Management of the Teeth in Maxillofacial Trauma

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KEYWORDS

• Teeth • Dental • Trauma • Occlusion • Dentoalveolar fracture • Avulsion • Dental trauma • Alveolar fracture

KEY POINTS

- Knowledge of basic dental anatomy and occlusion is important in the maxillofacial trauma patient.
- Significant differences exist between pediatric and adult dentition that affect the overall treatment of dentoalveolar trauma.
- A thorough assessment of dentoalveolar injuries in the maxillofacial trauma patient is critical for optimizing dental outcomes.
- Understanding the immediate and delayed treatment options for dentoalveolar injuries and the impact on future dental health is important during fracture management, splinting, and maxillomandibular fixation.
- Special considerations for pediatric trauma should be considered to minimize interruption of dental development.

INTRODUCTION

Dentoalveolar trauma is a prevalent and impactful public health problem that has a significant physical, economic, and psychosocial burden on patients and communities. The lifetime cost of bodily injury to Americans has been estimated to exceed $400 billion in lost productivity as well as medical costs.[1] Dental trauma plays a significant role in this, as incidence of dental trauma in ages 8 to 13 is 9.7%,[2] and worldwide rates of traumatic dental injuries are 15.2% in permanent dentition and 24.2% in primary dentition.[3,4] Nearly half of facial injuries (48%) involve the oral cavity,[5] underscoring the importance of a solid understanding of modern techniques involved in addressing dentoalveolar trauma. Dental treatment and resources are highly variable between different hospital centers, and due to the nature of dental trauma needing continued monitoring and follow-up visits many treatments are deferred to outpatient dental care. There is a wide variety between different emergency facilities of dental materials and staff that are available. When these patients are deferred to an outpatient setting it may be weeks, or months, until they are evaluated by a dental provider, which can lead to undiagnosed injuries and delay in care. The purpose of this article is to discuss clinically relevant classification of dentoalveolar injury, review management, and discuss concomitant injuries and treatment of dentoalveolar injuries with maxillofacial fractures.

EVALUATION

First, a thorough trauma examination should be completed. The dentoalveolar aspect of the examination can be completed within this context and can help to diagnose both dentoalveolar injuries and maxillofacial fractures. It is important to

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Abbreviations

ATLS	Advanced Trauma Life Support
BW	bitewing
CT	computed tomography
MTA	mineral trioxide aggregate
PA	Periapical
3D	3-dimensional

remember that the intraoral evaluation is part of the primary Advanced Trauma Life Support (ATLS) survey to ensure there is no loose debris, missing teeth, or massive oral hemorrhage that could lead to airway compromise.[6] Once the patient is stabilized, formal maxillofacial examination can take place including a detailed maxillofacial examination. In order to complete a thorough examination, it is crucial to irrigate and remove debris and nonviable tissue, bone, and foreign objects that present aspiration risks. There are several methods for examining the oral cavity; however, the most important aspect for a clinical examination is consistency. The examination should be methodical and include assessment of the skin (bruising, abrasions, lacerations, etc), gross skeletal step offs (palpation of facial bones), involvement of cranial nerves (it is important to document any trigeminal nerve disturbances with midface or mandibular fractures), and an intraoral examination (assessment of vestibules, oropharynx, tongue, floor of mouth, teeth, and lips).[7]

It may be easiest to begin with soft tissue examination of the oral cavity. This will include the gingiva, palate, lips, pharynx, floor of mouth, buccal mucosa, and vestibules. Oral soft tissues are highly vascularized and bleed easily, thus identifying the source of bleeding can be essential to help with the examination. Next, a hard tissue examination can be completed. This can start with accounting for teeth that may have been lost during the injury. Completely intact adult dentition will have 32 teeth, and completely intact child dentition will have 20 teeth (**Fig. 1**). However, in the mixed dentition stage, between ages 6 and 12 years, this can be difficult due to erupting adult dentition and exfoliation of primary teeth (**Fig. 2**).[8] It is also important to note that adult dentition may not have 32 teeth due to routine extraction of third molars (wisdom teeth) or premolars for orthodontic treatment. If an avulsed tooth is not accounted for, a thorough review of head, neck, chest, and abdominal imaging is required to rule out aspiration, swallowing, or displacement of the tooth into soft tissues. If an avulsed tooth is noted, but not accounted for, it is recommended to obtain a chest X ray to assess for aspiration.[6]

Once teeth are accounted for, further dental assessment can be completed. Each tooth should be visually inspected for signs of trauma, including fracture enamel, missing restorations, or gross displacement.[9] After visual inspection, palpation of teeth and alveolus can be completed, specifically looking for mobility of individual teeth or alveolar segments, which can differentiate between dentoalveolar injury and more extensive trauma, like maxillary or mandibular fracture. Radiographic imaging will most likely be indicated for comprehensive diagnosis of dentoalveolar and maxillofacial fractures.

