

The Role of Endodontics After Dental Traumatic Injuries



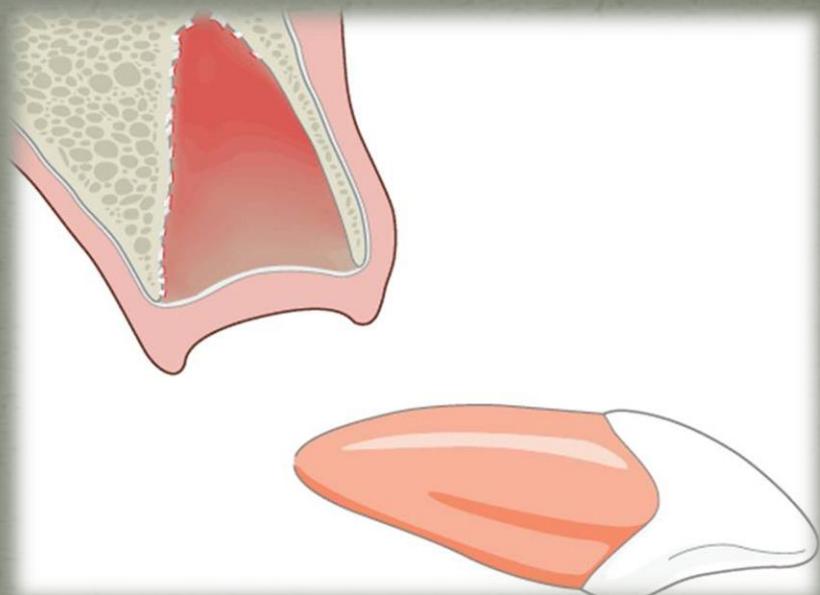
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A tooth that has been knocked out starts to die within 15 minutes, but if you put it in milk or hold it in your mouth it will survive longer.

FUN FACTS



LEARNING OBJECTIVES

1. Describe the clinical and radiographic features of various types of traumatic injuries listed below*
2. Describe pulpal, peri-radicular and hard tissues responses to the various types of traumatic injuries
3. List the information needed to be gathered from the patient: health history, nature of injury, and symptoms, etc.
4. List, describe and interpret the findings of the diagnostic tests and procedures used in examining patients with dental injuries
5. Describe the treatment strategies for various types of traumatic injuries.
6. Recognize outcomes of traumatic dental injuries.
7. Describe the differences in treatment strategies for traumatic dental injuries in primary and permanent dentition.

*Enamel fractures, uncomplicated crown fractures, complicated crown fractures, crown-root fractures, root fractures, concussion, subluxation, luxations (lateral, extrusive, and intrusive) and avulsions.



Most dental trauma occurs in the 7-12 year-old age group and is mainly due to falls and accidents near home or school. It occurs primarily in the anterior region of the mouth, affecting the maxillary more than the mandibular jaw.

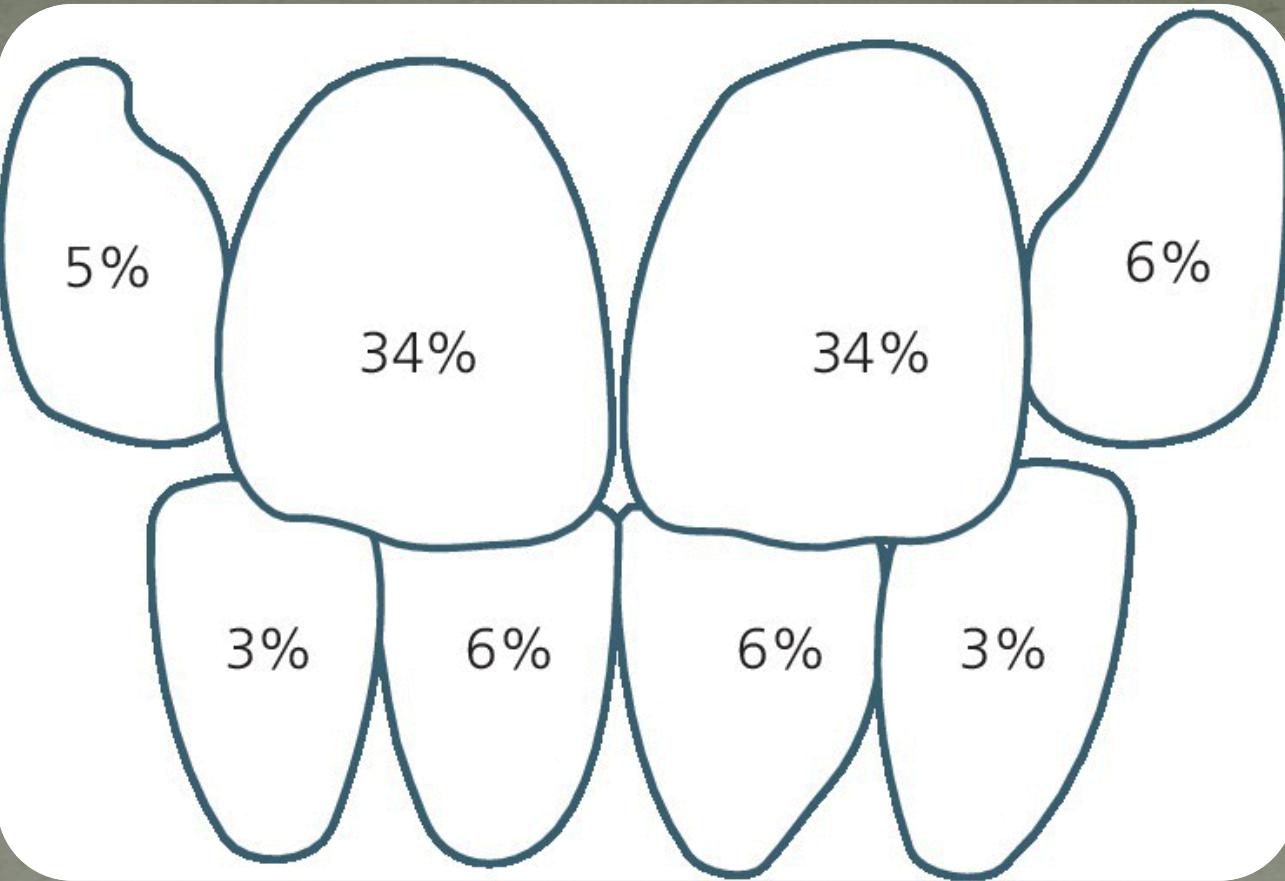
TRAUMA



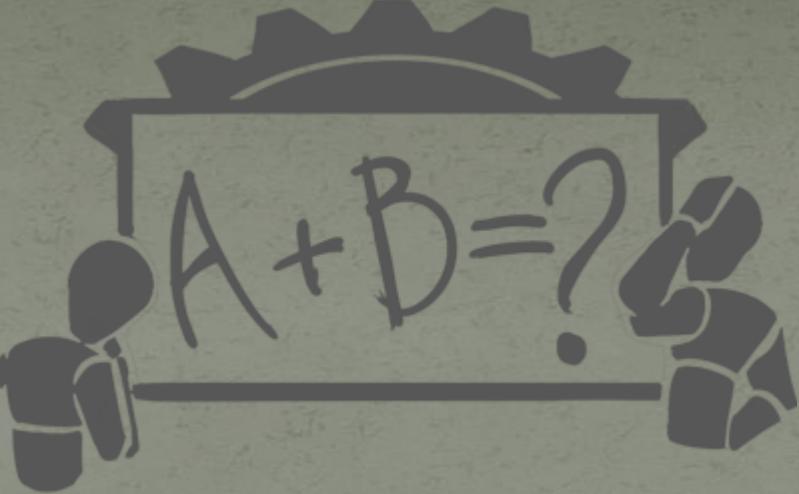
An overjet of 3 mm or greater increases the likelihood of suffering dental trauma. For those with an overjet of 9 mm or greater (image) the risk of trauma doubles.



Serious accidents, such as automobile crashes, can affect any tooth and can occur in all age ranges.



Distribution of injuries of the most frequently injured permanent teeth. 97% of all injuries: incisors.



The most important concept of managing dental trauma is to feel confident in the diagnosis. In the present litigious society, every clinician should know the proper guidelines for treatment of traumatized teeth to avoid the potential risk of litigation.



Occlusal accommodation and mouthguards for prevention of orofacial trauma.

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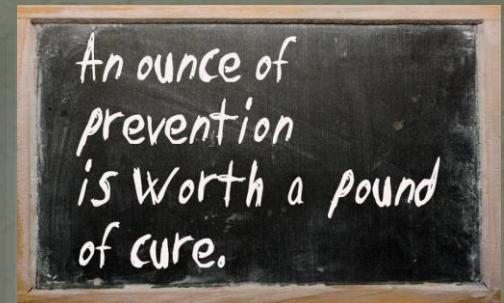
Abstract

PURPOSE: The aim of this study was to investigate the effect of two types of occlusal accommodation on the arch separation in centric and eccentric arch positions and to assess the opposing tooth contacts in professionally made, thermoformed sports mouthguards.

MATERIALS AND METHODS: Maxillary and mandibular alginate impressions, a wax interocclusal record of centric occlusion together with maxillary/condylar face-bow registrations, were recorded clinically for 10 undergraduate dental students who are sports activist volunteers of the School of Medicine and Dentistry, Queen's University Belfast. Two ethylene vinyl acetate thermoformed maxillary mouthguards were made for each player ($N = 20$) using a standardised procedure. Ten mouthguards served both as the control (i.e. the non-accommodated) group and also the accommodated, occlusally 'imprinted' group. The other 10 mouthguards served as the accommodated group. Casts were articulated, each non-accommodated and accommodated mouthguard was seated and the maximum vertical opening was recorded in all three arch relationships. The number of mouthguard and mandibular tooth contacts in each position.

RESULTS: The increased vertical occlusal dimension that was found in the presence of non-accommodated mouthguards was due to the sheet thickness of the material that was used to form the mouthguards. Only mouthguards accommodated by the teeth had increased occlusal contact in all arch relationships that were tested.

CONCLUSIONS: Within the limitations of this study, the modification of the occlusal surface made by flat grinding of the teeth in eccentric movements and increased the opposing tooth contacts in custom-made mouthguards. This may enhance patient compliance and the protective effect of these appliances thus resulting in a reduction of injuries to the teeth, and possibly to the head.

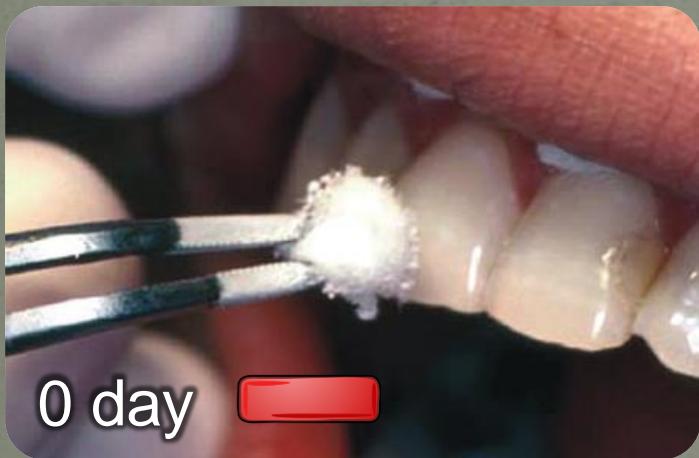


Important Aspects: Electric and Thermal Tests

- Traumatized teeth are vulnerable to false-negative readings from EPT or thermal stimulus: Traumatized teeth that yield no response cannot be assumed to have necrotic pulps.
- Teeth that give a response to thermal and electric tests at the initial examination cannot be assumed to be healthy and to continue to give a response over time.

Important Aspects: Electric and Thermal Tests

-The transition from **-ve** response to **+ve** response at a subsequent test may be considered a sign of a healing pulp. The repetitious finding of responses may be taken as a sign of a healthy pulp.



0 day



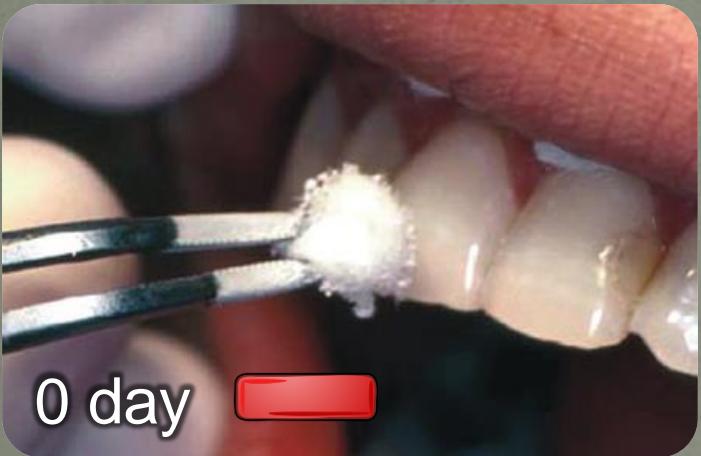
6 weeks later +



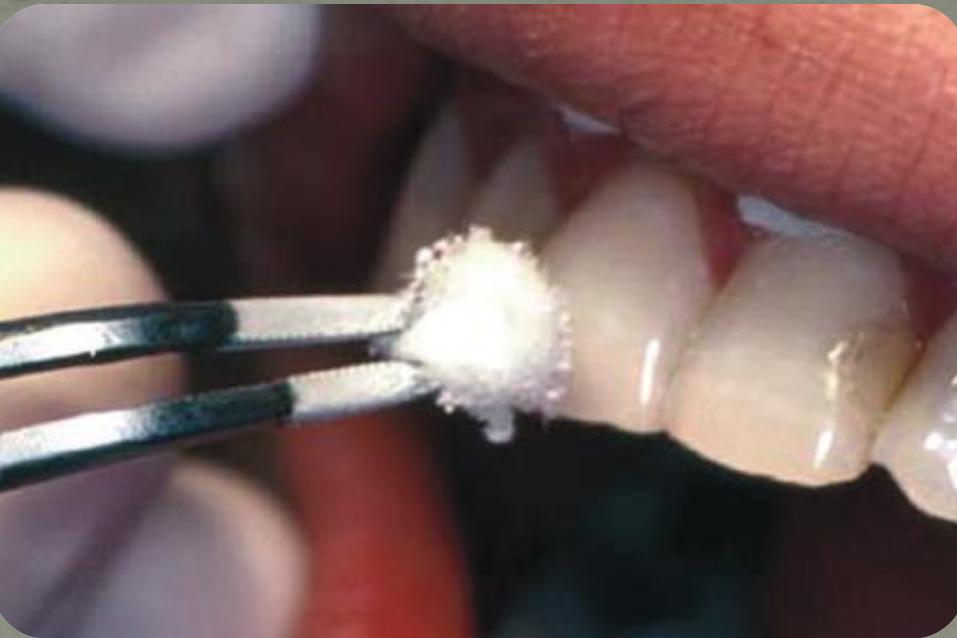
12 weeks later +

Important Aspects: Electric and Thermal Tests

-The transition from a response to no response may be taken as an indication that the pulp is probably undergoing or

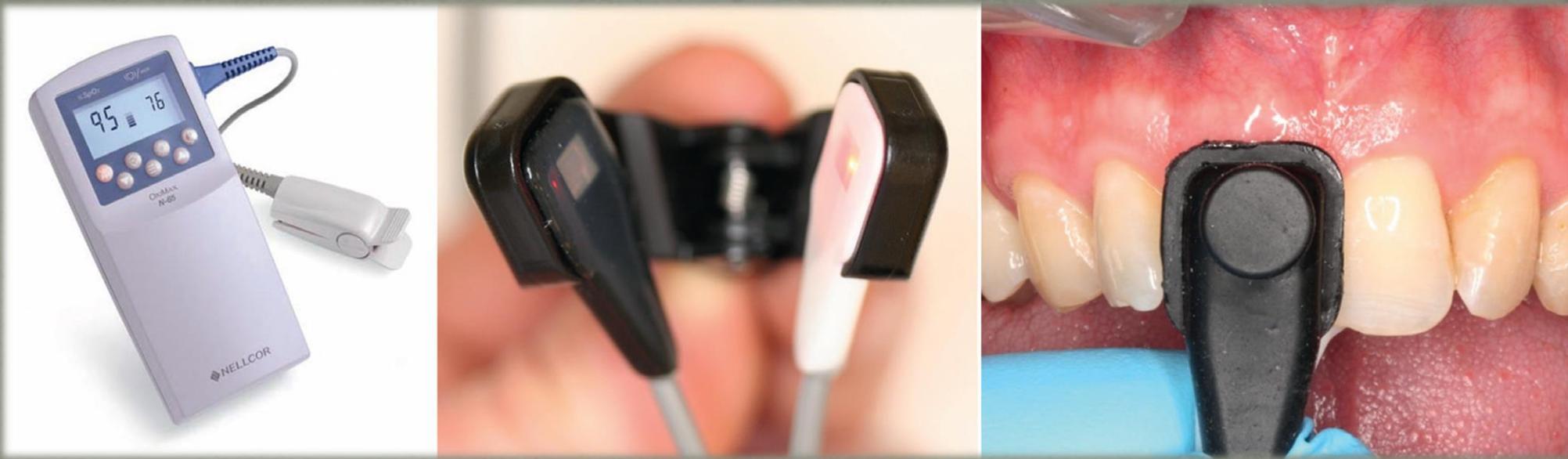


Important Aspects: Electric and Thermal Tests



Thermal test and EPT of all anterior upper and lower teeth should be performed/recorded at the time of the initial. These tests should be repeated at 3 weeks; at 3, 6, and 12 months.

