Adhesive Reattachment of a Tooth Fragment: The Biological Restoration

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Recent developments in restorative materials, placement techniques, preparation design, and adhesive protocols allow clinicians to predictably restore fractured teeth. Using a minimally invasive approach, treatment of the maxillary anterior region can be effortlessly completed within a single appointment. If the original tooth fragment is retained following fracture, the natural tooth structures can be reattached using adhesive protocols to ensure reliable strength, durability, and aesthetics. This article discusses the adhesive reattachment of a tooth fragment to a fractured incisor using a conservative preparation technique.

Learning Objectives:

This article describes a technique for the reattachment of a tooth fragment using conservative preparation techniques. Upon reading this article, the reader should:

- Understand the biological principles associated with tooth fragment reattachment.
- Be aware of the potential treatment options following tooth trauma.

Key Words: composite, aesthetic, fracture, fragment, enamel, biological

Maxillary central incisors dominate the physical appearance, and coronal fractures of the permanent dentition are the most frequent type of dental injury.[1,2]

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Approximately one out of every four persons under the age of 18 will sustain a traumatic anterior crown fracture.[3,4] Around the world, clinical investigations on dental trauma have revealed that a significant number of dental injuries occurred in children aged 6 to 13 years. These studies also reveal that the most common injury was an uncomplicated crown fracture (fracture of the enamel and dentin without pulpal exposure). A majority of the fractures involved the maxillary central incisors, with boys outnumbering girls almost two to one.[3,5,6]

During the last century, clinicians utilized a variety of procedures (eg, pin-retained resin, orthodontic bands, modified three-quarter crowns, full-coverage gold with bonded porcelain, porcelain jacket crowns, porcelain bonded crowns, porcelain inlays) for the restoration of the fractured crown.[7] These earlier restorative procedures provided function only. Adolescents, maybe more so than adults, are prone to social and psychological implications as a result of the appearance from metal in the mouth, which can compromise aesthetics.[8]

Recent developments in restorative materials, placement techniques, preparation design, and adhesive

Figure 1. Preoperative facial view of a fractured maxillary left central incisor.

Figure 2. Lingual view of maxillary left central incisor reveals superficial dentin exposure with no pulp involvement.

Figure 3. The recovered incisal fragment was utilized as the "biological restoration."

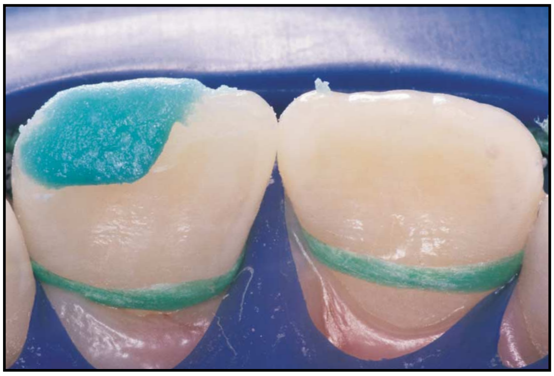

Figure 4. The fractured tooth was cleansed with 2% chlorhexidine, rinsed, and lightly air dried.

protocols facilitate restoration of fractured maxillary incisors. Early restorative materials (eg, silicates, acrylics) have been replaced by hybrid, microfill, and microhybrid composites. Traditional hybrid and microfill composites required the use of feather-edge, chamfer, shoulder, or long bevel preparation designs to facilitate the strength, sculptability, polishability, and durability provided by these materials. The feather-edge preparation required an overlay of composite resin that increased the volume of the composite on the labial and lingual enamel, which resulted in incisal breakdown, staining, and loss of retention.[9] The chamfer, shoulder, and long bevel preparation design provided a finish line and an increased volume of restorative material at the restorative margin, while maintaining the original contours of the tooth.[10] Contemporary hybrid composites have since been introduced with smaller filler size, shape, orientation, and distribution, which enhanced the physical and mechanical characteristics provided by these materials.[11] Since they eliminated the additional microfill at the restorative margin, these small-particle hybrid composites and microhybrids allowed a more conservative preparation design.

