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Review Article

Benefits of Lasers in Pedodontics

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Abstract

Introducing new technologies is a matter of interest to all physicians. Lasers have invaded medical field and dentistry as well. Several benefits are expected to be gained by laser assisted treatments, first of which is the painless dental maneuvers. This makes laser the treatment of choice for pediatric patients, who are avoiding dental treatment because of fear of pain. Thus pedodontists, are required to cope with new technologies such as lasers, in addition to the conventional means. As this technology is more entertaining to kids, as well as, it is less painful. The American Academy of Pediatric Dentistry (AAPD) emphasizes the introduction of different laser devices in pedodontics as an assisting tool in treating dental hard and soft tissue for kids, children, and adolescents, including handicapped patients. The aim of our review is to make laser more familiar to dentists, regarding; its use in diagnosis, hard and soft tissue treatments, its advantages and restrictions in Pediatric Dentistry. Thirty citations were chosen through data base searches including the previously mentioned subject, concerned with lasers application in pedodontics.

Keywords: Lasers; Pedodontics; Pediatric Dentistry

Introduction

The concept of light amplification by stimulated emission of radiation (LASER) was primarily introduced by Albert Einstein 1916 [1]. Laser acts by concentrating high energies into an intense narrow beam of electromagnetic radiation, thus giving an efficient, powerful ray that uses less energy than a conventional lamp. Laser light has unique properties, such as coherency and mono chromatism [1,2]. Physicians started using lasers in the mid 1970's for soft tissue procedures [3]. Oral and maxillofacial surgeons included the carbon dioxide (CO2) laser into practice for soft tissue lesions excision in the 1980s [2,3]. The first laser specifically for dental use was a neodymium-yttrium-aluminum-garnet (Nd:YAG) laser, developed in 1987 and approved by the Food and Drug Administration in 1990 [1,4,5]. Inside a laser device, an active medium is activated to emit photons of energy that are conveyed in a beam with a specific wavelength suitable to that medium [5]. We can classify lasers according to the active medium utilized to produce the energy. The radiated energy is essentially a monochromatic light with a single wavelength [6,7]. The absorption of laser energy differs whether in hard or soft tissues of the oral cavity according to the unique affinity of tissues for a specific wavelength. Thus wavelengths of different dental lasers are the keys of the level to which the laser energy can be absorbed by the target tissue [1,6,8]. Subsequently, the choice of a certain laser depends on the intended tissue to be treated. The basic effect of laser radiation within tissues is photo thermal [3,9]. Thus vaporization of the water content within the intended tissue occurs when the temperature is increased more than 100ºC, resulting in soft tissue removal [1]. Since soft tissue is rich in its water content, ablation of soft tissue is started at this temperature. While hard tissue composed of hydroxyapatite crystals and minerals are not excised at this temperature, but the water component is vaporized, the resulting steam expands and causing the separation of the constituents into small pieces [1,8]. Modern pedodontics must take advance from all new techniques and apply them once they are tested and proven to be effective [10]. The old concept of "Extension for Prevention" is nowadays changed for "Prevention of Extension" [11]. In order to fulfill this, new materials and new preparation designs have undergone continuous development. This reflects the tendency to conserve tissue as much as possible during dental procedures. With the introduction of new technology; as digital radiography with low radiation, dental microscope, diagnostic laser, ozone therapy, micro preparation, and air abrasion, thus diagnosis with a minimally invasive therapy are

simultaneously achieved [12]. Therefore the concept of Micro Dentistry and tooth conservation, have changed the way of practicing dentistry too much. This psychological and technological evolution includes adhesion techniques, fluoride treatment, as well as laser technology. It is necessary to adopt new technology, not only to improve the quality of our treatment, but also to make our job more entertaining [10,12]. The present article describes application of the most commonly used lasers and their advantages, considerations, and limitations in Pedodontics.

