Laser All-ceramic Crown Removal—A Laboratory Proof-of-Principle Study—Phase 1 Material Characteristics

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Background and Objectives: The removal of all-ceramic crowns is a time consuming and destructive procedure in the dental office. The removal of all-ceramic crowns using Er:YAG lasers has not been previously described in the scientific literature. The objective of this laboratory proof-of-principle study was to evaluate whether with regards to absorption and transmission characteristics of bonding cements and ceramics all-ceramic crowns can be removed from natural teeth using an Erbium laser.

Study Design/Materials and Methods: The Fourier Transform Infrared Spectroscopy (FTIR) was used on flat ceramic samples (IPS Empress Esthetic (EE), E.max CAD, and E.max ZirCAD) to assess which infrared laser wavelengths transmit through the ceramics. Additionally, FTIR spectra for four bonding cements (Variolink Veneer, Variolink II, Multilink Automix, and SpeedCEM) were obtained. The Er:YAG laser energy transmission (wavelength 2,940 nm, 10 Hz repetition rate, pulse duration 100 μs at 126 mJ/pulse to 300 μs at 508 mJ/pulse) through different ceramic thicknesses was measured. Ablation thresholds for bonding cements were determined. Cement samples were directly irradiated or laser light was transmitted through ceramic samples.

Results: While the ceramics did not show any characteristic water absorption bands in the FTIR, all bonding cements showed a broad H_2O/OH absorption band. Some cements exhibited a distinct absorption peak at the Er:YAG laser emission wavelength. Depending on the ceramic thickness, EE and E.max CAD ceramics transmitted between 21 and 60% of the incident Er:YAG energy, with E.max CAD transmitting more energy than EE at comparable thicknesses. In contrast, E.max ZirCAD transmitted only 5–10% of the incident energy. Initial signs of cement deterioration occurred at 1.3–2.6 J/cm^2. Multilink Automix, SpeedCEM, and Variolink II started ablation at 4.4–4.7 J/cm^2. Variolink Veneer needed 44% less energy for ablation.

Conclusion: Er:YAG laser energy can be transmitted through all-ceramic materials and those transmitted energies are sufficient for ablation of bonding cements. Lasers Surg. Med. © 2014 Wiley Periodicals, Inc.

Key words: all-ceramic crowns; Er:YAG laser; FTIR; laser energy transmission; laser debonding

INTRODUCTION

When tooth structure has been weakened due to extensive decay, large fillings, fractures or root canal treatments, the placement of a crown to strengthen the remaining tooth against occlusal forces might be indicated. Porcelain fused to metal (PFM) crowns, where porcelain is layered on top of a metallic alloy, still dominate the tooth-colored restoration market. PFM restorations have proved reliable during 40 years of successful use [1]. However, the use of PFMs is declining slightly, as many new all-ceramic and resin-based composite crown products enter the dental market. Several situations may indicate the use of materials other than PFM crowns. They include patients desiring a high level of esthetic compatibility, patients with proven or perceived allergies to the metals used in dentistry, and patients wishing to eliminate metal from their mouths. The constantly rising cost of precious metals is another factor reducing the use of gold alloys for dental restorations. Crowns completely made of ceramics are often less costly.

In the last few decades, there have been tremendous advances in the physical properties and methods of fabrication of ceramic materials [2]. Consequently, there have been trends to replace the metal ceramics systems with all-ceramic systems. Advances in bonding techniques (gluing the all ceramic crown to the tooth) have also increased the utilization of ceramics in dentistry [3,4]. The increasing demand for esthetic, tooth-colored restorations has resulted in an increased use of dental ceramics not only for visible anterior crowns, but also for posterior restorations [5,6]. Moving to all-ceramic crowns for posterior teeth

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