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Rehabilitation to crown–root fracture by fragment reattachment with resin-modified glass ionomer cement and composite resin restoration

CASE REPORT

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Abstract – Tooth fragment reattachment in cases of enamel/dentin fracture is based on adhesive protocols and is indicated because of its technique simplicity. Complex cases of root fracture or extensive coronal damage demand the integration of biological properties with the mechanical characteristics of the restorative materials. This paper is a report from one patient with a favourable result that addresses the clinical procedures involved in the association of resin-modified glass ionomer cement and composite resin for cases of coronal fracture of anterior teeth with invasion of the periodontal biological space and/or proximity with the pulp tissue. The research-based background for establishment of the treatment plan is discussed and a case of crown fracture with root involvement in a maxillary central incisor illustrates the operative technique of tooth fragment reattachment. After 1 year of follow up, the clinical and radiographic findings demonstrate that the adopted clinical protocol was successful and yielded an excellent pulp and periodontal response as well as maintenance of function and aesthetics.

Dental trauma is a very frequent accident among children and adolescents in the 11 to 18-year-old age range, usually associated with sports activities, falls and bicycle accidents (1, 2). The permanent maxillary central incisors are the most commonly affected teeth and enamel and dentin fractures, with and without pulp exposure, are the most prevalent. Fractures that partially involve the root are many times associated with these cases and may be a very important complicating factor (3).

The main problems caused by tooth fracture secondary to traumatic injures include functional, aesthetic and phonetic impairments (4). The treatment may be undertaken by either conventional restorative techniques or tooth fragment reattachment, whenever it is available. Despite the improvements in adhesive dentistry and the excellent aesthetic results provided by contemporary composite resins, the restorative procedures for these cases usually demand certain professional skills and clinical chairtime. On the other hand, tooth fragment reattachment offers a relatively simple and low-cost treatment protocol (5, 6).

In some cases of trauma, it is necessary to associate the fragment reattachment technique with a restorative procedure. This situation occurs when the traumatized tooth is fractured into two or more pieces and some of these fragments cannot be retrieved at the site of accident or cannot be properly repositioned. Other factors to be considered in cases of tooth fracture are the possible periodontal and endodontic involvement, such as invasion of the periodontal biological space and fracture line very close to the pulp tissue. In view of this, a multidisciplinary evaluation is a key approach to make an accurate diagnosis, treatment plan and case prognosis.

This paper addresses the use of resin-modified glass ionomer cement (RMGIC) to reattach a crown fragment to a fractured anterior tooth with involvement of the periodontal biological space and proximity with the pulp tissue.

Case report

A 12-year-old female patient was referred to the School of Dentistry of the University Center of Várzea Grande soon after sustaining a crown fracture to the maxillary left central incisor during sports activities at school. Intraoral clinical examination revealed a crown-root

Fig. 1. Preoperative clinical aspect of tooth 21 with a crown-root fracture.

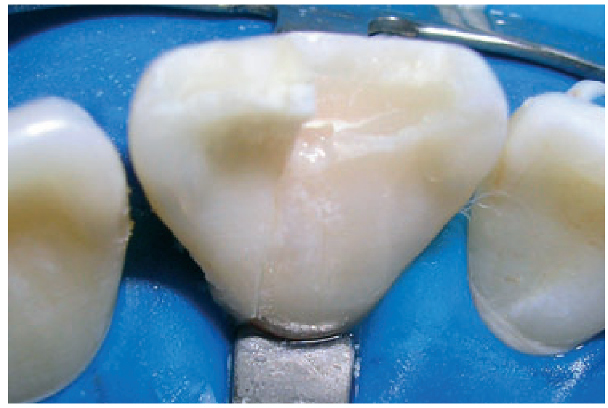

Fig. 3. Palatal view of fragment adaptation to the traumatized tooth.

fracture. Tooth 21 had a two-part crown fracture; one of the fragments was lost at the scene of the accident and the other fragment was still in place held by the gingival tissue (Fig. 1). There were no signs of soft tissue laceration or evidence of alveolar bone fracture. The radiographic examination revealed full root development and absence of an extensive root fracture. The tooth responded normally to cold, percussion and mobility tests.

After routine dental/medical history taking and examination, a treatment plan was established. For reasons of the loss of one of the crown fragments, the proposed treatment was the reattachment of the retrieved fragment associated with composite resin restoration. Under local anaesthetics, a sulcular incision was made on the buccal and palatal gingival tissue of teeth 11 and 21 with a no.15 scalpel blade, for removal of the displaced fragment and exposure of the fracture line. After rubber-dam isolation, it was observed that, in depth, the fracture line was very close to the pulp tissue, which was clearly noted by the transparency of the remaining dentin layer (Fig. 2).