Although composite resins do not have hydroxyapatite crystals, dentin tubules, or enamel rods, these newer formulations possess secondary optical properties such as translucency, opacity, opalescence, iridescence, fluorescence, and surface gloss. There is, however, no synthetic restorative material that can replicate the aesthetic characteristics or color stability of the natural tooth structure. Therefore, another aesthetic and minimally invasive restorative alternative for the fractured anterior tooth is the reattachment of natural tooth fragment.

The concept of reattachment began in 1964 when Chosack and Eidelman used a cast post and conventional cement to reattach an anterior crown segment on a 12-year-old boy.[12] Anterior tooth fragments have since been reattached using composite, interlocking minipins, and light-cured resins.[13] In the following years, various techniques have been described for the reattachment of the original tooth fragment using acid-etch bonding, various tooth preparation techniques, and light- and chemically cured composite resin.[1] No significant differences have been noted, however, in the fracture resistance of teeth prepared with a 45° external circumferential bevel with no mechanical preparation for creation of a "biological restoration."[14-16] This article describes a technique for the adhesive reattachment of a tooth fragment to the fractured incisor utilizing an ultra-conservative preparation technique.

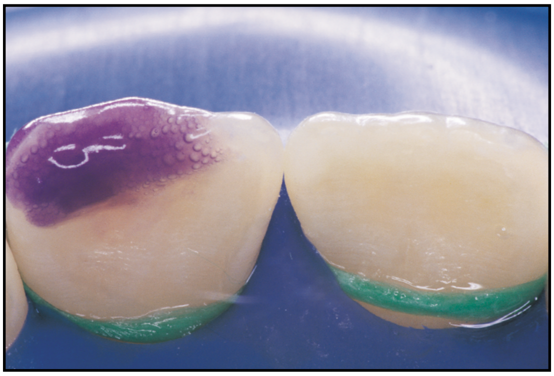

Figure 5. The fractured tooth and biological restoration were etched with a 37.5% phosphoric acid semi-gel for 15 seconds.

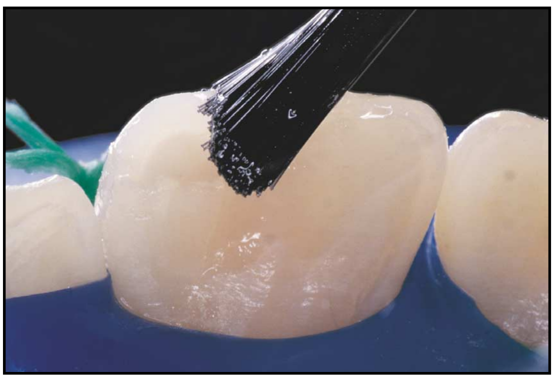

Figure 6. A single-component adhesive material was applied to the enamel and the wet dentin of the fractured tooth and fragment.

Treatment Considerations

Reattachment of the tooth structure influences aesthetics by retaining natural translucency and surface texture. Requiring only a single, less time-consuming appointment for treatment, this procedure is relatively simple, atraumatic, inexpensive, and can be performed on anterior or posterior teeth. In addition, reattachment allows for immediate, definitive management of the irreversibly traumatized pulp, minimally invasive preparation design, minimal loss of tooth structure, enhanced durability of the restoration (due to the natural incisal edge wear resistance that is identical to the surrounding dentition), and an immediate positive emotional response from the patient. In this procedure, the original tooth contours are restored, the conservative treatment allows future treatment alternatives, and a more predictable long-term appearance occurs following the placement of a minimal amount of composite at the restorative interface.[7,14,15]