Methods

This article is principally reviewing previous literature involved with the different uses of lasers regarding various Pediatric aspects. Through database searches using attributes such as: dental lasers, laser pediatric dentistry, soft tissue laser treatments, and hard tissue lasers. Articles were evaluated either by title or abstract and their relevance to pediatric dental care. Thirty citations were used to collect data together with recommendations and opinions of experts based on their previous experience.

Laser applications in pedodontics

Laser use in diagnosis

Laser fluorescence (LF) is used as a complementary mean in addition to the conventional methods for occlusal caries detection in questionable cases after clinical examination [12]. The diode laser conveys the emitted fluorescence on the occlusal surface of carious teeth corresponding to the degree of tooth demineralization [8,13]. Laser digital readings can indicate the proportional amount of caries present. Caries detection using laser fluorescence is contra indicated under dental sealants or composites as a result of the high percentage of errors in the readings due to the internal fluorescence coming from the sealant [12,13].

Laser application in oral surgery

Oral laser devices is being used in different pediatric soft tissue aspects. The most frequent use of lasers is in the excision of the labial or lingual frenum, exposure of un erupted teeth for orthodontic purposes, trimming of gingival tissue, gingivectomy, ablation of mucosal lesions, excisional biopsies, and treatment of aphthous ulcers and viral lesions [8,10,13]. The advantages of Nd:YAG, CO_2 and diode lasers, are the ability of performing surgery within bloodless field as the laser seals the blood vessels during cutting [8,10]. Erbium lasers are effective also in providing soft tissue surgeries; although, the coagulating ability of their wavelengths is not as effective as the wavelengths of Nd:YAG, or CO_2 [1,13-15].

Previous studies stressed on the numerous benefits of laser use in soft tissue surgery; such as its fast and ready use, reducing or completely eliminating the need for local anesthesia, providing a bloodless field during cutting, no need for suturing the wound, eventless healing period due to the bactericidal and bio-stimulant effects of laser. In addition to the patient 's satisfaction of the treatment, the ease of use of this technology facilitates the operators duty, which is sometimes so sophisticated while utilizing the conventional methods. Moreover, postoperative medications routinely used with the traditional technique such as anti-inflammatory and analgesics are reduced to a great extent [10,15-17].

Laser application in periodontics and orthodontics

The disinfectant effects of various lasers in the periodontal pockets has been well proved in adults, but there is few literature to prove the use of lasers in treating periodontitis in children. However there are several indications for laser use before, and during orthodontic treatment, or even after finishing the treatment. Such procedures became very easy, painless, bloodless and rapid, moreover can be performed by the orthodontist directly [12]. Numerous wavelengths can be used for different procedures, using various methods, according to the different laser-tissue interaction [18,19]. The most frequently performed and successful laser assisted procedures are frenectomies for orthodontic purposes. Previous studies stated the advantages of using lasers such as diode, Nd:YAG and or CO_2; reduced post-operative pain, discomfort and less edema and hematoma, facilitation of mastication and speaking, if compared to the conventional methods [20,21]. Excision of labial maxillary and mandibular frenums can be performed: the laser is very easy and effective even in newborns, in cases of severe ankyloglossia or thick upper labial frenum that complicates baby's suckling [13].

Hard tissue Lasers

The erbium lasers group (Er: YAG, and Er, Cr: YSGG), are the most common types of lasers used for hard tissue procedures, together with the Nd:YAG laser, they all have been used perfectly for caries removal and cavity preparation for restoration in both kids and adolescents [23-25]. Lasers also have been used successfully for indirect and direct pulp capping procedures [12,23]. Regarding pulpotomies of deciduous teeth lasers have been used effectively as it can decontaminate the root canals as well. Laser pulpotomies have been almost similar in results to the conventional formocresol medication [13,25,26].

