Management of Traumatic Injuries
to Children’s Teeth

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Continuing Education Units: 2 hours


Disclaimer: Participants must always be aware of the hazards of using limited knowledge in integrating new techniques or procedures into their practice. Only sound evidence-based dentistry should be used in patient therapy.

This course presents currently available knowledge of the latest techniques for treatment of dental injuries in children and adults based on the guidelines from the American Academy of Pediatric Dentistry and the International Association of Dental Traumatology.

Conflict of Interest Disclosure Statement
The author reports no conflicts of interest associated with this course.

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Overview
It’s a scenario played out daily. A child falls on the face resulting in a dento-facial injury. The family turns to their dental professional for treatment. The appropriateness of treatment can have a profound effect on the health and appearance of the patient’s dentition many years into the future. In this course participants will learn the latest techniques based on the guidelines from the American Academy of Pediatric Dentistry and the International Association of Dental Traumatology for treatment of dental injuries in children and adults.
Learning Objectives
Upon the completion of this course, the dental professional should be able to:
• Identify predisposing factors for traumatic dento-facial injuries.
• Conduct a comprehensive historical review, clinical and radiographic examination of traumatic injuries.
• Effectively treat traumatic injuries to primary and permanent teeth.
• Provide long-term follow up care.
• Counsel patients and parents on prevention of traumatic injuries.

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Introduction
Dental-alveolar trauma in children is distressing to the child and parent and its management can be equally difficult for the dentist. A traumatic dento/facial accident can compromise the integrity of a previously healthy dentition and result in an unsightly appearance, affecting the child’s self esteem. A call from a distraught parent of a dento/facially injured child is one of the few acute emergencies seen by dentists and warrant rearrangement of the office schedule.

Most injuries in children are caused by falls and play accidents. Peak incidences in the primary dentition are found at two to three years of age, when the child is developing motor coordination. In the permanent dentition, peak incidences are found at nine to ten years of age, when vigorous playing and sport activities become more frequent. High velocity or sharp injuries cause fractures and luxations of teeth while blunt trauma causes greater damage to soft tissues. Another major cause of dental injuries in young children is automobile and school bus accidents. Unrestrained children may hit the dashboard, windshield, or the seat in front of them during a sudden stop.

Children with chronic seizure disorders experience an increased incidence of dental trauma. The wearing of protective headgear and custom mouth guards are recommended for these high risk children.

Up to 50% of physically abused children suffer injuries to the head and neck. Signs of child abuse include injuries in various stages of healing, tears of the labial frena, and repeated injuries and injuries whose clinical appearance is not consistent with the history presented by the parent. Dentists who suspect child abuse in patients are required by law to report suspected cases to the proper authorities.

Thirty percent of children suffer trauma to the primary dentition and twenty two percent of children suffer trauma to the permanent dentition by age fourteen years. Injuries occur in males in a 2:1 margin over girls. The anterior teeth are the most commonly involved. Injuries usually involve a single tooth, except with sporting injuries and motor vehicle accidents. The predominant
predisposing factor is a Class II division 1 occlusion. As the overjet increases the frequency proportionately increases. The frequency of trauma to anterior teeth in a child with an overjet of 3-6 mm is double that of a child with an overjet of 0-3 mm. Children with an overjet greater than 6 mm have a threefold frequency rate.\textsuperscript{1,6}

**Examination and Diagnosis**

To efficiently arrive at a correct diagnosis and treatment plan for the traumatized oral structures a systematic examination is necessary. Assessment includes a thorough history, visual and radiographic examination and additional tests such as a palpation, percussion, pulp vitality testing and mobility evaluation. Intraoral and extraoral radiographs are useful for the evaluation hard and soft tissue injuries. The use of an Assessment of Acute Traumatic Injuries (American Academy of Pediatric Dentistry) is valuable in obtaining the necessary information.\textsuperscript{5}

When the patient presents for treatment of acute oral trauma the facial and oral areas are heavily contaminated, therefore, the first step in the examination process is to wash the patient’s face with a mild detergent. During the decontamination process an initial assessment of the injuries can be made.

**History of the Patient and Injury**

The assessment of the injury begins by asking questions that aid in diagnosis and treatment planning of the injuries. The questions include the following:

**Does the patient have any medical issues?**

A medical history can reveal medical conditions, allergies and other information that may influence treatment. Information relevant to dental injuries includes:

- Medications
- Cardiac disease, which may necessitate subacute bacterial endocarditis antibiotic prophylaxis. (The reader is referred to the American Heart Association’s latest guidelines for infective endocarditis published in its journal *Circulation: Journal of the American Heart Association* in April 2007).
- Bleeding disorders
- Allergies to medication
- Seizure disorders
- Tetanus prophylaxis status, especially if the child suffered a dirty wound. If the injured child has not received tetanus toxoid within the last five years a booster is indicated.

As forces that are strong enough to fracture, intrude or avulse a tooth can also result in cervical spine or intracranial injuries the dentist should perform a neurological assessment and make the proper medical referral even before commencing with dental treatment, if necessary.

The patient should be assessed for nausea, vomiting drowsiness or possible cerebrospinal fluid leakage from the nose which would be indicative of a skull fracture. The dentist should conduct a cranial nerve evaluation in the following four areas:

- The patient can track a finger moving vertically and horizontally through the visual field with the eyes in tandem to evaluate whether the extraocular muscles are intact and functioning.
- Pupils are equal, round and reactive to light.
- Light contact with various areas of the face measures normal sensory function
- Have the patient frown, smile, move the tongue and perform several voluntary muscular movement to determine symmetry of motor function.

**When did the injury occur?**

The answer will provide a timeframe that will influence the type of treatment rendered. A delay in seeking treatment should raise suspicions of child abuse.

**Where did the injury occur?**

The answer may suggest legal issues and financial responsibility for the injuries as well as degree of contamination of the wound.

**How did the injury occur?**

The answer to this question suggests the possible areas of injury i.e., a blow to the chin may suggest root/crown fracture in the posterior area or jaw fracture. Inconsistencies between the injuries exhibited by the child and the provided history should raise suspicions of child abuse.

