The Management of Dentoalveolar Trauma

Martin J. Duplantier DDS
Resident, Department of Oral & Maxillofacial Surgery
The University of Oklahoma Health Sciences Center

Paul S. Tiwana DDS, MD, MS, FACS, FACD
Reichmann Professor and Chair
Department of Oral & Maxillofacial Surgery
The University of Oklahoma Health Sciences Center

Oral facial trauma is common and is seen in approximately 10% of emergency room visits. Injuries to the dentition and oral structures are found in all age groups and across both genders. The orofacial complex operates in an extremely complex physiologic environment from both an aesthetic and functional perspective. Rehabilitation of these injuries requires a timely, comprehensive, and if necessary, staged reconstructive approach to fully return each patient to their pre-injury state.

BASIC CONCEPTS

Dental Anatomy

The human dentition at its most essential elements is a complex organ unit that is responsible at least in part for speech production, mastication, and support of the facial soft tissues. From a purely aesthetic standpoint a smile is a reflection of the human condition through the most important window to our world – the face. For these reasons, attention must be meticulously paid to restoring the injured dentition.

The primary dentition is formed histologically from ingrowths of epithelium (the dental lamina) in the developing embryo.[1] This epithelium subsequently undergoes cellular differentiation through several stages to form the succedaneous teeth. The adult dentition is formed in a similar fashion with further proliferation of the dental lamina. The teeth demonstrate significant differences when compared anatomically with each other; however, they are all histologically very similar. Anatomically, each tooth is divided into two parts: the crown (covered by enamel), and the root (covered by cementum). The dividing area between these two distinct areas is termed the cemento-enamel junction. A tooth is composed of four distinct layers: enamel, dentin, pulp, and the cementum. The hard outer shell of the tooth is enamel which is composed primarily of inorganic material. This is the most highly-mineralized tissue in the human body. Supporting this hard outer shell is the dentin. This tissue is also mineralized, although not to the extent of the enamel. The pulp contains both the vascular supply of the tooth as well as its nerve fibers. It also functions to form and repair the dentin layer. The pulp is housed in the center of the tooth with extensions (canals) that pass through the root(s) of the tooth into the surrounding bone. The cementum covers the root structure of the tooth. It is also avascular and serves to anchor the tooth to the surrounding alveolar bone through providing attachment for the periodontal ligament (PDL). The PDL is composed of dense collagen bundles that also provide sensory feedback for the compressive and lateral forces induced through mastication. The surrounding alveolar bone is histologically similar to the underlying basal bone of the maxilla or mandible. However, from a clinical standpoint, it is necessary to differentiate the two. The bony alveolar process of the jaw terminates just below the apices of the tooth roots. The mucosa of the oral cavity is separated in two types: keratinized or attached gingiva found directly around the teeth and on the hard palate; and non-keratinized which is found elsewhere throughout the mouth.

Dental Numbering System

The dentition is organized into arches (the mandibular and maxillary) and further into quadrants with each arch having two.[2] The primary dentition consists of 20 teeth with five in each quadrant: first and second molars, canine, and the lateral and central incisors. The identification system for the primary dentition begins with #A, the maxillary right primary second molar and continues to #T, the mandibular right primary second molar. The adult dentition contains 32 teeth with eight in each quadrant. The identification system for the adult dentition begins with #1, the maxillary right third molar and continues to #32, which is the mandibular right third molar. The adult dentition differs from the primary dentition in that two premolars and one third molar are located within each quadrant of the mouth.

Eruption Sequence

The eruption of the human dentition whether primary or permanent follows, for the most part, a well-defined sequence. It begins in the primary dentition with the eruption of the mandibular incisors on average at six to eight months of age and ends with the eruption of the second molars in the maxilla at approximately 29 months of age. However, root development will continue, with its completion at around age 36 months. In the permanent dentition, eruption usually begins with the first molar in both arches and continues until the third molars or wisdom teeth have erupted between the ages of 17 to 21 years. This chronology of eruption pattern serves to, among other reasons, maintain space and arch length for the erupting permanent dentition. Premature loss of the primary dentition carries with it the risk of development of an abnormal occlusion. Although, in general, primary teeth are not replanted after traumatic avulsion, the clinician must be vigilant in providing space maintenance where necessary because of this important physiologic function. Correlation of the chronological age of the orofacially injured patient and the presence or absence of teeth is critically important in developing and executing an appropriate treatment plan.[3]

