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Crown – Root Fracture of Permanent Teeth

A project

Submitted to the College of Dentistry, University of Baghdad, Department of Pedodontics & Preventive Dentistry in partial fulfillment for the requirement to award the degree of B. D. S.

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Dedication

First of all, I will dedicate this project to our almighty God who gave me the strength, power and knowledge in everyday of life.

To my parents "I could never have done this without your faith, support, and constant encouragement". Thank you for teaching me to believe in myself, and in my dreams.

To my brother for his moral support, unconditional love ,patience and because he always understood.

To my close friends who make the hard days pass easier.

To my supervisor Dr.Noor Mohammed and all my teachers, doctors and Professors for their scientific support.

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First of all, I thank “Allah” almighty for granting me the will and strength to accomplish this project, and I pray that his blessings upon me may continue throughout my life.

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Finally, thanks to all of the teaching staff at the Department Pedodontics and Prevention; for their kind efforts.

Certification of the Supervisor

I certify that this project entitled ***" Crown – Root Fracture of Permanent Teeth "*** *was prepared by the fifth-year student* ***Maryam Tahseen Flaih*** *. under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the bachelor's degree in Dentistry.*

Signature

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List of Abbreviation

CA(OH)2	Calcium Hydroxide
CBCT	Cone beam Computed Tomography
CH	Chlorhexidine
CNS	Central Nervous System
GIC	Glass Ionomer Cement
MTA	Mineral Trioxide Aggregate
TMJ	Tempro-Mandibular Joint

Aim of the Project

The aim of the project was to review the types of fractures affecting permanent teeth in children exposed to traumatic injuries , and to highlight the treatment options available to manage such traumas.

Introduction

Increased knowledge of the pathophysiology of dental trauma has resulted in an improvement in the standard of care for traumatized teeth and an increase in the prognosis for such teeth. Teeth that would have been extracted in the past can often be maintained in function during adolescence and early adulthood **(Heasman, 2013)**.

It is well documented that the majority of traumatic dental injuries occur in children. Injuries to primary or permanent teeth can appear rather severe, particularly when associated with trauma to supporting tissues (Gottrup *et al* ,2007). Peak injury times occur at 2–4 years in the primary dentition when a young child is exploring and becoming adventurous and 7–10 years in the permanent dentition owing to falls when playing **(Heasman, 2013)**.

The most common type of injury to the permenant dentition is crown fracture, the teeth most frequently involved in trauma are maxillary central incisors The next most frequent group is that of maxillary lateral incisors and maxillary canines. Posterior tooth trauma is rather rare, and it is typically caused by jaw fracture; it usually involves longitudinal crown root fracture(Lam, *et al*., 2008).

The distribution of permanent teeth most frequently involved in trauma is similar to that of primary teeth , boys have been reported to be about twice as likely to suffer from dental trauma than girls **(Andreasenjo, *et al*., 2007).**

Crown fractures are caused by direct impact of teeth against hard objects or surfaces. Soft tissue impact on fixed surfaces of reduced hardness mainly causes luxation injuries. The outcome is dependent on the force of the impact **(Glendor, 2008)**.

The most common predisposing factor is increased overjet with protrusion of maxillary incisors. Insufficient lip coverage seems to play a role as well **(Lam, *et al.*, 2008)**. Hyperactive children, as well as those with frequent epileptic seizures or motor disabilities, are also more susceptible to dental trauma **(Sennhenn, *et al*., 2006).**

Review of literature

1. Traumatic Injuries

Definition

Traumatic dental injury a term which refers to physical injuries of sudden onset and severity to the teeth with / or it surrounding one and soft tissue which require immediate medical attention **(Heasman, 2013)**.

Almost half of permanent tooth trauma cases in the 7–18-year-old age group occur at school. Naturally, rates may vary among societies with different lifestyles **(Glendor, 2008)**. A 10% are caused by road accidents, if bicycles are also included **(Gottrup, *et al*., 2007)**. Sport injuries are frequent, particularly in contact sports, such as football, basketball, handball, and boxing. Many of "sport" injuries actually do not occur during an organized event but rather in backyard play where prevention is much harder to achieve **(Oldin, *et al*., 2015)**.

2.Consequences of Traumatic Injuries

Consequences of traumatic injuries is as follows **(Heasman, 2013)**: -

1- Fracture which include: -

• concussion which is with no abnormal loosening or displacement but marked reaction to percussion.

• Subluxation which appear with abnormal loosening but no displacement

2- Displacement which include: -

• Total Displacement (avulsion) which is complete displacement of tooth from socket.

•Partial displacement which include: -

• Lateral luxation which is Displacement other than axially with comminution or fracture of alveolar socket

• Intrusive luxation which is Displacement into alveolar bone with comminution or fracture of alveolar socket

3.Diagnosis

3.1 Medical History

A medical history is taken to find out about possible allergies, coagulation disorders, cognitive disorders, or other information that might affect the treatment plan. Part of this history taking should be assessment of any possible central nervous system (CNS) injuries, like brain concussion or intracranial hemorrhage. This is because every dental trauma is by definition a head injury **(Karolyhazy, *et al*., 2010)**. The most common signs of a CNS injury are loss of consciousness or post-traumatic amnesia; however, delayed reactions like loss of/or diminished consciousness, situational confusions, headache getting worse, nausea/vomiting, and or behavioral changes/unexplained irritation can be also signs. If there are any signs of brain injury, the patient needs to be referred immediately to appropriate emergency services **(McCrory, *et al.*, 2013)**.

