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"An overview of Maxillo Facial fractures and current concepts in the management of mandibular fractures in children"

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Abstract: *Trauma is the leading cause of morbidity and mortality among children. Pediatric patients are not smaller versions of adults in either physiology or morphology, and the management of pediatric facial injuries requires an understanding of this principle.There is a great disparity between pediatric and adult patients with regard to the available epidemiologic data, and there is little consensus in the literature about the management of pediatric facial fractures. This article reviews the spectrum of pediatric facial trauma along with a review of growth and anatomic considerations, diagnosis, and recent advances in management of these injuries. This study is based on various references from textbooks, articles inCochrane library.*
Key words: *Maxillofacial trauma, Children*

I. Introduction:

During recent years, there has been a considerable advance in the prevention and management of maxillofacial injuries in children. The pattern of fractures and frequency of associated injuries are similar to adults but the overall incidence is much lower compared to them. Management of facial and dental injuries in children requires knowledge about child‟s particular stage of development and accordingly modification of the treatment approach keeping the future growth and development in mind [1].

Though the quality of the management of maxillofacial trauma has improved significantly during the past few decades, certain specific issues pertinent to the pediatric facial trauma have not received as much attention in the literature. The management of pediatric patients with facial injuries requires special attention to anatomic and physiologic considerations. The Treatment of facial fractures is limited to closed reduction for minimally displaced fractures. Open reduction and rigid internal fixation is rarely indicated, and is done for severely displaced fractures. Childrenrequire long-term follow-up, to monitor potential growth abnormalities due to trauma. This article is a reviews epidemiology, diagnosis and recent management protocols of facial fractures in children.

II. Epidemiology Of Facial Fractures In Children:

Incidence:

Overall, facial fractures in the pediatric population comprise less than 15% of all fractures. They are rare below age 5 and their incidence rises as children begin school. Another peak in incidence occurs during puberty and adolescence with increased unsupervised physical activity [1,2].

Posnick et al reviewed 137 patients, found 6-12 year old range to be most common (42%) for facial fractures. Total 32% orbital fractures occurred in the orbital floor, 19% medial wall 18% orbital roof. The incidence of orbital floor fractures parallels with the development of maxillary sinus [3,4] [figure -1].

Rowe in 1969 stated that middle third fractures are rare in children and comprises of only 0.5 % of total fractures sustained [5,6,7]. Hall in 1972 reported only 32 cases of mid facial fractures in a series of facial fractures in 495 children [8].

Morgan et al in 1972, reviewed 300 cases of mid facial factures, found 1.3% cases were under 6 year age group, 2.7% were between 7 and 12, making a total of 4% in children under 12 years age [9]. Hall in 1972, Mac coy 1966, Kaban et al in 1977, stated that fractures of the nasal bones and mandible account great majority of fractures in children [8,10,11]. Hall (1983) in a series of 1088 facial fractures found that nasal bones accounted for 507(46.6%) and the mandible 263(24.2%). Among all mandibular fractures, condylar fractures constitute 9.1% [12].

A study done by Posnick et al in 137 inpatients with 318 acute facial fractures at a single urban tertiary care pediatric hospital, it was found that mandible fractures were the most common (55%), followed by orbital (30%), dentoalveolar (23%), midface (17%), nasal (15%), zygoma (14%), and cranium (12%) [4].

In series of case reports in pediatric patients by Andrea Alcala-Galliano, nasal fractures were most frequent (58.6%), followed by mandibular fractures (21.5%). Orbital (9.5%), frontal skull (5.1%), and midfacial (3.8%) fractures were next in frequency, and complex fractures (naso-orbito-ethmoidal, Le Fort) were the least common (1.5%) [13].

Figure -1:Drawing of the pediatric skull shows the anatomic locations and frequency ofoccurrence of facial fractures in children by Andrea Alcalá-Galiano et al case series [13].