Because of the proximity with the pulp tissue and involvement of the periodontal biological space (Fig. 3), an RMGIC (Vitrebond; 3M/ESPE, St Paul, MN, USA) was the material of choice for the reattachment technique. The fragment was secured at its incisal border with a small gutta-percha stick to facilitate its handling. The internal surfaces of the fragment and traumatized tooth were etched with 10% polyacrylic acid, rinsed and blotted with absorbent paper. After mixing, the RMGIC was applied to the fragment and tooth remnant, the fragment was reattached in the correct position and the luting material was light cured for 40 s (Fig. 4). After removal of cement excesses, the fracture line was beveled on both buccal and palatal sides with a high-speed spherical diamond bur under copious air/water spray cooling (Fig. 5). The beveled surface was etched with 37% phosphoric acid for 30 s, rinsed and blotted with absorbent paper. Scotchbond Multi-Purpose Plus adhesive system (3M/ESPE) was applied to the etched surface and light cured according to the manufacturer's instructions. The beveled fracture line was filled with composite resin (Filtek Z250; 3M/ESPE) to reinforce mechanically the glass ionomer cement reattachment as well as to mask the opacity of this material (Fig. 6). The coronal portion corresponding to the fragment lost during the traumatic injury was built with composite resin (Fig. 7), re-establishing dental anatomy and function. Occlusion was checked and adjustments were made as necessary.

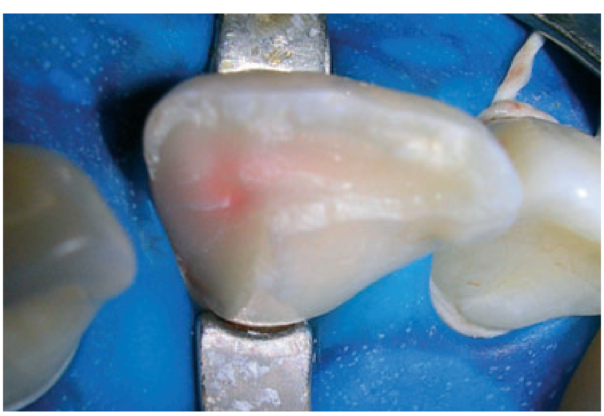

Fig. 2. Proximity with the pulp tissue perceived by dentin transparency.

Fig. 4. Fragment positioned and reattached with resin-modified glass ionomer cement.

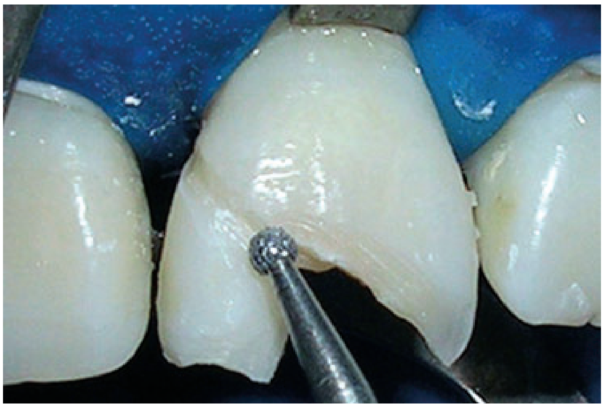

Fig. 5. Beveling of the fracture line with a high-speed diamond bur.

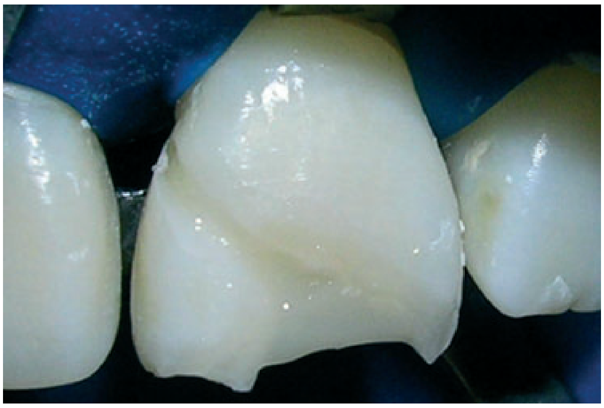

Fig. 6. Composite resin restoration of the coronal portion corresponding to the lost tooth fragment.

Fig. 7. Immediate final clinical aspect.