3.2 Dental History

Whether at the initial phone call or once the patient has arrived at the dental office, the dentist needs to know what happened. For collecting reliable and comparable data, it is recommended that a standardized dental trauma sheet should be filled out. The most important questions that should be answered first are the following **(American Academy of Pediatric Dentistry, 2009)**: -

- When did the injury happen? The time intervening between the injury and the beginning of treatment is decisive for selecting the therapeutic protocol and for prognosis.

- Where did the injury happen? This information is important in order to find out how far the patient is from the dental office and also for social or/and legal purposes. If the injury happened in contaminated soil, anti-tetanus protection should be checked.

- How did the injury happen? The nature of the impact can lead to suspicions about the type of injuries to be expected. For example, a blow to the chin often results in condyle fracture or crown/root fracture in molars or premolars.

- Have the teeth been counted? Is any missing? If there is suspicion that a tooth may have been aspired into the respiratory tract, the patient is referred for a chest radiograph.

- Is there any difficulty in closing mouth or a malocclusion? If yes, there might be tooth displacement, alveolar process or jaw fracture, displacement, and / or fracture of a Tempro Mandibular Joint (TMJ) component.

- Did any tooth become mobile? If yes, a luxation injury is suspected.

3.3 Clinical Examination

3.2.1 Intraoral Examination

The patient is carefully examined for **(Bourguignon, *et al*., 2020)**: -

1- Edema or hemorrhaging in the gums or the mucosa

2- Malocclusion

3- Missing, displaced, loosened, or fractured teeth or teeth with enamel cracks.

4- Mobility: at the horizontal and vertical levels, considering the normal mobility of primary teeth ready to fall out and of permanent teeth recently erupted.

5- Percussion: sensitivity or pain means injury to the periodontal ligament, while a sound similar to that of an impacted metal object indicates the tooth has intruded into the bone.

6- Crown discoloration: it is likely to happen a few days after the accident, or it might have preexisted due to prior injury to the same tooth.

7- Reaction to sensitivity testing: the first few days, measurements may be unreliable but should be done because the information is useful for comparison purposes at later sessions or to other non-injured teeth.

8-Every injury to the lower face needs to be assessed for possible traumas caused to dental tissues and for any coexisting periodontal tissue trauma.

3.2.2 Extraoral Examination

The patient should be examined for the following **(Nikolaos Kotsanos, *et al*., 2022)**: -

1- The patient is checked for the presence of abrasions, edemas, bruising, hematomas (particularly in the conjunctivas), and hemorrhagic foci.

2- Facial bones should be palpated to locate any abnormalities that might lead to fracture. If the edema or pain does not allow direct palpation, appropriate radiographs should be taken.

3- The patient is to be asked to open and close his/ her mouth so as to identify whether there is limitation or deviation in the mandibular movement and to diagnose condyle fractures (e.g., temporomandibular disorders).

4.Classification of dental injuries

Injuries in permanent teeth are classified into **(Gawlak, *et al*., 2017)**: -

I- Injuries to the hard dental tissues and the pulp.

II - Injuries to the periodontal tissues.

III- Injuries to supporting bone.

IV- Injuries to gingiva or oral mucosa.

Injuries to hard tissue and pulp are further classified into (Fig. 1) **(Heasman,2013)**: -

A) Crown fracture which include: -

- enamel infraction
- enamel fracture
- enamel-dentin fracture (uncomplicated)
- complicated crown fracture

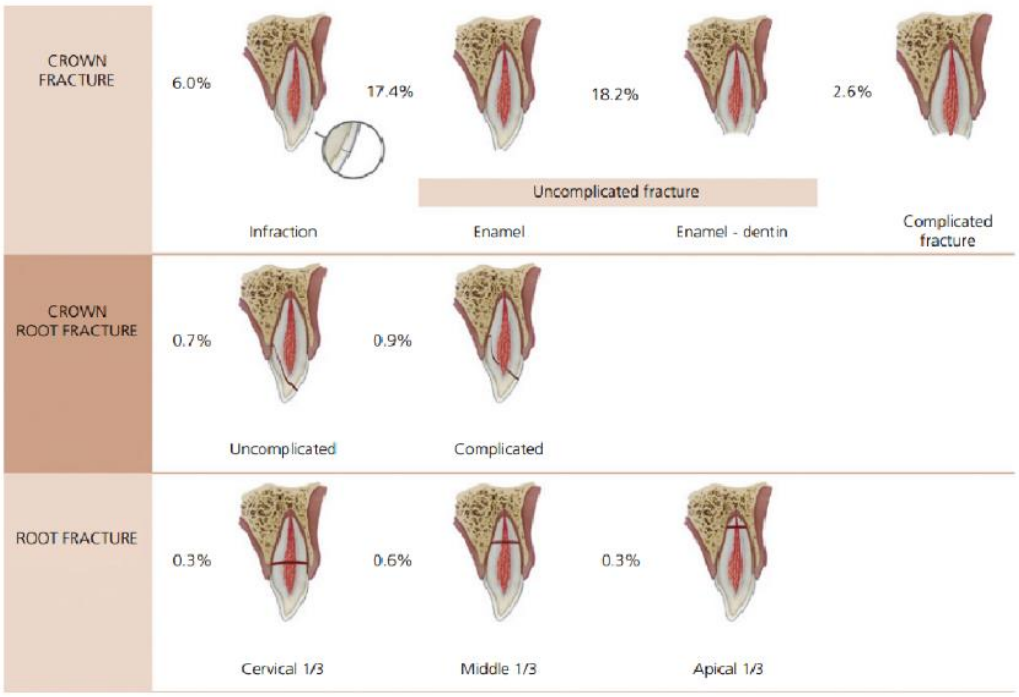

Figure 1: classification of hard tissue and pulp injury (Koch, *et al*., 2017).