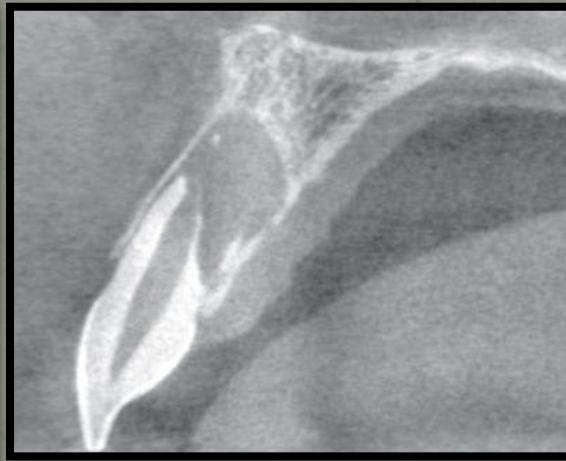
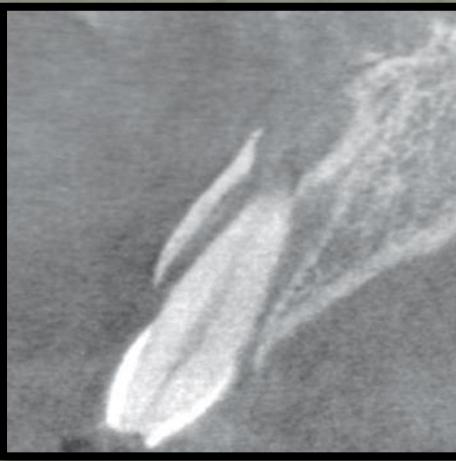
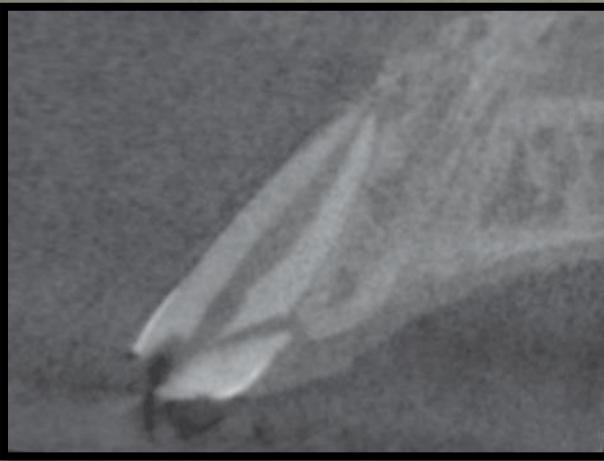
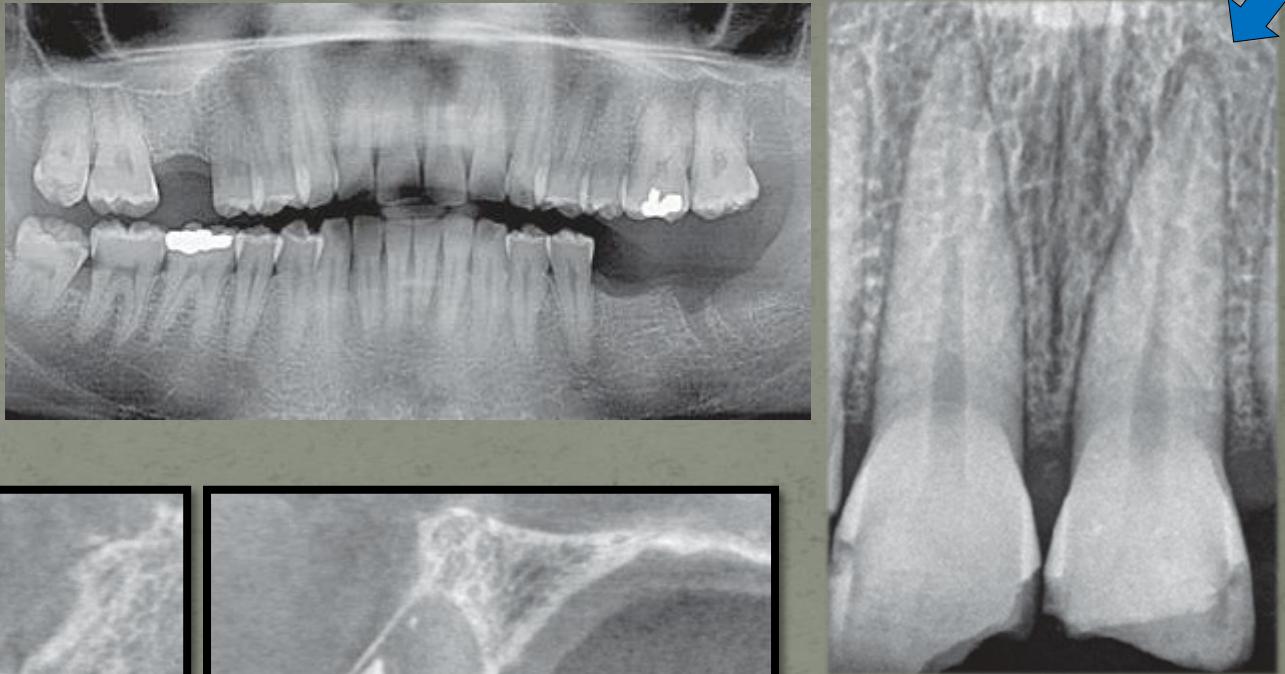
Pulpal Blood Flow



Pulse oximetry unit with a commercially available sensor that fits dental tissues.

Radiographic Examination

Perhaps the use of CBCT imaging for dentoalveolar injuries will be considered “best practice” sometime in the near future.



Radiographic Examination



Poorly healed laceration:
suspected missing fragment



Healing

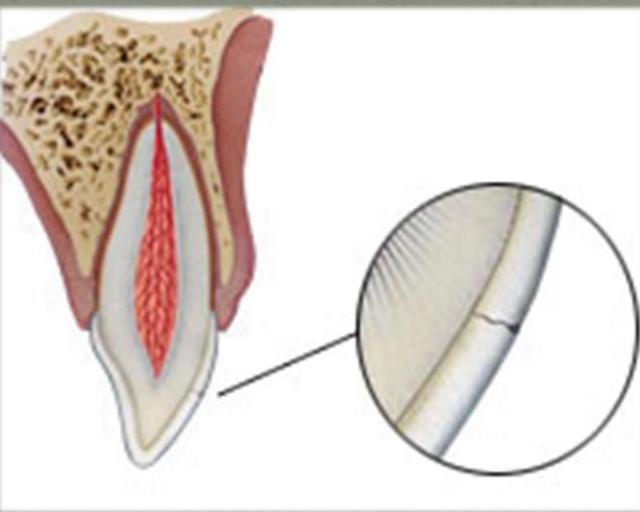


Radiograph the injured area: A soft tissue radiograph with a normal-sized film briefly exposed at reduced kilovoltage should reveal the presence of many foreign substances, including tooth fragments

CROWN FRACTURES

Crown Infraction

Incomplete fracture or a crack in enamel, without loss of tooth structure. Enamel infractions as a rule do not require treatment. However, in severe cases of multiple infraction lines, the indication might be to seal the enamel surface with an adhesive to prevent taking up stains.



CROWN FRACTURES

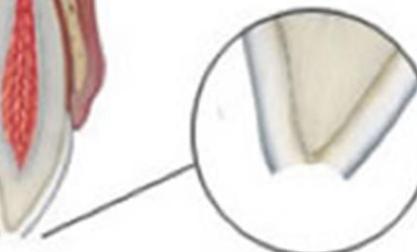
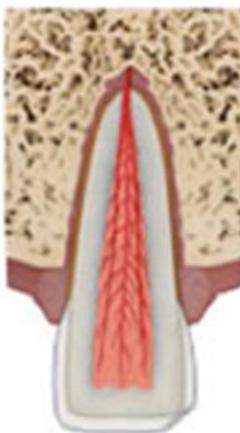
Uncomplicated Crown Fracture

Fracture of the enamel only or the enamel and dentin without pulp exposure. The most commonly (1/3 to 1/2) reported dental injury. It has little danger of resulting in pulp necrosis. The biggest danger to pulpal health is iatrogenic (during aesthetic restoration) of these teeth.

CROWN FRACTURES

Uncomplicated Crown Fracture

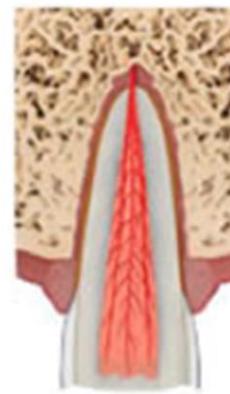
In Enamel



CROWN FRACTURES

Uncomplicated Crown Fracture

In Enamel and Dentin



CROWN FRACTURES

Uncomplicated Crown Fracture: Treatment

- Exposed DT need to be closed as soon as reasonably possible by: Fragment reattachment, composite restoration or temporary coverage.
- RDT: More than 0.5 mm thick, the tooth can be restored with the restoration of choice. A protective layer of hard-setting Ca(OH)_2 in the deepest part of the dentin (RDT less than 0.5 mm). In most of the cases Ca(OH)_2 is not used (reduced strength of fragment bonding).

Immediate Fragment Attachment

Advantages

Immediate hermetic seal of DT

Immediate restoration of function and esthetics

Short treatment time



Fragment Attachment



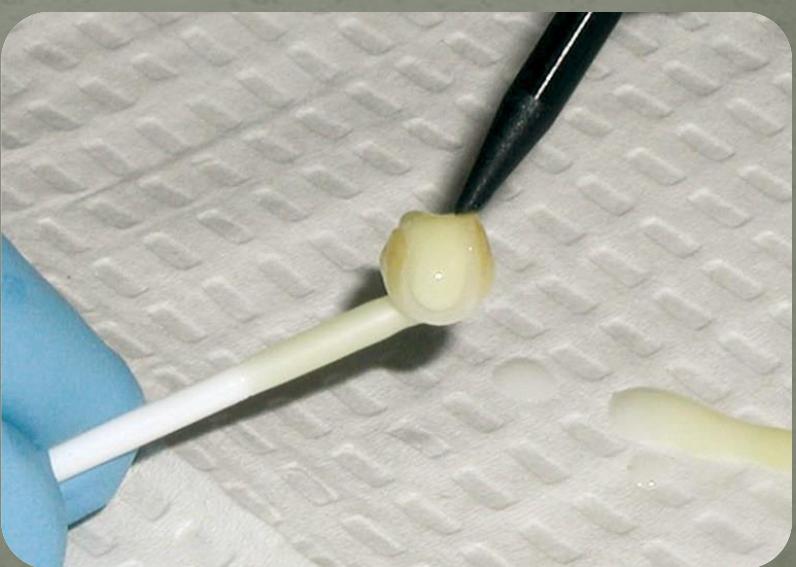




**Helpful
Tips**



The 2" long stick is 2 mm in diameter with an adhesive tip on one end. Apply light pressure to pick up small items for easier handling and placement. The adhesive does not transfer to the item. To release, simply twist the stick gently.



Parkell Dry Field Mouth Props



Helpful
Tips



To Mask the Fracture Line



- Remove any excess of composite resin with discs.
- Remove a 1-mm gutter of enamel on each side of the fracture line, both labially and palatally, to a depth of 0.5 mm using a small round or pear-shaped bur. The finishing line should be **irregular** in outline.
- Etch the newly prepared enamel, wash, dry, apply bonding agent (air thin, light-cure), apply composite, cure and finish.

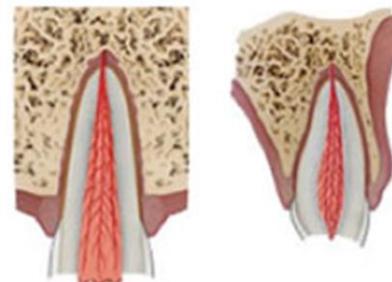


If provisional treatment is the chosen strategy, the entire fracture surface is covered with GIC and a composite is placed for approximately 1 month. The fragment is kept moist in physiologic saline which is changed weekly. In case it was left dry, wet storage for 24 hours may normalize the situation.

CROWN FRACTURES

Complicated Crown Fracture: Treatment

A complicated crown fracture involves enamel, dentin, and pulp. A crown fracture involving the pulp, if left untreated, always results in pulp necrosis





Treatment options for complicated crown fracture are **(1)** vital pulp therapy: pulp capping, partial pulpotomy, or full pulpotomy; and **(2)** pulpectomy.

The choice of treatment depends on: stage of development of the tooth, the time between trauma and treatment, concomitant periodontal injury, and the restorative treatment plan.

Stage of Development of the Tooth

In an immature tooth, every effort is made to keep the tooth vital, at least until complete root development. Removal of the pulp in a mature tooth is not as significant as in an immature tooth because a pulpectomy in a mature tooth has an extremely high success rate. However, it has been shown that under optimal conditions, vital pulp therapy (rather than removal) can be carried out successfully on a mature tooth.

Time between trauma and treatment



For 48 hours after a traumatic injury, the initial reaction of the pulp is proliferative, with no more than a 2-mm depth of pulpal inflammation. After 48 hours, chances of direct bacterial contamination of the pulp increase, with the zone of inflammation progressing apically; as time passes, the likelihood of successfully maintaining a healthy pulp decreases.





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Unless impaction of contaminated debris is obvious, it is expected that in the first 24 hours after the injury, a proliferative response with inflammation extending not more than 2 mm into the pulp will be present.

Concomitant Attachment Damage

A periodontal injury compromises the nutritional supply of the pulp. This fact is particularly important in mature teeth, in which the chance of pulp survival is not as good as for immature teeth.

Restorative Treatment Plan

If the restorative treatment plan of a mature tooth is simple and a composite resin restoration will suffice as the permanent restoration, vital pulp therapy should be given serious consideration. If a more complex restoration is to be placed (e.g., a crown or bridge abutment), pulpectomy may be the more predictable treatment method.

Vital Pulp Therapy: Requirements for Success

- Treatment of a non-inflamed pulp: Optimal time for treatment is within 24 hours (pulp inflammation is superficial). As time between the injury and therapy increases, pulp removal must be extended apically to ensure that non-inflamed pulp has been reached
- Bacteria-tight seal: This requirement might be the most critical factor for successful treatment
- Pulp dressing: Currently, bioceramic materials are considered the pulp capping agents of choice. MTA 1st generation bioceramic material. MTA does not enjoy the same popularity as Ca(OH)₂ as a pulp capping agent in the treatment of traumatic exposures.
Why?

-MTA: a wet cotton pellet be placed over it until it is set, and then the permanent restoration can be fabricated at a later time (2-step procedure).

-MTA was gray in color and reported to cause discoloration in the tooth crown when used as a capping agent in anterior teeth. White MTA also causes discoloration (bismuth oxide).



-Newer generation bioceramic materials have come to the market without disadvantages of old type of MTA. These materials are now considered superior to Ca(OH)_2 as the capping agent for traumatic pulp exposures.

NEW!



Hard tissue barrier after $\text{Ca}(\text{OH})_2$ partial pulpotomy. A, Histologic appearance of replacement odontoblasts and a hard tissue barrier. B, Clinical appearance of the barrier on removal of the coronal restoration 3 months after placement of the calcium hydroxide. C, Radiographic appearance of the hard tissue barrier.

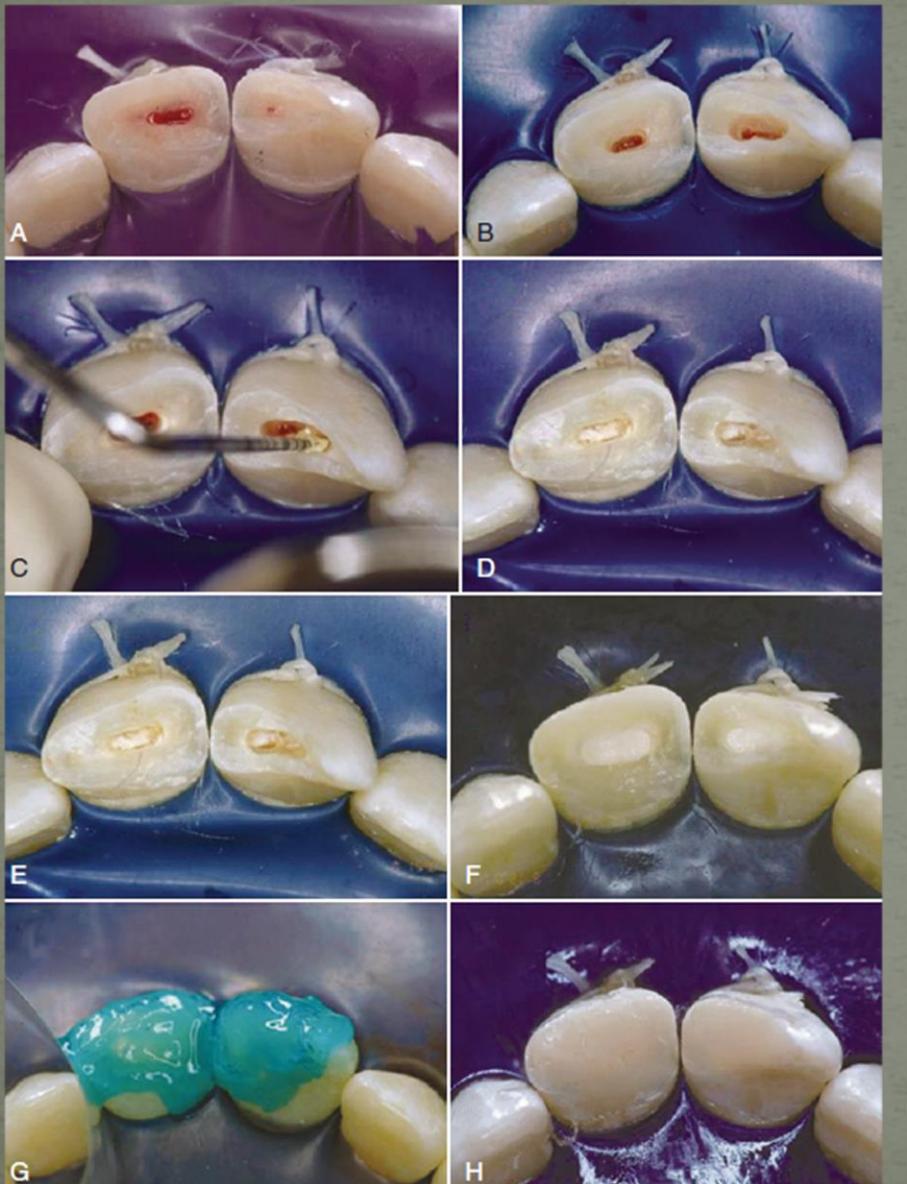
Treatment Methods

Pulp Capping

Placing the dressing directly on the pulp exposure without any removal of soft tissue

The success rate of this procedure (**80%**), compared to partial pulpotomy (**95%**) because superficial inflammation develops soon after the traumatic exposure and a bacteria-tight coronal seal is much more difficult to attain in superficial pulp capping because there is no depth to the cavity to aid in creating the seal, as there is with a partial pulpotomy.

Treatment Methods: Partial Pulpotomy



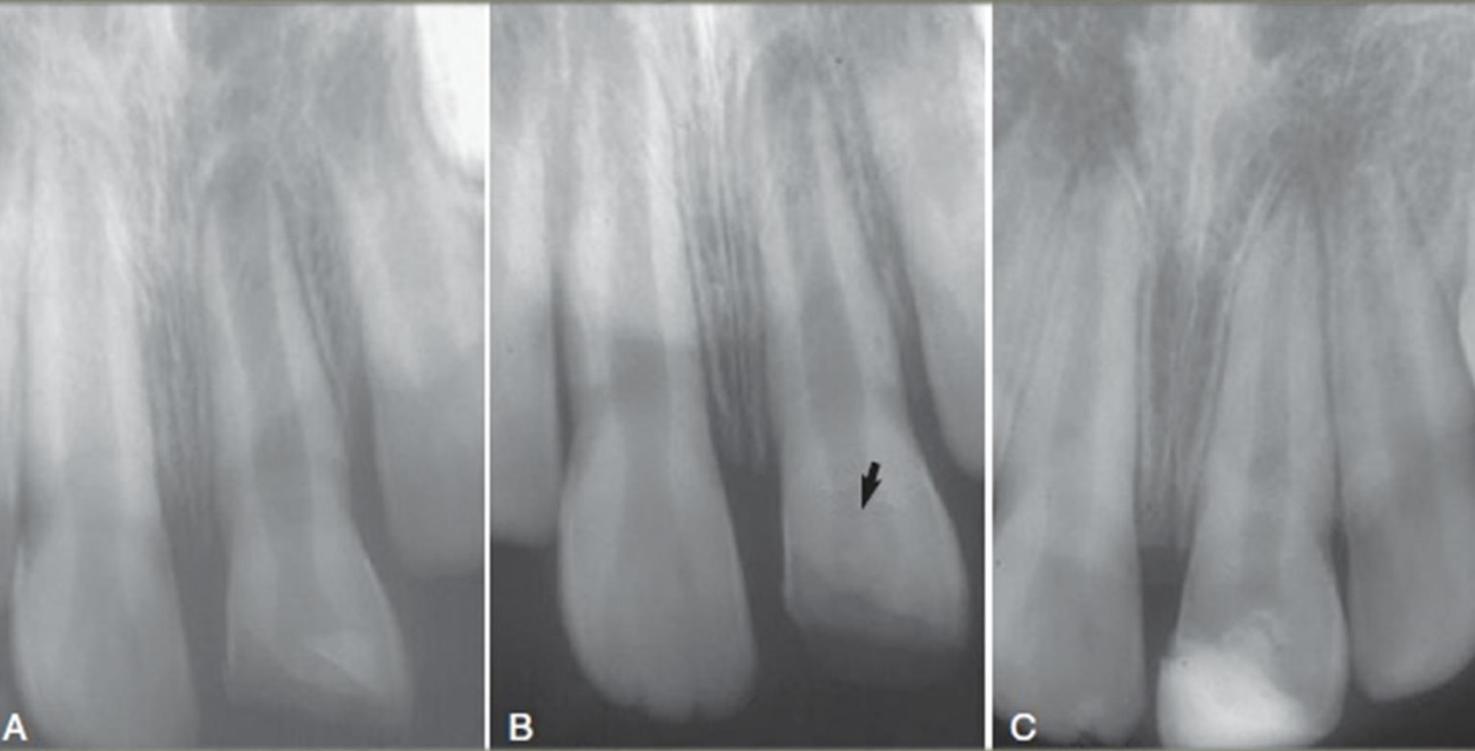
The partial removal of coronal pulp tissue to the level of healthy pulp.

