Case Report

Innovative management of complicated crown-root fracture with biomimetic materials: A case report with a 2-year follow-up

Maninder Kaur, Munish Singla, Harleen Kaur, Saloni Gupta, Reetu Arora

Department of Conservative and Endodontics, Adesh Institute of Dental Sciences and Research, Bathinda, Punjab, India

Abstract

The concurrent complicated horizontal crown-root fracture and complicated vertical crown fracture are rarely delineated in the literature. This case report suggests a twophase singlevisit treatment to reinstate the maxillary lateral incisor with bioinspired materials. In Stage 1, endodontic therapy was given, followed by fracture fragment stabilization innovatively in Stage 2. At 2 years of follow-up, clinical examinations revealed satisfactory periodontal condition without mobility or discoloration of the tooth. Cone-beam computed tomography revealed a close approximation of the vertical fracture line and healing of the horizontal crown-root fracture with a type II pattern. This case report concludes that a minimally invasive procedural approach with biomimetic materials can be performed instead of extensive therapy like extraction.

Keywords: Complicated crown-root fracture; fiber reinforced resin; Fibrafill cube; horizontal crown-root fracture

INTRODUCTION

Traumatic injuries to the teeth result in damage to many dental and periradicular structures. Most dental trauma occurs in the adolescent and early adulthood phases. Maxillary central incisors are more prone to traumatic injuries (approximately 68%), and next in line are the maxillary lateral incisors (27%) followed by mandibular incisors (5%).[1] Horizontal root fracture accounts for 0.5%–7.1% of all traumatic injuries. A crown-root fracture that originates in the crown and extends to the root involving enamel, dentin, and cementum comprises 5% of dental injuries.[2] The patient endures both physical as well as psychological repercussions.[3] Therefore, deep knowledge is required to preserve the tooth and give the patient an exquisite appearance for their psychological well-being.

Address for correspondence:
Dr. Maninder Kaur,
Department of Conservative and Endodontics, Adesh Institute of Dental Sciences and Research, Bathinda, Punjab, India.
E-mail: maninder96523@gmail.com

Date of submission : 15.09.2024
Review completed : 16.10.2024
Date of acceptance : 25.10.2024
Published : 13.01.2025

Access this article online

Quick Response Code:

Website: https://journals.lww.com/jcde

DOI: 10.4103/JCDE.JCDE_670_24

Dental traumatic injury categorized the crown-root fracture as either complicated or uncomplicated depending upon pulpal involvement.[4] Complicated crown-root fractures (CCRF) involve enamel, dentin, and pulp and occur in 0.9%–13% of all dental injuries.[5] Complicated crown-root fractures commonly occur in the middle third of the root and are rarely seen in the coronal and apical third.[6]

The major challenge is imposed when unfavorable fractures like complicated horizontal crown-root fractures (CHCRFs) and vertical crown fractures come across. Because the management of these fractures is complex and the prognosis is uncertain. As a result, treatment falls into extraction.

The recent International Association of Dental Traumatology guidelines recommend orthodontic extrusion of the subgingival segment, surgical extrusion, root submergence, intentional replantation, extraction, and autotransplantation for such CCRF.[7]

But with the advent of newer materials like MTA, biodentin, Fibrafill cubes, and fiber-reinforced materials, complicated

How to cite this article: Kaur M, Singla M, Kaur H, Gupta S, Arora R. Innovative management of complicated crown-root fracture with biomimetic materials: A case report with a 2-year follow-up. J Conserv Dent Endod 2025;28:96-100.

fractures can be treated conservatively. These materials truly behave like dentin substitutes. The monoblock effect provided by these materials allows the stresses to dissipate over a larger area of the tooth, thus improving the long-term prognosis.

In the current era, patients are keen on preserving their natural teeth rather than being replaced by artificial ones, which further allows us to preserve the surrounding supporting structure and aesthetics to gain the patient's confidence. The present case report aims at saving the natural tooth despite a complicated fracture with a follow-up of 2 years.

