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Clinical Technique/Case Report

Color Repair of a Composite Resin Restoration

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Clinical Relevance

A color repair technique can effectively correct an unsatisfactory restoration without replacement of the entire restoration, thus avoiding unnecessary removal of healthy tooth structure.

SUMMARY

Fractured teeth with both enamel and dentin involvement might be treated with adhesive composite resin restorations. In cases where a perfect color match between the composite restoration and the remaining tooth structure is not achieved, a repair might be carried out to correct the color of restoration. This procedure avoids the restoration replacement, preserving tooth structure without compromising the esthetic outcome.

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DOI: 10.2341/17-079-T

INTRODUCTION

Tooth fractures caused by falls or sports injuries are the most common forms of dental trauma.[1] They mostly involve the anterior permanent dentition, affecting around 15% of the population under 18 years.[2] Crown fractures are classified[1] as simple when they are restricted to enamel and dentin and complex when pulp and/or periodontal injury occurs.

Complex fractures represent between 0.3% and 0.5% of all tooth fractures.[3,4] In these situations, a multidisciplinary approach is required to reestablish the biologic width, treat the pulpal tissue, and restore the tooth.[4,5] Simple fractures, when restricted to enamel, do not require restorative treatment. However, when dentin is involved, the tooth requires a restoration due to the hypersensitivity caused by the dentin exposure.

Treatment options include the reattachment of the fragment[5,6] and direct adhesive restoration with composite resin. Whenever possible, the fragment should be reattached and the fractured tooth restored with its own structure. The reattachment provides optimal form, texture, and color. When the tooth fragment is not available or reattachment is not feasible to treat a fracture involving less than two-thirds of the clinical crown, an adhesive direct

Figure 1. *Right maxillary central incisor showing coronal fracture.*
Figure 2. *Intraoral view of the fractured tooth.*
Figure 3. *Palatal view of the fractured tooth.*
Figure 4. *Facial and palatal view of the diagnostic waxing.*

restoration with composite resin is the treatment of choice.[7,8]

The natural layering technique is a popular way to mimic the optical properties of the natural tooth using composite resin increments. However, achieving optimal esthetics is a challenge since the involved structures have different optical characteristics. Now that contemporary materials can closely match the optical characteristics of the natural tooth, clinicians must have a good understanding of how enamel and dentin interact with light.[9-12]

Because the enamel and dentin are of different thicknesses, each third of the tooth has specific chromatic properties. The cervical third is characterized by higher saturation because of the increased dentin thickness and thin enamel. As a result, the chromatic expression is minimally influenced by enamel, and the color of the dentin dominates. This explains the higher saturation and intermediate value in this third. The middle third has a large volume of dentin and thick enamel, attenuating the chroma of the dentin and increasing its value. The incisal third has a thin layer of dentin in the form of mamelons, and the enamel layer dominates. The opalescent halo and the opaque halo are found in the incisal third. The opalescent halo is the result of enamel opalescence, and the opaque halo, with its whitish-orange color, is the result of the interaction of light with enamel at the incisal edge.[9-14]

The natural layering technique reproduces the optical characteristics of natural dentition by using composite resin increments with different translucencies.[13,14] In this technique, the composite resin is placed in three layers: an internal layer, an intermediate layer, and an external layer.[9] The internal layer is made of a dentin-shade composite resin and is responsible for the chroma and the dispersion of light. The intermediate layer, located in the incisal third, reproduces the optical characteristics that occur in the natural enamel, creating the opalescent and the opaque halo. The external layer is made with an enamel-shade composite resin and sets the value of the restoration; it also replicates fluorescence.[9]

Even with excellent materials and a well-established technique, the restoration may have an unsatisfactory outcome and require a modification. Repairing a composite resin restoration is considered a minimally invasive procedure since in most situations restorative material is added with minimal reduction of the restoration or tooth structure.[15]

The goal of this clinical report is to describe the color repair of the restoration of a fractured maxillary central incisor, the esthetic outcome of which was unsatisfactory because of a poor color match.

