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Introduction:

Trauma is the leading cause of death in children. Some children occasionally sustain severe injuries of the face which requires appropriate therapy. Serious maxillofacial injuries with the exception of animal bites occur less frequently in children compared to adults. Treatment issues in children compared to adults is also somewhat different owing to the needs of the growing facial skeleton in children. Whereas absolute reduction of fixation of fractures is indicated in adults, concern for minimal manipulation of the facial skeleton in children is mandated to prevent growth abnormalities. Rigid fixation via well concealed incisions has become routine in adult trauma victims but the use of rigid fixation in children is somewhat controversial. Periosteal stripping can affect bone growth and this paradox arises: the treatment required to accomplish a complete reconstruction may adversely affect growth and development of the face. This may be more prominent in the midface compared to the mandible. Facial fractures in the pediatric age group generally account for about 5% of all facial fractures and this percentage drops considerably in those less than the age of five. Some factors that account for the disparity in the incidence of facial fractures between adults and children include the higher cranial to facial skeleton size, the softer and more elastic bones, protective thick soft tissues, and the lack of pneumatization of the paranasal sinuses in children.

Epidemiology:

Pediatric maxillofacial injuries account for about 5% of all facial injuries suffered. With increasing age, fracture patterns begin to mirror those of adults. Nasal fractures are by far the most common injury suffered but the true frequency is difficult to determine because many of these fractures are treated in the office setting. The most common fractures in children requiring hospitalization and/or surgery generally involves the mandible and in particular the condyle. With maturation, fracture patterns mirror those of adults and fractures of the symphysis, body and angle begin to predominate. Midfacial injuries are rare in children and any one author’s experience with these injuries is quite limited. Midfacial injuries usually require a high impact in order for these bones to fracture. These injuries may be caused by motor vehicle accidents or child abuse. Associated injuries in pediatric maxillofacial trauma victims are common and includes neurologic and orthopedic injuries so these should not be overlooked. Childhood play, motor vehicle accidents and child abuse are common causes of pediatric maxillofacial injuries. A child’s face has protective anatomic features which decreases the incidence of facial fractures. Immature bone has an increased proportion of cancellous bone which leads to an increased incidence of greenstick fractures in children. Also the presence of unerupted teeth in the
mandible also makes the mandible more resistant to fractures. The consequence of this is that equivalent forces applied to the face in an adult compared to a child will cause less trauma to a child’s face as compared to an adult’s.

Facial Growth:

One must appreciate facial development in order to understand the differences between pediatric and adult facial fractures. Eighty percent of cranial growth occurs in the first two years of life and is complete by age seven but facial growth continues into the early twenties such that the craniofacial ratio at birth is 8:1 while this ratio at adulthood varies from two to two and a half to one. In addition, the facial skeleton is shielded by the overhanging skull in infancy. Also the paranasal sinuses are poorly developed in children. These factors account for the higher proportion of upper facial fractures in children compared to lower facial fractures in adults. More orbital roof fractures and intracranial injuries including temporal bone fractures are noted in younger children because of these anatomical considerations. Surgical reconstruction is rarely required in orbital roof injuries but is often needed in orbital floor injuries. The greater cranium to face ratio and lack of frontal sinus development often exposes the orbital roof to injuries in younger children. As the paranasal sinuses develop and facial development progresses, injuries are occur more commonly in the midface and lower orbit. Injuries to certain vulnerable sites in the face may affect facial growth: these include the nasal septum, the multiple suture lines of the midface and mandibular condyle. Even among these growth centers, certain sites are more vulnerable. The mandible with its constant motion and continued adaptation of bone resists facial growth asymmetries more than midfacial injuries which often do not have this dynamic adaptation. However, because there are more mandibular injuries than midfacial injuries, growth disturbances later in life are more often noted in the mandible. Also, certain types of condylar injuries may be more prone to growth disturbances as discussed later.