Wound Healing

There are essentially two types of injury seen in dentoalveolar trauma. Injuries which cause separation of intercellular structures, and those injuries that cause a crushing or compression injury that affects both intercellular and intracellular structures. The dental enamel cannot undergo cellular repair itself. It is repaired instead through the deposition of secondary dentin from beneath its structure. The periodontal ligament and the dental pulp are the two main tissue components that have the ability to undergo cellular repair. In separation injuries, as seen in dental avulsion, repair proceeds along existing cellular mechanisms. In compressive injuries such as an intrusive luxation, wound healing is delayed secondary to the activity of osteoclasts and macrophages which must remove the injured tissue first. Initially following injury, as with other organ systems, the coagulation cascade promotes hemostasis and the release of factors such as platelet derived growth factor. These factors begin the wound healing process followed by the infiltration of neutrophils and macrophages which further direct wound healing. Subsequent later stages of healing require the deposition of immature collagen and the proliferation of fibroblasts. In an uncomplicated injury to the periodontal ligament, which attaches the root to the alveolar bone, initial collagen is laid down after one week. Approximately 14 days post injury, two-thirds of the strength is returned to the healing ligament. The procession of normal wound healing for the dental pulp is determined by the apex of the root. If the root apex is open (the foramen of entry of the neurovascular bundle is greater than 1mm in diameter), revascularization begins approximately four days post injury and proceeds at a rate of 0.5mm per day. If the apex of the tooth is closed such as seen in the mature permanent tooth (the foramen of entry of the neurovascular bundle is less than 0.5mm in diameter), revascularization is severely impeded and pulpal necrosis usually ensues.

Complications in Wound Healing

Essentially, there are two main recognized complications with wound healing: injuries which cause resorbtion of the root surface and ankylosis. Surface resorbtion is caused by damage to the innermost aspect of the periodontal ligament from severe crush injuries or excessive desiccation of the root surface after avulsion. Specifically affected are the epithelial rests and the cementoblasts. If these two cellular components are severely injured, wound healing becomes directed by the adjacent alveolar bone. Here, macrophages and osteoclasts will resorb the root surface causing saucer like cavities. If the underlying cementoblast layer is intact, eventually new cementum will be laid down and the periodontal ligament will reform following the contour defects in the tooth root. If the cementoblast layer is also compromised, the underlying dentin is exposed to bacterial pathogens and an inflammatory resorbtion will follow. This can be arrested by root canal therapy, whereby the pulp of the tooth is mechanically extirpated and then sealed. In the most extreme cellular injury, healing proceeds entirely from the alveolar bone and the periodontal ligament is replaced by bone causing ankylosis and eventual loss of the tooth. In the growing child, dental ankylosis also causes arrest of growth in the surrounding alveolus with obvious implications for resultant malocclusion and alteration in the normal eruption pattern of the permanent dentition.

Epidemiology

The epidemiology of dentoalveolar trauma follows that of maxillofacial trauma in general. In the young child a peak for injury is seen in the two to three years of age group. This is thought to be secondary to the developing neuromuscular coordination in this age group. In the permanent dentition, another peak of incidence is usually noted in the 10-year-old patient. This coincides with the beginning involvement in athletic activity for older children. The etiology of the trauma is reported as being most commonly due to falls, followed by motor vehicle crashes, interpersonal violence, and then sports related activities.

EXAMINATION AND DIAGNOSIS

Classification of Injury

Classification of dentoalveolar injuries has undergone numerous modifications and has been somewhat regionally based in terminology. The World Health Organization in 1995 proposed a classification scheme that would be anatomically based and universally reliable.[4] It is essentially composed of four types of injuries with sub-classification to further delineate the clinical problem. The first group are those injuries to the hard dental tissues and pulp only. This includes the enamel, dentin, and pulp tissues of the tooth itself. The second group is composed of injuries to the hard dental tissues, pulp, and alveolar process of the maxilla and mandible. This group includes root, and crown-root fractures, as well as fractures of the underlying bone. The third group comprises injures to the periodontal tissues. Encompassed here are those injuries affecting the periodontal ligament such as luxation (displacement) and avulsion of teeth. The last group consists of injuries to the oral soft tissues such as abrasions and lacerations of the gingiva and oral mucosa. While complex dentoalveolar trauma can certainly be composed of more than one injury classification, the system allows for the relatively straightforward communication of types of injury, therapeutic implications, and possible complications imposed by each category.