IMAGING

There are several options for imaging to diagnose dentoalveolar trauma, and the choice of imaging depends on severity of trauma and modalities available at the facility. In the emergency department (ED) setting many patients with facial injuries will have a maxillofacial computed tomography (CT) scan completed, which can be used to diagnose dentoalveolar fractures and facial fractures. Maxillofacial CT allows for complete visualization and 3-dimensional (3D) rendering of skeletal structures, which can help differentiate between isolated dentoalveolar injury and more extensive facial fractures (**Fig. 3**). CT can also allow for assessment of soft tissue structures, which can be useful to determine airway patency, foreign objects, and soft tissue infection. However, if clinical suspicion is low and there are concerns for radiation exposure, dental radiographs allow excellent visualization and have less radiation. This can be particularly useful in the pediatric population where panoramic radiograph allows visualization of unerupted teeth (see **Fig. 2**).

Other images that can be obtained in a dental clinic setting are bitewing (BW) and periapical (PA) radiographs.[10] These can be useful for diagnosis of isolated dental injury and periodontal injury. They provide accurate evaluation of dental anatomy and integrity, which can facilitate dental restoration and rehabilitation. Panoramic imaging can also be used to further assess dental trauma with the benefit of being one image that includes all dentition (**Fig. 4**). Although PA, BW, and panoramic images are clinically accurate, low cost, and low radiation exposure, these images are typically only available in an outpatient dental clinic; limited emergency rooms may be able to obtain a panoramic image. It is important to refer these patients to the dentist after discharge for further evaluation.

Finally, photographic documentation can be very useful in cases of facial and dentoalveolar

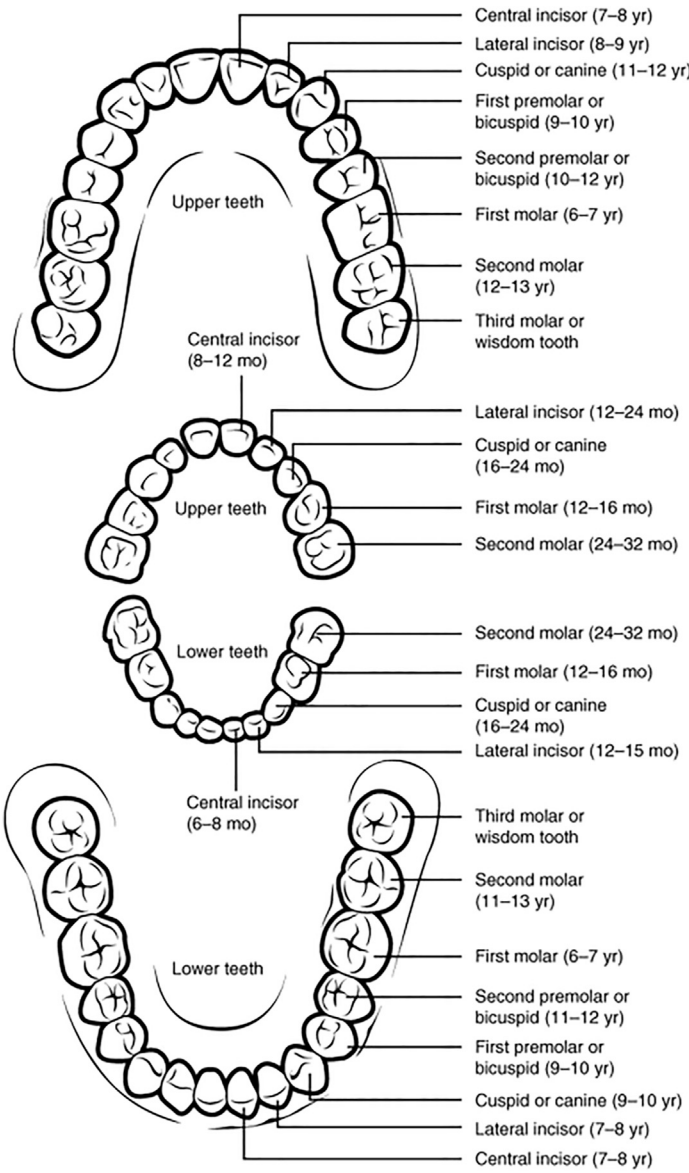

Fig. 1. Primary and permanent teeth: the top and bottom set of teeth illustrate a full set of permanent maxillary and mandibular teeth, respectively. The middle sets of teeth illustrate primary teeth in a young child. (*Data from* Wise AT, Portugal SE. Dental and maxillofacial. In The Youth Athlete: A Practitioner's Guide to Providing Comprehensive Sports Medicine Care. 2023;25–136. https://doi.org/10.1016/B978-0-323-99992-2.00005-0.)

trauma. Photos allow for monitoring of soft tissue healing as well as changes in tooth coloration, which may indicate pulp necrosis and affect long-term treatment planning. When rendering treatment, it may be helpful to also see "before" photos of the patient's occlusion in order to reduce teeth into their proper orientation (**Fig. 5**).

