SMGroup

Pediatric Maxillofacial Traumas

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INTRODUCTION

Maxillofacial traumas include facial bone fractures as well as soft tissue abrasions and lacerations. Typically multiple facial bones are affected; however these may be accompanied by brain, lower limb, abdomen and chest injuries depending on the severity of the experienced event. Today increased rapid transport facilities increase the incidence of maxillofacial traumas. In such patients, firstly the airway should be evaluated, hemorrhage should be controlled and examination should be performed to find out whether any neurological deficit is present. Especially in pediatric patients, the most appropriate method for treatment should be selected since multiple maxillofacial traumas adversely affect craniofacial development. The basic approaches to facial traumas for adults and children are generally similar. However, due to noncompliance of children, diagnosis is typically made by radiological examination rather than by clinical evaluation. In children, fractures occur mostly in the form of greenstick fracture. Since fracture healing is rapid, reduction should be made during the first weeks. We aim to restore the patients' former bone structure with minimal aesthetics and functional loss.

EPIDEMIOLOGY

In pediatric age group, maxillofacial injuries typically occur in the form of laceration and abrasion, and maxillofacial fractures are usually rare. Exposure to traumas that are severe enough to cause fractures is more uncommon in children than in adults. Their facial skeleton is soft and flexible, making it resistant to hard blunt forces. Fractures, if occur, are usually in the form of incomplete greenstick fracture.

Two important factors should be kept in mind to understand the cause of pediatric facial injuries: the event that caused the injury and the maxillofacial anatomy [1]. The most common causes of maxillofacial traumas in children are falls, motor vehicle accidents and sports activities [2]. In children under 6 years, maxillofacial traumas especially due to falls are very common [2]. The most frequently broken bones are the nasal bone and mandible [3,4]. In children, bones are less mineralized and dominated by cancellous bone, thereby healing much more rapidly than those of adults. Sinus pneumatization occurs later, especially for the maxillary and ethmoid sinuses (Figure 1).

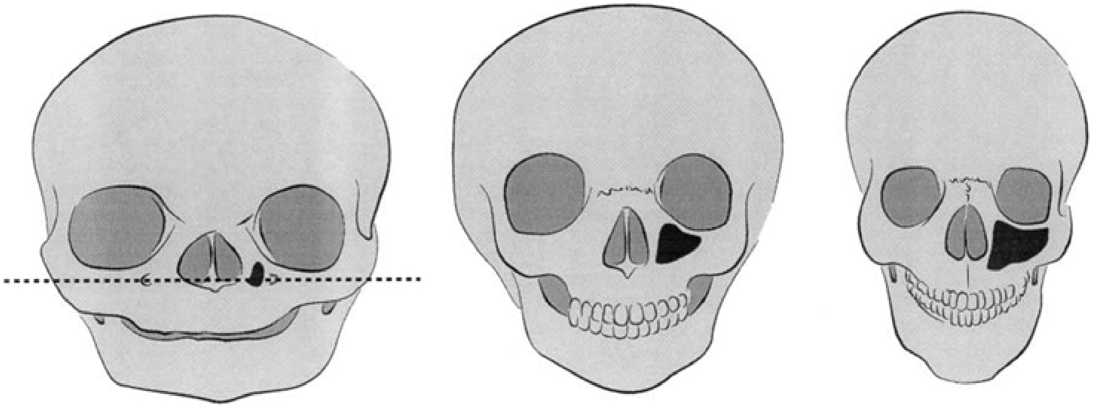

Figure 1: Infant, child and adult skulls showing skeletal changes occurring with craniofacial growth and development.

(Adapted from Kazanjian VS, Converse JM. Surgical treatment of facial injuries. Baltimore: Williams & Wilkins; 1974.)

Falls rarely cause serious injuries in pediatric age group despite being commonly seen in this age group. On the other hand, motor vehicle accidents can cause severe damages depending on the crash speed. Motor vehicle accidents occurring after the perinatal period are among the major causes of death, of which the incidence increases with increasing age [5]. Advanced vehicle security systems and legal sanctions regarding seat belts have significantly reduced the severity and incidence of facial fractures occurring after motor vehicle accidents [6-8]. Sports-related facial fractures occur mainly between 10 and 14 years of age. Since motor skills and physical activities increase with increasing age, children in this age group are affected more [9].

Bone fractures occurring as a result of trauma are classified into complete fractures and incomplete fractures depending on the continuity of the bone. A complete fracture is called displaced fracture if the ends of the broken bone are completely separated from each other or non-displaced fracture if they are not completely separated. On the other hand, incomplete fractures do not extend through the entire thickness of the bone. Such fractures are subclassified into fissures, depression fractures, compression fractures, condylar fractures and epiphyseal separation.