CLINICAL TECHNIQUE REPORT

A nine-year-old boy presented with a fracture in the right maxillary central incisor due to trauma during a soccer match at school (Figure 1). Clinical and radiographic examinations were performed along

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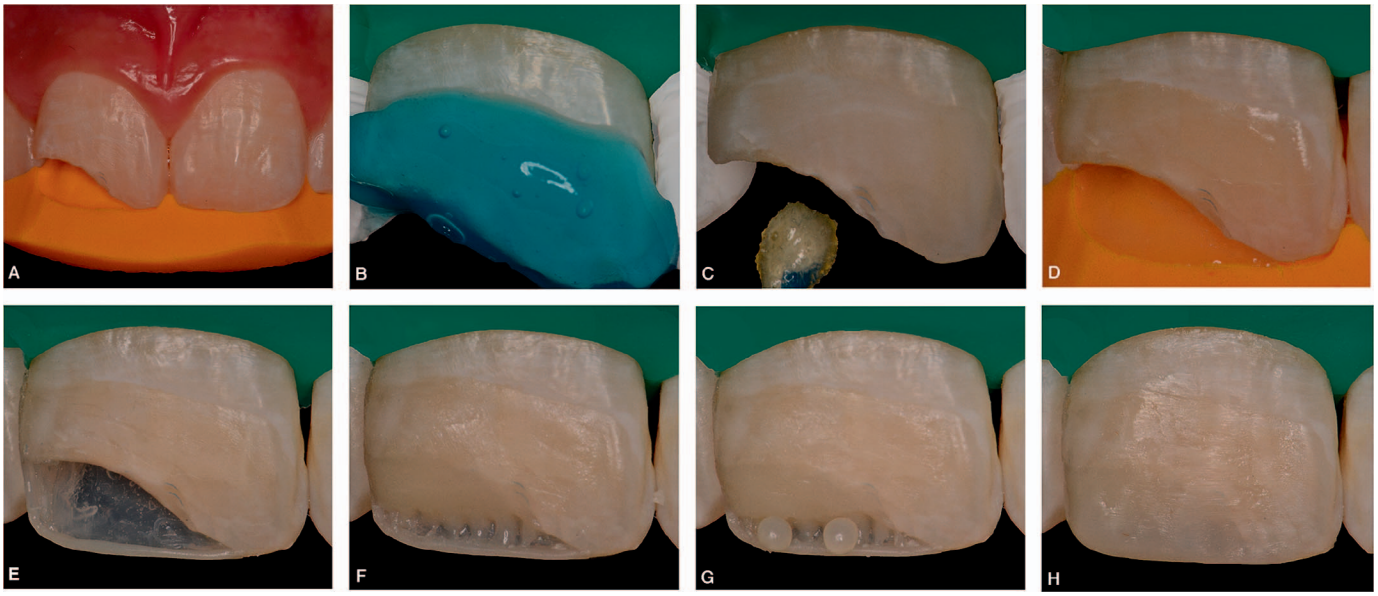

Figure 5. *(A) Silicone index fabricated from the cast in position. (B) Acid etching. (C) Application of the adhesive system. (D) Placement of the palatal enamel increment through the silicone index. (E) Replicating the opaque halo with a dentin-shade composite resin. (F) Dentin increments being placed. The mamelons were carved at this stage. (G) Placement of the opalescent-shade composite resin. (H) Placement of the enamel-shade composite resin.*

with intra and extraoral photographs. The examinations showed a horizontal coronal fracture in the middle third of the tooth, with no pulpal involvement (Figures 2 and 3). The vitality of the tooth was determined with a positive response to cold.

Emergency treatment consisted of a provisional composite resin restoration. Prior to the restoration of the fractured tooth, impressions of both the maxillary and the mandibular arches were taken to make a diagnostic waxing (Figure 4) and to allow the fabrication of a silicone palatal index (Figure 5A). After one week, dental prophylaxis and shade selection were carried out, as was a trial restoration to determine the thickness of the composite resin increments that would be used.

