The technological advancements from dental material research have provided the restorative dentist with a myriad of opportunities through developments in material science and adhesive technology. The use of direct and indirect systems for the intracoronal restoration of posterior teeth has increased dramatically with the improvements in physical and mechanical properties of these systems and patient demand for tooth-coloured restorations. Direct composite resin restorations and laboratory processed inlays fabricated with porcelain or composite resin represent an aesthetic restorative solution for intracoronal restorations. Modern adhesive restorative materials and techniques allow preservation of remaining tooth structure, conservation of tooth structure during preparation while reinforcing the remaining tooth structure and improving the longevity and aesthetics of the restoration. Each of these systems (i.e. direct, indirect composite and porcelain) can provide precise marginal integrity, ideal proximal contacts, wear resistance similar to tooth structure, reduced polymerisation shrinkage, excellent anatomical morphology and optimal aesthetics (Howard, 1997; Touati, Aidan, 1997).

Since all of these restorative systems can provide predictable clinical results, a discussion of the consideration factors for their use and comparison of the attributes and capabilities of each will allow for proper case selection by the patient, technician and restorative dentist. As patients seek conservative treatment that is biocompatible, durable, safe, and aesthetic, increased use of composite resin materials for the direct restoration of the posterior dentition has drawn more attention to technological advances in the field. In the past, composite resins were limited by low wear resistance to abrasion, colour variation, increased polymerisation shrinkage, low flexural strength, low modulus of elasticity and a high incidence of fracture. Therefore, the uses of these direct systems were limited to smaller restorations. Newer formulations in filler size, shape, composition, and concentration have significantly enhanced the physical, mechanical and optical properties of these resin systems and increased their use in medium to larger restorations.

**Consideration factors for use of direct composite**

The integrity of the bond and the marginal adaptation to the tooth structure are critical for clinical success in posterior composite restorations (Bouschlicher et al, 1999). 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. The search for a tooth-restorative interface to mimic the natural tooth condition has resulted in establishing an effective micromechanical bond between composite and mineralised tooth structure. These advances in adhesive restorative biomaterials by clinicians and manufacturers have resulted in adhesive restorations that provide increased retention, marginal adaptation and seal and reduced microleakage. This evolution in the development of adhesive dental technology, with adhesive materials and techniques has dramatically changed the limitations of directly placed composite restorations.

There are several consideration factors for the use of direct composite resin in medium to larger restorations that include: polymerisation shrinkage, anatomical morphology, and cavity dimension and preparation.

**Polymerisation shrinkage**

In a restorative procedure using composite resins, the polymerisation reaction of the resin matrix phase can compromise dimensional stability (Davidson, Feilzer, 1997). This conversion of the monomer molecules into a polymer network is accompanied with a closer packing of the molecules, leading to bulk contraction (Venhoven et al, 1993). Alternatively, when a curing material is bonded on all sides to rigid structures, bulk contraction cannot occur and shrinkage must be compensated for by increased stress, flexure or gap formation at the adhesive interface (Davidson, Feilzer, 1997). The shrinkage stresses are transferred to the surrounding tooth structure, since it restricts the volumetric changes (Venhoven et al, 1993). The factors that

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Influence polymerisation shrinkage include: type of resin, filler content of the composite (Venhoven et al, 1993) elastic modulus of the material, curing characteristics (Oullet 1995), water sorption, cavity configuration (Feilzer et al, 1987), and the intensity of the light used to polymerise the composite (Feilzer et al, 1995).

Although polymerisation is the cause, shrinkage stress may be the mechanism for the clinical challenges with adhesive restorations in clinical dentistry (Davidson, Feilzer, 1997). These include: microleakage, marginal breakdown fractures, secondary caries, inadequate marginal adaptation, staining, pulpal irritation, post-operative sensitivity, and possible endodontic therapy (Bausch et al, 1982).

To overcome these clinical challenges of direct resin composite posterior restorations, several methods for stress reduction can be considered when selecting restorative materials that are subject to shrinkage. These include application of liners and bases that act as shock absorbers, selective bonding in appropriate cavity configurations, reduction of light intensity from curing units (Feilzer et al, 1995) using a combination of selective bonding and incremental layering of small increments of composite resins and selection of low-shrinkage composite resin systems (Asmussen, 1975).

**Anatomical morphology**

The restorative dentist should develop an anatomical morphological thinking process that can integrate traditional concepts of function and form with knowledge of colour and anatomy when developing direct composite restorations. Recent innovations in armentarium and procedures have resulted in the use of directly bonded restorative materials to re-establish function, shape and contour of the teeth, colour (hue, value, and chroma), natural light transmission, and to recapture strength and aesthetics through conservative adhesive tooth preparation design. In the past, there was difficulty encountered by clinicians in achieving precise marginal integrity, ideal proximal contacts and anatomical contours for larger cavity preparations. Advances in proximal contouring devices (i.e. sectional matrices) and improved sculptability of the small particle hybrid composites have complemented incremental layering techniques (i.e. horizontal, vertical and oblique layering techniques) and light curing methods (i.e. three-sited light-cure method). This has resulted in improved proximal contact, elimination of overhangs, ideal tooth contours, minimising or eliminating excess resin at the proximal line angles, improved marginal integrity and a reduction in microleakage at the gingival margin.