B) Crown – root fracture is of two types: -

• uncomplicated crown root fracture

• complicated crown root fracture

C) Root fracture

4.1Crown fracture

4.1.1 Enamel Infraction

incomplete fracture crack of enamel without loss of tooth substance (Fig 2). infraction is frequent (10 – 12.5%) in permanent teeth, but often missed. It is caused by direct impact onto a hard object or surface and may appear along with other fracture types to the same or adjacent teeth **(Glendor, 2008)**.

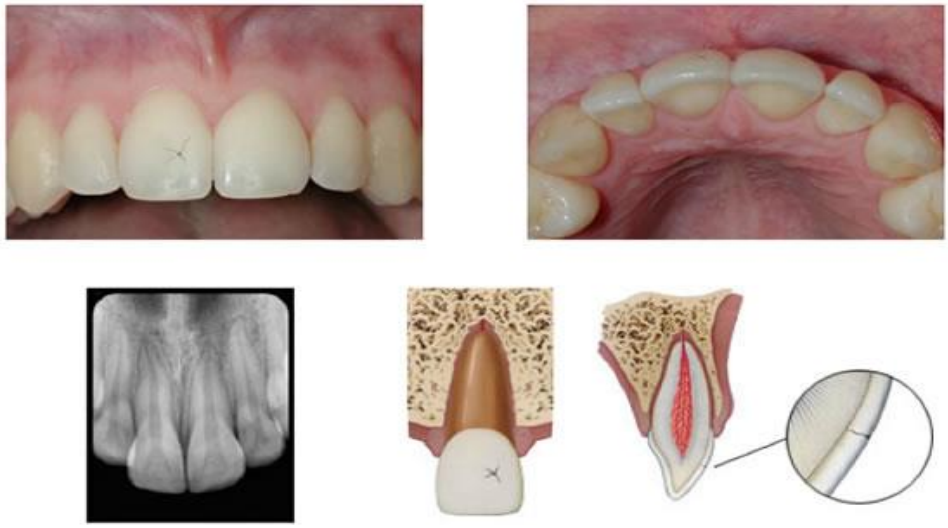

Figure 2 : Enamel Infraction (Nikolaos, *et al.*, 2022).

• Diagnosis

Cracks follow various directions and stop close to the dentin-enamel junction. Diagnosis is facilitated by the light scattering observed, due to the crack, when a light beam falls almost perpendicularly to the longitudinal tooth axis. Radiographic examination is recommended. Response to pulpal sensitivity tests is normal **(DiAngelis, *et al*., 2016)**.

• Treatment

In case of severe infractions, etching and sealing with bonding resin should be considered; otherwise, no treatment is required **(DiAngelis, *et al*,. 2016)**.

• Follow up

Clinical and radiographic recalls are not necessary in the cases of sole infractions. Pulpal necrosis rate is 3.5% and most probably caused by tooth concussion or loosening, which occurred at the same time as the enamel infraction but escaped attention. When an associated luxation injury is suspected, the cracked tooth should be followed more closely **(DiAngelis, *et al.,* 2016)**.

4.1.2 Complete Enamel Fracture

In this type of crown fracture, there is a partial enamel loss due to impacting on a hard object (Fig.3). The range of incidence rates in permanent teeth (26–76%) depends on the extent to which treatment is sought for such small injuries **(Petti, *et al*., 2018)**.

• Diagnosis

After the appropriate trauma form has been completed, an investigation should ensue as to whether additional trauma of a different kind occurred, such as root fracture. Root developmental stage affects tooth prognosis **(Petti, *et al*., 2018)**.

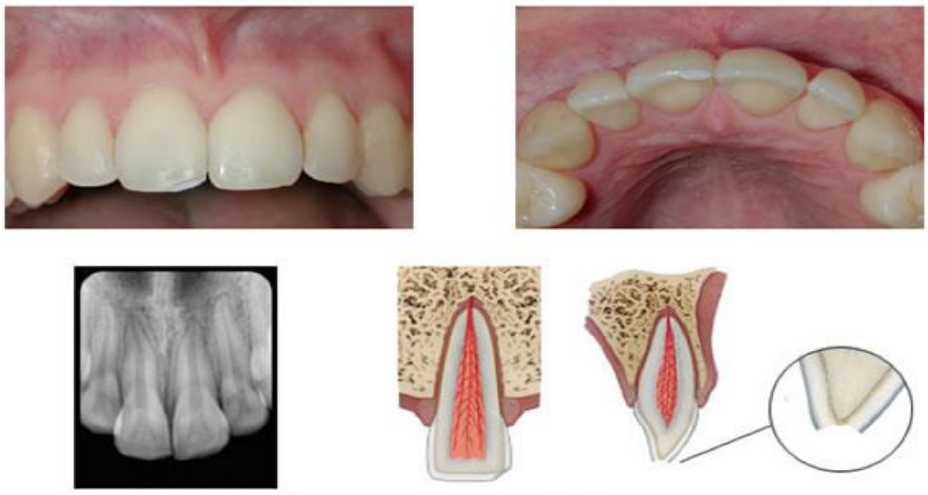

Figure 3 : Complete Enamel Fracture with partial enamel loss (Koch, *et al*., 2017).

