REVIEW ARTICLE

Lasers in pediatric dentistry: A review

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Abstract

In ancient Greece, the sun was used in heliotherapy, or the exposure of the body to the sun for the restoration of health. The Chinese used the sun to treat such conditions as rickets, skin cancer and even psychosis. This use of light for treatment of various pathologies is referred to as phototherapy. In 1903, a Danish physician named Niels Finsen developed a technique known as carbon arc phototherapy for the treatment of lupus vulgaris that employed the use of ultraviolet rays.

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Introduction

Light has been used as a therapeutic agent for many centuries.[1] There are three main types of lasers being used as instruments for surgical therapy in the oral cavity: The neodymium lasers - YAG (Nd: YAG), of argon (Ar) and carbon dioxide (CO_2).[2] Over the last few years, lasers have become a household name. In early 1960's Dr. A.L. Schawlow, co-inventor of laser principle described laser as an "invention in search of an application." Today, laser has found myriad uses in many disciplines of medicine and surgery replacing the scalpel and the whine of the handpiece in dental surgery.[3]

Often the word lasers are associated with the words like magical "magical" and "lightening quick" with the use of lasers in medical practice.[4]

The first laser, or "maser" as it was initially called, was developed by Theodore H. Maiman of Hughes Aircraft Corporation in 1960. "Maser," like the more familiar term "laser," is an acronym for "microwave amplification by stimulated emission of radiation," which describes the basic principle by which all lasers operate.

The word LASER is an acronym for light amplification by stimulated emission of radiation.

Tissue Interaction and Safety

Because of the monochromaticity of laser energy, different laser wavelengths have different absorption coefficients when in contact with dental tissue; laser energy can be transmitted or absorbed based on the composition of target tissue. Water, which is present in all biologic tissue, best absorbs the two Er wavelengths, followed by CO_2 wavelength. Conversely, water allows the transmission of shorter wavelength lasers, including Ar, diode, and Nd: YAG. Apatite crystal, which forms the structure of teeth and bone, readily absorbs CO_2 wavelength and, to a lesser degree, those in the Er family. Apatite does not, however, absorb the shorter wavelengths of Ar, diode, and Nd: Yag. Hemoglobin and other blood components and the tissue pigment melanin absorb the short wavelength lasers.[5]

Because human dental tissues are composed of a combination of water, apatite crystal, blood, and the tissue pigment, the clinician must choose the best laser for each treatment. For soft tissue treatments, the practitioner can use any dental laser regardless of wavelength because all dental lasers are absorbed by one or more of the soft tissue components. For hard tissue surgery, however, the only lasers are from the Er family. Er lasers use extremely short pulse durations and can easily ablate layers of calcified tissue with minimal thermal effects.[5]

The clinician can treat a variety of dental pathologies using different lasers, and when there is a choice between different laser parameters, the underlying principle is to use the least amount of laser energy to perform the treatment objective. Lasers primarily interact with dental structures photothermally. The temperature of the target tissue increases as laser light is absorbed, and when the tissue reaches 100°C, the inter- and intracellular water boils away, causing either soft tissue vaporization or explosive expansion and disruption of hard tissue (ablation). If the tissue temperature continues to be raised to about 200°C, it is dehydrated and then burned in the presence of the air (carbonization). Carbon, as the end product, absorbs, all wavelengths.[5]

Applications of Lasers in Pediatric Dentistry

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 American Academy of Pediatric Dentistry recommends that a child's first visit to the dentist occur no later than 6 months after the first teeth erupt, or around a child's first birthday. During the initial visit, the pediatric dentist can assess medical histories, educate parents on healthy oral practices (e.g., brushing, flossing, diet, oral problems, and when appropriate, determine necessary preventive or interceptive actions. Oral examinations by 1 year of age allow for earlier recognition and treatment and esthetically acceptable occlusion. Soft-tissue procedures, that once were rejected because they necessitated general anesthesia, can be safely and quickly treated with lasers in the dental office. Clinical experience indicates that restorative treatment in most children can be accomplished with little or no local anesthetic agents and their associated concerns, such as lip or tongue biting, which often occur when the child is numb.

Laser technology allows the dentist to perform microdentistry, removing only diseased dental tissue and preserving the remaining healthy tooth structures. Dental disease can be diagnosed early by using digital dental radiography, laser-assisted diagnosis of dental decay, or magnification such as dental loupes or a dental operating microscope.

