Simplifying composite placement in the interproximal zone

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Introduction

Understanding the importance of particle size and shape in the utilisation of new composite resin formulations with techniques to optimise the materials' properties allows the clinician to attain predictable and pleasing aesthetic results.

In the past, when utilising composite resin material to achieve a restorative result with optimal physical and mechanical characteristics, it often required the use of a combination of hybrid and microfill. The hybrid provided the strength and sculptability and the microfill furnished the polish and durability of the restoration.

Layering techniques were developed for use with smaller increments of composite resin material to improve and optimise the depth of cure while reducing the effects of shrinkage and stress forces during the polymerisation process (Tjan, Glancy, 1988; Kovarik, Ergle, 1993). Yet, when different restorative composites of varying refractive indexes, shades and opacities were stratified, clinicians observed a 'polychromatic effect' (Dietschi, 1995). However, by utilising an anatomic stratification with successive layers of dentine, enamel and incisal composite, a more realistic depth of colour could be achieved, as well as surface and optical characteristics that mimic nature (Jefferies, 1998; Donly, Browning, 1992).

The improvements in the restorative quality and aesthetic result that have developed from the inequities of these different composite resin systems (hybrid and microfill), in conjunction with the use of innovative placement techniques to optimise the materials' properties, have stimulated scientists, researchers, clinicians and manufacturers to explore and develop new nanoparticle formulations of restorative biomaterials. Materials that are not only applied in relationship to the natural tissue anatomy, but that have physical, mechanical, and optical properties similar to that of tooth structure.

Nanotechnology

Nanotechnology, or molecular manufacturing, may provide the crucial information for determining how to best utilise

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Figure 1

the composite materials (Kirk et al, 1991). By understanding how the actual size and shape of filler materials influences the mechanical and physical properties of the material, the potential for improved adhesion and the clinical success of the restoration is increased.

Composite resin with filler particle size that is dramatically smaller in size can be dissolved in higher concentrations and polymerised into the resin system with molecules that can be designed to be compatible when coupled with a polymer, and provide unique characteristics (physical, mechanical, and optical).

In addition, optimising the adhesion of restorative biomaterials to the mineralised hard tissues of the tooth is a decisive factor for enhancing the mechanical strength, marginal adaptation and seal, while improving the reliability and longevity of the adhesive restoration. Currently, the particle size of many of the conventional composites are so dissimilar to the structural sizes of the hydroxyapatite crystal, dental tubule and enamel rod, that there is a potential for compromises in adhesion between the macroscopic (40nm to 0.7um) restorative material and the nanoscopic (1 to 10 nanometers in size) tooth structure (Muselmann, 2003). However, nanotechnology has the potential to improve this continuity between the tooth structure and the nanosized filler particle and provide a more stable and natural interface between the mineralised hard tissues of the tooth and these advanced restorative biomaterials.

A nano-hybrid flowable composite resin system (G-aenial Universal Flo, GC America) may possess these improved physical, mechanical and optical properties. These properties and the clinical behaviour of this biomaterial formulation is contingent upon its structure. This resin filler technology allows a higher filler loading because of the fine filler size, uniform shape and distribution of particles. This resin filler chemistry allows the particles to be situated very closely to each other and the reduced interparticle spacing and homogeneous dispersion of the particles in the resin matrix increases the reinforcement and protects the matrix (Bayne, Taylor, Heymann, 1992; Turssi, Ferracane, Vogel, 2005; Lim et al, 2002).

In addition, the proprietary chemical treatment of the filler particles allows proper wettability of the filler surface by the monomer and thus an improved dispersion and a stable and stronger bond between the filler and resin. Research studies clearly indicate the significance that filler content and

Figure 2a

Figure 2b

Figure 2c

Figure 3a

Figure 3b

Figure 4a

Figure 4b

Figure 5a

Figure 5b

coupling agents represent in determining characteristics such as strength and wear resistance (Lim et al, 2002; Venhoven et al, 1996; Condon, Ferracane, 1997; Beatty et al, 1998). Recent studies report that flowable composites have comparable shrinkage stress to conventional composites (Baroudi, Silikas, Watts, 2008; Cadenaro et al, 2009; Gallo et al, 2010).