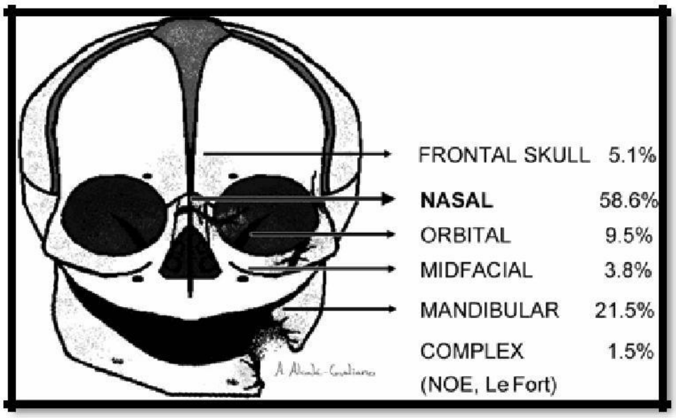


Figure 2: Analysis of 263 mandibular fractures in children admitted to the Royal Children'sHospital, Melbourne, Australia during 10-year period between 1970- 1979 by Dr. Roger Hall [12].

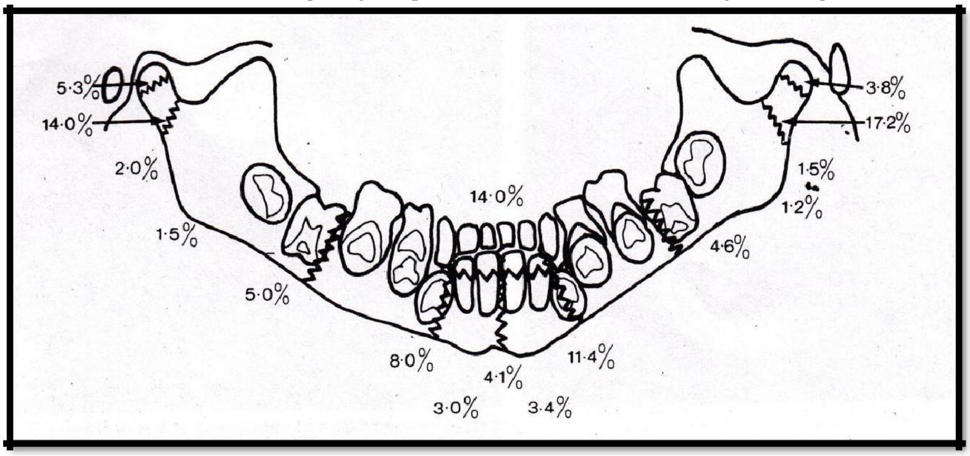
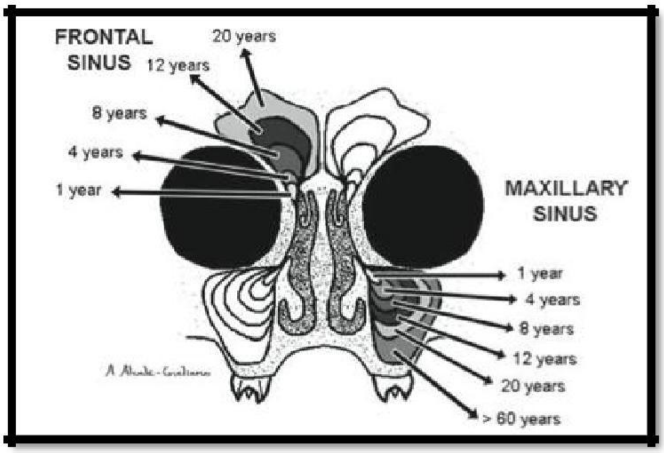


FIGURE -3:The development of the frontal and maxillary sinuses according to age in years. Increasing development of the paranasal sinuses is positively correlated with the prevalence of midfacial fractures in children [13].



III. Aetiology

Falls, sports-related injuries and Road traffic accidents constitute the most frequent causes of facial fractures in children (Table-1).While young children usually sustain injuries from low-velocity forces older children are more likely to be exposed to high- velocity forces Social, cultural and environmental factors vary from one country to another and influence the incidence and etiology of craniofacial trauma [13].

