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Margin Quality, Homogeneity, and Porosity Assessment of Fiber-Reinforced CAD/CAM Composite

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Objectives The aim of this study was to evaluate the margin quality of anterior crowns made of experimental short fiber-reinforced CAD/CAM composite (SFRC CAD) block before and after cyclic fatigue aging. Moreover, to investigate the chemical microstructure, homogeneity, and porosity of the SFRC CAD in comparison with other commercial CAD/CAM materials.
Methods 40 anterior crowns were milled from five CAD/CAM blocks divided into five groups (n=8/group). The first group made of lithium disilicate ceramic blocks (IPS e.max CAD, IVOCLAR), the second made of zirconia-reinforced lithium disilicate blocks (Celtra Duo, Dentsply Sirona), the third made of hybrid polymer-infiltrated ceramic network blocks (VITA ENAMIC, VITA Zahnfabrik), the fourth made of hybrid nanoparticle-filled resin blocks (Cerasmart 270, GC), and the last made of SFRC CAD blocks. Crowns were inspected with stereomicroscope and margins discrepancies were measured. Specimens were scanned using micro-CT system to investigate the porosity and homogeneity. The same crowns were subjected to cyclic fatigue aging (120,000 cycles, Fmax=220 N) and margin discrepancies were measured again. SEM/EDS and XPS analyses were employed. Margin quality data were statistically analysed using two-way ANOVA.
Results SFRC CAD group resulted in the least margin discrepancies compared to other groups before and after cyclic fatigue aging test, while IPS e.max group resulted in the highest margin discrepancy values ($p<0.05$). Micro-CT scanning revealed a homogenous distribution of the fillers of the tested materials with low porosity. After cyclic fatigue aging test, the SFRC CAD crowns have the highest survival rate, followed by IPS e.max, while none of the VITA ENAMIC group crowns have survived the whole fatigue aging cycles.
Conclusions Material type and fatigue aging can significantly affect crown margin quality, with hybrid and resin-based groups resulted in better margin quality than ceramic-based ones. All tested materials have homogenous structure with extremely low porosity.