

Clinical Approach of Laser Application in Different Aspects of Pediatric Dentistry

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Abstract:

The application of laser in dentistry is considered as a favorable technique for patients due to its many advantages compare to other current methods. One of the main goals in pediatric dentistry is to provide the treatment as comfortable as possible without any risks for the care. Laser is being used in different pediatric dental conditions including caries detection, caries removal and cavity preparation, soft tissue surgery and in low level laser therapy applications. The application of current common lasers in dentistry resulted in less stress and fear in patients during dental procedures, also leading to more conservative non-invasive methods for soft and hard tissues with minimal discomfort and bleeding.

Keywords: hard tissue; soft tissue; pediatric dentistry; laser.

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Introduction

The application of laser in dentistry is considered as a favorable technique for patients because of its many advantages compared to other current methods. Since lasers exist in different type of devices and various wavelengths, they can be used in numerous procedures in dentistry (1). The main principle in the application of laser is the use of light energy instead of rotation forces and sharp blades. When using lasers in restorative dentistry instead of the use of drill which can cause microfractures in dental structures, vibration and noise which are considered to be the main factors in children's fear are eliminated. It is also possible to remove caries without anesthesia or with less local anesthesia. Therefore, the dangers of lips and tongue bites which are frequent problems

with children can be avoided (2).

Soft tissue surgery can also be performed with superficial local anesthesia, decreasing the post surgical pain and swelling, thus making the need for sedatives and tranquilizers disappear. Children are appropriate candidates for treatment with lasers, because they suffer from repeated sessions for hard tissue removal and soft tissue surgeries, as well as pain and hemorrhage. But, in the application of lasers, necessary precautions have to be taken (3).

Lasers Types in Pediatric Dentistry

Different lasers are used in pediatric dentistry. These lasers include caries detection lasers Diagnodent (Diode 655nm), argon lasers for composite curing, CO₂ lasers with wavelength of 10600nm for soft tissue surgeries, Nd:YAG lasers

with wavelength of 1064nm as well as Diode with wavelength of 810-980nm for soft tissue cutting, the Erbium laser family including Er:YAG (2940nm) and Er;Cr:YSGG (2780nm) which are used in hard tissues, cavity preparation and in soft tissue surgery. And also Low Level Lasers which are used in stimulatory and inhibitory biologic process (4).

Laser Application in Hard Tissues

Caries Detection

Diagnodent is a caries detection tool, which is the Diode laser with wavelength of 655nm. The Diagnodent via emitted fluorescence from occlusal or proximal teeth surfaces shows a number that reflects the degree of demineralization of the teeth and the amount of decay. This device has two tips, A and B, A for occlusal surface and B for proximal surface. This device is categorized as class I laser in safety and doesn't require laser protection glasses. The tips and the calibrator stone can be sterilized in autoclave up to 135°C, so it prevents the contamination of the patients (6,7).

With the classification of the obtained numbers from the device, the degree of decay is determined and a treatment plan adopted based on the decay depth. From 0-13, the tooth is without decay, and cleaning only is enough. From 14-20, it reflects enamel decay that needs a professional cleaning and fluoride therapy has to be performed. From 21-29, it correlates with enamel deep decay, in some cases in addition to fluoride therapy less invasive repairs and control of decay risk factors is needed. Numbers over 30 correspond to dentinal decay that needs restorative treatments (8,9).

The use of this tool in caries detection for children is very efficient. Considering the dread of children for dentists and their lack of cooperation, obtaining radiographs in order to diagnose carious lesions is very problematic, and in case of head movement causing a change of film position, the process has to be repeated. But the Diagnodent is a device that has a non frightening appearance and has the capacity of repetitive exams. It's even possible to explain the device to the child and let him handle the machine, to make him or her more cooperative. This device has also the ability to show decays in early stages that are not seen in radiographs. Therefore it is possible to quickly

perform prophylactic treatments in order to prevent caries development. Also in recall sessions, it's an appropriate device for evaluation of progression or prevention of decays (10,11).

Hard Tissue Cutting

The Er:YAG laser has been granted the FDA approval from 1997 for caries removal as well as cavity preparation including enamel and dentin preparation without pulp damage. With the irradiation of this laser wavelength to the tooth, the small amount of water present in enamel and dentin is evaporated which provokes the explosive displacement of the damaged structure. Clinically, the separation of small parts of dental tissue with the action of laser, and changes in air pressure around provoke a popping sound. In the target tissue in which the amount of water is more (Decay>Dentin>Enamel) the sound is greater. This characteristic helps the dentist to selectively remove carious tissues instead of healthy ones. In comparison to wavelengths near infrared, the effect of Erbium laser results in least heat dispersion through dental structure. The use of water spray with this laser, helps in the spread of the particles coming from tissue separation, and creates a cool environment in the target tissue (12,13).