Cvek partial pulpotomy: A, The fractured teeth are cleaned and disinfected under rubber dam. B, Cavities are prepared at high speed with a round diamond bur 1 to 2 mm into the pulpal tissue. C, D $\text{Ca}(\text{OH})_2$ is placed on the pulp. E, Avoid smearing the walls of the preparation with $\text{Ca}(\text{OH})_2$. F, GIC filling. The exposed dentin is etched (G) and then covered with composite resin (H). I, Radiograph 6 months later shows formation of hard tissue barriers in both teeth.

NOTES

- Administration of an anesthetic (possibly without a vasoconstrictor).
- A slow-speed bur/spoon excavator should be avoided.
- If bleeding is excessive, the pulp is amputated deeper until only moderate hemorrhage is seen.
- Use of NaOCl is recommended to rinse the pulpal wound.
- Do not allow a blood clot to develop.

Follow

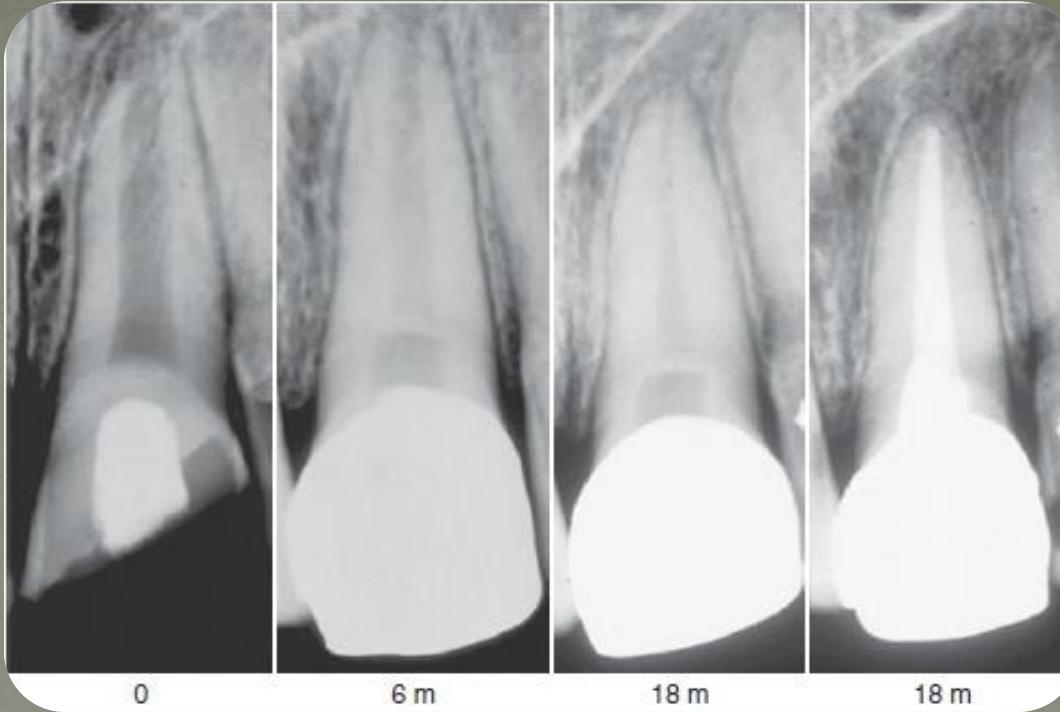
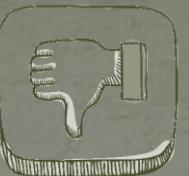


Continued root development after partial pulpotomy. A, Radiograph of immature tooth with a complicated crown fracture. B, At the time of placement of $\text{Ca}(\text{OH})_2$ after partial pulpotomy. C, Follow-up confirming that the pulp maintained vitality and the root continued to develop.

Treatment Methods

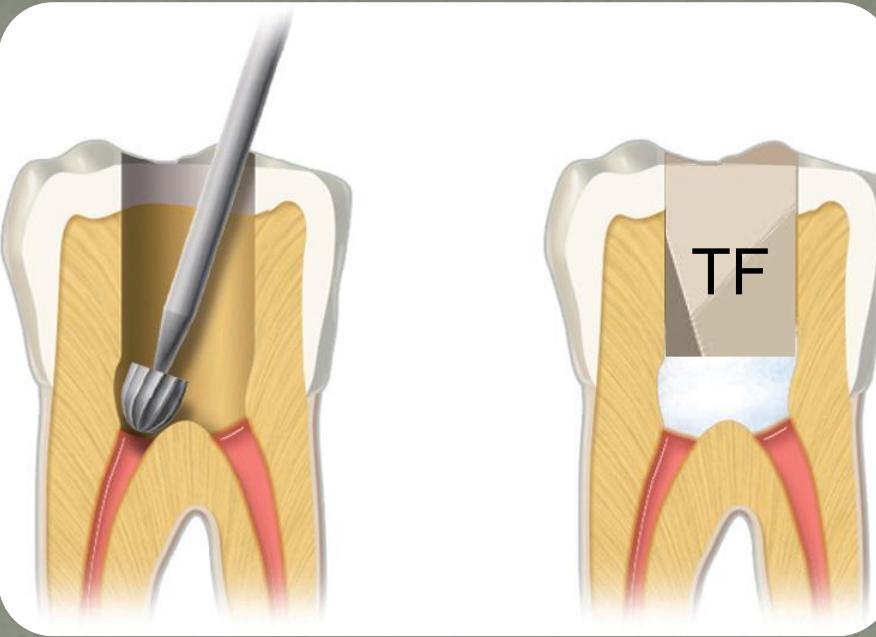
Full Pulpotomy

Removal of the entire coronal pulp to a level of the root orifices. Traumatic exposures after more than 72 hours and carious exposure of a young tooth with a partially developed apex are two examples of cases in which this treatment may be indicated. Full pulpotomy is contraindicated in mature teeth.



Sensibility testing is not possible “loss of coronal pulp”. Radiographic follow-up is extremely important. The prognosis is 75%. Some authors have recommended pulpectomy routinely after the roots have fully formed in full pulpotomy. This philosophy is based on the pulpectomy procedure having a success rate in the range of 95%, whereas if apical periodontitis develops, the prognosis of root canal treatment drops significantly to about 80%.

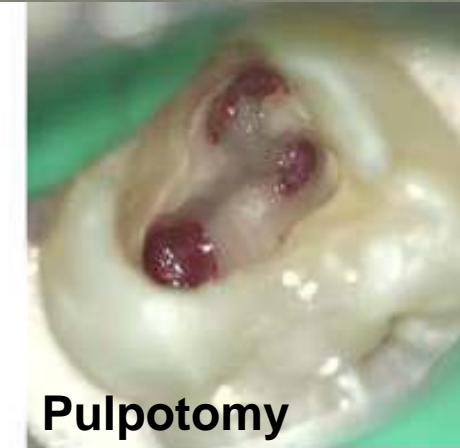
Symptomatic Irreversible Pulpitis



In emergency situations, the allotted time necessary for this treatment is often an issue. Especially with multi-rooted teeth, a pulpotomy has been advocated for emergency.

Interim Treatment for Irreversible Pulpitis: Pulpotomy

In some situations, patients have to decide between extraction and endodontic treatment for irreversible pulpitis. Because of financial circumstances, patients may choose extraction. Although not ideal, pulpotomy and temporary restoration may allow the patient time to find the means to finance complete endodontic treatment.



Pulpotomy



1 week later

Maxillary infiltration, rubber dam isolation, removal of pulp chamber tissue, hemostasis with NaOCl.

Contemporary tools: EAL, DOM, CBCT have almost entirely eliminated the lack of time as a factor for selecting pulpotomy and pulpectomy without complete instrumentation.



When

Treatment Methods

Pulpectomy

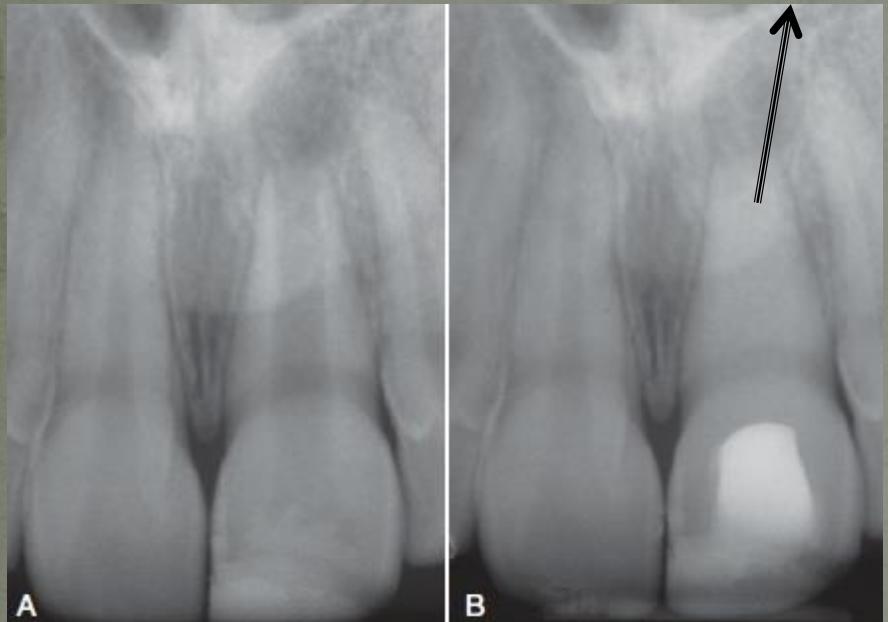
Indications

1. A complicated crown fracture of mature teeth if conditions are not ideal for vital pulp therapy or if it is foreseeable that restoring the tooth would require placement of a post
2. Necrotic immature teeth: lack of apical stop, thin dentinal walls.



WL determination, then very light filing along with 0.5% NaOCl irrigation (increased volume). Canal is dried and a creamy mix of Ca(OH)_2 spun into the canal and packed against the apical soft tissue with a plugger or *thick* paper point. This creamy mix is left for 1-4 weeks followed by placement of a thick/powdery mix.

Immature: Pulpectomy: Apexification



At 3-month intervals radiographic evaluation: Hard tissue barrier has formed? $\text{Ca}(\text{OH})_2$ has washed out of the canal? If no washout is evident, it can be left intact for another 3 months. Excessive dressing changes should be avoided because the initial toxicity of the material is thought to delay healing. When completion of a hard tissue barrier is suspected, $\text{Ca}(\text{OH})_2$ is washed out with NaOCl. A file of a size that can easily reach the apex can be used to gently probe for a stop at the apex. When a hard tissue barrier is indicated radiographically and can be probed with an instrument, the canal is ready for obturation.

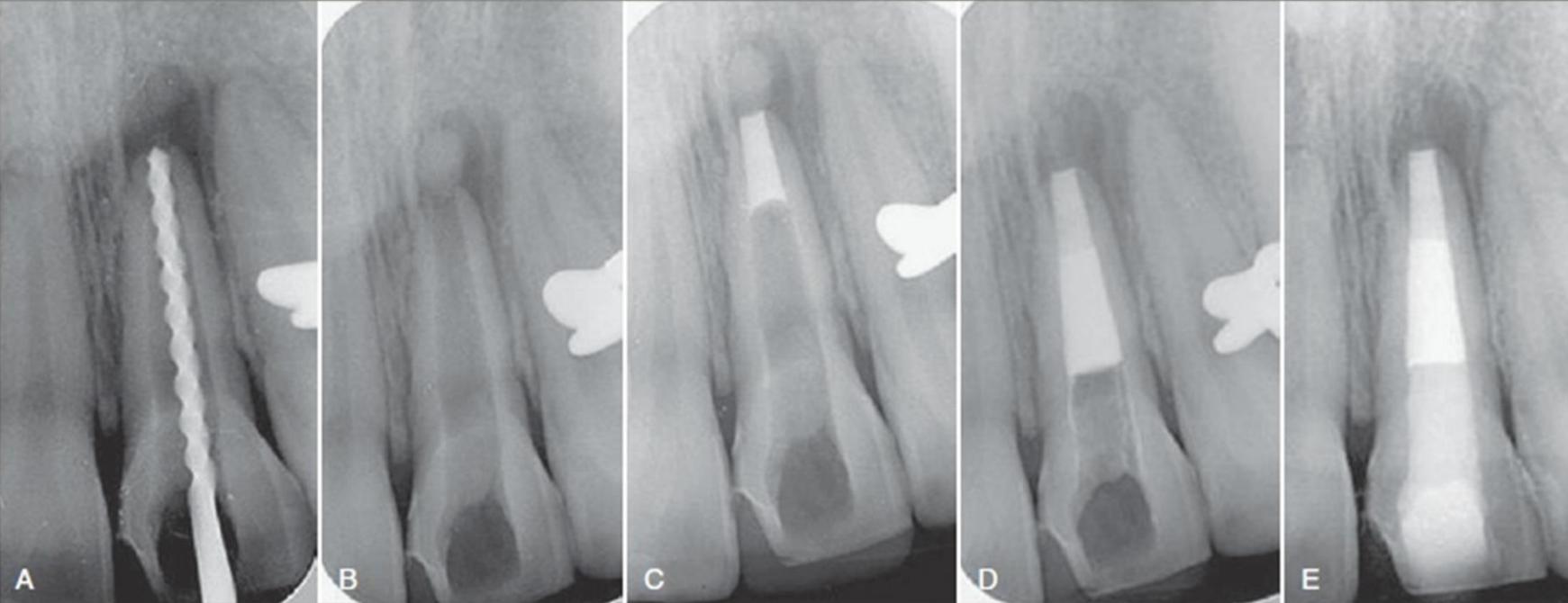
-Sealer and softened filling material is expressed through the “Swiss cheese” holes in the barrier (image).

-Formation of the hard tissue barrier might be some distance short of the radiographic apex because the barrier forms wherever $\text{Ca}(\text{OH})_2$ contacts vital tissue.

Avoid excessive lateral force during obturation, owing to the thin walls of the root.



Immediate Apexification



Apexification with MTA: Apical barrier technique gained popularity. A, The canal is disinfected with light instrumentation, copious irrigation. B, Calcium sulfate is placed through the apex as a barrier against which the MTA is placed. C, A 4-mm MTA plug is placed at the apex. D, The body of the canal is obturated. E, A bonded resin is placed below CEJ to strengthen the root.

Treatment Methods: Revitalization

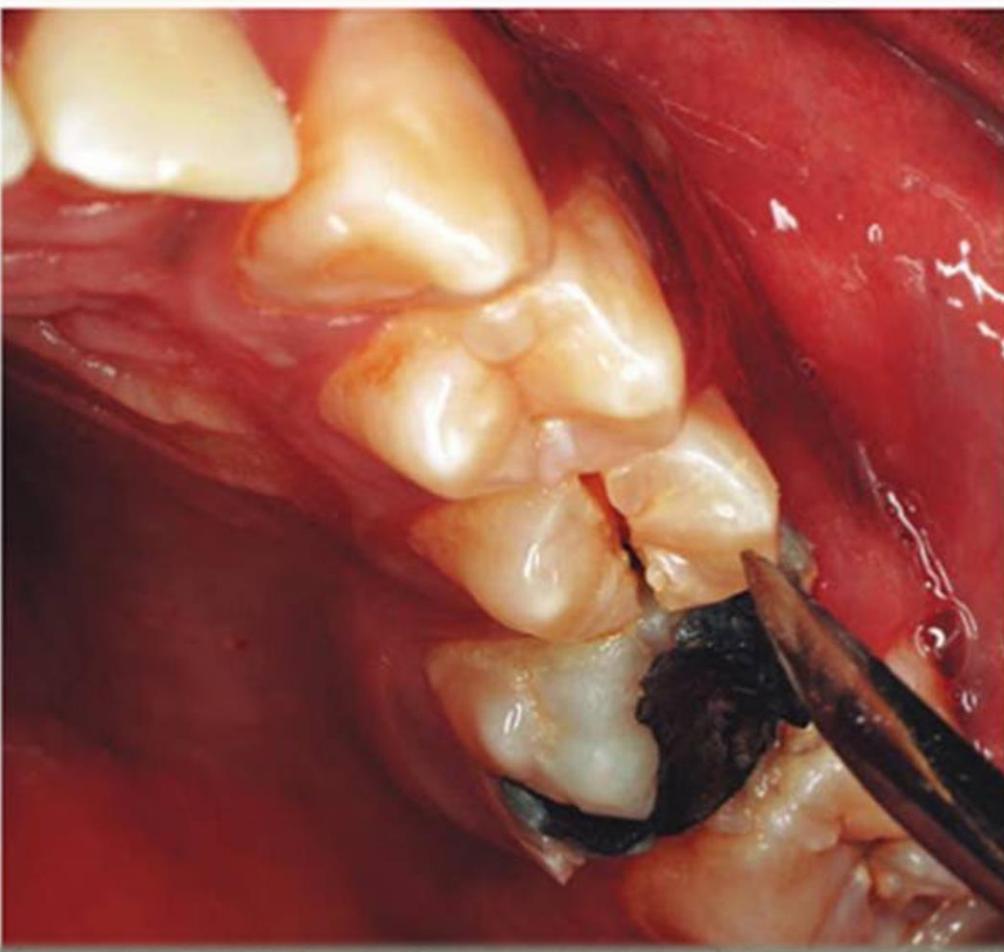
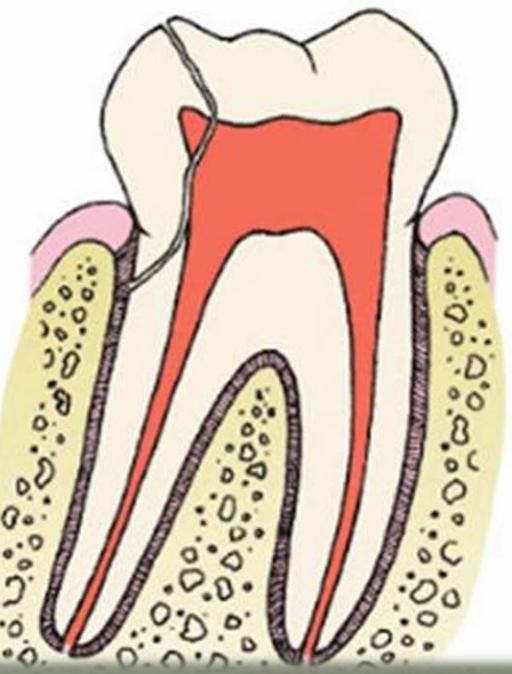
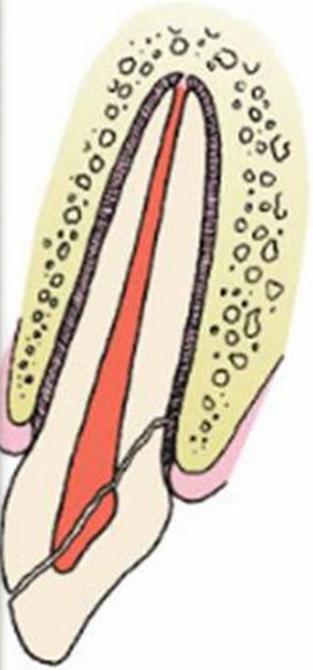
1. Avulsed immature tooth
2. Necrotic immature teeth