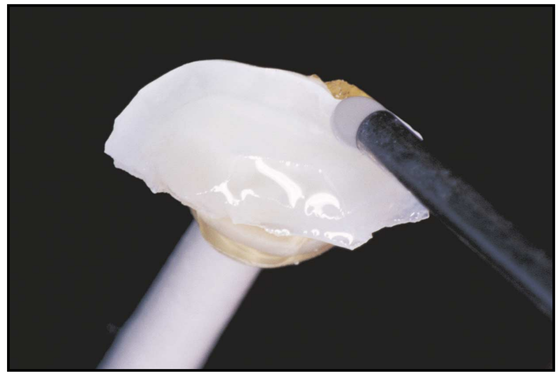

Figure 7. A light-cured/dual-cured resin cement was injected onto the internal surface of the fragment using a needle tube syringe tip.

Another functional benefit that may have been previously considered a disadvantage concerns the 50% to 60% fracture strength of the bond between tooth fragment and remaining tooth structure.[17,18] The recurrence of debonding at the interface could be considered a "protection factor" to anterior teeth that are subjected to trauma. Dissipation of energy generally occurs along the periodontal ligament, alveolar bone, and the teeth. If fracture resistance is increased, forces may be generated and directed to the pulp and periodontal structures, resulting in necrosis and damage to the tooth and surrounding structures. This reattachment procedure, although noted as a "provisional restorative treatment," may be an important link as a safeguard shock absorber during "accident-prone years," reducing long-term damage to pulp and surrounding structures.

Prevention and Education

The presence and preservation of the original tooth fragment can be enhanced by patient education that emphasizes the management of fractured and avulsed teeth, the importance of preservation of pulpal vitality, and the restorative measures available.[5] Orthodontic occlusal relationships (eg, overly protruding incisors, lip relationships that predispose the patient to anterior tooth fracture, avulsion) and the importance of early orthodontic intervention therapy are equally important aspects. Reinforcement of injury prevention and precautionary measures (eg, crash helmets, safety belts, mouth protectors) that can be provided should also be incorporated whenever possible.[5]

Finally, the creation and development of the dental restorative team during etiology, diagnosis, management, and the treatment of adolescent dental trauma ensures a more comprehensive and optimal outcome.

Management of Crown Fractures Involving Exposed Dentin and Pulp

Although this article discusses the reattachment of the tooth fragment for the simple anterior fracture, the primary goal in repairing the adolescent fracture is preservation of pulpal vitality. Crown fractures involving enamel and dentin without pulp exposure are classified as uncomplicated or Class 2 crown fractures.[19] Crown fractures involving enamel, dentin, and pulp are considered complicated or Class 3 occurrences.[19] Andreasen indicates that fracture of the crown with pulp exposure is between 5% and 8% of all traumatic injuries.[19] Management and treatment of these complex crown fractures may involve enamel, dentin, pulp, and periodontal tissues, which could absorb the energy dissipated from the traumatic injury. Therefore, in fractures of adolescent teeth, the extent of trauma must be clinically and radiographically assessed.

Upon radiographic examination, the fractured anterior crown with open apices and sufficient blood supply that has a pulp exposure may require a vital pulpotomy. This apexification procedure is surgical and involves the removal of the coronal portion of the pulp and placement of calcium hydroxide. Care should be taken to ensure that no air pockets remain at the amputation site to allow a continued development of the root and closure of the apices. Other methods suggested for the management of pulp exposure of the fractured anterior immature crown include direct pulp capping, partial pulpotomy, and partial pulpectomy.[19-21]

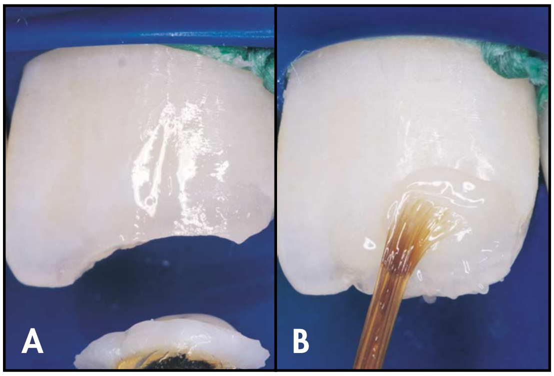

Figure 8A. The biological restoration was seated onto the fractured tooth. 8B. Excess cement was removed with a sable brush.

