Use of Lasers in Dentistry

About This Document
The Following statement was prepared by the AAE Research and Scientific Affairs Committee to address issues being raised by some endodontic patients.

The use of lasers in dentistry was suggested approximately 35 years ago as a means of using energy generated by light to remove or modify soft and hard tissues in the oral cavity. A **Laser** is an acronym for **Light Amplification by Stimulated Emission of Radiation**. The radiation involved in generating laser light is nonionizing and does not produce the same effects attributed to X-radiation. The Food and Drug Administration has approved the use of various lasers to remove diseased gingival tissues and for other soft tissue applications, in the removal of dental caries, as an aid in placing tooth-colored restorations, and as an adjunct in root canal procedures, such as pulpotomies. This position paper concentrates on laser use in root canal treatment.

Lasers emit light energy that can interact with biologic tissues, such as tooth enamel, dentin, gingiva or dental pulp. Laser classification is based on a variety of factors including wavelength, technique (i.e. direct irradiation, laser activated disinfection), target and laser effects. Parameters of laser light emission include average power (in Watts), energy (in Joules) power density (in W/cm^2) frequency of pulsation (in Hz) and energy fluence (J/ $fabricm^2$).The interaction is the effect of the particular properties of laser light including: 1) monochromaticity, where the light is all the same color (same wavelength); 2) coherence, where the waves of light are all in phase; and 3) collimation, where the light rays are parallel to each other and do not diverge. The application of this light energy results in the modification or removal of tissue. In root canal treatment, lasers may be used to remove the dental pulp and organic debris, and to modify the dentinal walls by inducing melting and resolidification cycles resulting in the enlargement of the walls of the root canal system. Once the preparation is completed, the root canal is obturated, and the laser may be used to soften and mold the obturating material to the prepared root canal system. These procedures are accomplished by the interactions between the laser light, dentin and obturating materials. The net result of laser tissue interaction will depend upon the degree of laser energy that is absorbed or scattered by the tissue or the tissue fluid. Different parameters such as laser

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wavelength, energy level, mode of application, and tissue characteristics will influence the effect of a particular laser on the tissue. The primary effects of lasers on root dentin are thermodynamic (increased temperature), and photochemical.[1,2]

Root canal treatment is currently performed using a combination of hand and rotary instruments to remove the soft tissue, clean the root canal space and shape the space to receive the obturating material, usually gutta-percha. This biocompatible material is then placed with a cementing medium using special hand instruments to ensure complete sealing of the root canals. Laser energy, when added to root canal procedures, presents advantages and disadvantages. Currently, root canal procedures clean the canal space by utilizing a combination of mechanical removal of tissue and chemical decontamination. The use of lasers to aid root canal disinfection is more promising than their application in root canal preparation. For disinfection, laser energy can be used directly or in combination with a photosensitive chemical that, when bound to microorganisms, may be activated by low-energy laser light to essentially kill the microorganism *(Photodynamic Therapy (PDT))*. Additional experiments suggest that the propagation of acoustic waves emanating from a pulsed-low energy laser may aid in distributing disinfecting solutions more effectively across the root canal system *(Photon Induced Photoacoustic Streaming (PIPS))*.[2]

Root canal preparation using laser light has not been proven to be more effective than mechanical shaping[14-16] and comes with several significant disadvantages. Root canal spaces are often curved in at least two dimensions. Conventional root canal instruments follow the curvatures in a root. In contrast, laser light will only travel in a straight path; laser probes must therefore continue to be fabricated in a way that the laser light emerges laterally, uniformly interacting with the root canal wall.[3-13] Further, the interaction between laser energy and tissue can cause a rise in temperature that can affect the canal space as well as the outer surfaces of the tooth. The resulting injury to dentin, soft tissue, and the surrounding bone may result in ankylosis[17] or the eventual loss of the tooth. Moreover, cycles of melting and resolidification of radicular wall dentin apparently have no positive effect on clinical outcomes.

The use of lasers as an aid in disinfection has been researched extensively in the last few years. Currently, there exists a body of evidence from in vitro/in vivo studies on the antibacterial efficacy of high-power laser and photodynamic therapy,[18-32] and in vitro experiments with PIPS[33-35] in root canals. However, their effects on the clinical outcomes of root canal therapy are not known at this point. While the FDA has approved one laser (diode) as an adjunct for removal of pulp tissue in a pulpotomy and apicoectomy, more research is required to develop laser energy for use in non-surgical endodontics that is equal to and perhaps one day, superior to present treatment modalities.

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