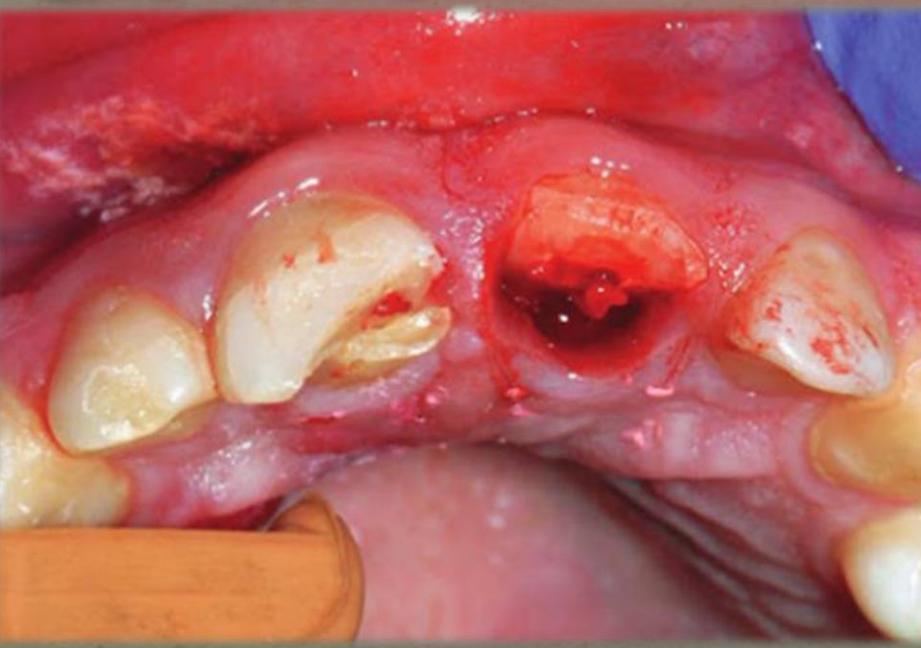
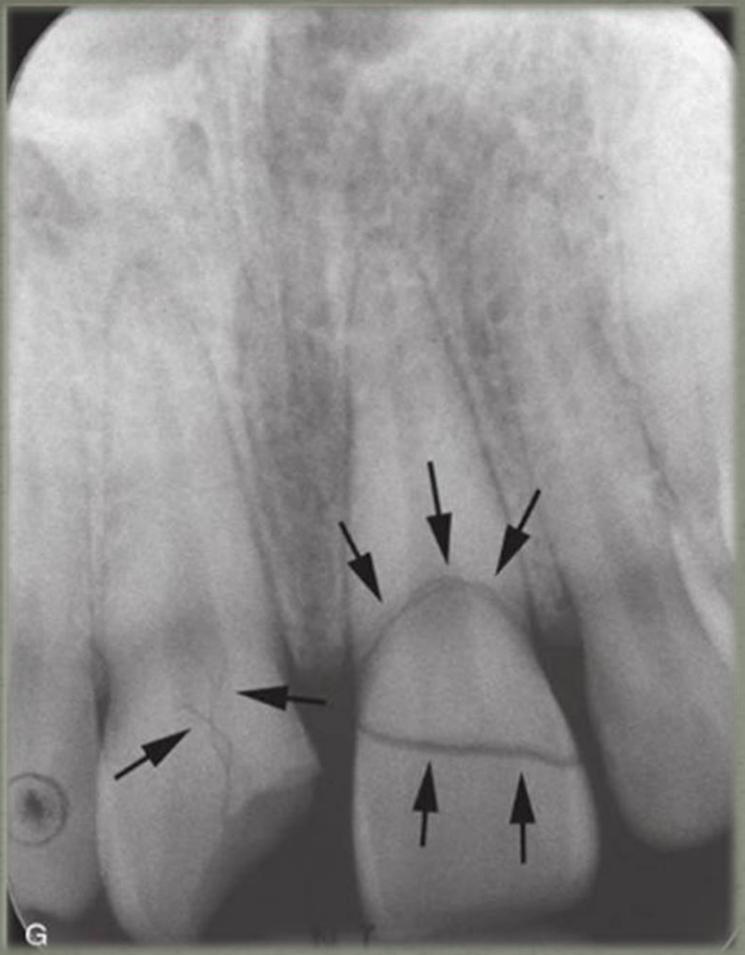
An immature tooth with periradicular periodontitis and a traced sinus tract to the apex of the root. B, Radiographic checkup 7 months after treatment that included application of a mixture of ciprofloxacin, metronidazole, and minocycline. C, At 24-month checkup, showing continued root development both in length and width of the root.



Crown-Root Fracture

A periodontal and endodontic challenge. The tooth must be treated periodontally to enable a well-sealed coronal restoration. This could be accomplished by simple gingivectomy if the extent of the root component of the fracture is large. Alternatively, the tooth could be orthodontically or surgically extruded such that the exposed surface of the root fracture is treatable. Once the feasibility of the coronal restoration is assured, the particular crown fracture is treated as previously described.

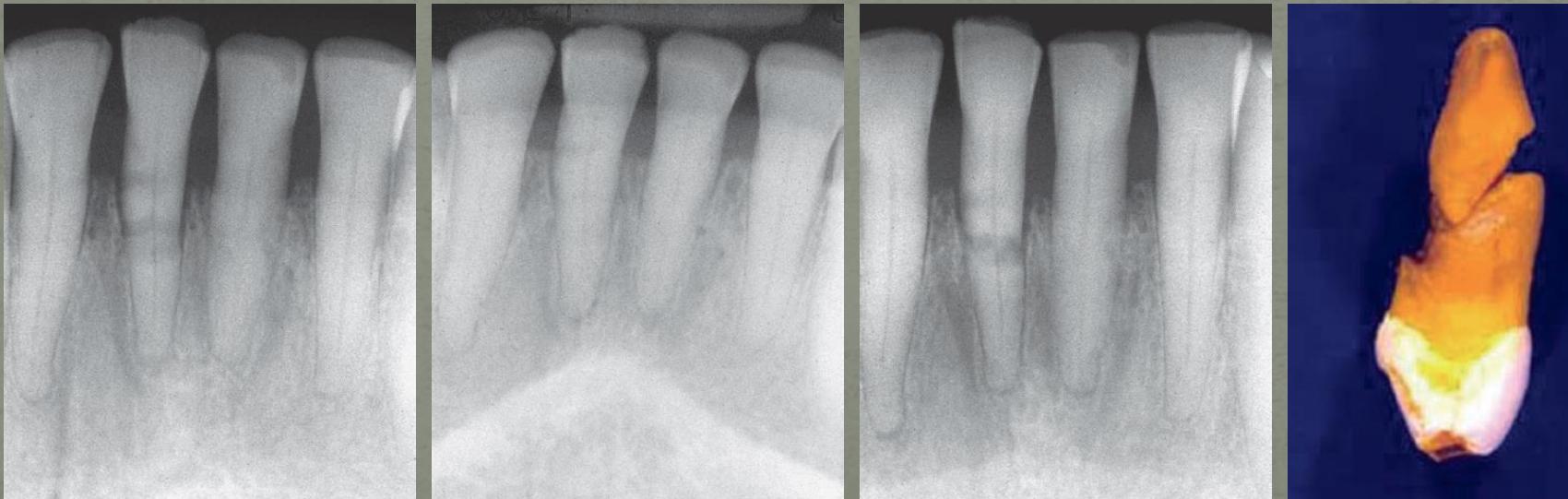


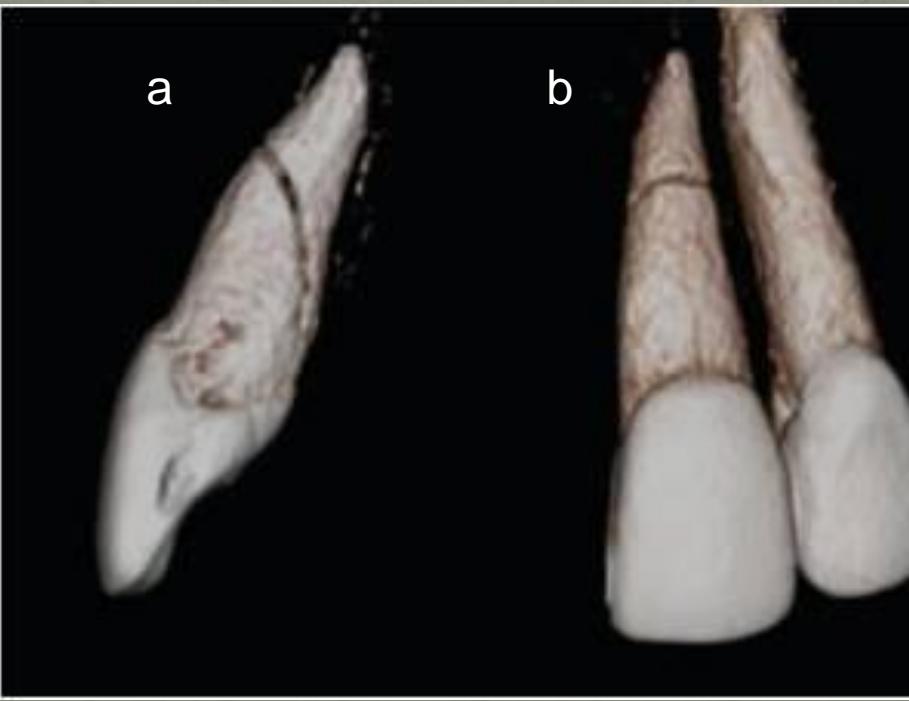


Root Fracture

Fracture of cementum, dentin, and pulp: less than 3% of all dental injuries. Immature teeth with vital pulps rarely sustain horizontal root fractures. When a root fractures horizontally, the coronal segment is displaced to a varying degree, but generally the apical segment is not displaced. Because the apical pulpal circulation is not disrupted, pulp necrosis in the apical segment is extremely rare. Permanent pulpal necrosis of the coronal segment, requiring endodontic treatment, occurs in about 25% of cases.

Radiographic examination for RF is important. Because RF are usually oblique (facial to palatal), one periapical radiograph may easily miss it. It is imperative to take at least 3 angled radiographs (45° , 90° , and 110°) so that at least at one angulation, the x-ray beam passes directly through the fracture line to make it visible on the radiograph.

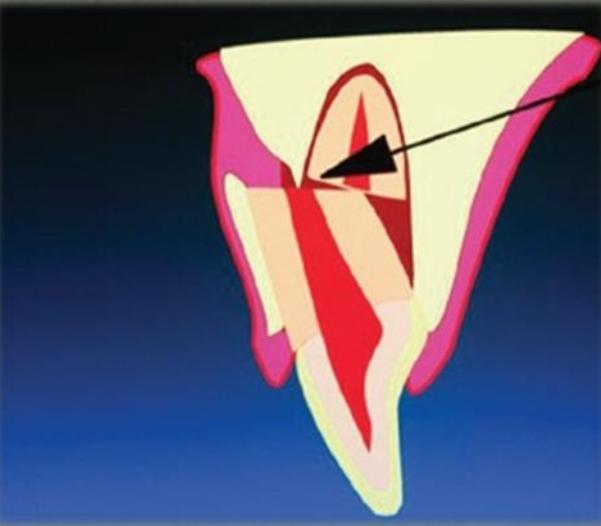




Root Fracture: Treatment

Emergency treatment involves repositioning the segments into close proximity as much as possible and semi-rigid splint to adjacent teeth for 2-4 weeks

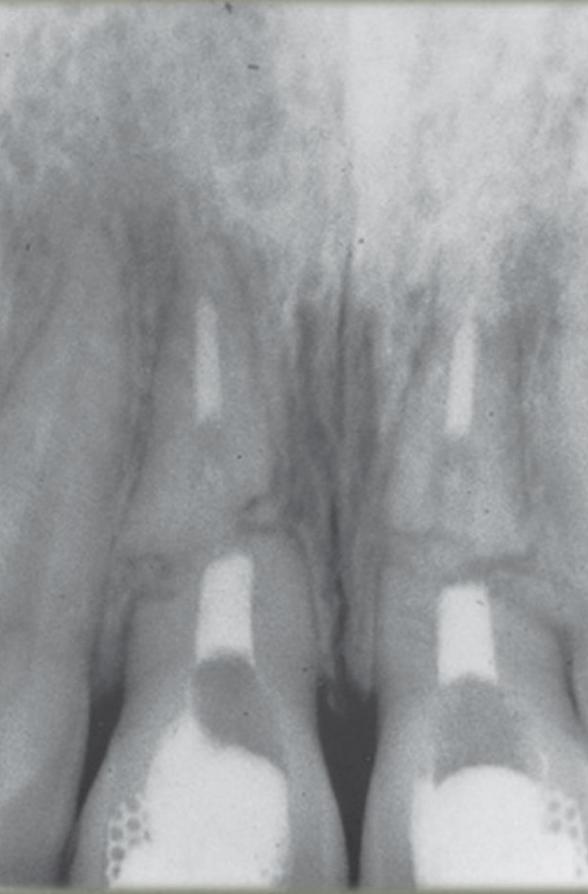
In Case of Severe Displacement of the Coronal Segment



Apical extension of the coronal segment is lodged in the cortical bone. Re-approximation of the two segments: release the coronal segment from the bone by gently pulling it slightly downward with finger pressure or extraction forceps and, once it is loose, rotating it back to its original position. If a long time has elapsed between the injury and treatment, repositioning of the segments close to their original position probably will not be possible.

Healing Patterns of Root Fractures

- i. Healing with calcified tissue. Radiographically, the fracture line is radiopaque.



Healing Patterns of Root Fractures



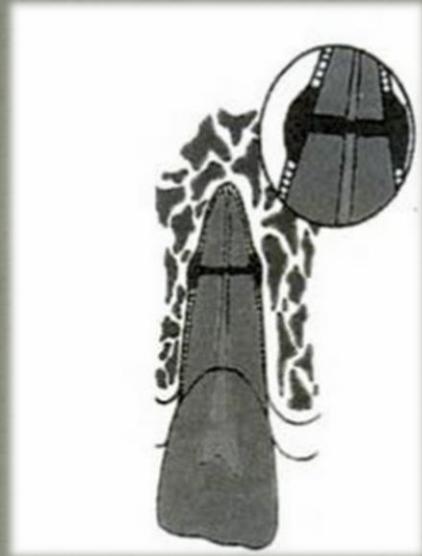
Healing with interproximal connective tissue. Radiographically, the fragments appear separated by radiolucent line, and the fractured edges appear rounded.

Healing Patterns of Root Fractures



Healing with interproximal bone and connective tissue. Radiographically, the fragments are separated by a distinct bony ridge.

Healing Patterns of Root Fractures



Inflammatory tissue without healing: Radiographically, a widening of the fracture line and/or a developing radiolucency corresponding to the fracture line. This is typical when the coronal segment loses its vitality. The infective products in the coronal pulp cause an inflammatory response and radiolucencies at the fracture line.

Apical Root Fractures

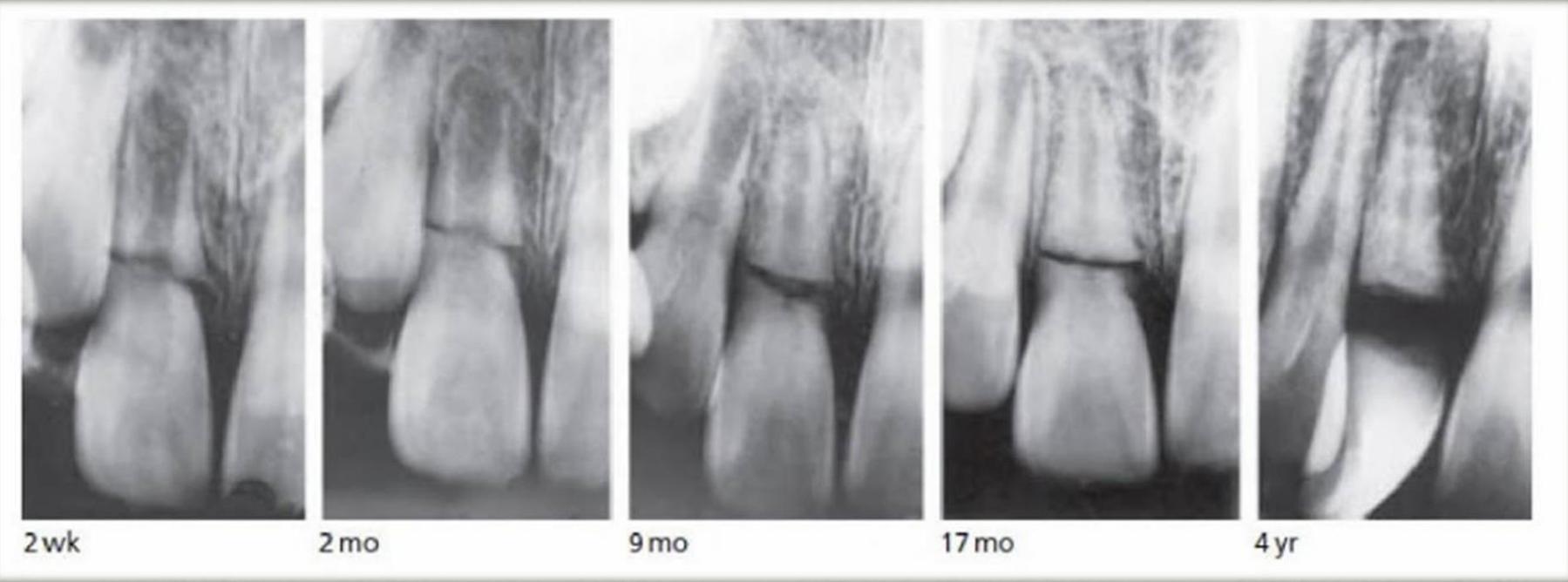
Mid-Root Fractures

Coronal Root Fractures

Coronal Root Fractures

If the coronal segment is adequately splinted, chances of healing do not differ from those for midroot or apical fractures. However, if the fracture occurs at the level of the crest of the alveolar bone, the prognosis is extremely poor.

