Review Article

Oral and Dental Laser Treatments for Children: Applications, Advantages and Considerations

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Abstract:

It is of utmost importance to make children interested in and willing to use dental services in order to prevent and treat oral diseases. Therefore, pediatric dental practitioners need to learn new technologies such as lasers, in addition to basic principles. Lasers have opened new horizons in the treatment of both soft and hard oral tissue problems in children. The present article describes application of the most commonly used lasers and their advantages and considerations.
Keywords: laser; pediatric dentistry; application; advantage

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Introduction

Oral health has a great role in the generalwell-being, functional capacity and social welfare of children (1). In this context, oral soft and hard tissue conditions are two aspects which need special attention. Dental care and treatment is a very important health service for children, because tooth decay and untreated dental problems might have serious repercussions on children's general health and well-being (2). On the other hand, reports indicate that children and adolescents develop a wide variety of oral conditions, such as oral mucous lesions (3).

According to the attitude of dental practitioners, the third birthday can not be considered a suitable time for a child to visit a dental office for the first time in his/her life. Most studies have shown that the oral cavity is colonized by bacteria during the first year of life (2); therefore, oral examination at one year of agemight help prevent or minimize the incidence of oral diseases (4).

A dental visit provides a unique psychological and behavioral experience for a child, which might pose a distinct challenge for the dental practitioner in rendering treatment (5). Furthermore, from a professional viewpoint, the principal aim of dental treatment is to encourage the development of positive dental attitudes and promote oral and dental health of the community (6).

These aims require special demands of dentists and pedodontists to provide effective treatment modalities. As a result, familiarity with psychological, behavioral and physical demands of childhood is absolutely necessary; however, the role of modern and new technologies, such as lasers cannot be overemphasized in this context.

The term laser is an acronym, standing for "light amplification by stimulated emission of radiation" (7,8). It is an electromagnetic energy with unidirectional and monochromatic properties distinguishing it from ordinary disorganized radiant

energy (8). Lasers make it possible to transmit and concentrate light beams with high energy levels on a desired site. This high-energy beam of light can exert chemical, mechanical, or thermal effects in the body (9).

Application of different kinds of lasers in medicine is so widespread now that it has become the standard treatment modality in a large number of medical fields, such as ophthalmology and dermatology, for various routine procedures (10). Dentistry too, is evolving in a manner and pace similar to other medical fields (11). Sognaes and Stern proposed the use of lasers to prevent caries in 1965 (11); however, it was not until 1990 that lasers became an integral part of dental practice (12).

Use of lasers is quite new in pediatric dentistry; they provide the pediatric dentist with new treatment options to basically modify some treatment modalities, change some, and supplement some others (10,13,14).

In this article, the authors describe applications of the most commonly used lasers in pediatric dentistry along with their advantages, and finally propose recommendations, so that pedodontists can safely make use of this new technology.

Application

Lasers can be used in pediatric dentistry in minimally invasive treatment procedures, including diagnosis of dental disease and prevention, removal of diseased tissue, and preservation of the remaining healthy structures (11,15).

Due to ever-increasing number of occlusal carious lesions (16), diagnostic methods should detect these lesions early and with better accuracy to avoid unnecessary restorative procedures (16,17). It appears laser fluorescence is comparable to standard techniques of caries detection in occlusal pits and fissures (16,18,19).

At present, there are commercially available detection technologies for the diagnosis of dental diseases and anomalies, such as Diagnodent, which is a diode laser with a wavelength of 655 nm (11,16,17). Carious lesions exhibit stronger fluorescence in comparison with healthy tooth structures; therefore, this laser fluorescence device was developed for detection of carious lesions (11,16,20). This detection device analyzes the emitted fluorescence on occlusal surfaces of teeth. The fluorescence correlates with the degree of tooth structure demineralization (11,16,17). Therefore, this laser fluorescence device improves the diagnostic accuracy of the so-called “hidden caries” (16). Laser fluorescence has also proved efficacious in the diagnosis of residual caries (19). Nevertheless, Diagnodent tends to overrate discolored pits and fissures (11,16,19). As a result, these values should be used cautiously and as adjunctive information in the decision-making process by the dental practitioner (11,16,17); more data are necessary to assist in the clinical evaluation of the information provided by this laser system (19).

Laser technology has other uses, which include sealing of pits and fissures and cavity preparation (10,15). This technologymakes the enamel more resistant to caries attack,and also the need to acid etching procedure is eliminated, or reduced (10).