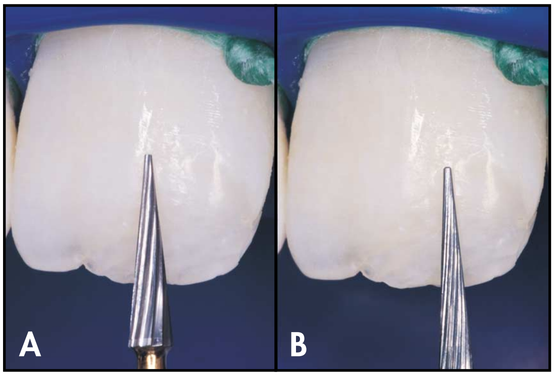

Figure 9A. Following polymerization, initial finishing was achieved using a 12-fluted needle-shaped bur to replicate natural form and texture. 9B. Flutes were increased to 30 to accomplish a smooth surface.

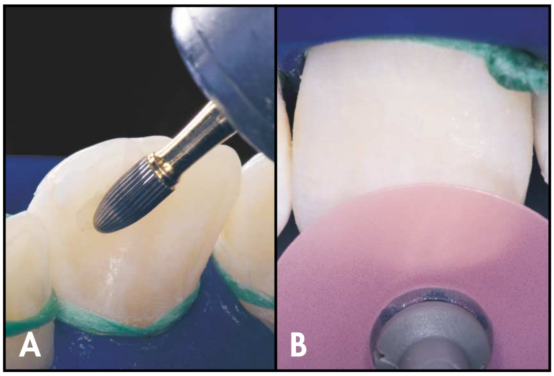

Figure 10A. The lingual interface was finished with a fluted, rounded, egg-shaped finishing bur for appropriate curvature of the tooth surface and biological restoration. 10B. Final finishing of the facial cavosurface interface was completed with aluminum oxide discs.

The literature has also suggested that a crown fracture with pulp exposure has a lower probability of maintaining vitality. Endodontic treatment can, therefore, be incorporated as a result of periapical disease or implications from endodontic origin. These apexification procedures allow development of the thickness of the dentinal walls to provide increased structural strength and integrity for possible future endodontic and restorative therapies.[21]

Another consideration is the noncarious exposure of the adolescent fractured anterior crown with complete apical closure. Studies have demonstrated that pulp

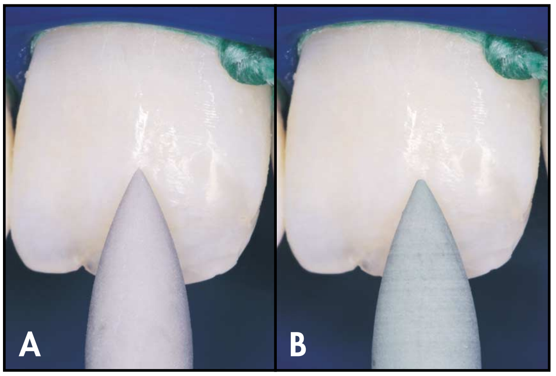

Figure 11A. Final polishing was performed with a prepolish silicone. 11B. Subsequent polishing was performed with a silicone point.

