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REVIEW ARTICLE

Lasers in Dentistry- A Literature Review

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ABSTRACT:
Laser is one of the most captivating technologies in dental practice. Even though, introduced as an alternative to the traditional halogen curing light, the laser now has become the instrument of choice, in many dental applications. This paper gives an insight on laser in dentistry.

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INTRODUCTION

Laser is the acronym of the words 'Light Amplification by Stimulated Emission of Radiation.' Lasers have come shown a long way since Albert Einstein described the theory of stimulated emission in 1917. Today lasers technology has and is influencing our life in many ways. Its advancements in the field of medicine and dentistry are playing a major role in patient care and wellbeing.[1]

In 1960, Theodore Maiman, a scientist with the Hughes Aircraft Corporation, developed the first working laser device, which emitted a deep red-colored beam from a ruby crystal. During the next few years, dental researchers studied possible applications of this visible laser energy. Studies in the 1970s and 1980s turned to other devices, such as CO2 and neodymium YAG (Nd: YAG), which were thought to have better interaction with dental hard tissues.[2]

The Nd: YAG laser was developed in 1964 by Bell Telephone Laboratories. Though Nd: YAG Lasers where discovered a year after the ruby laser it was largely overshadowed for a long time by the ruby laser and other lasers of the era (carbon dioxide laser). It was not until 1990 that this laser was available for dental use.[3]

The carbon dioxide laser was invented by Kumar N Patel in 1964 when working at Bell Telephone Laboratories. Carbon dioxide laser was perhaps the first laser that had truly hard tissue and soft tissue application. Weichman & Johnson in 1971 was one of the first to use lasers in Endodontics, they unsuccessfully attempted to seal the apical foramen in vitro by means of a high power infrared (CO_2) laser. Carbon dioxide lasers are well absorbed by water and had the ability be the laser of choice for various dental soft tissue and hard tissue application, however these gas based lasers could not be delivered through optic fiber due to its large wave length that will not fit into the crystalline molecules of the conducting glass and has to be conducted either by a hollow wave guide or an articulate arm delivery system. Also being well absorbed by water they cannot be delivered by fibers or fiber tips that contain water like the quarts fiber tips, as this would disintegrate the fiber.[4]

Classification

Lasers are classified into several groups: class I (inherently safe); class II and III a (where the eye is protected by the blink reflex); class III b (where direct viewing is hazardous); and class IV (where the laser power is above 0.5 Watts, and the laser is classed as extremely hazardous). Most dental and medical lasers are class IV, and thus compliance with safety standards is necessary to protect the dentist, patient and support staff.

Uses of lasers in dentistry[5]

The rapid development of laser technology has seen its introduction into various fields of dentistry. Some of the present applications of laser in dentist are as follows:

1. Diagnosis

- Detection of pulp vitality
- Doppler flowmetry
- Low level laser therapy (LLLT)
- Laser fluorescence- Detection of caries, bacteria and dysplastic changes in the diagnosis of cancer

2. Hard tissue applications

- Caries removal and cavity preparation
- Re-contouring of bone (crown lengthening)
- Endodontics (root canal preparation, sterilization and Apicectomy
- Laser etching
- Caries resistance

3. Soft tissue applications

- Laser-assisted soft tissue curettage and peri-apical surgery
- Bacterial decontamination
- Gingivectomy and Gingivoplasty
- Aesthetic contouring, Frenectomy
- Gingival retraction for impressions
- Implant exposure
- Biopsy incision and excision
- Treatment of aphthous ulcers and Oral lesion therapy
- Coagulation / Hemostasis
- Tissue fusion - replacing sutures
- Laser-assisted flap surgery
- Removal of granulation tissue
- Pulp capping, Pulpotomy and pulpectomy
- Operculectomy and Vestibuloplasty
- Incisions and draining of abscesses
- Removal of hyperplastic tissues and Fibroma

4. Laser-induced analgesia

5. Laser activation

- Restorations (composite resin)
- Bleaching agents

6. Other

- Removal of root canal filling material and fractured instrument
- Softening gutta-percha
- Removal of moisture/drying of canal