The restorative procedure was made under rubber dam isolation, and the natural layering technique was used with a nanohybrid composite resin (IPS Empress Direct, Ivoclar Vivadent, Schaan, Liechtenstein). The silicone index was positioned to restore the palatal enamel with an enamel-shade (A3) composite resin (Figure 5D). The opaque halo was then made with a dentin-shade (A3.5) composite resin (Figure 5E). The bulk of the restoration was established with dentin composite resin, replicating the correct tooth angulation and the different dentin thicknesses of each third of the tooth. At this stage, the dentin mamelons were shaped at the incisal edge (Figure 5F). The opalescent halo was reproduced with an opalescent-shade composite resin, placed in the spaces between the mamelons (Figure 5G). The restoration was finished with the placement of the enamel-shade composite resin (Figure 5H), reproducing the enamel and its surface texture.

After one week, the patient returned and reported high satisfaction with the outcome and no hypersensitivity. However, the value of the restoration did not match that of the remaining tooth structure. Additionally, the restoration had a grayish color, and the opalescent halo was different from that of the contralateral tooth (Figure 6). To improve the color match with the remaining tooth structure, a color repair procedure[16,17] was recommended. For this purpose, 0.7 mm of the superficial enamel composite resin was removed with a diamond bur[16] (#3216, Microdont, São Paulo, Brazil) to create space for a new layer of a dentin-shade composite resin. A slot was made in the incisal edge in the region of the opalescent halo with a round diamond bur (#1011, Microdont) (Figure 7). The surrounding enamel was then etched, while the composite resin was cleaned by applying 37% phosphoric acid for 30 seconds. A silane-coupling agent (Monobond N, Ivoclar Vivadent) and the adhesive system were applied. The opalescent-shade composite resin was placed into the slot (Figure 8). Then a greater amount of the dentin-shade composite resin was placed, extending beyond the tooth/restoration interface (Figure 9). Finally, a thin layer of the enamel-shade composite resin was placed (Figure 10).

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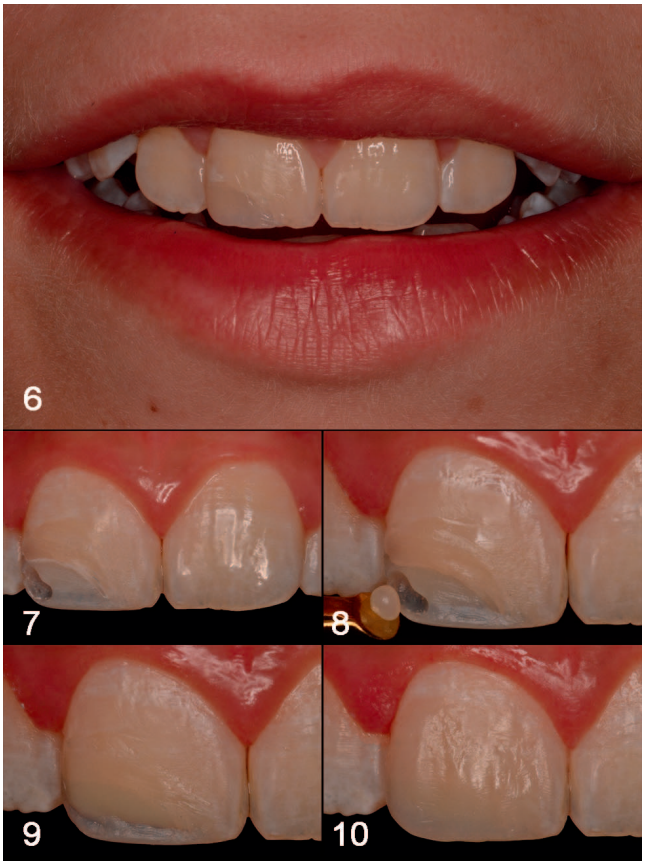

Figure 6. *Outcome after one week. The color match was not satisfactory.*
Figure 7. *Reduction of the unsatisfactory restoration.*
Figure 8. *Placement of the opalescent-shade increment.*
Figure 9. *Placement of the dentin-shade increment. To avoid the perception of the junction, this increment was extended beyond the tooth/restoration interface.*
Figure 10. *Placement of the last increment with enamel-shade composite resin.*

The finishing and polishing procedures were accomplished in one week (Figure 11). After the procedure, a satisfactory match was observed between the remaining tooth and the repaired restoration (Figure 12). A mouth guard was fabricated to protect the restoration and prevent future dental trauma during the patient's sports activities (Figures 13 and 14).[31-34]

The materials and equipment used in this technique are presented in Table 1.