Dentoalveolar trauma can be classified into several broad categories, and a patient with dentoalveolar trauma may involve injuries with one, or all, of these categories. These categories can help to determine treatment:[11]

1. Fracture of teeth (crown/root)
2. Luxation/displacement of teeth
3. Avulsion
4. Alveolar fracture

DISCUSSION AND THERAPEUTIC OPTIONS

The initial treatment of dental and alveolar fracture includes proper diagnosis, treatment planning, and most importantly, follow-up, in order to have favorable outcomes. After reviewing imaging and completing a thorough examination, the diagnosis can be grouped into the previously mentioned categories; (1) fracture of crown or root, (2) luxation or displacement of teeth, (3) avulsion, (4) alveolar fracture. Because dental injuries are closely associated with maxillofacial injuries, it is important to

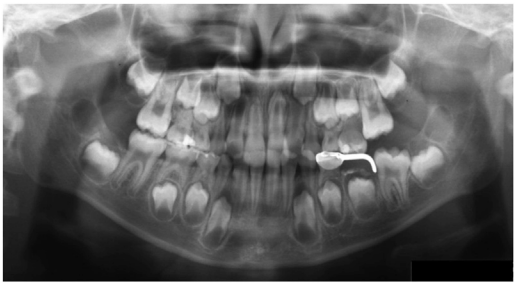

Fig. 2. Orthopantomogram of mixed dentition, this patient has adult anterior dentition and molars, but primary teeth present in the premolar area, and a "space maintainer" orthodontic device present on the patient's lower left. (*Data from* Tanaka S, Karibe H, Kato Y, et al. Evaluation of eye movement patterns during reading of mixed dentition panoramic radiographs in dental students. Pediatric Dental J 2023;33(1): 33–41. https://doi.org/10.1016/j.pdj.2023.01.002; Olynik CR, Gray A, Sinada GG. Dentoalveolar trauma. Otolaryngol Clin N Am 2013;46(5):807–823. https://doi.org/10.1016/j.otc.2013.06.009.)

treat dental alveolar fractures concurrently with facial fractures as stable occlusion remains the goal of facial reconstruction.

Fractures of teeth have different classifications and severity. Fractures of a tooth crown can be uncomplicated (involving enamel and dentin) or complicated (involving enamel, dentin, and pulp). Fractures of the crown can also involve the root and be uncomplicated (involving root, dentin, and enamel) or complicated (involving root, pulp, dentin, and enamel) or only involve root structure. Luxation and displacement of teeth also have different classifications. *Concussion* of the tooth results in sensitivity of the tooth, but the tooth is not mobile or displaced. In *subluxation*, the tooth is mobile if manipulated, but the tooth is not displaced. With *intrusive luxation*, the tooth is displaced apically, or further into the alveolus, and during *extrusive luxation*, the tooth is displaced coronally, or out of the alveolus. When a tooth is extrusive luxated it may be difficult for a patient to occlude, or bring their teeth together properly. *Lateral luxation* of the tooth means it is displaced in any direction, typically lingually or labially. Finally, the tooth may be *fully avulsed*, or the tooth is exarticulated from the alveolar bone. Please see **Figs. 6** and **7** for reference of tooth fracture and luxation classifications.

The prevalence of dental trauma associated with maxillofacial fracture varies depending on the literature, with one study noting that of 67 fractures in the oro-maxillofacial area 26 involved dental injuries.[12] Dentoalveolar and maxillofacial fractures occur concomitantly frequently enough that the practitioner managing facial fractures needs a working knowledge of dentoalveolar injuries and occlusion. In one study, the most common causes of dental trauma cases were due to fall (40%), followed by motor vehicle collision (33.12%), violence (21.25%), and occupational accidents (5.63%).[13]

CROWN FRACTURE

The most common, and minor, isolated injury in dentoalveolar fracture is a crown fracture, ranging between 26% and 76%. Depending on the amount of enamel, dentin, and/or pulp involved, the patient may require calcium hydroxide base and acid etch