Oral Clinical Examination

As with any head and neck injury, examination of the patient with dentoalveolar trauma should include a thorough medical history including tetanus status of the patient, mechanism of injury, as well as the physical examination out of other underlying injuries such as neurologic, ophthalmologic, or facial bone trauma.[5] Once this is complete physical examination of the oral cavity should proceed. The patient should be positioned in the semi-reclined position, a good examination light is a must, and hand instrumentation should at the very least be comprised of a sterile tongue depressor or ideally, a dental mirror and explorer. First, the oral soft tissues including the gingiva, oral vestibule, palate, tongue, and posterior pharynx are inspected for injury as well as the presence of foreign bodies. Attention is turned to the dentition itself. Correlation of the patient's age, with what teeth are erupted in the mouth is necessary to ascertain which teeth should be present and if injury is present, whether the tooth is part of the primary or permanent dentition. The examiner must also determine with reasonable certainty the occlusal scheme of the patient's dentition and aberrant tooth position. This can easily be determined when the patient is asked to bite their teeth together. The alveolus is then palpated for mobility or tenderness in both arches. Subsequently, individual teeth are examined by utilizing several testing methods. The percussion test is done with the back end of the metal dental mouth mirror. When the examiner taps gently on the tooth, he or she is trying to elicit two things. Firstly, whether there is any tenderness to percussion of the tooth which may indicate damage to the periodontal ligament. Secondly, the examiner is attempting to elicit a percussion tone. The sound heard can either be normal low tone or high metallic tone. A high tone during percussion may indicate that the tooth is impacted inappropriately into the underlying bone as seen with intrusive injuries. A second test frequently employed is the mobility test. This test allows the examiner to determine whether an individual tooth is mobile or, a group of teeth are mobile, which may indicate alveolar bone fracture. Mobility is graded on a scale from 0 to 3. A score of 0 is normal, while a score of 3 is demonstrative of severe mobility. However, it must be remembered that intruded or ankylosed teeth will not be mobile and score normally during this test. The last specialized clinical exam is the electric pulp test. It is not employed in young children or in young patients with immature permanent teeth due to the unreliability of the test. Furthermore, there is a high rate of false positives, and one should defer this test to several weeks later. Essentially, a small electric current is used to determine the responsiveness of the dental pulp to stimulation, and gives the examiner an idea as to its functional status. A general good visual examination of the teeth should be sufficient to yield to the examiner as to whether the dental crown is fractured with the pulp exposed (area of bleeding noted within the fractured area) or the presence cracked teeth without pulp exposure.

Oral Radiographic Exam

The last component of the clinical work-up for the patient with dentoalveolar trauma is directed radiographic examination. The "panorex" or orthopantomograph x-ray is perhaps the most common readily available dental x-ray available in the emergency medical setting. It is extremely useful in the diagnosis and management of mandibular fractures. However, it is useful neither as a "screen" nor for the diagnosis of dentoalveolar trauma especially for teeth in the anterior mandible or maxilla. The focal trough of the panorex film leaves the anterior maxillofacial complex somewhat distorted and over penetrated. In addition, it is these same anterior maxillary and mandibular teeth that are most at risk for trauma secondary to their relative prominence within the face when compared to the posterior dentition. While it is true that some dentoalveolar injuries may be seen and diagnosed using the panorex x-ray the most appropriate radiologic exam is the periapical film. These are the small films utilized in routine dental practice that allow for the detail required to accurately diagnosis and manage dentoalveolar trauma. In addition, these small films can be placed in the oral vestibule to x-ray the soft tissue of the lips or cheek to screen for imbedded foreign bodies.

TOOTH FRACTURE

Crown Fracture Without Pulp Exposure

Tooth fracture can be defined by the relation of the fracture to the position of the dental pulp and the dental root.[6] In the patient with crown fracture without pulp exposure (commonly referred to as a "chipped" tooth), a fracture through the enamel of the tooth is present. This fracture may extend only into the enamel or may also involve the underlying dentin. On periapical x-ray film, the injury demonstrates the fracture through the tooth, but clearly the pulp remains covered by dentin. The prognosis and outcome for these injuries is excellent. Treatment focuses on cleaning and sealing the exposed dentin with a composite restorative material (commonly referred to as a "white filling"). If the segment of the fractured crown is located, it also may be reattached to the tooth. In addition, if the fracture extends minimally into the enamel, and the aesthetic shape of the tooth is not compromised, treatment can simply consist of smoothing the sharp areas around the fracture for patient comfort.

