SCIENTIFIC ARCHIVES OF DENTAL SCIENCES (ISSN: 2642-1623)

Volume 4 Issue 4 April 2021

Review Article

Maxillofacial Trauma in Pediatric Population - A Review

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Received: November 12, 2020; **Published:** March 31, 2021

Abstract

Maxillofacial trauma is one of the most common reasons in children due to their greater cranial mass to body ratio when compared to adults. Among them, soft tissue and dentoalveolar injuries are more common when compared to facial bone fractures. These injuries are more common in boys when compared to girls which is attributed to their increased physical activity. Their impact can be seen on the psychological development and facial growth of the children which can also affect their families. Fractures in children are minimally displaced because elastic bone is covered by thicker layer of adipose tissue which in turn acts as protective layer. Evaluation of pediatric trauma includes stabilisation, physical examination, imaging and adapting the appropriate mode of treatment. Usually, the management is conservative and non-invasive in children to prevent any disturbances in growth. The use of resorbable materials in treating pediatric population provides sufficient stability and rigidity to avoid complications and follow up is necessary to assess the outcome which in turn depends on the development of the child.

Keywords: *Maxillofacial; Dentoalveolar; Psychological; Stabilisation; Resorbable*

Introduction

Pediatric trauma which involves the facial bones is found to be related to several deformities, injuries and complications [1]. Facial trauma associated with severe injury can have a functional and esthetic impact on the growing children and their families. Some pediatric facial injuries may be trivial which include breeches, bruises, contusion, hematomas and damages to teeth and its supporting tissues [2]. Children between seven to twelve years are most commonly affected by trauma [3]. The most unique feature about trauma in children is that they are difficult to examine both clinically and radiographically. The bell shaped pediatric teeth is not suitable for the for surgeons during treatment particularly while using splints and wires for retention [4]. Pediatric patients also exhibit rapid healing and lesser complications when compared to elders [5].

Hospitalisation can have both psychological impact as well as disturbances in feeding pattern and behavioural problems [6].

Epidemiology of pediatric trauma

Soft tissue and dentoalveolar regions are most commonly affected due to pediatric trauma. Pediatric facial fractures are quite infrequent and not as prevalent as in adults [7]. Inspite of the fact that among all fractures, only 15% of them are pediatric facial fractures, these are still found to be related to morbidities and deformities which can be very severe [8]. The case fatality rates for pediatric head and face trauma in the year 2016 were found to be 3.74% and 3.07% respectively [9]. In facial trauma, older people are prone to bone fractures (increase of 4.4% per year of age) and soft tissue injuries (increase of 2% per year of age), while children are more

susceptible to dentoalveolar trauma (decrease of 4.5% per year of age) [10]. Children in the age group of 6 to 7 years and those between 12 and 14 years, are found to be more commonly affected by trauma due to their greater physical activity and involvement in sports and athletics [11].

Road traffic accidents (RTA) are the most common cause (5 - 80.2%) followed by inadvertent causes like falling from trees (7.8 - 48%); sports-related injury (4.4 - 42%) and violence (3.7 - 61.1%) [12]. The incidence of facial fractures is higher in boys than girls which is due to unsafe and more threatening physical activities among boys [13]. The lesser number of girls may be due to a traditional civilised environment where girls are protected and under cautious supervision when compared to boys. There are also very few chances for girls to participate in sports and physical activities in some areas [14]. Most common fractures in children are mandibular fractures followed by nasal fractures, orbital, frontal and midfacial fractures. Nasoorbitoethmoidal fractures are the least common fractures [15].

Effect of age and development

In children, the frontal prominence of the skull and the maxillary retrusion of the face can lead to a significant higher probability of cranial fracture than facial bone fracture, the skull thus protects the face. At birth the skull-to-face ratio is found to be 8:1 and 2.5:1 in adults. Children have a greater reluctance to facial bone fractures and a higher predisposition to greenstick fractures when compared to adults. The lesser amount of calcification, more pliable suture lines and the presence of rich and ample cartilaginous bones, provide larger resilience and elasticity to a child's skeleton. These pediatric bones are also found to be surrounded by adipose tissue which in turn protects them [1].

Psychological development

During infancy, hospitalization, trauma, and surgery will disrupt patterns of feeding and sleeping [15]. During the preschool phase, separation anxiety and fear of loss of mother may act as stressors and during the school age phase hospitalisation, trauma and surgery could be a potential insult to the child's ability. Similarly during adolescence the child's sense of autonomy may be challenged [16].