Cavity Preparation

Respect of minimally invasive restorative dentistry principles, has made the use of Erbium laser for carious tissue removal appropriate, which results in the preservation of tooth healthy tissues. The removal speed with the Erbium laser is a little slower compared to high speed turbines, but considering the lack of need for anesthesia injection and the elimination of the anesthesia effect waiting time, it is possible to gain some times. Furthermore the Erbium laser family can decrease the bacterial population of the target tissue compared to conventional current methods. Cavity preparation with current methods provokes pain, and the noise and vibrations produced make the patient uncomfortable. This uncomfortable feeling influences the cooperation of children and teenagers. Therefore considering the aforementioned reasons, the use of laser in children for enamel and dentin removal with the least anesthesia or without need

of it seems very reasonable and logic, also because it eliminates the dangers of lips and tongue bites which are frequent problems with children. In addition, in case of pulp damage, its repair starts and is completed sooner than with the normal drill. The amount of power needed to remove enamel is 6w, dentin 4w and carious tissues 2w. When preparing proximal cavities, it's better to use a matrix to avoid etching of the surrounding tooth proximal surface (14-16).

Fissure Sealant Therapy

The use of laser gives the dentist the ability to clean and sterilize enamel fissures. Studies have shown that enamel surface prepared with Erbium laser has properties similar to enamel etched with acid. The important point is to not move the Erbium laser in a way to produce more etch in a zone compared to other regions (17,18).

Etching

There were some important differences between the results of various studies in evaluation of the bond strength of restorative material bonded to teeth surfaces etched with Erbium laser family and with acid etch technique. These differences could be the results of laser parameters (Output energy and frequency) and the type of restorative material used. The obtained SEM images showed an increase in retention of restorative material for the surfaces irradiated by laser and a decrease in bacteria in the pits and fissures, the sterilization property of laser on irradiated surfaces is seen. In general, the best results have been obtained in simultaneous use of laser and acid (19).

Carious Lesions Prevention

The main objective of preventive treatments in modern dentistry is caries prevention. Fluoride therapy either in a systemic way or local application can prevent the beginning and the progress of caries. Laser via changes in the enamel crystal structure efficiently improves the resistance to acids and prevents the spread and progress of lesions. The use of fluoride before and after laser irradiation increases the fluoride uptake and decreases the amount of solubility in acidic solutions. Laser

irradiation provokes more adhesion of fluoride to lower layers of enamel and dentin which is possible by penetration of fluoride in micro spaces in enamel and dentin. SEM images from structures irradiated with laser accompanied by application of fluoride showed that laser irradiation provoked the formation of many spherical or globular precipitations on the surface. Laser heat effects and the creation of micro openings and small cracks facilitate the penetration of fluoride. It seems that the simultaneous use of laser and fluoride, without taking into account of wavelengths, is the best method of carious lesions prevention (20). Lasers that are being used in carious lesions prevention comprise Nd:YAG, CO₂, Er:YAG, Er;Cr:YSGG, Argon and Diode. Many studies on the effect of Nd:YAG laser have been performed. In addition, recently there are some studies mentioning the efficacy of this laser in the treatment of progressive caries lesions with reports of good children cooperation and better tooth fluoride penetration. The Erbium laser family has also used in this domain, but the important point when applying them is the use of appropriate parameters, which have to be under the ablation threshold for tissue removal. One of the advantages of Argon laser application is the ability to evaluate the clinical effects on lesions right after irradiation. The diode lasers mechanism is more based on their bactericidal effect. The use of CO₂ laser in carious lesions prevention is because of its high absorption by phosphate hydroxyapatite radicals. The best results with these lasers are obtained when used with 9600 wavelength (21).

