

Importance of heat generation and propagation on dental tissues due to high-intensity laser irradiation for safe clinical use

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Abstract

Erbium lasers are strongly absorbed by water and hydroxyapatite, which are the main components of hard tissues (enamel, dentin and bone). Consequently, these lasers can be efficiently used for cutting hard tissue, for cavity preparation, for caries removal, caries and erosion prevention, when laser irradiation should change chemically the structure of dental hard tissue in order to increase their resistance to demineralization. More recently, erbium lasers are being used for debonding ceramics. Only using proper irradiation conditions, minimally invasive procedures with low thermal or mechanic damages to the tissues can be achieved. For these applications, erbium lasers can increase the temperature up to 1200°C on dentin and enamel surface, and the thermal effects must be controlled to avoid thermal damages, such as carbonization and cracks that can weaken the irradiated tissue or even damage the pulp or periodontal tissue. Therefore, it is strongly required to know the thermal effects of laser irradiation on target tissues, which depend on the laser parameters and refrigeration methods. Studies regarding superficial thermal changes promoted by the Er,Cr:YSGG laser irradiation on enamel will be described, according to the experimental measurements performed by infrared thermography. Fast-response thermocouples were also used to determine the temperature increase inside the pulp chamber and at periodontal tissue during laser irradiation simulating a clinical protocol. These studies were useful for determining laser energy densities and time of irradiation. The characteristics of laser irradiation, such as wavelength, laser absorption and optical properties of enamel were strictly considered. These studies demonstrate the strong effects of a higher-absorbed laser wavelength on biological tissues and how the practitioners can avoid possible thermal damages due to laser irradiation. The knowledge of optical changes on biological tissues due to heat is also an important point to be considered for determining laser parameters in a future clinical practice.

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