

# Management of Complicated Crown Fractures in Vital Immature Incisors

Mahshid Bagheri<sup>1,\*</sup> and Mohammad Mortazavi<sup>2</sup>

<sup>1</sup>Department of Paediatric Dentistry, Razavi Hospital, Mashhad, IR Iran

<sup>2</sup>Department of Endodontics, Razavi Hospital, Mashhad, IR Iran

\*Corresponding author: Mahshid Bagheri, Department of Pediatric Dentistry, Razavi Hospital, Mashhad, IR Iran. Tel: +98-5116668888; +98-9151113056, Fax: +98-5118407195, E-mail: mahshid.bagheri@kclalumni.net

Received 2015 July 19; Accepted 2015 July 22

## Abstract

**Introduction:** Dental trauma is one of the most serious oral conditions especially among children. It frequently occurs in children from 6 to 13 years old, often involving teeth with incomplete root formation. The most common dental injury at this age is crown fracture.

**Arguments:** To provide this clinical guide, Pubmed and Scopus were searched using the following keywords: Immature, Incisor and Pulpotomy. More importantly, the latest clinical guidelines provided by the International Association for Dental Traumatology, British Society of Paediatric Dentistry, and the Royal College of Surgeons of England and National Institute for Health and Care Excellence were studied and incorporated into this paper (Grade 1 evidence).

**Conclusions:** Management of a young patient who has sustained such trauma includes a wide range of options based on the clinical and radiographic findings. Here we explain in detail the latter as well as covering available literature and guidelines.

**Keywords:** Crown Fracture, Immature Incisor, Pulp

## 1. Introduction

Dental trauma is one of the most serious oral conditions especially among children. It frequently occurs in children from 6 to 13 years old, often involving teeth with incomplete root formation (1). The most common dental injury at this age is crown fracture (2, 3).

Crown fractures are the most frequent injuries in the permanent dentition (4). According to the 1994 child dental health survey, children have a one in five chance of traumatizing their immature permanent incisor teeth (5).

An English study showed the prevalence of dental trauma in high school children to be 34% (6). Dental trauma accounts for 18% of all injuries in pre-school children (7). It has been shown in many studies that males experience significantly more dental trauma (8-10). The most common etiology of trauma in permanent dentition is falls followed by traffic injuries, acts of violence and contact sports.

Complicated crown fractures are a subtype of crown fractures which describe the loss of hard tissues (enamel and dentine) along with the involvement of the pulp. As mentioned by Andreasen and Andreasen, a frontal impact, the energy of which exceeds the shear strength of enamel and dentine leads to crown fracture. The fracture line direction depends on the direction of impact but is usually horizontal and follows enamel rods' direction (4).

Maxillary central incisors are the most frequently injured teeth (7, 8, 11-13). An over jet greater than the normal range (0 -3.5 mm) increases the risk of trauma to maxillary

incisors (11). The long term prognosis of traumatized teeth depends on appropriate emergency management (14).

Dental trauma is a stressful condition for the child patient and parents or guardian. Therefore, calming down patient and parents followed by thorough examination is the first step in proper management.

The following should be considered prior to the treatment of a traumatized child patient.

## 2. Arguments

### 2.1. Evidence Acquisition

Pubmed and Scopus were searched using the following keywords: Immature, Incisor and Pulpotomy. More importantly, latest clinical guidelines provided by The British Society of Paediatric Dentistry, The Royal College of Surgeons of England, and National Institute for Health and Care Excellence were studied and incorporated into this paper (Grade 1 evidence).

### 2.2. History Taking and Examination of the Traumatized Patient

In order to accurately measure the extent of trauma to the child patient, a systematic examination is required. While gently cleaning soft tissues, an initial assessment of the extent of trauma may be made.

Medical history taking is followed by asking “how, where and when the trauma had happened” to aid the detection of other probably present injuries as well as estimating the degree of contamination and considering the time period between initial trauma and presentation in the surgery, respectively.

Asking about “loss of consciousness” and other signs of brain concussion requiring urgent medical attention is important but does not contraindicate emergency dental care.

“History of previous dental trauma” is significant when it comes to radiographic interpretation of findings such as pulp canal obliteration or arrested root formation while other teeth have complete roots formation.

History taking is followed by clinical and radiographic examination. Extraoral examination (i.e. symmetry, lymph nodes, and temporomandibular joint) as well as intraoral examination (i.e. wounds or lacerations of soft tissues, fractures of hard tissues, and fractures or infractions of teeth) would indicate the type of radiographs required. It is very important in the case of crown fractures to take a radiograph of the lip if any wound present, to find out if the missing fractured part of the tooth is embedded in soft tissues, if it is not brought along with the patient. It is usually hard to make sure in clinical examination as the orbicularis oris muscle closes tightly around foreign bodies in the lip. This radiograph requires only one-fourth of the normal exposure time.

