Lasers in Endodontics

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Abstract: With the advent of laser by Maiman in 1960 and its application in endodontics by Weichman in 1971, numerous papers on potential applications for lasers in endodontics have been published. The agenda of this paper is to summarize laser applications in endodontics, including their use in pulp diagnosis, dentinal hypersensitivity, pulp capping and pulpotomy, sterilization of root canals, root canal shaping and obturation and apicectomy. The effects of laser on root canal walls and periodontal tissues are also reviewed. The primary question is whether a laser can provide equal or improved treatment over conventional care while secondary issues include treatment duration and cost/benefit ratio. This article reviews the role of lasers in endodontics the various research reports from the last decade regarding the same and surmises what the future may hold for lasers in endodontics.

Key words: Dentine, Laser Diagnosis, Laser Therapy Use, Rootcanal Treatment.

INTRODUCTION

LASER is an acronym for "Light amplification by stimulated emission of radiation". 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 range. The application of lasers in dentistry was first investigated by Stern & Sognnaes and Goldman et al., by conducting studies on hard dental tissues with use of a ruby laser to reduce subsurface demineralization and successfully to a reduction in permeability, to acid demineralization, of enamel after laser irradiation was found. Following this other lasers, such as argon (Ar), carbon dioxide (CO2), neodymium: yttrium-aluminum garnet (Nd:YAG), and erbium (Er):YAG lasers were used. The first laser use in endodontics was reported by Weichman & Johnson who attempted to seal the apical foramen In vitro by means of a high power-infrared (CO2) laser. Although their goal was not achieved, sufficient relevant and interesting data were obtained to encourage further study which led to the attempt to seal the apical foramen using the Nd:YAG laser (Weichman et al.)

In dentistry and endodontics in particular, acceptance of this technology by clinicians has remained limited, perhaps partly due to the fact that this technology blurs the border between technical, biological, and dental research. The purpose of this paper was to summarize laser applications in endodontics.

APPLICATIONS

ASSESSMENT OF PULP VITALITY (LASER DOPPLER FLOWMETRY):

HeNe and GaAlAs semiconductor diode lasers at a low power of 1 or 2 Mw are used in laser Doppler flowmetry. To prevent laser beams from reflecting off the surrounding gingival, the measurement of the laser beams reflected from the dental pulp should be carried out under the rubber dam. The principle in the diagnosis of pulp vitality by laser Doppler flowmetry is based on the changes in red blood cell flux in the pulp tissue. The advantage of this diagnostic method is that it allows painless diagnosis. The laser Doppler flowmetry method is useful in detection of pulp vitality of immature or traumatized teeth and for patients who are sensitive to tooth pain. Different lasers show varied effects on the dentin pulp complex eg: GaAlAs, Semiconductor Diode Laser, He-Ne Laser, CO2 laser, Er:YAG laser and argon laser have been used for ablating dental pulp tissue, soft dentin and curing composite resin.

DE -SENSITIZATION OF HYPERSENSITIVE DENTIN AND TEETH

Kimura, Y Wilder Smith, P et al suggest that in general, the efficiency for the treatment of dentine hypersensitivity using lasers is higher than other methods, but in severe cases, it is less effective. Therefore it is necessary to consider the severity of dentine hypersensitivity before laser use.

PULPOTOMY AND ROOT CANAL WALL PREPARATION

A laser that can cut enamel and dentin with fine optical fibers has been developed, making it possible to remove pulp tissue and prepare root canals. A few problems remain to be solved in the near future, however only straight and slightly curved canals are indications for applying this treatment.

REMOVAL OF PULPAL REMNANTS AND DEBRIS AT THE APICAL FORAMEN

The pulsed Nd: YAG laser was used for removing pulp remnants and debris that are deposited at the apical foramen. The effects of this laser irradiation on the apical foramen include sterilization, removal of pulp remnants, control of hemorrhage, and stimulation of cells surrounding the root apex as well as debridement of the surface.

ROOT CANAL SWEETING AND IRRIGATION IN COMBINATION WITH IRRIGATORS AND LASERS

Straight and slightly curved root canals as well as wide root canals are indications for this treatment. The pulsed Nd: YAG laser, Er: YAG laser, and Cr: YSGG laser are recommended. The CO2 laser was useful in removing and melting the smear layer on the instrumented root canal walls and the Er: YAG laser was the most effective in removing the smear layer from the root-canal wall.