If reapproximation of the fractured segments is not possible, extraction of the coronal segment is indicated. The level of fracture and length of the remaining root are evaluated for restorability. If the apical root segment is long enough, gentle orthodontic eruption of this segment can be carried out to enable fabrication of a restoration.

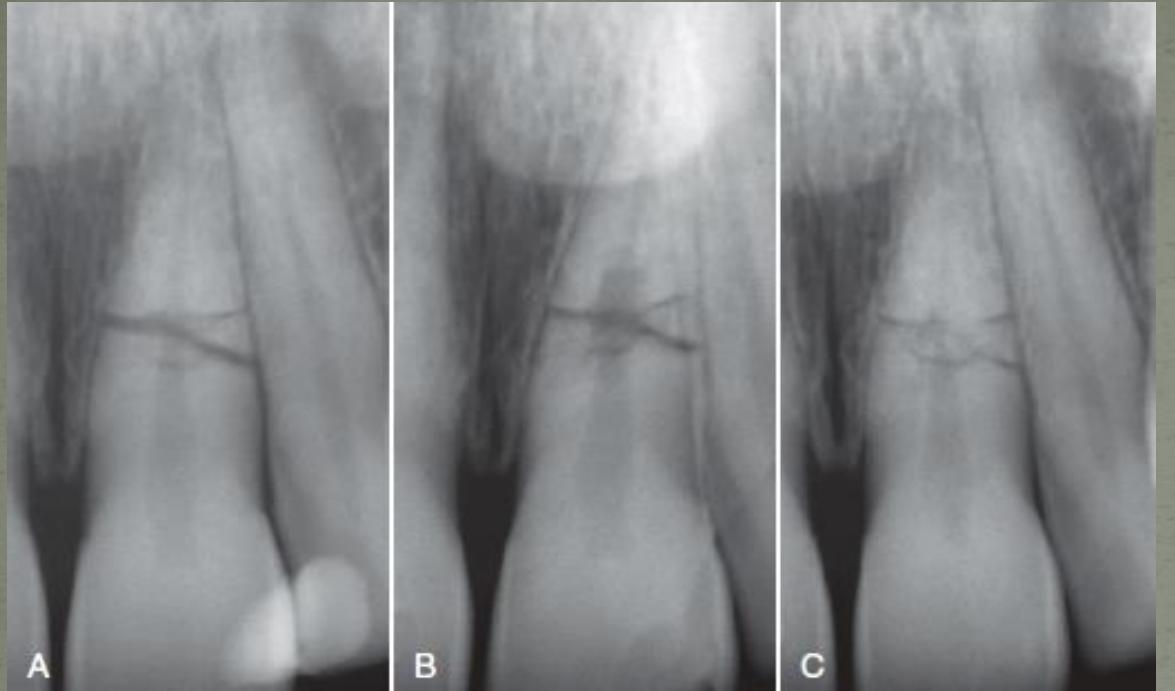


Healing of a cervical fracture with connective tissue. Immature incisor with transverse root fracture in the cervical 1/3. The tooth was immobilized, the complete treatment was delayed because of the patient's fear of treatment. After 4 years, the tooth suffered another injury and had to be extracted.

Mid-Root Fractures

In many cases the pulp in the coronal segment will become necrotic after the injury; however, because of a very large apical opening in the coronal segment, revascularization is possible if the segments are well re-approximated.

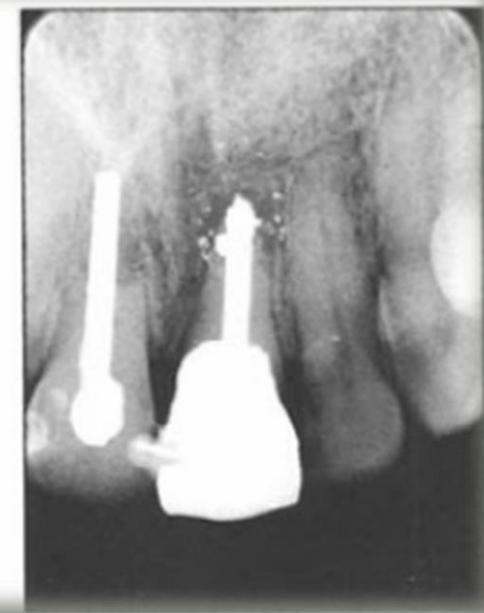
Endodontic treatment is indicated in the coronal root segment only unless periapical pathology is seen. In most cases the pulpal lumen is wide at the apical extent of the coronal segment, and long-term calcium hydroxide treatment or an MTA apical plug is indicated. The coronal segment is filled after a hard tissue barrier has formed apically in the coronal segment.



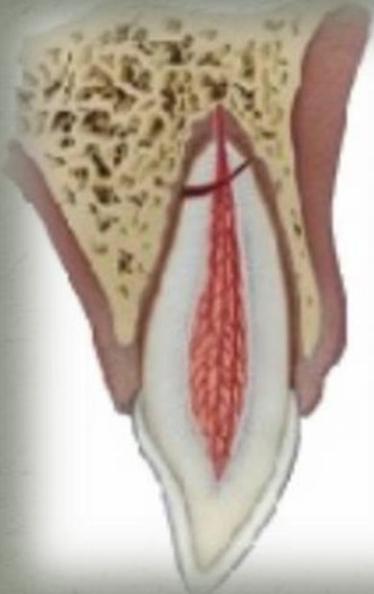
Tooth was diagnosed with compound midroot fracture. A, Coronal portion was repositioned and then splinted to the lateral incisor with a composite splint. B, At 6-month recall, the pulp responded normally to cold, but an internal root-resorptive defect was noted on radiograph. No treatment was indicated, because the pulp did respond normally to vitality tests. C, At 42-month recall, the tooth was still asymptomatic, and the pulp still responded to vitality tests. The resorptive defect had healed, and signs of dystrophic calcifications were evident in the apical and coronal segments.

Mid-Root Fractures: Treatment Options

1. Re-positioning and splinting
2. Disinfection and obturation of the coronal segment only (necrosis is rare for the apical part and 25% of coronal segment undergoes necrosis)
3. If both segments undergoes necrosis: a. endodontic treatment for both segments or b. extraction of the apical segment and endodontic treatment of the coronal segment.
4. Intra-radicular splinting
5. Removal of the apical segment and stabilization of the coronal with endodontic implant



Apical Root Fractures



Root fractures in the apical third usually require no immediate treatment but must be observed long term.

Follow-up

After the splinting period is completed, follow-up is as for all dental traumatic injuries: at 3, 6, and 12 months and yearly thereafter.

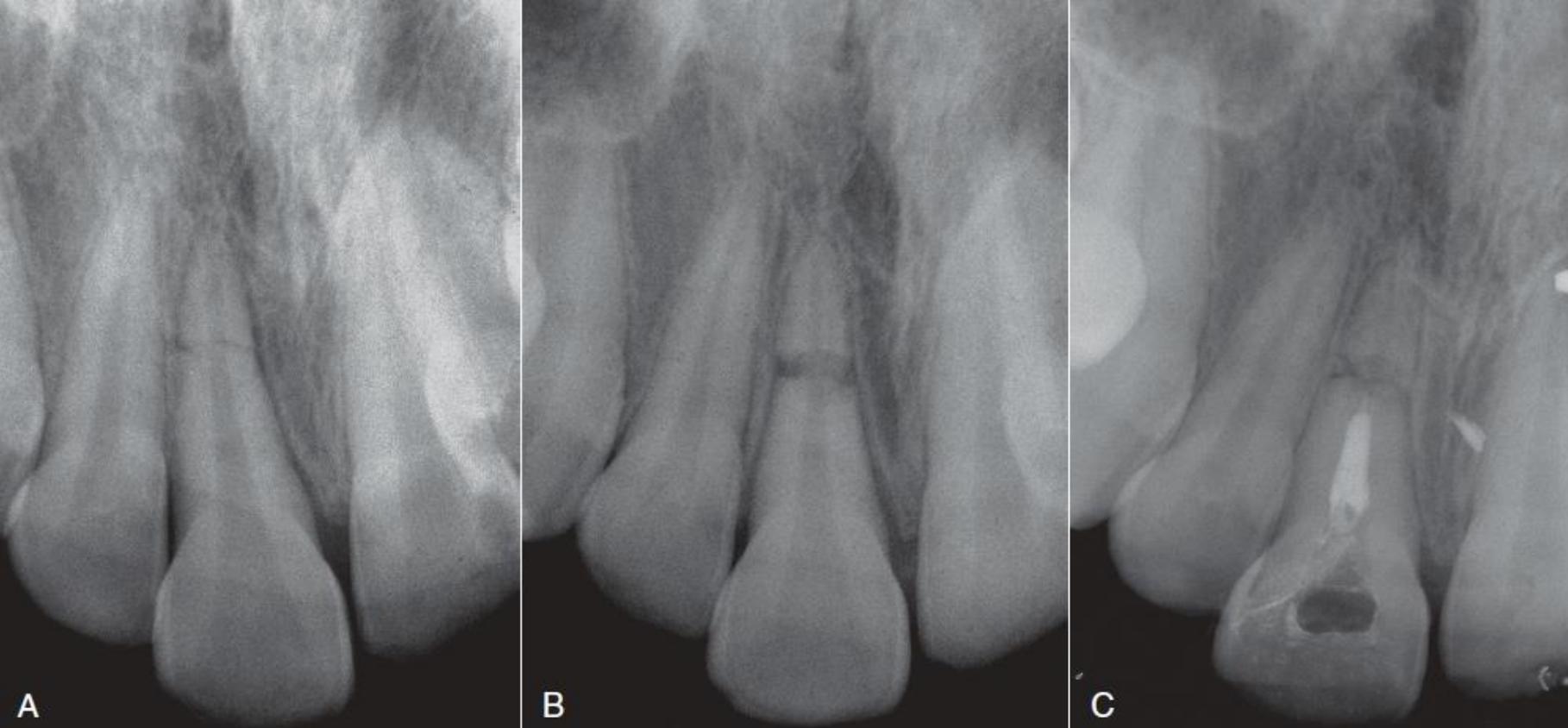
Prognosis

Factors influencing repair

1. Degree of dislocation/mobility of the coronal fragment are extremely important in determining outcome
2. Immature teeth are seldom involved in root fractures, but in the unlikely event they are, the prognosis is good
3. The quality of treatment is vital to successful repair. The prognosis improves with quick treatment, close reduction of the root segments, and semi-rigid splinting for 2-4 weeks



Root fracture of the maxillary right central incisor. A and B, Periapical radiograph and clinical photograph of the tooth when the patient arrived at the emergency department. C and D, Reduction, repositioning, and splinting.



Root fracture of the maxillary right central incisor. A, Preoperative periapical radiograph. B, One month later, after removal of the splint. Note the separation of the coronal and apical fragments. Endodontic therapy of the coronal fragment was initiated. C, Two-year follow-up.

Luxation Injuries

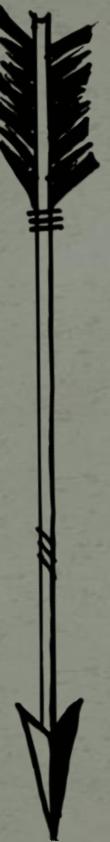
what are other
words for
luxate?



dislocate, splay, slip,
disjoint, disarticulate, detach,
dismember, disarrange, put out,
put out of joint



More intense injury and subsequent sequelae.



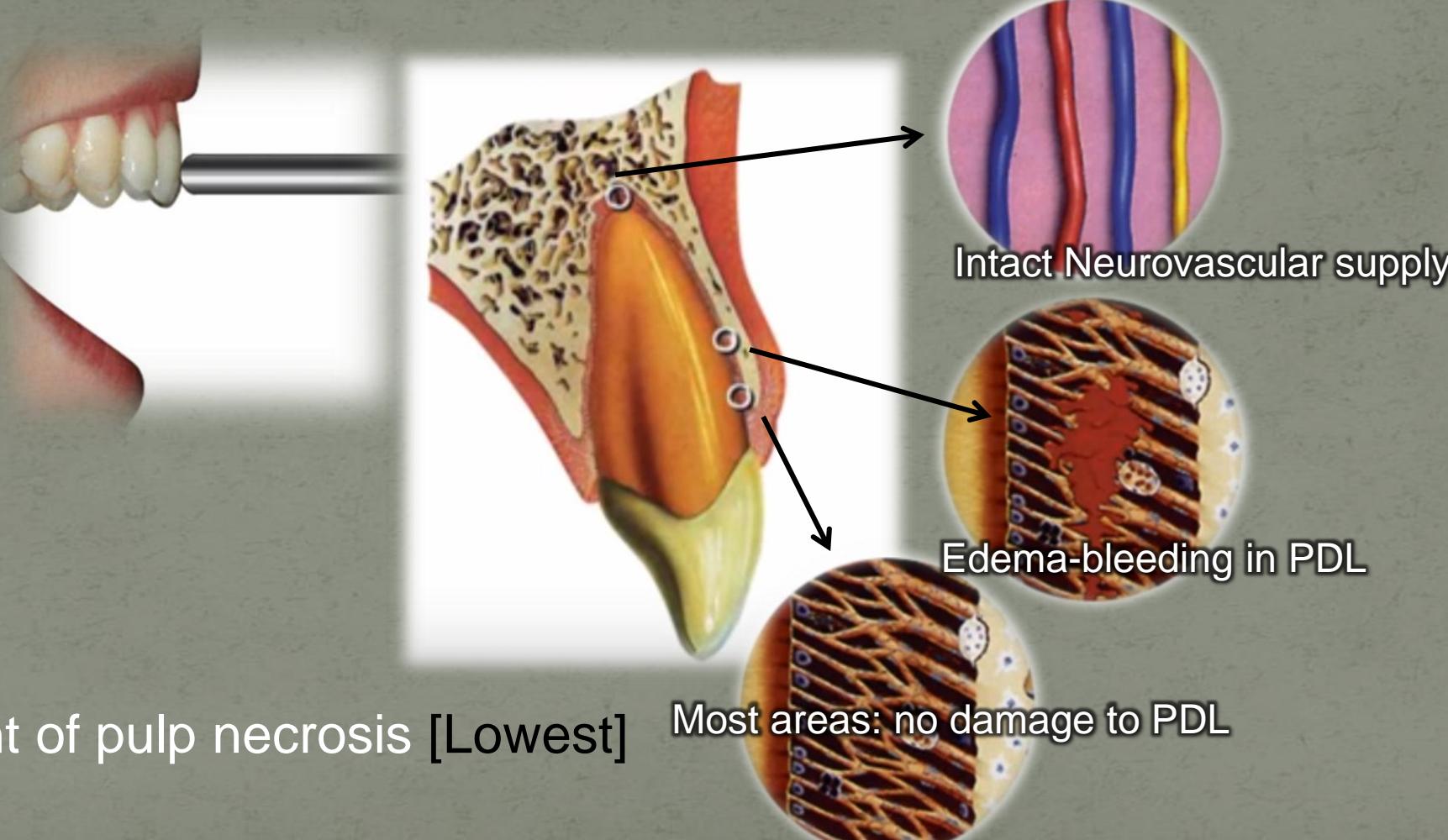
Luxation Injuries

1. Concussion
2. Subluxation
3. Lateral luxation
4. Extrusive luxation
5. Intrusive luxation

Luxation injuries as a group are the most common of all dental injuries, with a reported incidence ranging from 30% to 44%.

Luxation Injuries: Concussion

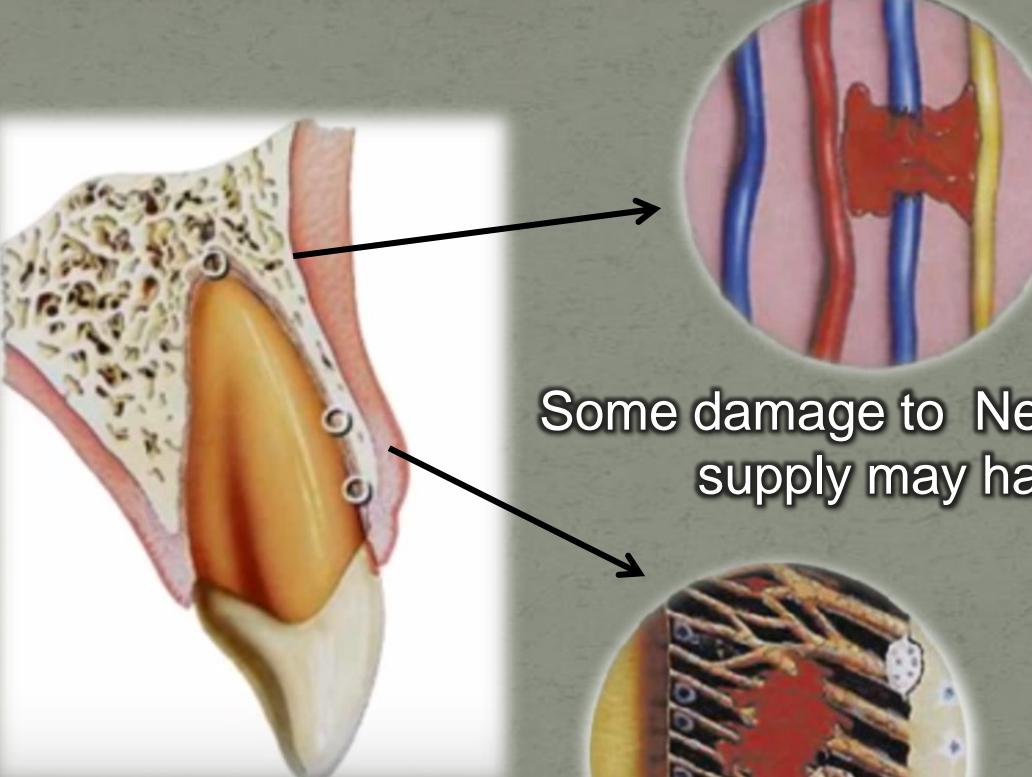
No displacement, normal mobility, sensitivity to percussion



Damage to the attachment apparatus (PDL and cemental layer) [Lowest]

Luxation Injuries: Subluxation

Sensitivity to percussion, increased mobility, no displacement.



Some damage to Neurovascular supply may happen



In several areas: separation of PDL, interstitial bleeding/edema

Treatment: Concussion and Subluxation

Do not need any immediate treatment. Responses to vitality tests should be investigated and noted. Even after mild injury, such as subluxation, the pulp might be unresponsive to vitality tests for several weeks if not months. When the pulp is unresponsive initially after the trauma, patients should be recalled on a regular basis and monitored for any additional signs of infection of the root canal.

