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Original article

Bond durability and surface states of titanium, Ti-6Al-4V alloy, and zirconia for implant materials

Keiko Nakamura[a], Tomohiro Kawaguchi[b], Hiroshi Ikeda[c,*], Pirat Karntiang[c,d], Kae Kakura[c], Yusuke Taniguchi[e], Keita Toyoda[e], Hiroshi Shimizu[c], Hirofumi Kido[e]

[a]*Center for Oral Diseases, Fukuoka Dental College, Fukuoka, Japan*
[b]*Section of Removable Prosthodontics, Department of Oral Rehabilitation, Fukuoka Dental College, Fukuoka, Japan*
[c]*Division of Biomaterials, Department of Oral Functions, Kyushu Dental University, Fukuoka, Japan*
[d]*Division of Operative Dentistry, College of Dental Medicine, Rangsit University, Pathum Thani, Thailand*
[e]*Section of Oral Implantology, Department of Oral Rehabilitation, Fukuoka Dental College, Fukuoka, Japan*

Abstract

Purpose: Screw-retained implant crowns used as dental implants comprise a zirconia coping and titanium base bonded using resin cement. These devices are prone to debonding failures. This study investigated the bond characteristics of implant materials based on shear bond strength (SBS) and surface characteristics.

Methods: Chemically pure (CP) titanium grade-4 (Ti), Ti-6Al-4V alloy (Ti-6Al-4V), and tetragonal polycrystalline zirconia (zirconia) were evaluated as adherent materials. Plates of each material were polished, primed for the respective resin cements, and cemented using either methyl methacrylate-based resin cement (Super-Bond) or composite-based resin cement (Panavia). The cemented samples were subjected to 10,000 thermocycles alternating between 5 and 55 °C, and the SBS were obtained before and after thermocycling. The sample surfaces were characterized based on surface observations, roughness, and free energy (SFE).

Results: The SBSs of all materials bonded using Panavia were significantly compromised during thermocycling and reached zero. Although the SBSs of Ti and Ti-6Al-4V bonded using Super-Bond were not significantly affected by thermocycling, those of zirconia decreased significantly. The bond durability between zirconia and Super-Bond was improved via alumina air-abrasion, which caused no significant loss of SBS after thermocycling. Surface analyses of the air-abraded zirconia validated these results and confirmed that its surface roughness and SFE were significantly increased.

Conclusions: The bond durability between resin cement and zirconia was lower than that between Ti and Ti-6Al-4V. The alumina air-abrasion pretreatment of zirconia improved the SFE and surface roughness, thereby enhancing bond durability.

Keywords: *Titanium, Zirconia, Implant, Cementing, Bond strength*

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