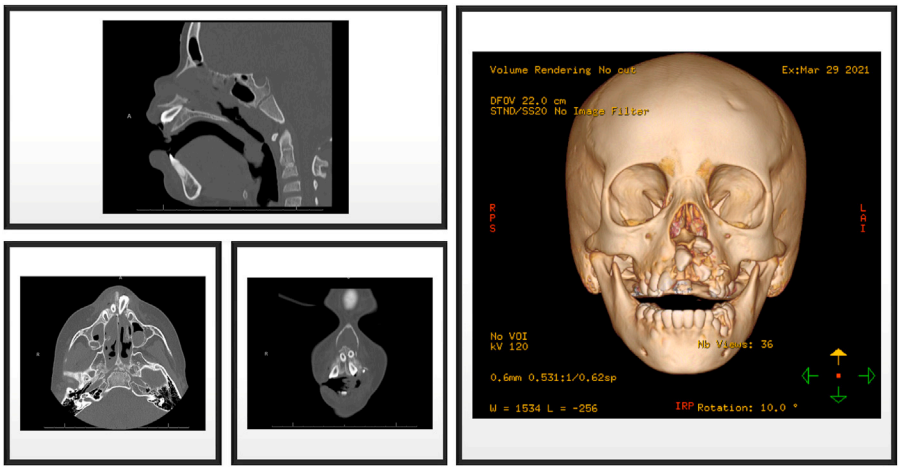

Fig. 3. Maxillofacial CT indicating an intrusion of anterior maxillary teeth with alveolar fragments in sagittal, coronal, and axial views. 3D reconstruction was made using combined CT images. (*Data from* Cho J, Sachs A, Cunningham LL. Dental trauma and alveolar fractures. Facial Plast Surg Clin N Am 2022;30(1):117–124. https://doi.org/10.1016/j.fsc.2021.08.010.)

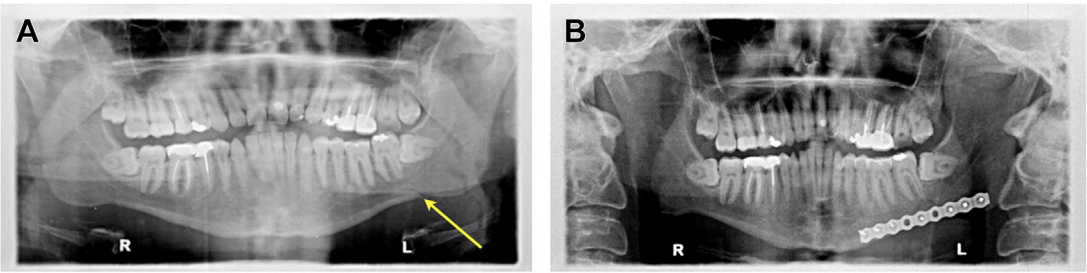

Fig. 4. (*A*) Preoperative Panorex of a patient with a fracture of the left mandibular body (*arrow*). (*B*) Postoperative film following open reduction and internal fixation of the fracture. (*Data from* Patel PB, Stanton DC, Granquist EJ. Common dental and orofacial trauma: evaluation and management. Med Clin N Am 2014;98(6):1261–1279. https://doi.org/10.1016/j.mcna.2014.08.003.)

resin restoration. The extent of pulp exposure and amount of crown fracture will determine the treatment and prognosis of whether the tooth is restorable or unrestorable.[14] If the pulp is exposed, this should be treated with immediate temporary protective restoration. These restorations are typically completed with mineral trioxide aggregate (MTA) and/or glass ionomer. These materials are not typically present in an ED. However, if available, the MTA can be placed over the exposed pulp and glass ionomer placed over the MTA and exposed dentin, then light cured for 30 seconds. Be careful to shield both your eyes and the patient's eyes from the blue curing light. The patient will need a referral to an outside dentist or endodontist for further evaluation and treatment. Ideally, the patient would follow-up as soon as possible with an endodontist, or root canal specialist. If the tooth cannot be saved, it will require extraction and most likely bone grafting in anticipation for an implant, which will require 3 to 9 months of healing time. Ultimately, this route of restoration of the oral cavity for function and esthetics will require extensive follow-up and treatment.[15] This remains a financial burden that is not feasible for all patients.

LUXATION AND DISPLACEMENT OF TEETH

The second most common dentoalveolar injuries are luxations and displacement of teeth; lateral luxation (12.5%) and subluxation (10%). The luxation of teeth can be categorized into subluxation, extrusion, and intrusion. In general, subluxation and extrusion are repositioned into their original position using digital manipulation and require some modality of semirigid fixation (splinting, see **Fig. 5**) for 2 weeks; whereas the involvement of a multitooth segmental fracture involving alveolar bone requires rigid fixation (Erich arch bars, **Fig. 8**) for 4 weeks. An exception to digital manipulation of the tooth is intrusion, which is treated conservatively through close observation to allow for spontaneous re-eruption.[7] In the literature, spontaneously re-eruption occurs with minimal intrusion less than 3 mm, or with primary dentition. If there is severe displacement, greater than 7 mm,