**Was there a period of unconsciousness?**

If yes, how long? Is/was there headache?
Amnesia? Nausea? Vomiting? These are signs of brain concussion and require medical attention and observation. Once the patient is deemed stable there is no contradiction for treatment of the dental injury.

*Have there been previous injuries to the teeth?*  
Positive answers may explain chronic conditions to the teeth unrelated to the acute injuries, i.e., obliterated pulp canal, shortened roots, abscesses.

*Is there a disturbance in the bite?*  
A positive answer may indicate alveolar, jaw or condylar fracture.

*Is there any reaction in the teeth to cold /heat?*  
A positive answer indicates dentin exposure and the need for treatment.

**Clinical Examination**

The medical and injury history is followed by the clinical examination. The most convenient position to examine the young child, especially with limited cooperative ability is the knee to knee position. The dentist and parent are seated opposite each other with their knees touching. The parent lowers the child's head into the dentist's lap, while holding the child's hands and restraining the legs against his/her body. The dentist stabilizes the head and conducts the clinical examination. The dentist may also conduct the examination with the child in the parent's lap. The parent restrains the child's lower body by with their legs and the child's upper body with their arms. Positioning the child in the parent's lap may comfort the child to the extent that they will cooperate for clinical and radiographic examination.

In the event that the child will not cooperate in any of the previous mentioned positions, examination and treatment may have to be performed using a restraining device (Papoose Board®, Olympic Medical).

The dentist may also conduct the examination with the child in the parent's lap. The parent restrains the child's lower body by with their legs and the child's upper body with their arms. Positioning the child in the parent's lap may comfort the child to the extent that they will cooperate for clinical and radiographic examination.
Clinical examination begins with an extraoral examination to rule out injuries to the facial bones. The facial structures should be palpated to determine discontinuities of facial bones. The temporomandibular joints are palpated and any swelling, clicking or crepitus is noted. Mandibular function during excursive movements is checked. Stiffness or pain in the patient’s neck requires immediate referral to a physician to rule out cervical spine injury.

The intraoral examination follows with examination of the soft tissues. Lacerations of the lips and cheeks are checked for the presence of foreign matter such as tooth fragments or gravel. These particles should be removed at the initial visit to prevent infection and tissue fibrosis.

All teeth in the mouth are examined for mobility, displacement and crown fracture and findings are recorded.

Mobility testing determines the extent of loosening, horizontally and vertically. Mobility can be indicative of various injuries, i.e. crown-root fracture, root fracture, subluxation, luxation.

Displacement of the teeth should be noted indicating the position (labially or lingually) and interference with occlusion.

Percussion testing can be performed digitally or with the handle of a dental instrument. Tenderness to percussion is indicative of damage to the periodontal ligament.

Pulpal sensibility testing relates to the assessment of pulpal health. Previously termed “vitality testing” this new terminology stresses the fact that neural and vascular components of the pulp tissue need individual consideration. A tooth may not respond to a thermal test but may have an intact blood supply. It is not performed in the primary dentition because of the inability of younger children to cooperate for the test and report their reactions objectively. A recently traumatized tooth may be in shock and may fail to respond accurately. If the tooth does not respond positively to vitality testing emergency treatment may be completed and the tooth retested at the follow-up visit.

The radiographic examination follows the clinical examination. Radiographs allow for detection of root fractures, intrusions, extent of root development, pulp chamber size, periapical radiolucencies, root resorption, degree of tooth displacement, unerupted tooth position, jaw fractures and the presence of tooth fragments and foreign bodies in soft tissue. Although some radiographs may show negative findings at the initial appointment, they are important as baseline comparisons with subsequent radiographs.

All films taken should clearly show the periapical areas of the involved teeth. In cases where root fractures are suspected, second and third radiographs take from slightly different horizontal and vertical angles positions to verify the location of the fracture.

In cases of intruded incisors a lateral view of the anterior region is taken. The radiograph is taken either by placing a 3 X 5 inch extraoral film next to the child’s cheek and perpendicular to the radiographic beam or placing a size 1 film intraorally between the buccal surfaces of the primary molars or permanent premolars and the cheek and perpendicular to the radiographic beam. The exposure time for a normal periapical film is doubled.

Since the orbicularis muscles close tightly around foreign bodies in the lip, palpation of foreign bodies are difficult to palpate. They are best identified radiographically. To determine the presence of foreign bodies such as tooth fragments and other radio-opaque debris in the soft tissues the radiograph is placed between the hard tissue and the soft tissue of the lip. The exposure time is one fourth of a normal periapical film.
Categories of Injury
Trauma to the young child’s orofacial structures may involve soft and/or hard tissues. The extent of injury is influenced by how far a child falls, speed of movement during the fall and the object or surface landed upon. A fall can result in a single injury or a combination of injuries.

Soft Tissue Trauma
The soft tissues are often involved during traumatic injuries to the orofacial area and maybe bruised or lacerated by the impact of teeth against the tissue. Usually application of pressure with gauze to the injured site should provide adequate hemostasis. If hemostasis cannot be obtained or the laceration is so severe that the edges are not well opposed, sutures are recommended.

Lips often cushion the teeth during a fall, bearing the brunt of the injury and resulting in bruises and lacerations. If a laceration is present it should be carefully examined to determine whether a foreign object such as a tooth fragment or gravel has been introduced into the wound.

The maxillary labial frena may tear as a result of a fall. This type of injury is common during falls experienced while learning to walk. However, such an injury occurring in infants who do not walk or crawl is probably due to an object being forced into the child’s mouth and should be investigated as a result of child abuse.

Impalement of the soft palate is commonly found in the child who falls while hold an object in the mouth – a stick, pencil or pen, straw or toothbrush. Most impalement injuries heal spontaneously and do not require treatment, however the area should be thoroughly explored for foreign body objects and a prophylactic antibiotic should be prescribed to avoid infection complications.