According to the manufacturers, this next generation flowable resin formulation is purported to offer mechanical, physical and aesthetic properties similar or greater than many conventional hybrid composites (Yamase et al, 2010).

The clinical attributes of the material include improved adaptation to the internal cavity wall with easier insertion and manipulation, increased wear resistance and enhanced polishability and retention of polish. They also show greater elasticity and colour stability as well as a radiopacity similar to enamel.

Simplifying the application technique

Adhesive procedures require properly integrating multiple interrelated steps during the restorative process, which increases the potential for error. Restorative complications

Figure 6a

Figure 6b

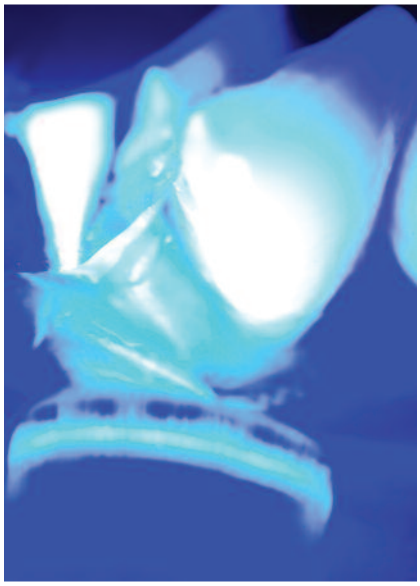

Figure 6c

and compromised clinical results can occur from improper placement of these adhesive materials. Although not scientifically proven, logic dictates that reducing the possibility of error by simplifying the application of materials should improve the restorative result and the quality of the restoration.

The following clinical presentation describes a simplified technique utilising a next generation nanoparticle flowable composite resin (G-aenial, GC America) to restore the interproximal zone.

Restoring the interproximal zone

Restoring the interproximal zone with composite resin restorations using conventional hybrid composites has always presented challenges. Improper placement of these viscous composite materials can result in gaps, voids and deficient marginal seal at the restorative interface. However, by utilising a modified self-etch technique and a simplified placement of a next generation flowable an ideal tooth-restorative interface can be achieved.

The patient presents with interproximal caries on the mesial aspect of the mandibular left lateral incisor (Figure 1). After radiographic evaluation (Figure 2a), a shade comparison was performed prior to the restorative procedure (Figures 2b and 2c). The dehydration of the tooth from water molecules being depleted from the enamel rods can result in improper shade matching.

Once anaesthesia had been administered to the patient, the tooth was isolated with a dental dam to protect against contamination, using a modified technique. The technique involved the creation of an elongated hole that allowed placement of the dental dam over the retainers to achieve adequate field control and protect against contamination (Croll, 1985; Liebenberg, 1994). The caries was removed with a #2 high-speed round bur (#2 round bur, Brasseler USA), which produces rounded line angles (Figures 3a and 3b). The outline form was as conservative as possible without removing healthy tooth structure unless dictated by caries. The axial line angles may vary in pulpal depth with the thickness of the enamel portion of the external walls and the axial wall will be outwardly convex, following the normal external tooth contour and the DEJ, both inciso-gingivally and facio-lingually (Sturdevant, 2002).

To allow for a better resin adaptation, all internal line angles were rounded and cavity walls made smooth. Sufficient retention for composite is achieved primarily by micromechanical adhesion to the surrounding enamel and underlying dentine and it is not necessary to produce an undercut in the preparation (Sturdevant, 2002). A circumferential bevel is placed in enamel using a tapered diamond bur (Figures 4a and 4b). An enamel bevel is indicated because it increases the surface area for end-on etching of the enamel rods for an increased etched surface, resulting in a stronger enamel to resin bond, which increases the retention of the restoration and reduces marginal leakage and discolouration (Sturdevant, 2002; Oilo,

Figure 7

Jorgenson, 1977; Lorton, Brady, 1981). Also, placement of a cavosurface bevel improves the aesthetic integration of restorative material with the colours of the surrounding tooth structure (Sturdevant, 2002; Oilo, Jorgenson, 1977; Lorton, Brady, 1981; Sturdevant, 1995).

