



FRACTURE TOUGHNESS OF HEAT-PRESSED AND LAYERED CERAMICS

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Statement of problem. Veneering ceramic materials designed to be used with high noble alloy and zirconia-based restorations have been reported to be susceptible to chipping in vivo.

Purpose. The purpose of this study was to evaluate and compare the fracture toughness of heat-pressed and layered ceramics intended for zirconia and high-noble alloy substrates.

Material and methods. Bar specimens were fabricated from 8 different ceramics (Ivoclar-Vivadent [I] and Noritake [N]) intended for pressing (P) and layering (L) to high noble alloy (M) and zirconia (Z) substrates, following the ISO 6872 protocol. The single edge notch beam test method was used to create a notch in the center of each specimen, which was then tested with a universal testing machine ($n=6$, cross-head speed=0.5 mm/min) and the fracture force values recorded. These values were used to calculate the fracture toughness (K_{IC}) for each specimen. Fracture surfaces were examined with a scanning electron microscope, and the basic components of the tested ceramics were determined by using energy dispersive x-ray (EDX) spectroscopy. Data were analyzed with 3-way ANOVA, followed by multiple comparisons using the Holm method ($\alpha=.05$).

Results. The mean (SD) of the calculated fracture toughness values obtained ranged from 1.20 (0.04) $\text{MPa}\cdot\text{m}^{1/2}$ (group NZL) to 1.74 (0.04) $\text{MPa}\cdot\text{m}^{1/2}$ (group IZL). Fracture toughness was significantly higher in group IZL (1.74) than group IZP (1.41), but lower in group NZL (1.20) than group NZP (1.36) ($P<.001$). Fracture toughness was somewhat lower in group IML (1.36) than group IMP (1.47) ($P=.018$), and no significant difference was found between group NML and group NMP ($P=.14$). Veneering ceramics used with a metal substrate showed a crystalline structure mixed with a glassy phase pattern on the fracture surface. The results of EDX analysis on the fracture surfaces indicated that the tested ceramics were composed of Si, Al, K, Na, Mg, and oxygen elements.

Conclusions. Ceramics used for veneering zirconia substrate may have various fracture toughness values that relate primarily to the processing technique. (J Prosthet Dent 2013;109:234-240)

CLINICAL IMPLICATIONS

Results of this study suggest that, in general, and assuming all other physical characteristics remain virtually the same, it is desirable to use a ceramic veneering material with a higher K_{IC} .

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