• Treatment

Treatment depending on fragment size and patient's esthetic requirements, may comprise grinding to improve incisal edge appearance or crown reconstruction using tooth fragment if available or composite resin **(DiAngelis, *et al.*, 2016)**.

• Follow-up

Clinical and radiographic recalls as well as vitality tests should be performed at 6–8 weeks and 1 year after the injury. Pulpal necrosis rate is a mere 1.7%. However, if an associated luxation injury occurred or is suspected, the tooth should be monitored more closely **(Petti, *et al*., 2018)**.

4.1.3 Uncomplicated Crown Fracture

It's an enamel-dentine fracture without Pulp Exposure (Fig, 4), is the highest fracture incidence (40%) to permanent teeth The tooth needs to be restored the soonest possible, not only for comfort or esthetic purposes but also to prevent pulpal microbial infection due to exposure of a high number of dentinal tubules

to the oral environment which provide direct communication between the pulp and the oral cavity and allow bacteria as well as chemical and thermal stimuli to be transmitted in addition to avoiding issues such as deviation of adjacent teeth or overeruption of antagonists **(Gottrup, *et al*., 2007)**.

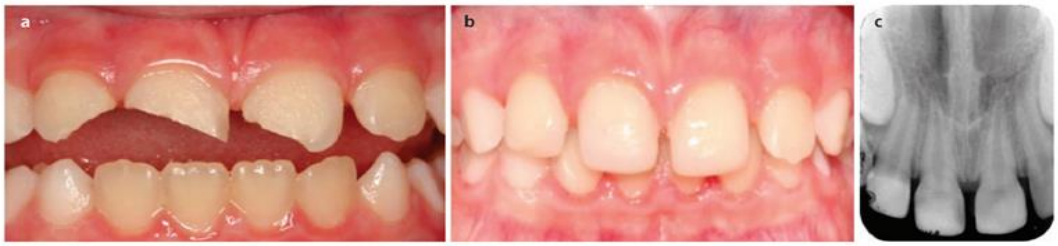

Figure 4: Enamel-dentine fracture without Pulp Exposure

(Nikolaos, *et al.*, 2022).

• Diagnosis

Radiographic examination is imperative to exclude the possibility of root fracture or tooth displacement **(Bourguignon, *et al*., 2020)**.

• Treatment

Restoring young permanent incisors with a ceramic crown should be avoided. There are two options for treating this type of permenant tooth fracture

I – if the broken fragment is lost , a composite buildup should be made as follows **(Bourguignon, *et al*., 2020)**:-

1. Rubber dam should always be used. isolating with a double lip retractor is not sufficient, since breathing vapors contaminate the etched surfaces and compromise adhesion.

2- Local anesthesia is not always necessary, since even if a thin dentin wall remains, it may be covered with a base such as Glass Ionomer Cement (GIC) and blowing or rinsing the tooth causes no pain any more.

3-Beveling broken enamel reinforces retention and improves esthetic result.

4- Dentin coverage if needed, etching, and the application of an adhesive, the composite resin should be applied using:

(a) celluloid partial or full strip crown, depending on whether the fracture is angular or almost horizontal, respectively (Fig,5).

Figure 5: Full strip crown for restoring a broken dental fragment (Oldin, *et al*.,2015).

(b) A more elaborate composite resin buildup may be made by taking a silicone impression and pouring a plaster model which is sent to a lab technician who will reconstruct the tooth and fabricate a “silicone key” or a mouth-guard (Fig, 6).

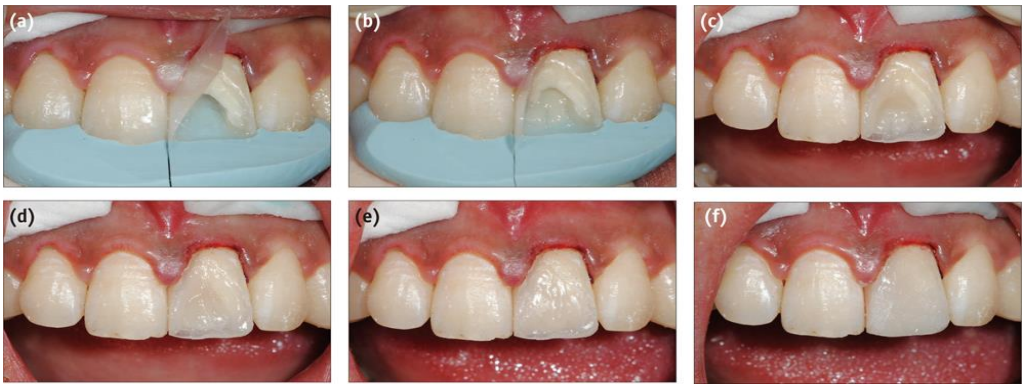

Figure 6: Silicone key for composite resin buildup (Nikolaos, *et al.*, 2022).

5-Using a palatal matrix to gradually add layers of enamel and dentin composite in different shades and forms trying to mimic a natural tooth.

6-Finishing and polishing are essential steps to obtain a good tooth-composite interface and an esthetically pleasing restoration.

II- If the broken fragment is found intact (Fig, 7).

it is an interesting esthetic option to consider bonding it back. The crown fragment should be kept moist or be rehydrated in water for at least 15 minutes before it is bonded **(Poubel, *et al.*, 2017)** .The Technique used for refitting a fragment of tooth as follows **(Heasman, 2013)** :-

1. Check the fit of the fragment and the vitality of the tooth.

2. Clean the fragment and the tooth with pumice-water slurry.

3. Isolate the tooth with rubber dam.

4. Attach the fragment to a piece of gutta-percha to facilitate handling.

5. Etch enamel for 30 seconds on both fracture surfaces and extend for 2mm from fracture line on tooth and fragment. Wash for 15 seconds and dry for 15 seconds.

