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Lasers in Endodontics: A Review

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Abstract--The scope of lasers in the field of Endodontic practices and research has increased rapidly in the past few years. Laser is light amplification by stimulated emission of radiation which provides blood loss field during treatment procedures. It is a non- invasive procedure with various applications in dentistry. However, lasers are slightly costlier than traditional treatment but are an effective tool to increase efficiency, specificity, ease and comfort of the dental treatment. This present article reviews the various applications of lasers in Endodontics.

Keywords--lasers, endodontic lasers, light amplification.

Introduction

The field of dentistry has shown biggest boon in the use of modern technology to bring improvements in the treatment procedures. Among which is the use of LASER (Light Amplification by Stimulated Emission of Radiation) in the field of Endodontics. Laser light is a man-made single-photon wavelength. Through the process of optical amplification Laser emits light. Lasers was first introduced to the public in 1959, in an article by a Columbia University graduate student, Gordon Gould¹. A laser is a device which transforms light of various frequencies into a chromatic radiation in the visible, infrared, and ultraviolet regions with all the waves in phase capable of mobilizing immense heat and power when focused at close range². A laser From the crystals of yttrium-aluminum-garnet treated

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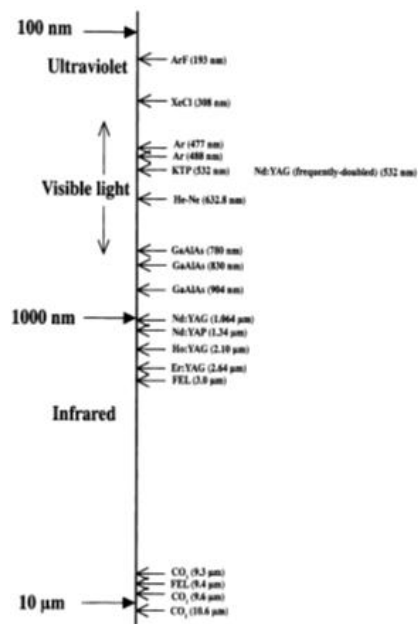
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with 1-3% neodymium (Nd: YAG) was developed in the year 1961¹. In 1962, the argon laser was developed, whereas, the ruby laser became the first medical laser to coagulate retinal lesions, when it was used in 1963. Since then, the use of lasers has progressed rapidly. In 1964, Patel at Bell Laboratories developed the CO₂ laser.¹

In 1990, the Food and Drug Administration (FDA) approved the use of laser therapy in intraoral gingival and mucosal tissue surgery as the therapy ensured a wound without suture, pain, and bleeding and increased the convenience for the dentist. The first laser use in endodontics was reported by Weichman & Johnson (1971) who attempted to seal the apical foramen *in vitro* by means of a high power-infrared (CO₂) laser.²

The laser amplified focused light energy which has the potential to interact with the biological dental tissues and structures in order to penetrate the surface of the tooth and access to the pulp cavity, clean, disinfect and shape the root canal system and finally help to fill it in three dimensions³. The most commonly used lasers in endodontics are: Neodymium:YAG (Nd:YAG), Diode Laser, Erbium:YAG (Er:YAG), Erbium Chromium:YSGG (Er,Cr:YSGG) and He:Ne laser.



Classification of lasers:⁴

- According to their active medium lasers are divided into three groups.
 - Solid-state laser:
 - Gas lasers:
 - Diode lasers:

Produces wavelengths in the visible spectrum.

- According to the wavelength (nanometers)
 - UV (ultraviolet) range – 140 to 400 nm
 - VS (visible spectrum) – 400 to 700 nm
 - IR (infrared) range – more than 700 nm
- According to tissue applicability
 - Hard tissue- eg: Er:YAG, Er:YSGG, CO₂
 - Soft tissue lasers- eg: Diode, Nd:YAG, CO₂

Applications of laser: ⁴

- Prevention of dental caries
- Management of post endodontic pain
- Diagnosis of dental pulp vitality
- Treatment of dentinal hypersensitivity
- Pulp capping and pulpotomy (Vital pulp therapy)
- Root canal irrigation
- Obturation of root canal
- Bleaching of root-treated discoloured teeth

Prevention of dental caries

Dental hard tissues when irradiated with laser shows reduces the carbonate-to-phosphorous ratio, and leads to the formation of more stable and less acid soluble compounds, reducing susceptibility to acid attack and caries. Laboratory studies have indicated that enamel surfaces when exposed to laser irradiation are more acid resistant than non-laser treated surfaces⁵. The threshold pH of dissolution of enamel was reduced from 5.5 to 4.8, and for hard tooth structure was 4 times more resistant.

