Paticularies in pediatric facial fracture in children

Soft – tissue injuries and lacerations account for the majority of facial trauma in children. Common mechanisms of facial injury in children include falls, sport related injuries,assaults and motor vechicle accidents. Children account for approximately 15% of all facial fractures, with children younger than 5 years comprising only 5% of this total. The majority of facial fracture in children ocuur in teenagers, with a 2,5:1 male predominance.

The low prevalence of facial fractures in children is multifactorial. The face of children is relatively small compared with the head and thus the most fractures in young children tend to involve the upper face and scull. In addition, the face is mich stronger because the sinus cavities aare poorly developed aand the proportion of cancellous to cortical bone is greater, providing more elasticity. Young children are also afforded some protection by fat pad, particularly the buccal fad pad in the malar region.

Managing pediatric facial fractures is often difficult, because the goal of obtaining the best possible reduction and fixation must be balanced with potential growth disturbances associated with open surgical approaches to the pediatric facial skeleton. Evidence for facial growth restriction after wide subperiosteal dissection has been reported; however, other authors have reported no growth disturbances after wide undermining of the frontoorbital region, such as from the treatment of craniosynostosis.

Different areas within the facial skeleton demonstrate different healing properties. In a growing child, the condyles of the mandible have an excellent ability to remodel, and therefore a conservative approach often may be taken with pediatric condylar fractures. It is often prudent to accept minor occlusal disturbances in a growing child while attempting to treat fractures conservatively, because these may be corrected with future orthodontic treatment. Other areas, such as the orbit, may not tolerate malunion so well and therefore may require adequate exposure for internal fixation. It is imperative that surgeons communicate clearly to parents the potential risks of growth disturbances that the fracture itself may impose, along with its surgical correction. In addition, there is an increased risk to unerupted and developing tooth buds in pediatric jaws. Communication helps parents understand the need for long-term follow-up.

The pediatric facial skeleton is a dynamic, evolving structure and the face of a 1-year-old is very different from that of a teenager. What begins as a vertically short, wide, and resilient mass matures into an elongated, projecting, and less resilient structure. These facial changes, coupled with the decreasing elasticity secondary to increased mineralization of the facial skeleton, lead to differing patterns of injury as the child ages. Although increasing skeletal mineralization and hardening continue throughout life, most experienced craniofacial surgeons agree that the brittleness of facial bones increases dramatically after the age of 2 to 3 years. Seemingly equivalent traumatic force in the child and adult creates injuries in the child with less comminution.

The development of paranasal sinuses also greatly affects the pattern of fracture in the pediatric population. Maxillary sinus aeration begins after birth and is completed, reaching the nasal floor, by approximately 12 years of age. Frontal sinus aeration is not evident until age 4 to 5 and is completed in late adolescence. Sinus development and eruption of permanent dentition contribute to the evolution of an immature, solid mass into a pillared, hollow structure. Before these changes, the typical pattern of Le Fort fractures rarely occurs; more commonly fractures follow oblique patterns. Furthermore, Messinger et al. have described the unique patterns of supraorbital fractures before the development of the frontal sinuses. Thus, as sinus aeration and permanent dentition develop, there is a progression to-ward a more adult-type pattern of fracture.

A high tooth-to-bone ratio exists in the pediatric bone. Fractures frequently occur through developing tooth crypts. Teeth in the line of fracture may develop with malformations. Teeth begin to erupt at age 6 months, and the full complement of 20 primary teeth is erupted completely at about age 2 years. These teeth are relatively stable until age 6 years when root resorption begins to occur, which causes the teeth to loosen. Permanent dentition erupts, beginning with the first molars and central incisors, at ages 6-7 years. The second molars erupt at age 12 years.

The mixed dentition in the pediatric patient presents a unique challenge in the management of maxillofacial fractures. Primary teeth and partially erupted secondary teeth are not a stable foundation for arch bars or similar techniques utilized for intermaxillary fixation (IMF) in adults. Because of the conical shape of the teeth, it is often difficult or impossible to place the wires required for fixation. In addition, primary teeth can be avulsed by the pressure exerted in IMF. Intermaxillary fixation can best be obtained through the use of occlusal splints, fashioned in the operating room, and secured with circummandibular or pyriform aperture wires . If arch bars are used in the young mouth, circummandibular or pyriform aperture wires securing the arch bars may decrease the chance of tooth displacement.

In the infant and throughout childhood, the mandible and maxilla are filled with tooth buds in various stages of eruption Therefore, injuries to this region can result in the maldevelop-ment of permanent dentition. Extreme care must be taken to avoid further injury by limiting debridement and manipulation. Tooth buds in the fracture line should not be discarded but should instead be carefully preserved. Finally, if internal stabilization is needed, one must take great care to avoid placement of wires or screws near or through developing teeth.

Despite these concerns, the pediatric dentition does offer the reconstructive surgeon one advantage. Minor occlusal discrepancies may be accepted because of the potential for orthodontic remodeling with growth.

Understanding the centers of growth and the development of the craniofacial skeleton is crucial to one's ability to treat pediatric craniofacial trauma. Within the craniofacial skeleton there are significant regional differences in growth patterns.