However, the cavosurface is not bevelled if little or no enamel is present or access is difficult for finishing procedures. A gingival bevel is not recommended if the preparation extends gingivally on to root structure or is of poor enamel quality. In addition, bevels are not placed on lingual surface margins that are in areas of centric contact or subjected to heavy occlusal forces, because composite has a lower wear resistance than enamel for withstanding heavy occlusal forces (Sturdevant, 2002). Thus, bevelling should be performed on class III preparations when there is adequate enamel present because it increases the potential for bonding, however it should not be placed on margins in the occlusal contact zone.

Bevelling increases the fracture resistance by increasing the bulk of the restoration, increases the bonding surface area, and decreases microleakage and marginal discolouration (Welk, Laswell, 1976) by exposing the enamel rods for etching (Lorton, Brady, 1981; Craig, 2001). The preparation was cleaned with a 2% chlorhexidine solution (Consepsis, Ultradent, South Jordan, UT), rinsed and lightly air-dried.

A dead metal matrix was placed and secured in the interproximal zone and a selective enamel etch procedure was performed. The prepared and unprepared enamel was etched with a 37.5% phosphoric acid gel (GEL Etchant, Kerr/Sybron, Orange, CA) for 15 seconds and rinsed for five seconds (Figures 5a and 5b). A self-etch adhesive (G-aenial Bond, GC America) was placed on the enamel and dentine surfaces with an applicator tip for 10 seconds, air-dried for five seconds using an A-dec warm air tooth dryer and light-cured for 10 seconds (Figures 6a, 6b, 6c). The dead metal matrix was replaced with a mylar plastic strip in the interproximal zone to confine and adapt the composite material to the tooth surface. The mylar strip produces a smooth surface (Chung, 1994) while maintaining the anatomical contour during the polymerisation process (Figure 7).

A bleach shaded flowable composite material (G-eanial Universal Flo, GC America) was injected into the preparation and the syringe tip was slowly removed while extruding the material. The mylar strip was firmly adapted to an ideal contour and light cured for 40 seconds using a ramp mode (Figures 8a-8e).

The material is thixotrophic; this property allows the material to structurally breakdown so it flows through the syringe tip when the material is stressed, then the hydrogen bonding restructures and it becomes more viscous (Craig, 2001). Uno and Asmusen (1991) suggest that using a slower polymerisation causes an improved flow of molecules in the material while decreasing the polymerisation shrinkage stress in the restoration.

Figure 8a

Figure 8b

Figure 8c

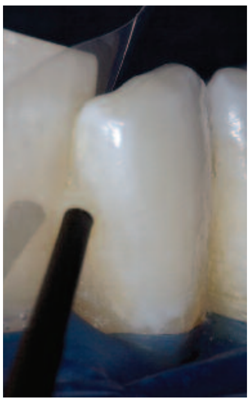

Figure 8d

Figure 8e


Figure 9


Figure 10a


Figure 10b


Figure 10c


Figure 11

The mylar strip was removed and the interproximal region was inspected for any residual composite resin tags or overhangs. The excess residual resin was removed with a surgical blade (#12 BD Bard-Parker, BD Medical) (Figure 9). The proximal surfaces were cleaned and smoothed with a loose abrasive diamond polishing paste, which was carried into the interproximal region with finishing strips (Figures 10a, 10b, 10c). The proximal surface was inspected for adequate contact with unwaxed floss prior to removing the dental dam (Figure 11).

After the dam was removed, a definitive lustre and surface reflectivity was accomplished with a goat-hair wheel and diamond polishing paste using an intermittent staccato motion (Figure 12). This restorative procedure demonstrates the optimal aesthetic results that can be achieved in the interproximal zone through proper adhesive protocol and a simplified application of flowable composite resin (Figure 13).

Figure 12

Figure 13

Conclusion

The continual development of new technology changes and, hopefully, improves, the practice of dentistry. Understanding the importance of particle size and shape in the utilisation of new composite resin formulations with techniques to optimise the materials' properties allows the clinician to attain predictable and pleasing aesthetic results. Although the long-term benefits of this material remain to be determined, the utilisation of an optimised nanoparticle flowable composite in the aforementioned patient demonstrated enhanced sculptability, the polishability of a microfill, the strength of a hybrid, and the ability to simulate the optical properties of the natural tooth. Through continued advancement in clinical and material research, refinements in formulations will continue to improve.

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