RESEARCH ARTICLE

Comparative Evaluation of Post-operative Sensitivity in Smart and Conventional Bulk-fill Composites Under Different Bonding Protocols: An In Vivo Study

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Abstract: Introduction: Post-operative sensitivity remains a frequent clinical concern in resin composite restorations. Smart bulk-fill composites have been developed to enhance cavity adaptation and reduce polymerization stress, potentially minimizing patient discomfort. Methods: Sixty patients with Class I carious lesions extending into the middle third of dentin were randomly assigned to four groups based on composite material (SDR or Tetric N-Ceram) and bonding protocol (selective etch or total etch). Post-operative sensitivity was recorded on the 7th, 15th, and 30th days using a 4-point Likert scale. Results: All groups showed a significant decline in sensitivity over time (p < 0.001). SDR with selective etch (Group 1A) showed the lowest sensitivity, whereas Tetric N-Ceram with total etch (Group 2B) showed the highest scores at all intervals. Selective etching significantly reduced sensitivity compared with total etching. Conclusions: Selective etching produced less post-operative sensitivity compared to total-etch protocols. SDR demonstrated superior performance compared with Tetric N-Ceram.

Keywords: post operative sensitivity, bulk fill composites, SDR, Tetric N Ceram, selective etch, total etch.

Introduction

Smart materials are characterized by their ability to sense and respond to changes in their environment, such as alterations in temperature, stress, pH, or moisture. These responsive properties have been incorporated into newer composite restorative materials to improve clinical outcomes. Despite continuous advancements, composite restorations may still present challenges, including marginal discoloration, microleakage, secondary caries, and post-operative sensitivity.

Prevention of marginal gap formation plays a critical role in reducing microleakage, pulp inflammation, and patient discomfort. Bulk-fill composites were introduced to overcome limitations of conventional composites by allowing placement in thicker increments while maintaining adequate polymerization and reducing shrinkage stress. Smart bulk-fill composites exhibit improved flow, adaptation, and stress-relieving properties. This study aimed to compare the post-operative sensitivity associated with a smart bulk-fill composite (SDR) and a conventional bulk-fill composite (Tetric N-Ceram) using.

selective-etch and total-etch bonding protocols

MATERIALS AND METHODS

Study Design and Ethical Approval
This in vivo comparative study was conducted on 60 patients requiring Class I restorations. Ethical approval was obtained from the institutional review board (Approval No.: *[Insert]*). Written informed consent was obtained from all participants.
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Sample Selection

Inclusion criteria

- Patients ≥18 years old
- Class I lesions extending to the middle third of dentin
- Residual dentin thickness ≥2 mm
- Periodontally healthy teeth with no tenderness on percussion

Exclusion criteria:

- Existing restorations
- Non-carious cervical lesions
- Attrition, abrasion, erosion
- Cracks, fractures, or periapical pathology

Materials Used

- **SDR®** (Dentsply Sirona, USA) – smart bulk-fill composite
- **Tetric N-Ceram®** (Ivoclar Vivadent, Liechtenstein) – conventional bulk-fill composite
- **Single Bond Universal** (3M ESPE, USA)
- Rotary instruments (Mani, Japan; NSK, Japan)
- Light-curing unit (Ivoclar Vivadent, ≥550 mW/cm² at 470 nm)
- Polishing system (Super-Snap, Shofu, Japan)

Group Allocation

Patients were randomly assigned into four groups:

- **Group 1A:** SDR + Selective etch
- **Group 1B:** SDR + Total etch
- **Group 2A:** Tetric N-Ceram + Selective etch
- **Group 2B:** Tetric N-Ceram + Total etch

Clinical Procedure

Cavity preparation was standardized using round carbide burs under water coolant. Rubber dam isolation was performed for all cases.

Selective-etch protocol (Groups 1A, 2A): 38% phosphoric acid on enamel only for 15 seconds.

Total-etch protocol (Groups 1B, 2B): 38% phosphoric acid on enamel and dentin for 10–15 seconds.

The adhesive was applied and light-cured for 20 seconds.

Restoration placement:

- SDR placed in ≤4 mm increments and light-cured.
- Tetric N-Ceram placed in ≤4 mm increments, allowed 20–30 seconds for self-curing, then light-cured.

Restorations were finished and polished, and occlusion was verified.

Post-operative Sensitivity Assessment

Sensitivity was evaluated on Days 7, 15, and 30 using the following **4-point Likert scale**:

- 0 = No sensitivity
- 1 = Slight
- 2 = Moderate
- 3 = Severe

Statistical Analysis

Data were analyzed using SPSS (Version *[Insert]*). Kruskal–Wallis, Dunn's post hoc, Friedman, and Wilcoxon Signed Rank tests were applied. Significance level was set at **$p < 0.05$**.

RESULTS

All groups exhibited a progressive reduction in post-operative sensitivity from Day 7 to Day 30.

Descriptive Statistics

Group	Bonding Protocol	Day 7 (Mean± SD)	Day 15 (Mean± SD)	Day 30 (Mean± SD)	
1A	SDR+Selective Etch	1.40±0.52	0.80±0.42	0.20±0.42	
1B	SDR+Total Etch	2.10±0.57	1.30±0.48	0.60±0.51	
2A	Tetric N-Ceram+Selective Etch	1.80±0.63	1.00±0.47	0.30±0.48	
2B	Tetric N-Ceram+Total Etch	2.30±0.48	1.60±0.52	0.90±0.57	

Inter-group Analysis

Kruskal–Wallis test showed significant differences among the four groups at all time points ($p < 0.05$). Dunn's post hoc test identified Group 1A as significantly lower in sensitivity than Group 2B throughout the observation period.

Friedman test revealed a significant reduction in sensitivity over time within each group ($p < 0.001$). Wilcoxon tests confirmed significant differences between Day 7 and Day 30 scores.

DISCUSSION

This study evaluated the influence of two bonding protocols on post-operative sensitivity associated with smart and conventional bulk-fill composites. Selective etching consistently produced lower sensitivity scores compared with total etching, likely due to reduced dentin demineralization and more controlled hybrid layer formation. SDR demonstrated superior performance, attributable to its flowable consistency and stress-relieving polymerization modulator.

These findings align with previous research reporting reduced polymerization stress and improved cavity adaptation in smart composites. The higher sensitivity associated with total-etch protocols may be related to increased dentin permeability and technique sensitivity.

Limitations include a relatively short follow-up period and restriction to Class I restorations. Future studies may evaluate long-term clinical performance, Class II lesions, and patient-reported outcomes.

CONCLUSIONS

- Selective etching significantly reduced post-operative sensitivity compared with total etching.

- SDR exhibited the lowest sensitivity values, demonstrating superior clinical performance over Tetric N-Ceram.
- Post-operative sensitivity decreased
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Sl	parameter	Mean	SD	t-	p-

- significantly over 30 days in all groups.

Smart bulk-fill composites may enhance patient comfort due to improved adaptation and reduced polymerization stress.

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