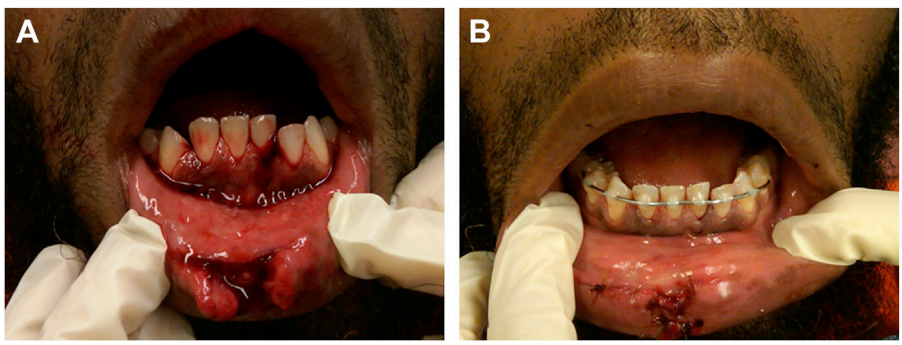

Fig. 5. (*A*) Dentoalveolar fracture. Note the laceration of gingiva and malposition of multiple teeth. (*B*) Bony segment repositioned and stabilized with a splint. These splints are required to be in place until bone union has occurred (typically 4–6 weeks). (*Data from* Patel PB, Stanton, DC, Granquist EJ. Common dental and orofacial trauma: evaluation and management. Med Clin N Am 2014;98(6):1261–1279. https://doi.org/10.1016/j.mcna.2014.08.003.)

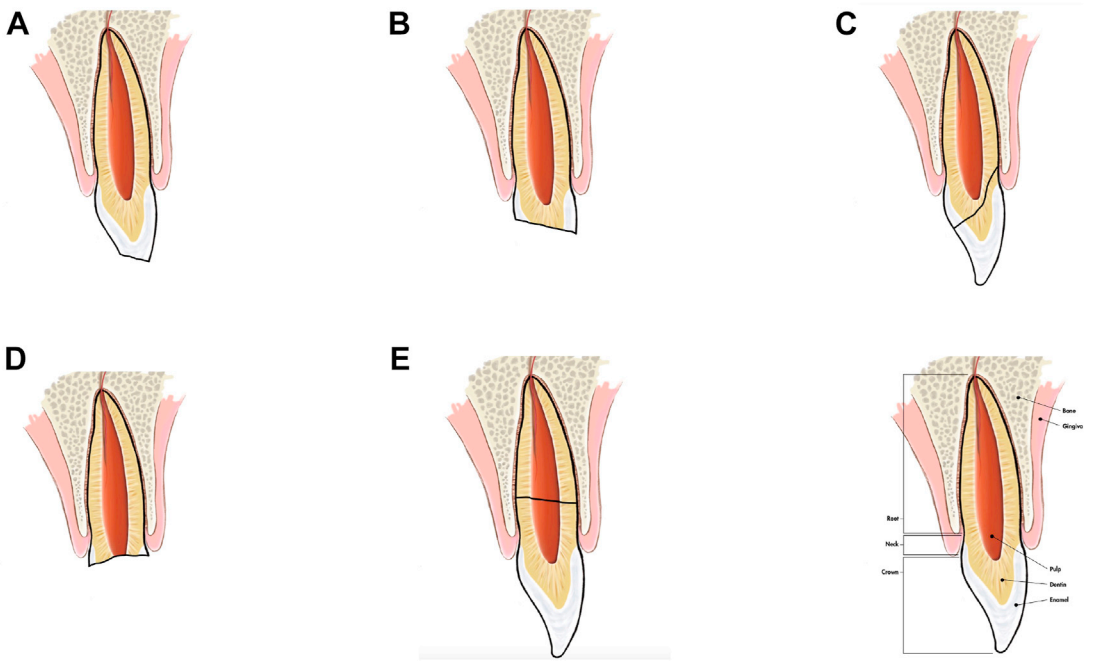

Fig. 6. (*A–E*) Classification of dentoalveolar injury. (*Data from* Reynolds JS, Reynolds MT, Powers MP. Diagnosis and management of dentoalveolar injuries. 4th edition. Elsevier Inc; 2013. https://doi.org/10.1016/b978-1-4557-0554-2.00013-7.)

surgical repositioning is recommended followed by semirigid splints for 4 weeks. Intrusion of primary teeth are almost never indicated to reposition, as these will typically re-erupt spontaneously. If not, they are indicated for extraction, and the patient should be referred to a pediatric dentist for assessment and treatment planning. If the injury is severe and there is a complete loss of alveolus integrity as