Lasers as a mean of caries protection

Erbium laser 2780 and 2940 nm, CO_2 laser 9300 - 10600 and Argon laser at 488 - 514 nm all those types were tested in regards

of changing the physicochemical properties of enamel surface: cross-sectional micro-hardness and enamel solubility tests were performed to assess the outcome [12]. In earlier studies, it was reported that irradiation with Argon laser together with acidulated phosphate fluoride treatment (APF) gave a result of more than 50% reduction in carious lesion depth in respect of the control cavities, while reduction by only 26% to 32% if compared with lased-only cavities [27]. Also it was stated that the CO_2 irradiation is successful in decreasing the subsurface enamel demineralization and that if it is combined with recurrent fluoride treatment can reinforce this preventive effect [28]. Another research confirmed that, the specific wavelengths of the erbium laser also have the affinity to enhance acid resistance of enamel. Sub ablative erbium irradiation may help to minimize the solubility of enamel, thus reducing caries susceptibility, but this was not statistically significant [29].

Laser use on hard tissue

The cutting ability of the Er:YAG laser on enamel and dentine was first assessed by Keller and Hibst [30]. Others investigated the various applications of the erbium laser, and testing the anatomical effects on hard and soft tissue including the dental pulp. These applications differ in some parameters such as the air-water flow, energy density, and pulse repetition rate [31]. The success of erbium wavelengths in hard tissue preparation and caries removal was assured by many previous researchers through investigating the ideal parameters of their use. The concept of changing the handpiece with a laser beam which has no tactile impression on the patient, as the laser removes hard tissue without touch, or vibration, less noisy and much less pain. The matter which has encouraged pedodontists to use it readily [23,24]. The fact that laser is used as a substitute to the rotatory instruments by many dentists dealing with young patients' restorations, this is due to the safety in its use even when used with compromised patients or infants, as well as its being well tolerated and accepted by the majority of patients [30]. The use of manual excavators seemed to be the most suitable method for carious dentin removal in deciduous teeth, combining good treatment time with effective caries removal, while the steel bur appeared the fastest but with the highest level of over preparation. The laser is considered as an intermediate tool; among the slowest but with more conservative concept; between the least traumatic hand excavator for the removal of soft dentine in primary dentition and the more traumatic carbide burs although very fast but with highest percentage of over-preparation [12].

Laser use in endodontics

Pulp capping

Glass ionomer cement was used successfully as a pulp capping agent after application of Nd:YAG laser to coagulate the tissues. The erbium laser is completely absorbed by the water in the uppermost layer and changed into heat. While the CO_2 laser has a purely thermal effect on the tissue; most of the energy conveyed to the tissue is absorbed by a superficial layer (100μ) and changed into heat. However, these lasers have less coagulating effect than the Nd:YAG laser [32,33]. On the other hand, Olivi and Genovese in 2006 [34] pointed to the advantage of Er,Cr:YSGG laser when used with adjustable air-water jet as it is superior in having both coagulation effect on pulp tissue together with being most conservative mean helping to avoid over-preparation and over-heating of the remaining tooth structure [34]. The same authors reported the success of two laser wavelengths, Er,Cr:YSGG laser and Er:YAG laser, in pulp capping procedures. When compared with conventional calcium hydroxide capping, and they proved the superiority of success in the Er, Cr group and in the Er:YAG group, over the control conventional group [31].

Pulpotomy

Formocresol pulpotomy was the treatment of choice for exposed deciduous teeth, although it has a high success rate, nowadays this procedure is condemned, due to the presence of formaldehyde with its potential risk of having carcinogenic or mutagenic effects. Thus lasers have been introduced for pulpotomy procedures. Pescheck., *et al.* [26] in their study used CO_2 laser in a group compared to formocresol group for pulpotomies in deciduous teeth, with a higher success rate in the laser group. In different studies it was concluded that the super pulsed mode produced a greatly higher survival percentage than the continuous wave mode. However, other investigators correlated the survival rate to the age and the apex stage of formation in the deciduous teeth [35]. Odabafl., *et al.* [36] on the other hand, used the Nd:YAG laser for pulpotomy on primary teeth, but lately they reported a less clinical and a radiographic survival rates at 12 months follow-up periods, when compared to the formocresol group. Regarding root canal treatment of pediatric permanent teeth, Nd:YAG and diode laser are used taking the favor of their bactericidal effects in root and lateral canals. Studies comparing different procedures for preparing and sterilizing the root canal walls of primary teeth, using Er,Cr:YSGG laser, or either manual or rotatory instruments, stated that laser irradiation gave almost the same results when compared with the rotatory technique and was superior to manual procedure, beside using the laser saved time for finalizing and shaping root and lateral canals [37].