CASE REPORT

A 20-year-old male patient was referred to the department of conservative dentistry and endodontics with a history of trauma to the maxillary anterior tooth region 1 month ago. The patient's dental, medical, and family history was noncontributory. An extraoral examination revealed a healed suture line corresponding to the left cheek region. The intraoral examination revealed a horizontal fracture at the cervical third with the involvement of pulp and pulp polyp in maxillary left lateral incisor #22 [Figure 1a and b]. The palatal fragment of #22 showed Grade II mobility and was tender to palpation testing. The periodontal probing depths were within the physiological limits (four probing points per tooth). The tooth gave a positive lingering response to cold (Endo Frost, Roeko, Langenau, Germany) and an early response to an electric pulp test device (Gentle-Pulse, Parkell, USA). Multiple angled intraoral periapical (IOPA) radiographs revealed fracture lines in 22 [Figure 1c], which was further ruled out using cone-beam computed tomography (CBCT) evaluation. The coronal and axial view revealed a fracture line extended mesiodistally at the cervical region [Figure 1e,f] and the sagittal view showed a fracture line continued subgingivally on the palatal surface of the tooth at the cervical area [Figure 1d]. From the clinical, radiographical, and CBCT findings, a diagnosis of CHCRF and complicated vertical crown fracture (CVCF) #22 was confirmed. Various treatment options, such as orthodontic extrusion, extraction and replacement with an implant or fixed partial prosthesis or preserving the tooth using biomimetic materials, were given to the patient. The patient opted for saving the original tooth and thus, two-staged treatment plans comprising endodontic therapy and stabilization of the fractured palatal fragment with MTA followed by reinforcement with fiber-reinforced composite block and splinting to immobilize the fragment were planned. This conservative approach encompassed minimal tooth removal and replacement of it with bioemulation materials. Preserving the original tooth structure is crucial because it maintains the gingival health, aesthetics and biological aspects of the tooth, which will be imperilled if the natural tooth is replaced with prosthetic restoration. Written informed consent was obtained from the patient and was informed about the success and failure related to the complicated fracture.

In Stage 1, access opening was done under the rubber dam isolation, and the working length was determined using an electronic apex locator (Dentsply Propex Pixi Apex Locator) and confirmed using a digital periapical radiograph. Root canal instrumentation was performed manually using K-files (Dentsply Maillefer, Ballaigues, Switzerland) to prevent fracture propagation on the remaining tooth structure. During instrumentation, 1% sodium hypochlorite (Parcan; Septodont, Saint-Maur, France) was replenished at each file change. Final irrigation was performed with 17% EDTA solution (Prevest Denpro Limited, India). The root canal was dried with absorbent paper points, followed by obturation #22 [Figure 1g,h]. In Stage 2, management of CHCRF and CVCF was done. Obturation was removed from the cervical third of the crown with a heated plugger. Then, two vertical grooves of 2-3mm were made [Figure 1i] with tapered fissure carbide bur (169L, Mani, Inc. Japan) on the internal wall of the labial and palatal fracture fragment at the proximal aspect to place MTA (MTA-Angelus, Londrina, PR, Brazil) to seal the vertical fracture (VF) line [Figure 1j] and stabilize the horizontal fracture. After the initial setting of MTA, resin-modified glass inomer cement (GC Fuji II LC, GC Corporation, GC America) was placed over the obturation and along the mesial and distal walls. The tooth surface was etched with 37% phosphoric acid (Ivoclar Eco-Etch, Ivoclar Vivadent, Liechtenstein) for 20 seconds, followed by rinsed for 20 seconds, and blot dried for 10 seconds [Figure 1k]. The universal adhesive (G-Premio Bond; GC Europe N.V.) was actively applied in self-etch mode to the tooth surface for 20 seconds and dried for 5 seconds using an air syringe to allow the solvent to evaporate [Figure 1l]. The adhesive was light polymerized for 20 s. The fibrafill cube (ADM Fibrafill, Brno, Czech Republic) was placed inside the cervical third of the crown [Figure 1m] and cured for 20 s. The cervical to the middle third of the crown structure was built with a Fibrafill cube, placed in an oblique incremental technique and the incisal third was built with fiber-reinforced composite (everX Posterior, GC Corporation Tokyo, Japan) and cured for 20 s. A lingual splint was placed at #21, 22 and 23 to stabilize the palatal fragment [Figure 1n,o]. Postoperative instructions were given to the patient to prevent exerting too much stress on the anterior teeth.