Fracture healing is classified into primary and secondary healing. During primary healing, if the ends of the broken bone are completely fixed on each other a healing occurs very rapidly through callus tissue formation. Secondary healing consists of four successive phases: Hematoma phase, granulation tissue formation phase, callus (neoosteogenesis) formation and lamellar bone formation. The callus tissue that forms during the first four weeks is a spongious bone which is non-stable and ensures the integrity. The lamellar bone, which is the original structure of the bone, is in trabecular form. The callus tissue is removed by osteoclastic activity and replaced by a lamellar bone. This is the original bone tissue which is more stable.

The cancellous bone structure which ensures softer and more flexible bones in children provides protection from traumas by increasing the flexibility. Moreover, the subcutaneous soft tissue in children is more protective because of being thicker than in adults. The thinness of the cortical bone also increases the flexibility. Greenstick fractures are more commonly seen in children because of this flexibility. Moreover, incomplete maxillary and mandibular dental development increases the resistance to fractures [10].

APPROACH TO PATIENTS WITH TRAUMA

The objective of the treatment in maxillofacial trauma is to provide functionality and aestetics. The earlier the treatment is initiated the better the outcome. Especially interventions during the first 2-3 hours after the trauma are important; the patient has less hematoma and edema during this period and interventions beyond this period will be more challenging. In children, treatment during the first 5-7 days is the primary treatment. The secondary treatment aims to treat the complications developed during the fracture healing process and to provide wound site care. If the injury was accompanied by head trauma, firstly the cranial fractures should be repaired.

90% of maxillofacial traumas are accompanied by concomitant pathologies. Among these, the most common ones are neurological, orthopedic, opthalmological, thoracic, abdominal and urological injuries [11-13]. Physical examination reveals equimosis, soft tissue edema, crepitation and subcutaneous airway disturbances. Hematoma and pathological movements may also be present on the fracture site. These may be accompanied with symptoms such as trismus, malocclusion, numbness due to trigeminal nerve injury, hemotympanum, external ear lacerations, bleeding from the ears, nose and mouth, or CSF leakage.

Emergency situations include hemorrhage, orbital hematoma, optic nerve injuries, and occlusion of the pharyngeal inlet by the tongue thereby occluding the respiratory tract. In patients with trauma, the primary basic intenvertions should be inspection of the airway and cervical spine (A), maintenance of breathing (B), re-establishment of circulation (C) and re-establishment of vasculary access. Patients should be assessed by radiographic imaging whether there is any damage in the brain and spine. Specifically, computerized tomography should be performed in patients who are considered to have maxillofacial trauma. Magnetic resonance imaging is useful mainly in patients who are considered to have vascular or soft tissue injury.

Formation of lamellar bone which is necessary for fracture healing requires alignment and fixation of the ends of the broken bone. This method, which uses screws, plates and prostheses and pushes the fracture ends to each other without leaving any space in between is called semi-rigid fixation. The mean healing time is 6-8 weeks and this method also allows for mobilization of patients. They will be able to eat and make dental care. In this method, the rate of complications such as infection and excretion is increased due to the use of too many screws or plates. Rigid fixation uses metal plates. However, metals undergo immune reactions by being oxidized and phagocytized during the period during which they remain in the body [14]. Titanium plates are thought to cause fewer reactions, however in children; resorbable materials are preferred today since titanium plates hinder bone growth. Resorbable plates include polilactic acid, polyglycolic acid, polyparadioxanon derivatives etc. These materials, which have sufficient rigidity, ensure callus formation and removed by phagocytes [15].

Many non-displaced or minimally displaced fractures, mainly greenstick fractures, can heal without surgery with a bland diet and activity restriction. Other fractures are treated by simple closed reduction with maxillomandibular fixation and Barton dressing. If open reduction and internal fixation is needed, minimally invasive and resorbable materials should be preferred.

Nasal fractures are most commonly seen in maxillofacial bone injuries. Such fractures comprise the patient population who do not require surgery and treated as outpatients. On the other hand, mandibular fractures are the most common facial fractures requiring hospitalization. About 30-50% of facial fractures excluding nasal fractures are mandibular fractures [16-18]. Midfacial fractures are rare in children and usually seen after motor vehicle accident injuries. Orbital fractures, zygomaticomolar fractures and LeFort maxillary fractures occur at rates of 20-25%, 10-15% and 5-10% respectively. Orbital roof fractures occur in very young children whose frontal sinus have not developed, and include mostly fractures associated with head trauma [6,19-21].