At birth, the cranial/facial proportion is 8:1. This ratio becomes 4:1 at around 5 years of age and 2:1 in adulthood. The growth of the neurocra-nium is 25% accomplished at birth, becoming 75% accomplished at 2 years, and 95% by 10 years of age. By comparison, facial growth is only 65% complete at 10 years. Cranial growth is a continuous process that occurs in a defined period of time and is essentially dictated by brain expansion and somewhat influenced by the cranial sutures. The brain's volume triples by the end of the first year of life. The sutures gradually narrow, and the fontanelles are closed in sequence. This rapid growth occurs until 3 years of age and then dissipates into adulthood.

In contrast, facial growth demonstrates a drastically different pattern of discontinuous growth until puberty is complete. Multiple mechanisms such as the synchondroses, the sutures, and apposition-résorption all play roles in this process. At 3 months of age the facial dimensions are 40% of those in adults, and they become 70% by 4 years and 80% by 5 years of age.[10] At approximately 5 years, growth slows dramatically until the beginning of puberty, at which point ac-celerated growth occurs from the increased secretion of hormones. At 17 years, the facial growth slows down again and eventually halts. Upper facial skeletal growth occurs secondarily to cerebral and ocular growth. Orbital expansion is complete by 6 to 8 years of age; the frontal sinus becomes visible by 5 years and obtains complete aeration well after puberty. Midfacial growth is associated with dental development. By 2 years, transverse maxillary growth is near complete, whereas palatal and midline maxillary suture growth finishes between 8 and 12 years. At 12 years of age, pneumatization of the maxillary sinus occurs along with dental eruption. Lower facial growth also exhibits sequential growth. The mandibular symphysis fuses completely by 2 years when the deciduous teeth are erupting. The primary growth centers of the mandible are thought to be the condyles, and they contribute to the vertical growth, activated by muscular activities. These activities place stress on the periosteum, which, in turn, causes apposition and resorption of bone, creating mandibular growth in all other directions.

During the first years of life, the size and proportions of the facial skeleton change markedly. The facial skeleton increases in relation to the rest of the head, and the sinuses and dentition develop postnatally. The mandible is relatively small at birth and grows by remodeling. The eruption of teeth and the development of the alveolar process also contribute to vertical growth. Apposition of bone at other surfaces causes the bone to develop a more adult shape. Thus, the mandible assumes a more forward position and a longer shape. The condylar growth centers are crucial in mandibular development. Each center consists of chondrogenic, cartilaginous, and osseous zones. A thin vascular layer covers the chondrogenic zone. Bone is deposited at the posterior borders of the rami and condyles. Trauma to the growth center just beneath the articular disk is cause for concern. Delayed growth on the affected side can cause facial asymmetry, mandibular deviation, and malocclusion.

Because the young patient has a high ratio of cancellous to cortical bone, child's bones are much more pliable and a thick layer of soft tissue covering, “greenstick” and "egg-shell" type are common. A "greenstick fracture" means that one side of the fracture has broken and one side is bent; therefore it is classified as an incomplete break. The name for a greenstick fracture comes from the analogy of breaking a young, fresh tree branch. The broken branch snaps on one side (the outer side of the bend), while the inner side is bent, and still in continuity. Most often the greenstick fracture must be bent back into the proper position (called a "reduction") and then casted for about six weeks. Greenstick fractures can take a long time to heal because they tend to occur in the middle, slower growing parts of bone.

The pediatric mixed dentition represents a unique challenge to the reconstructive surgeon. Not only does it impose limitations on the method of fixation used, but it must also be taken into account that injury to primary teeth or the surrounding bone and soft-tissue matrix may lead to future abnormalities of the teeth in succession. The immature, pediatric skeleton presents two other unique challenges to the reconstructive surgeon. First, because of the rapid healing of the pediatric skeleton, fractures must be treated sooner than in adults, preferably within 3 to 4 days. Later reduction can be difficult, if not nearly impossible. Second, consideration must be given to the effects injury and its treatment may have on subsequent facial growth. Unfortunately, despite appropriate treatment at the time of injury, disruption of normal development can occur. Ousterhout and Vargervik presented several patients in whom midfacial fractures resulted in halted development and midfacial hypoplasia. Rapid healing occurs in pediatric bone, and the best reduction is obtained within 5 days. However, if callus is already formed, a slight discrepancy in primary occlusion is acceptable. Some degree of functional remodeling can be anticipated.

The youngest patients are unable to provide a history, and slightly older children are limited by descriptive ability, fear of the situation leading to the trauma, as well as anxiety in the hospital setting. The patient may report pain in the jaw region, particularly upon movement. Minor displacement leads to noticeable changes in occlusion. Ask patients whether their bite feels normal.

DIAGNOSIS

Diagnosis of pediatric facial fractures is usually challenging. One must maintain a high degree of suspicion, especially in the presence of other major organ system injuries. It is not unusual to have a patient who is unable to cooperate accompanied by anxious parents in the emergency department, which may necessitate sedated examination when safely possible. A history must be carefully obtained from both the parents and any witnesses of the incident, along with emergency medical support personnel. Preinjury photographs of the child, dental records, and models from the child's dentist and orthodontist are often helpful for treating children with facial fractures.

Plastic surgeons must work closely with the physician team to coordinate the care of a child with multiple injuries, following Advanced Trauma Life Support protocol. Especially important is the examination of the cervical spine in children with trauma. There is a reported 10% associated risk of concomitant craniofacial trauma and cervical spine injury.