USES OF LASERS ON HARD TISSUES

Lasers for Caries Detection

This diagnostic technology in which a Diagnodent, a 655 nm diode laser, aids in the detection of incipient caries is called laser-induced fluorescence. When the laser irradiates the tooth, the light is absorbed by organic and inorganic substances present in the dental tissues, as well as by metabolites such as bacterial porphyrins.[6] These porphyrins showed some fluorescence after excitation by red light. Since bacteria are present in the carious lesions, carious tissue exhibits more fluorescence as compared to the healthy tissue which distinguishes between the carious and sound tooth structure. It can detect occlusal, interproximal carious lesion or identify occult lesions beneath fissure sealants. Although, the procedure is considered to be safe, further studies are required for explorations the beneficial effects of this innovative technology.[7]

Lasers for Caries Removal and Cavity Preparation

The Er:YAG lasers are proven to be safe and effective in caries removal and cavity preparation in pediatric and adults patients without significant damage to tooth structure or patient discomfort. This device also aid in removal of defective composite restoration and ablate the distal carious lesion while a tunneling technique (in which the laser's sapphire tip was angled directly toward the distal carious lesion), thus preserving the tooth's distal marginal ridge.[8] The principle used is fluorescence. As the laser is targeted to the tissue, bacteria present in the infected dentin provides signal to the clinician and could also control the action of a pulsed laser to achieve automated caries removal.[9]

Lasers Used for Calculus Removal

The Er: YAG laser is used for calculus removal as the bacterial porphyrins in dental calculus give a strong fluorescence signal, which can be used to control lasers used for scaling. These lasers are effective in removing lipopolysaccharides and other root surface endotoxins and are highly bactericidal against certain periodontal pathogens including P. gingivalis and Actinobacillus actinomycetemcomitans.[10]

Laser Assisted Bleaching

The objective of laser bleaching is to achieve the ultimate power bleaching process using the most efficient energy source while avoiding any adverse effects. Using the 488-nm argon laser as an energy source to excite the hydrogen peroxide molecule offers more advantages than other heating instruments. The argon laser rapidly excites the already unstable and reactive hydrogen peroxide molecule; the energy then is absorbed into all intermolecular and reaches eigenstate vibrations. Lasers can enhance bleaching by photo-oxidation of colored molecules in the teeth or by interaction with the components of the bleaching gel through photochemical reactions. The result is a visually whitened tooth surface.[11]

Surgical Procedures

Many different laser wavelengths have been used in Oral and maxillofacial surgery. Since there is excellent absorption of CO2 laser at wavelength of 10,600 nm in the water-based tissues, it is widely indicated in oral surgical procedures performed intraorally and extraorally. CO2 lasers make relatively deep and precise incisions and thus excellent hemostasis. There is less traumatic bone cutting with the use of Erbium lasers resulting in postoperative discomfort to the patients. The management of patients with sleep apnea, TMJ derangements, dental implants, premalignant lesions, and post-traumatic facial scarring has improved significantly with the advent of laser surgery.[12]

Laser Bleaching

In October 1998, the ADA Council concluded that because of concerns regarding pulpal safety and a lack of controlled clinical studies, the CO2 laser could not be recommended for tooth-whitening applications. The council indicated, however, that the argon laser might be an acceptable replacement for the conventional curing light if the manufacturer's suggested procedures are followed carefully.[13]

Use of lasers on soft tissues

Laser curettage- Both the Nd:YAG and gallium-arsenide (or diode) lasers are promoted for curettage. A critical review of the best available evidence, however, strongly indicates that there is no added benefit to the patient when this procedure is performed after traditional mechanical scaling and root planning. Proponents of laser curettage point to the ability of these lasers to kill microorganisms.[14] Although the data indicate that this effect is possible albeit inconsistent, it has not been correlated with an improvement in periodontal attachment level. With no demonstrable benefit and with a significant risk of collateral damage to the periodontium, laser curettage appears to be neither scientifically nor ethically justified. Er: YAG laser possess suitable characteristics for various surgical and non-surgical procedures but randomized controlled clinical trials have to be encouraged to confirm its status as an adjunct or alternative to conventional periodontal therapy.[15]

Conclusion

Use of Laser in dentistry is increasing day by day. As long as the clinician has completed a training course & proceeds through the learning curve at a comfortable pace, the rewards will quickly be noticed by the patient and the dental team. Lasers can prove to be a blessing in disguise if used safely and properly.

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