Debonding of the splint was done after 14 days and further follow-up was made at 1, 3, and 6 months, and at 1 year radiographically [Figure 2a-d] and CBCT evaluation was done at 2 years. Clinical and radiographic examination revealed no sign/symptom or evidence of periapical lesion, root resorption, alveolar bone loss, and an excellent adaptation of the mobile palatal fragment with MTA and

Figure 1: (a) Preoperative intraoral view showing fracture at cervical third with pulp polyp; (b) intraoral view after removal of pulp polyp; (c) preoperative radiograph showing horizontal fracture line at cervical region and periapical radiolucency; (d and f) cone-beam computed tomography images showing fracture line; (d) sagittal view showing fracture line extended toward the palatal side; (e) coronal view showing fracture line evident at cervical area; (f) axial view showing fracture line involving enamel, dentin, pulp and extended vertically till cervical region; (g and h) intraoral view showing access opening and radiographs showing complete root canal treatment; (i) buccal grooves made on internal aspect of buccal and palatal surface; (j) intraoral periapical (IOPA) showed MTA placement in vertical fracture line; (k and l) tooth surface was prepared with etching and bonding agent; (m) placement of Fibrafill cube at coronal and middle third of tooth; (n) IOPA showed splinting from #21–#23 and complete buildup of the tooth; (o) postoperative image showing complete buildup #22

composite resin. At a 2-year follow-up, clinical examination revealed no discoloration or mobility of the reattached fragment, and the periodontal probing depth was within normal limits. The 2-year postoperative IOPA revealed the resolution of periapical radiolucency presented in Figure 2e. A 2-year postoperative CBCT showed a close approximation of the VF line [Figure 2f]; however, radiolucency seen at the horizontal fracture line revealed healing of the fracture fragment with connective tissue, as seen in Figure 2g and h; this interpretation was confirmed by a senior radiologist.

DISCUSSION

Management for complex crown-root fractures at the cervical third is challenging due to the decreased stability of

