A Review Study

Lasers in Endodontics- A Review of Literature

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Abstract

Lasers are commonly used to reshape our gums during root canal procedures and to kill bacteria. Application of lasers in dentistry has been increased due to its safety and effectiveness in dental treatments. Lasers have been used as coadjuvant treatment in endodontic therapy with respect to both low-intensity laser therapy (LILT) and high-intensity laser treatment (HILT) to improve clinical procedures' success rate. The major procedures done with lasers in endodontics are dentin hypersensitivity, removal of carious tissues, tooth preparations, pulp capping or pulpotomy and also in root canal treatment.Lasers are often used to remove mouth lesions and to soothe discomfort. A thorough literature search was performed using the database like Pubmed, google scholar, BioRxiv, MESH database using the keywords 'light amplification device' and 'Endodontics' and also their types with no date and year restrictions.12 articles with similar data have been found which were analysed and have been included in this study. Talulation were done using google documents. The recent articles discussed in this study help us in gaining further knowledge about lasers and their usage in endodontics. The various methods of using lasers discussed in this article has been widely used by dental practitioners with 100% success rate. So it has been concluded that lasers are well established instruments. Upcoming research based on lasers are showing more benefits and ability to perform less invasive procedures with greater comfort of patients has led to the development of lasers in modern dentistry especially in endodontics.

Keywords: *Endodontics; Light amplification devices; Soft tissue and hard tissue lasers; Diode lasers ablation; Analgesic effects.*

Introduction

Lasers are generally used to reshape our gums during root canal procedures and to kill bacteria. Lasers can also be used for excising a small piece of tissue to examine cancer cells known as biopsy or removal of lesions. Lasers are also used to remove mouth lesions and soothe pain[1].

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Application of lasers in dentistry has been increased due to its safety and effectiveness in dental treatments. The major procedures done with lasers in endodontics are dentin hypersensitivity, removal of carious tissues, tooth preparations, pulp capping or pulpotomy, enamel erosion , and also in root canal treatment. Lasers are also used for tooth bleaching and diagnosis of dental pulp vitality. Root canal preparation can also be done during Rotary instruments but dealing with lasers is comparatively easier[1,2].

The term LASER is an abbreviation for 'Light Amplification by The stimulated Emission of radiation'. There are various types of application of lasers in endodontics that are mainly classified as hard tissue lasers and soft tissue lasers. Paste containing Bioactive Glass and Topical cream containing Casein Phosphopeptide has the ability to remineralize the tooth

structures[3]. The various hard tissue applications are to prevention of caries, bleaching, restorative removal and curing, cavity preparation, dentinal hypersensitivity and for various diagnostic purposes. Whereas incase of soft tissue application it includes wound healing, removal of hyperplastic tissue, Photodynamic therapy and also photostimulation of few lesions. Usage of lasers has been proved as the most effective treatment as it provides a painless, specific, efficient, cost efficient, scoreless and comfortable dental treatment[4]. When compared to previous studies post operative pain is felt after using endodontic needle and endoactivator which is now replaced by painless laser therapies. Carbon Dioxide, Neodymium Yttrium aluminium garnet and Er.YAG used in case of both hard and soft tissue application but this is quite an expensive treatment so not recommended most of the time and it may also cause pulpal injury. Usage of low cost devices is preferred widely known as Low level laser therapy or biostimulation[3,5].

Lasers after approaching an appropriate wavelength for melting the hard tissue, This is said to be the main application of laser technology In surgical endodontics[6]. Chlorhexidine with sodium hypochlorite, neem and tulsi can be used for irrigation during endodontic surgeries[7,8]. Lasers used for Dentinal hypersensitivity can be classified into low output power lasers and Middle output power lasers. Initially a low out power laser has been used to support wound healing and also healing of fractures[9]. They also have an anti-inflammatory effect which helps in stimulation of nerve cells[10].

Microwave Amplification by stimulated emission radiation was developed later. Lasers are used in determination of pulp vitality and also in Apicoectomy, Retrograde and endodontics apical cavity preparation and periapical curettage[10].

There are lasers Generate visible light, ultraviolet rays, Infrared rays, Invisible rays. Generally, electrons jump from higher energy levels to lower energy levels to emit light photons**.** Lasers are also used to diagnose Dental pulp vitality**.** The main aim of our study is to provide knowledge about usage and purpose of lasers in Endodontics[11].

Materials and Methods

A thorough literature search was performed using the database like Pubmed,google scholar, BioRxiv, MESH database using the keywords 'light amplification device' and 'Endodontics' and also their types with no date and year restrictions. The language is restricted to English. 12 articles with similar data have been found which were analysed and have been included in this study. Talulation were done using google documents.