Examination of the injured child:

Examination of the injured child is more difficult compared to the examination of the injured adult. History taking may be more difficult and it is crucial that the physician establish a patient and compassionate manner when examining the child. Children older than about 4 are reasonably cooperative if spoken to in a calm and gentle fashion. Sedation should be used only as a last resort if crucial information is needed from the physical exam and of course proper airway precautions should be taken to assure safety of the child when giving sedation. In patients with tenuous airways, sedation should be avoided altogether. Lacerations should be evaluated looking for injuries to underlying structures. Gentle palpation should occur over all bony surfaces. Examine mandibular range of motion with fingers in the external auditory canal and have patients open and close their mouths actively. Cranial nerves should be assessed and an ophthalmologic exam should be performed to look for retinal or optic nerve injuries.

Soft-Tissue Injuries:

Facial soft tissue injuries are fairly common in children. As with adults, the wounds should be examined thoroughly for underlying injuries to the parotid duct or facial nerve. If these are identified, they should be repaired as for adults. Scars generally are more noticeable in children due to their exuberant healing and thus these wounds should be closed in layers to prevent scar widening or depression. Anatomic borders should be lined up properly. All foreign material should be removed to prevent traumatic tattooing and local anesthesia should be employed using topical anesthesia and buffered infiltrative anesthesia to decrease pain. Topical anesthesia should be used with caution on mucosal surfaces as the systemic absorption and toxicity of these agents may be increased. TAC is commonly used but because of its cocaine component, toxicity may result when applied to mucosal surfaces.

Auricular hematoma is often the result of childhood play and may result in cauliflower ear deformity if not treated early and properly. An incision should be placed in the natural helical
crease of the ear and the hematoma should be evacuated and dental roll bolsters placed to approximate the perichondrium to cartilage.

Bite wounds should be managed as for adults. Generally wounds may be closed if seen within 6 to 8 hours after injury. Antibiotic coverage and tetanus toxoid should be given if not current. The antibiotics used should cover common oral organisms such as pasteurella. Cleocin may not adequately cover some human oral organisms but augmentin may be a good alternative.

Oral commissure burns are common in children from chewing on electrical cords. These should be treated conservatively initially as the difference between nonviable and viable tissue is difficult to determine. Definitive repair usually involves delayed commissuroplasty. In addition, to prevent oral commissure stenosis, stenting may be used – an artificial silastic appliance may be placed to prevent commissure adhesion and stenosis although Koltai does not recommend this.

Rigid Fixation:

Rigid fixation is a technique used in the management of facial fractures that has developed over the past 20 years. Used primarily in adults for proper restoration of three dimensional form and function, it has become the standard of care for adult facial trauma victims. However use in children is somewhat controversial. Many studies have been performed on infant animals showing that plate fixation across midfacial and cranial sutures lines may result in growth retardation along these suture lines. Since these studies were performed on infant animals with rapid facial growth patterns, it is difficult to draw firm conclusions with regards to human children. But these studies do highlight the fact that rigid fixation should be used cautiously in children and only if other means of reduction and fixation are not achievable. If proper reduction of facial fractures is not achievable by other means, rigid fixation should be performed because the alternative of improper correction is unacceptable. The goal of treatment should be an accurate, functional, aesthetic three dimensional restoration of preinjury form and function. If this requires rigid fixation with plating, then this must be done.

Radiologic Examination:

CT has become commonplace in the imaging of pediatric and adult facial fractures. Axial scanning accurately gives an idea of orbital volume and changes in facial width after orbital and maxillary fractures. Coronal projections add important information in complex nasoethmoid and orbital fractures and these projections also document orbital roof fractures. Coronal projections may be difficult to obtain in an uncooperative child but every attempt should be made to obtain both projections as their combined information gives the most accurate three dimensional assessment of fracture patterns. For mandible fractures, the panorex is the most useful imaging study: again, this requires a cooperative patient in the steady upright position which is not always possible. The Towne’s view which is an AP projection may give information about the condyles and mandibular angles. However plain films in children are generally more difficult to interpret. This is due to the unerupted tooth buds obscuring fractures, the increased incidence of greenstick fractures and the fact that the cortex is underdeveloped leading to difficulty in visualizing fractures. Because of this fact, imaging may require additional CT scanning of the mandible to accurately show all fractures. For nasal fractures, it is very difficult to visualize these fractures in adults on plain film and it is even more difficult in children because of their cartilaginous skeleton.