	Sensitivity to percussion	Mobility	Displacement
Concussion	Yes	No <i>Physiologic mobility</i>	No
Subluxation	Yes	Yes	No

Luxation Injuries: Lateral luxation

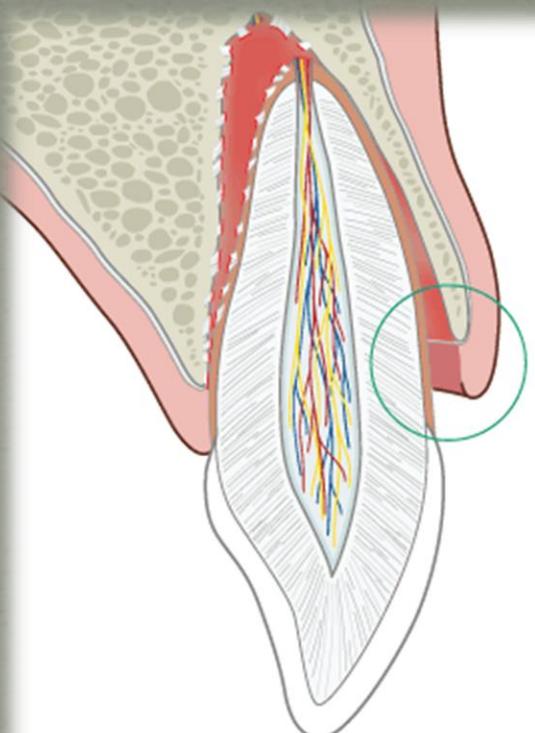
Displacement in a direction (labially, lingually) other than axially, accompanied by a communication or fracture of the alveolar socket.



Severance of the neurovascular supply, entrapment of the apex

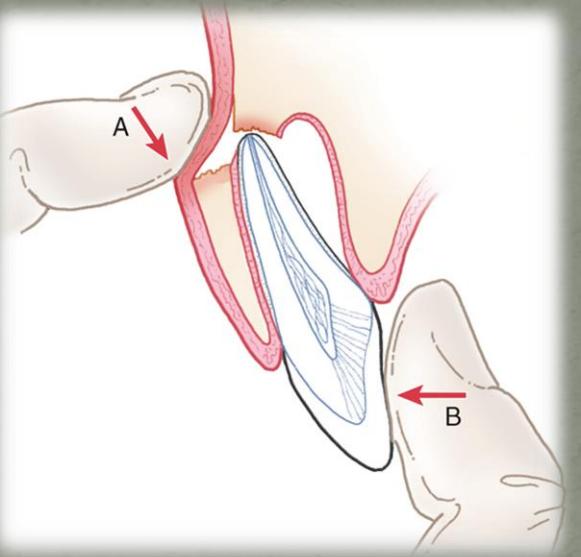
Luxation Injuries: Extrusive luxation

Displacement in a coronal direction



Treatment: Lateral and Extrusive luxation

Repositioning as soon as possible and physiologic splinting:
2 weeks for extrusion and 4 weeks for lateral luxation.



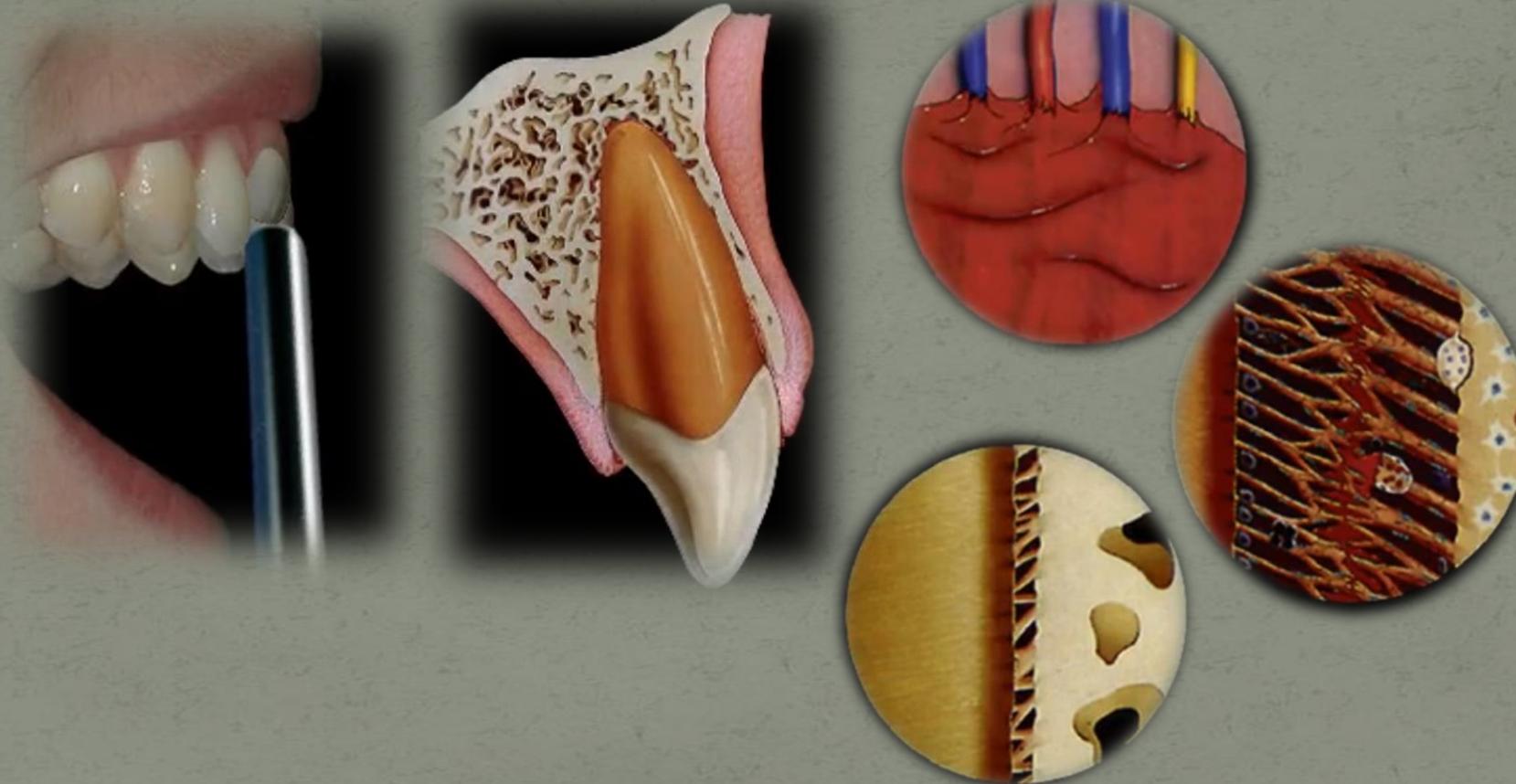
The apex might be perforating the facial bone plate, and the tooth must be slightly and gently pulled down to loosen the hold before it is repositioned in its original position

RCT decision follows avulsion guidelines (discussed later). Fully formed apex tooth have moved into the cortical plate, there is a good likelihood of the pulp being devitalized; therefore, endodontic treatment should be initiated as early as 2 weeks after the injury. If the apex is still not fully formed, waiting for signs of revascularization is strongly recommended.



Luxation Injuries: Intrusive luxation

Displacement in an apical direction into the alveolus



Development of pulp necrosis [Highest]

Damage to the attachment apparatus (PDL and cemental layer) [Highest]



The tooth is immobile, and percussion tone is high and metallic. The tooth appears shortened and there is bleeding from the gingivae.



Don't Forget

-Normal teeth have dull sound on percussion.

-Metallic sound and absence of normal mobility: ankylosis or locking (intrusion and lateral luxation).

-Erupted tooth with an impacted tooth directly against it, will have a solid sound to percussion.

Treatment: Intrusive luxation

Permanent mature teeth that are intruded are not likely to spontaneously re-erupt. Treatment, such as orthodontic extrusion or immediate surgical repositioning, should be considered. If orthodontic extrusion is planned for an intruded tooth, it should be initiated asap (not be delayed longer than 2-3 weeks). If an intruded tooth is immediately reimplanted, it should be splinted for at least 4 weeks, but in most cases the splint needs to be left on the tooth longer. Root canal treatment is indicated for intruded teeth with the exception of those with immature roots, in which case the pulp may revascularize.

Incompletely formed teeth with an open apex may reposition spontaneously

Biologic Consequences

Favorable healing after a luxation injury occurs if the initial physical damage to the root surface and the resultant inflammatory response to the damaged external root surface are again covered with cementum.

Unfavorable response occurs when there is direct attachment of bone to the root, with the root ultimately being replaced by bone.

Biologic Consequences

External Inflammatory Root Resorption:

- A. Caused by an injury (alone) to the external root surface
 - 1. Localized Injury: Healing with Cementum

Injury is localized (concussion or subluxation injury), a local inflammatory response and a localized area of root resorption. If no further inflammatory stimulus is present, periodontal healing and root surface repair occur within 14 days. Treatment is not required because it is free of symptoms and not even visualized radiographically in most cases. In a minority of cases, small radiolucencies can be seen on the root surface (spontaneously repair). The pulp is not involved. If the pulp responds to sensitivity tests, this is a clue that no treatment should be performed.

Biologic Consequences

External Inflammatory Root Resorption:

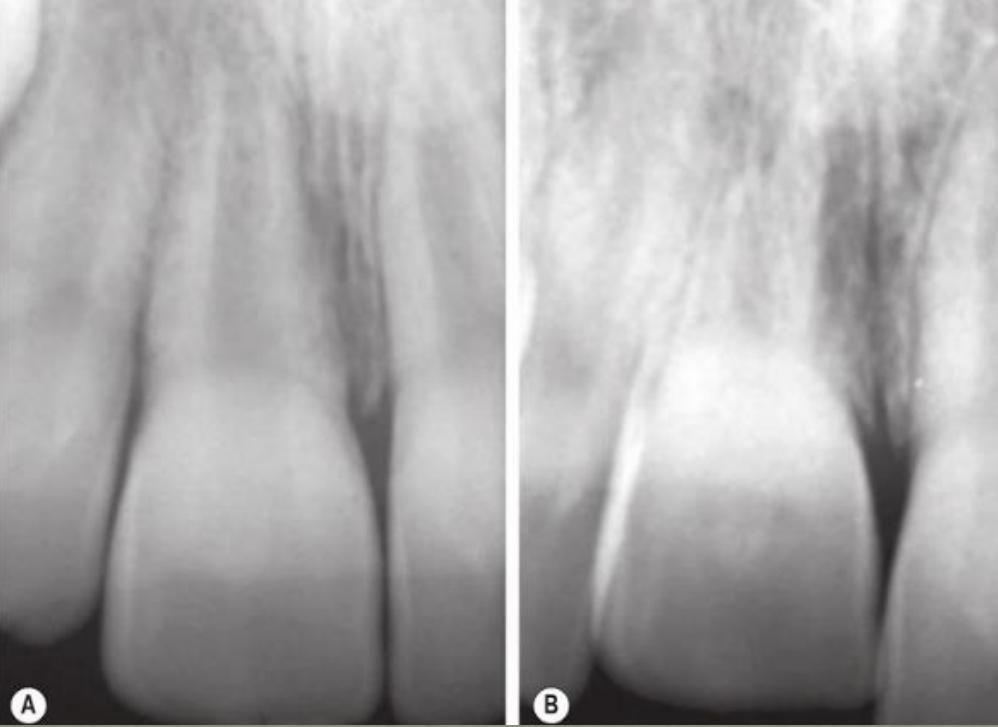
A. Caused by an injury (alone) to the external root surface

2. Diffuse Injury: Healing by Osseous Replacement

Severe traumatic injury (intrusive luxation or avulsion “extended dry time”), involving diffuse damage on >20% root surface. Initial reaction (inflammation) resulting in diffuse root surface area devoid of cementum. Bone cells rather than the slower-moving PDL cells, move across from the socket wall and populate the damaged root. Bone comes into contact with the root without an intermediate attachment apparatus. This phenomenon is termed *dentoalveolar ankylosis*. *Ankylosis (osseous replacement) cannot be reversed* and can be considered a physiologic process. Root is resorbed by osteoclasts, bone slowly replaces the root.



Radiographic appearance of osseous replacement. The root acquires the radiographic appearance of the surrounding bone (without a lamina dura). Note that radiolucencies typical of active inflammation are not present.



Examples of replacement resorption where the PDL and root structure are replaced with bone. (A) 4-month recall of tooth # 11 after *avulsion* and replantation. Some signs of ankylosis are seen radiographically and the tooth exhibits high-pitched metallic sound to percussion. (B) Progression of ankylosis, and the tooth is becoming infra-positioned (18-month recall).

Treatment

Minimizing the initial inflammation which is destructive in nature. If Ledermix is placed in the root canal immediately after a severe trauma in which osseous replacement is expected, favorable healing occurs at a very high rate.

The effect of intracanal anti-inflammatory medicaments on external root resorption of replanted dog teeth after extended extra-oral dry time.

[Chen H¹](#), [Teixeira FB](#), [Ritter AL](#), [Levin L](#), [Trope M](#).

Author information

Abstract

The prognosis of replanted teeth depends on several factors, the most important being the length of extra-oral dry time. Studies show that after 60 min dry time, root resorption is predicted. Immediate intracanal placement of Ledermix, a paste containing triamcinolone (corticosteroid) and demeclocycline (tetracycline) has been shown to inhibit root resorption after extended dry time. However, discoloration is possible from the tetracycline in Ledermix. To evaluate the individual influence of corticosteroid and tetracycline on external root resorption after extended extra-oral dry time. Sixty-nine premolar roots of four beagle dogs were extracted and instrumented with NiTi files. Group 1 (negative control) was immediately replanted after root filling with GP and sealer; Group 2 (positive control) was root filled with GP and sealer and replanted after 60 min dry time; In groups 3-5, the canals were filled with Ledermix, Triamcinolone, and Demeclocycline, respectively, and replanted after 60 min dry time. After 4 months, the dogs were sacrificed and the roots were examined histologically for type of healing (favorable or unfavorable) and remaining root diameter. The groups treated with Ledermix, Triamcinolone and Demeclocycline had statistically significantly more favorable healing (75.8%; 69.8%; 52.4%) and more remaining root structure (5.59; 5.48; 5.09) than the group filled with GP and sealer (positive control) (0; 1.15). Corticosteroids were as effective as Ledermix at inhibiting external root resorption.

Triamcinolone (corticosteroid portion of Ledermix) was as effective as Ledermix at inhibiting external root resorption. These findings need to be replicated in human studies.

Biologic Consequences

External Inflammatory Root Resorption:

B. Caused by an Injury to the External Root Surface and Inflammatory Stimulus in the Root Canal

Recognized inflammatory stimuli that cause root resorption are pressure, pulp space infection, and sulcular infection.

Necrotic infected pulp provides stimulus for PDL inflammation. Because of the lack of cemental protection (trauma), the periodontal inflammation includes root resorption in addition to the expected bone resorption.

Biologic Consequences

Consequences of Apical Neurovascular Supply Damage
Pulp Canal Obliteration (Calcification)

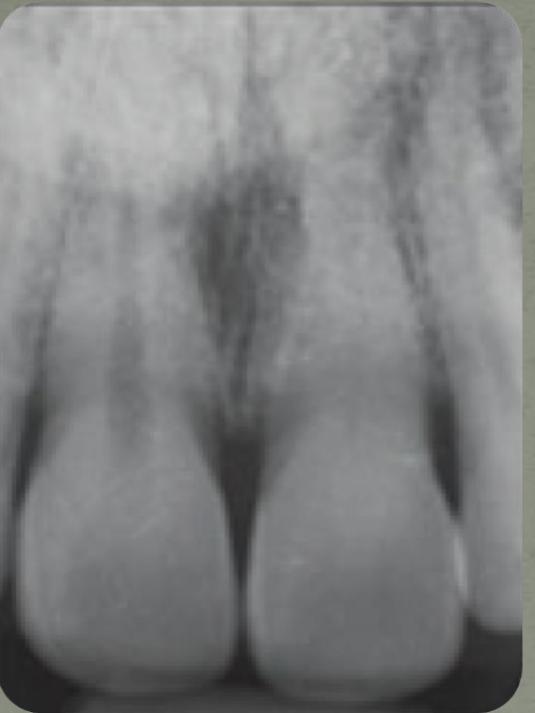


A. Pulp canal calcification after a luxation injury. B. The typical yellow appearance of the tooth caused by thickened dentin in the pulp chamber

Pulp Canal Obliteration (Calcification)

Common after luxation injuries. The frequency of pulp canal obliteration appears inversely proportional to pulp necrosis. The exact mechanism of unknown: (i) sympathetic/parasympathetic control of blood flow to the odontoblasts is altered, resulting in uncontrolled reparative dentin. (ii) Hemorrhage/blood clot formation in the pulp after injury form a nidus for subsequent calcification if the pulp remains vital. It is more frequent in teeth with open-apices (>0.7 mm radiographically), those with extrusive and lateral luxation injuries, and those that had been rigidly splinted.

Calcific Metamorphosis



Maxillary right central incisor showing the typical yellowish discoloration associated with pulp space obliteration.

METAMORPHOSIS



Calcific Metamorphosis



Yellowish Hue



A response to traumatic injury, characterized by a reduction in the size radicular and coronal pulp spaces. It usually occurs in teeth with incomplete root formation. Trauma disrupts blood vessels entering the tooth, thus producing pulpal infarction. The wide periapical foramen allows connective tissue from the periodontal ligament to proliferate and replace the infarcted tissue, bringing with it cementoprogenitor and osteoprogenitor cells capable of differentiating into either cementoblasts or osteoblasts or both.

Partial or complete radiographic
obliteration (not histologic)

Clinical management of calcific metamorphosis

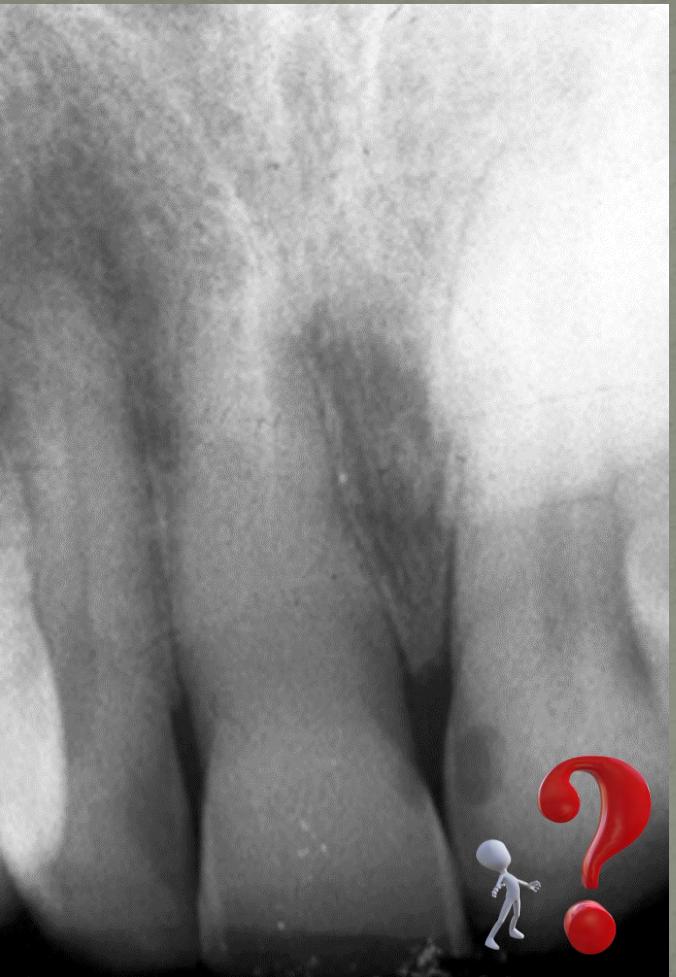
Does the tooth need a root canal? In 1965, Patterson and Mitchell

(2) felt that a tooth that had signs of calcific metamorphosis should be regarded as a potential focus for infection and root canal therapy should be initiated. However, clinical observation provided the foundation for guidelines. The Naval Academy study (3) found over a year period only 3/41 (7.3%) of teeth with CM developed necrosis, and as a result the only definitive criterion for treatment was the appearance of a periapical lesion. Jacobsen and Kerekes (4) conducted a study of teeth in which partial canal obliteration was identified in 10% of cases and total canal obliteration in 64%. Only 10% developed pulpal necrosis. Smith (5) performed a study and found that teeth with calcific metamorphosis have a low incidence of periapical pathosis development (0-16%) and recommended delaying treatment until symptoms or radiographic changes develop. **The development of CM following trauma does not justify prophylactic root canal therapy (3,4,6).**

Esthetic concerns

If the tooth with trauma becomes discolored and the patient has esthetic concerns, external bleaching should be considered first. However, since the decrease in translucency and acquisition of a yellowish color is due to irregular reparative dentin formation, external bleaching of the enamel may not achieve a clinically successful result. Intentional root canal treatment may be performed to facilitate internal bleaching. This may be carried out whether the pulp is vital or necrotic. Rotstein and Walton felt such teeth could be bleached with fair esthetic results (8). A study by Friedman et al. found that after a recall period of 18 years, 79% of internally bleached teeth had clinically acceptable or better esthetics (9).