Pulp Therapy in Deciduous Teeth

Today substances like formocresol are used in deciduous teeth pulp therapies, which smell disturbs children, but also its contact with mucosal surfaces can cause necrosis and ulcers that are very unpleasant and painful for children. Studies have shown that laser have good effects in pulp therapy, which results are similar or even better than formocresol. Taking into account the many advantages of laser compared to conventional methods, like hemostasis, preservation of living tissues near the tooth apex, absence of vibrations and smells, satisfaction of children and parents are more guaranteed. Concerning the use of laser in pulp therapy, one of its main advantage and perhaps

actually more important is its safety compared to other conventional methods and their possible side effects, especially concerning formocresol which is strongly criticized in the literature. Nd:YAG laser with output power of 2W and frequency of 20Hz and Erbium laser with power of 0.5W and frequency of 20Hz can be used for this purpose (22,23).

Laser Application in Soft Tissues

Frenectomy

The abnormal junction of the frenum on the maxilla results in diastema between teeth, weak hygiene, gingival retraction, and repetitive trauma during tooth brushing. The best laser for treatment of this condition is Erbium laser, which is used simultaneously with water spray. This intervention is performed without need of sutures, scar tissue formation and any problem in healing. Usually frequencies between 30-45Hz and energy between 35-55mJ is used. Diode laser with power of 1W in continuous mode can also be used, but it is essential to pay attention to the fact that with this method the possibility of damage to surrounding tissues, pain and discomfort after surgery is more than application of Erbium laser. On the other hand, with the use of laser, limitation of the amount of hemorrhage during the surgery helps to provide a better field view for surgeon. Furthermore, patient comfort after surgery is without doubts one of the biggest advantages for patients (24-26).

Ankyloglossia

Ankyloglossia is a frequent finding in newborns, which can cause significant problems in terms of breast feeding, nutrition and speech if the adhesion is severe. For the treatment of this condition surgical lasers without need for anesthesia or sedatives are used. It is important to protect the infant and dentist's eyes with laser glasses and pay attention to the sublingual glands (27).

Exposure of Unerupted Teeth for Orthodontic Objectives

For soft tissue removal and exposure of unerupted permanent teeth for orthodontic objectives, it is

possible to use different wavelengths of lasers, including Er:Cr:YSGG, Nd:YAG, Er:YAG and Diode laser. Erbium laser has the ability to remove soft and hard tissues, so when using this laser, one should pay close attention to the enamel in the surgical point surroundings, in order to reduce the risk of etching. While using the Diode and Nd:YAG lasers this risk doesn't exist, because their wavelengths do not interact with hard tissues. If for tooth exposure, only soft tissue removal is necessary, most of the time the surgery can be performed without need of local anesthesia, only with the application of anesthetic gels, which is a big advantage in infant patients. The Erbium laser with energy more than 100mJ and frequency of 20Hz is used for soft tissue cutting and bone removal. To reinforce the hemostasis, again the Erbium laser with energy of 65mJ energy, frequency of 20Hz and pulse duration of 600µs is used (28).

Gingival Remodeling and Gingivectomy

In children with gingival hypertrophy, we can use various lasers for gingival remodeling. Gingival hypertrophy can be caused by some medications like Dilantin or by weak hygiene after orthodontic appliances have been set. Also in cases of tooth decay that propagated under the gingiva, it's possible to use laser to remove gingival tissue and proceed through repair stages without gingival hemorrhage. In this case Erbium laser with energy of 55-80mJ and frequency of 20-30Hz without water spray is used (29).

Lesions Removal and Biopsy

Soft tissue lesions in children and teenagers are clinical findings resulting from trauma, because in these ages traumas and blows are frequent. Between those lesions we can point the benign fibrotic lesions resulting from lip trauma. These lesions if pigmented can be removed by Argon, Diode and Nd:YAG lasers. And if the lesions are not pigmented, it's easier to remove with Erbium and CO₂ lasers, because these wavelengths are easily absorbed in water (25).

Usually this operation needs local anesthesia, but rarely needs sutures. Advantages of laser in removal of these lesions are least hemorrhage

and post surgical discomfort. In addition, the pathologist has to be informed that the lesion has been removed by laser, in order to make an accurate diagnosis. Erbium laser with mean energy of 55mJ and frequency of 15-45Hz as well as Diode laser with 1-1.5W power can be used. For Diode laser, it is better to use them in well vascularized regions, in order to benefit from their hemostasis characteristic (28).