Figure 7: A broken fragment is found intact a) Enamel–dentin fracture of the left central incisor in an 8-year-old boy. (b) The fractured crown fragment. (c) Condition immediately after reattachment of the fragment (Koch, *et al.*, 2017).

6.Dentine bonding agent directly applied after itching to both surfaces and then dry for 15–30 seconds. 7. Apply enamel–dentine bonding agent to both surfaces then lightly blow away any excess. Lightcure for 10 seconds.

8. Place appropriate shade of composite resin over both surfaces and position fragment. Remove gross excess and cure 60 seconds labially and palatally.

9. Remove any excess composite resin with sandpaper discs.

10. Remove a 1mm gutter of enamel on each side of fracture line both labially and palatally to a depth of 0.5mm using a small round or pear-shaped bur. The finishing line should be irregular in outline.

11. Etch the newly prepared enamel, wash, dry, apply composite, cure and finish.

• Follow-up

Clinical examinations including vitality testing and periapical radiographs need to be repeated at 6–8 weeks and 1 year following the injury. Pulpal necrosis has been shown to occur in 9% of such traumas, but this rate also depends on how soon after trauma the pulp was protected. If trauma to periodontal tissues happened as well, pulpal necrosis likelihood rises to 28%. The presence of a periapical radiolucency or root development interruption of young permanent incisors means that the pulp became necrotic and infected. This makes root canal treatment imperative **(Bourguignon,*et al*., 2020)**.

4.1.4 Complicated Crown Fracture

It is an enamel-Dentine Fracture with Pulp Exposure, The pulp is exposed to the oral environment and bacterial contamination starts immediately. That's why treatment should be provided the soonest possible **(Heasman, 2013)**.

• Diagnosis

Crown fracture with pulp exposure does not automatically cause pain, but sensitivity to hot and cold stimuli, as well as low intensity pain during mastication. The scale of pulp exposure and the time interval between injury and treatment a direct effect on the inflammatory reaction extending into the pulp. At the initial examination, pulp sensibility tests are unreliable and pulp vitality can be perceived visually. Radiographic examination is imperative, similar to the previous types of trauma, so as to exclude the possibility of root fracture and to confirm apex status **(Bourguignon, *et al*., 2020)**.

• Treatment

The aim of pulpal treatment is to maintain pulp vitality to allow immature teeth to complete their root development. Root canal treatment should thus be avoided. Treatment depends on root formation stage and degree of pulpal inflammation. Such treatment options include the following **(Arapostathis, *et al.*, 2005)**:-

A- Direct pulp capping,

B- Partial pulpotomy

C- Cervical pulpotomy

D- Root canal treatment

A- Direct pulp capping

The success rate of this procedure is lower than Cvek's partial pulpotomy; therefore, direct pulp capping is not frequently recommended. Ideal clinical prerequisite conditions for direct pulp cover are to observe a vital pulp where the

pulp exposure is limited (up to about 1 mm) and for the intervention to take placesoon after the trauma (up to several hours). Besides, the pulp should be free of inflammation owed to another cause, e.g., deep caries **(Poubel, *et al*., 2017)**. steps followed are **(Lauridsen, *et al* , 2012)**:-

- Local anesthesia without vasoconstrictor.

- Tooth isolation with rubber dam.

- Cleaning of tooth surfaces and disinfection of tooth and rubber dam.

- Rinsing and disinfection of the pulpal exposure with saline solution. Blood clot presence reduces the likelihood of healing, either by preventing direct contact of therapeutic agents with pulp tissue or because the space left after its decomposition is inviting bacterial presence.

- Once hemostasis is obtained, calcium hydroxide (CH) powder mixed with saline or anesthetic solution to the consistency of a paste is applied; this remains the gold standard for pulp coverage. Alternatively, MTA has been used in the recent past years and has been shown to favor dentin bridge formation and pulp vitality maintenance as well. However, MTA, whether gray or white, has been shown to create tooth discoloration, and its use is not recommended anymore for pulp capping, especially in anterior teeth. Biodentine, a new bio ceramic cement, seems to be a promising material for pulp capping, but more studies are needed before its widespread use can be safely recommended **(Bourguignon, *et al.,* 2020)**.

- When Ca(OH)2 is used as the pulp dressing material, it should be covered hermetically. Glass ionomer cements seem to provide an adequate marginal seal before the tooth is restored with composite resin **(Suzuki, *et al*., 2010)**.

B-Partial Pulpotomy

In cases of more extensive pulp exposure and delayed arrival at the surgery (up to 2 days following the injury), partial pulpotomy is preferred (Cvek technique) in order to remove the inflamed portion of the pulp first. The aim is to obtain a dentin bridge formation below the cover material. The technique is recommended for either mature or immature teeth. After anesthesia and rubber dam isolation, the technique steps are the same as described above for direct pulp capping; however, an additional step is required, the partial amputation of the pulp before the placement of the capping material as shown in figure (Fig, 8) **(Bourguignon, *et al*., 2020)**. The amputation is done as follows **(Suzuki, *et al*., 2010)**: -

- A small reservoir of approximately 2 mm deep is created by amputation of the exposed pulp with a high-speed sterile bur under copious water spray. A diamond causes less damage than a low-speed bur or an excavator.

