

Clinical Performance for Three of Bulk-fill Restorations in Class II Cavities

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Abstract

The development of bulk-fill restorative materials has greatly impacted dental practice by enabling more efficient and effective restorations. Bulk-fill restoratives are aimed to be placed in larger increments than conventional composites without compromising their physical properties. This review will focus on the Federation Dentaire Internationale criteria as applied to clinical performance evaluation of three prominent bulk-fill restorative materials: Surefil One, Viscolor, and Equiaforte HT fil. The Federation Dentaire Internationale criteria provide a standardized assessment of clinical performance across key domains, including Esthetics, Functional, and biological impact. Each material will be evaluated based on these criteria, considering their clinical longevity, ease of application, and suitability for varying patient needs.

Keywords: Class II cavities, Clinical performance, Equiaforte HT fil, Surfil one, Viscolor

1. Introduction

The increasing demand for minimally invasive procedures and durable dental materials has led to innovations in restorative dentistry. Bulk-fill restorative materials are a new type of dental material designed to simplify and speed up the restoration process. The restorative material can be applied in bulk layers up to 4e5 mm, ensuring low polymerization shrinkage stress and effective polymerization [1]. Nevertheless, there is a deficiency of data about the impact of these restorative materials on cuspal deflection [2]. The proposal, based on the World Dental Federation Dentaire Internationale (FDI) criteria, facilitates the classification of dental restorations according to biological, esthetic, and functional criteria. Therefore, their use was recommended in clinical trials assessing dental restorations based on materials, operative technique, or interventions, and clinical applications to determine whether a restoration should be maintained, modified, or replaced. A study evaluating dental restorations compared the FDI criteria with the traditional United States Public Health

Service criteria, commonly known as the 'Ryge criteria.' [3].

2. Overview of FDI criteria

The FDI's clinical criteria for the dental materials assessment provide an internationally recognized framework for assessing restorative materials [4]. Into three main categories, the criteria are divided:

(a) Esthetic properties:

Including surface luster, surface staining, anatomical form, and color match, translucency.

(b) Functional properties:

Including fracture resistance, occlusal wear, retention, marginal adaptation, and radiographic examination.

(c) Biological properties:

Including, recurrent caries, tooth integrity post-operative sensitivity, and adjacent mucosa.

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The FDI system rates materials on a scale 1e5, with 1 being clinically excellent and 5 being poor.

2.1. Bulk-fill restorative materials

Recently, bulk-fill restoratives have become the material of choice, especially for deep cavities, because they simplify the application process by filling the cavity in a single 4e5 mm increment, thereby reducing chairside time. It is assumed that bulk fill resin based composite (RBCs) can be cured to a thickness of 4e5 mm, demonstrate higher light transmission properties, and experience lower polymerization shrinkage stresses due to reduced light scattering at the fillerematrix interface. This can be achieved by reducing the amount of filler. To achieve this deeper curing, RBCs have been modified in composition to improve the penetration of visible light through the material. These adjustments include a boost in the size of the filler and the innovative photo initiators utilization [5]. It has been noted that the polymerization of composite resins can lead to a reduction in intermolecular distance from 0.3e0.4 nme0.15 nm, potentially creating stresses due to the contraction of the material. This could potentially contribute to the bonding breakdown and an increase in restoration microleakage. Studies have shown that bulk-fill RBCs may demonstrate better polymerization shrinkage stress behavior and less cuspal deformation compared with conventional composite resins. However, the improved performance of these newer composite restoratives in terms of marginal adaptation to cavity walls has not yet been confirmed. RBCs are further divided into high-viscosity and low-viscosity (flowable) materials [6]. High-viscosity bulk fill composites contain a higher amount of filler particles compared with low-viscosity bulk fill composites. As a result, flowable composite resins show better adaptation to cavity walls but tend to have a higher degree of polymerization shrinkage and weaker mechanical properties. When restoring areas exposed to occlusal stresses, it is recommended to finish the restoration with a 2 mm capping layer of a high-viscosity RBCs due to their higher mechanical strength. Bulk-fill composite materials can be especially beneficial for posterior tooth restorations due to improvements in polymerization shrinkage and the application process. However, further research, particularly in vivo studies, is needed to validate the improved clinical effectiveness of RBCs [7].