Nasal Fractures

Among facial fractures, the mostly affected site is the nasal bone because of being the most prominent and weakest area of the face. Anterior traumas mainly break the joint between the upper two-thirds part and the lower one-third part of the nose [22]. The classification of nasal fractures by the direction of trauma is shown in Table 1 [23].

Table 1: Classification of nasal fractures.

Nasal fracture type
Frontal type (Nasal fractures caused by anterior blunt force trauma)
Type 1: A fracture that does not extend beyond the line joining the tip of the nasal bones and the anterior nasal spine, and the anterior nasal spine is intact
Type 2: A fracture that is limited to the external nose, and involves diffuse depression of the nose, bending of the nasal bones and extends into the anterior nasal spine
Type 3: A fracture that extend into the skull base and orbital walls
Lateral type (Nasal fractures caused by lateral traumas)
Type 1: A nasal bone fracture at the side of the trauma
Type 2: Besides the fracture at the side of the trauma, displacement of the contralateral nasal bone above or below the maxillary frontal process
Type 3: Multiple fracture fragments and lateral displacement of the entire nasal pyramid

Redness, tenderness, swelling, epistaxis and pain in the nasal bridge as well as nasal deformation can be seen following nasal fractures. Epistaxis is often observed after nasal trauma and stops spontaneously if no major vascular injury is present. Nasal congestion can be caused by clot formed in the passage after hemorrhage, septal deviation and nasal depression fractures. If ethmoid bone or dura mater tears are present CSF leakage and associated rhinorrhea may be observed.

Patients admitted with nasal fractures should be examined carefully. During the inspection, a careful evaluation should be performed for ecchymosis, edema, redness, hematoma and nasal deformity. Changes in the nasal tip and columella should also be evaluated during the inspection. Palpable crepitation, mobilization and tenderness should be considered in favor of fracture.

In patients with nasal bone fracture, anterior rhinoscopy is performed using a nasal speculum, and the passages are evaluated. Presence of septal hematoma requires treatment since infection of the hematoma leads to cartilage destruction and saddle nose deformity [24].

Os nasal and Waters view X-Ray radiographies can be used for radiological assessment, and if head trauma is considered, CT imaging should also be performed. Nasal fracture diagnosis should be made after the patient's clinical findings, physical examination findings and radiological assessment are evaluated in combination.

Nasal fracture treatment can be performed under general or local anesthesia. General anesthesia should be preferred in noncompliant young children, patients with mental retardation and extremely scared older children. The ideal time for fracture reduction is 5-7 days in children. For both general and local anesthesia, topical anesthesia is required for decongestion and to minimize bleeding. Topical anesthetic-impregnated cotton balls should be inserted carefully into the lower, middle and upper meatus. Nerve blockade should be performed using local anesthetics containing 1-2% xylocaine with 1:100000 adrenaline or 0.025 mg of adrenaline and 40mg of lidocaine [22].

During nasal fracture treatment, fracture is elevated using intranasal instruments supporting the nose by bimanual external manipulation to avoid over-elevation. After the procedure, antibiotic-impregnated tampons are inserted into both passages. To provide external fixation, cast, formable metal splines and thermoplastic materials can be used. Only external splints and no nasal tampons should be applied in patients who are considered to have CSF leakage. Open reduction should preferred in cases that haven't healed with closed reduction.

Mandibular Fractures

The second most common facial fracture is mandibular fracture. The mandible moves anteriorly during the development, and the incidence of trauma is increased in older children due to this fact. The mandible consists of the symphysis-parasymphysis, body, ramus, angle, coronoid process, condyle and alveolus. The congenitally weak sites are the third molar area (especially in cases that the third molar tooth was exposed to blunt force), socket of the canine tooth, and the condylar neck.

The inferior alveolar nerve enters the mandibular foramen, passes through the mandibular channel with the artery and vein bearing the same name; the mental foramen is located lateral to the mandible at the level of the second premolar tooth. The inferior alveolar nerve originates from here, being named mental nerve which is the sensitive nerve of the lower jaw and lip. The nerve should be preserved during the plate and screw fixation in mandibular surgery.

In young children, the most commonly broken site following a fall on the jaw is the mandibular condyle [24]. Depending on the presence of a fracture, pain, restriction of opening mouth, malocclusion, tenderness, bone mobility at the fracture site and redness are observed. If fracture is suspected, this should be confirmed by panaromic mandibular and computerized imaging. Stabilization is challenging in children under 2 years since the primary teeth has not been completely grown yet, and an arch bar or splints are used in children between 2 and 5 years of age. In children between 6 and 12 years, extra support is needed for the arch bar because of root resorption, therefore circum-mandibular wiring and oral suspension are used. In those above 13 years of age, using fixation materials is safer [25].

