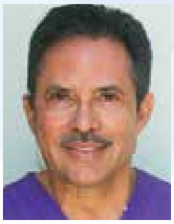
by Dr. Isaias Íñiguez



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Can We Fix It?

An in-depth look at cusp replacement using composite, pins and polyethylene fibers

Introduction

This article suggests blending two different techniques—titanium pins with high-strength polyethylene fibers—within one procedure. Using the different reinforcing architectures is beneficial to matching substrate properties and ensures retention of restorative material. They reduce stress and provide an even distribution of force throughout mastication.

Case study No. 1

A 55-year-old male patient had chief complaints of a broken tooth and hypersensitivity in the mandibular lower right side. He also presented a fractured amalgam with a missing distobuccal cusp of the first molar. He requested to have the restoration done within one appointment.

Materials, methods and results

To provide the adequate strength to sustain the masticatory forces and fractures, a titanium pin was inserted following the adhesive procedures. To reduce microleakage, a composite was incrementally placed, with reinforcement of the polyethylene fiber layers well adapted between increments.

When the patient returned a year later, the restoration was in very good condition. In this particular situation, a direct reinforced composite restoration was the optimal choice because it may have some advantages over other conventional approaches.

Clinical significance

Posterior cavities needing a cusp replacement are usually treated with laboratory-fabricated onlays, direct/indirect restorations, or crowns. This case demonstrates immediate cuspid reconstruction, optimizing the potential of direct posterior composite restorations. When used correctly, this has many advantages over other restorative methods.

For more than four decades, composites have been used in posterior teeth; unfortunately, the initial clinical performance of the first posterior composites weren't ideal.[1] These days, composites have improved their physical, mechanical and adhesive properties,[2] but wear and marginal leakage remain a concern.[3] Recent long-term clinical evaluations demonstrate that composites are an acceptable alternative for posterior teeth within certain clinical parameters.[4,5] If clinicians are adequately skilled and familiar with most of the adhesive dentistry secrets, then they will extend the indication for direct restorations into a more destroyed tooth.[6]

The placement of a Class II composite restoration is often associated with undesirable effects of shrinkage such as an interfacial gap formation.[7,8] Sometimes, because of composite shrinkage, the material pulls away from the cavity wall during polymerization.[9,10] This may contribute to a microgap formation, which permits the entry of bacteria and oral fluid[11,12] and results in hypersensitivity and staining of the margins and recurrent caries.[13]

***Fig. 1:** A patient presents with a large amalgam Class II failure in the mandibular first molar with a fractured distobuccal cusp. While an onlay or crown is probably the restoration of choice, a direct resin was chosen because of the patient's time constraints.*

***Fig. 2:** The one-time-use Max pin latch type came in a sealed plastic container. Place the pin into a low-speed handpiece.*

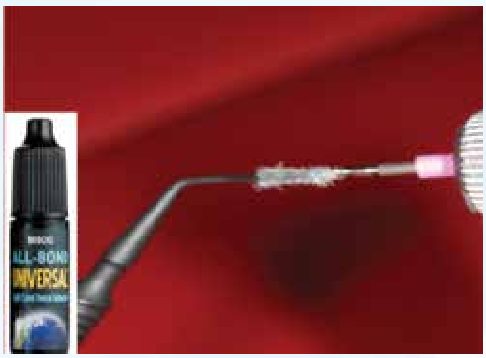

***Fig. 3:** All-Bond Universal primer from Bisco (10 micros) is applied to the Max pin.*

Early investigations on the durability of resin–dentin adhesion found decline over time. Tooth–resin adhesion may degrade by chemical and physical stress.[14] However, the mechanism of the decrease in bond strength was unknown until it was published in 2004. As a result of long-term exposure in a humid environment, the hybrid layer degrades, and the dentin–adhesive resin bonds weaken.[15] If there is a presence of sclerotic dentin, the bond strength significantly decreases.[16]

A fabricated indirect restoration laboratory (onlay or crown) is considered the treatment of choice when a cusp is lost.[17] CAD/CAM technology can also be applied for inlays and onlays.[18] Both alternatives offer advantages and disadvantages, and both are complex and expensive treatments. Crowns are highly invasive, and can be pricey as well. The full-coverage crown should always be the last treatment option, because it is the most invasive and traumatic restorative procedure.[19]

Many crowned teeth could have been restored with less aggressive restorations.[20] Direct options such as composite or amalgam restorations are acceptable, with both being a single-appointment procedure and having a similar prevalence in cusp fracture.[21] Amalgam has long history of use with clinical success, and has been an effective restorative material for Class I and Class II preparations. However, its use has declined because patients and clinicians preferred aesthetic, adhesive, mercury-free restorative materials.[22]