Crown Fracture with Pulp Exposure

In the patient who sustains a crown fracture with pulpal exposure, the definition requires that a fracture of the dental crown must extend through the enamel, dentin, and pulp of the tooth. On physical examination, the fractured surface of the tooth demonstrates the area of pulpal exposure and small hemorrhage is noted from this area. Radiographically, as one would suspect, the fracture clearly passes through the pulp chamber of the tooth. The management of these injuries is directed at disinfection of the exposed pulp and placement of a covering material. This can be accomplished through one of two techniques. Exposure of a small amount of the dental pulp lends itself to the pulp capping procedure. Here, the tooth is isolated with a dental dam, and the fractured tooth is disinfected with an antimicrobial wash. This is followed by the placement of a calcium hydroxide material over the area of injury which functions to cover the exposure, induce the pulp to lay down reparative or secondary dentin, and further reduces bacterial contamination. (**Figure 1**)

If the exposure is somewhat larger, and the injured tooth is an immature permanent tooth a partial pulpotomy (extirpation of the superficial pulpal tissue) may be attempted. In this technique once again, the tooth is isolated with the dental dam. Next, the most superior portion of the pulp is removed, and the calcium hydroxide dressing is placed. Both of these techniques have a very good prognosis for success if done promptly and executed carefully. Follow-up with the patient's dentist should be maintained and the appropriate aesthetic dental restoration placed. The patient must be warned that pulpal necrosis is a possibility necessitating root canal therapy or dental extraction.

A)

B)

Figure 1. *Enamel-dentin injury with small pulp exposure to teeth #7 and #8.* ***A)*** *Pre-treatment.* ***B)*** *Post treatment with direct pulp cap and composite restoration. (photo courtesy of Evan Riley, DDS)*

Crown-Root Fracture

Further extension of this injury pattern may include the crown-root fracture. Here, an oblique fracture extends through the enamel, dentin, and possibly the dental pulp down through to the root surface of the tooth below the gingival margin. Clinically, the mobile segment of tooth is visualized with the fracture extending below the gingiva attached to the tooth. Radiographically, it is difficult to discern whether the fracture extends down through the root surface because of the angle by which the x-ray beam passes through the tooth. Often, it appears as a crown fracture unless the film is taken at a more oblique angle. As with crown fracture, the crown-root fracture may or may not involve the dental pulp depending on the location of the fracture. The management of this injury is similar to the management of the crown fracture with or without pulp exposure as described above. If the fracture is just below the gingival or alveolar bone margin of the tooth, crown lengthening (ostectomy of alveolar bone to allow more crown structure to be exposed above the gingival margin) may be attempted for visualization of the fracture margin to allow accurate placement of restorative material. This is usually only attempted after the pulpal status of the tooth is stabilized from the traumatic injury either through primary healing or root canal therapy if necessary. If the fracture extends too far down the root surface, dental extraction becomes necessary. The long-term prognosis of the injury is primarily dependant on the extent of the associated root fracture.

Root Fracture

Dental root fracture is a difficult condition to manage and as might be expected, prognosis is substantially reduced. With this injury pattern, there is a horizontal or oblique fracture completely through the root below the level of the alveolar bone. Clinically, the injury usually appears to be an extrusive luxation with axial displacement and retro-positioning of the tooth in the alveolus. The crown with its partial root is usually mobile. On periapical film, the fracture is seen running horizontally through the root structure below the level of the alveolar bone. The treatment for this injury is centered on gentle, but accurate repositioning of the fractured segments together with semi-rigid splinting to hold the segments in place. Once the repositioning is complete, a radiograph is taken to ensure the segments are seated correctly together with referral to the patient's dentist for follow-up care. Those injuries which occur in permanent immature teeth with open or wide apexes have a good success rate in having hard tissue healing between the segments. In those patients with mature permanent teeth, the prognosis as mentioned above remains guarded. The usual outcome for this group of patients is to have in effect a "non-union" of the segments with fibrosis between the segments. If the wound is contaminated, often granulation tissue with abscess formation may ensue, likely necessitating dental extraction. Vertical root fractures carry the worst prognosis and typically warrant extraction.

