



LASERS IN DENTISTRY: A BRIEF REVIEW

Dental Science

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ABSTRACT

The term LASER is an acronym for 'Light Amplification by the Stimulated Emission of Radiation'. As its first application in dentistry by Miaman, in 1960, the laser has seen various hard and soft tissue applications. In the last two decades, there has been an explosion of research studies in laser application. In hard tissue application, the laser is used for caries prevention, bleaching, restorative removal and curing, cavity preparation, dentinal hypersensitivity, growth modulation and for diagnostic purposes, whereas soft tissue application includes wound healing, removal of hyperplastic tissue to uncovering of impacted or partially erupted tooth, photodynamic therapy for malignancies, photostimulation of herpetic lesion. Use of the laser proved to be an effective tool to increase efficiency, specificity, ease, and cost and comfort of the dental treatment

KEYWORDS

Laser, Dentistry, Er:YAG.

INTRODUCTION

The word "laser" is an acronym for "light amplification by stimulated emission of radiation." It refers to a device that emits light that is spatially coherent and collimated; a laser beam can remain narrow over a long distance, and it can be tightly focused. When directed at tissues, different interactions result. The absorption, reflection, transmission, and scattering of the laser light vary depending on the wavelength of the laser and the characteristics of the tissue. The use of lasers in dentistry has increased over the past few years. The first laser was introduced into the fields of medicine and dentistry during the 1960s.[1] Since then, this science has progressed rapidly. Because of their many advantages, lasers are indicated for a wide variety of procedures.[2] Conventional methods of cavity preparation with low- and high- speed handpieces involve noise, uncomfortable vibrations and stress for patients. Although pain may be reduced by local anaesthesia, fear of the needle and of noise and vibration of mechanical preparation remains causes of discomfort. These disadvantages have led to a search for new techniques as potential alternatives for dental hard tissue removal.[3]

CLINICAL APPLICATIONS

Cavity preparation

The Er: YAG laser was tested for preparing dental hard tissues for the first time in 1988. It was successfully used to prepare holes in enamel and dentine with low 'fluences' (energy (mJ)/unit area (cm²)). Even without water-cooling, the prepared cavities showed no cracks and low or no charring while the mean temperature rise of the pulp cavity was about 4.3°C.[4] In 1989, it was demonstrated that the Er: YAG laser produced cavities in enamel and dentine without major adverse side effects. The ablation efficiency was about one order of magnitude lower than for soft tissue. It was then concluded that dentine and enamel removal was very effective with no risk to the pulp and the ablation rates in enamel were stated to be in the range of 20-50 µm/pulse, and in dentine they were reported to be as high at lower fluences.[5]

Caries removal

Cariou material contains a higher water content compared with surrounding healthy dental hard tissues. Consequently, the ablation efficiency of caries is greater than for healthy tissues. There is a possible selectivity in the removal of cariou material using the Er: YAG laser because of the different energy requirement to ablate cariou and sound tissues leaving those healthy tissues minimally affected. However, Rechmann *et al.* found that selective ablation of cariou dentine is difficult with the Er: YAG laser. The ablation thresholds of healthy dentine and cariou dentine are different. The ablation threshold of healthy dentine is two times higher than the corresponding threshold of cariou dentine.[6]

Therefore, very small fluences (energy (Joules) / area (cm²)) of the Er: YAG laser energy are required to selectively ablate cariou dentine. This low fluence will result in low efficiency of the ablation process. In another *in vitro* study investigating the effectiveness of caries removal by Er: YAG laser, it was found that the Er: YAG laser ablated cariou

dentine effectively with minimal thermal damage to the surrounding intact dentine. The laser removed infected and softened cariou dentine to the same degree as the bur treatment. In addition, a lower degree of vibration was noted with the Er: YAG laser treatment. However, the study did not address the issue of selective removal of cariou tissue and further studies of caries removal using lasers are indicated.[7]