Result and Discussion

Applications of lasers in endodontics

The main usage of lasers in endodontics will be discussed in this chapter. The first and foremost application as a diagnostic tool for endodontics is the analgesic effects of laser, Dentin hypersensitivity, Treatment of vital pulpal tissue by pulpectomy and direct pulp capping[12].

Root canal disinfection and irrigation, Access cavity preparation and root canal orifice enlargement[13], Root canal wall preparation, sweeping of the root canal and irrigation, sterilisation or disinfection of the root canals[14], obturation with gutta percha or resin, removal of the temporary cavity filling materials- Root canal sealing materials and also fractured instruments inside the root canal[15].

Lasers are also used incase of vertical root fracture diagnosis and treatment[16], laser assisted obturation removal and gutta percha obturation material[17].

Usage of lasers in endodontic surgeries include: Flap preparation, cutting bond to prepare window access to the apex of the roots[18], Apicoectomy, Root end preparation for retro fill amalgam or composite and also for removal of pathological and hyperplastic tissue[19] .

Variation in between hard and soft tissue lasers and their application in endodontics

Hard tissue application is for prevention of caries, bleaching, restorative removal and curing, cavity preparation and also for diagnostic purposes but soft tissue laser application is for wound healing, removal of hyperplastic tissues to uncover the impacted tooth[20].

Mechanism of lasers

The first and foremost mechanism of lasers is the direct application of laser irradiation on the electric

activity of nerve fibres which happens within the dental pulp[21].

The second mechanism of lasers modification of the tubular structure of dentin by melting or fusing of hard tissue layer or smear layer and then subsequently dentinal tubules are sealed[22].

Lasers use Photo-Thermal and photomechanical effects which is resulting from the interaction of different wavelengths and various other parameters on the target tissue. Especially dentine, Smear layer, debris, residual pulp and bacteria in their aggregate forms[23].

This can also be told as a light beam from the optical fibre entering the tissue has been Absorbed in the blood cells and fibre tips and collects the scattered light which inturn provides information about the pulp vitality. This provides a painless, invasive and scarless treatment but takes longer than other vitality determination techniques**.**

Lasers for diagnosing pulp vitality

LASER Doppler flowmetry is a minimally - intrusive assessment technique and measures the flow of pulp tissue through blood. Benefits include; The technique is more objective and more reliable in evaluating the Pulp Tissue Safety. These have benefits in data storage, for Measurements which are to be compared later. Includes drawbacks, Its technique is sensitive and requires putty splint preparation to hold the probes, and it's costly[24].

Dentinal hypersensitivity

Lasers used in treatment are divided into two different groups: 1. Lasers with low power output (He-Ne and Gallium / Aluminum/ Lasers with arsenide [Ga / Al / As]), 2. Lasers with low power output (Nd : YAG and CO2 Lasers) Lasers. Clinically and under SEM, Kumar and Mehta assessed the Nd : YAG Laser Irradiation Effectiveness alone and in combination 5% Sodium fluoride varnish used in dentine care feeling hypersensitive. They discovered Nd : YAG combination Laser and 5 percent varnish of sodium fluoride appeared to be impressive effectiveness as compared with a single therapy, Aranha et al. evaluated dentine hypersensitivity in the treatment of Impact of the lasers Nd : YAG and Er: YAG on dentine reduction permeability through sealing of open tubules.

Tests showed that the Er : YAG laser was 60 mJ, 2 Hz and the Nd : YAG laser is useful for decreasing at 1.5 W, 15 Hz permeability to the dentin. Laser efficiency for treating DH varies from 5% to 100%, depending on the laser type and parameters to diagnosis. Studies suggested the Nd: YAG Laser, Er : YAG laser and Ga-Al-A reduced laser low-level hypersensitivity to dentine[25].

Root canal shaping

The shaping of root canals aims at removing organic tissues and facilitates irrigation and the obturation of canals. Laser spotlights can be delivered via an optical fiber that enables better delivery the root canals are open. The technique requires more extension of the root canal before the laser probes by conventional methods can be put into a canal[26].

Use of lasers in periradicular surgery

Apicectomy is an surgical procedure in which the root apex is used removes; removes adjacent periapical tissues and curetted simultaneously. LASER which is used for surgery in a bloodless Surgical environment by vaporization and coagulation of tissue and the sealing of little blood vessels. Where the cut surface irradiates, the surface is sealed and sterilised. Er : YAG laser could even cut hard dental tissue without substantial use damage to thermal or to structure. Miserendino which uses CO2 lasers. The diagnosis of secondary apical abscess in an apicoectomy was capable of sealing the dentinal tubules in the apical portion of the rooting and sterilization of the Gouw-Soares region under investigation use of the Er: YAG, Nd: YAG and Ga-Al-As periapical lasers clinically performed surgery[27].