DISCUSSION

Long-lasting composite resin restorations can be made with a minimally invasive approach thanks to advances in the development of restorative materials with improved mechanical properties.[18] The major challenges of the technique are related to selecting

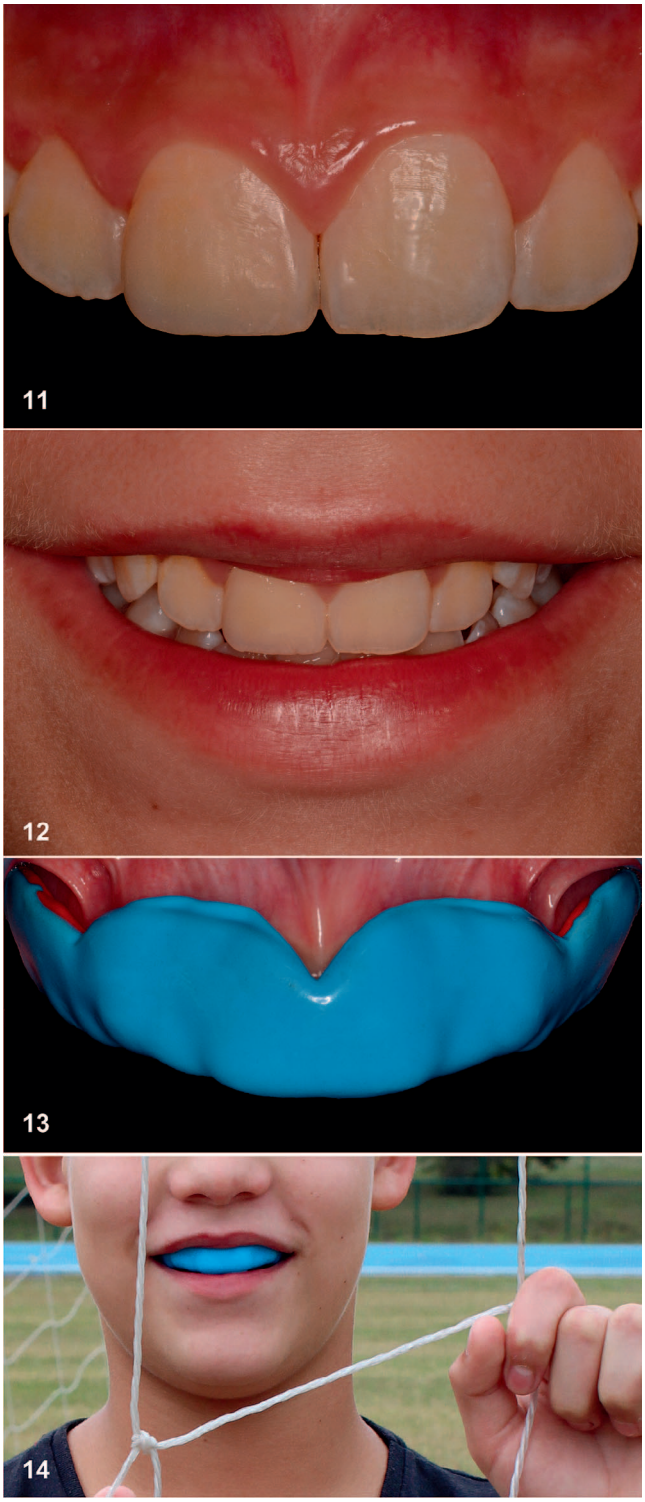

Figure 11. *Intraoral view after the repair; the color of the restoration matches the remaining tooth structure.*
Figure 12. *Definitive outcome.*
Figure 13. *Mouth guard in position.*
Figure 14. *Mouth guard in use.*

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Table 1: *Materials and Equipment*

