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In Vitro Comparison Of Depth Of Cure And Microhardness Of Posterior Bulk Fill Composites

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Abstract
Objective: *To compare the depth of cure (DOC) and microhardness of three different posterior bulk-fill composites using the Vickers hardness test.*
Materials and Methods: *Three commercially available posterior bulk-fill composites - GC EverX Posterior, 3M ESPE Filtek Bulk Fill, and SDI Aura Bulk Fill - were evaluated. Thirty samples were prepared and tested for depth of cure and microhardness. The Vickers hardness test was used to measure top and bottom surface hardness, and the depth of cure was assessed using the penetrometer method.*
Results: *GC Ever X Posterior exhibited the highest microhardness and depth of cure. Filtek Bulk Fill and Aura Bulk Fill followed in decreasing order. The microhardness ratio (bottom/top) met the minimum acceptable threshold for clinical performance in all groups.*
Conclusion: *The physical and mechanical properties of posterior bulk-fill composites vary significantly by material. Fiber-reinforced composites like Ever X Posterior show enhanced depth of cure and microhardness, improving their suitability for posterior restorations.*
Keywords: *Bulk-fill composites, Depth of cure, Microhardness, Vickers hardness, Composite resin, Light curing*

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I. Introduction

Resin-based composites (RBCs) have transformed conservative and esthetic dentistry due to their excellent physical properties and esthetics [1]. Traditional RBCs require incremental layering to ensure light penetration and complete polymerization. However, this approach is time-consuming and susceptible to defects such as voids and incomplete curing[2].

To address these issues, bulk-fill composites were developed. These allow for placement in layers up to 4 mm thick and offer benefits such as reduced polymerization shrinkage and decreased cuspal deflection. A critical property of these composites is their depth of cure (DOC)—defined as the extent of polymerization at increasing depths from the surface[3].

Another important parameter is microhardness, which reflects the material's resistance to wear and its ability to withstand occlusal forces. The ratio of bottom-to-top surface hardness should exceed 0.80 to be considered adequately polymerized [4].

This study compares the DOC and microhardness of three commonly used bulk-fill composites: GC everX Posterior, 3M ESPE Filtek Bulk Fill, and SDI Aura Bulk Fill.

II. Materials And Methods

Materials Used

In the present study, three commercially available posterior bulk-fill composite resins were selected:

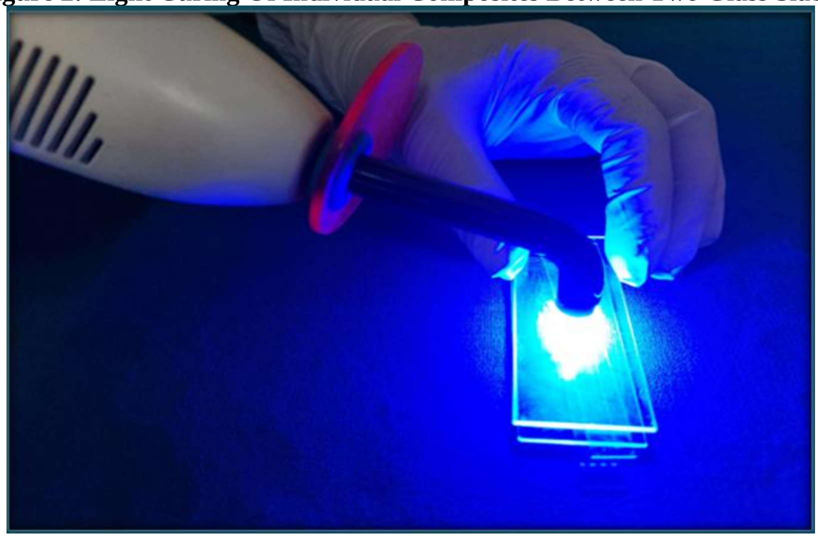
1. **GC everX Posterior** (GC Corporation, Tokyo, Japan)
2. **Filtek Bulk Fill Posterior Restorative** (3M ESPE, St. Paul, MN, USA)
3. **Aura Bulk Fill** (SDI Limited, Bayswater, Victoria, Australia)

Sample Preparation

A total of 30 samples were prepared, with **10 specimens for each material** (n=10 per group). All specimens were fabricated using a standardized cylindrical stainless steel mold with dimensions of **4 mm height** and **5 mm diameter**, in accordance with previous studies on bulk-fill composites. The composite was incrementally filled in the mold and covered with a Mylar strip to ensure a flat surface. Light curing was carried out using a **Bluephase G2 LED curing unit** (Ivoclar Vivadent, Schaan, Liechtenstein) at an intensity of 1200 mW/cm² for 20 seconds from the top surface, following the manufacturer's recommendations.

Figure 1: Complete Armamentarium With Three Composites And Moulds.

Figure 2: Light Curing Of Individual Composites Between Two Glass Slabs.