Is there a canal?



Complete radiographic obliteration of the root canal space does not necessarily mean the absence of the pulp or canal space; in the majority of the cases, a pulp canal space with pulpal tissue is present. The pain threshold to thermal and electrical stimuli usually increases; often the teeth are unresponsive. Palpation and percussion are usually within normal limits.

Single-Tooth Bleaching:



Biologic Consequences

Consequences of Apical Neurovascular Supply Damage

Pulp Necrosis/Pulp Space Infection

The factors most important for the development of pulp necrosis are the type of injury (concussion least, intrusion most) and the stage of root development (mature apex more than an immature apex).



Because a serious injury is required for pulp necrosis, areas of cemental covering of the root usually are also affected. Bacterial toxins can pass through the dentinal tubules and stimulate an inflammatory response in PDL resulting in root and bone resorption

Pulp Necrosis



Maxillary right central incisor showing marked discoloration. This grey discoloration is more commonly associated with pulpal necrosis following trauma rather than pulp canal obliteration. Pulp canal obliteration with associated periapical pathosis.

Biologic Consequences

Internal Root Resorption (IRR)



Internal resorption is characterized by an oval-shaped enlargement of the root canal space
External resorption, which is much more common,
is often misdiagnosed as internal resorption

IRR

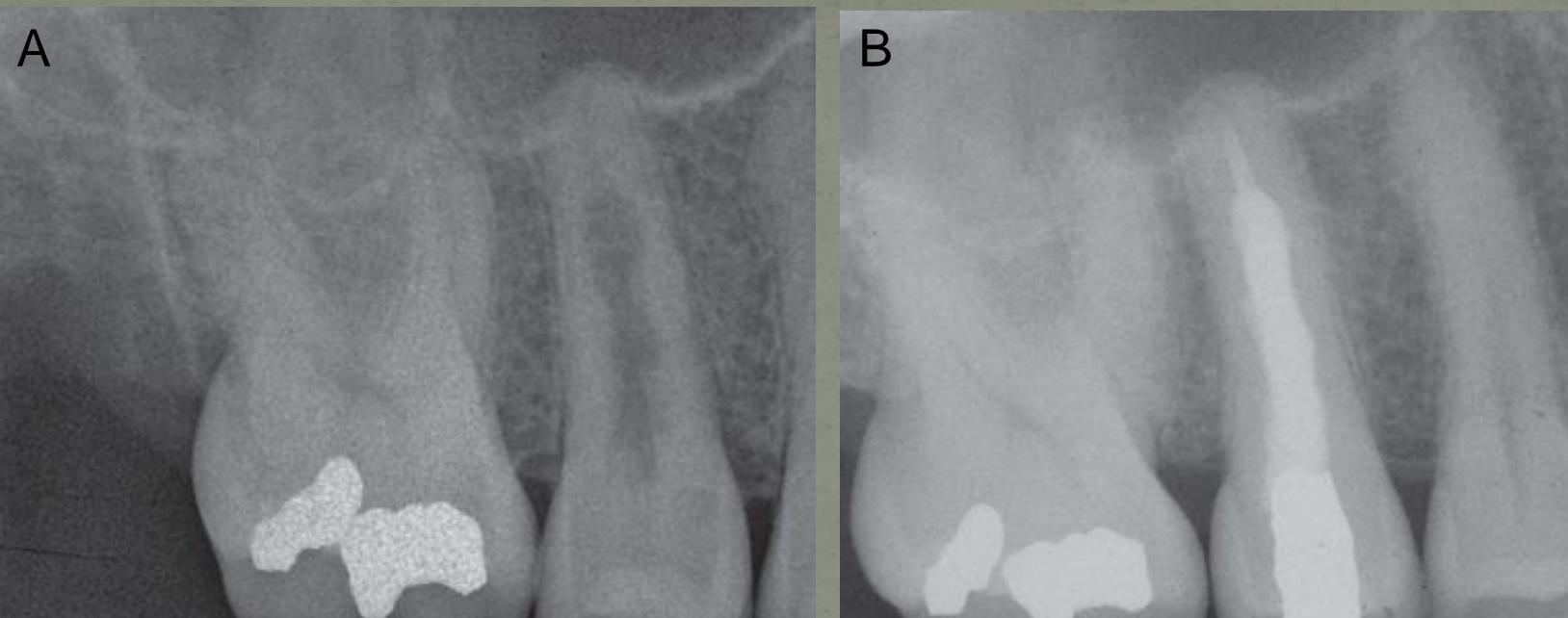
Usually asymptomatic

Granulation tissue

Vital and necrotic tissue

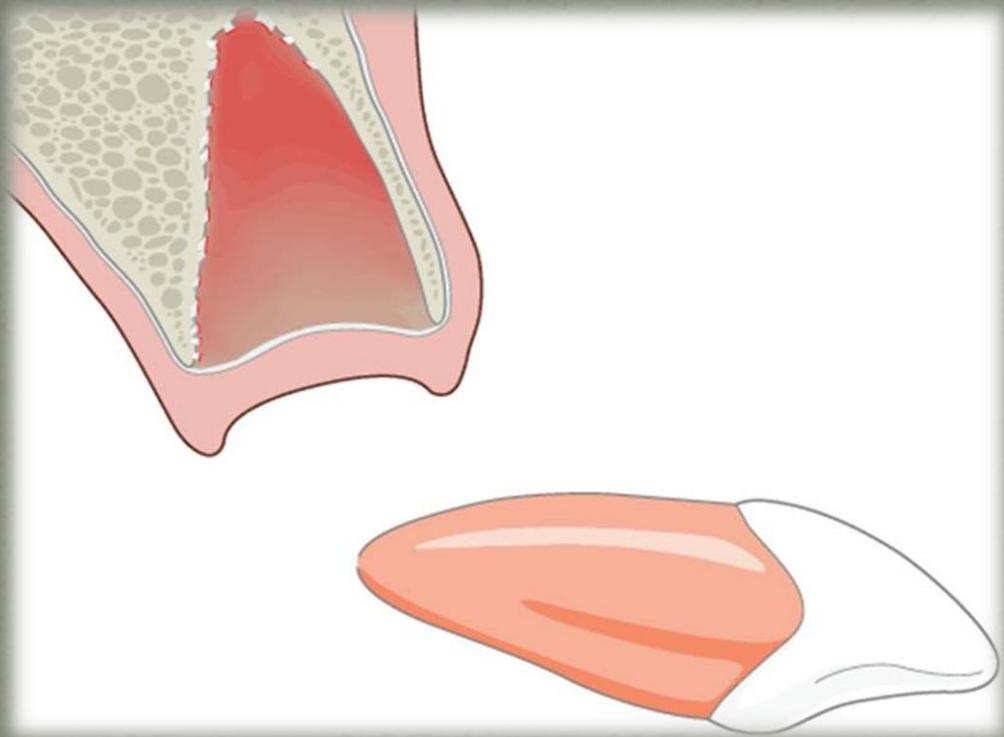
Lost/altered predentin
and odontoblastic layer

Treatment



A, Internal root resorption in a maxillary premolar with a history of trauma 7 years before the diagnosis (patient's head slammed against side window during an automobile accident).
B, Three-year follow-up radiograph after endodontic treatment.

Avulsion



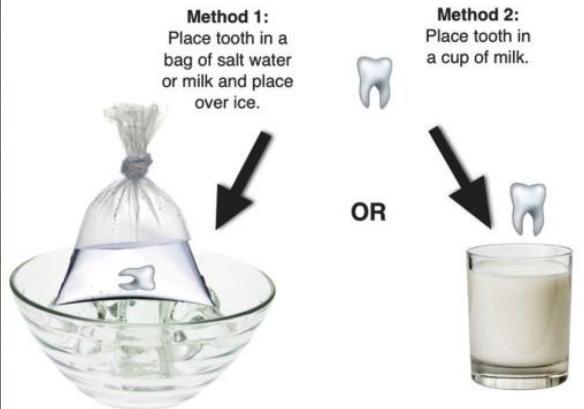
Public and clinicians from many dental disciplines must be knowledgeable about the treatment strategies involved

Complete displacement of a tooth out of its socket

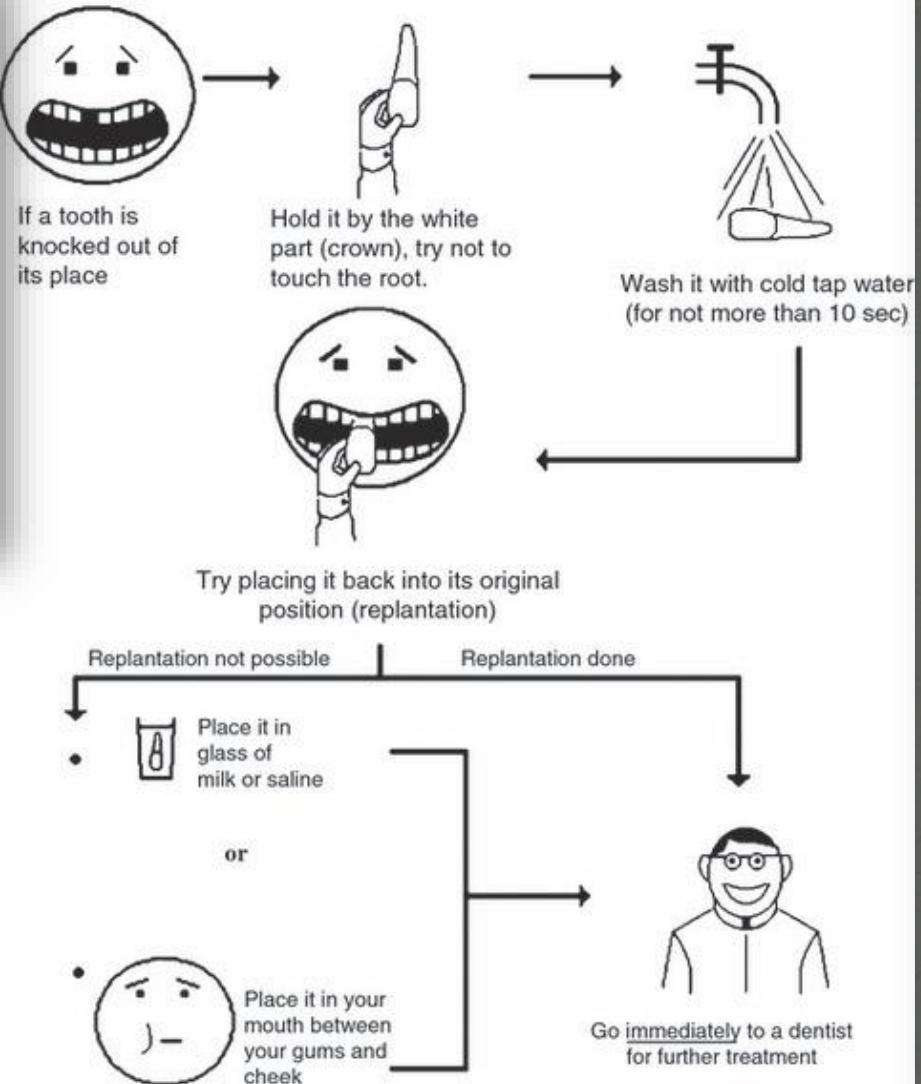


How to Treat a Complete Tooth Avulsion (Knocked-Out Tooth)

1. Rinse the tooth with water (no soap), taking care to only touch the crown of the tooth (the part you can see when it's in place).
2. Method 1: Place tooth in a bag of salt water or milk and place over ice.
3. Method 2: Place tooth in a cup of milk.
4. Call us immediately. If you act quickly it's possible to save the tooth.

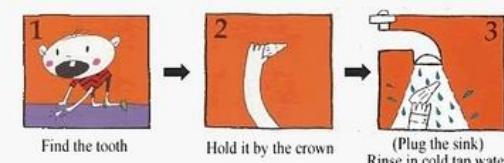
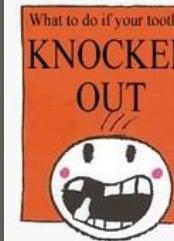
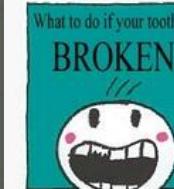


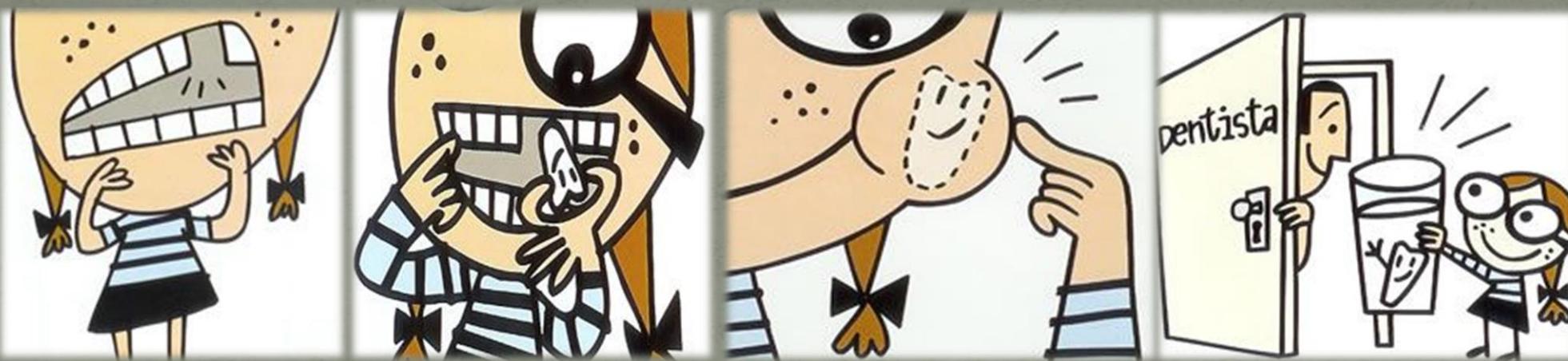
First aid treatment for a knocked out tooth (avulsion)



Save your tooth

Most of your permanent teeth may be saved if you know what to do after a blow to the mouth





If visiting the dentist takes more than 1 hour, try to get it back in its position, put it in glass of milk or in your cheek .



The single most important factor to assure a favorable outcome after replantation is the **speed** with which the tooth is replanted.

Consequences of Tooth Avulsion

If the PDL left attached to the root surface does not dry out, the consequences of tooth avulsion are usually less.

If excessive drying occurs before replantation, damaged PDL cells elicit a severe inflammatory. Bone will attach directly onto the root surface and replacement resorption takes place.

Pulpal necrosis always occurs after an avulsion injury. If revascularization does not occur or effective endodontic therapy is not carried out, the infected pulp and cemental damage results in an external inflammatory resorption that can be very serious and can lead to rapid loss of the tooth

Treatment Objectives

Minimizing resultant inflammation due to the two main consequences of avulsion:
attachment damage and pulpal infection.

Treatment is directed at minimizing additional damage which happens due to drying

All efforts are made to promote revascularization of the pulp (open apex). When revascularization fails (in the open apex tooth) or is not possible (in the closed apex tooth), all treatment efforts are made to prevent or eliminate toxins from the root canal space.



Clinical Management

Emergency Treatment at the *Accident Site*

Replant if possible, bite on a clean towel to avoid aspiration

Every effort should be made to replant the tooth within 15-20 min. This usually requires emergency personnel at the site of the injury with some knowledge of treatment protocol. The clinician should communicate clearly with the person at the site of the accident. The aim is to replant a clean tooth with an undamaged root surface as gently as possible, after which the patient should be brought to the office immediately.

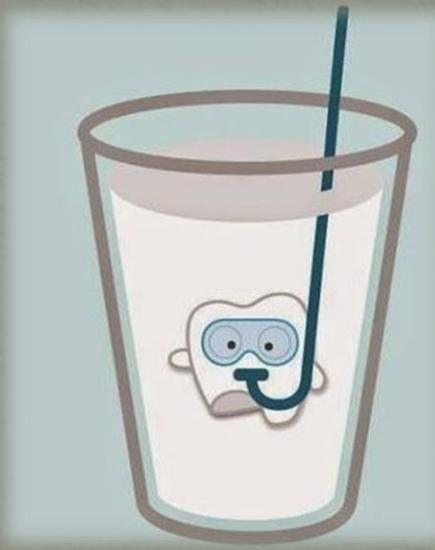




Clinical Management

Emergency Treatment at the *Accident Site*

Place in an appropriate storage medium



If doubt exists that the tooth can be replanted adequately, the tooth should quickly be stored in an appropriate medium until the patient can get to the dental office for replantation.

Suggested Storage Media

In order of preference

Milk (cold)

Saliva*

Physiologic saline

Water *



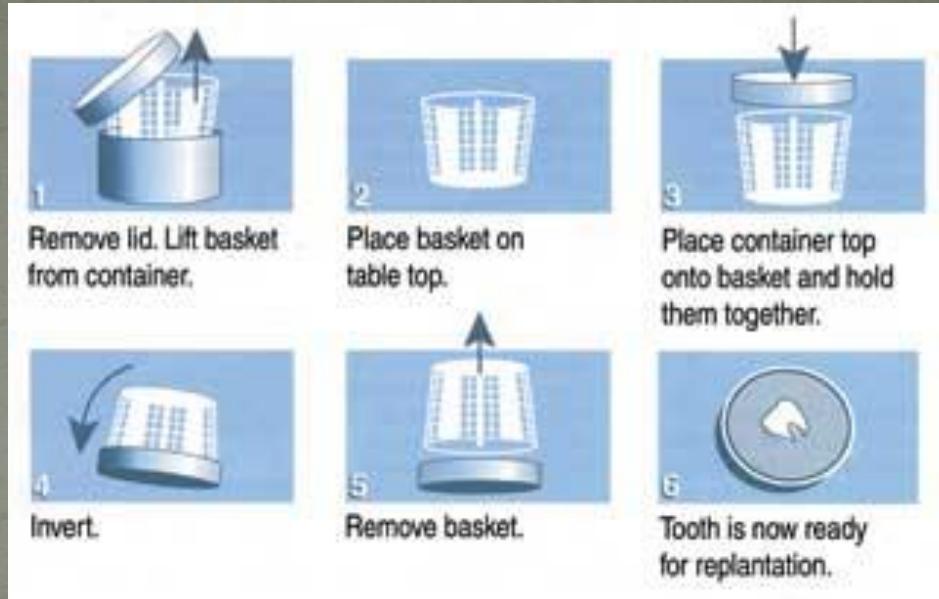
* In mouth vestibule or in a container
into which the patient expectorates.