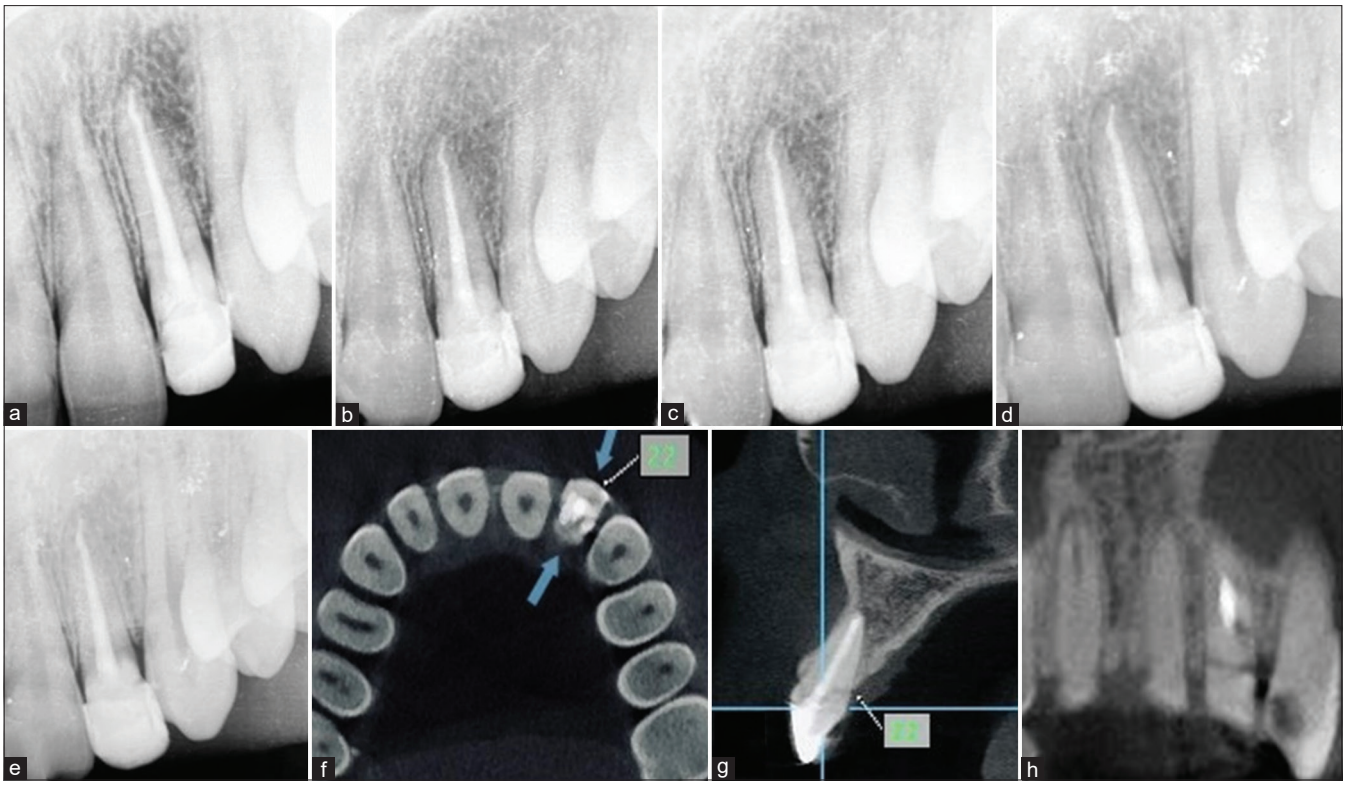

Figure 2: Follow-up intraoral periapical at (a) 1 month; (b) 3 months; (c) 6 months; (d) 1 year; (e) 2 years; (f and h) cone-beam computed tomography images of 2-year postoperative follow-up; (f) axial view showing good approximation of vertical fracture line; (g and h) sagittal and coronal view showing radiolucency at horizontal fracture line

coronal fragments. Since the patient was willing to preserve the tooth, the treatment plan was designed conservatively. The biomimetic materials were chosen for fortifying the fractured tooth as they functionally behave like dentin.

The subcrestal and subgingivally extended fracture always poses an intriguing challenge for restoration. To restore the appropriate biological dimension and to aesthetically repair the damage, a multidisciplinary strategy based on crown lengthening with or without orthodontic extrusion and eventual prosthetic reconstruction is the standard paradigm of treatment for these conditions.[8]

However, fragment reattachment was used as an alternative treatment in this instance as it is a minimally invasive procedure and enables prompt completion of the treatment procedure. Based upon a systematic review, by Khandelwal *et al*., if the clinical circumstances are favorable, fragment reattachment can be regarded as a feasible treatment option in CCRF.[9]

In the present case, the implementation of a two-phase treatment plan may have contributed to favorable outcomes. In Stage 1, single-sitting endodontic treatment was done. In Stage 2, CVCF and CHCRF were managed by stabilizing and reattaching the palatal fragment with MTA and splinting on the lingual aspect of #21, 22 and 23.

MTA is the most biocompatible endodontic material, able to promote tissue regeneration. MTA also provides an effective seal against dentin and cementum and promotes biological repair and regrowth of the periodontal ligament (PDL).[10] These properties are due to its setting in the presence of blood, saliva, or other biological fluids and low solubility after setting.[11]

Tani-Ishii N reported repair of VF with MTA by preparing a groove along the VF and placing MTA in the groove. Accordingly, in the present case, vertical grooves were made for MTA placement in the VF line.[12]

Sucharita and Archie stated that the glass fiber post consists of strong glass fiber bundles, which dissipate the occlusal stress more like a natural tooth. However, the drawback of using fiber post was losing more cervical dentin during post space preparation; potentially, it decreased the structural integrity of the fracture fragment.[13] Thus, in the present case, the Fibrafill cube was used to reinforce the cervical to the middle third of the tooth structure as it constitutes continuous braided E-glass fibers reinforcement between the microhybrid composite layer that replicates the resilience of natural dentin. This integrated membrane is resistant to stress concentration, helps in the distribution of stresses more evenly, and thus prevents crack development

and propagation. This material creates a monoblock effect and also imparts strength to the restorative material.