LUXATION INJURIES

Subluxation

Luxation injuries involve the bodily displacement of the tooth, without actual fracture of the tooth itself.[7] With subluxation injuries, on clinical examination the tooth is tender to palpation and percussion with abnormal mobility. Occasionally, bleeding from the gingival sulcus of the affected tooth is noted. However, on radiographic exam the tooth appears without fracture and is seated correctly in the socket. Treatment for this injury is directed at placement of a semi-rigid splint for two weeks. Alternatively, the opposing teeth can be reduced slightly by removing contact from the injured tooth and the patient is placed on a soft mechanical diet for several weeks. Both treatment options are effective for management and the outcomes for this injury are usually very good although slightly decreased for the mature permanent tooth with a closed apex.

Extrusive Luxation

Extrusive luxation injuries of teeth are essentially partial avulsions. The tooth on clinical examination appears to be vertically displaced from its place in the alveolus. The tooth is grossly mobile on examination with hemorrhage from the socket. When examined with a periapical film, the tooth is obviously extruded from the socket but bodily intact. The partially-empty socket appears radiolucent. The periodontal ligament and neurovascular bundle at the root apex is completely lacerated. Emergency management is directed at gentle repositioning of the tooth back in place within the socket which is radiographically confirmed. The tooth is then semi-rigidly splinted with wire for at least two weeks. (**Figures 2A-C**) In those patients with immature permanent teeth and open root apexes the prognosis is somewhat good, although many will have obliteration of the pulpal space. However, in the mature permanent tooth with a closed root apex, almost all patients will undergo pulpal necrosis and require root canal therapy for definitive care. The periodontal ligament in these patients has a reasonable prognosis for healing given that it has most likely been lacerated or torn and not crushed.

A)

B)

C)

Figure 2. *Extrusion injury of teeth #8 and #9.* ***A)*** *Initial malposition of teeth #8 and #9.* ***B)*** *Reposition with light axial digital pressure.* ***C)*** *Resin material applied for flexible splint.*

Lateral Luxation

Lateral luxation injuries are not common and are the result of an apically directed oblique force. (**Figure 3**) By definition, the alveolar bone around the facial surface of these teeth is also fractured. On clinical examination, the tooth appears slightly intruded and usually displaced palatally.

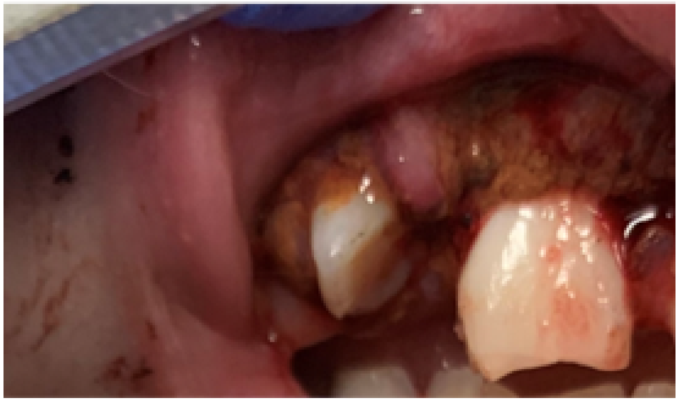


Figure 3. *Lateral luxation of tooth #7.*

On palpation, the area is tender to palpation and the root of the tooth is usually palpable through the gingival mucosa. A high tone is heard on percussion of the tooth. Radiographically, the tooth appears to be pushed laterally with a radiolucent empty socket at the apex. In these circumstances, management requires gentle repositioning of the tooth within the alveolar socket. A follow-up radiograph should be taken to confirm correct reduction and a semi-rigid splint is applied for approximately four weeks. The increased length of splinting time is necessitated due to the accompanied alveolar bone injury. As with other injuries, permanent teeth which have immature open apices have a somewhat better long-term prognosis, although obliteration of the pulp chamber is the usual outcome. In those permanent teeth with closed, mature apices pulpal necrosis is frequent and root canal therapy is often necessary. In addition, some resorption of the apical root surface may occur secondary to the crush injury to the periodontal ligament in this region.