* Least desirable. Hypotonic
environment: rapid cell lysis

Save-A-Tooth



Cell culture media in specialized transport containers, such as Hank's Balanced Salt Solution (HBSS, pH: 7.2), have shown superior ability to maintain the viability of the periodontal ligament fibers for extended periods.



Presently, HBSS are considered impractical because they need to be present at the accident site before the injury occurs. However, if we consider that more than 60% of avulsion injuries occur close to home or school, it seems reasonable to assume that it would be beneficial to have these media available in emergency kits at these sites.



<https://en.wikipedia.org/wiki/Viaspan>

Clinical Management Management in the Dental Office **Emergency Visit**

Prepare socket, prepare root, replant, construct a functional splint. Recognizing that a dental injury might be secondary to a more serious injury is essential. The attending dental clinician is likely to be the first health care provider the patient sees after a head injury, so ruling out any injuries to the brain and/or CNS in general is paramount. Once a CNS injury has been ruled out, the focus of the emergency visit is the attachment apparatus. The aim is to replant the tooth with a minimum of irreversibly damaged cells (that will cause inflammation) and the maximal number of periodontal ligament cells that have the potential to regenerate and repair the damaged root surface.

Clinical Management

Diagnosis and Treatment Plan

- Emphasis on questions about when, how, and where the injury occurred.
- Socket is examined and rinsed with saline. A radiograph is taken. Adjacent teeth are examined.
- If the tooth was replanted at the site of injury, the position of the replanted tooth is assessed and adjusted if necessary.
- If the patient presents with the tooth out of the mouth, the storage medium should be evaluated and the tooth placed in a more appropriate medium if required

PREPARATION OF THE ROOT

Preparation of the root depends on: (i) maturity of the tooth (open versus closed apex) and on (ii) the dry time of the tooth before it was placed in a storage medium. A dry time of 60 minutes is considered the point where survival of root periodontal ligament cells is unlikely.

Extraoral Dry Time Less Than 60 Minutes

Closed Apex

Rinse of debris with saline and replant gently. Revascularization is not possible but the chance for periodontal healing exists. Dry time of less than 15-20 min is considered optimal, and periodontal healing would be expected. In a dry time less than 60 minutes the root surface consists of some cells with the potential to regenerate and some that will act as inflammatory stimulators.

Extraoral Dry Time Less Than 60 Minutes

Open Apex



Gently rinse off debris, soak in doxycycline for 5 min or cover with minocycline, replant. In an open apex tooth, revascularization of the pulp and continued root development are possible.

Extraoral Dry Time More Than 60 Minutes

Closed Apex

Remove PDL by placing in acid for 5 min, soak in fluoride, replant.

Endodontics may be performed extraorally

Root is prepared to be as resistant to resorption as possible (attempting to slow the osseous replacement process). Tooth is soaked in acid for 5 min to remove all remaining periodontal ligament: removing the tissue that would initiate the inflammatory response on replantation. The tooth is then soaked in 2% stannous fluoride for 5 min and replanted.



Enamel matrix protein



It was suggested to be used in cases with extended extraoral dry times to make the root more resistant to resorption and stimulate the formation of new PDL. Unfortunately, more recent studies have shown that the positive effect of Emdogain is only temporary, and most of these teeth start to resorb after a few years.

Extraoral Dry Time More Than 60 Minutes

Open Apex

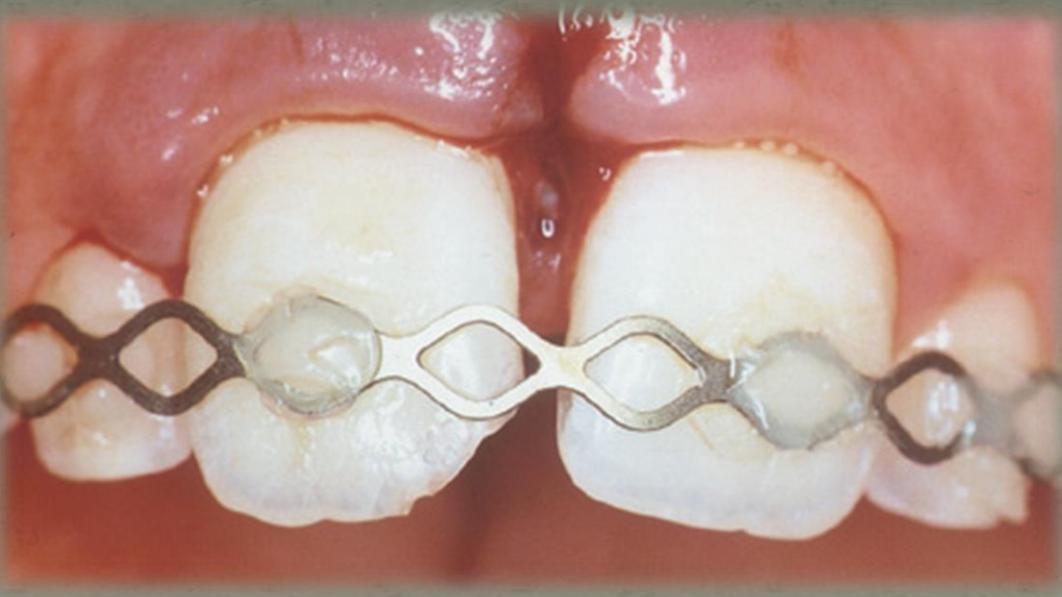
Replant? If yes, treat as with closed apex tooth.
It is advantageous to perform endodontic treatment (apexification) extra orally.



PREPARATION OF THE SOCKET

Emphasis is placed on removal of obstacles in the socket to facilitate replacement of the tooth into the socket. It should be lightly aspirated if a blood clot is present. If the alveolar bone has collapsed or may interfere with replantation, a blunt instrument should be inserted carefully into the socket to reposition the wall.

SPLINTING



Titanium trauma splint (TTS)

Semirigid (physiologic) fixation: 1-2 weeks. The splint should have no memory (so the tooth is not moved during healing) and should not impinge on the gingiva and/or prevent maintenance of oral hygiene in the area. Radiograph: verify the positioning of the tooth. 1 week is sufficient to create periodontal support. Therefore, the splint should be removed after 1-2 weeks. The only exception is with avulsion in conjunction with alveolar fractures (4-8 weeks splinting)

MANAGEMENT OF SOFT TISSUE



Careful exploration of the **lip** wound should be performed to rule out an **embedded tooth fragments or foreign body**. This is accomplished by placing a dental film between the **lips** and the dental arch and using **25%** of the normal **exposure time**.

Adjunctive Therapy

Systemic antibiotics: At the emergency visit and continuing until the splint is removed

- Children 12 years and younger/patient with tetracycline staining risk: Penicillin V at an appropriate dose for patient age and weight. (Adult: 1000 mg loading dose, followed 500 mg 4/daily/7 days)
- Children older than 12 years of age/little risk of staining: Doxycycline 2/daily/7 days at the appropriate dosage for patient age and weight
- The need for analgesics should be assessed on an individual case basis. The use of pain medication stronger than non-prescription NSAIDs is unusual.

Flexible Analgesic Strategy

	Aspirin-like drugs indicated	Aspirin-like drugs contraindicate
Mild Pain	Ibuprofen 400-600 mg	Acetaminophen 325 mg
Moderate Pain	Ibuprofen 400-600 mg + Acetaminophen 325 mg	Acetaminophen 650 mg
Severe Pain	Ibuprofen 400-600 mg + Hydrocodone 7.5 mg & Acetaminophen 300 mg	Acetaminophen 325 mg & Oxycodone 10 mg



The patient should be sent to a physician for consultation regarding a tetanus booster within 48 hours of the initial visit.



The bacterial content of the sulcus also should be controlled during the healing phase. In addition to stressing to the patient the need for adequate oral hygiene, the use of chlorhexidine rinses (0.12%) twice a day for 7 -10 days is helpful.



Soft Diet and Soft Toothbrush

Second Visit

1-2 weeks later

The focus of the 2nd visit is the prevention/elimination of potential irritants from the root canal space. At this appointment the splint is removed; the tooth might still have class I or class II mobility after splint removal, but all indications are that it will continue to heal better without the splint.

Endodontic Treatment

Extraoral Dry Time Less Than 60 Minutes Closed Apex

Initiate endodontic treatment after 1-2 weeks. When endodontic treatment is delayed or signs of resorption are present, provide long-term Ca(OH)₂ treatment before obturation.

Canal is obturated when reestablishment of a lamina dura is seen radiographically. However, filling at this visit (1-2 weeks after trauma) is acceptable if thorough examination confirms normality.

Endodontic Treatment

Extraoral Dry Time Less Than 60 Minutes *Open Apex*

Avoid endodontic treatment and look for signs of revascularization. At the first sign of an infected pulp, initiate apexification procedure. Patients are recalled every 3-4 weeks for pulp vitality testing. Thermal tests with carbon dioxide snow (-78° C) or dichlorodifluoromethane (-40° C) placed are the best methods in these cases.

Endodontic Treatment

Extraoral Dry Time More Than 60 Minutes *Closed Apex*

Teeth with closed apices are treated endodontically in the same way as teeth that had an extraoral time of less than 60 minutes.



Endodontic treatment may be performed aseptically extraorally before replantation

Endodontic Treatment

Extraoral Dry Time More Than 60 Minutes

Open Apex (If Replanted)

No attempt is made to revitalize them. If endodontic treatment (apexification) was not performed out of the mouth, initiate apexification procedure.



Temporary/ Permanent Restoration

Coronal leakage caused by defective temporary and permanent restorations results in a clinically relevant amount of bacterial contamination of the root canal after root filling. Therefore, the tooth should receive a permanent restoration as soon as possible

Follow-up

3 months, 6 months, and yearly for at least 5 years. If osseous replacement is identified, a more closely monitored follow-up schedule is indicated. In the case of inflammatory root resorption, a new attempt at disinfection of the root canal space by standard retreatment might reverse the process. Teeth adjacent to and surrounding the avulsed tooth or teeth may show pathologic changes long after the initial accident, so these teeth, too, should be tested at follow-up visits and the results compared to those collected soon after the accident.

TABLE 17-2 5-Year Pulpal Survival Data for Injuries Involving the Periodontal Ligament

Type of Injury	Open Apex (%)	Closed Apex (%)
Concussion	100	96
Subluxation	100	85
Extrusive luxation	95	45
Lateral luxation	95	25
Intrusive luxation	40	0
Replantation	30	0

TABLE 17-3 Prevalence of Resorption after Periodontal Ligament Injury

Type of Injury	Open Apex (%)	Closed Apex (%)
Concussion	1	3
Subluxation	1	3
Extrusive luxation	5	7
Lateral luxation	3	38
Intrusive luxation	67	100
Replantation	Frequent	Frequent

1
MORE THING

So... I Hurt
My Baby
Teeth...
Do I Need
a Dentist?



MANAGEMENT OF TRAUMATIC INJURIES IN THE PRIMARY DENTITION

Crown Fractures Without Pulp Exposure:

Restore with GIC or composite, or the fracture sites may be smoothed without restoration.

Crown Fractures With Pulp Exposure:

Partial pulpotomy with Ca(OH)_2 , pulpotomy, or extraction, depending on the patient's age and cooperation .

Crown Root Fractures:

Extraction is indicated

Root Fractures:

Remove coronal part, leave apical part or no treatment if there is no mobility or no marked displacement.

MANAGEMENT OF TRAUMATIC INJURIES IN THE PRIMARY DENTITION

Intrusion

The main concern is the effect on the underlying permanent dentition, which is estimated at 50%-75% damage rate. *If the primary tooth intruded into the developing tooth germ, extraction is indicated.* Otherwise, the tooth may be allowed to re-erupt spontaneously.

Intrusion

The direction of the apex can be determined by:

1. Inclination of the crown
2. Palpation of the soft tissue above the affected tooth
3. Imaging with periapical/occlusal radiographs

Determine whether the root is forced in a palatal or buccal direction



Foreshortened appearance of the intruded tooth implies buccal displacement of the root and thus away from the permanent tooth germ, whereas an elongated image suggests palatal displacement towards the permanent successor.

MANAGEMENT OF TRAUMATIC INJURIES IN THE PRIMARY DENTITION

Extrusion

It might be left untreated, repositioned if there is occlusal interference, or extracted if there is severe displacement and considerable mobility.

MANAGEMENT OF TRAUMATIC INJURIES IN THE PRIMARY DENTITION

Lateral Luxation

Palatal displacement of the crown: leave it untreated if there is no occlusal interference. Minor occlusal interference: slight grinding. Major interference: reposition.

Buccal displacement of the crown: In case of collision with the permanent tooth bud, extraction.



a



b

(a) Severe luxation of the right central incisor. No treatment other than observation was performed. (b) Two months later, the tooth is back in normal position.

Buccal or Palatal displacement of the crown?

MANAGEMENT OF TRAUMATIC INJURIES IN THE PRIMARY DENTITION

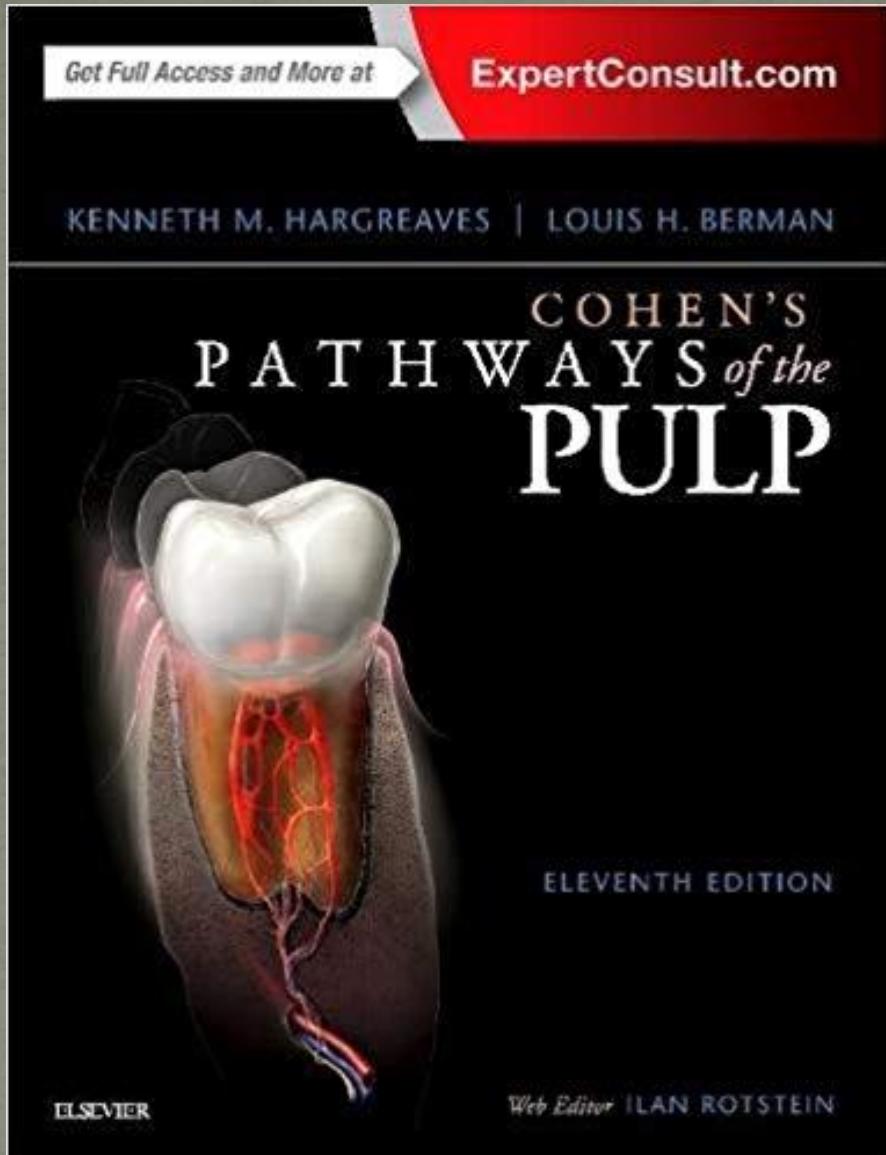
Ask the parents to bring the avulsed tooth

Avulsion

A radiographic examination is essential to ensure that the missing tooth is not intruded. Replantation is **contraindicated**, as pulp necrosis is a frequent complication. Moreover, there is a risk of further injury to the permanent tooth germ by the replantation procedure, whereby the coagulum from the socket can be forced into the follicle.



References



CHAPTER 20

The Role of Endodontics After Dental Traumatic Injuries

MARTIN TROPE | FREDERIC BARNETT | ASGEIR SIGURDSSON | NOAH CHIVIAN

CHAPTER OUTLINE

Unique Aspects of Dental Trauma

Most Common Types of Dental Trauma

- Crown Fractures*
- Crown-Root Fractures*
- Root Fractures*
- Luxation Injuries and Avulsion*

Follow-Up After Dental Trauma

Radiographic Examinations

- Cone Beam Computed Tomography and Dentoalveolar Trauma*
- Root Resorption*
- Horizontal (Transverse) Root Fractures*
- Luxation Injuries*

Crown Fractures

- Crown Infraction*
- Uncomplicated Crown Fracture*
- Treatment*
- Complicated Crown Fracture*
- Treatment*
- Vital Pulp Therapy: Requirements for Success*
- Treatment Methods*
- Treatment of the Nonvital Pulp*

Crown-Root Fracture

Root Fracture

- Diagnosis and Clinical Presentation*
- Treatment*
- Healing Patterns*
- Treatment of Complications*

Luxation Injuries

- Definitions*
- Incidence*
- Treatment*
- Biologic Consequences*

Clinical Management of the Avulsed Tooth

- Consequences of Tooth Avulsion*
- Treatment Objectives*
- Clinical Management*
- Diagnosis and Treatment Planning*

Preparation of the Root

- Extraoral Dry Time Less Than 60 Minutes*
- Extraoral Dry Time More Than 60 Minutes*

Preparation of the Socket

Splinting

Management of the Soft Tissues

Adjunctive Therapy

- Second Visit*

Endodontic Treatment

- Extraoral Time Less Than 60 Minutes*
- Extraoral Time More Than 60 Minutes*

Temporary Restoration

- Root Filling Visit*

Permanent Restoration

- Follow-Up Care*

The
End.