An upper anterior occlusal view is also recommended together with an intra-oral periapical radiograph to investigate if any root fractures or alveolar fractures present.

Last but not least, it is recommended to take photographs following consent as a record for future comparisons or medical legal issues. It is noteworthy that inconsistency between the patient’s traumatic appearance and history provided by parents or guardian may indicate child abuse and should be reported.

The use of a proforma trauma stamp is strongly advised as an aide memoire in this stressful clinical situation (Appendices).

### 2.3. Biological Considerations

A brief view of the state of the pulp tissue in case of a complicated crown fracture is helpful in treatment planning. Exposed dentinal tubules and the exposed pulp allow direct and indirect insult to the pulp itself, this results in an inflammatory response from the pulp and formation of granulation tissue (15).

Soon after injury, the exposed pulp is covered with a layer of fibrin. Immediately sub-adjacent to the exposure site, a zone of acute inflammation is seen. Proliferative changes occur after 2 days and the pulp protrudes through the exposure. We should bear in mind that the inflammatory zone is still confined to the superficial 1-2 mm of the pulp even one week after injury (4).

Pulp status following crown fracture depends on differ-

ent factors such as: whether there is a concomitant luxation injury and the stage of root development, whether dentine has been exposed and if so, whether dentinal coverage has been carried out.

Luxation injury concomitant to crown fractures with or without pulp exposure is the primary source of pulpal complications following injury. Thus, even if it is exposed to an intact vascular supply, the pulp will defend bacterial invasion. In the case of associated luxation, these events may be modified by ischemia and autolysis of the pulp (4).

### 2.4. Treatment

Bahaviour management of a stressed patient may be done through using inhalation sedation. Paracetamol may be prescribed to ease pain.

Treatment of complicated crown fracture in general involves the desire for maintaining a vital pulp. If the tooth becomes non-vital at this point, the root development would immediately stop because leads to serious consequences for endodontic management. Therefore, it is important in these teeth to maintain pulp vitality in order to allow the normal process of root end closure (apexogenesis) to continue (16).

If all investigations show that the pulp is still vital and the patient has presented reasonably soon after trauma, our treatment options for this patient would be either direct pulp capping or pulpotomy (Cvek’s Pulpotomy, Coronal Pulpotomy).

As mentioned earlier, when trauma causes crown fracture and exposes the pulp, bacterial contamination of the pulp tissue will occur at the exposure site. Therefore, the time interval between injury and treatment is the key to the successful management. There is greater risk of bacterial contamination in larger exposures once exposed to the salivary organisms for prolonged periods.

Clinically, there are three important factors to monitoring: 1. exposure size, 2. degree of contamination and 3. time elapsed since exposure (16).

In case of the patient’s early presentation (within 24 hours) with small pulpal exposure, pulp capping is considered. One should be able to provide perfect coronal seal with an ideal restoration.

In this technique, the tooth is isolated with rubber dam and the fracture surface is cleaned with chlorhexidine. Calcium hydroxide paste is gently placed on the pulpal wound. Glass ionomer cement is placed over calcium hydroxide. The tooth then, can either be built up with composite resin adhesive materials or by the reattachment of the fragment, if possible, with composite resin. Fragment reattachment was shown to have better results in terms of long term prognosis and aesthetics (17). Radiographic evidence of hard tissue barrier can be seen in 3 months (18).

If the patient’s presentation lasts up to 4 days and pulpal exposure is larger than pinpoint in teeth with incomplete root development, pulpotomy is the treatment of

choice. The amount of pulp tissue that has to be amputated depends on the exposure size and degree of contamination. Amputation of the inflamed pulp can be done at two different levels; removal of 2 - 3 mm of the superficial pulp tissue that is called partial pulpotomy and removal of the coronal pulp called coronal pulpotomy (16). The two techniques will be explained in brief:

Partial pulpotomy, also called Cvek's technique, was first explained by Cvek (19). The aim of this procedure is to remove all possibly infected pulp tissues. The tooth is Anaesthetized and then isolated with rubber dam. Fracture surface is cleaned with chlorhexidine. The pulp is then removed to the depth of 2 - 4 mm using a round carbide bur or diamond mounted in an air rotor with water spray. Haemostasis is gained by placing a cotton pellet soaked in saline over the pulp for 5 minutes (4, 16). Once haemostasis presents, a thin layer of non-hard setting calcium hydroxide paste or mineral trioxide aggregate is placed and packed gently. A glass ionomer base is then placed and the tooth is restored by composite resin build up or fragment reattachment.