Facial growth

The two halves of the mandible join in the midline by the end of first year which is completed by 2 years. The chin prominence develops and the deciduous teeth also erupt by this time. The condyle is responsible for the vertical growth of the mandible. The growth of the mandible occurs by deposition in the posterior regions and resorption in the anterior regions [17]. Most of the transverse growth is complete by 2 years. Accurate knowledge of sinus development is very helpful when diagnosing facial injuries. The ethmoid sinuses are cavities which are partially air filled at birth and reach their full size by 12 years [18]. By 9 years, maxillary sinus attain their maximum growth. The maxillary sinuses attain their maximum size after all the teeth erupt [17]. By 2 years, most of the cranial sutures are obliterated and after puberty frontal sinuses reach their full size [19].

Pediatric trauma vs adult trauma

The partially calcified skeleton of children which exhibits more elasticity can result in numerous internal organ injuries. Children have increased metabolic rate, cardiac output and a greater demand for oxygen which can even cause respiratory failure [20].

The characteristics of a child's airway are a shorter trachea, a narrower epiglottis with flabby oral and pharyngeal soft tissues. All these can cause increased airway resistance, easy obstruction and strenuous intubation which are complications during treatment of a child [21].

Hypoxia and hypercapnea which are both vicious signs are due to smaller stroke volume in children. Blood pressure in children is maintained through vasoconstriction, tachycardia and cardiac contractility especially when a pediatric injury can result in blood loss and hypovolemia [21].

Pediatric abdominal injury may require immediate surgical involvement. Stability of a pediatric facial skeleton can be attributed to the inviolable maxilla and mandible with unerupted permanent teeth and the decreased air filled spaces of sinuses in the oral and maxillofacial regions [22]. Their skeletal injury can result in growth disturbance and more number of greenstick fractures which can, in turn, cause blood loss greater than in an adult [21].

Secondary brain injuries are also common in children due to their higher oxygen demand and changes in the cerebral blood flow. Any underlying mass lesions may go unnoticed due to the fact that fontanelles are open in children and the cranial suture lines are flexible. Vomiting after pediatric trauma is considered to be common and insignificant. There is a possibility that their spinal cord could also be injured without any aberrations in the radiographs [21].

Types of maxillofacial injuries

Pediatric maxillofacial injuries can be classified into hard tissue injuries and soft tissue injuries. The pediatric facial skeleton is not susceptible to fractures but their injuries to soft tissue are more common [23]. In a study by Albeshir., *et al*. among soft tissue injuries laceration was the highest (94.23%) followed by Contusion (3.71%) and Dermabrasion (1.85%) [24]. Lips were the most commonly lacerated especially the lower lip [24]. Of all the hard tissue injuries, Avulsion is a threatening dental injury due to unanticipated trauma which can cause removal of the tooth out of the socket along with injury to the supporting tissues (42.4%). Proclined maxillary incisors and incompetent lips are also contributing factors to trauma. Children between 9 and 11 years are mostly affected due to avulsion [24].

Avulsion can occur anywhere but early transport would always be beneficial for replanting the tooth. Inadequate knowledge about replantation and anxiety could be the reasons for failure of replanting avulsed tooth.

Subluxation which can be defined as an injury to the tooth and its supporting structures resulting in increased mobility without displacement of teeth was seen in 31.06% cases, followed by intrusion (15.9%) and crown fractures without pulp exposure were seen in 10.6%. Dentoalveolar fractures were the least common among all the hard tissue injuries (0.05%) [24].

Evaluation of pediatric trauma

Stabilisation

It is very important to stabilise a pediatric patient who has suffered from a trauma.

Physical examination

Pediatric facial fractures can occur after a threatening trauma so a thorough physical examination is always needed. Inspection for intracranial or cervical spine injuries, skull fractures or any soft tissue injuries is required. Mandible and midface fractures have the highest rate of related injuries which are most commonly found to be correlated with neurocranial injuries [27].

Battered child (Child abuse)

Examination of battered child is of utmost clinical significance especially in cases of physical or sexual abuse. Head and neck regions are most commonly affected in a case of battered child [20]. Multiple physical injuries include teeth are frequently missing, broken, or may be nonvital. Regions in the oral cavity which can show evidence of burns, hematoma due to any sexually transmitted disease include the gingiva, palate, and the tongue. Signs of burns or ecchymosis can be seen in lips (especially from cigarettes).Sometimes there can be evidence of multiple fractures or hematomas in pediatric facial skeleton. The ears may also exhibit signs of ecchymosis, lacerations or any perforations. Laryngeal fractures due to choking and rope burns from hanging are absolutely indicative of child abuse. Skin of the child might show bite marks, imprints of objects (e.g. belt buckles), loss of hair, scars, burns (thermal or chemical) [25]. Other physical findings may include retinal hemorrhage, numerous subdural hematomas (without skull fracture), damaged internal organs of abdomen, old scars and genital or perianal trauma [26].

