Deep resins, white fillings: A new technique for composite restorations

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Fig. 1

Fig. 1_The SonicFill system consist of a handpiece for delivering sonic energy to a dispensing tip containing a specially formulated resin-based composite.

_Abstract

This article describes a new bulk-fill resin, or deep resin composite, SonicFill (Kerr Corp., USA), possessing fluctuating viscosity by the application of sonic energy. The rationale for the system is explained, together with concerns and the benefits in clinical practice. Deep resins are primarily indicated for white fillings in posterior teeth, but the unique varying viscosity of the SonicFill concept offers other useful clinical applications. Numerous case studies are presented for a variety of clinical situations including replacing defective posterior fillings; core build-ups and retaining fixed orthodontic brackets and retainers.

_Introduction

The use of amalgam for posterior restorations has declined considerably in the last two decades, and continues to do so. The reasons are twofold, first, scientific advances in the development of superior, alternative restorative materials and second, patient wishes.

One of the major concerns about amalgam restorations is cavity preparation, which is both invasive and extensive, undermining the remaining tooth substrate already ravished by disease. Furthermore, placing amalgam restorations without a dentine-bonding agent fails to seal the margins, and is therefore potentially detrimental.

From the patients' perspective, grey fillings are unsightly, especially in mandibular teeth, and usually shunned in favour of tooth coloured "white" restorations. However, the clinical time and cost of these

Fig. 2_Pre-operative lower left mandibular molar showing rampant occlusal decay.
Fig. 3_A round bur is used for judicial decay excavation, leaving deeper decay *in-situ* to avoid accidental pulpal exposure.
Fig. 4_Completed cavity preparation following decay removal, with 90 degrees cavo-surface angles.
Fig. 5_A periodontal probe confirms the cavity depth for ensuring that a single increment of 5 mm of the resin is sufficient to fill the cavity.


Fig. 2


Fig. 3


Fig. 4


Fig. 5

aesthetic white restorations is far greater than the single-step amalgam fillings.

The launch of bulk-fill composites, or deep resins, a few years ago is a sign of the times. The epicurean and prosperous lifestyles of the last two decades are being traded for austerity and frugal constraints. Hence, the introduction of these restorative materials is both timely and fortuitous.


Fig. 6


Fig. 7


Fig. 8


Fig. 9

Fig. 6_The bonding agent, OptiBond XTR primer, followed by the adhesive, is copiously applied to both enamel and dentine, according to the manufacture's instructions.
Fig. 7_The appropriate shade of SonicFill deep resin is dispensed into the cavity using the handpiece, ensuring that the Unidose tip is totally submerged in the material to avoid entrapment of air.
Fig. 8_After the tip is removed, the SonicFill resin regains its high viscosity to allow sculpting, in this instance, a flat shape CompoRoller carving tip is used for creating cuspal inclines.
Fig. 9_A conical shaped CompoRoller carving tip is used for refining occlusal fissures.

Both patients and dentists are forgoing their hedonistic demeanour for asceticism, seeking ways to reduce expenditure while striving to maintain standards. Patients are declining treatment plans that they may have considered prior to the credit crunch, in favour of simpler and cost effective methods for restoring dental health. In addition, dentists are no longer complacent about elaborate treatment plan acceptance, and instead are offering less expensive, timesaving alternatives for achieving health and function, without the opulence of superlative aesthetics. Thus, the bulk-fill deep resins, which offer expediency and reduced treatment cost, are catering for the current economic volatile market.