Management of post endodontic pain

Sometimes patient experiences pain the day after endodontic treatment. This is especially more common after the treatment of chronic complaints. This can be managed by LLLT(Low level laser therapy)⁶. It is effective for reducing pain and inflammation after endodontic treatment and can be used as a diagnostic tool for pulp hyperemia. The therapy performed with such lasers is often called LLLT, and the lasers are called “therapeutic lasers.” Light in infrared spectrum at specific wavelength penetrates the tissue and is absorbed where the light energy is converted into biochemical energy, restoring normal cell function⁷.

Diagnosis of dental pulp vitality

The most accurate marker of pulp vitality is Vascular supply. A possible test For detecting pulp vitality is assessing vascular supply which relies on the passage of light through a tooth. Laser Doppler flowmetry (LDF) was adapted for use on human teeth in order to measure pulpal blood flow. ⁸It is a noninvasive, objective, painless and semiquantitative method which is reliable for measuring pulpal blood flow.

LDF has some limitations, as it is expensive, not readily available and requires skill in its application in teeth with large restorations, and laser light may not reach pulp and measure the true blood flow^{8,9,10,11}.

Treatment of dentinal hypersensitivity

The study showed that the combination of Nd:YAG laser with 5% sodium fluoride varnish showed an impressive efficacy in treating dentine hypersensitivity¹². The effectiveness of lasers for treating DH varies from 5-100%, depending on the type of laser and the treatment parameters.¹² Studies have reported that the Nd:YAG laser¹³, the Er:YAG laser and gallium-aluminiumarsenide low level laser all reduced DH, but the reductions were not significantly different from those of a placebo or positive controls¹⁴.

Pulp capping and pulpotomy (Vital pulp therapy)

In immature permanent teeth, devitalisation and root canal treatment¹⁵ are not advisable until full apex formation and closure have occurred. Thus endodontic treatment of choice comprises pulpotomy and subsequent dressing with calcium hydroxide¹⁶. If a laser is used for the procedures, a bloodless field is easier to achieve due to the ability of the laser to vaporise tissue and coagulate and seal small blood vessels¹⁷. Thermal tests were used for vitality assessments and LDF for direct measurement of pulpal blood^{18,19,20}.

Root canal irrigation

Numerous measures have been described to reduce the numbers of root canal micro-organisms, including the use of various instrumentation techniques, irrigation regimens and intra-canal medicaments²¹. A greater degree of disinfection was achieved with a 120 s application of laser than with sodium hypochlorite treatment.

Obturation of root canal

Major aim of modern root canal treatment is three-dimensional cleaning, disinfecting, and shaping of the root canal system along with sealing without leakage from the apical foramen to the crown²². apical leakage of lateral condensation, Nd:YAG laser-softened gutta-percha and System-B techniques was compared by Maden et al. and found no significant difference between the groups²³.

Bleaching of root-treated discoloured teeth

The desire to have whiter teeth, and the bleaching technique, has been documented since the mid-nineteenth century²⁴. Patients' awareness of options available for changing the colour of natural dentition has created an increase in public demand. Bleaching corrects or improves the colour of teeth and is also the least expensive aesthetic treatment option. The indications are acquired superficial stains, penetration and absorbed stains, age-related stains, patients who desire conservative treatment to improve appearance, colour change related

to pulp trauma and necrosis, and interproximal discolourations²⁵. Laser-assisted bleaching technique has been shown to be an efficient method to treat resistant discolorations in less than one hour²⁶.

Potential Side Effects

The tooth root is in contact with the alveolar bone via the periodontal membrane and ligament. During laser usage for intracanal applications, thermal injury to periodontal tissues is of concern. Several studies investigating laser-induced thermal effects on the pulp have been published, but few have dealt with the effects on the peri-radicular tissues from energy introduced into the root canal.²⁶ The temperature increases were measured on the external apical third of the root surface using a thermocouple and results showed that the temperature rise was always below 70C. To avoid increasing the temperature changes at the outer root surface related to the safe temperature threshold (70C) various total irradiation times were tested. Cohen *et al.*¹¹⁰ found that if the Ho:YAG laser was used within the root canal at the parameter below 1W, 5Hz and total energy 58J the root surface temperature rise remained below 2.20C.²⁶

Conclusion

In the past few years the scope of use of lasers has increased significantly in the field of Endodontics. This present article summarizes the various uses of lasers in endodontics which provides rapid, painless, and atraumatic treatment which is a trend in modern dentistry. But More studies are required to accept the use of lasers in future for complete eradication of microbes in root canal system in regular endodontic practices.

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