Uses of laser in traumatic injuries of teeth

Children and kids are subjected to accidents accompanied with dental injuries frequently. Often these may be simple, while other times they represent disastrous mishap which needs urgent treatment. Laser guided management can be a help in these situations [12].

Laser application in dental trauma

Erbium laser is well known to be the only laser possessing the suitable wavelengths for hard tissue procedures; such as caries excavation with least traumatic technique, with minimal complications. When the crown of a tooth is traumatized, the enamel only or and dentin may be involved in the fracture, while sometimes if complicated the pulp is exposed [12,38]. Erbium lasers are beneficial in this aspect to establish complete treatment including; marginal preparation of the tooth and pulp coagulation if exposed, sometimes pulpotomy is indicated or even pulpectomy [12,38], erbium lasers is also used for soft tissue maneuvers. When the crown of a tooth fractures, a huge number of dentinal tubules will be exposed. In previous studies, it was stated that the use of erbium-chromium and erbium lasers, with little amount or completely without water jet, is capable to seal and fuse the dentinal tubules together, thus minimizing fluid penetration into the tissues, and this in turn reduces the over sensitivity of dentine [12,38]. Different wavelengths such as diode, Nd:YAG, and CO_2 lasers may also have those useful palliative action for dentine conditioning but for a lesser extent [39]. They can also be helpful to; do pulp capping whether direct or indirect, disinfect contaminated root canals, and in management of soft tissue lesions.

The use of laser in soft tissue trauma

Nowadays lasers are an optional tool for soft tissue traumatic lesions of the oral cavity, namely; gingivae, periodontal ligament, frenae, tongue and lips; as they have the property of coagulation with perfectly bloodless field, anti-bacterial effect, photo-biostimulation and analgesic effect for reducing discomfort and pain of trauma. Also, it was reported as one of the lasers' benefits is that the wound will heal rapidly, without suturing, and with minimal post-operative complications [39]. Previous studies pointed to the better quality of treatment provided by lasers, such as; their bactericidal effect if applied to the socket whether after extraction or traumatic avulsion of a tooth; treatment of a periodontal defect due to bone loss causing tooth luxation; gingival surgery following accidental trauma to the oral cavity; gingivectomy and gingivoplasty; surgical incision to remove a remaining root or soft tissue lesion, as mucocele.

Low level laser Therapy (LLLT)

Laser as a mean of physiotherapy and pain relief

Low level laser therapy (LLLT) or soft laser application is one of the various uses lasers representing a non-invasive technique in dental field. Primarily, helium-neon lasers were used as (LLLT), although nowadays the semiconductor diode lasers 635 - 830 nm are more predominately used [40]. The LLLT has an essential palliative and bio stimulating effect which enhance the natural body repair mechanism. That is needed urgently, especially in the immuno- compromised patients, and patients with type I diabetes, or cardiac patients especially with subacute bacterial endocarditis, and patients suffering from malignancies and under chemo or radiotherapy. In other words, LLLT activates the body reparative processes, affecting many of the body systems and also have multiple positive effects on the inflammatory process, causing reduction in the exudation of fluids and enhancing the regeneration and healing of tissues [39-42]. Biostimulation for few days, leads to minimizing of post-operative edema and an increasing of collagen formation and epithelization. The LLLT is applied in various locations of dental profession, both at the soft tissue level as well as in hard tissue. Regarding the soft tissue applications the laser rays act by bio-stimulation of affected tissue such as; aphthous ulcerations, herpetic stomatitis, mucositis, and pathologic pulp tissue. However, one of the hard tissue applications is to increase orthodontic movement. Considering neural tissue, laser beams assists in pain reduction, nerve renewal, minimizing symptoms of temporomandibular dysfunction syndrome, and helps minimizing post-surgical and in orthodontic pain. Several investigators have stated that the LLLT, has five principle applications in pedodontics [12,38]. It can be used to relief pain during primary or even permanent teeth eruption by lasing the regional lymph nodes. Also before infiltration of local anesthesia a small laser dose of 2J can anesthetize the mucosa topically for a short period of time, thus injection can be performed painlessly. Laser irradiation of 4 - 6J can reduce the severe pain of the pathologically exposed pulp of a primary tooth. Laser radiation of 3 - 4J as previously mentioned is used in traumatology to reduce pain of injured lip and fractured anterior teeth, and may help in reducing traumatic edema [39-41].

