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RESEARCH ARTICLE

LASER DENTISTRY – *"Enhancing Dental Perfection".*

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Abstract

Application for and research on lasers in dentistry continues to expand since their introduction to the dental profession. Over time, understanding of lasers has grown among researchers an the lasers themselves have become smaller and better suited to dental tasks, eventually making them accurate and safe enough for procedural use. Lasers (an acronym for "light amplification by the stimulated emission of radiation") deliver energy and heat in the form of light, and their uses in dentistry ranges from cleaning to removing tooth decay; Laser provides more conservative, less invasive treatment of carious lesion therefore laying the foundation for the "minimally invasive era" in today's dentistry. Dental lasers also significantly contribute to the field of Aesthetic dentistry. A laser in dentistry has allowed dentists to give state of art treatment to their patients. Speed, comfort and ease of approach are some of the advantages of these techniques. This review is aimed to give an overview of the lasers used in dental practice.

Introduction:-

"A charming smile can open doors and knock down barriers that stand between you and a fuller richer life".
- DUSTE

Light has been used as a therapeutic agent for many centuries. In ancient Greece, the sun was used in heliotherapy, or the exposure of the body to the sun for restoration of health. The Chinese used the sun to treat conditions such as rickets, skin cancer, and even psychosis. The beneficial effects of the sun in the treatment of rickets became apparent in the late 1700s. This use of light for treatment of various pathologies is referred to as phototherapy.[1]

In today's world, modern science and technology have undergone rapid changes over the past decade than in the previous 100 years combined. It has helped us in achieving pleasing appearances with the advent of newer treatment options, better materials and innovative procedures.

Otolaryngologists, oral surgeons, and periodontists were among the first practitioners to use medical lasers intraorally to perform a variety of soft tissue surgical application.[2] In May, 1990, the first laser designed specifically for general dentistry, the dLase 300 Nd:YAG laser, developed by Myers and Myers, and wascleared by the Food and Drug Administration.[3]

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The newer treatment procedures are conservative, painless and more reliable and contribute towards better esthetic outcome. A laser in dentistry has allowed dentists to give state of art treatment to their patients. Speed, comfort and ease of approach are some of the advantages of these techniques. Thus, the clinician should learn the use of lasers in dentistry,which has been evolving at a rapid rate, leading to a significant expansion of the worldwide base of knowledge, in turn, resulting in rapid development of new ones for the betterment of the society.

History Of Lasers:-

The experimental work into the physics of laser light production highlighted the attraction of the use of intense radiation energy, of single wavelength, in many military and communications applications. Maiman's laser used a solid ruby as an 'active medium', which was energised or 'pumped' by an electrical source.

Many other kinds of laser were invented soon after the solid ruby laser – the first uranium laser by IBM Laboratories (in November1960), the first helium-neon laser by Bell Laboratories in 1961 and the first semiconductor laser by Robert Hall at General Electric Laboratories in 1962; the first working neodymium-doped yttrium aluminium garnet (Nd:YAG) laser and CO2 laser by Bell Laboratories in 1964, argon ion laser in 1964, chemical laser in 1965 and metal vapour laser in 1966. In each case, the 'name' of the laser was annotated with regard to the active medium (source of laser photons) used.[4,5]

Although Maiman had exposed an extracted tooth to his ruby laser in 1960, the possibilities for laser use in dentistry did not occur until 1989, with the production of the American Dental Laser for commercial use. This laser, using an active medium of Nd:YAG, emitted pulsed light and was developed and marketed by Dr Terry Myers, an American dentist. Though low-powered and due to its emission wavelength, inappropriate for use on dental hard tissue, the availability of a dedicated laser for oral use gained popularity amongst dentists. This laser was first sold in the UK in 1990.[6]

Types Of Lasers In Dentistry:-

The early 1960s witnessed the beginning of dental laser investigations, with attention devoted to developing basic laser parameters as they related to dental hard and soft tissues.Initial investigator used ruby laser to explore tissue interaction with enamel and dentin, later on other wavelengths such as CO_2 , Nd:YAG, argon, holonium(Ho):YAG, and Erbium(Er):YAG, were investigated.Historically the first laser marketed for the intraoral use generally were CO_2 lasers with otorhinolaryngologic clearance authorized by FDA.[7]

A varied number and variety of lasers are being put to use in dentistry today. On a broad basis, they can be classified as follows:

Based on the type of laser medium used:

Gas Lasers	Solid Lasers	Liquid Lasers	Electronic Lasers
Helium Cadmium	Ruby	Liquid dye	Semiconductor
Helium Neon	Rhodamine	Water vapour	Diode
Argon	Neodymium		
Nitrogen	Erbium		
Carbon Dioxide			
Krypton			
Carbon Monoxide			

According to the type of tissue being acted upon:-

***Hard tissue lasers* –** The hard tissue lasers are used to cut precisely into bone and teeth, to prepare teeth surfaces for bonding, to remove small amounts of tooth structure, and to repair certain worn down dental restorations.