Photodynamic therapy for malignancies

This therapy has been employed Incase of oral mucosa malignancies particularly multi focal squamous cell carcinoma. Here there will be a generation of reactive oxygen species which inturn damages the cells associated with the blood vascular network directly and triggers necrosis and apoptosis. This activates the host immune response and promotes the anti tumour immunity by activating macrophages and T lymphocytes[28]. This treatment is very successful and approximately has a success rate of 90%.

Analgesic effects of the laser

Nd-YAG is widely used as an analgesia in endodontics. Wavelength of Nd-YAG interferes with the Sodium pump mechanism which inturn change the cell membrane permeability and also alter the endings of sensory neurons temporarily, Which leads to block depolarisation of C and A fibres of the nerves I.e fast and slow conduction fibres. Evaluation of pulp vitality can be done using an electric pulp tester[28,29]. This application in the oral cavity reduces the firing frequency of the nociceptors (Pain receptors). Local carbon dioxide laser irradiation will reduce the pain associated with orthodontic force application without involvement of the tooth[30].

Indications and contraindications of laser in endodontics:

Indication of lasers in endodontics are teeth with lateral canals which leads to periodontal involvement, Pulp necrosis and purulent pulpitis, gangrenous changes, periapical lesions upto 5mm or more[31].

Laser treatments cannot be done in person who have advanced periodontitis caries, deep crown and root fracture and obliterated root canals in endodontic treated teeth[32].

Application of carbon dioxide lasers in endodontics:

Co2 lasers have been available in the medical and dental field for the past 25 years. They possess 10,600 nm of infrared wavelength that is highly absorbed by water. They are continuous wave lasers that can be operated in gated wave modes including super pulsed modes. Co2 lasers have a bactericidal action but there are no reports shouting nerve analgesic Irradiation effects of Co2 lasers in endodontics[33]. This laser can be used for performing root canal procedures.

Application of nd yag lasers in endodontics:

ND YAG lasers have a wavelength of 1064 nm and can be used to extract bacteria from contaminated teeth[34]. This is the first true pulsed laser introduced in dentistry. ND YAG lasers are used for cleaning and shaping in endodontics and they also play a role of analgesia. They are very effective in prevention of dental decay[35].

Xenon fluoride lasers

Xenon fluoride lasers are used to seal the exposed dentinal tubules. They are also used for pulp capping,checking the pulp vitality and for root canal treatments In endodontics. They have a visible light of 400nm -750nm and this is commonly used in endodontic treatments. Chlorhexidine helps in local intensity enhancement of lasers[36].

Table: 1: Lasers in Endodontics:

Lasers in endodontics	wavelength	uses in endodontics
CO2	Beam of Infrared light with the principle wavelength bands cantering on 9.4-10.6 micrometers	Dentinal hypersensitivity, pulp capping and pulpotomy, modifications of root canal walls, sterilisation of root canal system
Argon	488nm(Blue)- peak and 514nm(green)- Relatively short	caries removal, Root canal and tooth preparation
Nd:YAG	infrared-1064nm	used for root canal wall preparation, smear layer can be eradicated completely with sealing of dentinal tubules.
Er:YAG	infrared light-2940 nm	access cavity preparation, root canal shaping and cleaning

Laser safety

Even though lasers are very easy to use there are few precautions that have to be taken care of while using lasers. First precaution is usage of protective eye wear with a specific wavelength. Warning sign supposed to be posted outside the nominal hazard zone[37]. Every office should be appointed with an laser safety officer to proper usage of lasers, to coordinate the staff in training and to check the use of protective eyewear and also to prevent laser injury and to provide treatment on inflammation caused due to lasers[38].

Commercially available lasers

1)Dentsply sirona:

These majorly manufacture diode lasers, they are soft tissue lasers used in wound healing and periodontal treatments[39].

2)Biolase:

Biolase epic pro soft tissue lasers, This Laser has greater penetration, control and consistency than Co2 Laser[40].

3)Picasso:

Picasso lite is a laser used in soft tissues and is used for surgical procedures in soft tissue. This Laser has a multi tip handpiece.[41]

4)Fotona:

Fotona sky plus is an Er.YAG Laser with a wavelength at 2940nm, it is used in both hard tissue and soft tissue lasers. This is a highly customisable Laser[42].

Conclusion

So it has been concluded that lasers are well established instruments. Upcoming research based on lasers are showing more benefits and ability to perform less invasive procedures with greater comfort of patients has led to the development of lasers in modern dentistry especially in endodontics.

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