- Pulp bleeding can be arrested by placing a cotton pellet soaked in saline on the pulp stump with light pressure for a few minutes or by rinsing gently the pulp wound with sodium hypochlorite. Allowing time for hemorrhage control is important. However, if hemostasis is not achieved, this likely means that the inflammation extends beyond the prepared zone and that it is necessary to amputate the pulp further, more cervically.

- In Cvek's pulpotomy technique, the pulp is then covered with a thick calcium hydroxide paste.

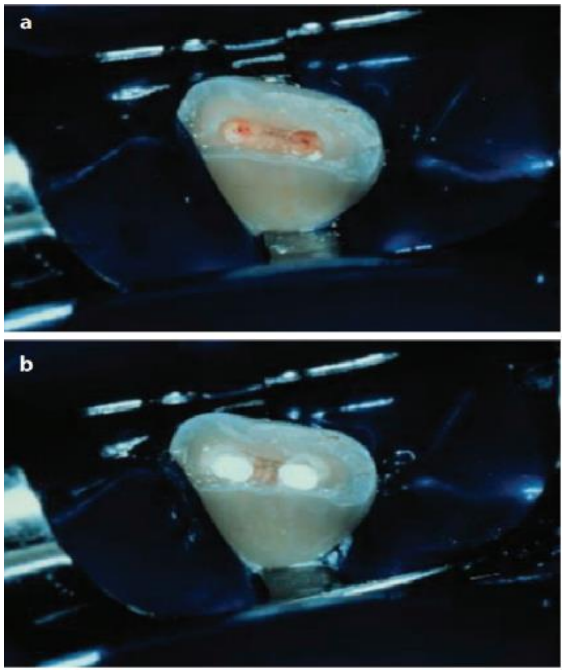

Figure 8 : Cvek's partial pulpotomy. a A small reservoir, almost a box of approximately 2 mm, is created by amputation of the exposed pulp with a high-speed sterile bur under copious water spray.. b After obtaining hemostasis, the pulp is covered with a thick calcium hydroxide paste (mixture of calcium hydroxide powder with saline or anesthetic solution). A hermetic seal covering the calcium hydroxide should then be placed before fragment bonding or composite buildup (Nikolaos, *et al*., 2022).

C. Cervical pulpotomy

As in the case of pulp exposures due to caries, cervical pulpotomies are usually performed on immature permanent teeth when the objective is to attempt to maintain root pulp vitality (Fig, 9). This is preferred in cases when the inflammation is quite advanced due to major pulp exposure and when a longtime interval since trauma has elapsed, maybe exceeding 3–4 days. This is sometimes indicated for teeth that have also suffered other injuries as well. The technique is the same as partial pulpotomy; however, pulp amputation is done at the cervical level of the tooth **(Hafez*, et al*., 2002)**.

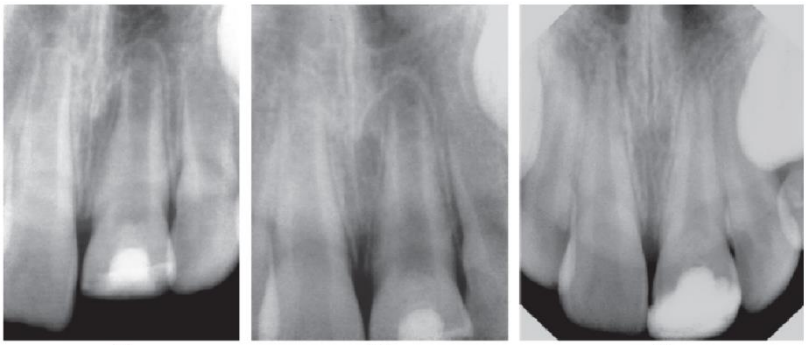

Figure 9: Cervical Pulpotomy on a maxillary left central incisor with an open apex. (a) Radiograph 3 months after pulpotomy. Note the dentin bridge. (b) Radiograph 6 months after pulpotomy. The dentin bridge has thickened. (c) Radiograph 3.5 years after Cvek pulpotomy. The root formation is completed and the apex closed. The dentin bridge has thickened but the root is free of abnormal calcification (Hafez, *et al*., 2002).

Restoration

After any of the three pulp treatments described above, crown restoration is performed as already discussed, with composite resin reconstruction, possibly with the “silicon key” technique, or with reattachment of the broken crown fragment.

Quite often though, tooth eruption is in process, and part of the fracture line may lie under the gingiva. In these cases, the cervical area may be restored by using resin modified glass ionomer cement (RMGIC) or, even better, the total reconstruction can be made by using exclusively RMGIC, which can be considered as temporary until the tooth has sufficiently erupted. **(Nikolaos, *et al*., 2022)**.

Follow-up

In all three treatment modalities described above to tackle exposed vital pulps, clinical and radiographic examinations, in combination with sensibility testing, are important and should be repeated on follow-up visits at 6–8 weeks, 3 months, 6 months, and 1 year following the injury **(Bourguignon, *et al* , 2020)**. Clinically, it should be confirmed that there is no pain or apical inflammation and that the crown color is normal. Radiographs should confirm continuing root development. If a periapical radiolucency appears, root canal treatment should be performed **(Nikolaos ,*et al* ,2022)**.

4.2 Crown-Root Fracture

Crown-root fractures to permanent anterior teeth are not so common. They have been reported to appear in 0.5–5.5% of all dental trauma cases to permanent teeth **(Nikolaos, *et al*., 2022)**.

Treatment depends on the depth of the fracture line within the bone socket and the ensuing difficulty of isolation and restoration. The more apically the fracture line ends, the worse the prognosis **(Zhen, *et al*., 2017)**.