Restoration removal

The Er: YAG laser is capable of removing cement, composite resin and glass ionomer. The efficiency of ablation is comparable to that of enamel and dentine. Lasers should not be used to ablate amalgam restorations however, because of potential release of mercury vapour. The Er: YAG laser is incapable of removing gold crowns, cast restorations and ceramic materials because of the low absorption of these materials and reflection of the laser light. These limitations highlight the need for adequate operator training in the use of lasers.[8]

Treatment of dentinal hypersensitivity

Dentinal hypersensitivity is one of the most common complaints in dental clinical practice. Various treatment modalities such as the application of concentrated fluoride to seal the exposed dentinal tubules have been tested to treat the condition. However, the success rate can be greatly improved by the ongoing evaluation of lasers in hard tissue applications. A comparison of the desensitising effects of an Er: YAG laser with those of a conventional desensitising system on cervically exposed hypersensitive dentine showed that desensitising of hypersensitive dentine with an Er: YAG laser is effective, and the maintenance of a positive result is more prolonged than with other agents.[9]

Bleaching

The objective of laser bleaching is to achieve an effective power bleaching process using the most efficient energy source, while avoiding any adverse effects. Power bleaching has its origin in the use of high-intensity light to raise the temperature of hydrogen peroxide, accelerating the chemical process of bleaching. The FDA approved standards for tooth whitening has cleared three dental laser wavelengths: argon, CO₂ and the most recent 980-nm GaAlAs diode. There are no reports at present about the use of the Er: YAG laser in bleaching techniques. The wavelength of the Er: YAG laser may be unsuitable for the procedures, but it is a further area that could be explored.[10]

Removal of the pocket epithelium

Lasers are also used for soft tissue periodontal applications. The Nd: YAG was the first laser wavelength to be compared to the scalpel for treating periodontal pockets and controlling bacteremia and gingival bleeding. The probing pocket depth and bleeding index scores were reduced using the pulsed Nd: YAG laser. Furthermore, clinical evaluation of soft tissue biopsies taken from human subjects using the Nd: YAG laser versus a curette presented a complete removal of the epithelium of the pocket after use of the pulsed Nd: YAG laser compared to the curette. Similar effects presented in pig jaws (*in vitro*)

after the use of a 980 nm diode laser with 2–4 W power settings and continuous wave compared to the conventional curette.[11]

Laser root conditioning

The use of CO₂ lasers to decontaminate root surfaces has been investigated, providing more information about the exact power settings and parameters required to avoid root damage. Barone *et al.* showed that a defocused, pulsed CO₂ laser is able to create smooth and clean root surfaces compared to a focused, continuous wave; the latter leads to melting and root surface damage. Later studies using the same parameters for CO₂ lasers reported root conditioning with a better fibroblastic activity, cellular proliferation, and greater fibroblast attachment. Different clinical case reports have demonstrated these advantages of CO₂ laser de-epithelialization.[12]

Bacterial reduction

A laser application that has been especially promoted in the past is for the reduction of bacteria in pockets, due to the high absorption of specific laser wavelengths by the chromophores. Initially, the use of an Nd: YAG laser was shown to reduce the load of *Porphyromonas gingivalis* and *Prevotella intermedia*. [13]

CONCLUSION

The following is the summary of advantages and disadvantages of using lasers in dentistry is based on the literature and the author's experience.

Advantages of using lasers include

1. Less pain
2. Less need for anesthetics (an advantage for medically compromised patients)
3. No risk of bacteremia
4. Excellent wound healing; no scar tissue formation
5. Bleeding control (dependent on the wavelength and power settings);
6. Usually no need for sutures
7. Use of fewer instruments and materials and no need for autoclaving.
8. Ability to remove both hard and soft tissues
9. Lasers can be used in combination with scalpels (however, the laser is a tool and not a panacea).

Disadvantages of using lasers include

1. Relatively high cost of the devices
2. A need for additional education (especially in basic physics)
3. Every wavelength has different properties
4. The need for implementation of safety measures (i.e. goggle use, etc.).

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