Conic- or bell-shaped primary teeth makes is difficult to apply arch bars and wires. Presence of growing dental buds makes internal mandibular fixation of the mandible difficult in pediatric patients. Therefore, they should be used only in absolute necessity. If indicated, interosseous wires or microplate screws should be carefully used as close a possible to the inferior mandibular border. In pediatric age group, plates and screws should be removed at postoperative weeks 4-5 to avoid adverse effects on growth.

To minimize complications in condylar fractures, the duration of fixation should be 1-2 weeks. In pediatric age group, the best treatment method in condylar and subcondylar fractures is closed reduction. While open reduction and internal fixation is preferred in adult condylar fractures, more conservative methods should be preferred in pediatric cases [26,27]. If the fracture fragments are not displaced, reduction is not needed and fixation is sufficient. In displaced fractures, open or closed reduction is performed. Since morbidity is higher in open reduction, closed reduction should be preferred in non-displaced fractures, in coronoid and condylar fractures, children with growing teeth and fractures without significant separation [22]. Then maxilla mandibular fixation should be performed using elastic bands.

In young children, corpus and angulus fractures are conservatively treated. In older children, rigid fixation is performed to avoid malocclusion and malunion. Plates inserted into the lower edge of the jaw prevent both the teeth that haven't erupted yet and the inferior alveolar nerve from being damaged. In older children, segmental fractures of the alveolar area are more commonly seen. Buch fractures are fixed using an arch bar. If there is a single detached tooth, it is immediately replaced and stabilized using wires placed around it [24].

In displaced symphysis fractures, intraoral incision followed by Open Reduction and Internal Fixation **(ORIF)** is performed if the patient is above 6 years [26]. The most common complications are malocclusion, malunion, nonunion and infection. Late complications are impairment of permanent teeth, dislocation in TMJ, and facial asymmetry associated with midface deformity. Open reduction should be avoided as far as possible because of the risk of arthrosis and growth disorder. It should also be taken into consideration that the condylar head has a very high level of ability for remodeling in children.

Midface Fractures (Maxillary and Zygomatic)

Midface fractures usually occur following a hard blunt force trauma. Early treatment aims to re-establish normal dental occlusion and the normal contours of the face and to prevent infection.

Classification of midface fractures

Transverse maxillary fracture was firstly described by Guerin [28]. Rene Le Fort identified the characteristics of common midface fractures after applying a blunt trauma to a cadaver in 1901. Le Fort classified midface fractures into three groups: [29]

Le fort fractures

Le Fort I Fractures: Unilateral or bilateral fractures described as separation of the palate from the maxillary corpus. The fracture line traverses the nasoseptum at the nasal base, and passes through the lateral piriform aperture, canine fossa and lateral maxillary wall. The traumatic separation occurring in Le Fort I fractures are also called 'floating palate' [29].

Le Fort II Fractures: The most common midface fracture type. The fracture line passes through the nasal bone, lacrimal bone, orbital base and infraorbital edge, traversing the upper part of the maxillary sinus and the pterygoid laminae extending into the pterygopalatine fossa. Since the fragment is mobile, Le Fort II fractures are called 'floating maxilla' [29].

Le Fort III Fractures: Also known as craniofacial separation, this condition is the most severe one of midface fractures. The fracture line passes through the nasofrontal suture, advances through the junction of the frontal bone and ethmoid bone towards the posterior superior orbital fissure, splitting in half. There is usually a high fracture in the pterygoid laminae. These fractures are fragmented and cause a 'dish-face' deformity. Since all facial bones are separated from the cranium, it is also called 'craniofacial separation'.

Non-le fort fractures

Sagittal Maxillary Fractures: is associated with palatoalveolar or fragmented Le Fort fractures. Since the vomer forces the palate to the midline, the fracture typically occurs in the frontline [30].

Medial Maxillary Fractures: These fractures occur as a result of blunt force traumas to the nasal or maxillary medial wall, involving the maxilla and orbita.

Maxillary Sinus Anterior Wall Fractures: These are minor isolated arterior wall fractures, and can be caused by blunt, iatrogenic and penetrant injuries.