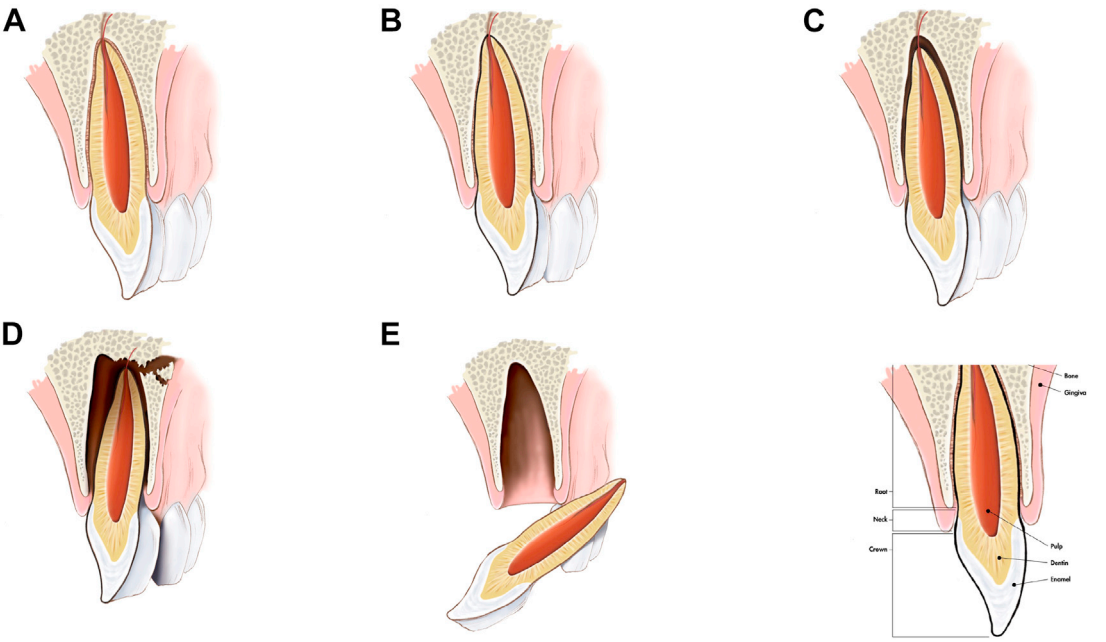

Fig. 7. (*A–E*) Classification of subluxation/displacement (periodontal) injury. (*Data from* Reynolds JS, Reynolds MT, Powers MP. Diagnosis and management of dentoalveolar injuries. 4th edition. Elsevier Inc; 2013. https://doi.org/10.1016/b978-1-4557-0554-2.00013-7.)

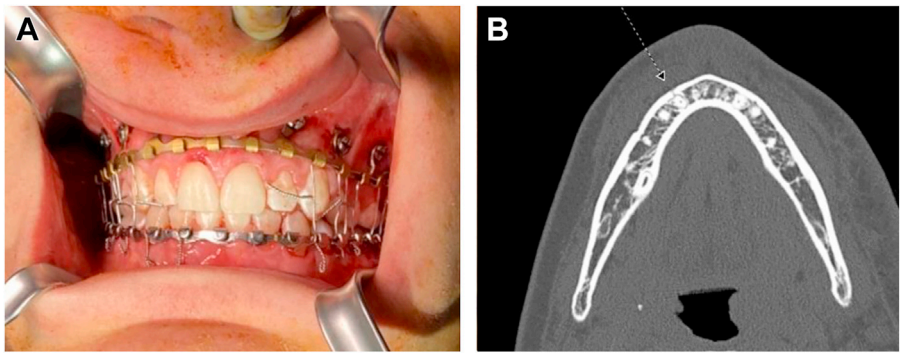

Fig. 8. (*A*) Erich arch bar (on mandible) and hybrid bone anchored plate (maxilla) for maxillomandibular fixation and (*B*) cone-beam CT of patient's mandible with fracture noted by dotted arrow. (*Data from* Sosovicka M, DeMerle M. Adolescent orofacial trauma. Dent Clin N Am 2021;65(4):787–804. https://doi.org/10.1016/j.cden.2021.07.005.)

depicted in **Fig. 3**, removal of these teeth is sometimes indicated.

AVULSION

The treatment of avulsion is dependent on if the patient has primary or secondary dentition. The most common dental avulsion occurs in the anterior maxillary and mandibular teeth (49.8%). A primary tooth should not be replaced, as this can lead to possible infection and damage to secondary dentition. A secondary tooth should be implanted immediately, within 30 to 60 minutes of avulsion and be splinted for 7 to 14 days (see **Fig. 5**). Permanent dentition reimplantation depends on several factors; the stage of root development, length of time avulsed, and storage medium. The less time that the tooth is dry the better. Appropriate storage mediums include Hank's Balanced Salt Solution ("Save a Tooth," SmartPractice, Phoenix, AZ), milk, saline, saliva, and water. While Hank's Balance Salt Solution has a better prognosis for tooth reimplantation than other mediums, there is little evidence available showing preference between the other storage options.[16] The socket and tooth should be very gently irrigated with saline to remove any gross debris, do not scrub and scrape socket or tooth, this will disrupt and possibly remove the periodontal ligament necessary for successful implantation.

