The Influence of Transmission Type & Beam Profile of Er:YAG Lasers on Cavity Shape & Quality of Composite Restorations

Carl A. Bader, Dr. med.dent.
Private practice, Porrentruy, Switzerland
Scientific Instructor, Division of Cariology and Endodontology, Univ. of Geneva, CH.
Instructor in Dental Laser Applications, Programme of Master of Advanced Studies in Oral Biology, University of Geneva, Switzerland

Since their introduction over fifteen years ago Er:YAG Lasers have been established as the most efficient laser types for cavity preparation and hard tissue ablation. Well absorbed in water and hydroxyapatite, Er:YAG laser light seems to have been made for the effective removal of dentin and enamel with only slight side-effects such as thermal damage to the pulp or rarely pain during cavity preparation.

To gain maximum efficiency, relatively high energies of up to over 1000 mJ per pulse are used for the ablation of hard tissues. The shorter the pulse duration and the steeper the increase and decrease of its power setting are, the lower the density of energy is needed for ablation.

Fast heating of water and hydroxyapatite as a consequence of absorption inside the tissue leads to a rapid expansion (over 1600 x the volume) until the rupture of the irradiated tissue. The result of this mechanism is a thermo-mechanical ablation led by instant evaporation of water, which tears out fractured particles out of surrounding tissue, creating little craters with unevenly shaped margins.

The tooth surface left behind after Er:YAG preparation is disintegrated with micro-cracks and loosely bound particles, potentially compromising adhesion and thus increasing microleakage of restorations. Different measures have been proposed to remove the damaged surface layer, such as phosphoric acid etching, ultrasound or air-abrasion, to obtain an optimal substrate quality for adhesion.

However, these methods complicate the clinical procedure, are time consuming, require an additional tool and may be painful to the patient. From the clinical point of view finishing of the tooth surface by means of the Er:YAG laser after preparation would represent the most suitable solution.

The laser systems sold in the market use different types of energy transmission from the laser to the handpiece, each of them with its specific spatial beam profile. Many factors, such as pulse formation, pulse width, beam profile and other technological elements should be taken into account in relation to each other to allow an accurate comparison of the lasers' clinical efficiency. Although different beam transfer technologies may have specific advantages and disadvantages, it is impossible to compare different laser systems based on this property or on their parameter settings. For each of them research has to show the secure parameters for cavity preparation and finishing methods.

The spatial beam profile is different for each transmission type. The glass fiber produces a quasi-Gaussian shape whereas articulated arms achieve a distribution of even higher orders with an important concentration of the density of energy around the central peak, or a ring-shaped intensity distribution with big differences from the middle to the outer regions of the beam.

Reference:

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