Coronal pulpotomy can be used in the same patient who has presented later than 4 days and; therefore, the pulp is contaminated. Having started with the Cvek's technique, if haemostasis is not achieved, more pulp tissues are amputated until all coronal pulps are removed. The same materials are used to restore tooth structure (4, 16).

### 2.5. Follow-Up

As encouraged by the International Association of Dental Traumatology (IADT) guidelines, the patient has to be seen in 6 - 8 weeks. If responses to pulp tests are positive and no signs of apical periodontitis present, the patient will be followed up in 1 year after the trauma. If favourable outcomes present, no further follow up has to be done. If signs of failure are detected, the same treatment will be carried out for non-vital tooth (20).

Clinical signs of success are described as: absence of any pain or discomfort from the tooth, normal colour of the crown, and no evidence of abscess. Radiographic signs as: no evidence of any periapical pathology and evidence of continued root development.

Pulp sensibility tests are done but one should not rely on results as sole indicators of success (16).

### 2.6. Prognosis

Prognosis depends on the presence of associated PDL injury, extent of exposed dentine and the age of pulp exposure.

The success rate for direct pulp capping was mentioned to be about 80%, Cvek's technique was 96% and success rate for coronal pulpotomy 75% (16, 18, 19, 21).

When pulp capping or pulpotomy is performed with calcium hydroxide, coagulation necrosis occurs immediately beneath calcium hydroxide, just below this zone a wound healing response can be seen where new odonto-

blasts are differentiated and begin to form new dentine. This happens 2 - 3 weeks after treatment. At this stage, up to 5 micrometer of dentine can be deposited daily. Therefore, a significant hard tissue barrier should be formed under the pulpal wound in 2 - 3 months.

In general, the following conditions should be fulfilled so that a hard tissue barrier formation can be expected:

- A) Pulp should be free of inflammation prior to injury.
- B) Vascular supply of the pulp should not be compromised by any associated PDL injury.
- C) Use of an appropriate pulp capping or amputation technique.
- D) Exclusion of bacteria in the pulp capping or pulp amputation zone throughout the healing period.

These treatment options were discussed for the vital traumatized tooth. If the patient presentation is very late and pulp contamination is gross, examinations and investigations will indicate non-vital pulp. At this point we will ask for a laser-Doppler flow investigation of the tooth if possible. This is the only test that can show pulp vitality (22). If results show non-vital pulp, treatment options will be different.

### 2.7. Prevention

It has been mentioned that 25% of children with traumatized teeth were subject to repeated trauma. It is likely that multiple dental traumas increase the possibility of the occurrence of a more serious injury to permanent teeth which results in the need for more complicated treatments (23). Therefore, more efforts are needed from parents, teachers and dental team to prevent trauma. We should definitely give useful prevention advice to the child patient and parents before discharging them. Recommendation methods include close supervision of children while playing, orthodontic treatment of children with excess incisal overjet, use of fitted mouth guards and use of helmets during athletic activities (24).

## 3. Conclusions

Management of traumatized young permanent incisors with exposed pulps and incomplete roots is challenging. It is important to try to preserve pulp vitality in order to gain continuous root formation. A high rate of success in Cvek's technique has been mentioned. Although there is also high success rate in the apexification technique, one should always start with less aggressive techniques if the tooth is yet vital. The authors strongly recommend the use of mouth guards in patients with excess overjet or involved in high trauma risk activities. Prevention is always easier than treatment.

### Footnote

**Authors' Contribution:** Mahshid Bagheri has written the manuscript and Mohammad Mortazavi has helped in proof reading, referencing and final checking for typos.

## Appendices

Please visit article's online version for appendices.

