Glass-ceramic Flexural Strength after Hydrofluoric Acid and Unfilled Resin Treatment

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The use of hydrofluoric (HF) acid is considered one of the most effective methods for achieving durable resin bond to glass-ceramics. Nonetheless, HF acid etching effect on glass-based ceramics strength remains uncertain and only a few contradictory studies have reported the influence of an unfilled resin (UR) application on the ceramic strength.

Objectives: To investigate the effect of HF acid etching followed by silane and UR applications on the biaxial flexural strength of a nanofluorapatite glass-ceramic.

Methods: 144 disc-shaped (15±1mm in diameter and 0.8±0.1mm in thickness) nanofluorapatite ceramic specimens were allocated into 12 groups: G1-control (no etching), G2-30s, G3-60s, G4-90s, G5-120s, G6-60s+60s. Meanwhile, G7-G12 were treated in the same fashion as G1-G6, but followed by silane and UR applications. Surface morphology of G1-G12 was assessed by scanning electron microscopy/SEM. The flexural strength was determined by biaxial testing per ISO 6872. Statistical analyses were two-way ANOVA and the Sidak multiple comparisons procedure (α=0.05). Additionally, Weibull statistics and finite element analysis (FEA) were carried out.

Results: A significant effect of etching time ($p=0.0290$) on flexural strength was observed. G4 led to a significantly ($p=0.0392$) higher flexural strength than G1. Correspondingly, G10 revealed a considerably higher flexural strength than G7 ($p=0.0392$). Furthermore, flexural strength was significantly higher for G7-G12 than for G1-G6 ($p<0.0001$). For G1-G6, G4 showed the highest Weibull characteristic strength and G10 also presented the highest Weibull characteristic strength among G7-G12. FEA showed lower stress concentration in G7-G12 with the gradient stress supporting the fracture types of the biaxial test. Finally, the SEM data revealed that the HF acid etching affected the surface of ceramic specimens by generating pores and irregularities and more importantly that the UR was able to penetrate into the ceramic microstructure.

Conclusions: HF acid etching followed by silane and UR applications enhanced the ceramic biaxial flexural strength.

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