Intrusive Luxation

Counter-intuitively, perhaps one of the most severe injuries is intrusive luxation. With this injury, an apical force drives the tooth through the base of its socket into the alveolar bone. Clinically, the tooth will appear to be short compared to the adjacent teeth, immobile, and have a high-sounding tone on percussion. On periapical x-ray, the tooth will appear to be displaced into the alveolus and the small radiolucent space around the root marking the periodontal ligament space is obliterated. Management of this injury, despite its overall poorer prognosis, is directed at slowly over time extruding the tooth into position. In the patient with the permanent tooth with an immature open apex, the tooth can be allowed to, with reasonable assurance, spontaneously erupt back into position. Alternatively, orthodontically-assisted eruption of the tooth can be used to reposition the intruded tooth over time. In the permanent tooth with the closed or mature apex, spontaneous eruption will not occur. In these instances, orthodontic assistance is necessary for repositioning the tooth within the alveolus. Pulpal necrosis requiring root canal therapy is almost always the case except perhaps in the patient with a very wide open apex. External root resorption is also very commonly found secondary to the severe, widespread compression injury of the periodontal ligament. The clinician must also be alert for the possibility of ankylosis with this injury.

AVULSION

Clinical Appearance and Treatment

Avulsion injury to the dentition (commonly referred to as "knocked out teeth") are severe traumatic injuries that require urgent evaluation and management.[8] The clinical and radiographic exam are straightforward with this injury, and the tooth is not present in the socket. The socket itself is tender to palpation and is either bleeding or filled with coagulated blood. (**Figure 4**)

Figure 4. *Extrusion of tooth #E, with avulsion of tooth #F.*

The most important questions asked in this clinical situation are: where is the tooth? And how long has it been out of the socket? Usually, the patient will present the tooth to the clinician without even being prompted to ask, however if the location of the tooth is unknown, the small but real possibility exists that it may have been either ingested or aspirated. (**Figure 5**)

Figure 5. *Grossly displaced tooth after left mandible fracture exhibiting high risk of aspiration or entry into the GI tract.*

In these instances, a chest x-ray and abdominal series must be taken to rule out the presence of the tooth in the lungs or gastrointestinal tract. If the tooth is presented to the clinician, the amount of time since the avulsion must be assessed. If the extra-alveolar time since avulsion is less than one hour, replantation can be considered. However, several factors must be assessed including the health status of the avulsed tooth and the medium in which the tooth was stored. Ideally, the tooth should be replaced in the socket immediately at the time of avulsion followed by seeking emergency care. Alternatively, it can be stored in the patient's oral vestibule, milk, organ transplant media, or any other physiologic fluid substance. Unfortunately, if the tooth has been stored in a non-physiologic substance such as water or mistakenly "scraped" clean by well meaning individuals, this significantly decreases the success of replantation. A tooth affected by severe periodontal disease or rampant dental caries should not be replanted as this will significantly decrease success, even if done within one hour of avulsion. If the patient and avulsed tooth present within one hour of the injury and there has been no overt storage related injury to the tooth, replantation should go forward. The procedure requires the tooth to be gently rinsed with physiologic saline to remove debris followed by irrigation and suction of the socket to remove the coagulated blood and foreign debris. The tooth is then gently repositioned and seated within the socket. The tooth is then splinted with a semi rigid wire to the adjacent teeth for two weeks. Systemic antibiotic therapy should be initiated with oral penicillin or clindamycin in the allergic patient for one week post replantation. While it is possible to replant teeth that have been avulsed for greater than one hour, as mentioned above the desiccation suffered by the cellular systems are severe. More often, teeth replanted after greater than one hour will undergo pulpal necrosis and severe root resorption followed by likely ankylosis and ultimately tooth loss. In the growing child, the restricted alveolar growth that is caused by ankylosis merits the decision to often not replant the avulsed permanent tooth after more than one hour of extra-alveolar time. The decision to replant the avulsed tooth after greater than one hour can be made in the skeletally-mature patient with the understanding that it still entails limited success. This warrants extensive procedure modification including: soaking the tooth in sodium fluoride solution, extra-oral root canal therapy, and rigid splinting for at least six weeks. In general, the most important prognostic factors for replanted teeth are: the amount of extra-alveolar time elapsed since injury, the storage solution (or lack thereof), and as previously discussed, the open *vs*. closed status of the root apex.