The immediate postoperative radiographic examination showed excellent adaptation of the fragment to the fractured tooth (Fig. 8). After 1 year of follow up, the tooth responds positively to thermal pulp sensitivity tests, there are no signs of gingival inflammation or presence of periodontal pockets and the aesthetic outcome is favourable (Fig. 9). No radiographic images suggestive of periodontal or periapical alterations were observed within the surveillance period (Fig. 10).

Fig. 8. Immediate radiographic examination.

Fig. 9. Clinical aspect 1 year after reattachment.

Discussion

The technique of tooth fragment reattachment has advantages over direct composite resin restorations, namely, procedural simplification, less clinical chairtime and immediate reestablishment of aesthetics and function (7, 8). However, in this case, one of the fragments had been lost during the traumatic injury, which determined the need for associating the reattachment technique with a composite resin restoration.

The success of the reattachment technique is directly related to the evolution of the adhesive materials, which currently provide a high-quality bond strength between the fragment and the remaining tooth structure, in addition to immediate reestablishment of function and aesthetics (5, 8). However, the restorative materials should not be selected based exclusively on their mechanical properties. Treatment success also depends on the biocompatibility of the restorative materials with the dental and periodontal tissues (9).

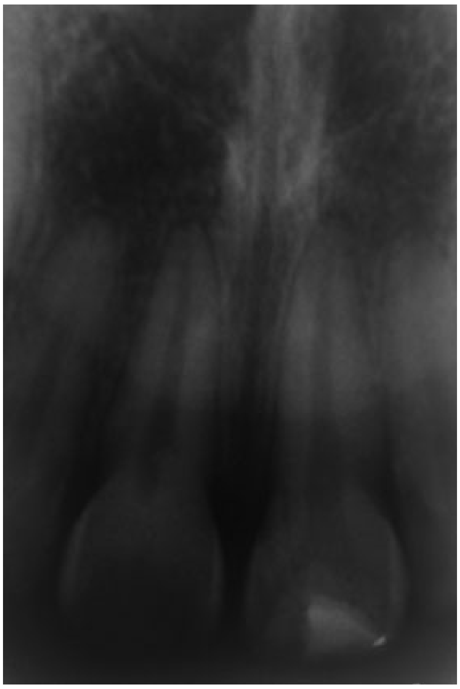

Fig. 10. Radiographic image 1 year after reattachment.

In this case, important factors taken into account were: the excellent adaptation of the fragment to the fractured tooth, proximity of the fracture line with the pulp tissue, characteristics of the remaining dentin and involvement of the periodontal biological space. Therefore, the major challenge was to select a material that fulfilled the mechanical and biological requirements for fragment reattachment.

The most frequently used materials for reattachment of fractured tooth segments are the adhesive systems, associated or not with resin-based materials, because they provide high bond strength between the reattached fragment and the traumatized tooth (5). However, in spite of their excellent mechanical results, adhesive systems have low biocompatibility. They are highly cytotoxic when applied directly to the pulp (10, 11) and may induce a pulpal inflammatory response when applied to very deep dentin areas (9). As in the present case, the fracture line had a very deep location, even permitting to visualize the pulp tissue through the extremely thin remaining dentin layer; the low biocompatibility of the adhesive systems was taken into consideration while choosing the material for reattachment.

In vivo studies have demonstrated that adhesive systems induce moderate-to-severe inflammatory response when applied directly to the exposed pulp tissue (10, 12). However, an inflammatory response is triggered not only with direct application of the adhesive systems to the exposed pulp, but also when the thickness of the remaining dentin layer is very little. In these cases, the adhesive systems may also cause an extremely severe inflammatory response. Costa et al. (9) have demonstrated that dentin thicknesses less than 300 μm do not prevent the diffusion of adhesive system components to the pulp. Scanning electron microscopic and optical microscopic studies in human teeth have shown that the unpolymerized resin components of the adhesive systems may diffuse through the dentinal tubules and reach pulp chamber when applied to very deep dentin areas (12–14). *In vitro* investigations have shown that low concentrations of certain components of resin materials, such as 2-hydroxyethylmethacrylate, are highly cytotoxic and have an inhibitory effect on DNA and protein syntheses (12). Previous acid etching of dentin increases even more the diffusion of resin components, which increases dentin permeability by removal of smear layer and smear plugs, decalcifies the peritubular and intertubular dentin and presents hypertonic property (9).

In the present case, another issue to be considered is that there was probably no deposition of reparative or sclerotic dentin because the injured incisor was a young tooth that had not suffered previous aggressions because of carious lesions or restorative procedures. Also, the fracture itself does not determine the formation of smear layer and smear plug. Therefore, the remaining dentin has small thickness and a significant relationship between the number of dentinal tubules and the total dentin area, which means that it is highly permeable.