Hard Tissue Trauma
Proper management of trauma to the primary and young immature permanent teeth is important for a number of reasons. 1,5,6,7

- Traumatized teeth may lose their vitality over time and may become discolored or abscessed or both
- Some traumatic injuries to primary teeth can damage the permanent teeth.
- Traumatic injuries that cause movement of teeth may interfere with the child’s occlusion resulting in pain during biting and talking.

Hard tissue trauma is divided into various categories:

Infraction
Infraction is defined as an incomplete fracture (crack) of the enamel without loss of tooth structure. Clinical examination reveals normal gross anatomic and radiographic appearance, however, upon closer examination, craze lines are apparent in the enamel, especially with transillumination. A periapical radiograph of the involved area is taken to rule out root fracture and injuries to the supporting tooth structure. Pulp sensibility testing is recommended in adult teeth to monitor pulpal changes however results in primary teeth may be unreliable. Test results may be negative initially indicating transient pulpal damage.

The treatment objective is to maintain the structural integrity of the tooth and pulp vitality. Treatment ranges from observation to application of bonding agent and/sealant to the fractured enamel structure. The prognosis for health of the tooth is usually uneventful.

No follow up is needed unless they are associated with a luxation injury or other fracture involvement of the same tooth.
**Crown Fracture – Uncomplicated**

An uncomplicated crown fracture involves only enamel or enamel/dentin structure without involvement of the pulp. Clinical and/or radiographic findings reveal a loss of tooth structure consisting of only enamel or both the enamel and dentin. Injured lips, tongue and gingiva should be examined for embedded tooth fragments and debris. Pulp sensibility testing is recommended to monitor pulpal health changes in adult teeth but are unreliable in primary teeth. Initial testing may be negative initially indicating transient pulpal damage.

Treatment objectives are to maintain pulp vitality and restore normal esthetics and function. For small fractures, rough margins and edges may be smoothed. For larger fractures, lost tooth structure may be restored with calcium hydroxide (if the fracture is close to the pulp), glass ionomer cement and composite. The prognosis of uncomplicated crown fractures depends primarily upon associated injuries to the periodontal ligament and secondarily upon the extent of dentin exposed. Follow up clinical and radiographic exam should be scheduled at three to four weeks in children, six to eight weeks in adults and one year for all ages.

**Crown Fracture – Complicated**

A complicated crown fracture is defined as an enamel/dentin fracture with pulp exposure. Clinical and radiographic examination reveals a loss of tooth structure with pulpal involvement. As with the non-complicated tooth fracture, the injured lips, tongue and gingival should be examined for tooth fragments and debris. Radiographic examination consists of periapical and occlusal radiographs of the injured teeth and of the injured soft tissues to rule out foreign body contamination. Pulp sensibility testing is not indicated initially since pulpal involvement is confirmed by sight. Subsequent monitoring is recommended.

Treatment objectives are to maintain pulp vitality and restore normal esthetics and function. The type of treatment rendered is dependent on pulp vitality and the stage of root development or resorption.

- **Primary teeth**: If the root is in the process of resorbing the suggested treatment is extraction. If the pulp tissue is vital, a pulpotomy is performed. Pulp capping is not a recommended procedure for primary teeth. If the pulp is nonvital and the root structure is intact a pulpectomy is performed. Follow up treatment consists of clinical and radiographic examination at three to four weeks, six months and one year intervals.

- **Permanent teeth**: Pulpal treatment is dependent upon the time elapsed since injury, size of the exposure and root development.
  - A tooth with either an open or closed apex, may be treated with a pulp capping technique if the tooth is treated within four hours of the injury and the size of the exposure is pinpoint. The tooth is isolated with rubber dam and decontaminated with chlorhexadine. A layer of calcium hydroxide paste is placed over the pulp exposure and the tooth is restored with a composite restoration.
In a tooth with an open (immature) apex, with a pulp that has been exposed for an extended period of time (>4 hours) and/or the exposure is greater than 1mm, and the pulp is vital, a Cvek pulpotomy (apexogenesis) is performed. The tooth is isolated and decontaminated with chlorhexidine. The contaminated pulpal tissue is removed, using a round carbide bur or diamond mounted in a high speed handpiece using copious amounts of water. The pulp is removed to a depth of 2-3 mm past the level of the exposure. Once complete hemostasis is achieved, a thin layer of calcium hydroxide paste or mineral trioxide aggregate (MTA) is applied to the wound and gently compressed. A thin layer of glass ionomer cement is placed over the dressing within the preparation and the tooth restored with composite resin. Follow up treatment consists of clinical examination after one week and radiographic examination at six to eight weeks, and one year intervals.

A tooth with an open (immature) apex and non-vital pulp requires extirpation of the entire infected pulp. The canal is prepared to within 1mm short of the radiographic apex. The canal is irrigated thoroughly with sodium hypochlorite (1% NaOCl) to dissolve pulp tissue remnants and to disinfect the canal. A calcium hydroxide paste is inserted into the canal with mild pressure using a cotton pellet and gutta percha point, taking care not to extend beyond the apex. Glass ionomer cement or zinc oxide eugenol is placed as a temporary dressing. The calcium hydroxide paste is replaced at three month intervals until a calcific bridge is formed at which time conventional endodontic treatment may be commenced.

Injured teeth with completed root development should undergo complete pulp extirpation and root canal therapy. The prognosis of complicated crown fractures appears to depend primarily upon associated injuries to the periodontal ligament. The age and size of the pulp exposure and the stage of root development at the time of injury can also affect the tooth’s prognosis. Follow up treatment consists of clinical examination after one week and radiographic examination at six to eight weeks, and one year intervals.