The typical crown-root fracture is oblique in a labial-palatal direction it starts a few mm supragingivally on the labial surface and ends 2–5 mm sub gingivally in the palatal aspect.

In this case, radiographic diagnosis presents some difficulties. If the crown component is retained in place by periodontal fibers, it may present a wide range of mobility levels, depending on how far sub gingivally its palatal border lies. There is usually a pulp exposure. More rarely, the fracture line may be almost parallel to the longitudinal tooth axis **(Nikolaos,*et al.*, 2022)**.

Crown – root fracture divided into **(Zhen, *et al*., 2017)**:

1- Uncomplicated crown root fracture includes, Fracture of enamel, dentine and cementum but not involving the pulp.

2- Complicated crown root fracture includes, Fracture of enamel, dentine, cementum and exposing the pulp.

4.2.1 Diagnosis

It is achieved through clinical and radiographic examination to exclude the possibility of additional root fracture or displacement. Cone beam computed tomography(CBCT) can be considered for better visualization of the fractured path, its extent, and its relationship to the marginal bone **(Bourguignon, *et al.*, 2020)**.

4.2.2 Treatment

Prior to attempting any treatment, a decision must be made on whether the remaining tooth structure will be mechanically strong enough to support a future restoration. If not so, it is wise to consider the possibility of submerging the root, rather than attempting to extrude it to create restorable margins. Options for treating this type of fracture are discussed below **(Faria, *et al*.,2015)**:

1-Removal of the crown part and restoration

This is the most conservative way to treat a fracture, and it may be preferred if part of the fracture line lies only slightly sub gingivally **(Zhen, *et al*, 2017)**.

The crown part may be restored by reattaching the broken fragment, by composite resin buildup or through a prosthetic crown (Fig, 10). However, isolation problems usually prevent ideal bonding at the subgingival border (Bourguignon*, et al*., 2020).

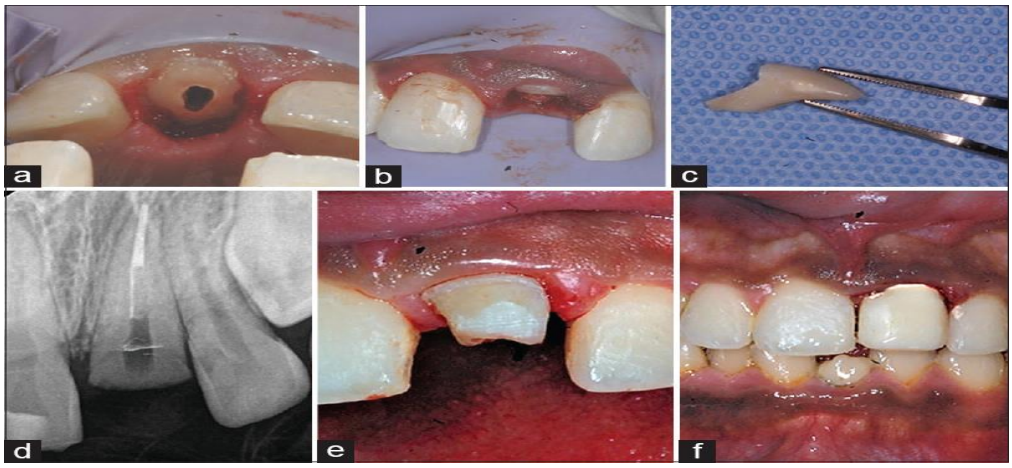

Figure 10: Clinical photos after removal of the broken coronal segment (a-c). Periapical radiograph after root canal treatment and postspace preparation (d). Clinical photo of core buildup (e). Clinical view after cemented temporary crown (f) (Bourguignon, *et al.*, 2020).

2-Gingivectomy (and osteotomy, if necessary)

This may be indicated in cases where the subgingival fracture line lies in a region of no esthetic concern, e.g., in the palatal surface. However, there is risk of failure due to the development of persistent periodontal inflammation palatally **(Zhen, *et al*., 2017)**.

3-Orthodontic extrusion of the tooth with or without gingivoplasty

This approach is more time consuming when compared to the surgical approach, since it usually takes 5 weeks to obtain 2–3 mm extrusion, as well as at least another 8–10 weeks of splinting to retain the tooth in its new position.

The depth of the fracture line is important because the crown/root ratio following extrusion should be at least 1:1 after crown reconstruction. Since there is concomitant displacement of the bone and periodontal tissues along with the tooth movement, lateral fiberotomy has to be performed every 7–10 days during the orthodontic traction period. Alternatively, bone and gum remodeling may be performed in a single procedure at the end of orthodontic traction **(Faria, *et al.*, 2015)**.

Figure 11 :Orthodontic extrusion of upper right permenant central incisor With crown root fracture after traumatic injury (Nikolaos, *et al.*, 2022).

4-Surgical extrusion of the tooth

This is an intentional partial avulsion so that the root is repositioned to a more coronal position to allow fracture margins to lie at the level of the gingiva. Following splinting in the new position, the tooth should receive root canal treatment. Prognosis is good, but there is 5% possibility for the root to resorb within 3 years **(Nikolaos, *et al.*, 2022)**. or, according to other authors, 12% in 4 years **(Elkhadem, *et al.*, 2014)**.

5-Extraction

Finally, there is the option of extracting the tooth if none of the solutions above is suitable. Prosthetic treatment at a later stage may, however, be quite complex, because alveolar bone resorption increases with time **(Bourguignon, *et al*., 2020)**. This is why the solution of allowing the tooth root to remain, through the excision and removal of only the coronal fragment followed by suturing of the gingiva, has been proposed **(Salama,*et al*.,2007)**.