In addition, the clinician may also be able to determine from

![Figure 1: For the use of direct composite resin in medium to larger cavity preparations the clinician should consider polymerisation shrinkage, anatomical morphology, and cavity dimension and preparation](image)
the pre-operative environment the following: anatomic morphological details, such as developmental grooves and the shape of embrasures, as well as prominences, convexities, facets, angles, plane areas, or any other characteristics that can provide helpful information when reconstructing the tooth surfaces. Also, a hand drawn occlusal diagram can be made prior to administering anaesthesia and rubber dam isolation, allowing the pre-operative occlusal stops, wear facets, and excursive guiding planes to be recorded with articulation paper. Initial occlusal registration is valuable in preparation design when considering placement of centric stops beyond or within the confines of the restoration, and in minimising occlusal adjustments and finishing procedures (Liebenberg, 1996).

Cavity preparation and dimension
Tooth preparation for direct composite restorations differs from the laboratory-processed inlay (i.e. composite, porcelain). The preparation design is based on knowledge of the physical and mechanical properties of these new restorative biomaterials and clinical experience. Since resistance and retention are determined primarily by adhesion to enamel and dentin, a more conservative preparation is achievable (Robbins et al, 1996). A conservative preparation design can be used because the adhesive procedure strengthens the cusps and provides additional support for the dentition. The direct composite preparation design preserves sound tooth structure and requires no extension for prevention. The preparation is limited to access to the defect, removal of existing caries and pre-existing restoration and requires less volume to resist clinical fracture than a metallic restoration (i.e. amalgam) or laboratory processed inlay (i.e. composite, porcelain). The cavity dimension for medium to larger occlusal and approximal cavity preparations for direct composite restorations can be more conservative than laboratory processed inlays because the preparation does not require the removal of undercuts for proper path of insertion and adaptation to the cavity walls. In addition, the direct placement method can be used with minimal preparation because it uses the undercuts and surface irregularities to increase the surface area for bonding. This conservation of dentin and the reinforcement of tooth structure with composite resin reduce the possibilities of tooth fracture during function or in the event of traumatic injury (see Figure 1).

There are clinical situations in which the patients present with the desire to have tooth-coloured restorations, but are financially unable to accept the clinician’s ideal recommendations (i.e. indirect onlays or porcelain crowns). These larger dimension occlusal and approximal cavity preparations can be restored as transitional restorations. This restoration is defined as one that will serve as an intermediate procedure but has the potential for longevity in specific clinical situations (i.e. areas of low occlusal stress and where there is minimal potential of tooth flexure). The transitional restoration uses the aforementioned methods of stress reduction, anatomical morphological development, adhesive preparation design and the application of polyethylene reinforcement fibres (Ribbond, www.ribbond.com; Construct, www.kerrhawe.com).
These reinforcement fibres are adapted as close to the tooth surface as possible and the presence of the glass or polyethylene network creates a change in the stress dynamics at the restoration/adhesive interface. The network of fibres provides multiple stresspaths for redistribution of imposed load to intact portions of the teeth, and away from the bonded surfaces. This fibre insertion significantly increases the fracture strength and resistance to microcracking while decreasing shrinkage and creep, reduces the poison effect and reduces the C-factor of the restored tooth (Belli et al, 2005) (see Figure 2). The transitional restoration can provide increased mechanical strength, marginal adaptation and sealing, and restoration retention that will improve the reliability and longevity of this type of restoration in comparison to the core build-up.

From the wide range of restorative biomaterials, direct composite resin systems provide an aesthetic alternative for intracoronal posterior restorations. The clinical attributes include:

- Can be completed in one appointment
- No impression or provisional is required
- The operator has total control of the restorative process and the surrounding dentition for comparison (see table).

**Advantages of direct composite bonding**

- Completion in one appointment
- Minimal preparation
- Clinician has total control over technical process
- No impressions, no lab fee, provisionals not required
- The aesthetic results are enhanced with surrounding dentition for comparison

**Conclusion**

While new products and technological advances impact our profession positively, a new burden rests on clinicians to continually educate themselves on the properties and applications of the new materials. Use of direct composite resins with the aforementioned consideration factors should be employed to complement (Touati, Aidan, 1997) our existing clinical repertoire. Part two of this discussion will address the consideration factors for the use of laboratory processed composite and porcelain intracoronal restorations and provide a comparison of the attributes and capabilities of each system.

**References**