Nasal Fractures:

Children’s noses differ significantly from those of adults. The soft, compliant cartilages of a child’s nose bend easily during blunt trauma. In addition, the nose does not project as much from the face as compared to adults. These two things combine to lead to a decreased incidence of nasal fractures because impacting forces are dissipated over the entire midface resulting in a broad band of edema without anatomic specificity. Nasal fractures and septal injuries are often overlooked because of this diffuse pattern of injury. If a fracture does occur, it usually affects the septum. The septum may be fractured longitudinally in its anterior position or it may be dislocated from its bony attachments leading to nasal obstruction and long-term growth
disturbances. Initial assessment should include an intranasal evaluation to evaluate for septal hematoma and if discovered should be evacuated under general anesthesia. Most nasal injuries are often re-evaluated in 3 to 4 days after the swelling has subsided when a more accurate assessment of the nasal injury can be made. Most reductions can be performed with closed techniques however if injuries are greater than two weeks old or significant dislocations exist, open techniques are sometimes necessary. Again open techniques should be as conservative as possible with preservation and not resection of cartilage being the main goal.

An interesting situation arises with newborn nasal trauma. Neonates sometimes present with an asymmetric tip deformity with a flattened tip off to one side with the septum lying in the same direction. The bony dorsum is generally straight. Some feel this is caused by birth trauma while others suggest this is caused by prolonged abnormal intrauterine position. Some surgeons do perform immediate surgical reduction by straightening and relocating the septum while others observe these injuries. Most of these nasal injuries do straighten out with time without any surgical intervention. The injuries that do require reduction are often those with complete dislocations of the septum off the nasal spine. Repositioning of the dislocated segment is usually adequate treatment.

Mandible Fractures:

The age-specific growth of the mandible and developing dentition differentiate care of the pediatric mandible fracture from those of adults. Isolated dental and alveolar injuries are common in children. These injuries are rarely accounted for since these injuries are treated in the outpatient setting. The canines and/or incisors are usually avulsed because of their anterior dental location. This is generally considered a dental emergency. Deciduous teeth do not need to be replaced into the socket while secondary teeth should be replaced within one hour. During the period of mixed dentition between the ages of 6 to 12, all teeth should be replaced because it is not known whether a tooth is a secondary tooth. Alveolar fractures should be treated with arch bars placed above or below the tooth roots and patients should be instructed on a soft diet. Some recommend treatment of alveolar fractures longer than the customary period of three weeks of fixation.

For mandibular fractures, intermaxillary fixation should be used cautiously as bony ankylosis and trismus may develop. Adequate immobilization of mandible fractures is often difficult before the age of two because of the lack of deciduous teeth but later growth and remodeling frequently compensates for a less than ideal postinjury alignment. Deciduous teeth have firm roots between the ages of 2 to 5 when arch bars may be placed but during the period of resorption from the ages of 6 to 12, arch bars may need extra support from circummandibular wiring and pyriform aperture suspension. In particular between the ages of 5 through 8, the deciduous molars can be used for immobilization while the anterior teeth are in various stages of replacement. The high osteogenic potential of the pediatric mandible allows nonsurgical management to be successful in an increased proportion of younger patients. This high osteogenic potential allows rapid union within three weeks. Nonunion or fibrous union is almost never seen in pediatric patients. These factors allow for a much greater potential to remodel imperfectly reduced fractures. This is accomplished by alveolar bone growth at the time of eruption of the permanent teeth. Generally younger children with mandible fractures tend to sustain more severe associated injuries compared to adults. Also, children tend to have one fracture of the mandible compared to adults who often have more than one fracture.