Examination of a craniofacial trauma patient should begin by observing the overall condition of the patient. Alertness and orientation should be carefully documented. A low threshold should be maintained for neurosurgical consultation in children with craniofacial trauma, because 75% of frontal sinus fractures are accompanied by loss of consciousness. The airway should be thoroughly evaluated. Endotracheal intubation in these patients is uniquely challenging because cervical spine clearance is often not entirely possible, and may be additionally complicated by mandible or midface fractures. Pediatric anesthesia support for nasal intubation over a flexible endoscope may be performed with limited cervical spine motion, and may be the best way to establish a nonsurgical airway If all else fails, tracheostomy or cricothyrotomy can be used.

Physical examination begins with the head. Careful palpation of the skull should be carried out after adequate cleansing of any scalp wounds, and this may require local anesthesia. Any scalp lacerations must be washed out and carefully examined for underlying skull fracture. Next, attention is given to the superior orbital ridge. Fractures in this region can often cause paresthesia of the forehead and may be associated with traumatic ptosis of the brow. It is important to realize that in young patients without a frontal sinus, forehead and supraorbital ridge fractures are essentially anterior cranial base fractures.

Orbital examination is extremely important because there is a significantly higher percentage of ocular trauma and blinding injuries in this population compared with adults. Studies have reported as high as a 3% blindness rate in children with orbital fractures. Consultation with a pediatric ophthalmologist should always be obtained when children present with periorbital trauma. Subconjunctival hematomas are pathognomonic for orbital fractures, because the conjunctiva is contiguous with the orbital periosteum; therefore patients with these conditions must be assumed to have an orbital fracture until a CT scan is obtained. Bilateral vision should be carefully documented; and when possible, evidence of afferent papillary defects is made. Extraocular movements should be tested voluntarily in conscious patients, and forced duction testing should be performed with unconscious patients and all patients undergoing surgery. If total ophthalmoplegia is found, along with upper eyelid ptosis and paresthesia in the VI distribution, this indicates the presence of superior orbital fissure syndrome. If blindness is present in addition to these findings, then orbital apex syndrome is diagnosed. Both these conditions are ophthalmologic emergencies that may require urgent surgical decompression and high-dose steroid therapy. The medial canthal tendons should be tested in patients with periorbital trauma, and this is done using the bowstring test. The bowstring test is performed by pinching the eyelids and distracting them laterally to check the stability or mobility of the medial canthus. Intercanthal distance should be measured and documented. Any periorbital lacerations medial to the lacrimal puncta indicate potential damage to the lacrimal drainage system.

Examination of the nose begins with the nasal root and continues caudally. Deviation of nasal bones should be evaluated, as well as compressibility of the nasal dorsum. Any rhinorrhea or nasal discharge should raise suspicion for cerebrospinal fluid (CSF) leak, therefore prompting CT scan imaging and consultation with the neurosurgical staff. A thorough intranasal examination should be carried out using a nasal speculum and an adequate light source, and any septal hematomas should be treated promptly.

Examination of the midface begins with the inferior orbital rims. Fractures in this region are often associated with cheek paresthesia and a step deformity that can be felt with manual palpation. The entire zygoma should be palpated. Fractures of the zygoma often result in lateral canthal dystopia and loss of malar prominence. Midface stability should be tested by attempting manual distraction of the maxilla while stabilizing the head; any independent movement of the maxilla may indicate a midface fracture. However, if the patient has an obviously mobile midface, one should refrain from manipulating it more, because this may cause optic nerve trauma. Occlusion is also an important diagnostic tool when evaluating the midface, because abnormal occlusal findings should prompt further radiologic studies. While examining the midface, attention should also be given to the ears. Hemotympanum, as well as mastoid hematoma (Battle's sign), may indicate a basilar skull fracture. External trauma, including subperichondrial hematomas, require prompt treatment.

Lower craniofacial skeleton examination begins with the mandible, obtaining the patient's own subjective assessment of occlusion whenever possible. Subjective malocclusion is a highly sensitive indicator of occlusal disorders. Objectively, malalignment of the dental arch and open bites are indicative of jaw fractures; however, patients with mixed dentition often have such preexisting malocclusions, normal for their development. Angle's classification should be used to document findings, and any evidence of malocclusion should prompt obtaining a panoramic film and/or a CT scan. Chin paresthesia is found often in patients with parasymphy-seal fractures. Palpation of the mandible starts at the temporal-mandibular joint and ends at the symphysis. A high index of suspicion must always be maintained with children, because pain during palpation is often the only indicator of facial fractures.

Diagnostic imaging for evaluating pediatric facial fractures has evolved over time. Sophisticated algorithms employed by computed tomography have become invaluable, and plain radiography currently has a limited role, because the pediatric facial skeleton is immature, and the pediatric skeleton has a high cancellous-to-cortical bone ratio. Fine-cut CT scans from skull to mandible should be used whenever possible. True coronal images are ideal, although if unable to clear the cervical spine, reconstructed coronal images, based on the fine-cut axial CT scan, can often suffice. Three-dimensional reconstructions of fine-cut CT scans are exceedingly useful for diagnosing fractures as well as for treatment planning. Of note, the Panorex is the single plain film that remains useful for evaluating pediatric patients who are able to cooperate for the study.

Clinical

Do not neglect a complete trauma evaluation. Children with mandibular fractures are at risk for airway compromise because of the direct trauma, swelling, or hematoma that causes obstruction or impaired consciousness. Often, airway management may be accomplished with positioning. However, presume cervical spine injuries until excluded. Suction the oropharynx of debris and blood as necessary.

