Quality of Restorations Performed with QSP Mode

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SUMMARY

Er:YAG lasers represent a promising technology with various applications in every field of Dentistry. Compared with other lasers, Er:YAG can effectively alter enamel and dentin surface because of its 2940 nm wavelength emission, which is coincident with the main absorption band of water and OH- groups in hydroxyapatite. Laser irradiation parameters define the exact interaction of the laser on the tissue. Pulse duration is an important factor for the ability of a laser to perform surface modification. Active electronic control of laser pulse duration and amplitude is possible today with the development of Variable Square Pulse® technology (Fotona, Ljubljana, Slovenia). With VSP, the duration of pulses can be adjusted from 50 μs (super-short pulse) to 100 μs (very short pulse), 300 μs (short pulse), 600 μs (long pulse) and 1,000 μs (very long pulse). Because of its higher energy in the shorter pulses, the energy loss through heat is lower. As a result of this, ablation becomes more effective and a thermal effect is not evident on the tissue.

The Quantum Square Pulse (QSP) mode has also recently been introduced in Er:YAG laser technology. In QSP mode, each pulse is split into several shorter pulses that follow each other at an optimally fast rate. In this way, absorption and scattering of the laser beam is avoided and undesirable thermal effects for the tissues are decreased. Lasers operating at this mode are reported to provide fast and precise hard dental tissue preparation.

When the effects of different Er:YAG laser pulse modes (MSP and QSP) on the microleakage of composite resin restoration (Clearfil Majesty Posterior, Kuraray) using a self-etch adhesive systems were evaluated, the cavities etched with Er:YAG laser QSP mode showed less microleakage than MSP mode etched and acid-etched surfaces.

The QSP mode is also successful in the etching of enamel surfaces for orthodontic bonding. Er:YAG laser etching with QSP mode presents a successful alternative to acid etching by providing higher or comparable shear bond strength values. The Scanning Electron Microscope (SEM), Atomic Force Microscope (AFM) and surface profilometry utilized in the study demonstrated successful alterations of the enamel surface with this technology (Figure 1-3).

Fig. 1: Atomic force microscope scan of an enamel surface etched with 37% phosphoric acid.

Fig. 2: Atomic force microscope scan of an enamel surface etched with MSP mode Er:YAG laser.

Fig. 3: Atomic force microscope scan of an enamel surface etched with QSP mode Er:YAG laser.

To evaluate the microtensile bond strength (μTBS) of a self-etch adhesive to dentin after treatment with Er:YAG laser using different pulse durations and parameters, the dentin surfaces were irradiated with an Er:YAG laser with the following parameters: (1) energy output: 200 mJ or 120 mJ; (2) water cooling: 50 ml/min or 25 ml/min; (3) pulse duration: MSP mode or QSP mode. The Er:YAG laser irradiation increased the μTBS of the adhesive-to-dentin surface when compared...
with the results of self-etch adhesive alone. Among the Er:YAG laser irradiated surfaces, the highest μTBS result was achieved in the low-energy output and low-water cooling applied group (Figures 4-7).

According to the results of the current studies, it can be concluded that the QSP mode of the Er:YAG laser is a very effective and promising new pulse mode for preparing surfaces for the bonding of resin materials on hard dental tissues.

REFERENCES