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Dye Penetration, Porosity, and Void Formation in Proximal Slot Preparations

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Objectives: The aim of this in vitro study was to test the hypothesis that SonicFill systems have the potential to improve restoration adaptation in minimally invasive Class II fillings (slot), as compared with a traditional bulk fill restorative composite applied with an incremental technique. A novel Swept-source OCT (SS-OCT) was also compared to traditional evaluation technique.

Methods: Thirty standardized DB ivorine lower first molars with disto-buccal slot preparation (Figure 1) were divided into two groups (15 teeth/group) and restored using techniques: Traditional (TR) with Filtek bulk-fill, and SonicFill (SF) with SonicFill resin according to the manufacturer recommendation. After restoration in a simulated clinical setting, the samples were sealed and immersed in fluorescein dye at 37°C for 24 hours. The distal proximal surface were flattened and polished with a series of sandpapers. Digital imaging was captured for dye penetration and surface porosity. Images were assessed by using image analysis software (ImageJ, NIH, Bethesda, MD, USA). A swept-source OCT (SS-OCT, Yoshida, Tokyo, Japan) with a center wavelength of 1310 nm (bandwidth 140 nm) and 50-kHz sweep rate was used to obtain real-time cross-sectional monitoring and 3D images of the internal void formation. The OCT 3D images were measured to calculate internal void area percentage and data were analyzed by Student t-test with a significance level at α=0.05.

Figure 1 Standardized DB cavity preparation.

Table. Internal void (%) as measured by SS-OCT

Technique	Average	Standard Deviation
Traditional	6.09	2.4
SonicFill	3.13	1.4

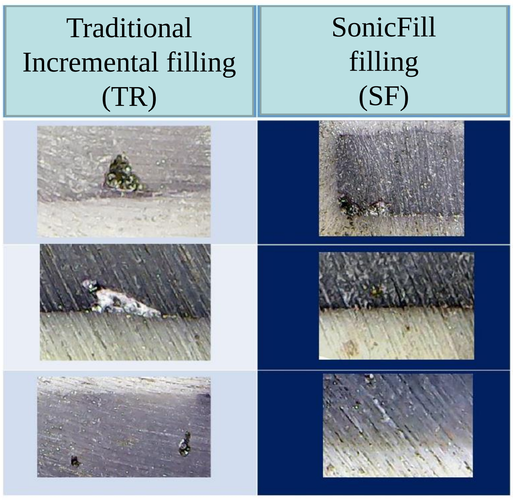

Figure 2. Representative samples of surface porosity and dye penetration from TR and SF groups.

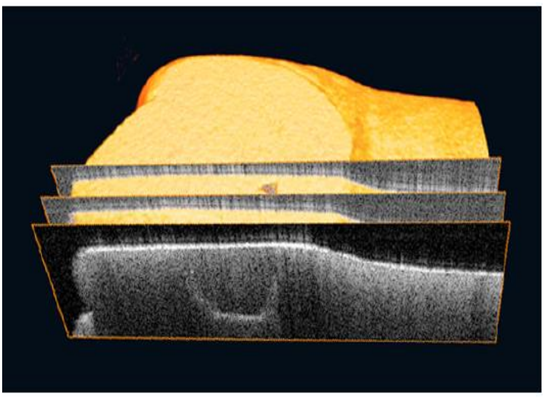

Figure 3. The SS-OCT images have shown 3D images of internal void formation and can be used to measure and calculate internal void area percentage.

Results:

The 2D images demonstrated surface porosities (Figure 2). Microleakage detected by the dye penetration method indicated no statistically significant differences between two filling techniques. The SS-OCT 3D images revealed the results of filling techniques and the percentage of internal void area. The SF (SonicFill) group showed significantly less internal void formation, as compared to the TR (Incremental filling) group ($p < 0.05$) (Table).

Conclusions:

Dye penetration evaluation did not show any significant differences between the two tested groups. The traditional incremental filling technique (TR) obtained statistically significant higher percentage of internal void area inside the restorations than the SonicFill technique by using SS-OCT 3D imaging analysis ($p < 0.05$). The use of SoniFill seems to be warranted while restoring a proximal slot cavity. The OCT real-time nondestructive examination and 3D quantification were successfully applied and found to be superior to traditional assessment techniques in terms of the more complete and accurate internal void calculation.