These fractures are rare in children and mostly seen in the form of greenstick fractures. Such patients may experience epistaxis, airway obstruction and cerebral injuries. These are parallel to the maxillary sinus aeration and rarely seen in children under 5 years of age. These fractures do not occur in the form of classic Le Fort fractures and include fractures extending from the midline into the cranium. Central nerve system injuries are seen in 40% of patients and cerebrospinal fluid leakage is seen in 14%. Maxillary hypoplasia, aesthetics and functional loss were reported [31]. The main objective in midface fractures is to restore the midface width and height, and to re-establish normal occlusion as well as projection. If the fragments are displaced, surgery is indicated. 3 reference points are needed for view: frontozygomatic suture, infraorbital rim and anterior zygomaticomaxillary buttress. Various incisions are used to access these sites: lateral eyelid incision, infraciliary or transconjunctival lower eyelid incision and transoral buccal sulcus incision [32]. Firstly dental occlusion is re-established, thereafter repair is performed starting from cranial to caudal [33].

Fixation is not preferred in young children since it hinders eruption of teeth and causes maxillary sinus hypoplasia. In older children, projection is re-established through three-dimensional reconstruction and rigid fixation. It is sufficient to use monocortical microscrews to stabilize the teeth that haven't erupted yet.

Zygomatic arch fractures are mostly seen in the form of greenstick fractures. Zygomatic arch fractures result in malar eminence depression and lateral canthus displacement. Mandibular coronoid process is deformed due to the displaced fracture. Closed reduction using the Gillies approach is usually sufficient. The deep temporal fascia prevents the zygomatic branch of the fascial nerve from being damaged during dissection. In older children, fixation is performed at 2 or 3 points. Bone grafting required to enhance the zygomatic contour should be delayed until adulthood [34].

Orbital Rim and Base Fractures

These fractures are rare in children because of insufficient maxillary sinus pneumatization. For such injuries an ophthalmologist should be consulted. These are often associated with orbital rim fractures. The most common cause of impairment of orbital integrity is orbitozygomatic fractures. These fractures often affect the lateral and inferior orbital wall and the rim area. Fractures in this site are treated using lateral orbital wall, transconjunctival or bicoronal incisions [35].

For orbital blow-out fractures, the treatment should be immediately planned since these results in enophthalmia, ophthalmia and diplopia during the early period. Absorbable gelatin films are used to reconstruct the defects on the base. If there are major defects, bone grafts obtained from the calvarium are used [36].

Orbital roof fractures in children are different from those seen in adults. These fractures are more commonly seen in children than in adults because of the absence of frontal sinus pneumatization. If symptoms such as enophthalmos, exophtalmos, and decrease in vision or diplopia are present, they should be treated. Such children should be evaluated jointly by a neurosurgeon, ophthalmologist and otorhinolaryngologist.

Frontal Sinus Fractures

These fractures usually occur following falling from a high place, motor vehicle accident and assault with a hard object. The risk of intracranial injury is very high in such cases. Such injuries occur more frequently than other facial injuries in pediatric age group. The absence of frontal sinus between 5 and 10 years of age increases the frequency of such fractures and causes accompaniment of orbital roof and central nerve system damages. For such patients, a neurosurgeon should be consulted. If a frontal sinus fracture is accompanied by an orbital roof fracture, early or late exophtalmos or encephalocele may develop. Primary bone grafting reduces this risk [37].

Frontal sinus fractures in late childhood period involve the approaches in adults, especially anterior frontal sinus fractures can result in cosmetic deformity. The most common sequelae are mucocele or pyocele development which is accompanied by central nerve system complications. Such fractures can be treated unilateral or bilateral supraorbital incision. In supraorbital incision, supraorbital nerve damage should be taken into consideration. Non-displaced linear fractures can be followed-up. If there is a minor depression on the anterior wall bone, elevation will prevent cosmetic deformity. If there are multiple fracture fragments, these should be reduced and stabilized using wires or microplates [38]. Posterior wall injuries usually include central nerve system injuries. Non-displaced or minimally displaced posterior wall fractures should be monitored very carefully as late complications can develop. In patients with dural leakage, the dura should be repaired by carefully elevating the posterior wall. In such patients, pericranial flap should be laid over the dura then closing the nasofrontal recess and appropriately obliterating the sinus [38].

CONCLUSION

In conclusion, maxillofacial traumas can be seen in pediatric age group and the primary aim here is to maintain the patient's vital functions by ensuring airway safety and cervical stabilization as soon as possible. After this intervention, the effects of trauma on the central nerve system should be evaluated. Diagnosis should be made by using computerized tomography and radiological imaging combined with clinical and physical examination findings. Treatment should be planned after evaluation by a neurosurgeon, plastic surgeon, otorhinolaryngologist and ophthalmologist.

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