MORPHOLOGICAL CHANGES IN THE ROOT CANAL AFTER LASER IRRADIATION

Khan et al examined the morphological and temperature changes of the apical portion of human extracted teeth treated by Nd: YAG, CO2 and Argon-lasers. The scanning electron microscopic evaluation showed that the laser energy vaporized the deposited debris, producing a glaze-like surface.
STERILIZATION OR DISINFECTION OF INFECTED ROOT CANALS

The laser is an effective tool for killing microorganisms because of the laser energy and wavelength characteristics. To prevent thermal damage to the periodontium surrounding the tooth, various techniques are considered and recommended. Pulsed Nd: YAG, argon, semiconductor diode, CO2, Er: YAG, and other lasers have been considered for use in this treatment. Rooney et al. reported sterilization rates of 80% to 90%, whereas others have reported rates of 60%, depending on the condition of the root canals, the type of laser device, the application parameters, and the techniques.

Root Canal Drying - Infrared lasers have been used for debridement and sterilization of both soft and hard tissues. Adjunctive sterilizing effect. A laboratory study by Walsh, L.T., Walsh, L.J. examined the feasibility of using pulsed infrared laser radiation to remove moisture from root canals (with an adjunctive sterilizing effect).

CLOSURE OF APICAL FORAMINA OF ROOT CANALS

Preliminary studies performed by the author revealed that closing small apical foramina was possible using the pulsed Nd: YAG laser. By combining light-curable composite resin and argon laser or combining sectioned gutta-percha points and a pulsed Nd: YAG laser, however, the author found that it was relatively easy to close the apical root canal.

PREVENTION OF MICROLEAKAGE OF RETROGRADE ROOT CANAL FILLING

A decrease of micro leakage at apicoectomy was confirmed in vitro. The closure of exposed dentinal tubules on the cut surface at the root end was observed by scanning electron microscopy. Pulsed Nd: YAG and CO2 lasers are recommended for the same.

Retrograde endodontic apicoectomy, apical cavity preparation, and periapical curettage by laser - A new laser device for tissue treatment was developed in the United States. This Er, Cr: YSGG laser is applicable for the treatment of soft and hard tissues. Apicoectomy, retrograde endodontic apical root end cavity preparation, and periapical curettage can be performed using this one laser device. CO2 and Nd: YAG lasers have been investigated for the same too.

HAZARDS OF LASER SMOKE DURING ENDODONTIC THERAPY:

The purpose of McKinley, LB., Ludlow, M.O. study was to evaluate the potential for spreading bacterial contamination from the root canal to the patient and the dental team via the smoke produced by the laser. Five extracted teeth were deliberately inoculated with a specific strain of Escherichia coli. The canals were subjected to an argon laser. The smoke plume was captured and cultured. All of the cultures were positive for growth of the E. coli used. The authors concluded that the laser smoke does present a hazard of bacterial dissemination and that precautions must be taken to protect against spreading infections when using lasers in the root canal.

THE FUTURE OF LASERS IN ENDODONTICS

In the early 1990s xenon chloride excimer laser was used to clean and shape the root canal, eliminating the need for files and reamers. The goal of researchers and manufacturers has to be to identify a wavelength that would replace reamers and files, have other hard or soft tissue applications, be cost-effective, and be at least as effective as conventional root canal therapy. Although there has been a large amount of research in laser endodontics using various wavelengths, no system has been built to meet all the previously stated requirements. Even though many German dentists are using the free-running pulsed Nd: YAG and diode lasers for adjunctive root canal therapy, as of this writing, only a handful of lasers have FDA clearance in the United States. That clearance limits the laser's use only to coronal pulp procedures; this expected to change, however. Once the needed FDA clearance for total laser endodontics is obtained the unit will probably be an infrared wavelength, and its delivery system will be use a small (50 to 200 um) optic fiber that will have the ability to side-fire. It is predicted that gutta percha will be replaced with flowable composite material that will be injected into the lased canal and cured with the small hand-held blue diode laser. A system as just described would save valuable clinical time by eliminating the shaping of the canal that is presently necessary to accommodate the gutta-percha cones. Most of the aforementioned components exist today; their safety and effectiveness need to be demonstrated.

CONCLUSION

With the development of thinner, more flexible and durable laser fibres, laser applications in endodontics will increase. Since laser devices are still relatively costly, access to them is limited. Ideally, the laser in the future will have the ability to produce a multitude of wavelengths and pulsewidths, each specific to a particular application. Once our knowledge of optimal laser parameters for each treatment modality is complete, lasers can be developed that will provide dentists with the ability to care for patients with improved techniques.

REFERENCES


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