Figure 12. Postoperative facial view 6 months following treatment reflects harmonious integration of color, form, and texture that can be achieved from the reattachment of the biological restoration.

tissue possesses the inherent ability to repair, heal, and form reparative mineralized structures beneath several restorative materials,[22,23] and recent indications revealed that the failure of composite restorations may be related to the sealing and adaptation of the tooth restorative interface. Bacterial infiltration and microleakage have been attributed as a major factor in the pulpal inflammation and necrosis of exposed vital dentin, regardless of the selection of the restorative material applied to the dentin or the pulp.[22] The use of nonadhesive restorative materials (eg, calcium hydroxide) as a protective agent may, however, generate a gap at this interface. This gap can subsequently result in bacterial colonization and/or a hydraulic pump effect that stimulates the flow of tubular fluid inward, which may cause postoperative sensitivity upon mastication.[22,24] The hybridization of the exposed dentin with an adhesive system is now considered the most effective way of protecting this pulp-dentin interface and bonding the composite resin to the tooth structure, which provides resistance to microleakage and retention to the restoration regardless of the depth of the preparation.[22,25,26] The reattachment procedure can be utilized as a transitional restoration to provide a coronal seal for pulp therapy during apexification or as an attempt to avoid the ingress of bacteria and maintain a vital pulp.

Clinical Procedure

A 10-year-old boy presented several hours following traumatic fracture of the maxillary left central incisor (Figure 1). The fractured portion of the tooth was recovered and stored in sterile water to prevent discoloration and/or infractions from dehydration.[27] Clinical and radiographic examination revealed no evidence of pulpal exposure, mobility, root fracture, or soft tissue damage, and complete root formation was apparent. Only superficial dentin was exposed, and the dentin was not sensitive to clinical probing (Figure 2). Examination of the tooth fragment revealed no fragmentation of the edges (Figure 3). The fragment was placed in a 0.12% chlorhexidine solution for disinfection.

The potential ramifications of dental trauma were discussed, and the benefits and disadvantages of composite resin buildup and reattachment alternatives were provided. The decision was made by the patient's parents and the clinician to preserve natural tooth structure and utilize the patient's fragment as a biological restoration.[16]

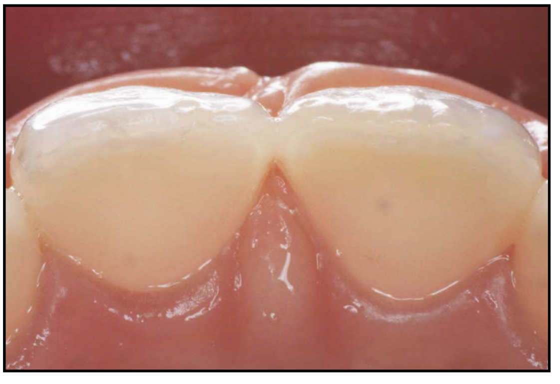

Figure 13. Lingual view 6 months postoperatively exhibits proper uniformity and aesthetics.

After anesthesia was administered, rubber dam isolation was accomplished using a modified technique to create an elongated hole that allowed placement of the dam over the retainers. The fractured segment was removed from the chlorhexidine solution and repositioned on the tooth, with no discernible disruption or defect at the cavosurface margin of the fracture site. A small portion of the internal dentin surface of the fragment was removed to accommodate resin cement placement, with care taken to preserve the peripheral margin. Additional tooth preparation was not required. The fragment and tooth were subsequently cleaned with a 2% chlorhexidine solution, rinsed, and lightly air dried (Figure 4). The "total-etch" technique was utilized due to its ability to minimize the potential of microleakage and enhance bond strength to dentin and enamel.[28-30] The tooth and fragment were etched for 15 seconds with phosphoric acid (Figure 5), rinsed for 5 seconds, gently dried for 5 seconds, and lightly air thinned to avoid desiccation. The dentin and enamel were remoistened with water, and a hydrophilic adhesive agent (eg, Optibond Solo Plus, Kerr/Sybron, Orange, CA; Prime & Bond NT, Dentsply/Caulk, Milford, DE) was applied to each for 20 seconds with a disposable brush. Using continuous motion, the excess adhesive was removed with a dry microbrush applicator (Figure 6). A light-cured/dual-cured resin cement (eg, Nexus II, Kerr/Sybron, Orange, CA; VarioLink II, Ivoclar Vivadent, Ahmerst, NY; Illusion, Bisco, Schaumburg, IL) was injected onto the internal surface of the fragment (Figure 7). An adhesive applicator tip was used to seat the fragment firmly in place, and the excess resin cement was removed with a sable brush using the "Wet Brush Technique" (Figure 8).[31] It was imperative to leave some residual cement at the margins to prevent voids and to compensate for polymerization shrinkage. The biological restoration was polymerized from all aspects (ie, facial, incisal, lingual, proximal) for 60 seconds each.