Fractures of the mandibular arch may allow a bony segment to be displaced posteriorly. Manual traction or a traction stitch on the tongue may alleviate airway obstruction. If necessary, orotracheal intubation is usually possible and preferable to an emergent surgical airway. Quickly accomplish control of hemorrhage because the blood volume in the child is small. Perform a thorough trauma physical examination.

Young patients are more difficult to examine. Inspect the face first and note obvious asymmetry. Swelling and ecchymosis of the face, especially the preauricular areas, may be clues to underlying fractures. A chin laceration on the young child usually indicates a superiorly directed midline force, which often results in condylar damage. Examination of the jaw during mouth opening and closing may reveal deviation of the jaw or limited mobility. Trismus may also be evident after a mandibular fracture and is commonly due to muscle spasm and pain. However, restriction of jaw motion may be secondary to a displaced zygomatic fracture impinging on the coronoid process of the mandible.

Intraoral examination may reveal lacerations or hematomas. If bone is exposed through an intraoral or cutaneous laceration, antibiotics are indicated. Penicillin covers most mouth flora. A first-generation cephalosporin covers most skin flora. Examination of teeth for injury also is important. Rapid treatment of dental injuries, especially of the permanent dentition, is essential. Examination of the ear may also be rewarding. Fractures of the condyle can cause bleeding or ecchymosis of the anterior wall of the external auditory canal.

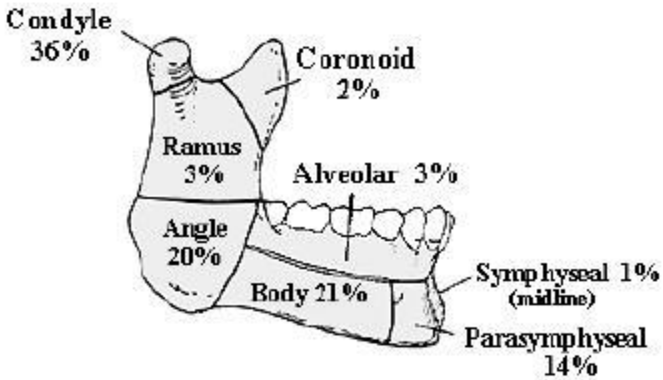
Next, perform orderly palpation of the facial skeleton. Step-offs and instability may be apparent. Bimanual examination of the mandible may be helpful. Palpation in the auditory canal during movement of the jaw may reveal crepitation or evidence of a displaced condylar head.

A fracture of the body of the mandible may affect the inferior alveolar nerve, leading to numbness of the teeth or chin. Displaced fractures may also affect the lingual nerve, which innervates the anterior two thirds of the tongue, or they may affect the long buccal nerve, which supplies sensation to the cheek mucosa and corner of the lip.

Assessment of occlusion is more difficult in the child than in the adult. Children often do not have a full complement of teeth. Knowledge of pretraumatic occlusal status is important in evaluation and treatment. In adults, wear facets are useful, particularly when other serious injuries are present. In children, dental wear may not be apparent.

Associated injuries

Mandibular fractures carry the highest rate of associated injuries in pediatric patients with facial fractures. In Kaban's 1977 series, 22 of 29 pediatric patients with mandibular fractures had other injuries, mostly confined to the head and face, which included 1 cervical spine injury. In 1992, Thoren reported associated midface fractures in 8% of patients, most of these in patients aged 13-15 years. Skull fracture or cerebral injury occurred in 13% of patients, and orthopedic injuries occurred in 8%.



- **MANDIBULAR INJURY:**
  A. Evaluation:
- After the nose and zygoma, the mandible is the third most likely bone in the face to fracture. Mandibular condylar fractures account for 60% of all mandibular fractures in children. Mandibular fractures in children often occur through developing tooth crypts. Fractures of the mandible are usually associated with tearing of the gingival tissue – and hematomas on the buccal and lingual sides of the intraoral aspect of the mandible.

- First, examine the patient's face for swelling and asymmetry. Palpate the borders of the mandible to find any sharp irregularities – which would indicate a mandibular fracture. Palpation of the external auditory canal during jaw movement may reveal a condylar fracture. A chin laceration in a young child may indicate that the force may have damaged the condyles. Restricted jaw motion can indicate either a condylar fracture, or a displaced zygomatic fracture impinging on the coronoid process of the mandible. Before performing an intraoral examination, assess the sensitivity in the distribution of the mental nerve using a cotton swab with the patient's eyes closed – comparing one side to the other.

- Next, palpate the tooth-bearing regions of the mandible (the alveolus), using two gloved hands for comparison. The patient should also be asked to bite together to assess the dental occlusion.

  B. Imaging and radiology:
- The mandibular series and panoramic projections are useful for visualizing mandibular fractures. The standard mandibular series includes four projections: posteroanterior (PA), Towne's, and left and right lateral oblique. The occlusal view demonstrates a symphysis

fracture. The panorex is the radiograph of choice for mandibular fractures, but plain radiographs are often easier to obtain in a hospital setting.

- The PA view is obtained with the patient lying prone.

- The Towne occipitofrontal view (an AP view) demonstrates condylar fractures very well. It is an AP projection created by having the patient lay supine. For this view, the x-ray beam is directed 35 degrees caudad through the frontal bone. In the resulting image, the patient's head appears to be very elongated.

