Effect of Repeated Firings on Microtensile Bond Strength of In-Ceram Alumina with Two Different Veneering Ceramics

Atila Ertan, DDS, PhD[a]/Bulem Yuzugullu, DDS, PhD[b]/Senay Canay, DDS, PhD[c]/Bahadır Ersu, DDS, PhD[a]

Microtensile bond strengths of In-Ceram Alumina cores veneered with two ceramics after different numbers of firing cycles were evaluated. After In-Ceram Alumina cores were fabricated, they were veneered with either Vitadur Alpha or Vita VM7. A control group of each core-veneer combination was fired twice, and a second group was fired five times to induce thermal fatigue. Obtained microbars were subjected to microtensile bond strength tests. Data were analyzed using two-way analysis of variance. Microtensile bond strength values for Vita VM7 specimens were higher than those for Vitadur Alpha ($P < .001$). Although the number of firing cycles revealed no change in bond strength, the veneering material proved to be an important factor. *Int J Prosthodont 2011;24:515–516.*

All-ceramic cores are veneered with ceramic material via application and bonding, through cycle firings, of layers of veneering porcelains onto a high-strength core for optimum esthetics.[1] To ensure the structural integrity of layered restorations under functional loads and to prevent chipping and delamination of veneer ceramic, the core-veneer bond must be of sufficient strength. Stress distribution in a two-phase material construction is more complex than a homogenous single-phase material construction. Therefore, additional factors must be considered for layered restorations. Thermal expansion behavior, firing shrinkage, interface toughness and roughness, and heating and cooling rates are all factors that must be handled carefully to prevent generation of undesired tensile stresses.[2]

To the authors' knowledge, no study in the literature has aimed to investigate the effect of firing cycles on all-ceramic systems. Therefore, the purpose of the present study was to evaluate In-Ceram Alumina cores (Vita Zahnfabrik), in combination with two veneer systems developed for these cores, in terms of microtensile bond strength (MTBS) related to different numbers of firing cycles, which may cause thermal fatigue.

[a]Assistant Professor, Hacettepe University, Faculty of Dentistry, Department of Prosthodontics, Ankara, Turkey.
[b]Associate Professor, Baskent University, Faculty of Dentistry, Department of Prosthodontics, Ankara, Turkey.
[c]Professor, Hacettepe University, Faculty of Dentistry, Department of Prosthodontics, Ankara, Turkey.

Correspondence to: *Dr Bulem Yuzugullu, Baskent University, Faculty of Dentistry, Department of Prosthodontics, 11. sok no: 26 06490 Bahcelievler, Ankara, Turkey. Fax: +90 312 215 29 62. Email: bulemy@gmail.com*

Materials and Methods

In-Ceram Alumina was used as the core material, and Vitadur Alpha (Vita Zahnfabrik), long considered the industry standard for alumina substructures, and the recently developed low-fusing, fine-grain, feldspar-ceramic Vita VM7 (Vita Zahnfabrik) were implemented as veneer materials. In-Ceram Alumina core specimens (7 mm high, 10-mm diameter) were produced by compacting aluminum oxide powder in stainless steel molds, followed by a sintering and glass-infiltrating process. Prepared core materials were cleaned ultrasonically for 15 minutes in ethanol and deionized water and air dried. For the veneering ceramic, In-Ceram Alumina disks were seated in an adjustable aluminum mold, and the ceramic slurry was condensed, blot dried, and fired according to the manufacturer-prescribed sintering cycle. Each veneering ceramic was fired on In-Ceram Alumina disks in either two (control group) or five separate firings to establish a 7-mm-high layer of veneering ceramic.

Disk-shaped layered specimens of each group were cut into microbars ($14 \times 1 \times 1$ mm^3) using a slow-speed diamond saw sectioning machine (Isomet, Buehler). Peripheral slices (0.5 mm) were eliminated in case the results could be influenced by rounded edges of the core-veneer interfaces by uncompensated shrinkage after the veneering process. Microbars were evaluated under a stereomicroscope for presence of surface defects. Fifteen sound microbars were selected randomly from each group.