Once the resin cement was polymerized, the residual excess at the restorative margin was finished with a series of finishing burs. A long, needle-shaped finishing bur was used to finish the labial surface according to the proper anatomical contours of the facial aspect of the anterior tooth. Initial finishing was achieved with a 12-fluted, needle-shaped bur to replicate natural form and texture (Figure 9A). A smooth surface was achieved by following a sequential increase in the number of flutes (Figure 9B).[7]

Figure 14. A custom mouthguard was fabricated to prevent future traumatic dental injury.

Finishing of the lingual surface was performed with a rounded, egg-shaped finishing bur (eg, 9406, BluWhite Diamond, Kerr/Sybron, Orange, CA; OS1, Brasseler USA, Savannah, GA) (Figure 10A). A smooth surface was achieved by following a sequential increase in the number of flutes.[7]

Since finishing focuses on contouring, adjusting, shaping, and smoothing of the dentition, the use of multi-fluted finishing burs allowed the clinician to follow the lobes and ridges of the teeth to facilitate complete removal of excess resin. The long, needle-shaped finishing bur had sufficient length to overlap the tooth-resin interface and provide a parallel plane to the tooth surface while following the contours of the lobes. The size and shape of the bur depends on and is directly related to the amount of excess resin cement and the shape of the lingual surface.

The facial cavosurface interface was subsequently polished to a high luster using aluminum oxide discs, prepolish, and high shine silicone rubber points (Identoflex, Kerr/Sybron, Orange, CA; Astropol, Ivoclar Vivadent, Amherst, NY) (Figure 10B). The lingual cavosurface margin was polished with prepolish and high shine silicone rubber points following the concave lingual surfaces of the anterior teeth (Figure 11). To impart a high luster or surface reflectivity on the tooth, the final polishing was accomplished with composite polishing paste and goat-hair brushes applied at conventional speed.

Following rubber dam removal, the patient was asked to perform closure without force and then centric, protrusive, and lateral excursions. Any necessary occlusal equilibration was accomplished with an egg-shaped finishing bur, and the final polish was repeated. After the polishing procedure was completed, a final 2-minute postcuring was performed to improve the degree of conversion and ensure surface hardness. An impression was taken, and a mouthguard was custom-fabricated and delivered to the patient at the following visit to prevent future traumatic dental injury. The final 6-month post-operative result reflected the harmonious integration of color, form, and texture that can be achieved from the reattachment of the biologic restoration (Figures 12 through 14).

Conclusion

Progress in adhesive technology and composite resin materials allows not only for the creation of aesthetic restorations, but for the preservation and reinforcement of tooth structure, as has been demonstrated herein. Since research indicates that adolescent patients have the highest incidence of fracture of anterior teeth, this article has attempted to provide the restorative team with the etiology, diagnosis, management, and treatment of adolescent dental trauma. By using this knowledge, clinical experience, and judgment, the restorative clinician can integrate the reattachment procedure into his or her practice to provide the contemporary dental patient with a viable treatment alternative.