Glass ionomer cements are one of the groups of adhesive materials that present biological compatibility with the dental tissues. Their fluoride-release capacity and ability to adhere chemically to the dental structures in a simple and rapid manner are some of the advantages of these materials (9, 15, 16). RMGICs present better mechanical properties than conventional glass ionomer cements. The mechanism of union of RMGICs to enamel and dentin occurs in two ways: micromechanical retention, by interdiffusion of the components of the cement within the collagen fibres present in micropores of the superficial dentin (0.5–1 μm deep) and chemical union between the carboxylic groups from the polyalkenoic acid and the calcium from hydroxyapatite. (17–20). For this reason, Van Meerbeek et al. (21, 22) consider the glass ionomer cement as a contemporary adhesive system.

Regarding the biocompatibility of these materials, *in vivo* studies have shown that RMGICs do not cause pulpal inflammatory response when applied to very deep dentin (9, 16). Costa et al. (9) have demonstrated in an *in vivo* study with human teeth that a RMGIC (Vitrebond; 3M/ESPE) presented results similar to those of calcium hydroxide cement when applied to very deep class V cavities, even when the thickness of the remaining dentin was less than 300 μm. Duque et al. (16) reported similar results when the same material (Vitrebond; 3M/ESPE) was applied to deep dentin in monkey's teeth, i.e., absence of pulp inflammation and deposition of reparative dentin.

The biocompatibility of the RMGICs may be attributed to different factors. Their excellent sealing capacity associated with their antimicrobial activity decreases considerably bacterial penetration, which can induce pulp inflammation (23). Another explanation would be the possible formation of crystals inside the dentinal tubules because of the acid-base reaction and interaction of components form Vitrebond with the dentin. These crystals would act as plugs that would seal the dentinal tubule entrances preventing cytotoxic components from leaching form the RMGIC to the pulp tissue (9, 24).

Resin-modified glass ionomer cements also present excellent biological response when applied to cavities with invasion of the periodontal biological space. Dragoo (25) has reported a reduction in the gingival bleeding and probing depth in subgingival RMGIC restorations after 1 year of follow up. Gomes et al. (26) evaluated the clinical and histological response of periodontal tissues to restorative procedures in dogs and found that the RMGIC restorations were associated with the best responses of the connective and epithelial tissues. Based on the results of these studies, Vitrebond was the RMGIC of choice for reattachment of the tooth fragment in the case reported herein.

In spite of all biological advantages, RMGICs have lower bond strength than adhesive systems. This could compromise the success of reattachment technique as it is also related to the quality of the union of the fragment to the remaining tooth structure. In the present case, part of the crown of the fractured maxillary incisor had to be restored with composite resin for re-establishing function and aesthetics. In addition, the composite restoration would act as a link between the fragment reattached with glass ionomer cement and the remaining tooth structure, thus increasing the bond strength.

Furthermore, a bevel was made (chamfer margin) on the buccal and palatal fracture line, followed by placing a layer of composite resin to increase the bond strength between the RMGIC-reattached fragment, as well as to mask the opacity of this material. *In vitro* studies have demonstrated that beveling (chamfer margin) the extension of the fracture line and filling with composite resin increased the fracture and fatigue strengths in comparison with teeth reattached exclusively with resin-based materials (5, 8).

After 1-year of follow up, the tooth is responsive to pulp sensitivity tests and presents absence of gingival inflammation and mobility as well as maintenance of normal probing depth. Radiographically, the periodontal tissues are healthy with no signs of periradicular pathosis. The patient has attended periodically scheduled recall visits for clinical and radiographic control of the case (7).

Our goal is to apply this technique in the next cases of crown fracture with characteristics similar to those described and publish the results in the future.

