extent than adult patients. Hence it relies upon the Pediatric dentist to be well versed, familiar and knowledgeable with regard to the child's growth and development consistent with their subsequent age. The use of laser may produce certain hazards and need some precautions, its use in pediatric dental practice is found to be emerging as the the golden standard. This article presents with three case reports in which diode laser had been utilized for treatment of ankyloglossia in pediatric patient.

Keywords: laser dentistry, diode laser, pediatric dentistry

Introduction
Light amplification by stimulated emission of radiation (LASER) is an active medium is stimulated for photon production within a defined monochromatic beam of predetermined wavelength [1]. In the recent era laser therapy have become the most acceptable treatment strategy in the field of dentistry. High patient compliance rate and acceptance rate of laser technique have made it an alternative to conventional surgical methods [2]. Since 1970, Lasers have been integrated in to therapeutic applications in the fields of Medicine and allied health sciences. The beginning of 1980's intimidated the new era of application of carbon dioxide lasers in Dentistry in treating oral lesions. Neodymium yttrium-aluminium-garnet (Nd: YAG) laser was the first exclusive dental laser developed in 1987 for dental surgical procedures [3]. The high concentration of chromophores in the gingival tissues makes diode laser highly efficient in surgical management of associated tissues. This highly tissue specific diode laser is activated in contact mode providing adequate tactile feedback which is a predetermined requisite for treatment procedure. The main objective of Pediatric Dentistry is to provide the required dental care to children in a very calm and child friendly dental scenario [4]. Laser has several applications in Pediatric Dentistry which includes diagnosis and prevention of dental caries, soft tissue surgeries and endodontic therapies [4]. Laser minimized the use of injections, eliminated the vibrations, made it highly acceptable by patients as well as their parents. This makes dental visit stress free and install positive dental attitude in a child. The advancements in laser technology have made them the most reliable treatment option among pediatric population, thus signifying their application as a considerable alternative to the existing conventional surgical procedures.

History of Dental Lasers
Laser was first introduced in an article in 1959 by Gordon Gould, a Columbia University graduate student. In 1917, when physicist Albert Einstein described the theory of stimulated emission, the principle of the laser was unfolded [5]. The first working laser was developed by Theodore Maiman at Hughes Research Laboratories in 1960. 1%–3%neodymium was used with yttrium-aluminum-garnet crystals for the production of Nd-YAG laser in 1961.CO2 laser was invented in 1964 by Patel at Bell Laboratories. [5] In 1971, Weichman and Johnson reported the use of infrared CO2 laser for apical foramen sealing in in vitro study. However, it was introduced in oral surgery for removal of soft-tissue lesion in the 1980s. In 1987, neodymium-yttrium aluminum garnet (Nd-YAG) laser was specifically developed for dental procedure, and later in 1990, it was approved by the Food and Drug Administration [5].

Classification of Lasers

1. **Based on active material6 used**
- Gas lasers
- Solid lasers
- Liquid lasers

2. **Based on the wavelength7**
- Invisible ionizing radiation
- Visible
- Invisible thermal radiation

3. **Based on their operating mode8**
- Continuous
- Pulsed

4. **Based on their power supply**
- Low power lasers
- Mid power lasers

5. **Based on delivery systems**
- Flexible hollow waveguide or tubes
- Articulated arms
- Fiber optic

6. **Based on clinical use**
- For diagnosis Ex: Laser fluorescence, laser Doppler flowmetry
- For non-surgical treatment
- Laser activation of bleaching agent
- Laser activation of light curing materials
- For surgical treatment
- Soft tissue
- Hard tissue
- Combined

Laser-Tissue Interaction

When laser light is applied on target tissue, it initiates photothermal reaction which causes heat generation and a rise in temperature within the tissue [6]. When this temperature rises above 60°C, it causes protein coagulation within the tissue [6]. 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 [6]. When laser light hits target tissue, four types of interactions take place which depends on the optical properties of the target tissue and the wavelength of the laser light.

These interactions are as follows

Absorption: The presence of chromophore within the target tissue is responsible for the absorption of laser light. Different wavelengths of laser light have different coefficients of absorption with hard and soft-tissue components such as mineral, water, blood component, and pigment. The laser light having a shorter wavelength predominantly between 500 and 1000 nm is well absorbed by blood components and tissue pigments whereas those with longer wavelength have higher affinity with hydroxyapatite crystal and water molecule [6].

Transmission: This may occur through the target tissue without causing any effect, and this property largely depends on the wavelength of laser light. Erbium family laser and CO2 laser are well absorbed by tissue fluids whereas laser energy from argon and Nd-YAG is get transmitted to the adjacent tissue when it hits tissue fluids. [6].

Reflection: Laser light may be reflected from the target tissue without producing any effect on the tissue. This unintentional reflection could be dangerous for the eyes. However, this property is used by caries detecting laser to measure sound tooth structure [6].

Scattering: This results in heat transfer and damage of tissue adjacent to the target area. It also decreases the favorable clinical outcome. However, this property is beneficial when the clinician is intended to treat an aphthous ulcer or cure a composite resin restoration [6].

Indications of Dental Lasers in Pediatric Dentistry
- Caries detection by laser fluorescence
- Prevention of enamel and dental caries
- Caries removal and cavity preparation
- Pit and fissure sealants

- Curing light activated resins
- Laser pediatric crowns
- Bleaching of vital and non-vital tooth
- Laser fusion of vertical root fracture
- Removal of old restorative materials
- Laser analgesia
- Orthodontic tooth movement
- Dental traumatology
- Exposure of teeth to aid in tooth eruption
- Frenectomy
- Ankyloglossia
- Treatment of Aphthous ulcers, Herpes labialis lesion, Leukoplakia [7].
- Treatment of mucocele
- Pediatric endodontics [7].