ALVEOLAR FRACTURE

Many maxillofacial trauma patients have concomitant dentoalveolar fractures with an incidence ranging from 19% to 47.5%.[5,17,18] If there are alveolar fractures associated with luxation and or avulsion, proper protocols for luxation and avulsion should be followed in conjunction with anatomic reduction and repositioning of the alveolar fracture using closed or open techniques. Most alveolar

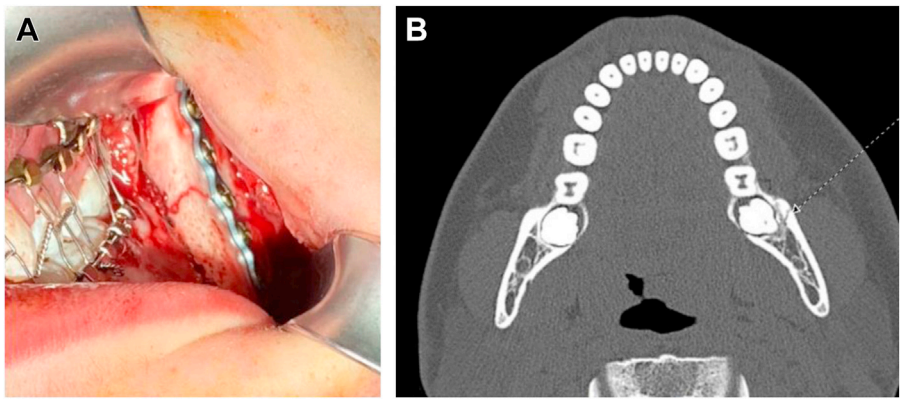

Fig. 9. (*A*) Titanium bone plate and screws used for intraoral ORIF of mandibular left angle fracture with (*B*) cone-beam CT with fracture noted by dotted arrow. (*Data from* Sosovicka M, DeMerle M. Adolescent orofacial trauma. Dent Clin N Am 2021;65(4):787–804. https://doi.org/10.1016/j.cden.2021.07.005.)

fractures can be reduced using the closed reduction technique with rigid fixation for 4 weeks. There are many wiring techniques for closed reduction depending on the patient's age, dentition (primary, mixed, secondary), or lack of dentition. When patients have permanent dentition, Erich arch bars can be used (see **Fig. 8**). Open reduction and internal fixation (ORIF) of alveolar fractures is indicated when an extensive alveolar fracture is associated with a unilateral Le Fort I maxillary fracture, when the dentoalveolar fracture cannot be reduced using closed methods, and/or postoperative maxillomandibular fixation in undesired (**Fig. 9**). In certain cases of maxillary or mandibular fracture, when maxillomandibular fixation is indicated to stabilize occlusion for internal fixation interdental wires, such as Minne Ties (Invisian Medical, Prairie Village, KS), can be used instead of Erich arch bars (**Fig. 10**). These can be placed in the embrasure, or spaces, between teeth and tightened in order to establish occlusion.

CONSIDERATIONS IN THE PEDIATRIC PATIENT

Pediatric patients have unique challenges in maxillofacial and dentoalveolar fractures because of concerns with growth, tooth buds of developing teeth, and dental variations, which makes the placement of fixation plates difficult. **Fig. 2**, a panoramic radiograph of mixed dentition, illustrates these challenges as one can see that the primary dentition does not provide the stability to withstand the forces of Erich arch bars and they may damage the permanent dentition. Although nonsurgical and conservative approaches are typically recommended because of the high osteogenic growth potential and remodeling found in pediatric patients, mandible fracture with dentoalveolar fractures necessitates open reduction and internal fixation. Thus, the use of Risdon cable wires (**Fig. 11**) can be used because it is easily adapted to primary teeth with fixation on the permanent molars as long as the patient is older than 6 years. This allows the placement of guiding elastics or wires. Ultimately, there are many techniques and variations in open reduction; however, the choice of technique depends on the surgeon's experience, comfort, and availability of resources.

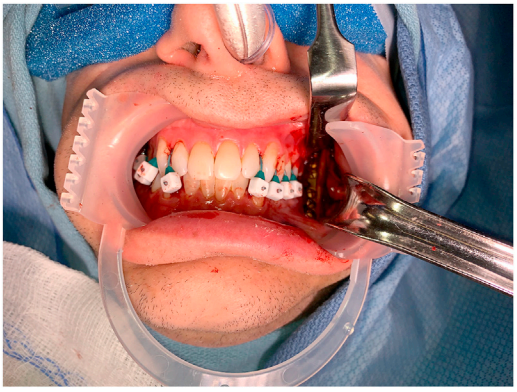

Fig. 10. Minne Ties placed and trimmed intraoperatively for maxillomandibular fixation. Minne Ties are placed through maxillary and mandibular embrasures to establish maxillomandibular fixation. (*Courtesy of* Alan W. Johnson, MD, MS, Minneapolis, MN.)