_Incremental vs. bulk-fill

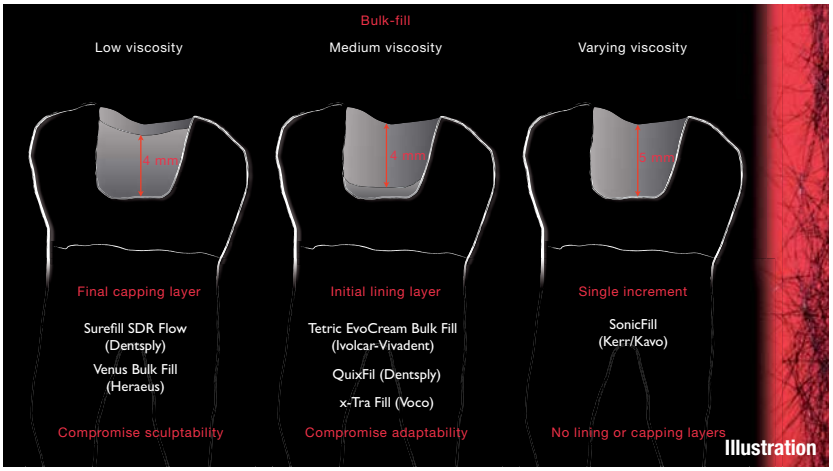
Currently, the options for placing direct tooth coloured restorations are either by the incremental or bulk-fill approach. The rationale for incremental layering is that most universal hybrid composites can only be cured to a depth of 2 mm, and hence consecutive layers are necessary to fill the cavity.[1] Furthermore, successive layers reduce the cavity configuration factor (C-factor) for lowering pulpal deflection[2] and mitigating bond failure[3] following polymerisation shrinkage. In addition, superior aesthetics can be achieved by mimicking the natural dentine and enamel layers with corresponding increments of the RBC and incorporating specific tints and stains. Hence, highly aesthetic restorations with superior anatomical form are possible. However, with contemporary universal hybrid composites possessing low-shrinkage & low-stress,[4] the C-factor and microleakage are less of a concern.[5] The disadvantages of incremental layering is the onerous process with greater probability for introducing porosity between the layers, and the protracted treatment session is reflected by a higher cost for the patient. Furthermore, the initial flowable stress relieving lining is ineffective for reducing cuspal deflection,[6] further questioning the validity of this procedure.

Unquestionably, the incremental approach is ideally suited for anterior restorations where aesthetics are a prime concern, but is it also necessary for posterior restorations? In a recent article, Smales et al.[7] stated that "...clinical technique is the determining factor for success and longevity of composites", and added there has been "...little improvement in the last 30 years!" Therefore, any procedure that simplifies the taxing clinical technique of composite placement is likely to improve predictability and durability of restorations. Consequently, introduction of bulk-fill resins endeavour to expedite direct composite restorations in posterior teeth. The rational of the bulk-fill resins is reducing clinical steps by a filling the cavity in a "single" increment, thereby simplifying the existing incremental technique. This also ensures reduced porosity and uniform consistency restoration, with reduce clinical time and cost for the patient.

At present three types of bulk-fill resins are available, distinguished primarily by their viscosity, which is low, medium or fluctuating. The low viscosity variety offers superior adaptability, while the medium viscosity type is better for carving and sculptability (see schematic representation on the illustration below).

_A utopian composite?

Contemporary resin-based composite filling materials can arbitrarily be categorised as flowable and universal composites. Each variety has unique chemical,



Illustration


Fig. 10


Fig. 11

Fig. 10_Finishing and polishing is accomplished by using various shapes of Opti1Step polishing tips. **Fig. 11**_The post-operative result shows the polished SonicFill deep resin: white filling displaying acceptable aesthetics.

physical, mechanical and optical properties, but the disguising feature between the two composites is their handling properties.

Flowables are low viscosity, offering improved wetability for better adaptation to cavity floors and walls, while the universal composites offer high viscosity allowing optimal sculptability and carving for creating correct anatomical morphology. Hence, the clinician is faced with a catch-22, ideally adaptability is essential, but the slumping sticky flowables are not conducive for shaping.

Conversely, the high resistance to flow of universal composites are ideal for contouring but may create voids within the restoration or the cavo-surface margins due to reduced fluidity. A utopian composite should possess the handling characteristics of a flowable for adaptation, as well as having high viscosity for facilitating sculpting. The SonicFill system resolves this dichotomy.