During cavity preparation, the procedure begins with the use of very low-energy settings of the laser in order to achieve an analgesic effect on the tooth involved. Then the higher-power setting of the laser is used in order to remove the enamel and expose the infected dentin. Subsequently, the low-power setting is used once again to remove decayed dentin (21). Different ablation rates for carious and sound tissue lead to selective removal of carious lesions (22). No smear layer is formed with the application of laser, which results in an increase in bond strengths of tooth-colored materials (10). A number of clinical investigations have shown improvements in the treatment of early childhood caries by selective removal of decayed enamel surface with laser which affects only the carious rather than the healthy tissue (11).

Laser technology can also be used in pulpotomy and pulpectomy, and in different surgical or oral pathology treatment modalities (8,10,11,14,15). This technique reveals the favorable effects of lasers in pulpotomy procedures of primary teeth (23). Delivery of a laser beam in to the root canals decreases microbial counts, promoting canal decontamination (10). The bactericidal effect in the root canal is approximately 99% (11).

Lasers can also be used in different pediatric soft tissue procedures, such as frenectomy, operculectomy, exposure of unerupted teeth, some oral pathologic conditions, including pyogenic granuloma, mucocele, fibroma, hemangioma, herpes

labialis and aphthous ulcers (10,11,21,24). Lasers can also be used to remove redundant gingiva for precise placement of stainless steel crowns (23), which are widely used in restoring severely damaged molar teeth (25).

Types of Lasers in Dentistry

Different types of lasers can be used in dentistry (10,15,19), with different properties, making them suitable for different tissues and dental procedures (7,10). We present a brief discussion about the most commonly used lasers in pediatric dentistry.

Argon laser. The argon laser functions at a wavelength of 457-502 nm (15,19). It has a number of soft-tissue applications, including frenectomy and gingivectomy. The most important advantage of the argon laser is the fact that it operates at a wavelength suitable for absorption by hemoglobin, resulting in excellent hemostasis (19).

Studies have reported that argon laser beams increase resistance of sound enamel and white spot lesions to caries attack (11). Argon lasers cause resins to set; however, theymay not produce a resin with physical properties superior to those cured with conventional halogen light-curing units (19).

CO_2 laser. The CO_2 laser has the most widespread use for soft tissues in medicine and dentistry (9), and are extensively used by oral surgeons (13). CO_2 lasers function at a wavelength of 10600 nm (9,15,19). In pediatric dentistry, CO_2 lasers are used for some soft tissue procedures, such as treatment of oral ulcerations, frenectomy, and gingivectomy surgical procedures (19).

Apart from their use as a "light scalpel", recent studies have suggested the use of low-energy CO_2 laser beams to control pain of ulcerative lesions in the oral cavity (9). It is possible to carry out precise (9,13), bloodless soft tissue surgeries with the CO_2 laser, with minimal disturbance of surrounding tissues and without untoward biological side effects (8,13,23). Its application on the base of the lesion results in the contraction of the surgical area, thus decreasing its size and providing the dental practitioner with a clear operating field (13), and allowing for real-time visual feedback. Post-operative pain is usually minimal or non-existent (19).

The CO_2 laser has some disadvantages (13,19). It generates a great deal of heat and as a result, it rapidly carbonizes the tissue involved (13); although some new brands of CO_2 laser machines create lesser carbonization by ultra pulse mode, wound healing can also be delayed fora few days (19).

Erbium laser family (Er:YAG and Er,Cr: YSGG). Erbium lasers can have a large number of applications for pediatric patients in dentistry, because they can be used to treat both soft and hard tissues (4,7,8,10,13,15,26,27) and in operative and surgical procedures (14,27). Dental literature is replete with reports describing successful application of this laser in dental surgical procedures (13,26). The Er:YAG and Er, Cr: YSGG lasers use wavelengths of 2940 and 2980 nm respectively (27). Erbium laser has been used in a wide variety of procedures on hard tissues (19). It has some uses in pediatric dentistry,including etching of the enamel, removal of carious lesions, preparation of cavities, and treatment of the pulp (11,15,19). The erbium lasers can prepare Cl I, Cl III and Cl V cavities (10,26). It is of clinical interest to note that erbium laser can melt the enamel to form a substrate which is resistant to the demineralizing effect of acids (19,28).

This type of laser has numerous advantages (7,11,15,19,26,27). It can cut enamel, dentin, cementum, and bone with minimal thermal damage (13,27), producing clean and sharp enamel and dentin margins (26). No smear layer is produced, which produce effective bonding (10,19). Furthermore, irritation of the pulp is not a problem, because energy penetration depth is minimal (19).There is no need for local anesthesia in some dental procedures (8), while in some others a small amount of the anesthetic agentis necessary, compared to that necessary for conventional techniques (7,8,19,26). This laser also exhibits antimicrobial properties when it is used within the root canals (19).