- The lateral oblique views are best suited for viewing fractures of the condylar process, coronoid process, body, ramus, and angle of the mandible. For this projection, the x-ray beam is directed 20 degrees cephalad to the occlusal plane, and towards the center of the x-ray cassette.

C. Emergency care:

- In patients with bilateral condylar fractures, the mandible will be displaced posteriorly, which occasionally results in airway compromise. Prophylactic antibiotics (penicillin G or penicillin VK) should be started as soon as possible when there is a mandibular fracture – to protect the wounds from intraoral bacterial contamination. Clindamycin can be used for patients who are allergic to penicillin.

D. Definitive care:

- Surgical treatment and fixation of mandibular fractures must restore occlusion, function, and facial harmony. Surgery is not indicated in most pediatric condylar fractures, however. Most pediatric patients with condylar fractures may be treated non-operatively. For greenstick and nondisplaced fractures of the mandible, management is limited to analgesics and a soft diet. Range of motion excercises should be encouraged after the initial edema has subsided.

- Jaw immobilization is required when there is a bilateral condylar fracture, or a severe limitation or deviation of movement. If immobilization is necessary, 2-3 weeks are usually adequate in children, followed by 6-8 weeks use of guiding elastics.

Some caveats for closed reduction

- Fractures in children involving the developing dentition: Such fractures are difficult to manage by open reduction because of the possibility of damage to the tooth buds or partially erupted teeth. A special concern in children is trauma to the mandibular condyle. The condyle is the growth center of the mandible, and trauma to this area can retard growth and cause facial asymmetry. Early mobilization (7-10 d of intermaxillary fixation) of the condyle is important. If open reduction is necessary because of severe displacement of the fracture, the use of resorbable fixation or wires along the most inferior border of the mandible may be indicated.
- Coronoid fractures: These fractures usually require no treatment unless impingement on the zygomatic arch is present.

Some caveats for open reduction

Condylar fractures: Although strong evidence supporting open reduction of condylar fractures is lacking, a specific group of individuals benefit from surgical intervention. Careful evaluation of each case on an individual basis is crucial.

- Absolute indications
  1. Displacement of the condyle into the middle cranial fossa
  2. Inability to obtain adequate occlusion by closed techniques
  3. Lateral extracapsular dislocation of the condyle
- Relative indications
  1. Bilateral condylar fractures in an edentulous patient when splints are unavailable or impossible because of severe ridge atrophy
  2. Unilateral or bilateral condylar fractures when splinting is not recommended because of concomitant medical conditions or when physiotherapy is not possible
  3. Bilateral fractures associated with comminuted midfacial fractures

Management of mandibular fractures

The general principles of the management of maxillofacial trauma are similar in both children and adults, but the ongoing developmental changes in the growing face of a child must be taken into consideration.

Adequate treatment of mandibular fractures should accomplish several goals. Restoration of occlusion, function, and facial balance is necessary for therapy to be considered successful. Proper treatment may prevent complications such as growth disturbance and infection. The specific treatment of mandibular fractures depends on location of the fracture, degree of bony displacement, occlusal status, and dentition status of the child. Methods of fixation vary by dental status.

Before age 2 years, the deciduous teeth are not completely erupted. Children at this stage of development are treated as though edentulous. An acrylic splint may be fixed in place with circummandibular wires. If immobilization of the jaw is necessary, the splint may be fixed to both occlusive surfaces with both circummandibular wires and wires through the pyriform aperture.

Once deciduous teeth are established, at about ages 2-5 years, they may be used for fixation. Although the deciduous teeth are conically shaped (rather than having a cervical waist), interdental wiring may be used. Arch bars are somewhat more difficult to secure below the gum line. Redundant support may be necessary. Mini-arch bars attached with resin may be used to treat nondisplaced fractures, again avoiding immobilization of the mandible.

A state of mixed dentition exists in children aged 6-12 years. During this period, dental stability is more precarious. Primary tooth roots are resorbing. Teeth often are loose or absent. In children aged 5-8 years, deciduous molars may be used for fixation. In children aged 7-11 years, the primary molars and incisors can be used to anchor fixation. When adequate dentition is not available for fixation, Gunning splints may be used as in the younger patient. In children older than 9-12 years, standard intermaxillary fixation (IMF) with arch bars is possible because enough permanent dentition has been established. Braces may also be used briefly for fixation.

Rapid healing and the possibility of remodeling decrease the duration of immobilization necessary in the pediatric patient. Most studies report 2-3 weeks to be adequate, although a few recommend longer treatment. The rapidity of healing also dictates that management of the fractures should occur early. If treatment is delayed, removal of callus formed at the fracture site often is necessary.

If open reduction and fixation (OR&F) is required, use an intraoral approach, where possible. Place monocortical screws at the inferior border of the mandible to avoid damaging the underlying teeth. The open surgical approach to the condyle is through submandibular or preauricular approach, depending on location of fracture.

Eppley (2005) reported the use of resorbable polylactic and polyglycolic acid plates and screws in 14 patients with displaced fractures of the symphysis, parasymphysis, body, and ramus. Patients underwent open reduction and either 1.5-mm or 2.0-mm plate and screw fixation with no long-term implant-related complications.

Condylar fractures

In 1952, MacLennan reported a series of mandibular condyle fractures. Approximately 6% of these fractures occurred in children younger than 15 years. Less than 3% of condylar fractures were in children younger than 10 years.