Crown/root Fracture
A crown root fracture is a result of an enamel, dentin, and cementum fracture with or without pulp exposure. Clinical findings usually reveal a mobile coronal fragment attached to the gingiva with or without a pulp exposure. The fracture usually starts in the middle of the facial portion of the crown and extends to below the gingival level palatally. In the anterior region the coronal portion extends in an incisal direction resulting in pain upon occlusion. In the posterior region the fracture is usually confined to the buccal cusps. Root fractures can only be diagnosed radiographically. Radiographic findings may reveal a radiolucent oblique line that consists of crown and root structure in a vertical direction in primary teeth and in a direction usually perpendicular to the central radiographic beam in permanent teeth.
fragments may result in damage to the permanent tooth. The remaining fragments may be left to resorb normally. Follow up is clinical observation and radiograph after three to four weeks.

- **Permanent teeth**: If definitive treatment cannot be performed at the initial visit, the emergency treatment is to reposition the coronal fragment and temporarily splint it to the adjacent teeth with composite for up to four weeks to reduce patient discomfort. Definitive treatment alternatives are to remove the coronal fragment followed by a supragingival restoration or necessary gingivectomy; decoronation, extraction or surgical or orthodontic extrusion to prepare for restoration. If the pulp is exposed, pulpal treatment alternatives are pulp capping, pulpotomy, and root canal treatment.

    The prognosis of teeth with crown/root fractures is dependent on the location of the fracture and the extent of the enamel, dentin, cementum and pulp involvement. Fractures extending significantly below the gingival margin may not be restorable. Follow up is splint removal by four weeks. In the primary dentition, follow up is clinical and radiographic examination at three to four weeks, and one year. In the permanent dentition follow up is at six to eight weeks and one year.

**Root Fracture**

Root fracture is defined as a dentin and cementum fracture involving the pulp. Classification is based on the level of the fracture in relation to the apex of the root. The fracture may occur in the apical third, middle third or cervical third of the tooth. The more cervical position the fracture, the worse the prognosis. The apical fragment usually remains in its original position while the coronal fragment is displaced. Since the crown of the tooth is often intact and stable, diagnosis of a root fracture can only be made radiographically and may require multiple radiographic exposures at different horizontal and vertical angulations for an accurate diagnosis. Root fractures in primary teeth may be obscured due to superimposition of a succedaneous tooth.

The treatment objective is to reposition and stabilize the coronal fragment as soon as possible in its anatomically correct position to optimize healing of the neurovascular supply and periodontal ligament and maintain esthetic and functional integrity.

- **Primary teeth**: Treatment alternatives are dependent on the stability of the coronal fragment of the injured tooth. If the tooth is stable and causing no discomfort to the patient the tooth the needs only to be monitored by clinical and radiographic examination post trauma, at two to three weeks, six to eight weeks, six months, one year and then annually until the permanent tooth erupts.

If the tooth is mobile and the patient express discomfort the coronal fragment should be extracted. If the apical fragment is too difficult to retrieve it should be left to resorb so as not to disturb the developing permanent tooth. The tooth is monitored for apical pathology and normal resorption. Follow up consists of clinical examination and radiographs after three to four weeks.

- **Permanent teeth**: If the coronal fragment is stable and immobile (high apical root fracture) no treatment is indicated. If the coronal fragment is mobile, reposition and stabilize the fragment with rigid splinting of composite resin and wire or orthodontic appliances for four weeks if the fracture is in the middle third of the root, four months if in the cervical third. If splinting is unsuccessful, the coronal
fragment is extracted and endodontic therapy is performed on the apical fragment. Further treatment options for a subgingival root are gingivectomy, orthodontic extrusion or surgical extrusion.

It is uncommon for the apical fragment to develop pulp necrosis. If pulp necrosis of the coronal fragment occurs, there will be radiographic signs of bone loss at the level of the fracture as well as clinical symptoms, such as pain, gingival swelling, excessive mobility and sinus formation. If this occurs:

- Extirpate the pulp from the coronal fragment to within 1 mm of the fracture line. Do not advance the instrument through the fracture site.
- Place calcium hydroxide paste to induce hard tissue bridging at the fracture site. This may take up to 18 months.
- Observe with gutta percha once the bridge has formed.
- If the calcium hydroxide fails to form a bridge, an alternative treatment is to place a 4 mm thickness of Mineral Trioxide Aggregate (MTA) at the apex, allow to harden and obturate with gutta percha.

If the apical fragment shows signs of necrosis, it should be surgically removed and endodontic therapy performed on the coronal fragment.

Follow up clinical and radiographic examinations are scheduled at six months and one year and yearly for five years.

Dento-alveolar Splint Fabrication
Splinting guidelines for tooth/bone fractures and luxated/avulsed teeth recommend flexible, non-rigid splinting except in root fractures in the cervical third of the tooth and alveolar fractures when rigid splinting is recommended.

Fabrication Technique:

Materials
Non rigid (flexible) splint:
- .017 X .025 stainless steel wire, composite
- .018 round stainless steel wire, composite
- Monofilament nylon (20-30 lb test) with composite

Rigid splint:
- 030 stainless steel wire, composite

Procedure
1. Adjust the length of the wire so that it extends one to two teeth on either side of repositioned tooth
2. Reposition the tooth
3. Prophy the enamel with pumice
4. Apply etchant and bonding solution
5. Place a dab of composite in the center of the facial surface of the teeth to be bonded
6. Position the wire on to the composite
7. Set the composite
8. Add additional composite so that the wire is covered, especially at the distal terminal ends.
9. Smooth the composite to insure that there are no rough surfaces that might irritate the soft tissue.
10. Rx chlorhexidine rinse for one week.

Concussion
Concussion is defined as an injury to the tooth supporting structures without abnormal loosening or displacement of the tooth. There may be bleeding around the gingiva as a result of injury to the tooth supporting structures. Concussed teeth will be tender to percussion due to an inflamed and injured periodontal ligament. Pulp sensibility testing is likely to give positive results. Radiographic examination reveals the tooth to be in its normal position in the socket.

Treatment objectives are to optimize healing of the periodontal ligament and maintain pulp vitality. This is accomplished by relieving the tooth from occlusion. Splinting is usually not indicated unless the patient complains of tooth mobility. The patient should be placed on a soft diet for two weeks.