***Soft tissue lasers* –** Soft tissue lasers penetrate soft tissue while sealing blood vessels and nerve endings. This is the primary reason why many people experience virtually no postoperative pain following the use of a laser. Also, soft tissue lasers allow tissues to heal faster.

Application Of Lasers In Dentistry:-

The uses of lasers in dentistry have revolutionized several areas of treatment in the last three and a half decades of the 20^{th} century. Initially it was used for ablating the hard tissues for acid etch treatment. Later lasers were used for cutting,

coagulation and cauterization of the soft tissues. It is also been used for the diagnosis of carious lesions and to test pulp vitality with Doppler. Now there are more than 40 uses for laser.[8]

A) Diagnosis:-

- Detection of pulp vitality- Doppler flowmetry, Low Level Laser Therapy
- Laser fluorescence- detection of caries, bacteria and dysplastic changes in the diagnosis of cancer

Laser light can be used in the visible region (blue or red) as a tool for the detection of carious lesions. Techniques developed to date for early caries detection by laser light rely on fluorescence naturally from the tooth material or from bacterial by-products. Fluorescence techniques have been introduced clinically in Europe and show great promise for improved management of dental caries. [9]

Laser Doppler flowmetry (LDF), is a noninvasive, objective, painless, semi-quantitative method, has been shown to be a reliable for measuring pulpal blood flow. This technique has been successfully employed for estimating pulpal vitality in adults and children, differential diagnosis of apical radiolucencies (on the basis of pulp vitality), examining the reactions to pharmacological agents or electrical and thermal stimulation, and monitoring of pulpal responses to orthodontic procedures and traumatic injuries. [10]

Studies were carried out to compare LDF with conventional pulp tests, EPT (electric pulp testing) and thermal tests, in children with certain dental injuries. At the initial assessment at presentation, all tests had poor sensitivity and specificity; however at 3, 6, and 12 months, LDF was significantly better than the other tests. There was no difference between tests at the later time periods, 18 months and 2 years. It was concluded that LDF identified more vital and non-vital teeth correctly at earlier time periods following injury than conventional tests. [11]

B) Hard tissue applications:-

- Caries removal and cavity preparation
- Bone recontouring
- Endodontic root canal preparation, sterilization and apicoectomy
- Laser etching
- Root canal restoration for retrograde filling of amalgam or composite

Application of laser in endodontics was introduced by Weilcham in 1971. Studies show that the effects of laser irradiation are dependent on wavelength specificity and energy density. By varying a number of parameters (Pulse mode, irradiation time, frequency and energy outputs), several types of lasers are indicated for use in various fields of dentistry. Clinical investigations into laser, used for apicectomy began with the CO_2 laser. Later Nd:YAG, Er:YAG and Ho:YAG lasers were used. The most promising wavelength has been the Er:YAG at 2.94 micrometers. [12]

The Er,Cr:YSGG laser has several hard-tissue applications like enamel etching, caries removal, cavity preparation, in vitro bone cutting with no burning, melting or alteration of the calcium: phosphorus ratio and root canal preparation. [13]

Clinically, cavity preparation in enamel results in ablation craters with a white chalky appearance on the surface of the crater. In dentine, cavity margins are sharp and dentinal tubules remain open without a smear layer. In a clinical study conducted to evaluate the efficiency and safety of the Er: YAG laser for caries removal and cavity preparation in dentine and enamel, Class I, II, III, IV and V cavities were prepared for amalgam and composite restorations. [14]

A comparison of the desensitizing effects of an Er:YAG laser with those of a conventional desensitizing system on cervically exposed hypersensitive dentine showed that desensitizing of hypersensitive dentine with an Er:YAG laser is effective, and the maintenance of a positive result is more prolonged than with other agents. [15]

C) Soft tissue applications:-

- Laser assisted soft tissue curettage and periapical surgery
- Bacterial decontamination
- Gingivectomy and gingivoplasty

- Aesthetic contouring, frenectomy
- Gingival retraction for impressions
- Implant exposure
- Biopsy incision and excision
- Treatment of aphthous ulcers
- Hemostasis
- Tissue fusion- replacing sutures
- Laser assisted flap surgery
- Removal of granulation tissue
- Pulpcapping, pulpotomy, pulpectomy
- Operculectomy and vestibuloplasty
- Incision and drainage of abscess
- Removal of hyperplastic tissue and fibroma

