Short Communication

Microleakage in Full-Crown All-Ceramic Restorations: Influence of Internal Surface Treatment, Silane Application, Alumina System, and Substrate

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This study investigated the influence of internal surface treatment and margin location on the microleakage of 2 alumina-reinforced ceramic crown systems: In-Ceram (VITA Zahnfabrik) and Procera (Nobel Biocare). Full crowns were produced for each of the 2 systems (n = 24) in human premolars, with margins located in enamel and dentin, and luted with Single Bond and RelyX ARC (3M ESPE). Four internal ceramic treatments were tested: *(1)* aluminum oxide blasting (AO), *(2)* AO plus silane, *(3)* hydrofluoric acid etching (HF), and *(4)* HF plus silane. After thermal cycling, leakage was measured quantitatively. Statistical analysis ($P < .05$) showed higher leakage in dentin margins compared to enamel. In enamel, Procera showed greater leakage compared to In-Ceram. Generally, lower microleakage was observed for the AO plus silane treatment.
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Alumina-reinforced ceramic systems show improved mechanical properties compared to feldspathic ceramic.[1,2] Despite improved adhesion with resin cements, microleakage remains a concern with ceramic restorations.[3] This can lead to pulpal sensitivity and secondary caries. Internal treatment of ceramic crowns by micromechanical retention (airborne particle abrasion or hydrofluoric acid etching) or chemical bonding (silanation) may reduce leakage.[1,2,4,5] Hydrofluoric acid is effective in ceramic systems with a vitreous phase, whereas airborne particle abrasion is indicated for ceramics with high alumina concentration. Silane may not be effective for alumina ceramics that have low silica concentration.[2]

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The cervical margins of all-ceramic crowns must be considered as one of the weakest areas, especially when the margin is located in dentin.[3] This study evaluated the influence of internal surface treatment and substrate on the microleakage of full crowns made with 2 alumina ceramics.

Materials and Methods

Standard full-crown preparations were performed in 48 recently extracted, noncarious human premolars using diamond burs (no. 4138) mounted on a milling machine. The teeth were reduced by 1.5 mm to a chamfer finish with the cervical wall located in enamel (buccal) and dentin (lingual).

Stone dies were used to produce Procera AllCeram (n = 24) (Nobel Biocare) and In-Ceram (n = 24) (VITA Zahnfabrik) cores. Procera AllCeram Porcelain and Vitadur Alpha (VITA Zahnfabrik) were used for the crowns.

Four surface treatments (n = 6) were performed for both ceramics: *(1)* aluminum oxide (50 µm) blasting (AO), *(2)* AO plus silane, *(3)* hydrofluoric acid (HF), and *(4)* HF plus silane. The AO treatment was performed with a microetcher for 20 seconds. The HF treatment was performed with a 10% HF gel (Dentsply) applied for 4 minutes and rinsed. The crowns were silanated with Ceramic Primer (3M ESPE).

Table 1 Means (SDs) of Leakage (mm) in Enamel for Different Groups (Silane, Treatment, and Ceramic)*

	Aluminum oxide blasting		Hydrofluoric acid etching	
	No silane	Silane	No silane	Silane
In-Ceram	4.7 (4.3)^{Aa†}	1.7 (0.9)^{Aa†}	13.1 (8.7)^{Bb‡}	1.1 (1.1)^{Aa†}
Procera	13.0 (4.4)^{Bb‡}	2.9 (4.3)^{Aa†}	9.4 (4.8)^{Bb‡}	11.9 (6.2)^{Bb‡}

*The same capital letters indicate similar means between the 2 ceramic systems; the same lowercase letters indicate similar means when comparing the use of silane; the same symbols indicate similar means between the internal treatments.

Table 2 Means (SDs) of Leakage (mm) in Dentin for Different Groups (Silane, Treatment, and Ceramic)*

	Aluminum oxide blasting		Hydrofluoric acid etching	
	No silane	Silane	No silane	Silane
In-Ceram	26.2 (6.9)^{Ba†}	18.5 (6.9)^{Aa†}	18.6 (9.0)^{Aa†}	16.9 (4.4)^{Aa†}
Procera	13.0 (4.4)^{Aa†}	10.0 (4.3)^{Aa†}	27.1 (7.1)^{Aa‡}	21.3 (5.9)^{Aa‡}

*The same capital letters indicate similar means between the 2 ceramic systems; the same lowercase letters indicate similar means when comparing the use of silane; the same symbols indicate similar means between the internal treatments.

Crowns were conditioned with 35% phosphoric acid for 15 seconds. Following rinsing and light drying, a bonding agent (Adper Single Bond, 3M ESPE) was applied in 2 coats and light cured for 20 seconds. Resin cement (RelyX ARC, 3M ESPE) was mixed and applied to the ceramic crowns, which were held in place for 8 minutes using a modified Vicat needle. Excess cement was removed and the interfaces were light cured (XL 3000, 3M ESPE) for 40 seconds. The margins of the restorations were polished with Enhance (Dentsply).

After 7 days, the specimens were stressed between 5°C and 55°C for 500 cycles. The specimens were isolated with nail varnish, except for the margins of the restorations and 2 mm of the surrounding tissues, and immersed in 1% aqueous solution of methylene blue. Specimens were sectioned across the center of the restoration. Digitized images were used to measure the length (mm) of dye penetration along the gingival wall (40× magnification).

Data were submitted to statistical analysis at a .05 level of significance. A Student *t* test was used to investigate differences between substrates. Three-way analysis of variance (ANOVA) and the Fisher test were used to investigate the other variables in each substrate.

Results

Means and SDs of microleakage for different groups are shown in Tables 1 and 2. Significantly greater ($P<.05$) dye penetration was observed in dentin. In enamel, AO plus silane generally reduced the microleakage for both ceramic systems ($P<.01$), and Procera exhibited more leakage than In-Ceram ($P<.05$). In dentin, statistical analysis showed that AO plus silane generally produced lower leakage values ($P<.05$), and both ceramic systems had similar leakage.

Discussion and Conclusion

Higher leakage was observed in margins located in dentin, as previously reported, because the organic matrix of dentin impairs bonding.[3] In enamel, Procera exhibited higher leakage. In-Ceram is composed of 85% by weight alumina core infiltrated with glass.[2] Procera is densely sintered alumina ceramic, with 99% by weight alumina,[1] and the conditioning of its internal surface may be less effective, thus explaining the increased leakage. Similar leakage in dentin may be explained by the increased dye penetration in this substrate, which may impair the determination of differences.

The AO treatment improved marginal sealing compared to HF. Borges et al[4] observed that AO and HF produce irregularities in alumina ceramics without changing their microstructure. Others reported that surface treatments with silica coating and silanation produced a significant increase in bond strength between resin cement and In-Ceram[2] or Procera.[1]

Silane application reduced dye penetration. Silane enhances adhesion of the ceramic material to silica even though the content of silica is minimal in alumina ceramic.[5]

References

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