DENTOALVEOLAR TRAUMA IN THE PRIMARY DENTITION

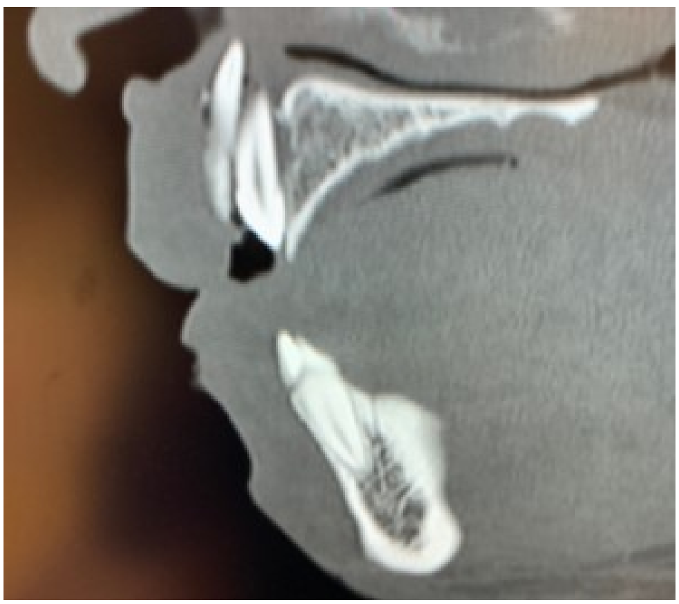
The primary concern of the clinician in the management of injuries to the primary dentition should be the maintenance of the health of the unerupted permanent teeth.[9] All but the most straightforward of injuries are usually managed by extraction of the injured tooth. Avulsed primary teeth are not replanted because of the risk of ankylosis and subsequent alveolar growth disturbance as well as impaction of the underlying permanent tooth. However, the intrusive luxation injury in the primary dentition must be examined closely. In some instances, the primary tooth will be pushed into the developing tooth bud of the permanent tooth causing injury and deformation. If noted to be displaced into the permanent tooth bud, the offending primary tooth should be extracted. If not, it can be left to spontaneous eruption back into place. All children with dentoalveolar trauma should be questioned carefully as to the mechanism of injury, as child abuse can be a causative factor. In any case, premature removal or loss of primary teeth can cause malocclusion in the permanent dentition and as such should be followed closely for this potential but treatable problem.

DENTOALVEOLAR FRACTURE

Clinical Appearance and Treatment

Alveolar fractures, represent a true bony fracture of the maxilla or mandible and must be considered as such even though teeth are contained in the mobile segment.[10] The clinical presentation usually reveals gingival hemorrhage combined with gross mobility of at least a two-tooth segment. (**Figures 6A-C**). The teeth are usually displaced palatally or lingually in conjunction with a malocclusion. Radiographic examination reveals a radiolucent line of fracture through the alveolar bone combined with displacement of the affected teeth from their sockets. The treatment of this injury follows the similar management of other maxillofacial fractures. The displaced segment is first reduced into position with gentle traction and the patient’s occlusion is checked for appropriate contact. Care should be exercised to not strip any gingival tissue from the mobile segment, as this may contribute to avascular necrosis. Next the segment is stabilized with the application of a semi-rigid wire splint or erich arch bar for approximately six weeks. The affected dentition is monitored for the possibility of pulpal necrosis and root canal therapy is instituted should this occur. Occasionally, stabilization of the segment is not possible with wire splinting. In these instances, it maybe appropriate to consider open reduction and internal fixation with plates and screws to further stabilize the mobile segment and prevent non-union. The patient should also be placed on a soft diet during the healing period.