2.1.1. Surefil one

Surefil one is a self-adhesive, bulk-fill restorative material that combines the properties of both

composite and glass ionomer. It's known for its ease of utilization, requiring minimal steps for placement, making it ideal for bulk-fill restorations.

In a clinical study by Ghada *et al.* [8], Surefil one showed superior bond strength so, exhibiting high fracture resistance and wear tolerance, making the material suitable for posterior restorations where mechanical strength is essential. Esthetic evaluations indicated minor discoloration over time, but these changes were deemed clinically acceptable according to FDI criteria. Another study by Ilie [9] demonstrated that surefil one bulk-fill application results in excellent marginal integrity and low post-operative sensitivity. These results are in line with FDI criteria that prioritize both functional durability and patient comfort.

2.2. Esthetics properties

Surefil one offers sufficient surface luster and resistance to staining, but it may not match the esthetic quality of conventional composite resins. Its opacity is slightly higher, which can affect the final appearance in highly visible areas. The material offers good surface luster after polishing and its surface staining remains stable over time under typical clinical conditions. Cieplik *et al.* [10] found that self-adhesive composite had dull surface luster due to a lack of etching and multiple pores and Liebermann *et al.* [11] analyzed that due to lack of etching by time, self-adhesive composites generally exhibit more hydrophilic properties and loss of surface luster than the non-self-adhesive composites.

2.3. Functional properties

In terms of functionality, Surefil one performs well in fracture resistance and wear resistance. Its ability to withstand occlusal forces makes it suitable for posterior restorations. However, its marginal integrity has shown some limitations in cases where adhesive bonding is suboptimal, especially in large restorations. Despite this, it has shown minimal shrinkage, contributing to its overall success in bulk-fill applications. Cieplik *et al.* [12], who confirmed enamel fissures or tooth fractures appearance over time. The supplied material's spatial expansion and water uptake may be the cause of these events.

2.4. Biological properties

Surfil one offers a favorable biological profile. Patients report minimal post-operative hypersensitivity, likely due to its self-adhesive nature, which eliminates the need for acid etching and reduces the

risk of pulp irritation. The material's biocompatibility is well-documented, with no reports of adverse reactions. Stoleriu *et al.* [13] who reported that self-adhesive composites showing defective in marginal adaptation thus increase hypersensitivity and limited ability of the self-adhesive composite to penetrate into the exposed collagen network, despite the application of the material first layer in an active way which cause recurrent caries.

2.4.1. Viscolor

Viscolor, a thermoviscous bulk-fill composite, a unique approach to posterior restorations by combining the flowability to a heated composite with a conventional composite mechanical strength when cooled.

The study by Hassan *et al.* [14] who evaluated that effect of preheating on composite lead to increased adaptation so, fracture resistance increased. These properties were attributed to the material's viscosity change during application, ensuring better cavity adaptation and minimizing air entrapment. Furthermore, the study concluded that viscolor's wear resistance, as well as its esthetic stability over time, met the FDI's requirements for clinically excellent restorations moreover Kampanas *et al.* [15] found that viscolor restorations exhibited minimal postoperative sensitivity and low incidence of secondary caries due to increase the adaptation, aligning with FDI's strict standards for biocompatibility and patient safety.

2.5. Esthetic properties

Viscolor showed superior esthetic outcomes compared with Surefil one, with excellent translucency and a natural tooth-like appearance. Its color match remains stable over time, and the material exhibits a high gloss after polishing. These properties make it suitable for utilization in posterior restorations where esthetics are a concern. Yang *et al.* [16] who demonstrated that preheating composite enhancing the adaptation of restoration, thus improving the finishing and polishing also Kampanas [15] reported that preheating composite enhancing finishing and polishing due to increased adaptation. Another study of Mamdouh and Akah [17] evaluated that the dispenser application gives the material lower viscosity, allowing it to flow optimally into the cavity margins and undercuts, minimizing the chance for air bubbles entrapment and staining later on.