_The SonicFill system

The SonicFill system consists of a handpiece that dispenses a resin-based composite filling material. The handpiece, designed by KaVo (Biberach), delivers sonic energy at varying intensities, which is adjusted on the shank from low to high (1 to 5) to control rate of composite extrusion. The handpiece fits onto the KaVo MULTIflex coupling and is operated by the universal foot control. The specially formulated deep resin is manufactured by Kerr (Kerr Corp., USA), which incorporates modifiers that react to sonic vibrations to alter the viscosity of the material. The Unidose capsules have smaller diameter 1.5 mm tips for accessing deep cavities, compared to the conventional larger 2.5 mm preloaded tips (PLT). The resin dispensing tips screw directly onto the handpiece head and deliver the composite when activated by the foot control. The sonic energy reduces the viscosity of the resin by 87 % allowing adaptation in deep cavities, up to 5 mm, in a single increment (Fig. 1). After the foot control is released the sonic energy ceases, and the resin returns to its high viscosity state, facilitating sculpting and carving to the desired anatomical form. Another defining feature of this unique deep resin is that it can be light cured to depths of 5 mm (20 seconds for LED units with an output of 800 mW/cm^2) in a single layer. Additional 10 seconds curing from both buccal and lingual sides are also recommended. The final stage is polishing the white filling, which is achieved with appropriate rotary instruments such as OptiDisc & Opti1Step (Kerr, Switzerland)—see case study in Figs. 2–11. Furthermore, the SonicFill resin has greater radiopacity than enamel, allowing easy detection of secondary caries.

_The concerns

As with any new product, there is a degree of scepticism, and inertia for adopting to a new technique and material. Some of the questions asked about the SonicFill system include the following:

Does bulk filling increase polymerisation shrinkage and associated stresses?

A low shrinkage composite is defined as having less than 2 % polymerisation shrinkage.[8] In addition, the stresses associated with volumetric contraction are more significant since they should be lower than the shear bond strength of the dentine adhesive to prevent bond failure and formation of voids at the tooth-resin interfaces.

Some of the older "condensable" composites exhibited excessive stresses during the polymerisation phase causing detachment of the filling material from the cavity walls, resulting in marginal discrepancies and post-

Fig. 12_A molar tooth showing a deep tortuous cavity, ideally suited for restoring with a bulk-fill deep resin, up to a depth of 5 mm with a single increment. **Fig. 13**_The erratic terrain of amorphous shaped cavities are best filled a low viscosity composite for superior adaptation, which can be achieved by temperature or applying sonic energy to a resin-based composite to improve flowability. **Fig. 14**_A Class I cavity with undercuts at its floor for retaining an amalgam filling.


Fig. 12


Fig. 13


Fig. 14

operative sensitivity. Numerous newer low shrinkage resins offer < 2 % contraction, and the highly filled (> 83 % by weight) SonicFill resin has shrinkage of only 1.6 %. Furthermore, the associated reduced stresses of 3 MPa are lower compared to many universal composites, which translates to the positive assumption that gap-free restorations are possible with bulk-fill deep resins.[9]


Fig. 15


Fig. 16


Fig. 17


Fig. 18

Is a "flowable" composite strong enough to resist occlusal forces?

Flowable composites, by definition, are weaker materials due to reduced filler content for lowering the viscosity of the material, and are therefore unsuitable for occlusal load bearing surfaces. Class I, II, and VI cavities require high strength and high wear resistant composites to maintain occlusal morphology.

Research has confirmed that universal composites function adequately under normal occlusal forces.[10] Although SonicFill transiently becomes flowable by applying sonic energy, it is essentially a high viscosity, highly filled composite with a compressive strength of 254 MPa, great than several universal composites.[11] In addition, it displays a bottom to top Rockwell hardness ratio of 86 % making it ideal for resisting occlusal forces.

Can a 5 mm increment be completely polymerised to its full depth?

The maximum thickness recommended for most universal and flowable composites is 2 mm for ensuring adequate bottom to top polymerisation of the resin. The conversion of the monomer matrix to a polymer is primarily dictated by the formulation of the resin material. Nevertheless, many studies have concluded that the depth of conversion of bulk-fill composites is a viable possibility.[12–14]

The greater amount of photoinitiators in the SonicFill composite resin allow a high degree of conversion ratio, more than 86 %, to a full depth of 5 mm (Fig.12). Therefore, the proverbial 2 mm layer thickness is an antiquated guideline for bulk-fill, deep resins.

Are aesthetics compromised using a single monochromatic layer?

Although aesthetics are paramount for the anterior region of the mouth, and indeed, success is often judged by the appearance of the restoration, posterior restorations are not assessed with the same critique. Innumerable clinicians, including the author, have published articles showing beautifully carved posterior composite fillings with intricate fissure patterns and staining that impeccably mingle with the surrounding tooth substrate. From an aesthetic perspective, these immaculate fillings are unquestionably flawless.

