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Review Article

Microdentistry with Lasers

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Abstract:

Treating infants and young children is a rewarding experience, especially when we guide parents and children down the path of prevention and interception of oral disease. The pediatric dentist has to be updated about the new technologies to treating patients along with basic principles. This article gives a brief discussion on the types, applications, advantages, and limitations of the use of lasers in pediatric dentistry.

Key Words: Lasers, microdentistry, pediatric dentistry

Introduction

The child is in a dynamic state of growth and development. As highlighted by Edelstein dental health plays an important role in the growth and well-being of a child,[1] hence dental treatment is a very important health service to prevent serious repercussions on a child's general health and well-being. Studies have proved that bacteria colonize the oral cavity as early as 1st year of life and it is recommended that the child's first dental visit be scheduled at this age thus minimizing or preventing the oral disease.[2,3]

The main aim is tissue preservation by preventing the initiation and spread of the disease achieved by performing treatment with as little tissue loss as possible.[4] With the new techniques available we can perform microdentistry by early diagnosis of dental disease using newer technologies such as air abrasion, rotary instruments for micro preparation, ozone therapy and the lasers.

The concept of "microdentistry" was introduced many years ago. The old concept "extension for prevention" has changed to "prevention of extension". Laser technology allows the dentist to perform microdentistry, by early detection and diagnosis, treatment of only the affected tissue and preserving the healthy tooth structure, thus fulfilling the motto. Diagnosis of the dental disease can be done using technologies such as radiovisiography, diagnodent, magnifying loupes or a dental microscope.[5] This article gives a brief discussion on the types, applications, advantages and limitations of the use of lasers in pediatric dentistry.

Laser Physics

The term laser is a cipher, for "Light Amplification by Stimulated Emission of Radiation".[6] Within a laser, an active medium is stimulated to produce photons of energy that are delivered in a beam with an exact wavelength unique to that medium. Lasers typically are classified by the active medium used to create the energy. The energy radiated by the laser is basically a light of one color (monochromatic) and thus a single wavelength.[7]

Oral hard and soft tissues have a specific affinity for absorbing laser energy of a specific wavelength. The wave-length of a dental laser is the deciding factor of the level to which the laser energy is absorbed by the target tissue.[8-10] For this reason, laser selection depends on the target tissue the practitioner wishes to treat. The principle effect of a laser within target tissues is photothermal.[11] When the temperature of target tissue containing water is raised above 100°C, vaporization of the water occurs, causing soft tissue ablation.[1] The water content of soft tissues is high thus enhancing, excision of soft tissues at this temperature. Hard tissue is composed of hydroxyapatite crystals and minerals are not ablated at this temperature, but the water component vaporizes, the resulting steam expands and then disperses the encompassing material into small particles.[7-10]

Many different lasers are useful in pediatric dentistry. There are lasers for diagnosing dental disease such as the diagnodent. Argon lasers are available for curing composite restorations and soft-tissue surgical procedures.[11] CO_2 lasers are used for surgical treatment of large soft-tissue lesions where coagulation, vaporization, and precision in tissue cutting is required. With the development and introduction of the erbium family of lasers, the pediatric dentist has a safe and efficient laser to treat both hard and soft tissue of the oral cavity. The benefits of treating patients with the erbium family of lasers include the bactericidal effects,[12] which can sterilize the area, and the numbing or analgesic effect on the target tissues, similar to the

Nd:YAG devices.

Application and use of different kinds of lasers in dentistry has revolutionized similar to that as in the medical field. In 1965 Sognaes and Stern proposed the use of lasers, but lasers became an integral part of practice in dental field only in the 1990's. Use of lasers help the pediatric dentist with new treatment options so as to modify, change and supplement some others; without changing the basic principles of dentistry.

The American Academy of Pediatric Dentistry (AAPD) have set certain protocols for the judicious use of lasers and is intended to inform and educate dental professionals on the fundamentals, types, diagnostic and clinical applications, benefits, and limitations of laser use in pediatric dentistry.

***Policy statement*[13]**

The AAPD:

- Recognizes the use of lasers as an alternative and complementary method of providing soft and hard tissue dental procedures for, children, adolescents and child with special health care needs
- Advocates that the dental professional receive additional didactic and experiential education and training on the use of lasers before applying this technology on pediatric dental patients
- Encourages dental professionals to research, implement, and utilize the appropriate laser specific and optimal for the indicated procedure
- Endorses use of protective eyewear specific for laser wavelengths during treatment for the dental team, patient, and observers.[13]

Applications

Diagnosis

Today's traditional clinical methods for diagnosing caries are not sensitive enough, but diagnodent for diagnosis of occlusal caries in deciduous teeth shows promising results in comparison to other traditional methods. The device analyzes the emitted fluorescence on the occlusal surface of the tooth, which correlates with the degree of demineralization in the tooth and, when quantified, indicates the relative amount of caries present.[14-18] Demineralization around brackets can also be measured by diagnodent, as shown in an *in vitro* study.[19-21] The disadvantage of diagnodent is, it tends to over score discolored fissures and is limited in terms of detecting early signs of enamel caries and occlusal lesions.

Caries prevention

Several *in vitro* and initial *in vivo* studies have shown that argon laser irradiation provides a certain degree of protection against enamel caries initiation and progression. Different argon laser delivery systems showed similar results, i.e. this type of laser is effective in reducing caries susceptibility of sound enamel and white spot lesions.[22,23] Using argon laser irradiation combined with topical acidulated phosphate fluoride treatment provides a protective surface coating against caries and results in significant decrease in lesion depth.[24,25] With the laser, there is no smear layer formation, enhancing bond strengths of resin materials. Laser enameloplasty prior to sealant placement is another use for this technology, caries (i.e.acid) resistance of the enamel is enhanced and the need for acid etching is reduced or eliminated.