Lasers for pediatric patients

Many different lasers are useful in pediatric dentistry. There are lasers for diagnosing dental disease such as the diagnodent (Kavo, Lake Zurich, Illinois). With the development and introduction of the erbium family of lasers, the pediatric dentist has a safe and efficient laser to treat hard and soft tissue of the oral cavity. The erbium laser's shallow depth of tissue penetration, high affinity for water, lack of thermal damage, and minimal reflective property make it ideal laser for pediatric dentistry.

Hard tissue procedures are performed in non-contact using water spray on the tissue. The water spray may or may not be used for soft tissue surgery; most treatments are in non-contact and contact with the tissue. Aphthous ulcers and herpetic lesions are always non-contact. The benefits of treating patients with the erbium family of lasers include bactericidal effects, which can sterilize the area and the numbing or analgesic effect on the target tissues, similar to the Nd: YAG devices.

Laser soft-tissue treatments

Treatment of ankyloglossia

Older children and adults are prepared in the usual manner using a local anesthesia of operator choice. The tongue is stabilized with a hemostat, and the frenum is revised. It is important to avoid the glands on the floor of the mouth. Healing progresses uneventfully.

Exposure of teeth for orthodontic care

A variety of wavelengths can remove soft tissue to uncover permanent teeth for an orthodontic guidance, but only the erbium lasers can remove soft tissue and bone. When only soft tissue requires removal, this procedure can be often completed without the need for local anesthesia, and a topical anesthetic should be applied.

Gingival recontouring and gingivectomies in orthodontic patients; dilantin hyperplasia and crown lengthening in caries preparations

In instances where gingival tissue has become hypertrophied due to medications such as dilantin or instances where poor oral care occurs while the patient is wearing orthodontic appliances, the laser can be used to reshape or remove excessive tissue growth. When restoring teeth where caries extend below the gingival tissue, lasers can remove the gingival tissue to allow placement of a restoration without concerns for bleeding.

Removal of lesions and biopsies

Lasers are excellent tools for removing soft-tissue lesions. All lesions removed should be sent to a pathology laboratory for diagnosis. Lesion removal usually requires local anesthetic; however, treatments rarely require sutures. Bleeding is minimal, and there is little or no post-operative discomfort. Instruments such as Ar, diode, and Nd: YAG are useful for pigmented and vascular lesions, whereas non-pigmented lesions are more effectively removed by an erbium or CO_2 laser due to those wavelength's absorption in the water of the lesions.

Treatment of pericoronal problems in erupting teeth

It is not uncommon for children whose first permanent molars are erupting to develop discomfort, swelling, or infection in the tissue overlying the emerging tooth. Lasers can be used in a non-contact mode to ablate the involved tissue and expose clinical crown of the involved tooth.

Treatment of aphthous ulcers and herpetic lesions

One of the easiest and most appreciated procedures using lasers is treatment of single isolated aphthous ulcers or recurrent

aphthous stomatitis. The treatment involves low power settings, and the laser energy is directed at the target tissue in a non-contact fashion. The involved area is lased in 15-30 s intervals, no local anesthesia is used and the procedure is repeated three or four times until the patient reports relief. The tissue may appear drier at the end of the treatment, without much change in color. In herpes labialis, using the laser when the prodromal signs first appear has a palliative effect on the area and may prevent the development of a full herpes lesion.

Pulp therapy

Accessory treatment by laser for indirect pulp capping

The discovery of closure of dentinal tubule by laser energy and the sedative effect on pulpitis has led to the development of indirect pulp capping of carious teeth. The mechanism is thought to be similar to that of sedation of dentinal hypersensitivity by the laser.[6]

Direct pulp capping

Because laser treatment has advantages with respect to control of hemorrhage and sterilization, laser use for direct pulp capping has attracted dentists attention. When using the CO_2 laser for this treatment, laser irradiation of the exposed dental pulp must be performed to stop bleeding and sterilize the area around the exposure.

Laser pulpotomy in primary teeth

In vital teeth, the laser cleans the pulp chamber in 10-20 s. The laser seems to provide adequate hemostasis and allows some vital tissue to remain at the apex. In non-vital teeth, the laser's success rates seem equal to conventional pulpotomy procedures, if a fistula is present, the success rate falls significantly.