However, others frown at such "perfection", stating that it is an exercise in self-indulgence, adding little functional or health benefits, to which a patient is totally indifferent. This is further elaborated by pointing out that patients do not notice this meticulous work or the effort required for achieving these highly aesthetic restorations (especially in maxillary molars). Further criticism is that patients are unlikely to photograph their posterior teeth, enlarge the images, and neither scrutinise nor appreciate the arduous effort for creating such 'masterpieces'.

Fig. 15_A pre-operative defective mesio-occlusal composite restoration in maxillary right molar showing marginal breakdown, ditching and poor occlusal anatomy.
Fig. 16_After removing the filling, a MetaFix (Kerr, Switzerland) matrix band and wooden wedge are placed to shape the filling and obtain a tight proximal contact point, respectively
Fig. 17_A burnisher or LM-Arte Condensa (LM-Instruments Oy, Parainen) is used to adapt the mesial aspect of the matrix band to the distal aspect of the anterior second premolar.
Fig. 18_After applying the bonding agent, the SonicFill deep resin is dispended into the cavity.


Fig. 19


Fig. 20


Fig. 21


Fig. 22

Fig. 19_Once the SonicFill tip is removed, the resin returns to a high viscosity state that is ideal for contouring the resin with a variety of hand instruments. A flat-plastic or LM-Arte Applica (LM-Instruments Oy, Parainen) is used for creating cuspal inclines.
Fig. 20_A LM-Arte Fissura (LM-Instruments Oy, Parainen) is used for defining fissures.
Fig. 21_A carver or LM-Arte Fissura (LM-Instruments Oy, Parainen) is used for shaping the marginal ridge.
Fig. 22_Having sculpted and contoured the resin, the restoration is light cured and ready for finishing and polishing.


Fig. 23


Fig. 24


Fig. 25


Fig. 26

Fig. 23_The post-operative white fillings after shaping with OptiDisc aluminium discs and polishing with Opti1Step silicone tips.
Fig. 24_A large defective amalgam restorations in the right mandibular molar requiring replacement.
Fig. 25_After removing the amalgam filling, extensive decay is precariously close to the pulp, which requires monitoring before proceeding to a definitive indirect restoration.
Fig. 26_A steel matrix bank is placed, and dentine bonding agent applied.

Furthermore, many object to stained fissures, which are perceived as dirty teeth. In reality, patients only desire clean, "white", functioning fillings to alleviate their symptoms. From a clinical standpoint, posterior fillings should possess a hermetic marginal seal to prevent breakdown, and correct anatomical form to restore occlusion.

After all, amalgam fillings, which are blatantly obvious and unaesthetic, have routinely been placed in posterior teeth for over a century without causing a massive revolt from the population. Therefore, offering patients white fillings that are functional and resilient at a fraction of the cost compared to layered restorations is an attractive option, especially in the current economic debacle; and the SonicFill system caters for this niche in the market.

_Benefits

For reasons mentioned above, the dental marketplace has recently been flooded with bulk-fill composites for direct restorations in posterior teeth. However, not all the deep resins for white fillings are identical. The defining features of the SonicFill system are fluctuating viscosity for adaptability and sculptability, single increment bulk-fill & bulk-cure up to 5 mm for expediency, high wear resistance for durability, and a reduced translucency for acceptable aesthetics. These key characteristics result in fewer clinical steps, saving time, reducing cost, improving efficiency, predictability, and longevity of direct posterior composite restorations.

Fluctuating viscosity

Most bulk-fill composites have a fixed, unchangeable viscosity that ranges from medium (e.g. Tetric EvoCeram Bulk Fill, Ivoclar Vidadent, Liechtenstein), to low or flowable (e.g. Surefill SDR Flow, DENTSPLY Caulk, Germany, Venus Bulk Fill, Heraeus, Germany).

A major drawback of universal composites is that their consistency is thick, not conducive for spreading and achieving tight adaptation to cavity walls and floors. Methods such as applying external sonic vibrations and temperature improve fluidity and therefore helps manipulating the composite to "fit" the erratic terrain of cavities (Fig.13). There are numerous external handheld sonic devices for applying vibrations for modelling resins, e.g. Compothixo (Kerr, Switzerland). Whilst these are efficacious for reducing viscosity of a resin, an extra step is added to the already onerous clinical procedure. Lowering viscosity is also possible by thermal means, e.g. heating resin to around 60 °C. However, the time to transfer the composite from the heating apparatus and adapting it to the cavity may cool the material, and hence negate the potential benefit. This is because heat is rapidly dissipated when the resin is placed in a tooth that acts as a heat sink at body temperature of 37 °C, thus reverting the composite viscosity to its unheated state. The SonicFill system overcomes the above two difficulties by lowering the viscosity at the point of delivery by applying internal vibrations to the resin, without the need for heat or external handheld sonic devices.