Caries restoration

There are two wavelengths, Er:YAG at 2940 nm and Er, Cr:YSGG at 2790 nm, which are similarly active in treating hard- and soft-tissue lesions. Er:YAG and Er, Cr:YSGG lasers are used successfully in all classes of cavity preparation. Studies have shown the efficient ablation of dental hard tissues with little or no thermal effects on the pulp.[26-28] Other studies showed the minimal vibration and noise of the Er:YAG during cavity preparation and no or minimal need for local anesthesia; enamel surfaces thus treated have been reported to be similar to those of acid-etched enamel surfaces.[29-31] Cavity preparation by Er:YAG lasers produce less or almost no noise, less vibration, and no need for local anesthesia.

Lasers in Oral Surgery

Nd:YAG, argon, CO_2 and diode lasers are useful for cutting, coagulation, and decontamination of soft tissue. Modern Er:YAG lasers, with their modifiable pulse lengths (up to 1000 μs), are also suitable for soft tissue management. Gutknecht *et al*. described lasers can be used for removal of fibroma, operculectomy, pyogenic granuloma, gingival hyperplasia, mucoceles, herpes labialis, aphthous ulcers, and hemangioma.

Pediatric Endodontics

Nd:YAG or diode lasers can be used for the treatment of infected root canals. The bactericidal effect within the root canal is around 99%. Er:YAG and Er, Cr:YSGG laser are effective for removing organic materials and smear layer within the root canal.[5]

CO_2 lasers pulpotomy in pediatric endodontics is a very common procedure and are described to be very effective, but pulsed Nd:YAG lasers can also be employed to perform pulpotomies. In a clinical study, it was shown that after a follow-up of 4 years, 99.4% were clinically successfully treated. Hemostasis of root pulp stumps can be achieved with laser technology. Laser irradiation in root canals also reduces the number of microorganisms, thus promoting canal decontamination.[5]

Low-Level Laser Therapy

Treating children with the low level laser therapy (LLLT) laser is not different from treating adults. However, a non-traumatic introduction to dentistry is very important. To a child a laser is not a threat; it's "cool."

According to Tuner and Hode, five main indications in pediatric dentistry are given:

1. The eruption of both deciduous and permanent teeth are sometimes painful. Therefore, irradiating the lymph nodes in the area is recommended for relief.
2. A radiation dose of 2 J has a brief anesthetic effect in the mucosa, allowing painless injection with a needle.
3. Direct application of a dose of 4-6 J into an exposed cavity of a deciduous tooth can be used for pain reduction.
4. Post-traumatic treatment after lip and anterior tooth trauma to reduce swelling and pain can be achieved by applying a dose of 3-4 J.
5. A dose of 0.5-2 J as an additional treatment in pulp capping will improve the outcome of treatment.[32]

Advantages of laser use

1. Selective and precise interaction with diseased tissues.
2. Less thermal necrosis of adjacent tissues is produced with lasers than with electrosurgical instruments.
3. During soft tissue procedures, hemostasis can be obtained without the need for sutures in most cases.
4. With the benefit of hemostasis during soft tissue treatments, wound healing can occur more rapidly with less post-operative discomfort, edema, scarring, shrinkage and a reduced need for analgesics.
5. Little to no local anesthesia, suturing is required for most soft-tissue treatments.
6. Reduced operator chair time with its associated vibrations, noise, smell and fear factor has been observed when procedures have been completed using lasers.
7. Lasers demonstrate decontaminating and bactericidal properties on tissues, requiring less prescribing of antibiotics post-operatively.
8. Provide relief from the pain and inflammation associated with aphthous ulcers and herpetic lesions without pharmacological intervention.[8,9,33]

Limitations of lasers in pediatric dentistry

- Requires additional training and education for the various clinical applications and types of lasers.
- High startup costs are required to purchase the equipment, implement the technology, and invest in the required education and training.
- Since different wavelengths are necessary for various soft and hard tissue procedures, the practitioner may need more than one laser.
- When using lasers, modifications in clinical technique along with additional preparation with high-speed dental handpieces may be required to finish tooth preparations.
- Wavelength-specific protective eyewear should be provided and other observers in attendance during laser use.
- When using dental lasers, it is imperative that the doctor and auxiliaries adhere to infection control protocol and utilize high-speed suction as the vaporized aerosol may contain infective tissue particles.
- The practitioner should exercise good clinical judgment when providing soft tissue treatment of viral lesions in immunocompromised patients; as the potential risk of disease transmission from laser-generated aerosol exists.
- To prevent viral transmission, palliative pharmacological therapies may be more acceptable and appropriate in this group of patients.[13]

Conclusion

Laser-supported pediatric dentistry is one of the most promising fields in modern minimally invasive dentistry. Erbium family of lasers is very useful for pit and fissure sealing, caries treatment, and cavity preparation. In soft-tissue surgery, CO_2 lasers and very long-pulsed Er:YAG lasers play a dominant role.

Application of laser technology is thus a luxuriate and exciting during dental procedures both for pediatric dental patients and the Practitioner. They must adapt behavior management techniques to new laser technologies and choose the best one for every dental procedure.

Finally the most important is special attention to be given to the practitioner to get familiar with the scientific principles, be aware and sound with the scientific literature on the safety, efficacy, and effectiveness and application of the technology.

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