Orbital fractures are common in children which may be attributed to their prominent forehead. Subconjunctival hemorrhage, edema, and bony step deformities (hard to palpate in children) are some of the characteristic features of orbital fractures [12]. Clinically, a white eye presentation with no symptoms is characteristic of trapdoor or white eye fractures which is seen only in children. There could be restriction of extraocular muscle movement leading to diplopia [27]. Fractures of nasal or naso orbital fractures can be evaluated by examination of mid face. The nasal bone is children is the most commonly fractured bone [28]. Telecanthus, shortening of palpebral fissures and saddle nose deformity are some of the characteristics seen in a Naso orbital ethmoidal fracture [29].

Oral examination should be done for injuries to teeth and its supporting tissues jaw bone fractures. Trismus, malocclusion and flattening of cheek are some of the signs we need to asses in cases of maxillary fractures. In case of mandibular fractures, we must also look for decreased maximal incisive opening apart from the other signs [12].

Diagnostic imaging techniques

Ultrasonography (USG) should be taken instead of radiographs to keep radiation exposure minimum for children. However, for a more elaborate evaluation Computed Tomography (CT) must be taken and it is necessary to confirm the diagnosis [1].

Treatment modalities

A conservative and non invasive treatment to prevent growth disturbance, use minimal manipulation with least intrusive devices. Conservative management is recommended for minimally displaced and greenstick fractures [30]. A majority of concomitant injuries in pediatric population are head-related injuries like concussion, intracranial hemorrhage, and skull fractures which are more common in children more frequently than in adults [31].

Pediatric facial fractures

Mandibular fractures

Mandibular fractures are reported to have the highest incidence (15 - 86.7%) among pediatric facial fractures. Among them condyle is the most commonly fractured. In cases where occlusion cannot be re-established open reduction may be considered [20].

Open reduction should be considered when the occlusion cannot be re-established and in such cases semirigid fixation can be considered. Observation and soft diet should be the treatment modality for greenstick and nondisplaced fractures. In cases of displaced fractures, short course of maxillomandibular fractures (1 - 2 weeks), traction with elastics and soft diet should be considered [20]. Ankylosis of temporomandibular joints can be seen as a complication in children if fixation time exceeds ten days in children [32]. In order to maintain stabilization in pediatric patients, a single miniplate at the inferior border of the mandible [12]. Maxillomandibular fixation for a period of 4 weeks is usually effective for body, ramus, angle, or symphysis injuries. In cases of semirigid treatment; in order to reduce growth and development restrictions in children, it should be removed within 3 months [33]. Condylar fractures which might be unobserved can cause ankylosis, temporomandibular disorders and other dentofacial abnormalities [24].

Midface and zygomaticomaxillary fractures

Maxillary fractures usually do not occur in children younger than 2 years. As the maxillary sinuses develop and the permanent teeth erupt, the frequency of maxillary fractures increases which is maximum around 13 - 15 years [1]. The primary goals of treatment of zygomaticomaxillary complex fractures (ZMC) include restoring facial height, contour, dental occlusion, and visual deficits [12]. Pediatric zygomatic complex fractures involving the lateral wall and floor of the orbit are mostly greenstick fractures [1]. Conservative management is required for minimally displaced fractures and open reduction internal fixation (ORIF) is suggested for displaced fractures [3]. Maxillomandibular fixation with elastic traction is the treatment of choice for maxillary fractures if teeth have sufficiently erupted. If not, then ORIF might be considered. During fixation, arrangement of screws away from the teeth to avoid damage to developing tooth buds is an important consideration while treating children [12].

Frontal bone fractures

Infants are more likely to experience frontal bone injuries because of the forehead prominence, consequences of which could be negligible [35]. The incidence of frontal sinus increases after puberty because of the sinus development. Leakage of cerebrospinal fluid and cerebral injury are some of the complications of frontal sinus fracture [24].