Product	Manufacturer
Dental dam rubber dam	Hygenic Akron, OH, USA
Power etching 37% phosphoric acid gel	BM4 Palhoça, Brazil
Tetric N-Bond adhesive system	Ivoclar Vivadent Schaan, Liechtenstein
IPS Empress Direct nanohybrid composite resin	Ivoclar Vivadent
KG Brush disposable applicator	KG Sorensen São Paulo, Brazil
Radii Cal LED unit	SDI Victoria, Australia
Sof-lex polishing disc	3M ESPE St. Paul, MN, USA
Diamond Flex polishing disc	FGM Joinville SC, Brazil
Diamond Excel felt disc	FGM
Diamond bur #3216 and #1011	Microdont São Paulo, Brazil
Polyshok EVA sheets	Sportsguard Laboratories Kent, OH, USA
Scotch-Brite Discs (abrasive discs)	3M ESPE
Monobond N (silane-coupling agent)	Ivoclar Vivadent
Virtual (impression material)	Ivoclar Vivadent

the color, masking the fracture line, and reproducing form, color, and texture.

A strategy to make the procedure more predictable is making a trial restoration, using the same composite resin increments that will be used in the definitive restoration together with the layering technique. However, even with adequate materials, a well-established technique, and the trial restoration, the outcome might still be unsatisfactory.

For the patient illustrated, the grayish color of the restoration was probably because the enamel-shade composite layer was thicker than 1 mm. Excessively thick enamel-shade composite layers have been reported to result in reduced translucency and value.[19,20] Therefore, the dentin-shade composite resin layer needed to be thicker than the enamel one to mask the fracture line and provide correct value.

The best technique to correct an unsatisfactory restoration is still not well established. Hickel and others[21] suggest four options for treating unsatisfactory restorations: monitoring, polishing, repair, or replacement.

In daily practice, unsatisfactory restorations are commonly replaced if they cannot be corrected with a less invasive approach.[21] However, replacing a restoration means loss of healthy tooth structure, as removing an adhesive restoration without removing healthy surrounding tissue is difficult. The removal of additional tooth structure weakens the tooth and may injure the pulp, resulting in a repetitive restorative circle.[22]

Not all unsatisfactory restorations must be replaced. Composite resin repairs are a minimally invasive approach, as often they consist of adding restorative material, with or without reduction of the restoration and/or tooth structure.[15] Thus, the advantages of the repair technique are the conservation of tooth structure, low risk of pulp injury, no need for anesthesia, low cost, and minimal chair-side time when compared with a complete replacement; also, repair is well accepted by patients[23] and increases the longevity of the restoration.[24]

To enhance the bond to the repair composite resin, different surface treatments have been suggested. They include airborne-particle abrasion, treatment with phosphoric acid and/or hydrofluoric acid, application of a silane-coupling agent, and roughening the surface with diamond burs.[25-30] Although all these procedures have been described, definitive outcome data are lacking.[29] In this case report, the surface of the composite resin was roughened with a diamond bur, and the bonding procedure was then performed with a silane-coupling agent and an adhesive system.[30] The composite resins selected for repair were the same ones used for the initial restoration. However, the thickness of the dentin composite resin was increased, and the thickness of the enamel composite resin was decreased. In this way, it was possible to correct the value of the restoration and to completely mask the fracture line. The repair protocol allowed a satisfactory outcome without removing the entire restoration.[16]

Advantages

The advantages of this composite resin repair technique are as follows:

- Repair is less costly and less time consuming than replacing the restoration; also, the technique is nondestructive and easy to execute.
- The technique is conservative and preserves tooth structure.
- The procedure is painless and well accepted by the patient.

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Disadvantages

The disadvantages of this composite resin repair technique are as follows:

- No repair technique has yet achieved optimum bond strength with the existing restoration, and early failure of the repaired restoration might occur.

CONCLUSIONS

The presented repair technique effectively corrected an unsatisfactory restoration without replacing it entirely, thus avoiding the unnecessary removal of healthy tooth structure.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of Federal University of Santa Catarina, Brazil.

Conflict of Interest

The authors of this article certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

(Accepted 15 November 2017)

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