A)



B)

C)

Figure 6. *Dental-Alveolar fracture.* ***A****) Minimally visible gingival laceration of teeth #7 and #8.* ***B****) Sagittal view.* ***C****) Axial CT displaying significant fracture and displacement between teeth #7 and #8 alveolar unit.*

ORAL SOFT TISSUE TRAUMA

Clinical Appearance and Treatment

The soft tissue of the oral cavity is essentially comprised of two different types of mucosa. The fixed or keratinized mucosa which is immediately sub-adjacent to the teeth and covers the hard palate. The second type of mucosa is non-keratinized and is essentially found everywhere else throughout the oral cavity and pharynx except for some specialized structures of the dorsal tongue. The identification of injuries to the oral soft tissues is paramount to their successful management. Lacerations of the posterior pharynx, floor of mouth, salivary ducts and posterior tongue while outside the scope of this chapter, contain important structures that merit appropriate consultation if injury to critical deeper structures is suspected. While no critical structures are located in the superficial anterior and posterior maxillary vestibule, the anterior mandibular vestibule contains the mental foramen through which the extension of the inferior alveolar nerve exits to provide sensation to the lip and chin. It is located bilaterally just below the root apex of the mandibular second premolar, although anatomic variation is possible. Lacerations from this region extending to the lip may sever or otherwise injure the mental nerve or one of its terminal branches. Subjectively, prior to the delivery of local anesthetic for wound repair, the patient will complain of paresthesia of the affected lower lip and chin distribution. This must be documented and appropriate consultation from a micro neurosurgeon may be warranted for management. For other intraoral and gingival lacerations, the wound is first copiously irrigated and inspected for foreign debris. Closure can be accomplished with a single suture layer of resorbable suture such as chromic gut. If the mentalis muscle is lacerated in the anterior mandibular vestibule, the muscle should be primarily repaired in addition to the mucosal repair to prevent mentalis sag or "witch's chin" deformity. Lacerations extending through the lip should be repaired in three layers after thorough irrigation and debridement. The clinician must be careful to account for dental fragments that are imbedded in the lip. This can be checked for expediently by taking a periapical x-ray of the soft tissue if necessary. Closure of the intraoral mucosa should be completed first, followed by another irrigation of the wound and sterile preparation of the wound site. Next, the orbicularis oris muscle is repaired and then the skin is repaired last with nylon suture. Special attention must be given to correct alignment of the vermillion border and the wet/dry line of the lip for optimal aesthetic reconstruction. The patient should also be placed on antibiotic therapy and appropriate follow-up.

SUMMARY

The restoration to pre-trauma form and function in the patient with orofacial injury requires knowledge of dental development, anatomy, and treatment options for management. The advent of dental endosseous implants has revolutionized our ability to restore the function of previously lost teeth due to trauma.

REFERENCES

1. Ten Cate AR: *Oral Histology Development, Structure, and Function*. 4th ed. Mosby, Philadelphia 1994. pp 1-80.
2. Ash MM: *Wheeler's Dental Anatomy, Physiology and Occlusion*. 7th ed. WB Saunders, Philadelphia 1993. pp 1-83.
3. Hollinshead WH: *Anatomy for Surgeons The Head and Neck*. 3rd ed. Lippincott-Raven, Philadelphia 1982. pp 325-388.
4. Application of the International Classification of Diseases to Dentistry and Stomatology. IDC-DA 3rd ed. Geneva: WHO, 1995.
5. Powers MP: *Diagnosis and Management of Dentoalveolar Injuries*. In Oral & Maxillofacial Trauma. Fonseca RJ, Walker RV eds. WB Saunders, Philadelphia 1991. pp. 323-358.
6. Bakland LK, Andreasen FM, Andreasen JO: *Management of Traumatized Teeth*. In Principles and Practice of Endodontics. 2nd ed. Walton RE, Torabinejad MT (eds.). WB Saunders, Philadelphia, 1996. pp 423-441.
7. Andreasen JO, Andreasen FM: *Textbook and Color Atlas of Traumatic Injuries to the Teeth*, 3rd ed. Munksgaard, Copenhagen, 1993.

8. Andreasen JO et al: *Traumatic Dental Injuries A Manual*. Munksgaard, Copenhagen, 2000. pp 1-64.

9. Baumann A, Troulis MJ, Kaban LB: *Dentoalveolar Injuries and Mandibular Fractures*. In Pediatric Oral & Maxillofacial Surgery. Kaban LB, Troulis MJ (eds.). Saunders, Philadelphia 2004. pp. 441-444.

10. Ellis EE, Assael LA: *Soft Tissue and Dentoalveolar Injuries*. In Contemporary Oral & Maxillofacial Surgery. 2nd ed. Peterson LJ et al (eds.). Mosby, Philadelphia 1993. pp. 557-586.