In the primary dentition parents should be informed that the traumatized tooth may darken.
However no treatment, other than observation, needs to be undertaken unless the patient complains of pain, the tooth becomes mobile, or infection develops. If the root of the primary tooth is intact a pulpectomy may be performed. If root resorption is present extraction is recommended. Parents are told the tooth may lighten after a period of one to two months. If that does not occur and there is no pathology, the tooth may be lightened with the use of composite material.

Mature permanent teeth with closed apices may undergo pulpal necrosis due to associated injuries to the blood vessels at the apex and will require endodontic therapy.

In the primary dentition follow up treatment consists of clinical observation at one week and radiographic examination at six-eight weeks and when symptoms occur.

In the permanent dentition, follow up treatment consists of clinical observation and radiographs at four weeks, six to eight weeks and one year.

**Subluxation**
Subluxation is defined as an injury to the tooth supporting structures with abnormal loosening but without tooth displacement. The diagnosis and treatment is similar to a concussion injury except for managing the increased mobility of the injured tooth. Treatment objectives are to optimize healing of the periodontal ligament and maintain pulp vitality. This is accomplished by relieving the tooth from occlusion. Splinting is usually not indicated unless the patient complains of tooth mobility. The patient should be placed on a soft diet for two weeks.

Parents should be informed that the traumatized tooth may darken, however no treatment, other than observation, needs to be undertaken unless the patient complains of pain, the tooth becomes mobile, or infection develops. Primary teeth do not require treatment for minor mobility and only need to be followed for pathology. The prognosis is usually favorable and the mobile tooth returns to its normal condition within two weeks. Follow up treatment is clinical observation at one week and six to eight weeks.

Mobile permanent teeth may need to be stabilized and occlusal interferences relieved. A flexible splint may be placed for no more than two weeks. Mature permanent teeth with closed apices may undergo pulpal necrosis due to associated injuries to the blood vessels at the apex.

Follow up treatment consists of splint removal after no more than two weeks, pulp sensibility testing and radiographic examination at one week, six to eight weeks and one year.

**Lateral Luxation**
Lateral luxation is defined as displacement of a tooth in a direction other than axially. The tooth may be displaced in a labial, lingual, or lateral...
direction. Damage to the periodontal ligament and contusion or fracture of the supporting alveolar bone may accompany this injury. Clinical examination reveals a tooth that is displaced in a lateral, palatal or lingual direction and may be locked into its new position thus not mobile. The tooth usually is not tender to touch. Pulp sensibility testing will likely give negative results. In immature teeth, pulpal revascularization usually occurs. Radiographic findings reveal an increase in the periodontal ligament space and displacement of the apex toward or through the labial bone plate. Treatment consists of:

- **Primary teeth**: Treatment depends on the degree of displacement, occlusal interferences and time to exfoliation. The teeth may be allowed to passively reposition if not interfering with occlusion. If interferences are present the tooth is actively repositioned and splinted to the adjacent teeth for one to two weeks to allow for healing. Primary teeth requiring positioning have an increased risk of developing pulp necrosis compared to teeth that are left to spontaneously reposition. When the injury is severe, the tooth is nearing exfoliation or the patient is uncooperative, extraction should be considered.

- **Permanent teeth**: Active repositioning of the tooth into its anatomically correct position should be initiated as soon as possible. The tooth is repositioned using finger pressure under local anesthesia. The tooth may need to be extruded to free the apical lock in the cortical bone. If the tooth is displaced greater than 5mm, the pulp is extirpated within 48 hours and the canal filled with calcium hydroxide. The tooth is splinted to the adjacent teeth for two to four weeks. Antibiotics, tetanus prophylaxis, and 0.2% chlorhexidine gluconate mouthrinse is prescribed.

Lateral luxations always have a dento-alveolar fracture component and the alveolar bone is repositioned into its correct position to maintain alveolar integrity. The bone may be stabilized with a flexible splint or suture material for four weeks.

In the primary dentition follow up treatment is clinical observation at two to three weeks and clinical observation and radiographs at six to eight weeks and one year. In the permanent dentition follow up is clinical and radiographic examination every two weeks while the splint is in place and then six to eight weeks, six months and annually up to five years. There is considerable risk for pulp necrosis and root resorption.

**Intrusion**

Intrusion is defined as apical displacement of the tooth into the alveolar bone. It is accompanied by compression of the periodontal ligament, disruption of the neurovascular supply to the pulp, contusion of the cementum and crushing fracture of the alveolar socket. In severe injuries the tooth may be locked into the bone. Clinical findings reveals a tooth that may appear shortened or even missing. In primary teeth the tooth apex is usually displaced labially toward or through the labial bone plate. In permanent teeth the displacement is into the alveolar bone. There is no tooth mobility nor tenderness to touch. Radiographic findings reveal that the tooth is displaced apically and the periodontal ligament space is not continuous. Determination of the position of the primary tooth in relationship to the developing permanent may be determined by a lateral radiograph. Alternatively, if the apex is displaced labially, the apical tip can be seen radiographically with the tooth appearing shorter than its contralateral. If the apex is displaced palatally towards the developing permanent tooth,
the apical tip cannot be seen radiographically and the tooth appears elongated. Treatment consists of:

- **Primary teeth**: Allow the intruded tooth to spontaneously erupt unless radiographs indicate intrusion into the developing tooth. The author’s experience has been to measure the amount of tooth exposed beyond the gingival margin. The tooth is measured four weeks later. If any re-eruption has occurred another measurement is taken four weeks later. This is repeated until the tooth is fully re-erupted (is even with the contralateral tooth). If the tooth exhibits no evidence of re-eruption after a four week period, extraction of the tooth is recommended to avoid ankylosis and possible injury to the developing permanent tooth.

- **Permanent teeth**: In immature teeth with incomplete apex formation and intrusion less than 7mm, the tooth is given the opportunity to passively erupt. If re-eruption is not observed within three weeks or if the intrusion was greater than 7mm, active orthodontic or surgical re-eruption is commenced and endodontic treatment initiated (apexogenesis or apexification). In mature teeth, if the intrusion is 3mm or less the tooth is given the opportunity to spontaneously re-erupt.