Physical exam of the mandible should evaluate the mandibular range of motion, open bite or occlusal deformity and any other associated injuries. Generally the condyle is the site most commonly injured in pediatric mandible fractures due to the large amount of medullary bone surrounded a thin rim of cortex. The three types of condylar fractures include intracapsular crush fractures of the condylar head and high condylar fractures through the neck above the sigmoid notch. The third type, which is the most common is a lower subcondylar fracture associated with a greenstick fracture. Treatment of these injuries is usually with a soft diet. Those with open bites or limitation of mandibular motion should be treated with 3 weeks of immobilization followed by guiding elastics which results in normal function. It is important to note that the incidence of growth disturbance is most influenced by the type of condylar fracture. For crushing intracapsular
fractures which are often suffered in early childhood, these injuries usually result in more growth disturbances than the greenstick fractures suffered in older children. For parasymphyseal and symphseal fractures, treatment can include open reduction with internal fixation. The risk of injury to tooth buds and the remodeling potential from subsequent mandibular growth often mandates a relatively conservative approach. Young children may require an acrylic splint held in place by a circummandibular wire. Some very complex injuries even in the youngest children require bone to bone approximation. This would involve standard plating and fixation techniques. When using either plates or screws in these complex cases, care must be taken to avoid unerupted tooth buds. The trauma often required to produce symphseal or parasymphseal fractures often results in serious neurocranial or other orthopedic injuries so these should not be overlooked. Body and angle fractures tend to be incomplete with patients retaining good occlusion and thus conservative treatment or intermaxillary fixation is all that is needed in these circumstances.

Orbital and Nasoethmoid fractures:

The orbit and nasoethmoid components of the face constitute important functional and aesthetic units of the face. The severity of injuries in this area may vary from minor fractures to complex fractures involving orbital-zygomatico-malar complexes. If these injuries are not properly reduced and fixed, severe functional and aesthetic consequences may result. CT scanning and physical exam are needed to accurately reveal the extent of these fractures. Ophthalmologic evaluation is essential before planning treatment. As stated previously, zygomatico-maxillary complex fractures are uncommon in children because of the lack of pneumatization of the paranasal sinuses, the soft elastic bone and the shielding from overlying cranium. With zmc fractures in younger children, these injuries are most likely due to very high impact forces and are often associated with other neurocranial injuries. Commination is also uncommon in zmc fractures in children and thus reduction and stabilization is often easier to achieve compared to adults. Surgical correction and reduction proceeds as with adults with three point reduction at the frontozygomatic suture, zygoma and anterior buttresses. Extensive periosteal stripping should be avoided to prevent later midfacial growth abnormalities. Orbital rim fractures are rare in children because of the relative lack of pneumatization of the frontal sinus and lack of orbital development compared to cranial development. Before age 7, the large cranium is exposed to trauma more commonly than the smaller face. When struck about the supraorbital rim, the pressure is transmitted to the orbital roof which can fracture. But as the frontal sinus pneumatizes into the superior orbital rim, this prevents the direct transmission of force from the superior orbital rim to the roof and thus roof fractures become less common. Instead frontal sinus fractures predominate. These orbital roof injuries are considered skull fractures and as such have an increased incidence of neurocranial injuries. Generally these injuries do not require repair unless a significant of the orbital roof is missing in which case intracranial pulsations may be transmitted to the orbital cavity. Other indications for repair occur when the orbital contents are pushed in by multiple fracture segments leading to an orbital blow-in fracture. Orbital roof injuries may be suggested by a history of a blow to the brow and late periorbital ecchymoses. Orbital floor and rim injuries are rarer than orbital roof fractures in children depending on the age because the impact is dissipated to the orbital roof. These injuries parallel the development of the paranasal sinuses and unfolding of the face from underneath the skull. Treatment is often needed in these injuries to prevent enophthalmos, diplopia and entrapment of the extraocular muscles. The varied pattern of orbital fractures is best understood by the location, direction and magnitude of the force of injury. In children, the changing geometry between the cranium and the face influences the location where the orbit is likely to be struck.

Conclusion:

Pediatric maxillofacial trauma is an uncommon occurrence but proper knowledge and treatment of these injuries leads to an often expected good recovery from injury with the reestablishment of pretrauma form and function.