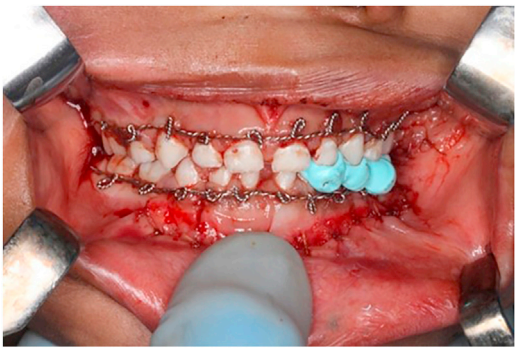

Fig. 11. Risdon cables composed of braided 26-gauge wires secured with circumdental wires used to facilitate intermaxillary fixation. Note the Blu-Mousse (Parkell Inc, Edgewood, NY, USA) in the left occlusal surfaces used to open the bite posteriorly to try to reestablish the ramus–condylar height. (*Data from* Hajibandeh J, Peacock ZS. Pediatric mandible fractures. Oral Maxillofac Surg Clin N Am 2023;35(4):555–562. https://doi.org/10.1016/j.coms.2023.05.001.)

CLINICS CARE POINTS

- Dental injury is commonly associated with maxillofacial trauma, underscoring the importance of a clinician's knowledge of dentoalveolar injury evaluation and management.
- Initial evaluation of maxillofacial trauma should include a thorough examination of the soft and hard tissues, including inspection and palpation of teeth and alveolar segments, as well as radiographic imaging.
- Photographic documentation of soft tissue damage before and after intervention is beneficial for ongoing management with outpatient dental/medical follow-up.
- In the event of dental avulsion of permanent teeth, successful reimplantation depends on several factors; the stage of root development, length of time avulsed, and storage medium. An avulsed tooth should be kept moist in commercial storage mediums, milk, saline, or saliva.

- In the pediatric population, Risdon cable wires can be applied on permanent molars that are commonly established around age 6 for rigid fixation in the event of dentoalveolar injury.

DISCLOSURE

The authors have nothing to disclose.

REFERENCES

1. Corso P, Finkelstein E, Miller T, et al. Incidence and lifetime costs of injuries in the United States. Inj Prev 2006;12(4):212–8.
2. Bellamkonda P, Varghese E, Alasabi AN, et al. Traumatic dental injuries and their association with demographics and other predisposing risk factors in school children aged between 8-13 Years: a descriptive, cross-sectional study. Indian J Community Med 2024;49(3):512–8.
3. Petti S, Glendor U, Andersson L. World traumatic dental injury prevalence and incidence, a meta-analysis-One billion living people have had traumatic dental injuries. Dent Traumatol 2018;34(2):71–86.
4. Patnana AK, Chugh A, Chugh VK, et al. The prevalence of traumatic dental injuries in primary teeth: a systematic review and meta-analysis. Dent Traumatol 2021;37(3):383–99.
5. Gassner R, Bösch R, Tuli T, et al. Prevalence of dental trauma in 6000 patients with facial injuries: implications for prevention. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999;87(1):27–33.
6. Galvagno J, Nahmias JT, Young DA. Advanced trauma Life Support ® update 2019: management and applications for adults and special populations. Anesthesiol Clin 2019;37(1):13–32.
7. Reynolds JS, Reynolds MT, Powers MP. Diagnosis and management of dentoalveolar injuries. Oral and Maxillofacial Trauma 2013;248–92.
8. Olynik CR, Gray A, Sinada GG. Dentoalveolar trauma. Otolaryngol Clin 2013;46(5):807–23.
9. Jones LC. Dental trauma. Oral Maxillofac Surg Clin 2020;32(4):631–8.
10. Alimohammadi R. Imaging of dentoalveolar and jaw trauma. Radiol Clin 2018;56(1):105–24.
11. Andreasen JO, Lauridsen E. Alveolar process fractures in the permanent dentition. Part 1. Etiology and clinical characteristics. A retrospective analysis of 299 cases involving 815 teeth. Dent Traumatol 2015; 31(6):442–7.
12. Palmela Pereira C, Santos R, Santos A, et al. A systematic review and meta-analysis of oral and maxillofacial trauma. J Forensic Odonto-Stomatology 2022;40(3):2–21.
13. Kallel I, Douki N, Amaidi S, et al. The incidence of complications of dental trauma and associated factors: a retrospective study. Int J Dent 20202968174. https://doi.org/10.1155/2020/2968174.
14. Hilton TJ. Keys to clinical success with pulp capping: a review of the literature. Operat Dent 2009;34(5): 615–25.
15. Tsukiboshi M, Tsukiboshi C, Levin L. A step-by step guide for autotransplantation of teeth. Dent Traumatol 2023;39(Suppl 1):70–80.
16. De Brier N, O D, Borra V, et al, International Liaison Committee on Resuscitation First Aid Task Force. Storage of an avulsed tooth prior to replantation: a systematic review and meta-analysis. Dent Traumatol 2020;36(5):453–76.
17. Hamdan MA, Rock WP. A study comparing the prevalence and distribution of traumatic dental injuries among 10-12-year-old children in an urban and in a rural area of Jordan. Int J Paediatr Dent 1995; 5(4):237–41.
18. Zhou H-H, Ongodia D, Liu Q, et al. Dental trauma in patients with maxillofacial fractures. Dent Traumatol 2013;29(4):285–90.