Treatment of Aphthous Ulcers and Herpetic Lesions

Isolated aphthous ulcers or stomatitis, is one of the reasons of children impatience and agitation. One of the easiest and more appropriate ways to treat these lesions is the application of low power laser like Diode laser in continuous mode, Nd:YAG and Erbium laser without the use of local anesthesia. It's possible to use Erbium laser with frequency of 15Hz and energy of 35mJ in a non-contact way. First, laser is maintained for 15s on the lesion and then it is moved in a rotation pattern above the lesion. The treatment is prolonged to a 1mm margin outside the lesion. If Diode laser is used 0.5w for 1min is applied in treatment of aphthous lesions and 2min in treatment of herpetic lesions. Considering the more penetration of Diode laser, this laser is better for the treatment of herpetic lesions. Nd:YAG laser is also used with energy of 50mJ and frequency of 20Hz. In most cases one treatment session results in the cutting of the entire lesion and the rapid resolution of the patient problem, but it's possible to repeat it 3 to 4 times. The use of protection glasses, mask and high power suction in this operation is necessary in order to prevent contamination by the evaporated particles which can be infectious (30,31).

Low Level Laser Application in Pediatric Dentistry

The different types of low level lasers are red visible Helium Neon (He-Ne), invisible infra red Gallium- Arsenide (Ga-As), Gallium-Aluminum-Arsenide (GaAlAs), Indium-Gallium-Aluminum-Phosphide (InGaAlP). Low level lasers act on target tissues via photochemical and photobiological effects. Low level lasers produce between 50-500mw power and have stimulatory as well as

inhibitory effects. Their application in pediatric dentistry include anesthesia, traumatized anterior teeth treatment, muscle spasms and cellulitis treatment, temporomandibular joint problems treatment, attenuation of Gag reflex and reduction of post surgical complications (32).

Teeth anesthesia

The application of low level lasers can decrease the need for injection of anesthesia. Anesthesia is performed by irradiation of low level lasers or high power lasers in non focal mode. Studies have shown that teeth irradiated by low level laser demonstrated lower levels of pain compared to control group. To obtain this effect, low level laser is applied at a distance of 1-3mm over the dentinal surface and tooth root for 1-2min (33).

Traumatized Anterior Teeth Treatment

Trauma to anterior deciduous teeth results in pulp damage, teeth discoloration and or damage to permanent teeth under them. In this condition in order to treat loose and displaced tooth, after correct positioning of the tooth, the facial and palatal surfaces of the traumatized tooth are irradiated for 1min. In some cases it's better to irradiate the traumatized tooth at day 3 and 5 post trauma (34).

Cellulitis and Spasm treatment

Patients with oral infection arising from tooth abscess, have mouth opening limitations in examination. Application of low level laser in the involved region on the maxilla and mandible for 3min (Amount of energy should be approximately 3J) results in the reduction of muscle spasm and allows enough mouth opening for tooth drainage of the infected tooth (35).

Temporomandibular Joint Problems Treatment

Children with antecedent of noise in ear, mandibular pain during mastication and limitation in complete mouth opening can be treated by low level laser every two days, although these conditions are not frequent in children. The normal protocol comprises 5 treatment sessions with the use of

2.2J energy and outside-inside mouth irradiation of every involved point for 1min (28).

Attenuation of Gag reflex

The P6 acupunctural point in the wrist region has the ability to reduce nausea. The application of 4J energy on this point is effective in the attenuation of gag reflex. The P6 point is located on the underside of the wrist at a 1 inch distance from the wrist crease. This method is beneficial for patients who have problems when placing radiographic films, placing rubber dam and working on posterior regions (36,37).

Treatment for Surgical Operations and Injuries

Patients undergoing surgery benefit from laser irradiation of the concerned region prior to surgery. This method results in reduction of post surgical pain and inflammation. The effect of laser on wound healing is due to its interaction with the cellular membrane and nuclear components. Laser irradiation on soft tissue results in decrease of inflammation and pain, improvement of the tension strength of the wound and stimulation of the immune system (35).

Composite Curing

For composite curing, Argon laser with wavelength of 488nm is used, on which camphorone is precisely sensitive. Laser polymerization compared to conventional light-cures is activated more rapidly. Rapid curing in pediatric dentistry which needs less time is important. Of course the use of 2mm composite layers should be respected (38).

Conclusion

The objective of pediatric dentistry treatments is preventive or repair treatments on mouth or teeth in a stress and pressure free environment. Since the control of children behavior and the reduction of the work time are some of the important pillars in pediatric dentistry, it seems that the use of lasers can be very beneficial. The most commonly used lasers in dentistry can lessen the stress and fear of patients during dental operations. They are more

conservative methods on soft and hard tissues, with minimal discomfort and hemorrhage.

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