2.6. Functional properties

Viscolor's strength lies in its functional performance. The material exhibits high fracture and wear

resistance, even in high-stress areas. Its thermoviscous nature allows it to adapt well to cavity walls, minimizing gaps and improving marginal integrity. This property reduces the risk of secondary caries and ensure long-term durability. A study was evaluated that viscolor exhibited the highest fracture resistance, attributing this to preheated composite. The process of preheating improves adaptation to the cavity wall and reduces stress, which in turn prevents material fractures. This occurs because the thermal energy causes the composite monomers to separate, allowing them to move more easily past each other. As a result, the material's adaptability and mechanical properties are enhanced [15]. Yang *et al.* [16] also noted that Viscolor showed the highest fracture resistance, crediting the advantages of preheated composites that improve adaptation and mechanical properties, ultimately reducing stress and preventing material fractures. Similarly, Deb *et al.* [18] demonstrated how heat affects surface contour and wear, leading to improved adaptation and enhanced polishability, which in turn reduces wear over time.

2.7. Biological properties

Postoperative hypersensitivity is minimal with Viscolor, as the material flows easily into the cavity, reducing voids and gaps. Its adhesive properties are strong, contributing to well-sealed restoration. Mamdouh and Akah [17] discovered that the dispenser application reduces the material's viscosity, allowing it to flow more effectively into the cavity margins and undercuts, thereby minimizing the risk of air bubble entrapment and the marginal gaps. Additionally, Ahmed *et al.* [19] reported that the good marginal adaptation provided by this technique leads to low postoperative sensitivity, which subsequently reduces the likelihood of recurrent caries over time.

2.8. Equiaforte HT fil

Equiaforte is a glass hybrid restorative material that has gained popularity as a bulk-fill restorative material, and its fluoride releasing properties.

Patwardhan [20] evaluated the clinical performance of equiaforte utilizing FDI criteria. Their study found that equiaforte provided satisfactory functional properties, particularly in terms of wear resistance and marginal integrity. While glass ionomer cement (GIC)-based material is generally less wear-resistant than composite resin, Equia Forte's incorporation of a high strength glass hybrid material made it more durable under stresses of posterior occlusion.

Regarding biological properties, Kutuk *et al.* [21] showed that equiaforte performed exceptionally well in minimizing postoperative sensitivity and preventing secondary caries. The material's chemical bond to dentine and its fluoride release further contributed to its superior biological performance. Sakr *et al.* [22] also highlighted equiaforte improved the mechanical properties due to the optimizing polyacid and particle size distribution so decreased the cuspal deflection.

2.9. Esthetics properties

While equiaforte is not as esthetically pleasing as viscalor or surefil one, it performs adequately in posterior restorations where esthetics are less critical. Its opacity can limit its utilization as in posterior teeth, but its surface finish and luster improve significantly with application of a protective coating. Attia *et al.* [23] analyzed that the increased opacity in Equia Forte Fil is due to the larger size of glass particles present in the material. These particles scatter light, giving the restoration an opaque and whitish appearance over time. Meanwhile, Gurgan *et al.* [24] demonstrated that applying a coat to Equia glass ionomer helps reduce attrition in occlusal cavities. Additionally, Gürses *et al.* [25] reported that the color match of Equia glass ionomer restorations was not as excellent as that of composite resin restorations during the follow-up period, primarily due to the wear of surface-coating agents over time.