Testing Protocols

Depth of Cure (DOC): The depth of cure was measured using the **penetrometer method**, which provides improved accuracy over the scraping technique. This method was performed in accordance with the protocol described by **Harrington and Wilson**, where a uniform load is applied via a needle into the cured specimen to determine the depth of resistance. Table 1 shows the composition and filler characteristics of all the three tested composites.

Table 1: Composition And Filler Characteristics Of Tested Composites.

Composite Material	Resin Matrix	Filler Content
Filtek Bulk Fill	AUDMA, UDMA, 1,12-dodecane-DMA	76.5% wt (58.4% vol)
everX Posterior	Bis-GMA, Bis-EMA, UDMA	74.2% wt (53.6% vol), E-glass fibers
Aura Bulk Fill	UDMA-based (unspecified)	Nanohybrid filler system

Microhardness Testing: Vickers microhardness was evaluated using a **Vickers hardness tester** following **ISO 10477** guidelines. Indentations were made on both the **top and bottom surfaces** of each sample under a 100 g load applied for 15 seconds. The average Vickers Hardness Number (VHN) was calculated from three indentations per surface to determine surface microhardness and assess the polymerization efficiency.

III. Results

Among the three tested bulk-fill composites, **GC everX Posterior** exhibited the **highest Vickers Hardness Number (VHN)** on both the top and bottom surfaces, followed by **3M Filtek Bulk Fill**, while **SDI Aura Bulk Fill** showed the lowest VHN values. In terms of **depth of cure (DOC)**, GC everX Posterior also outperformed the other materials, achieving the greatest polymerization depth, with 3M Filtek Bulk Fill in the intermediate range and SDI Aura Bulk Fill showing the least depth. Table 2: Vickers hardness values and bottom-to-top surface ratios.

The **microhardness ratio** (bottom/top surface) was found to be above the clinically acceptable threshold of **0.80–0.85** for all three materials, indicating adequate curing through the full 4 mm increment. Among them, GC everX Posterior recorded the **highest microhardness ratio**, followed by 3M Filtek Bulk Fill, with SDI Aura Bulk Fill displaying the lowest ratio. These findings indicate that, while all materials achieved satisfactory polymerization, GC everX Posterior demonstrated **superior curing performance and mechanical hardness** compared to the other two composites.

Table 2: Vickers Hardness Values And Bottom-To-Top Surface Ratios.

Group	Top Surface VHN	Bottom/Top Ratio
Filtek Bulk Fill	63.2	0.87
everX Posterior	71.6	0.91
Aura Bulk Fill	58.4	0.85

IV. Discussion

The improved depth of cure (DOC) and increased microhardness values observed in **EverX Posterior** are largely attributed to the incorporation of **E-glass fibers** within its formulation. These short fibers not only enhance the mechanical reinforcement of the composite but also aid in more effective light scattering and transmission, thereby promoting a more uniform and deeper polymerization [5,6].

Traditional methods for assessing DOC, such as the **scraping technique**, have been shown to be subjective and inconsistent, often lacking clinical relevance. In contrast, objective approaches such as **penetrometer testing** and **Vickers microhardness measurements** provide quantifiable and reproducible assessments of the polymerization gradient, offering a more clinically meaningful evaluation [7,8]. Vickers hardness testing, in particular, allows for the evaluation of top and bottom surface hardness ratios, with a ratio ≥0.80 generally indicating adequate curing [9].

The curing efficiency of bulk-fill composites is influenced by several factors, including **filler particle size**, **resin matrix composition**, **material translucency**, **curing light intensity**, and **composite increment thickness** [10]. Inadequate polymerization may lead to a cascade of clinical complications, such as **postoperative sensitivity**, **marginal microleakage**, and **restoration failure** [11,12]. Therefore, understanding and optimizing these variables are critical to achieving long-term success of resin composite restorations.

V. Conclusion

All three evaluated bulk-fill composites demonstrated clinically acceptable depth of cure (DOC) and microhardness values, meeting the minimum thresholds required for safe use in posterior restorations. The microhardness ratios of all materials exceeded the recommended clinical range of 0.80–0.85, indicating effective polymerization throughout the 4 mm increment.

Among the tested materials, GC everX Posterior exhibited the highest Vickers Hardness Numbers on both top and bottom surfaces, the greatest depth of cure, and the highest microhardness ratio, highlighting its superior performance in terms of both mechanical strength and curing efficiency. These results suggest that GC EverX Posterior is particularly well-suited for use in high-stress bearing areas, such as posterior occlusal surfaces, where enhanced physical properties are critical for long-term clinical success.

While all three materials can be considered viable options for bulk-fill applications, the selection of composite materials should be guided by the specific clinical scenario, such as cavity depth, location, esthetic demands, and expected occlusal load. Understanding the intrinsic properties of each material allows clinicians to make evidence-based decisions that optimize restoration durability and patient outcomes.

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