For MTBS testing, each microbar was bonded to a stainless steel attachment unit using light-polymerized adhesive resin (Clearfil SE, Kuraray), taking care to center the core-veneer interface at the free space

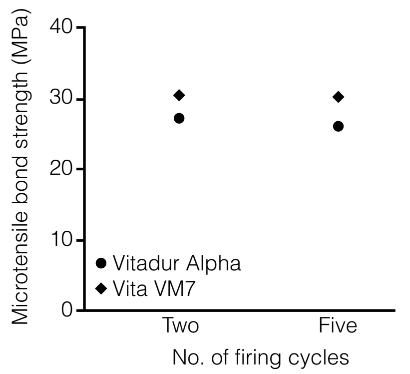

Fig 1 Microtensile bond strength values for both veneering materials with different numbers of firing cycles.

between the two plates of the attachment unit. Bonded bars were loaded until failure in a universal testing machine (Lloyd Instruments) under water cooling at a crosshead speed of 1 mm/min. Maximum load at failure was recorded.

Differences in MTBS values (MPa) were analyzed using analysis of variance (ANOVA) ($P < .01$). Two-way ANOVA was used to determine the effect of number of firing cycles on MTBS values between veneering ceramics. Multiple comparisons of data were analyzed using the Tukey honestly significant difference post hoc test.

Results

MTBS values for In-Ceram Alumina core/Vita VM7 specimens (27 to 34 MPa) were found to be statistically higher than In-Ceram Alumina core/Vitadur Alpha specimens (24 to 29.5 MPa) ($P < .001$), whereas the number of firing cycles showed no difference ($P = .12$). Interaction between veneering material and firing cycle factors was not found to be significant ($P = .44$) (Fig 1).

Discussion

For the layered restoration to gain full benefit of the underlying core material, the bond between the weaker ceramic and stronger framework must be sufficient to allow for proper transfer of loading stresses between the two materials. According to Fahmy,[3] the Vita VM7 veneer-core interface showed the highest bond strength among veneering ceramics developed for In-Ceram cores because of a slight difference in the elemental composition of its components, which may have produced better chemical bonding and perfected the slight mismatch in the coefficient of thermal expansion during firing. In another study,[4] the mean MTBS value for veneering ceramic to low leucite was higher than that to leucite, glass-infiltrated, or lithium disilicate ceramic. A previous study[5] showed similar MTBS values (24.2 to 31 MPa) to those found in the present study.

Further research is needed to confirm the indifference in MTBS after additional firing cycles among core-veneer combination groups using different all-ceramic systems and higher numbers of firing cycles.

Conclusion

To better benefit from the high strength of In-Ceram Alumina frameworks, the strength of the veneering ceramic is an important factor regardless of the number of firing cycles.

References

1. Al-Dohan HM, Yaman P, Dennison JB, Razzoog ME, Lang BR. Shear strength of core-veneer interface in bi-layered ceramics. J Prosthet Dent 2004;91:349–355.
2. White SN, Miklus VG, McLaren EA, Lang LA, Caputo AA. Flexural strength of a layered zirconia and porcelain dental all-ceramic system. J Prosthet Dent 2005;94:125–131.
3. Fahmy NZ. Bond strength, microhardness, and core/veneer interface quality of an all-ceramic system. J Prosthodont 2010;19:95–102.
4. Dündar M, Özcan M, Gökçe B, Çömlekoğlu E, Leite F, Valandro LF. Comparison of two bond strength testing methodologies for bilayered all-ceramics. Dent Mater 2007;23:630–636.
5. Aboushelib MN, de Jager N, Kleverlaan CJ, Feilzer AJ. Microtensile bond strength of different components of core veneered all-ceramic restorations. Dent Mater 2005;21:984–991.