## References

1. 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):235-9. [PubMed: 4146883]
2. Andreasen JO, Andreasen FM, Bakland LK, Flores MT. *Traumatic dental injuries: A manual*. 2nd ed. Oxford: Blackwell Science; 2003.
3. Zerman N, Cavalleri G. Traumatic injuries to permanent incisors. *Endod Dent Traumatol*. 1993;**9**(2):61-4. [PubMed: 8404697]
4. Andreasen JO, Andreasen FM. *Essentials of traumatic injuries to the teeth*. 2nd ed. Copenhagen: Blackwell Munksgaard; 2000.
5. O'Brien M, O'brie M. *Children's dental health in the United Kingdom 1993*. London, UK: HM Stationery Office; 1994.
6. Hamilton FA, Hill FJ, Holloway PJ. An investigation of dento-alveolar trauma and its treatment in an adolescent population. Part 1: The prevalence and incidence of injuries and the extent and adequacy of treatment received. *Br Dent J*. 1997;**182**(3):91-5. [PubMed: 9055474]
7. Glendor U. Epidemiology of traumatic dental injuries—a 12 year review of the literature. *Dent Traumatol*. 2008;**24**(6):603-11. doi: 10.1111/j.1600-9657.2008.00696.x. [PubMed: 19021651]
8. Bastone EB, Freer TJ, McNamara JR. Epidemiology of dental trauma: a review of the literature. *Aust Dent J*. 2000;**45**(1):2-9. [PubMed: 10846265]
9. Stockwell AJ. Incidence of dental trauma in the Western Australian School Dental Service. *Community Dent Oral Epidemiol*. 1988;**16**(5):294-8. [PubMed: 3263252]
10. Perez R, Berkowitz R, McIlveen L, Forrester D. Dental trauma in children: a survey. *Endod Dent Traumatol*. 1991;**7**(5):212-3. [PubMed: 1687388]
11. Burden DJ. An investigation of the association between overjet size, lip coverage, and traumatic injury to maxillary incisors. *Eur J Orthod*. 1995;**17**(6):513-7. [PubMed: 8682168]
12. Castro JC, Poi WR, Manfrin TM, Zina LG. Analysis of the crown fractures and crown-root fractures due to dental trauma assisted by the Integrated Clinic from 1992 to 2002. *Dent Traumatol*. 2005;**21**(3):121-6. doi: 10.1111/j.1600-9657.2005.00276.x. [PubMed: 15876320]
13. Jackson NG, Waterhouse PJ, Maguire A. Factors affecting treatment outcomes following complicated crown fractures managed in primary and secondary care. *Dent Traumatol*. 2006;**22**(4):179-85. doi: 10.1111/j.1600-9657.2006.00369.x. [PubMed: 16872386]
14. Zadik Y. Oral trauma and dental emergency management recommendations of first-aid textbooks and manuals. *Dent Traumatol*. 2007;**23**(5):304-6. doi: 10.1111/j.1600-9657.2006.00443.x. [PubMed: 17803488]
15. Cvek M. Endodontic Management of Traumatized Teeth. In: Andreasen JO, Andreasen FM, editors. *Textbook and Color Atlas of Traumatic Injuries to The Teeth*. 3rd ed. Copenhagen: Munksgaard; 1993. pp. 517-85.
16. Curzon MEJ, Duggal MS, Fayle SA, Toumba KJ. *Handbook of dental trauma: a practical guide to the treatment of trauma to the teeth*. Oxford: John E Wright & Co Ltd; 1999.
17. Cavalleri G, Zerman N. Traumatic crown fractures in permanent incisors with immature roots: a follow-up study. *Endod Dent Traumatol*. 1995;**11**(6):294-6. [PubMed: 8617166]
18. Ravn JJ. Follow-up study of permanent incisors with complicated crown fractures after acute trauma. *Scand J Dent Res*. 1982;**90**(5):363-72. [PubMed: 6960466]
19. 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):232-7. doi: 10.1016/S0099-2399(78)80153-8. [PubMed: 283188]
20. Flores MT, Andersson L, Andreasen JO, Bakland LK, Malmgren B, Barnett F, et al. Guidelines for the management of traumatic dental injuries. I. Fractures and luxations of permanent teeth. *Dent Traumatol*. 2007;**23**(2):66-71. doi: 10.1111/j.1600-9657.2007.00592.x. [PubMed: 17367451]
21. Fuks AB, Cosack A, Klein H, Eidelman E. Partial pulpotomy as a treatment alternative for exposed pulps in crown-fractured permanent incisors. *Endod Dent Traumatol*. 1987;**3**(3):100-2. [PubMed: 3476297]
22. Strobl H, Emshoff I, Bertram S, Emshoff R. Laser Doppler flow investigation of fractured permanent maxillary incisors. *J Oral Rehabil*. 2004;**31**(1):23-8. [PubMed: 15125592]
23. Ravn JJ. Dental injuries in Copenhagen schoolchildren, school years 1967-1972. *Community Dent Oral Epidemiol*. 1974;**2**(5):231-45. [PubMed: 4154162]
24. Alonge OK, Narendran S, Williamson DD. Prevalence of fractured incisal teeth among children in Harris County, Texas. *Dent Traumatol*. 2001;**17**(5):218-21. [PubMed: 11678541]