Bond Strengths of Veneering Ceramics to Reinforced Ceramic Core Materials

Mine Dündar, DDS, PhD[a]/M. Özcan, DDS, PhD[b]/E. Çömlekoğlu, DDS[a]/M. Ali Güngör, DDS, PhD[a]/
C. Artunç, DDS, PhD[a]

Fig 1 Shear bond strength testing machine (Autograph, Shimadzu).

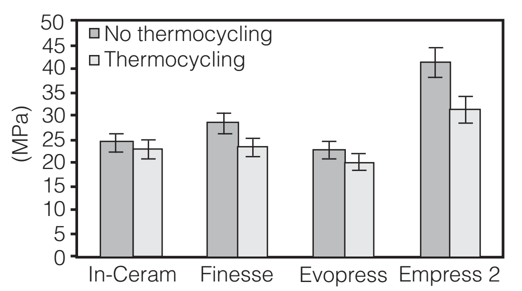

Fig 2 Shear bond strengths under dry and thermocycled conditions.

Reinforced core ceramics are commonly used to deliver more esthetic ceramic restorations with weaker, but more translucent, veneering ceramics.[1] The aim of this study was to evaluate the shear bond strengths of four individual veneering ceramics—three feldspathic and one fluorapatite—to their corresponding core ceramics: leucite-reinforced ceramic (Evopress, Wegold); low-leucite-reinforced ceramic (Finesse, Ceramco); glass-infiltrated alumina (In-Ceram Alumina, Vita); and lithium disilicate (Empress 2, Ivoclar Vivadent), respectively.

[a]Department of Prosthodontics, Ege University, School of Dentistry, Bornova, Izmir, Turkey.
[b]Faculty of Medical Sciences, Department of Dentistry and Dental Hygiene, Groningen University, The Netherlands.

Correspondence to: *Dr Mine Dündar, Department of Prosthodontics, School of Dentistry, Ege University, Bornova 35100, Izmir, Turkey. e-mail: minedundar@yahoo.com*

Int J Prosthodont 2005;18:71–72.

Materials and Methods: Ceramic cores (n = 10/group, total = 40) were fabricated according to manufacturers' instructions (thickness 3 mm, diameter 5 mm) and ultrasonically cleaned for 15 minutes in ethanol and deionized water. The veneering ceramics were condensed in a stainless-steel mold (diameter 5 mm, height 5 mm, core 3 mm, veneer 2 mm) and fired on the core materials. The samples were tried in the mold for minor adjustments, ultrasonically cleaned, and embedded in polymethyl methacrylate.[2] All groups of core–veneering ceramic combinations were randomly divided into two groups (n = 5/group) for dry and thermocycled storing conditions. Dry samples were kept in a dessicator at room temperature for 24 hours prior to testing, and the other groups were subjected to thermocycling (5 cycles; 5 and 55ºC; 30-second dwell time).[3] The shear bond strength tests were performed in a universal testing machine (cross-head speed 0.5 mm/min) (Fig 1). The bond strengths (mean, in MPa, ± standard deviation) and modes of failures were recorded. The means of each group were analyzed by one-way analysis of variance, and multiple comparisons were made by repeated measures test (α = .05) (SAS 8.02, SAS Institute).

Results: In dry conditions, the shear bond strength of veneering ceramic to core material in the Empress 2 system was significantly higher (41 ± 8 MPa; $P < .05$) than those of the Finesse (28 ± 4 MPa), In-Ceram Alumina (26 ± 4 MPa), and Evopress (23 ± 3 MPa) systems (Fig 2). Thermocycling significantly decreased the bond strengths in the Empress 2 system (31 ± 4 MPa) when compared with dry conditions, but the decrease was not significant in the Finesse, Evopress, and In-Ceram systems ($P \geqslant .05$). Although the failure mode was mainly adhesive at the core-veneer interface for In-Ceram Alumina, predominantly cohesive fractures in the core materials were observed in the Empress 2, Finesse, and Evopress systems. Scanning electron microscopic images exhibited cohesive failures, with partially delaminated surfaces revealing no clear crack sites, and the adhesive failures, particularly in glass-infiltrated alumina/feldspathic ceramic, exhibited visible delamination sites at the core-veneer interface.