Condylar fractures are classified into 3 groups. Intracapsular fractures involve the articular surface. High condylar fractures occur above the sigmoid notch and usually are medially dislocated by the force of the impact. Low subcondylar fractures usually are greenstick fractures in children and are the most common type of pediatric mandibular fracture overall.

However, in children younger than 5 years, crush injuries to the articular disk are more common. In the very young child (<3 y), the condylar neck is short and thick, and the force of trauma generally dissipates on the articular surface. Injuries to the articular surface may cause hemarthrosis and subsequent bony ankylosis. Early range of motion is important in preventing this complication. Injury to the cartilage also affects the growth of the mandible. In children older than 5 years, neck fractures are more common and are regarded as relatively self-correcting.

In contrast to adult patients, the vast majority of pediatric patients with condylar fractures may be treated nonoperatively. Usually, these patients have normal occlusion and range of motion. Early treatment includes analgesics and a soft diet. Encourage range of motion exercise once edema has subsided. Conservatively manage comminuted fractures of the head and condyle. In the edentulous child, no immobilization is required; in other patients, place IMF for 2 weeks. Even if displaced, the fracture typically heals well. Studies have demonstrated the ability of the condyle to remodel.

Indications for jaw immobilization are bilateral fractures with an open bite or severe movement limitation or deviation. Generally, the period of immobilization is 2-3 weeks followed by a period of 6-8 weeks of guiding elastics to counteract the force of the masseter-pterygoid sling, which pulls the inferior border of the mandible superiorly and tends to shorten the ramus.

Open reduction is indicated in a few situations as follows: (1) dislocation of the mandibular condyle into the middle cranial fossa, (2) condyle prohibiting mandibular movement, and (3) bilateral condylar fractures causing reduced rami height and open bite (although some advocate immobilization alone).

Dentoalveolar fractures

Dentoalveolar fractures are relatively common. Replacement of primary teeth is unnecessary; however, replacement may provide space maintenance until permanent dentition erupts. Permanent teeth should be replaced within 2 hours. Prior to dental attention, the tooth should be returned to the socket and held in place lightly. If this is not possible, the tooth may be transported in saline or milk. If the fracture fragment is large, reposition it, and place the patient in IMF. In 1993, Tanaka reported that 5 of 21 patients treated in this manner had resultant malocclusion; therefore, he recommended that a longer than 2- to 3-week period of fixation be considered. If the alveolus fragment is large, plate-screw fixation may be used, if this is possible without injuring the teeth.

In the literature discussing the effects of fractures on mandibular growth, a dichotomy exists between reports of nearly perfect healing of conservatively managed displaced condylar fractures and reports of severe growth disturbances or ankylosis. Some of this discrepancy may be explained by differences in the types of injuries sustained at various stages of development. The anatomic area of greatest concern is the condylar growth center.

In 1956, MacLennan proclaimed that children younger than 5 years are more susceptible to growth changes. These changes decrease directly with age. Children younger than 5 years are more likely to sustain injuries to the articular cartilage. Similarly, Rowe reported in 1969 that injuries to children younger than 3 years produce severe deformities, injuries to children aged 3-6 years result in moderate deformities, and injuries to teenagers heal in a similar fashion to adults.

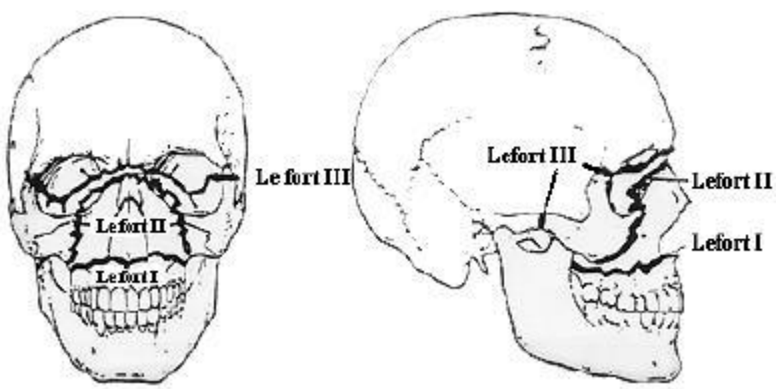
In 1971, Leake reported on long-term follow-up of pediatric mandibular condyle fractures. Leake concluded that if occlusion is normal after swelling has resolved, early motion is associated with excellent results and avoids potential complications of fixation. In 13 patients followed up at 2 months to 17 years, no abnormalities of range of motion, deviation, open bite, crossbite, overbite, retrusion, pain, or clicking were noted. Even in initially displaced fractures, eventual repositioning was documented radiographically. These patients ranged in age from 2.5-12 years at the time of injury, with an average age of younger than 6 years.

In 1993, Norholt reported that the dysfunction resulting from condylar fractures increased with increasing age at the time of trauma; however, the patients were aged 5-20 years at the time of the mandibular fracture. Radiologic abnormalities were commonly found but did not correlate with the severity or presence of clinical abnormality. None of the 55 patients whose cases were followed developed ankylosis or serious asymmetry.