Contraindication of Dental Laser in Pediatric Dentistry

- It is also not advised to use in cardiac patient with a history of anginal chest pain and arrhythmia
- Use of laser in dental practice requires intensive training and minute precision
- The high cost of laser armamentarium is also a disadvantage in developing country like India
- Lasers of different wavelength are required for different oral and dental procedure.
- It should be used with precaution in patient with immunocompromised state as there is a potential chance of disease transmission through aerosol during the laser procedure [7].

Precautions When Using Dental Lasers

The use of protective eyewear is mandatory as it causes ocular hazards. The operator must be cautious about accidental exposure to tissue and the operating area should have a limited accessibility for other persons to minimize its hazardous effects. The presence of flammable materials in laser surgical room should be avoided as it can produce combustion hazards. The use of explosive anesthetic gases is contraindicated when laser surgery is planned under general anesthesia [8].

Case Report-Management of Ankyloglossia in Pediatric Patient

An 8-year old girl reported to the outpatient section of the department with the chief complaint of difficulty in pronouncing certain letters in particularly “s”,“z”,“t” etc. On intraoral examination, it was identified that the patient had evident tongue-tie (Kotlow class II). The child’s tongue was restricted and hence was unable to reach the upper incisors and beyond the lower lip which was required for normal speech patterns to occur. The parents were very concerned about the present condition as it hampered the child’s confidence and also hindered her speech to a great extent. Parental written informed consent was obtained after explaining in detail about ankyloglossia and the available treatment options required for it. Lingual frenectomy was planned using diode laser (Biolase®; Biolase Tech, San Clemente, CA, USA) with a wavelength of 980 nm in continuous mode at a power setting of 1.8 Watts (W).Bilateral local anaesthesia (one cartridge of 2% Lidocaine with Epinephrine 1:100,000) was recommended. The patient as well as the working dental personnel wore protective eye shields. The tongue tip was firmly immobilized and the lingual frenum was dissected and released with a diamond-shaped incision using the laser beam. The muscle fibers were then separated from the floor of the mouth to enhance the tongue’s mobility. The soft-tissue surface was cooled with air/water spray adjunct to high speed evacuator. Hemostasis was sufficiently achieved. Paracetamol (200 mg) and 0.2% chlorhexidine mouth wash was prescribed for post-operative care. The parents were then advised to provide their child with a soft diet for the subsequent 3 days. The 1 week follow up revealed that healing was uneventful with normal wound scarring (Figure. 1a-1d).

Fig 1

Discussion

Ankyloglossia is defined based on the inability to extend the tip of the tongue beyond the vermillion border of the lips or a line joining the lip commissures, along with speech impairment. [9] It is classified based on "free tongue". Free tongue is defined as the length from the beginning of insertion of the lingual frenum into the base of the tongue to the tongue tip [9]. Based on the length of free tongue, five categories can be distinguished, which are as follows [9].

Clinically acceptable normal, greater than 16 mm

Class I: Mild ankyloglossia: 12 to 16 mm

Class II: Moderate ankyloglossia: 8 to 11 mm Class III: Severe ankyloglossia: 3 to 7 mm

Class IV: Complete ankyloglossia: Less than 3 mm

Continuous wave mode is used for surgical procedures and pulsed mode in frenectomy, pulpotomy and periodontal procedures and as canal disinfectants. Continuous wave mode can ablate tissue surface faster and buildup heat resulting in collateral damage of the target and adjacent tissue. Perhaps this heat buildup can be reduced up to a greater extent by moving the laser beam in a faster motion [9]. The smaller diameter fiber will deliver the increased power density; this allows the decreased power setting. Thus, lasers can reduce psychological trauma and fear among children as well as adults during the dental visits [10].

Barot et al. reported very positive results after a frenectomy with laser technology (wavelength: 810 nm; fiber diameter: 200 μm used in direct contact with the tissue; power 2 W in a continuous mode and a focused beam). Through this protocol, the authors achieved complete healing, an increase of >16 mm in tongue mobility and speech improvement after therapy [10].

Derikvand et al. demonstrated several advantages of laser technology such as improved healing and reduced postoperative complications [11]. According to Vozza et al., laser surgery offers several advantages such as disinfection, precise incisions, minimal damage to adjacent tissues, a hemostatic effect, improved postoperative progression, no need for sutures and a reduction in the dose of local anesthetic; a goal to be achieved especially in pediatric patients [12].

Postoperative exercises were advised to patients following tongue-tie surgery. These exercises provided the following functional improvements: (i) Develop new muscle movements, particularly those involving tongue-tip elevation and protrusion, inside and outside of the mouth, (ii) increase kinesthetic awareness of the full range of movements the tongue and lips can perform, (iii) encourage tongue movements related to cleaning the oral cavity, including sweeping the insides of the cheeks, fronts, and backs of the teeth, and licking right around both lips.

Conclusion

Lasers have shown to be able to supply an exhaustive therapeutic efficacy in the different clinical situations together with a precise and fast performance, speeding restorative tissue processes, reducing pain and postoperative edema [12]. Its avid application of ease of use, better hemostasis, no suture technique and considerable absence of post-operative pain thus signifies that lasers can be used as an acceptable treatment aid in pediatric patients. Despite the fact that American Academy of Pediatric Dentistry recommends the utilization of lasers as an adjunct option strategy babies, kids, teenagers, and people with special service's needs. In the present situation, lasers can be a satisfactory alternative to conventional surgical techniques in pediatric patients, providing better post-surgical conditions.

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