Conclusion: Bilayered ceramic specimens exhibited complex failure modes that could be attributed to differences in the flexural strengths between the two ceramics, as well as to the differences in their thermal expansion coefficients.[1] Although the thickness of the core ceramic was standard for all groups, it was reported that small variations could affect the strength of the restoration.[4] Fluorapatite veneering ceramic demonstrated higher bond strength to lithium disilicate ceramic than the leucite–glass ceramic/feldspathic ceramic or glass-infiltrated alumina/feldspathic core–veneer ceramic combinations did. After thermocycling, core–veneer bond strength was affected the most in lithium disilicate/fluorapatite combinations.

References

1. Ironside JG, Swain MV. Ceramics in dental restorations—A review and critical issues. J Aust Ceram Soc 1998;34:78-91.
2. Haselton DR, Diaz-Arnold AM, Dunne JT Jr. Shear bond strengths of 2 intraoral porcelain repair systems to porcelain or metal substrates. J Prosthet Dent 2001;86:526–531.
3. Özcan M, Niedermeier W. Clinical study on the reasons for and location of failures of metal-ceramic restorations and survival of repairs. Int J Prosthodont 2002;15:299–302.
4. Chai J, Takahashi Y, Sulaiman F, Chong K, Lautenschlager EP. Probability of fracture of all-ceramic crowns. Int J Prosthodont 2000;13:420–424.

Literature Abstract

Resonance frequency analysis of implants subjected to immediate or early functional occlusal loading

The objective of this study was to analyze the development of implant stability by repeated resonance frequency analysis measurements during 1 year in 23 patients treated according to an immediate/early-loading protocol. An additional objective was to evaluate the possible differences between failing and successful implants. Eighty-one Brånemark System implants were placed in 23 patients for immediate/early-occlusal loading in all jaw regions. The patient inclusion criteria were: 1) height and volume of bone to allow placement of implant with a minimum length of 7 mm; 2) no granulation tissue or signs of acute infections in cases of immediate implantation in an extraction socket; 3) no signs of pathology in the maxillary sinus (when placing implants in the posterior part of the maxilla); and 4) sufficient primary stability as judged clinically. Thirty of the implants were placed in extraction sockets and 62 were subjected to GBR procedures. In 71% of the cases, the provisional reconstruction was delivered on the same day. For all other cases (29%), the patients received the prostheses at the latest 11 days after fixture insertion due to technical or logistic reasons. Apart from clinical and radiographic examinations, the patients were followed with resonance frequency analysis at placement, prosthesis connection and after 1–3, 6, and 12 months. Statistical analyses were carried out to study the possible differences between implants that failed during the study period and implants that remained successful. Nine implants failed (11.2%) during the 1 year of loading. Resonance frequency analysis showed a distinct different pattern between the implants that remained stable and the implants that were lost. The implants that failed during the course of the study showed a significantly lower stability after 1 month with progressive lower stability until loss of implants. Within the limitations of this study, it is concluded that failing implants show a continuous decrease of stability until failure. Low resonance frequency analysis levels after 1 and 2 months seem to indicate an increased risk for future failure. This information may be used to avoid implant failure in the future by unloading implants with decreasing degree of stability with time as diagnosed with the resonance frequency analysis technique.

Glauser R, Sennerby L, Meredith N, et al. *Clin Oral Implants Res* 2004;15:428–434. **Reference:** 44.
Reprints: Dr Roland Glauser, Department for Fixed and Removable Prosthodontics, University of Zurich, Plattenstrasse II, CH 8028 Zurich, Switzerland. e-mail: glauser@zzmk.unizh.ch—*Tee-Khin Neo-Singapore*