McGuirt's 1987 follow-up study of patients after childhood mandibular fractures revealed abnormalities of occlusion and dentition in 35% of patients, including avulsed teeth, nonvital pulps, and hypoplastic teeth; up to two thirds of patients had radiographic abnormalities, and about a fifth had multiple radiographic abnormalities. Sixteen percent had clinical abnormalities. Based on these results, McGuirt recommends 6-8 weeks of guiding elastics after immobilization (to help pull the jaw forward), pterygoid muscle exercises, and long-term follow-up.

The cause(s) of growth disturbances remains unclear. Resultant abnormalities may be due to the loss of the growth stimulus or the mechanical restrictions and decreased blood supply secondary to scarring. Loss of range of motion may also affect growth. Studies show more tooth damage with plating than with wire fixation, possibly secondary to dissection that is more extensive and to manipulation. These findings may also be associated with the larger plates and screws formerly used.

A clinico-statistical and long-term follow-up study was performed on 81 pediatric fractures seen during the 14 years between 1977 and 1990. Of all maxillofacial fractures, the incidence of pediatric fractures was 14.7%. The ratio of boys to girls was 2.1:1, and the highest incidence involved boys over 13 years of age. Fractures of the upper alveolar bone and mandible were common. Conservative therapy, such as maxillomandibular fixation using orthodontic brackets was usually performed and was found to be successful. The long-term follow-up study revealed that 5 out of 21 patients with alveolar fractures complained of malocclusion and it is suggested that a longer duration of intramaxillary fixation and long-term follow-up might be needed for alveolar fractures in children.



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MIDFACE INJURY:

A. Evaluation:

- Midface fractures can be classified as Le Fort I, II, or III. Le Forte I is a fracture separating the palate and alveolus from the rest of the maxilla – a fracture which occurs above the roots of the teeth. This mobile maxillary segment moves like a “loose denture.”

- Le Fort II separates the midface from the skull, creating a free-floating pyramidal segment. This fracture also includes a mobile palate.

- Le Fort III involves a complete separation of the face from the cranial base. The mobile segment includes the maxilla, palate, zygoma, and ethmoid bones. It is a “craniofacial separation”.

B. Imaging and radiology:

- The standard facial film series for trauma includes four projections: the Waters’ (occipitomental), Caldwell’s (occipitofrontal), lateral, and submentovertex (“jug handle”) views.

- The Waters’ projection is the most valuable view of the midface: the zygoma, nasal bones, orbital rims, maxilla, and floor of the orbit are shown. It is a posterior-anterior projection with the x-ray beam angled 37 degrees caudad to the canthomeatal line. The patient is prone (face down) for this view.

- The Caldwell’s projection shows the middle and upper parts of the face: superior orbital rim, frontal sinuses, and orbital region. The x-ray beam is angled 15 degrees caudad to the canthomeatal line.

- The lateral view shows: the anterior wall of the frontal sinus, nasal bones, and walls of the maxillary sinuses.

- The submentovertex projection shows the zygomatic arches. This view also requires that the patient be prone – but with hyperextension of the neck. Therefore, the cervical spine must be cleared first.

C. Definitive care:

- Rapid healing occurs in pediatric bone. Therefore, perform definitive rigid fixation of the mobile bony segments within 5 days after the injury. Strive to establish normal occlusion, facial proportions, and facial symmetry. To avoid disturbing long-term growth and development, the surgeon needs to fixate malposed fragments using as little dissection as possible.

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J Korean Assoc Maxillofac Plast Reconstr Surg. 2003 Sep;25(5):426-431. Korean.

Clinical study of mandibular fracture of children.

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There are several factors that should be taken into consideration in the treatment of mandibular fracture of children. The growth pattern of mandible, teeth exchange, embedded tooth germs, and the fracture pattern different from that of adults are among those. In general, both surgical and non-surgical methods are considered as treatment protocols but the latter such as circumferential wiring with surgical plate would be a better choice when dealing with children of this type of trauma. This investigation was to estimate the fracture pattern of children in the northeastern area of Seoul, South Korea and compared the required results with literature reviews. The thirty-six child patients referred to the department of romaxillofacial surgery at Sanggyepaik hospital during last 12 years (from 1990 to 2002) were analyzed. This study shows the following results. The mandibular fracture was more prevalent among boys than girls. Falling was the most common cause of mandibular fracture in children aged 0 to 5 year. Symphysis and condyle were the most popular fractured sites in children. The circumferential wiring with surgical plate was the most provided treatment method.

The treatment of mandibular fractures in children.

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92 children with mandibular fracture were treated at our hospital between 1980 and 1989. Distribution and treatment of the fractures focus on a new classification based upon the stage of the dentition, site of the fracture and displacement of the tooth-bearing part of the mandible. The treatment rationale includes intermaxillary fixation by specially designed mini-arch bars with acrylic resin stiffening in cases with undisplaced fractures in the early stages of the dentition. With the help of this technique, invasive procedures for fracture immobilization become less common. The indication for miniplate osteosynthesis is limited to displaced or multiple fractures of the tooth-bearing part of the mandible. The combination of miniplates and monomaxillary splinting with mini-arch bars allows a shorter duration of intermaxillary fixation and hence early functional treatment of additional condylar fractures. Correctly applied miniplates neither injure the tooth germs nor lead to growth disturbances of the mandible. The classification and treatment of mandibular fractures in children are discussed.

bstract

The incidence of mandibular fractures is rare in the pediatric population when compared to adults. Although the basic principles for management are the same as for the adult, certain anatomical features of the pediatric mandible warrant special attention. Problems such as mixed dentition, unerupted teeth, and ongoing growth in the mandible require careful diagnosis and planning in deciding on the proper treatment.