References

1. Flores MT, Andreasen JO, Bakland LK, Feiglin B, Gutmann JL, Oikarinen K et al. International Association of Dental Traumatology Guidelines for the evaluation and management of traumatic dental injuries. Dent Traumatol 2001;5:193–8.
2. Castro JCM, Poi WR, Manfrin TM, Zina LG. Analysis of the crown fractures and crown-root fractures due to dental trauma assisted by the Integrate Clinic from 1992 to 2002. Dent Traumatol 2005;21:121–6.
3. Panzarini SR, Pedrini D, Brandini DA, Poi WR, Santos MF, Correa JPT et al. Physical education undergraduates and dental trauma knowledge. Dent Traumatol. 2005;21:324–8.
4. Öz IA, Haytaç MC, Toroglu MS. Multidisciplinary approach to the rehabilitation of a crown-root fracture with original fragment for immediate esthetics: a case report with 4-year follow-up. Dent Traumatol 2006;22:48–52.
5. Demarco FF, Fay R-M, Pizon LM, Powers JM. Fracture resistance of re-attached coronal fragments – influence of different adhesive materials and bevel restoration. Dent Traumatol 2004;20:157–63.
6. Toshihiro K, Rintaro T. Rehydration of crown fragment 1 year after reattachment: a case report. Dent Traumatol 2005;21:297–300.
7. Rappelli G, Massaccesi C, Putignano A. Clinical procedures for the immediate reattachment of a tooth fragment. Dent Traumatol 2002;18:281–4.
8. Sengun A, Ozer F, Unlu N, Ozturk B. Shear bond strengths of tooth fragments reattached or restored. J Oral Rehabil 2003;30:82–6.
9. Costa CAS, Giro EMA, Nascimento ABL, Teixeira HM, Hebling J. Short term evaluation of the pulp-dentin complex response to a resin-modified glass-ionomer cement and a bonding agent applied in deep cavities. Dent Mat 2003;19:739–46.
10. Hebling J, Giro EMA, Costa CAS. Human pulp response after an adhesive system application in deep cavities. J Dent 1999;8:557–64.
11. Costa CAS, Vaerten MA, Edwards CA, Hanks CT. Cytotoxicity of current dental adhesive systems on immortalized odontoblast cell line MDPC-23. Dent Mat 1999;15:230–40.
12. Costa CAS, Nascimento ABL, Teixeira HB, Fontana UF. Response of human pulps capped with a self-etching adhesive system. Dent Mat 2001;3:230–40.
13. Tay FR, Gwinnett AJ, Pang KM, Wei SHY. Structural evidence of a sealed tissue interface with a total-etch wet-bonding technique *in vivo*. J Dent Res 1994;73:629–36.
14. Gwinnett AJ, Tay FR. Early and intermediate tissue response of the dental pulp to an acid etched technique *in vivo*. Am J Dent 1998;10:35–44.
15. Yiu CKY, Tay FR, King NM, Pashey DH, Sidhu SK, Neo JCL et al. Interaction of glass-ionomer cements to moist dentin. J Dent Res 2004;4:283–9.
16. Duque C, Hebling J, Smith AJ, Giro EAM, Oliveira MF, Costa CAS. Reactionary dentinogenesis after applying restorative materials and bioactive dentin matrix molecules as liners in deep cavities prepared in nonhuman primate teeth. J Oral Rehabil 2006;6:452–61.
17. Hinoura K, Miyazaki M, Onose H. Dentin bond strength of light cured glass ionomer cements. J Dent 1991;70:1542–4.
18. Lin A, McIntyre NS, Davidson RD. Studies on the adhesion of glass ionomer cements to dentin. J Dent Res 1992;71:1836–41.
19. Tay FR, Smales RJ, Ngo H, Wei SH, Pashley DH. Effect of different conditioning protocols on adhesion of a GIC to dentin. J Adhes Dent 2001;2:153–67.
20. Yip HK, Tay FR, Ngo HC, Smales RJ, Pashley DH. Bonding of contemporary glass ionomer cements to dentin. Dent Mat 2001;5:456–70.
21. Van Meerbeek B, Vargas S, Inoune S, Yoshida Y, Peumans M, Lambrechts P et al. Adhesives and cements to promote preservation dentistry. Oper Dent 2001;6:119–44.
22. Van MeerBeek B, De Munck J, Yoshida Y, Inoue S, Vargas M, Vijay P et al. Adhesion to enamel and dentin: current status and future challenges. Oper Dent 2003;28:215–35.
23. Tarin B, Hafez AA, Cox CF. Pulpal response to a resin-modified glass-ionomer material on nonexposed and exposed monkey pulps. Quintessence Int 1998;29:535–42.
24. Titley KC, Smith DC, Chernecky R. SEM observations of the reactions of the components of a light-activated glass polyalkenoate (ionomer) cement on bovine dentin. J Dent 1996;24:411–6.
25. Dragoo MR. Resin ionomer and hybrid ionomer cements: Part II Human clinical and histologic wound healing responses in specific periodontal lesions. Int J Periodontics Restorative Dent 1997;17:75–87.
26. Gomes SC, Miranda LAM, Soares I, Oppermann RV. Clinical and histologic evaluation of the periodontal response to restorative procedures in the dog. Int J Periodontics Restorative Dent 2005;25:39–47.