Bond Strengths of Three Low-Fusing Ceramics to Ti-6al-4v and Ti-6al-7nb Alloys

Thesis

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Thesis Abstract

The increased interest in using titanium as a restorative dental material arose from its biocompatibility, resistance to corrosion, high strength to weight ratio, low modulus of elasticity, and low heat conductivity. Commercially pure titanium (CPTi) is commonly used for dental implants fabrication and, more recently, for fixed and removable prosthodontic frameworks. However CPTi has the known disadvantages of low strength, difficulty in polishing, and poor wear resistance. Several titanium alloys have been suggested to be used in dentistry because of their improved mechanical and physical properties. Among these alloys are the titanium-aluminum-vanadium alloy (Ti-6Al-4V) and the titanium-aluminum-niobium alloy (Ti-6Al-7Nb). Evaluation of the CPTi/low-fusing ceramics bond quality began in the last decade. However, investigations on the use of Ti-6Al-4V and Ti-6Al-7Nb in metal-ceramic restorations are very limited and needs further investigation.

The purpose of this study was to evaluate the bond strength and the mode of failure of three commercially available low-fusing ceramics with two titanium alloys using a circular interface shear test and scanning electron microscopic (SEM) analysis, respectively.

One-hundred and five flat metal disks, 15 mm in diameter and 2 mm in thickness, were prepared. Forty five specimens were cast using Ti-6Al-4V,

another 45 specimens were cast using Ti-6Al-7Nb, and the remaining 15 specimens were cast using gold-palladium (Au-Pd), which served as the control. The titanium alloys specimens were air-borne particle abraded with 250 μm alumina particles, whereas the control specimens were air-abraded with 110 μm alumina particles. The titanium alloys specimens were divided into three sets of 15 each and, subsequently, three low-fusing porcelains (Vita Titankeramik, Triceram, and GC Initial Ti) were applied with the aid of a custom matrix and were then fired. Vita VMK 95 porcelain was applied and fired to the 15 Au-Pd specimens. The overall porcelain dimensions were 5 mm in thickness and 6 mm in diameter. All procedures followed the manufacturer's instructions. Acrylic holders were fabricated around the porcelain portion of each porcelain-metal assembly. Shear bond testing was performed in a universal testing machine, with a 500-Kg load cell and a crosshead speed of 0.5 mm/min. The specimens were loaded until failure. The metal-ceramic interfaces of two failed specimens, from each group, were examined with a SEM. Data were statistically analyzed using one-way ANOVA followed by Tukey post-Hoc (α=0.05).

The mean bond strength values of the Ti-6Al-4V to Vita Titankeramik, Triceram, and GC Initial Ti were 21.15 ±4.5 MPa, 20.62 ±5.2 MPa, and 20.88 ±4.9 MPa respectively; and those of the Ti-6Al-7Nb to Vita Titankeramik, Triceram, and GC Initial Ti were 18.76 ±5.7 MPa, 17.54 ±4.3 MPa, and 18.73

±5.5 MPa, respectively. The mean bond strength for the Au-Pd/Vita VMK 95 was 23.11 ±3.2 MPa.

There were no statistically significant differences in the shear bond strength values between the control group and Ti-6Al-4V/Vita Titankeramik (P=0.918), Ti-6Al-4V/Triceram (P=0.785), Ti-6Al-4V/GC Initial Ti (P=0.860), Ti-6Al-7Nb/Vita Titankeramik (P=0.170), and Ti-6Al-7Nb/GC Initial Ti (P=0.165) groups. However, a statistically significant difference was found between the control group and the Ti-6Al-7Nb/Triceram group (P=0.029).

All the titanium alloy/low-fusing porcelain combinations tested, except the Ti-6Al-7Nb/Triceram, are compatible and recommended to be used clinically in terms of bond strength.