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References

1. Simonsen RJ. Restoration of a fractured central incisor using original tooth fragment. J Am Dent Assoc 1982;105(4):646-648.
2. Andreasen JO, Andreasen FM. Textbook and Color Atlas of Traumatic Injuries to the Teeth. 3rd ed. St. Louis, MO: Mosby-Year Book, Inc; 1994:216-256.
3. Andreasen JO, Ravn JJ. Epidemiology of traumatic dental injuries to primary and permanent teeth in a Danish population sample. Int J Oral Surg 1972;1(5):235-239.
4. Petti S, Tarsitani G. Traumatic injuries to anterior teeth in Italian schoolchildren: Prevalence and risk factors. Endodont Dent Traumatol 1996;12(6):294-297.
5. Zerman N, Cavalleri G. Traumatic injuries to permanent incisors. Endodont Dent Traumatol 1993;9(2):61-64.
6. Martens LC, Beyls HM, de Craene LG, D'Hauwers RF. Reattachment of the original fragment after vertical crown fracture of a permanent central incisor. J Pedod 1988;13(1):53-62.
7. Badami AA, Dunne SM, Scheer B. An in vitro investigation into the shear bond strengths of two dentine-bonding agents used in the reattachment of incisal edge fragments. Endodont Dent Traumatol 1995;11(3):129-135.
8. Andreasen JO, Andreasen FM. Dental trauma: Quo vadis? Tandlaegebladet 1989;93(11):381-384.
9. Sheykholeslam Z, Oppenheim M, Houpt MI. Clinical comparison of sealant and bonding systems in the restoration of fractured anterior teeth. J Am Dent Assoc 1977;95(6):1140-1144.
10. Bichacho N. Direct composite resin restorations of the anterior single tooth: Clinical implications and practical applications. Compend Cont Educ Dent 1996;17(8):796-802.
11. Leinfelder KF. Composite resins: Properties and clinical performance. In: O'Brien WJ, Powers JM, eds. Dental Materials: Properties and Selection. Chicago, IL: Quintessence Publishing; 1989:139-157.
12. Chosack A, Eidelman E. Rehabilitation of a fractured incisor using the patient's natural crown: Case report. J Dent Child 1964;31:19-21.
13. Spasser HF. Repair and restoration of a fractured, pulpally involved anterior tooth: Report of a case. J Am Dent Assoc 1977;94(3):519-520.
14. Diangelis AJ, Jungbluth M. Reattaching fractured tooth segments: An esthetic alternative. J Am Dent Assoc 1992;123(8):58-63.
15. Dean JA, Avery DR, Swartz ML. Attachment of anterior tooth fragment. Pediatr Dent 1986;8(3):139-143.
16. Busato AL, Loguercio AD, Barbosa AN, et al. Biological restorations using tooth fragments. Am J Dent 1998;11(1):46-49.
17. Munksgaard EC, Hojtved L, Jorgensen EH, et al. Enamel-dentin crown fractures bonded with various bonding agents. Endodont Dent Traumatol 1991;7(2):73-77.
18. Andreasen FM, Steinhardt U, Bille M, Munksgaard EC. Bonding of enamel-dentin crown fragments after crown fracture. An experimental study using bonding agents. Endodont Dent Traumatol 1993;9(3):111-114.
19. Andreasen JO. Traumatic Injuries of the Teeth. 2nd ed. St. Louis, MO: WB Saunders, 1981.
20. Bakland LK. Traumatic injuries. In: Endodontics. 3rd ed. Philadelphia, PA: Lea & Febiger; 1985:718-720.
21. Cvek M. A clinical report on partial pulpotomy and capping with calcium hydroxide in permanent incisors with complicated crown fracture. J Endod 1978;4(8):232-237.
22. Baratieri LN, Ritter AV, Perdigao J, Felippe LA. Direct posterior composite resin restorations: Current concepts for the technique. Pract Periodont Aesthet Dent 1998;10(7):875-886.
23. Cox CF, Bergenholtz G, Heys DR, et al. Pulp capping of dental pulp mechanically exposed to oral microflora: A 1-2 year observation of wound healing in the monkey. J Oral Pathol 1985;14(2):156-168.
24. Goracci G, Mori G. Scanning electron microscopic evaluation of resin-dentin and calcium hydroxide-dentin interface with resin composite restorations. Quint Int 1996;27(2):129-135.
25. Van Meerbeek B, Perdigao J, Lambrechts P, Vanherle G. The clinical performance of adhesives. J Dent 1998;26(1):1-20.
26. Cox CF, Suzuki S. Re-evaluating pulp protection: Calcium hydroxide liners vs. cohesive hybridization. J Am Dent Assoc 1994;125(7):823-831.
27. Andreasen FM, Rindum JL, Munksgaard EC, Andreasen JO. Bonding of enamel-dentin crown fractures with GLUMA and resin. Endodont Dent Traumatol 1986;2(6):277-280.
28. Kanca J 3rd. Improving bond strength through etching of dentin and bonding to wet dentin surfaces. J Am Dent Assoc 1992;123(9):35-43.
29. Nakabayashi N, Nakamura M, Yasuda N. Hybrid layer as a dentin-bonding mechanism. J Esthet Dent 1991;3(4):133-138.
30. Kanca J 3rd. Resin bonding to wet substrate. II. Bonding to enamel. Quint Int 1992;23(9):625-627.
31. Tay WM, Lynch E, Auger D. Effects of some finishing techniques on cervical margins of porcelain laminates. Quint Int 1987;18(9):599-602.