Intrusion of 3-7mm requires active orthodontic or surgical re-eruption is commenced as soon as possible and endodontic treatment is initiated within three to 4 weeks post trauma. Intrusion greater than 7mm is treated with surgical repositioning. Surgical repositioning is accomplished by gently repositioning the tooth with fingers or with forceps applied only to the crown, avoiding rotation of the tooth in the socket. The tooth is splinted for two weeks and endodontic therapy initiated within three to four weeks post trauma.

Extrusion

Extrusion is defined as partial displacement of a tooth axially from the socket. The periodontal ligament usually is torn. Clinical examination reveals a tooth that appears elongated and is mobile. Radiographic finds reveal an increased periodontal space apically. Treatment consists of:

- **Primary teeth**: Treatment depends on the degree of displacement, occlusal interferences and time to exfoliation. If the injury is not
severe (less than 3mm extrusion) the tooth may be repositioned or allowed to spontaneously align. When the injury is severe, the tooth is nearing exfoliation or the patient is uncooperative extraction should be considered.

• **Permanent teeth**: Active repositioning of the tooth with digital pressure into its anatomically correct position should be initiated as soon as possible. The tooth should be repositioned using slow and steady finger pressure in an apical direction to gently displace the clot formed between the floor of the socket and the tooth apex. If the tooth is displaced greater than 5mm, the pulp should be extirpated within 48 hours and the canal filled with calcium hydroxide, followed by final obturation after three months. The tooth should be splinted to the adjacent teeth for two weeks. Antibiotics, tetanus prophylaxis, and 0.2% chlorhexidine gluconate mouthrinse should be prescribed.

Treatment follow up is two weeks when the splint is removed and then clinical and radiographic examination at four weeks, eight weeks, six months and one year. In permanent mature teeth with closed apices there is increased risk for pulp necrosis and therefore these teeth must be carefully followed.

**Avulsion**

Avulsion is defined as complete displacement of a tooth out of its socket. The periodontal ligament is severed and fracture of the alveolus may occur. Clinical examination and radiographic examinations reveal that the tooth is not present in the socket. Radiographic examination is necessary to rule out intrusion, if the avulsed tooth is not found. Treatment consists of:

• **Primary teeth**: Avulsed primary teeth are not replanted because of the potential for subsequent damage to the developing permanent tooth and the increased frequency of pulpal necrosis. This treatment approach will be disconcerting to some parents who will urge the dentist to replant the tooth so as not to compromise the child’s appearance. The dentist should emphasize the advantage of sacrificing the primary teeth so as not to compromise the development of the permanent teeth. Parents are advised of primary teeth replacement alternatives.
• **Permanent teeth:** The sooner avulsed permanent teeth are replanted the greater chance for a favorable outcome. However, before attempting replantation:
  - Assess the patient’s medical status. Replantation is contraindicated in patients that are immunocompromised or suffer from severe congenital cardiac anomalies, severe uncontrolled seizure disorders, severe mental disability and severe uncontrolled diabetes.
  - Assess the integrity of the tooth and the supporting structures. Compromised integrity of the tooth (extensive decay) or supporting structures (alveolar fracture, bone recession due to periodontal disease) will reduce replantation success.

Replantation of an avulsed tooth is preferably done at the injury site to minimize extra-alveolar time. The tooth is rinsed with cold tap water for ten seconds to remove any gross contaminants and then immediately replanted in its socket. The patient is referred to the dental care facility for stabilization and antibiotic prophylaxis.

For children older than 12 years, when there is minimal risk of tetracycline staining administer Doxycycline twice daily for seven days at the patient's age and weight appropriate dose.

• Refer the patient to medical personnel for evaluation of need for tetanus toxoid vaccine.
• In teeth with open apices, that have been replanted immediately or kept in appropriate storage, pulp revascularization is possible. Avoid root canal treatment unless there is clinical and radiographic evidence of pulp necrosis.
• Patient instructions: Soft diet for two weeks. Brush teeth with a soft toothbrush after each meal. Use chlorhexidine 0.1% mouth rinse twice daily for one week.
• Follow up: Splint removal after two weeks. Perform clinical and radiographic examinations at four weeks, eight weeks, six months, twelve months and annually thereafter for five years. If the tooth exhibits symptoms, excessive mobility or ankylosis, or radiographic necrosis or resorption, endodontic or surgical treatment is indicated.

### Avulsed mature permanent teeth (closed apex)

• Clean the area with water spray, saline or chlorhexidine. Do not extract the tooth. Suture soft tissue lacerations if present. Verify proper positioning of replanted tooth clinically and radiographically. Place a flexible splint for two weeks.
• Prescribe systemic antibiotics: For children 12 years and younger administer Penicillin V at the patient’s age and weight appropriate dose. For children older than 12 years, when there is minimal risk of tetracycline staining administer Doxycycline twice daily for seven days at the patient’s age and weight appropriate dose.
• Refer the patient to medical personnel for evaluation of need for tetanus toxoid vaccine.
• Initiate root canal treatment seven to ten days after replantation and before splint removal. Place calcium hydroxide as an intra-canal medicament for one month until permanent filling of the root canal.
• Patient instructions: Soft diet for two weeks. Avoid contact sports. Brush teeth with a soft toothbrush after each meal. Use chlorhexidine 0.1% mouth rinse twice daily for one week.
• Follow up: Perform clinical and radiographic examination at two weeks when the splint is removed, then at four weeks, then at three

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**Avulsion Treatment**

**Tooth replanted before arrival at dental care center:**

**Avulsed immature permanent teeth (open apex)**

- Clean the area with water spray, saline or chlorhexidine. Do not extract the tooth. Suture soft tissue lacerations if present. Verify proper positioning of the replanted tooth clinically and radiographically. Place a flexible splint for two weeks.
- Prescribe systemic antibiotics: For children 12 years and younger administer Penicillin V at the patient’s age and weight appropriate dose.
months, six months, one year and annually thereafter. If the tooth exhibits symptoms, excessive mobility or ankylosis, or radiographic necrosis or resorption, endodontic or surgical treatment is indicated.