Data supports that glass fiber-reinforced composite increases the fracture resistance of weakened marginal ridges in molar teeth.[23] Fibers also increase the damage tolerance of a tooth; they can be used to provide additional support to weakened cusps and to span cracks.[24] In applications such as cuspid reconstruction, multidirectional reinforcement can arrest cracks and prevent their propagation in the cervical direction.[25] As shown in literature, dentin pins increase shear resistance of extensive composite restorations.[26]

Composite restorations may be the optimal choice because of their conservative preparation and aesthetics. Using pins and high-strength polyethylene fibers is another alternative. They offer an efficient load distribution and also make its structure extremely impact-resistant. This results in a successful aesthetic integration of the restoration.

In the late 1950s, the introduction of practical instrumentation use for stainless steel pins resulted in their extensive use in dentistry.[27] Pins in dentistry are indicated as additional aids of retention in badly broken-down or mutilated teeth. They are especially needed when one or more cusps need capping and when increased resistance and retention form are needed. With 5-year-old amalgam fillings, there was no difference in the performance of pin-retained amalgam and bonded amalgam.[28]

Case study No. 2

A 62-year-old patient in good general health presented with sensitivity in the right side of his mouth. The clinical exam revealed a mandibular right first molar with an extensive amalgam fracture and a missing distobuccal cusp (Fig. 1). The procedure was performed with a rubber dam to achieve total isolation. This technique is essential[29] and no other isolation method provides better control over oral fluids and moisture contamination.[30]

After completing the preparation of all internal angles, they must be rounded to reduce stress concentration[31] and improve the adaptation of composite resin to the dental structure. No bevels were placed on the occlusal or gingival margins. It is suggested to use one pin per missing cusp[32]; in this case, only one was needed. Displaying enough room from the base to the cusp tip (4mm) is crucial for the placement of the pin. Sufficient dentin is necessary to attain adequate strength to avoid external fractures of the tooth structure and to protect the pulp. Once the channel location is decided, a pinhole guide is formed with a ¼-round bur (slow speed) in dentin, 1.5mm on the external surface. The Max 021 system of pins from Coltene/Whaledent (Fig. 2) was used in this case.

Using a pilot drill, with a slow-speed contra angle, a pinhole was prepared until the drill shoulder came to a stop. The channel preparation was done to full depth and a pin was inserted into the handpiece and covered with primer adhesive from Bisco (Fig. 3) while operating at very low speed with light pressure until the pin sheared and the placement was completed (Fig. 4).

Every surface is microetched with 35 microns aluminum oxide (Crystal Air by Crystalmark Dental Systems). Two percent chlorhexidine (Cavity Cleanser by Bisco) was used to disinfect the preparation and it was then dried with light air. A selective-etch technique was chosen and phosphoric acid (Select HV Etch by Bisco) was applied on the enamel for 15 seconds (Fig. 5, p. 86), then rinsed thoroughly and dried. Then, OptiBond XTR primer (Kerr) was applied by scrubbing with moderate pressure for 30 seconds (Fig. 6, p. 86). The adhesive from OptiBond XTR was used with gentle agitation for 15 seconds (Fig. 7, p. 86), followed by a warm air dry to thin out the layer and evaporate the solvent.

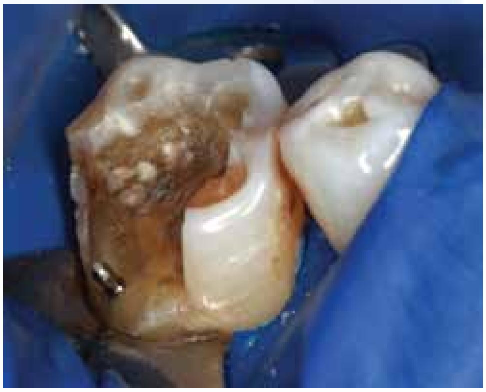

Fig. 4: *Rubber dam has been positioned after the amalgam was removed. (Note the access to the gingival extent of the fractured cusp.) During the pin placement, use a very low speed and slight pressure downward until the pin shears. This means the pin placement has been completed.*