CONTINUING EDUCATION (CE) EXERCISE NO. 15

15 CONTINUING EDUCATION

To submit your CE Exercise answers, please use the answer sheet found within the CE Editorial Section of this issue and complete as follows: 1) Identify the article; 2) Place an X in the appropriate box for each question of each exercise; 3) Clip answer sheet from the page and mail it to the CE Department at Montage Media Corporation. For further instructions, please refer to the CE Editorial Section.

The 10 multiple-choice questions for this Continuing Education (CE) exercise are based on the article "Adhesive reattachment of a tooth fragment: The biological restoration" by Douglas A. Terry, DDS. This article is on Pages 403-409.

1. In what percentage of adolescents is traumatic anterior crown fracture evident?

a. 50%.
b. 30%.
c. 25%.
d. 10%.

2. Restorative procedures utilizing the feather-edge preparation design resulted in:

a. Staining.
b. Loss of retention.
c. Incisal breakdown.
d. All of the above.

3. A crown fracture with pulp exposure has a higher probability of maintaining vitality. Bacterial infiltration and microleakage have been considered major factors in pulpal inflammation and necrosis of exposed vital dentin.

a. Both statements are true.
b. Both statements are false.
c. The first statement is true, the second statement is false.
d. The first statement is false, the second statement is true.

4. In the reattachment of a tooth fragment, significant differences have been noted in the fracture resistance of teeth prepared with a 45° external circumferential bevel with no mechanical preparation.

a. This statement is true.
b. This statement is false.

5. The advantages of reattachment of the tooth structure include:

a. Retained natural translucency and surface texture.
b. Definitive management of the irreversibly traumatized pulp.
c. Minimally invasive preparation design and immediate positive emotional response.
d. All of the above.

6. The primary goal in repairing the adolescent fracture is preservation of the original tooth fragment. The secondary goal is preservation of pulpal vitality.

a. Both statements are true.
b. Both statements are false.
c. The first statement is true, the second statement is false.
d. The first statement is false, the second statement is true.

7. Crown fractures involving enamel and dentin without pulp exposure are classified as:

a. Uncomplicated.
b. Class II.
c. Both a and b are correct.
d. Neither a nor b is correct.

8. The concept of reattachment included which of the following restorative techniques?

a. Light-cured resins.
b. Acid-etch technique.
c. Composite to interlock minipins.
d. Cast post and conventional cement.

9. Hybridization of the exposed dentin with an adhesive system is considered to do the following:

a. Protect the pulp-dentin interface.
b. Provide retention to the restoration.
c. Bond the composite resin to the tooth structure and provide resistance to microleakage.
d. All of the above.

10. Residual resin cement is left at the restorative margins for the following reasons:

a. To prevent voids.
b. To compensate for polymerization shrinkage.
c. Both a and b.
d. Neither a nor b.