**Tooth has been kept in appropriate storage media or extraoral dry time is less than sixty minutes:**
If immediate replantation is not possible, the avulsed tooth is transported to the dental care facility in an appropriate medium (in order of preference Viaspan, Hank’s Balanced Salt Solution, cold milk, saliva - buccal vestibule, saline, water). Upon arrival to the facility, tooth replantation consists of the following procedures:

- Assess the extra-alveolar period and storage medium – The risk of ankylosis increases significantly with an extraoral dry time of 15 minutes. In such a situation, if the apex is closed and alveolar growth is completed, replantation is recommended as the final result will be aesthetically acceptable. If the apex is open and considerable alveolar bone growth is still expected, the increased the risk of ankylosis may result in a compromised aesthetic result. In such a situation, replantation is questionable. However, parents can be very persistent in avulsion situations and demand the tooth be replanted. Should the dentist capitulate to such demands, the progress of the replantation procedure should be followed very closely and at the first sign of ankylosis, extraction or decoronation of the tooth is recommended.
- Clean the root surface and apical foramen with a stream of saline. Flush the socket clot with a stream of saline.
- Replant the tooth slowly with gentle digital pressure. Do not force the tooth. If resistance is met examine the socket for bony fractures. Verify the correct position clinically and radiographically.
- Splint the tooth with a flexible splint and leave in place for two weeks.
- Prescribe systemic antibiotics: For children 12 years and younger administer Penicillin V at the patient’s age and weight appropriate dose. For children older than 12 years, when there is minimal risk of tetracycline staining administer Doxycycline twice daily for seven days at the patient’s age and weight appropriate dose.
- Refer the patient to medical personnel for evaluation of need for tetanus toxoid vaccine.
- In teeth with open apices, that have been replanted immediately or kept in appropriate storage, pulp revascularization is possible. Avoid root canal treatment unless there is clinical and radiographic evidence of pulp necrosis. In a tooth with a closed apex initiate endodontic treatment seven to ten days after replantation.
- Patient instructions: Soft diet for two weeks. Avoid contact sports. Brush teeth with a soft toothbrush after each meal. Use chlorhexidine 0.1% mouth rinse twice daily for one week.
- Follow up: Perform clinical and radiographic examinations at two weeks when the splint is removed, at four weeks, eight weeks, six months, one year and annually thereafter. If the tooth exhibits symptoms, excessive mobility or ankylosis, or radiographic necrosis or resorption, endodontic or surgical treatment is indicated.

**Extra-oral dry time is greater than sixty minutes:**
Delayed replantation has a poor long term prognosis. The periodontal ligament is expected to become necrotic and healing is not expected. The long term outcome is expected to be ankylosis and resorption of the root. The goal in this situation is to maintain alveolar ridge contour. If ankylosis occurs and the infraposition of the tooth crown is more than 1mm, decoronation is recommended to preserve the contour of the alveolar ridge.

- Remove the necrotic PDL from the avulsed tooth with scalers and gauze.
- Perform root canal treatment on the tooth through the open apex prior to replantation. Fill the tooth extraorally with gutta percha and sealer.
- Soak the tooth in a 2% NaF solution for 20 minutes to make the root surface more resistant to osteoclastic activity and delay the ankylosis process.
- Replant the tooth slowly with gentle digital pressure. Do not force the tooth. If resistance is met examine the socket for bony fractures. Verify the correct position clinically and radiographically.
- Splint the tooth with a flexible splint and leave in place for four weeks.
• Prescribe systemic antibiotics: For children 12 years and younger administer Penicillin V at the patient’s age and weight appropriate dose. For children older than 12 years, when there is minimal risk of tetracycline staining administer Doxycycline twice daily for seven days at the patient's age and weight appropriate dose.
• Refer the patient to medical personnel for evaluation of need for tetanus toxoid vaccine.
• Patient instructions: Soft diet for two weeks. Brush teeth with a soft toothbrush after each meal. Use chlorhexidine 0.1% mouth rinse twice daily for one week.
• Follow up: Perform clinical and radiographic examinations at four weeks, three months, six months, twelve months and annually thereafter. If tooth exhibits symptoms, excessive mobility or ankylosis, or radiographic necrosis or resorption, endodontic or surgical treatment is indicated.
• Emphasize to the patient and parent that the prognosis for replantation is poor and they should have an open mind to the possibility of losing the tooth.

Conclusion
Fortunately we are unable to prevent all dentofacial injuries. Children cannot learn to walk without falling and older children cannot completely avoid tripping over their own feet during recess. In many cases the result is an injury to the mouth. However, there are preventive measures that can be taken to reduce the severity and frequency of injury.

The use of car safety seats for infants and young children and mouthguards and helmets for older children engaged in sports (contact and noncontact) can reduce the incidence of dentofacial injuries and its consequences. Dentists and auxiliaries have an obligation to educate patients and parents to available options to reduce such injuries.
Course Test Preview
To receive Continuing Education credit for this course, you must complete the online test. Please go to: www.dentalcare.com/en-us/dental-education/continuing-education/ce98/ce98-test.aspx.

1. The frequency of traumatic injuries occurs in a _______________.
   a. 2:1 margin of boys over girls
   b. 3:1 margin of boys over girls
   c. 2:1 margin of girls over boys
   d. 3:1 margin of girls over boys

2. The predominant predisposing factor in traumatic injuries is _________________.
   a. Class I occlusion
   b. Class II division I occlusion
   c. Class II division II occlusion
   d. Class III occlusion

3. Which is not a question that needs to be asked regarding dento-alveolar injuries?
   a. When did the injury occur?
   b. Where did the injury occur?
   c. Does the patient have medical insurance?
   d. How did the injury occur?

4. A sixteen month old presents herself at your office with a dento-facial injury. The most effective way to examine her is in a _________________.
   a. knee to knee position
   b. parent’s lap
   c. mechanical restraining device
   d. All of the above.