Laser treatment is expected to serve as an alternative or adjunctive to conventional mechanical periodontal treatment. Currently, among the different types of lasers available Er:YAG and Er,Cr:YSGG laser possesses characteristics suitable for dental treatment, due to its dual ability to ablate soft and hard tissues with minimal damage. In addition, its bactericidal effect with elimination of lipopolysaccharide, ability to remove bacterial plaque and calculus, irradiation effect limited to an ultra-thin layer of tissue, faster bone and soft tissue repair, make it a promising tool for periodontal treatment including scaling and root surface debridement.[16]

Er,Cr:YSGG is capable of multiple applications because its interaction with tissues is strongly influenced by variations in the air –to water ratios in the spray. It can be used on soft tissue, enamel, dentin and bone, and its shallow interaction minimizes the risk of collateral damage. Also, the ability to be used for multiple applications improves the economic feasibility of these lasers. [17]

Finkbeiner has suggested the usefulness of argon laser in soft tissue welding and soldering compared to conventional tissue closure methods. Epithelial exclusion using CO_2 laser had been suggested to retard its downgrowth, and studies have shown effective removal of epithelium from gingival tissue without damaging the underlying connective tissue.[18]

Mahmood, Watkinson and Rooney in a study have stated that for clinical situations with peri-implantitis the use of the CO_2 laser would be a safe alternative method provided that the operator chooses the right setting and power output as suggested.[19]

Er:YAG laser was also proposed for the implant maintenance, taking advantage of its bactericidal or decontamination effect. Matsuyama et al. performed debridement of implant abutment surface by Er:YAG laser and reported effective removal of plaque and calculus without producing damage to the implant surface. [20]

D) Laser induced analgesia:-

In selected patients, using the 660nm laser probe can achieve adequate pulpal anesthesia. Success in primary molars varies from 50% to 75%. Analgesia effect may be affected by things such as pigmentation of the patient's gingival tissues, because the diode may react with the pigment in the tissue rather than be absorbed by the pulpal tissues.[21]

Reports of pain relief mechanisms appear to originate in stimulating oxidative phosphorylation in mitochondria and through modulating inflammatory responses. Another study examined patients receiving both Nd:YAG laser and scalpel surgical techniques: most laser treated sites evoked minimal discomfort without anesthesia, while scalpel surgery required anesthesia.[22]

Jovanović, Mirković&Živković have proposed that soft tissue lasers can be recommended in Herpes Simplex Labialis therapy, for its evident analgesic effects, as well as for shorter disease duration.[23]

E) Laser activation:-

- Bleaching agent
- Restorations using composite

The objective of laser bleaching is to achieve an effective power bleaching process using the most efficient energy source, while avoiding any adverse effects. The FDA approved standards for tooth whitening has cleared three dental laser wavelengths: argon, CO_2 and the most recent 980-nm GaAIAs diode. [14]

F) Others:-

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

Conclusion:-

After many false starts, lasers delivering pulsed energies are at last being taken seriously as a tool in the treatment of Conservative, Endodontics and Aesthetic dentistry. We, the dentists, should balance our eagerness to apply these promising new tools with an appropriate measure ofcaution. These systems are of relatively higher cost and this will undoubtedly limit the extent of their implementation.

Lasers are an impressive treatment modality for a variety of clinical conditions. Hard tissue lasers are being used for a variety of purposes like preparation of enamel, dentin and cementum, and ablation of caries. Many multi-wavelength lasers are also used for polymerizing light activating materials.Laser provides more conservative, less invasive treatment of carious lesion therefore laying the foundation for the "minimally invasive era" in today's dentistry.Dental lasers also significantly contribute to the field of Aesthetic dentistry. This technology permits us to achieve desirable gingival contour, improved psychological and physical health and tooth whitening. Laser surgery has shown better results as compared to cryosurgery and electrosurgery with faster healing, no requirement of sutures and minimal post-operative bleeding and edema. In laser surgery, the tissue damage is superficial and hence there is less thermal damage to the muscles and tissues.

In the words of Steven Hawking, "Any physical theory is always provisional, in the sense that it is only a hypothesis: you can never prove it. No matter how many times the result of the experiments agree with the theory, you can never be sure that the next time the result will not contradict the theory".

Lasers are an impressive, potential treatment modality for a variety of clinical conditions. Some clinicians are still wary of entering this exciting field because of the size and cost of equipment. Lasers will continue to get smaller in size and less costly and affordable to every clinician in the near future. This is true of all technology consider the history of computers and pocket calculators. The original lasers were not only large but had six figure price tags. Today's dental lasers are smaller, light weight, highly portable and more reasonably priced.

Laser technology has blossomed in recent years, along with the emergence of new active media and wavelengths. With these impressive advances, potential has increased for further clinical application of lasers in surgery and medicine.Laser dentistry is futuristic in its approach. Laser applications in dentistry opens the door to the modern dentistry, with less pain, better healing, increased patient compliance and patient acceptance. Application of lasers in dentistry will surely increase in the near future.

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