Another advantage of fluctuation viscosity is that an initial lining, or a capping occlusal layer is obviated. The difference in viscosities of a material, off course, improves its handling characteristics, but it also affects the physical and mechanical properties of the resin. Unalterable, low viscosity bulk-fill resins (e.g. Surefil SDR Flow, Venus Bulk Fill) have lower filler content to confer flowability, which in turn makes the material weaker, requiring a capping occlusal layer with a universal composite to resist occlusal forces. Conversely, with medium viscosity materials (Tetric EvoCeram Bulk Fill), an initial flowable composite layer is necessary as a lining for better adaptation to the cavity walls. Similar to stratification with a universal composite, applying an initial low viscosity layer may introduce incremental voids and therefore compromise the integrity of the restoration.

Fig. 27_A coronal build-up using SonicFill resin to review and monitor the endodontic status prior to providing a definitive indirect restoration.
Fig. 28_Two months later the tooth was symptomless, and the SonicFill core is trimmed back for an indirect ceramic inlay.
Fig. 29_An impression is taken using a polyvinyl siloxane impression material Take1 (Kerr Corp., USA) and forwarded to the dental laboratory for fabricating a ceramic inlay.


Fig. 27


Fig. 28


Fig. 29


Fig. 30


Fig. 31


Fig. 32

Fig. 30_A palatal cusp fracture on a maxillary premolar with endodontic involvement.
Fig. 31_The lost palatal cusp is built-up with SonicFill resin to isolate the tooth from oral fluids before preparing an access cavity for root canal therapy.
Fig. 32_A fractured maxillary first premolar at the level of the gingival margin.

Bulk-cure

Bulk-fill, fixed viscosity composites such as Quixx and Surefil SDR Flow, Tetric EvoCeram Bulk Fill, Venus Bulk Fill, and x-Tra Fil (VOCO) offer a depth of cure of only 4 mm. In contrast, SonicFill is a true bulk-fill resin with a higher depth of cure up to 5 mm, compared to analogous products.

Strength and longevity

The survival of a composite, especially in the posterior regions, is determined by its ability to resist occlusal loads and maintain its anatomical form. Another advantage of the SonicFill resin is that due to its favourable strength, a capping occlusal layer is obviated, and research has confirmed that the high flexural strength (186 MPa) and compressive strength (254 MPa) of the SonicFill composite is comparable, or even great than several conventional universal composites.[15]

Reduced translucency

In order to achieve a greater depth of cure, many bulk-fill deep resins are highly translucent to allow the curing light to sufficiently penetrate to the bottom of a single incremental layer. Unfortunately, the increased inherent translucency of materials such as QuiXFil compromises aesthetics by having a greyish appearance due to low value, which is unsightly and readily noticeable. On the other hand, the SonicFill resin is relatively opaque and available in a variety of VITA shades, A1, A2, A3 and B1 and when appropriately polished, yields acceptable aesthetics.

_Clinical applications

The salient feature of the SonicFill system is fluctuating viscosity, and in clinical practice, varying viscosities offer vast versatility. In addition, the expediency for the provision of posterior white fillings is particularly beneficial for patients with limited compliance, such as the elderly or medically infirm who cannot endure protracted sessions for incremental layering, fissure staining and are satisfied with mediocre aesthetics. The clinical applications of SonicFill include posterior white fillings, coronal or core build-up, and cementing orthodontic brackets and fixed retainers.

Posterior fillings

The obvious use of a bulk-fill deep resin is resorting Class I, II and VI cavities in posterior teeth. These can either be new fillings or those that require replacement due to defective margins, marginal ditching, wear, poor morphology or bulk fractures, which applies to both failing amalgam and composite restorations. In order to retain an amalgam filling, creating undercuts are necessary (Fig. 14). However, after removing the offending amalgam filling, the remaining undercuts require obliterating to seal the cavity floor. This can be accomplished by reduction of the axial walls to remove the unsupported enamel, which is destructive and unnecessarily. An alternative method for obliterating the undercuts is sealing them by exploiting the initial low viscosity of the SonicFill resin, which flows into the undermined areas to preserve existing tooth substrate.