5. Clinical examination of a dento-facial injury begins with an _________________.
   a. intraoral examination
   b. extraoral examination
   c. examination of the occlusion
   d. examination of the dentition

6. Which statement is true about pulp sensibility testing?
   a. It yields information about the neurovascular supply to the pulp of involved teeth.
   b. It is not performed in the primary dentition because of the lack of younger children to cooperate.
   c. It is an effective test in the permanent dentition for both immature and mature teeth and can provide baseline information on the health of the injured teeth.
   d. All of the above.

7. In cases of intruded primary teeth, a radiographic view that is indicated is?
   a. Multiple views from different horizontal and vertical angles.
   b. Placing a size 1 film intraorally between the buccal surfaces of the primary molars and the cheek and perpendicular to the radiographic beam.
   c. A radiograph placed between the teeth and the lip.
   d. A panoramic radiograph.
8. To determine the presence of tooth fragments and debris in the lips, a radiographic view that is indicated is?
   a. Multiple views from different horizontal and vertical angles.
   b. Placing a size 1 film intraorally between the buccal surfaces of the primary molars and the cheek and perpendicular to the radiographic beam.
   c. A radiograph placed between the teeth and the lip.
   d. A panoramic radiograph.

9. An injury of a maxillary labial tear in infants that do not walk or crawl should be investigated for ____________.
   a. child abuse
   b. pacifier habit
   c. thumb sucking habit
   d. bruxism

10. An injury of impalement of the soft palate requires in most cases ________________.
    a. uvulaeactomy
    b. sutures
    c. mucosal graft
    d. Does not require treatment as it usually heals spontaneously.

11. Infraction is defined as:
    a. A crown fracture involving only enamel or enamel/dentin without involvement of the pulp.
    b. An incomplete fracture of enamel without loss of tooth.
    c. A crown fracture involving enamel/dentin with pulp involvement.
    d. Necrosis of pulp as the result of blunt trauma.

12. An uncomplicated crown fracture is defined as:
    a. A crown fracture involving only enamel or enamel/dentin without involvement of the pulp.
    b. An incomplete fracture of enamel without loss of tooth.
    c. A crown fracture involving enamel/dentin with pulp involvement.
    d. Necrosis of pulp as the result of blunt trauma.

13. In a complicated crown fracture of a primary tooth with root resorption the correct treatment is:
    a. Pulp capping with calcium hydroxide.
    b. A vital pulpotomy
    c. Pulpectomy
    d. Extraction

14. In a complicated crown fracture of an immature permanent tooth with a pinpoint exposure that is being treated within four hours of the injury, the correct treatment is:
    a. Pulp capping with calcium hydroxide.
    b. A vital pulpotomy
    c. Pulpectomy
    d. Extraction
15. **In a complicated crown fracture of an mature permanent tooth with a pinpoint exposure that is being treated within four hours of the injury, the correct treatment is:**
   a. Pulp capping with calcium hydroxide.
   b. A vital pulpotomy
   c. Pulpectomy
   d. Extraction

16. **The location of a root fracture with the best prognosis is:**
   a. Apical third of the root.
   b. Middle third of the root.
   c. Cervical third of the root.
   d. The prognosis is the same for all location.

17. **Which injury is best treated with a flexible splint?**
   a. Root fracture - apical third
   b. Root fracture - middle third
   c. Root fracture - cervical third
   d. Avulsion

18. **Which injury requires splinting for two weeks?**
   a. Root fracture - apical third
   b. Root fracture - middle third
   c. Root fracture - cervical third
   d. Avulsion

19. **Concussion is defined as:**
   a. Injury to the tooth supporting structures without abnormal loosening or displacement of the tooth.
   b. Injury to the tooth supporting structures with abnormal loosening but without tooth displacement.
   c. Displacement of a tooth in a direction other than axially.
   d. Partial displacement of a tooth axially from the socket.

20. **Subluxation is defined as:**
   a. Injury to the tooth supporting structures without abnormal loosening or displacement of the tooth.
   b. Injury to the tooth supporting structures with abnormal loosening but without tooth displacement.
   c. Displacement of a tooth in a direction other than axially.
   d. Partial displacement of a tooth axially from the socket.

21. **Lateral luxation is defined as:**
   a. Injury to the tooth supporting structures without abnormal loosening or displacement of the tooth.
   b. Injury to the tooth supporting structures with abnormal loosening but without tooth displacement.
   c. Displacement of a tooth in a direction other than axially.
   d. Partial displacement of a tooth axially from the socket.

22. **Extrusion is defined as:**
   a. Injury to the tooth supporting structures without abnormal loosening or displacement of the tooth.
   b. Injury to the tooth supporting structures with abnormal loosening but without tooth displacement.
   c. Displacement of a tooth in a direction other than axially.
   d. Partial displacement of a tooth axially from the socket.
23. Treatment for an avulsed primary tooth is _________________.
   a. replantation and stabilization for two weeks if the tooth is replanted immediately
   b. replantation, stabilization for two weeks, followed by a pulpectomy if the extra-oral dry time is
      less than sixty minutes
   c. replantation, stabilization for four weeks, followed by a pulpectomy if the extra-oral dry time is
      greater than sixty minutes
   d. extraction in all scenarios

24. What is the order of preference of transportation medium for an avulsed tooth?
   a. Cold milk, Hank’s Balanced Salt Solution, saliva, tap water
   b. Saliva, Hank’s Balanced Salt Solution, saline, tap water
   c. Hank’s Balanced Salt Solution, cold milk, saliva, tap water
   d. Saline, milk, Hank’s Balanced Salt Solution, saliva, cold milk

25. In avulsed teeth with open apices, that have been replanted immediately or kept in
    appropriate storage medium:
   a. Avoid root canal treatment unless there is clinical or radiographic evidence of pulp necrosis.
   b. Initiate endodontic therapy within three days.
   c. Initiate endodontic therapy in one week after replantation.
   d. Initiate endodontic therapy upon removal of the splint.
References

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