Literature evidence advocates root fracture at the cervical third often requires extraction when the coronal fragment shows severe mobility; however, in the present case, mobility was manageable (grade 2), so a conservative approach along with splinting was preferred to save the tooth.[14]

When crown-root fractures are treated adequately with repositioning, stabilization, and occlusal adjustment, the prognosis for healing is favorable.[15]

In follow-up visits over 2 years, the tooth was asymptomatic; no discoloration and periapical lesion nor mobility of the fracture fragment was seen. The 2-year postoperative CBCT showed a type II healing pattern of horizontal crown-root fracture (HCRF). Moreover, Andreasen JO has observed that nearly 43% of the HCRF heals with a type II pattern, which is healing by interposition of connective tissue.[16] In type II healing, PDL cells are usually the dominant contributor to the healing reaction; the connective tissue derived from the PDL grows into the fracture line. In these cases, there is no union of the fractured segments, but the coronal fragment can still be quite stable.[17] This case report showed a 2-year long follow-up along with evaluation using CBCT, which are its strongest aspects. The limitation of this documentation is focuses only on a single patient, making it impossible to evaluate the impact of biomechanical forces in a range of clinical scenarios.

CONCLUSION

A minimal invasive procedural approach with dentin substitute materials could be attributed to the successful prognosis of complex HCRF and vertical crown fracture.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Andrade ES, de Campos Sobrinho AL, Andrade MG, Matos JL. Root healing after horizontal fracture: A case report with a 13-year follow up. Dent Traumatol 2008;24:e1-3.
2. Andreasen JO, Andreasen FM, Andersson L. Crown-Root Fractures. Textbook and Color Atlas of Traumatic Injuries to the Teeth. 4th ed. Oxford: Blackwell; 2007. p. 314-66.
3. Rodríguez-Astorga A, Romo-Ramírez G, Ortiz-Magdaleno M. Reinsertion of a fractured clinical crown as a biological restoration after dental trauma. J Conserv Dent 2020;23:538-42.
4. Sarathy S, Arul B, Balasubramanian HP, Natanasabapathy V, Suresh N. A novel two-staged single-visit treatment of a maxillary central incisor with complicated crown-root fracture with additional horizontal mid-root fracture – A case report with a 5-year follow-up. J Conserv Dent Endod 2023;26:484-9.
5. Thakur V, Mittal S, Yadav R. Management of complicated crown fracture with biodentine partial pulpotomy and fracture segment reattachment. Int J Health Sci Res 2021;11:152-156.
6. Versiani MA, de Sousa CJ, Cruz-Filho AM, Perez DE, Sousa-Neto MD. Clinical management and subsequent healing of teeth with horizontal root fractures. Dent Traumatol 2008;24:136-9.
7. Bourguignon C, Cohenca N, Lauridsen E, Flores MT, O'Connell AC, Day PF, *et al*. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 1. Fractures and luxations. Dent Traumatol 2020; 36:314-330.
8. Giachetti L, Bertini F, Rotundo R. Crown-root reattachment of a severe subgingival tooth fracture: A 15-month periodontal evaluation. Int J Periodontics Restorative Dent 2010;30:393-9.
9. Khandelwal P, Srinivasan S, Arul B, Natanasabapathy V. Fragment reattachment after complicated crown-root fractures of anterior teeth: A systematic review. Dent Traumatol 2021;37:37-52.
10. Torabinejad M, Smith PW, Kettering JD, Pitt Ford TR. Comparative investigation of marginal adaptation of mineral trioxide aggregate and other commonly used root-end filling materials. J Endod 1995;21:295-9.
11. Tulumbaci F, Almaz ME, Arikan V, Mutluay MS. Shear bond strength of different restorative materials to mineral trioxide aggregate and Biodentine. J Conserv Dent 2017;20:292-6.
12. Tani-Ishii N, Mutoh N, Suzuki J. The clinical evaluation of vertical root fracture after endodontic treatment with mineral trioxide aggregate. Integr Mol Med 2017;4:1-5.
13. Sucharita V, Archie K. Tooth fragment reattachment: A case series. J Interdiscip Dent 2021;11:129.
14. Karhade I, Gulve MN. Management of horizontal root fracture in the middle third via intraradicular splinting using a fiber post. Case Rep Dent 2016;2016:1-5.
15. Hovland EJ. Horizontal root fractures. Treatment and repair. Dent Clin North Am 1992;36:509-25.
16. Andreasen JO, Andreasen FM, Mejàre I, Cvek M. Healing of 400 intra-alveolar root fractures. 1. Effect of pre-injury and injury factors such as sex, age, stage of root development, fracture type, location of fracture and severity of dislocation. Dent Traumatol 2004;20:192-202.
17. Abbott PV. Diagnosis and management of transverse root fractures. Dent Traumatol 2019;35:333-47.