Disadvantages of lasers use in pedodontics

There are some limitations of laser applications in pedodontics. Introduction of lasers in practice needs extra training and practicing for the different indications and devices of lasers [3,15,16,18,42]. In addition to the high expenses required to possess the armaments, adopt the new trend, and spend in the learning and practice courses [3,18]. As we already knew that each specific laser has a unique wavelength which is indicated for the specific site of use whether soft or hard tissue. Therefore each dentist may have to purchase more than one laser type for the different applications according to the wavelengths [3,12,43]. Safety means must be applied when using lasers for the practitioner and the nursing team as well as the patient, which are wavelength-specific goggles worn all the time during the laser session [1,3,44]. When using erbium lasers for cavity preparation it is always essential to use hand pieces to finish the cavity design or it is a must to do some modifications in clinical technique [3,16]. During the laser session it is most important for the practitioner and assistants to follow strict infection control program and to use high-volume suction

as the dispersed air droplets may carry infective tissue particles [3,12,26]. The dentist should have a proper decision whether to use laser or not for soft tissue lesions affected with contagious viral infections in medically compromised patients. Since there is a great possibility of infection transference through the infected droplets spray resulting from laser vapors [27,28,44]. So, as a protective mean against active viral lesions it is better to use analgesic medications especially in this type of patients.

Discussion

The previous studies regarding various lasers applications on soft tissue are almost in accordance, with same studies in the literature which have the beneficial outcomes. As it is well known that, the Nd:YAG, diode, and CO_2 lasers all work by the same principle and utilize the same technique [45,46]. On the other hand, during utilizing the erbium group of lasers for different hard tissue applications, we cannot compare the results due to the variable types present, not only with different wavelengths (2780 and 2940 nm), but also with different general construction [23,30,34,41]. There are several factors affecting the performance of this group of lasers as well as their tissue interaction outcome; such as: power density and fluency, difference of delivery system which is either in the form of optical fibers, or articulated arms transmitting energy, air/water flow and pressure of the integrated spray, the pulse length, the beam profile [45,47]. There is another essential factor which cannot be neglected, even when using the laser radiation therapy, which is the practitioner himself. The tactile sensation with the experienced hand is one of the mandatory parameters for the success of laser therapy. This type of conservative therapy is guarded by well knowing of laser technology as well as the choice of the unique wavelength. In addition to the trained operator who knows how to deal with vital tissues with accuracy. Working with a tool in a non-touch mode needs a sufficient training period and to learn the proper operating technique [48]. Many authors are in our side stating that, the success of any therapy depends on the mutual confidence and trust between the patient, especially if he is a child and the operator. This impression is always perceived by the patient and his parents as a very joyful, acceptable, and entertaining, mean of treatment, even considered as supreme [12,15].

Conclusion

Laser is proved to be successful in pediatric dental patients, as it is well accepted as a new treatment modality. It provides ideal prophylaxis and curing, with a much conservative approach rather than the conventional means, whether applied for hard or soft tissue. Thus it is of utmost importance for the professionals to be acquainted with the physical properties of the various laser types according to their different wavelengths.

Importance of this article in Pediatric field

- For improving Treatment quality.
- To encourage children to undergo dental procedures without fear.
- Conveying and teaching new technologies to dentists, re garding; diagnosis, management, uses, advantages and restrictions of laser use in Pediatric Dentistry.

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