In today's fast-paced society, many children sustain severe maxillofacial injuries that require surgical reconstruction. The factor that differentiates the treatment of pediatric facial fractures from those of adults is facial growth.

Compared to adults, fractures of the facial bones and mandible are uncommon in the pediatric age group, particularly those patients younger than 5 years.

The impact of craniofacial trauma is minimized by the reduced inertia, due to the light weight and small size. The force of impact is absorbed by the forehead and the skull rather than the face since the ratio of cranial volume to facial volume is greater in children than adults (8:1 at birth, 4:1 at 5 years vs. 2:1 in adults). Besides, pediatric facial bones are more resistant to fractures due to their higher elasticity, poor pneumatization (by sinuses), thick surrounding adipose tissue, and stabilization of the mandible and maxilla by the unerupted teeth.

Excluding the nasal bones, the mandible is the most frequently fractured facial bone in the pediatric patient. One third of pediatric trauma patients with facial fractures have a mandibular fracture.

The mandible is different from other facial bones in some important respects. In addition to its contribution to facial dimension and symmetry, the mandible has unique and important functional features. The mandible is the only bone in the face that moves in relation to the skull. Additionally, the mandible bears powerful muscular stresses; injury to this bone can be functionally disabling. Treatment of certain fracture types differs from treatment of similar fractures in adults and depends on the stage of developing dentition of the pediatric patient.

For excellent patient education resources, visit eMedicine's Back, Ribs, Neck, and Head Center, Breaks, Fractures, and Dislocations Center, and Teeth and Mouth Center. Also, see eMedicine's patient education articles Broken Jaw and Broken or Knocked-out Teeth.

Frequency

Incidence rates of mandibular fractures in children have been fairly consistent in the literature over the years. In 1956, MacLennan reported that 1% of mandibular fractures occur in children younger than 6 years. Similarly, in Rowe's 1969 study, 5% of mandibular fractures were in children aged 6-11 years; only 1% occurred in patients younger than 5 years. In 1992, Thoren reported that 7.7% of mandibular fractures occur in children younger than 16 years and 2.9% occur in children younger than 10 years. Incidence of mandibular fractures increases with age to young adulthood. Only 12% of pediatric mandibular fractures occur in patients younger than 6 years. While some series report an equal distribution between the sexes, a 2:1 male predominance for all mandibular fractures and an 8:1 predominance for condylar fractures have been reported.

Etiology

In several series, motor vehicle accidents and falls are the most common causes of pediatric mandibular fractures. However, the frequencies of etiologies of fractures in a Swiss series were 72% due to recreational activities and 17% to traffic accidents. Thoren's 1992 series reports 57% of fractures were due to vehicular accidents and another 18% to falls. The vast majority of the vehicular accidents are attributed to bicycle accidents. Some discrepancy in reported cause exists because some studies classify falls from a bicycle as falls and others classify this type of accident as a vehicular accident. Older school-age children also sustain injuries in sporting activities, while teenagers, like adults, are frequently subject to violent causes of injury.

Greenstick Fracture**Definition:** Because a child's bones are much more pliable than adult bone, an incomplete, or 'greenstick,' fracture may occur. A "greenstick fracture" means that one side of the fracture has broken and one side is bent; therefore it is classified as an incomplete break.

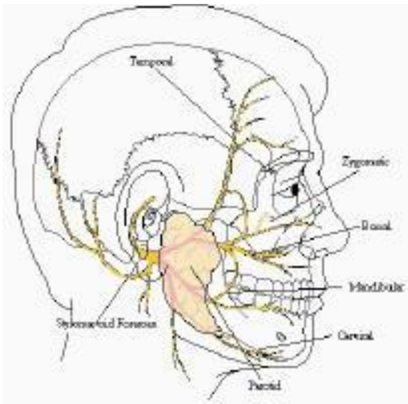
The name for a greenstick fracture comes from the analogy of breaking a young, fresh tree branch. The broken branch snaps on one side (the outer side of the bend), while the inner side is bent, and still in continuity. Most often the greenstick fracture must be bent back into the proper position (called a "reduction") and then casted for about six weeks. Greenstick fractures can take a long time to heal because they tend to occur in the middle, slower growing parts of bone.

MANAGEMENT OF FACIAL TRAUMA IN CHILDREN

The face allows recognition and communication among people. No other part of the body is as aesthetically important as the face. Facial injuries can range from a minor inconvenience to a lifetime disfigurement. For this reason, any injury to this area requires particular are and attention during treatment.

In the United States, approximately 3 million people are treated in a hospital emergency department for traumatic facial injuries each year. Five percent of pediatric trauma patients have facial fractures. Falls are the most common cause of facial fractures in children younger than 3 years of age. After 5 years of age, the leading cause of facial fractures is motor vehicle collisions.

The nasal bones and mandible (jaw) are the two most frequent sites of facial fracture. Mandibular fractures occur in 7.7% of children younger than 16 years of age. An equal incidence of mandibular fractures exists between both sexes. Trauma to the condylar growth center (the neck of the jaw) beneath the articular disk may cause delayed growth of the affected side of the jaw.



Condylar Fractures: Condylar fractures also occur just above the elbow joint. When a child sustains a condylar fracture he or she has broken off just one side of the elbow joint.