Retaining the root contributes toward maintaining alveolar crest volume so that it may be removed as late as possible after puberty, only if necessary and when the timing of implant placement is deemed appropriate A midterm prosthetic appliance will have to be made for the patient. Allowing the root to remain submerged and placement of a Maryland bonded bridge is also a very good option for these patients **(Malmgren, *et al*.,2015)**.

4.3 Root Fracture

Root fracture is a combination of pulp, dentin, cementum, and periodontal membrane trauma; it appears relatively rarely at a rate of 0.5–7.5%. Teeth process **(Malmgren, *et al.,* 2015)**. most often involved are maxillary central incisors, at a rate of 75%. In young patients, whose permanent incisors are immature and at various eruption stages, root fracture is a rather rare event. Socket elasticity probably makes such teeth more susceptible to displacement and avulsion rather than root fracture **(Jensen, *et al*., 2009)**.

Root fractures may be horizontal (Fig, 12) (transverse), oblique, or vertical (longitudinal). The latter often appears in mature teeth with an intra-radicular post and prognosis is bad. Horizontal and oblique fractures are more frequent and are distinguished into simple and multiple ones. Simple ones have a better prognosis.

They are distinguished into apical third, middle third, and cervical third fractures of the root. Prognosis is worse in cervical to middle third fractures due to less periodontal support during their potential healing process **(Maki, *et al.*, 2005)**.

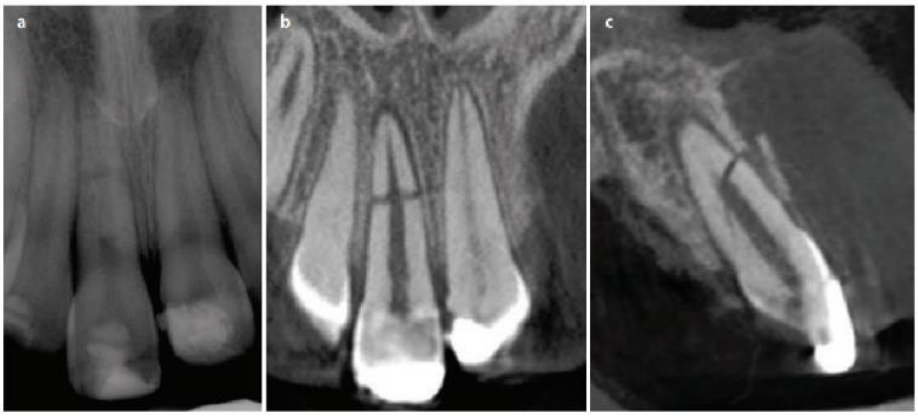

Figure 12 : (A) Periapical radiographic view of maxillary permanent right central incisor presenting a horizontal middle third root fracture. (B) The cone beam coronal view shows the same. (C) However, the cone beam sagittal view reveals that the fracture line is oblique and more complex: from the labial, it starts horizontally but then takes a vertical direction downward to the alveolar bone crest palatally. (Nikolaos, *et al.*, 2022).

Diagnosis

Horizontal and oblique root fractures may be difficult to diagnose clinically. Indeed, sometimes they may be erroneously diagnosed as tooth loosening (subluxation) or lateral displacement (lateral luxation) since clinical characteristics are the same. Furthermore, they may be missed, due to the presence of a more visible dental trauma, such as a crown fracture.

Involved teeth might be sensitive to percussion and palpation, and the coronal fragment may be slightly displaced lingually, labially, and/or incisally **(Faria, *et al*., 2015)**.It is also likely that the radiograph does not reveal a root fracture immediately after the injury, but at a later point in time. This is most probably due to either hemorrhage or granulomatous tissue formation at the fracture line, which gradually displaces the coronal fragment incisally **(Maki, *et al*., 2005)**. Additionally, depending on the direction of the radiograph beam, some root fractures may be undetectable. That's why, radiographic assessment comprises taking three periapical radiographs from different angles, plus an occlusal radiograph (CBCT) examination is also extremely helpful to diagnose the true extent of root fractures **(Bourguignon, *et al*, 2020)**.

Treatment

The basic principle for treating root fractures in permanent teeth is to reposition the luxated and mobile coronal fragment and immobilize it with a splint. Repositioning is performed under local anesthesia and confirmed through radiographic examination. Splinting is performed, for instance, with a passive twist fix wire and composite resin on the labial surface of affected and adjacent teeth. The splint should be semiflexible and passive, without applying forces on the teeth. Splinting should remain for about 4 weeks but may stay up to 4 months if the fracture is located at the cervical third of the root **(Bourguignon, *et al*., 2020)**.

Conclusion

Traumatic dental injuries are recognized as public dental health problem worldwide, that require adequate planning and interventions to prevent their occurrence. Safety measures should be implemented where dental traumatic accidents occur most frequently like at home and on roads.

The excess of activities can cause common dental trauma in childhood. These activities vary depending on the seasons in our country and region. also, Aesthetic and functional implications of tooth fracture depend upon its severity and age of the patient.

Clinical considerations for the management of crown root fractures include extent and pattern of fracture, restorability of remaining tooth, availability of fractured fragment, and damage to the attachment apparatus. Although dental caries and periodontal problems are decreased owing to increase in preventive dentistry applications, epidemiological studies show that traumatic dental injuries still constitute a significant percentage in children.

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