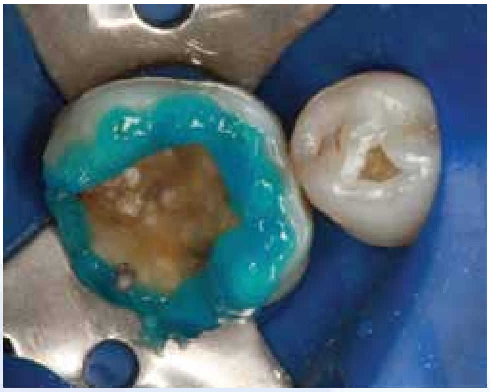

Fig. 5: *After smoothing the preparation, every surface involved is sandblasted for a few seconds, giving it a matte look. Selective-etch with phosphoric acid.*

Fig. 6: *After applying an antibacterial solution, a generous amount of primer is scrubbed for thorough penetration onto the surfaces.*

Fig. 7: *Once the primer has evaporated with the assistance of slight warm air, the bonding agent is applied and thinned out.*

Fig. 8: *An application of a thin layer of composite tacky flowable is placed. Then an end of an endodontic plugger was used to pick up the polyethylene fibers (Ribbond) soaked in unfilled resin to enable their transfer to the preparation. The fibers are placed and pushed closest to the dentin floor and extended slightly up the axial and proximal walls.*

A thin 0.5mm layer of tacky thickened flowable composite (Ribbond Securing Composite) was placed onto the pulpal floor, which is of high opacity. The high-strength polyethylene fibers, by Ribbond (Fig. 8), were blotted with an unfilled bonding adhesive and the excess was removed with lint-free gauze. The polyethylene fibers were adapted and pressed as close to the pulpal floor as possible (Fig. 9), then light-cured.

In one study, it was found when fibers were inserted into the depth of the proximal box, little or no microleakage took place[33] and increased the microtensile bond strength to the dentin in cavities with a high C factor.[34] Another thin layer of composite was applied (Fig. 10) and the final buildup was done with a warmed filled restorative composite to increase durability.[35] Tints (Kolor Plus by Kerr) were placed to create the anatomy and glycerin was placed on every surface (Fig. 11) and light-cured for 40 seconds on each side.

The rubber dam was removed, and the occlusion was inspected in all eccentric movements to avoid any premature contact (Fig. 12). The restoration was contoured and began spreading with intraoral polishing paste (DiaShine by VH Technologies) using a latch brush and keeping light in constant contact with the restoration (Fig. 13), to provide a higher surface luster (Fig. 14). As a preventive measure for occasional bruxism, the patient was provided a night guard.[36]

Results

No retention or resistance was formed in the cavity preparation. The retention of the restoration relied on the adhesive technique, the titanium pin[37] and the polyethylene fibers. It is of paramount importance to leave the restoration

Fig. 9: *Another polyethylene fiber is applied and pressed with the end of the plugger in a different direction.*

Fig. 10: *After application of polyethylene fibers, adapted closely, without suffering pullback. In the end they disappear into the composite. These fibers can increase the fracture toughness of the tooth and prevent dentin crack propagation.*

Fig. 11: *After an enamel composite layer is placed, the anatomy is created. Glycerin is applied to all margins to prevent the formation of an air-inhibited layer. The restoration is light-cured on the facial, lingual and occlusal sides.*

Fig. 12: *After removing the rubber dam, the occlusion is evaluated in every movement. The restoration is now contoured.*

Fig. 13: *A few weeks later, the patient came for examination. Intraoral polishing paste (DiaShine by VH Technologies) was used with a latch brush and kept continual contact with the restoration to provide a great surface finish.*

Fig. 14: *Note the excellent anatomical form and pleasing high surface luster.*

In applications such as cuspid reconstruction, multidirectional reinforcement can arrest cracks and prevent their propagation in the cervical direction. As shown in literature, dentin pins increase shear resistance of extensive composite restorations.

with enough strength to withstand an occlusal challenge, especially if the restoration is subjected to the same forces that initiated the original failure.

Conclusion

As oral health providers, we are always looking for the best treatment techniques for our patients.[38] Carefully combining pins and high-strength polyethylene fibers with excellent restorative material can improve the long-term prognosis of a tooth. The results are a successful aesthetic integration of the restoration—and easy repair, if necessary.

In selected clinical situations, reparation is an advantageous and practical alternative to a replacement and can significantly increase the lifetime of these restorations.[39] Cuspal coverage with direct posterior composite restorations may represent a valid alternative to conventional indirect restorations. The data indicates that composite resin is a technique-sensitive restorative material that can be used in large preparations, if proper manipulation and isolation can be maintained.[40] This requires an increased attention to detail, and the main reason for failure over time would be secondary caries and fractures. ■

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