All composite resin fillings are particularly susceptible to hydrolytic degradation over time. This causes ditching, microleakage, loss of contours or even catastrophic fracture, which can result in sensitivity, secondarily caries or endodontic complications. Replacement of old defective composite fillings with SonicFill is effortless and straightforward to restore occlusal form, provide


Fig. 33


Fig. 34

Fig. 33_Following root canal therapy, two fibre posts are placed to retain a core build-up.
Fig. 34_A core build-up using OptiBond XTR with SonicFill resin for supporting a definitive crown.


Fig. 35


Fig. 36

Fig. 35_Fixed orthodontic brackets can be accurately located and precisely cemented with SonicFill resin.
Fig. 36_Lingual orthodontic wire retained by correctly contoured (non-bulbous) resin, without impingement of the gingival margins for improved oral hygiene and periodontal health.

a hermetic seal to alleviate symptoms, and prevent future complex treatment (see case study in Figs. 15–23).

Coronal or core build-up

A gross loss of dentine and enamel is usually due to caries, tooth wear or trauma. In each of these circumstances, the objectives are building up the lost coronal substrate for restoring structural integrity, a foundation for a subsequent definitive restoration and preventing ingress of bacteria and oral fluids. The SonicFill resin, possessing high flexural strength, compressive strength, hardness, and reduced volumetric contractions together with a profound depth of cure is proficient for achieving these objectives.

For vital teeth that have extensive failing or fractured restorations, a coronal reconstruction serves as a long-term restoration, possibly for reviewing endodontic status and monitoring tooth vitality before the provision of a final restoration (Figs. 24–29). In addition, acute traumas causing cuspal fractures with pulpal exposure, necessitating root canal therapy, a core build-up acts to retain a rubber dam clamps for isolation during endodontic therapy (Figs. 30 & 31). Finally, for root treated teeth, intra-radicular posts can be used for building up a core with SonicFill resin for supporting an eventual crown (Figs. 32–34).

Retaining orthodontic brackets and fixed retainers

Fixed orthodontic therapy involves cementing orthodontic brackets with a resin cement or flowable composite. Because the latter possesses low viscosity, this presents a challenge for accurate location of the brackets. Furthermore, the inherent low viscosity of cements and flowables reduces thixotropic properties and makes removal of excess unset material a tedious chore. Although this is not officially included in the indications recommended by the company, the SonicFill resin resolved these problems since its dispensing tip delivers a small amount of material exactly where needed.

In addition, the initial low viscosity of the resin allows precise adaptation to the enamel surface, and when its viscosity increases, the brackets can be accurately positioned and excess material removed with ease before light curing. This substantially reduces clinical time, and avoids inadvertent damage to the surrounding enamel by scraping with hand or rotary instruments, or laceration of the gingival tissues during removal of excess set cement or flowable composite (Fig. 35).

Similarly, fixed orthodontic retainer wires can be accurately positioned on the lingual or palatal surfaces, and the highly viscous SonicFill unset excess resin removed prior to light curing. This avoids the frequently encountered lingual or palatal bulbosity associated with surplus composite around retainer wires (Fig. 36). Finally, since the SonicFill resin is precisely adapted to the retainer wire, inadvertent impingement of the gingival margin is mitigated, thus improving access for oral hygiene procedures, and preventing inflammation of the gingival margins.

_Conclusion

Bulk-fill, deep resins, provide an expedient and cost effective solution for posterior direct restorations where aesthetics are not a paramount concern. The SonicFill system offers the best of both worlds; adaptability of a flowable and the sculptability of a universal composite with the added benefit of 5 mm depth of cure in a single increment. Deep resins: white fillings, delivered with simplicity and efficiency. In addition, the favourable mechanical properties of the SonicFill resin and its fluctuating viscosity allow other clinical applications such as core build-ups and retaining orthodontic fixed brackets and appliances. Finally, it is not inconceivable that future varieties of bulk-fill deep resins may incorporate self-etching bonding agents that would obviate the need for a prior bonding protocol, and thereby further simplifying and reducing clinical steps._

Editorial note: A complete list of references is available from the publisher.

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