Fractures of orbit

Fractures of orbit are rare in pediatric population with the exception of trapdoor fracture [1]. In a study by Albeshir., *et al*. orbital fractures were reported with a lower frequency whereas in other reports they constituted about 20% of pediatric facial fractures [24]. The orbital fractures occur either due to direct force transmission or due to indirect hydraulic pressure [24]. In trap door fractures, a fragment of bone protrudes into the ethmoidal sinus

which were treated through an incision on the lower eyelid [1]. CT scan is essential for diagnosis of orbital fractures, clinical findings are considered more important for management of orbital fractures surgically [36]. Indications for surgery include entrapment of extraocular muscle (EOM) and traumatic optic neuropathy [37]. In case of traumatic optic neuropathy, steroid treatment is initiated before surgical treatment and for EOM entrapment, treatment should be initiated within 2 days to avoid fibrosis of extraocular muscles and double vision [38].

Nasal and naso-orbito-ethmoidal fractures

The most commonly injured and the most prominent bone in the facial skeleton is the nasal bone which could be overlooked due to local edema and decreased patient compliance. The nasal septum in children is more susceptible to trauma due to its rigidness [2]. Reconstruction of normal appearance and telecanthus correction should be the treatment of choice [12]. Nasal septal hematomas should be drained immediately and treatment is indicated only if there is a deformity [36]. Airway obstruction and aberrations in growth could be possible complications [15]. Displaced nasal fractures can be reduced after edema has resolved. In order to avoid growth disturbances, closed reduction with external fixation is the treatment of choice [39]. Hemostasis and fixation under general anesthesia is required in almost all cases but few cases can be reduced under sedation [40]. ORIF is usually the treatment of choice for naso-orbito-ethmoid fractures [41].

Associated injuries

In the study by Albeshir., *et al*. 45.08% of patients were found to have associated injuries like neurocranial (head) injuries, fractures of clavicle, radius, ulna, femur, tibia, blunt abdominal trauma and chest injuries [24]. Literature cites that associated injuries in pediatric facial fractures were in the range of 10% - 88% [42]. Neurocranial injuries are the most common associated injuries and their incidence was also found to be higher in boys when compared to girls [2,42].

Outcomes and complications

The consequences of facial trauma in children depend on the site and intensity of the fracture and also on the kind of treatment. The outcomes also change as the child grows and develops and hence follow up become very important. Infection, malunion or nonunion, malocclusion and retardation in the growth of children are considered as obstacles during treatment. Complications after facial fracture repair are less common in children than adults [36]. Rottgers., *et al*. gave a classification for adverse outcomes after facial trauma. The first type seems to be associated with the fracture (e.g. sudden blindness in orbital fracture). Type 2 outcome is related to the treatment (e.g. failure of hardware). Type 3 outcome seems to be associated with growth progression in children (e.g. delayed hypoplasia of mandible). In order to decrease type 2 and 3 outcomes, less intensive management is required [43].

Trauma to the pediatric facial regions can result in decreased bone growth and indefinite facial malformations [44]. Bilateral fractures, prolonged treatment, increased duration of fixation and juvenile age (2 - 5 years) could result in some difficulties while treating pediatric condylar fractures which include bleeding, bony union in the joints along with asymmetry of mandible [40]. An infrequent complication of orbital fractures in pediatric trauma is when there is a dural tear that permits normal cerebral pulsations to transmit pressure into the orbit which, in turn, can present with signs of exophthalmos [45].

Treatment considerations

The use of resorbable materials (such as plates and screws) in treating pediatric maxillofacial fractures especially when open reduction and internal fixation is the treatment of choice provide sufficient stability and rigidity without any complications. The use of these resorbable plates and screws avoid the need of a second surgery which can cause reduction in hospital spending and an improvement of the children's quality of life [46]. The osteosynthesis technique is the same for both adults and children but in children one must remember to remove the plates before 3 months [47]. In a study by Lloyd., *et al*. intranasal midazolam can be used as an alternative to general anaesthesia in the management of children with maxillofacial trauma because it is safe, cost effective, time saving, provides adequate sedation and most importantly reduces the anxiety of general anaesthesia [48].

Conclusion

Fractures in the pediatric population are less common when compared to that of adults, and boys are usually more commonly affected than girls [49]. Parental observation plays a very significant role in avoiding grave problems in children. The developing dental follicle in children has been proposed to be a presenting element that can lead to fracture. Pediatric soft tissue injuries are more common than facial bone fractures which include contusion, hematomas, bruises and lacerations. All wounds must be debrided, closed within 12 hours and tetanus toxoid vaccine should be administered [50]. Injury to the teeth and its supporting tissues is one of the most persistent causes for admission of children to the pediatric emergencies [51]. A routine follow up combined with regular dental visits can help us to evaluate any disruption in growth pattern which, in turn, can have a long term effect on their esthetics as well as function, if left undiagnosed.

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