Hard Tissue Interaction

The effectiveness of using a laser for the removal of caries is safe and well documented in the dental literature. The Nd: YAG laser is indicated for use in superficial pigmented caries removal; however, the erbium family of lasers are the lasers of choice and most efficient for deep enamel, dentin, and caries removal.

Lasers prevent micro-fractures seen with conventional drills and in most instances do not require anesthesia to prepare the teeth for restorations. When using the erbium lasers to remove dental caries, successful patient comfort depends on many operator variables and on the patient's experiences with previous dental treatment.

Removal of amalgam and other direct restorations

It is not recommended that any laser be used for the direct removal of failing amalgam restorations. If caries ablation requires removal of an existing amalgam, the laser tip should be directed at the surrounding enamel to produce a small trough. Hand instruments can then be used to lift out the metal, and the preparation can be completed. Lasers can be used to remove defective composite and glass ionomer restorations.

Sealant placement

Sealants have been available since 1955 and yet their placement remains underused. Up to 70% of all molars develop occlusal surface caries within 3 years of the tooth's eruption.

The laser allows the dentist to clean, sterilize, and clearly visualize the enamel grooves. Furthermore, studies have shown that the erbium-etched enamel has similar properties to acid-etched enamel. The laser requires water to remove caries and etch teeth; however, in instances where very young children may react negatively to the water spray, the practitioner may shut off the water and carefully etch the tooth. It is important to continuously move the laser tip around the pit and fissures to avoid injuring the tooth being etched. Conventional sealant placement including additional acid conditioning can follow.

Caries removal and tooth preparation

The erbium family of lasers may be used for the treatment of any class of caries. If the tooth has a high fluoride content, surface ablation may proceed slowly because of the minimal water content. In those cases, a high-speed turbine may be used to remove the enamel. The tip of the laser should be held perpendicular to the cutting surface to maximize cutting efficiency. Once the enamel is removed, the energy settings must be reduced because dentin and caries have more water content than enamel and cut more easily.

Combining soft- and hard-tissue treatments

There are a number of surgical procedures involving hard and soft dental tissues, such as apicoectomies and the removal of impacted teeth under bone. The erbium lasers are ideal for these surgeries and a variety of tips, settings and water sprays can be used. Soft-tissue ablation does not require water spray whereas removal of bone needs to be done with water.

Contraindication of laser therapy use

1. It is not prescribed in patients with pacemakers, or used with precaution
2. Laser should not be used in the uterus region in pregnant women
3. Shouldn't be used in epileptic patients or with frequency <800 Hz
4. Shouldn't be used in patients with antecedent of arrhythmia or chest pain
5. Shouldn't be used on glands, e.g. thyroid gland
6. Laser therapy should be avoid on tumorous tissues or benign tumors with malignant tendency
7. Prescription of laser therapy is forbidden in patients with lupus or patients treated with substances sensible to light
8. Low level lasers, under the title of cold-soft lasers, are used for years in different countries all over the world. The favorable effects of these lasers such as: Decreasing inflammation and pain, increasing the quality and rapidity of repair, increasing

the immunologic system, etc., are presented in different books and articles.[7]

Laser safety

Dental practitioners should be aware of dental laser safety, including not only an awareness of the potential risks and hazards related to lasers used, but also recognition of existing standards of care and a thorough understanding of safety control measures.[2] The types of hazards that may be encountered within clinical practice of dentistry may be grouped as follows;[8]

- Ocular hazard
- Tissue damage
- Respiratory hazards
- Fire and explosion
- Electrical shock
- Combustion hazard
- Equipment hazards.

Conclusion

Lasers have grown in scope of treatment and number of dental professionals using them. No longer are lasers limited to treating soft tissue conditions of periodontics or oral surgery. Some applications are controversial, and the prudent laser dentist must be careful to evaluate case selection, wavelength specificity, tissue interaction, safety parameters and patient tolerances as they explore "outside the box" thinking. Many modern medical and dental discoveries were byproducts of innovative minds thinking "outside the box." Laser dentistry is exciting in this respect; yet, good scientific principles require that caution and sound judgment be used in developing new laser applications for treating patients.[9]

Dentistry has been prompt in exploring several potential application of laser energy to dental research. Soon after lasers were invented, investigators began to examine the effects of different wavelengths of laser energy on oral tissues. From soft tissue surgery to restorative dentistry, from reshaping healthy gingiva to treating pathological conditions, researchers and clinicians have defined limitations and shown advantages of laser use in dentistry.[10]

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