2.10. Functional properties

Equiaforte showed good clinical performance due to its high fracture toughness and wear resistance. The material can withstand occlusal forces in posterior teeth and provides good marginal integrity. Its

fluoride release showed the additional benefit of protecting the surrounding tooth structure, which is particularly valuable in high-risk patients. Josic *et al.* [26] showed that the use of encapsulated GIC with glass hybrid technology, which offers enhanced mechanical and physical properties, making it a preferred material for restoring load-bearing areas. Shagale *et al.* [27] stated that Equia Forte demonstrated poor clinical performance after 12 months, primarily due to improper application of the resin coat on the proximal surface, which was difficult to access. This led to inadequate chemical adhesion to the metal matrix band and the formation of micro-crack during band removal. Furthermore, they observed a time-dependent increase in the percentage of cases showing fractures and cracks in the restorations. In contrast, Gurgan *et al.* [24] discovered that the recently introduced nanofilled resin coating enhanced the resistance of the GIC, improving marginal sealing and abrasion resistance. Additionally, Balkaya *et al.* [28] assessed that the loss of glass ionomer material in the proximate area might be linked to the protective resin. They noted that effectively applying the resin coating to the proximal wall of a glass ionomer restoration is particularly challenging due to the difficult accessibility of the proximal area.

2.11. Biological properties

Equiaforte showed low recurrent caries. This may be attributed to its fluoride release properties offer additional protection against secondary caries, making it an excellent choice for patients with poor oral hygiene. Postoperative sensitivity is uncommon, and the material demonstrates outstanding biocompatibility, with no adverse reactions reported in clinical use. Klinker *et al.* [29] demonstrated that

Table 1. Materials used in the study, their composition, manufacturer, and Lot numbers.

Material	Composition	Manufacturer/website	Lot No.
Self-adhesive composite (Surefil one)	Aluminium-phosphor-strontium-sodium-fluoro-silicate glass, water, highly dispersed silicon dioxide, acrylic acid, polycarboxylic acid (MOPOS)	Dentsply Sirona, Konstanz, Germany http://www.shofu.com	2203000118
Thermoplasticized composite (Viscalor)	Bis-GMA, aliphatic dimethacrylate, inorganic fillers	VOCO, Cuxhaven, Germany https://www.voco.dental/us/home	2149506
Hybrid glass system (EquiaForte HTfil and EQUIA Forte Coat)	EQUIAForte HT Fill: powder: fluoroaluminosilicate glass, polyacrylic acid powder, surface-treated glass. Liquid: aqueous polyacrylic acid. (filler content % by weight% by volume) Not available EQUIA Forte Coat: Nano filled resin matrix Combines both conventional & multifunctional MMA photoinitiators.	GC America, Inc http://www.gc.dental.com	2112131
			1507101

Table 2. Comparative evaluation based on FDI criteria.

Criteria	Surefil one	Viscalor	Equiaforte™ HT fil
Esthetic	Good color match, fair translucency, stable appearance [30].	Excellent color match, nature appearance, high gloss	Fair aesthetics, opaquer, improved with coating
Functional	High fracture resistance, good wear resistance, slight concerns with marginal integrity	Excellent fracture and wear resistance, super in margin adaptation [31].	High strength, good wear resistance, fluoride release enhances protection
Biological	Minimal postoperative sensitivity, good biocompatibility [32].	Minimal sensitivity, excellent biocompatibility	Fluoride release, minimal sensitivity

the mechanical strength of GI-based restorative surfaces should be optimized by coating them before being contaminated with water also Gurgan *et al.* [24] demonstrated that the proximal points were weakened in the evolving periods of three and four years as a consequence of cyclic stress, which resulted in occlusal-proximal marginal fracture (Tables 1 and 2).

2.12. Conclusion

When evaluated using the FDI criteria, each of the three bulk-fill materials demonstrated strengths in different areas. Surefil one offers a balanced combination of esthetics, functionality, and ease of use, making it a suitable option for general bulk-fill restorations. Viscolor excellent in both esthetics and functional, making it suitable for cases where both appearance and durability are key concerns. Equiaforte stands out for its biological properties, particularly its fluoride release, which protects patients at high risk for caries.

Ethical information

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Biographical information

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Author's contribution

None.

Conflicts of interest

There are no conflicts of interest.

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