Erbium laser is a superb surgical tool in children (7,8,13), because it promotes rapid wound healing (4,7,8,10,13,29), there is minimal post-operative discomfort, and very small amounts of analgesics are needed (14). These lasers contribute to a proper control of hemorrhage during soft tissue procedures because of their effect on coagulation (7,8,10,13,27); in addition, no sutures are necessary (8,13,27,30). Low post-operative discomfort, edema, scar formation, and shrinkage have all been reported to be associated with the use of

these lasers (4,7,8,10,26,30).The antibacterial and anti-inflammatory properties (10) of the laser might improve post-operative prognosis (13,27).

Advantages

Lasers are the most important minimally invasive tools in dentistry (21) and evidence shows that they will continue to be a superb tool in the dental field (9). Laser surgery is superior to scalpel surgery for several reasons (9). Soft tissue surgery with the use of lasers provides some advantages, including the need for small amounts of local anesthetic agents (9,11), better cutting precision with the laser than with the scalpel, a clearly visible cut and more rapid hemostasis, because the laser plugs the lymphatic and blood vessels, low risk of post-operative infections because the laser beam sterilizes the tissue simultaneously with cutting, and minimal post-operative pain and swelling, which leads to faster post-operative healing and decreased scar formation (9,30).

It is believed that a more appropriate healing process results from a higher synthesis of collagen fibers in the laser-irradiated tissues, resulting in a better connective tissue remodeling (30).

Conventional gingivectomy techniques entail the use of local anesthetic agents, and there is post-operative oozing of blood (30). Lasers make such procedures less painful and stressful for the patient by eliminating the need for a "knife" and aid the surgeon by establishing proper hemostasis (9).

Release of histamine subsequent to a laser procedure is much less than that after using a drill and a scalpel; therefore, pain and edema decrease to a great degree (21). It has been demonstrated that children accept soft tissue surgeries with the use of lasers more easily (30).

In addition, a large number of patients dread local anesthetic needles (9), or the whine of the dental hand piece during dental procedures. The greatest merit of the laser for a pediatric patient is the lack of injection of local anesthetic agents (10,30) and the associated pre-and post-operative discomfort (30). Therefore, many patients undergoing routine dental procedures would not have to receive local anesthetic agents, or wait for "getting numb." Eliminating the use of local anesthesia is a further advantage (11,14), which will facilitate behavior management process by the pediatric dental practitioner (8). It is also possible to carry out one-visit multi-quadrant restorations and pulp therapies using laser techniques.

Traditionally, young children requiring an intra-oral surgical procedure had to go to the operating room. Parents and physicians have been reluctant to send an infant or a very young child in to an operating room for an elective surgical procedure under general anesthesia (4). Lasers are able to solve this problem, too. Children with multiple carious lesions, or early childhood caries, in particular, enjoy the merits of this technique (11,23).

Irradiation of dental hard tissues with a laser beam results in the formation of more stable and acid-resistant compounds (26), with possible creation of re-mineralization micro-spaces that entrap free ions and reduce acid attack susceptibility (11,26). It might also provide an antibacterial effect (26). The laser even etches the tooth surface, making it ready for bonding procedures. Dental practitioners are also more confident during cavity preparation with the use of the laser beam, as it confers much more control (21).

Considerations

It is absolutely necessary for the dental practitioner to become familiar with the scientific principles and tissue effects of lasers used in the dental field (31), because application of lasers with little or no sound knowledge might result in great damage (11). The Academy of Laser Dentistry strongly recommends that all the providers be properly instructed and knowledgeable in the use of lasers (4); it advocates the use of lasers in pediatric dentistry only when a properly trained and sufficiently skilled dental professional applies it (11).

It is also essential for dental practitioners to exercise standard safety precautions for themselves and patients, including the use of correct-wavelength laser safety glasses, proper face masks and face shields, and use of high-speed oral evacuation equipment (4).

Dental practitioners must adapt behavior management techniques to new laser technologies (10). The dental practitioner should also evaluate safety, efficacy and effectiveness of different laser types (19), and select the best one for each pediatric dental procedure (10,19,31).

Conclusion

Pediatric laser dentistry is a promising field in modern minimally invasive dentistry, which enables provision of better care for children and adolescents, and is virtually "childfriendly". The technology makes our patients and their parents happy.

In addition, application of this new technology gives rise to less stress and more fun during dental procedures. If practitioners enjoy what they are doing, they are in a better state of mind to help pediatric dental patients accept the therapeutic procedure.

As a requirement before application of the laser beam, the practitioner should be properly trained and knowledgeable of the laser to be used. Attention to the laser equipment and careful selection of patients is another important factor for each treatment modality. On the other hand, the pediatric dentist needs to apply behavioral management techniques while applying the laser beam, as with all other dental procedures. They should also pay special attention to the reliable scientific literature regarding the safety, efficacy and effectiveness of the technology.

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