Two retrospective studies conducted by Hall (1983), compared two major etiological factors in facial fractures in children for 10-year periods 1960-1969 and 1970-1979. Hall concluded that seat belt legislation introduced in to the Australian state of Victoria in 1975 for children had considerable effect in reducing injuries due to road traffic accidents [12].Mc Coy et al in 1966 and Tate in 1971 reported non –accidental injury (battered child syndrome) cases in 10 and 6 children respectively [10, 14].

Table-1 –Frequency of etiology of facial fractures in children [15].

MVA	5.0-80.2%
Violence	3.7-61.1%
Falls	7.8-48.0%
Bicycle	7.4-48.0%
Play	10.0-42.0%
Sports	1.2-33.0%
Pedestrian	10.0-25.0%
Other	4.5-23.0%
Object	1.0-23.0%
Crush	10.0%
Birth	0.1-4.0%

The diagnosis of facial fractures is by clinical examination and radiographic evaluation.

The Diagnosis Of Facial Fractures In Children [16]:

The clinical features are

1. Changes in occlusion.
2. Paresthesia, anesthesia, or dysesthesia
3. Localized pain
4. Altered range of motion/deviation of the mandible
5. Changes in facial contour, symmetry, and dental arch form
6. Lacerations, hematoma, ecchymosis
7. Epistaxis
8. Mobility of teeth .
9. Crepitus or mobility .
10. Palpable bony step-offs

Advanced imaging techniques has great value in children, especially CT scans, as plain radiographs in young children are less helpful in viewing fracture site due to un erupted tooth buds obscuring fracture sites, increased incidence of green stick fractures and underdeveloped cortex [17, 18].

IV. Unique Maxillo Facial Features Of Pediatric Patients:

The main unique feature is the difference in size ratio of cranium to facial skeleton. In the early years of age, the ratio between cranial volume and facial volume is approximately 8:1 and by the completion of growth, this ratio becomes 2.5:1 and the pattern of facial trauma differs accordingly [19]. Themidface is inretruded position relative to the „„protecting"" forehead is an important reason for the lower incidence of midface and mandibular fractures and higher incidence of cranial injuries in young children especially less than 5 years of age. As with increasing age, the face grows in a downward and forward direction and the midface and mandible become more prominent and increases in incidence of facial fractures and decrease in cranial injuries with age (figure -4) [20].

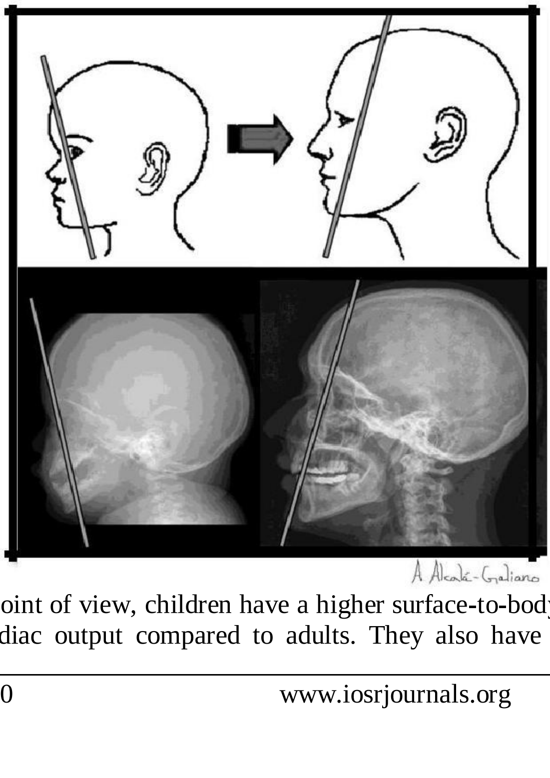
Another unique feature is, Facial fractures areminimally displaced in children as thick layer ofadipose tissue covers the more elastic bone and the presence of flexible suture lines. Moreover the stability of jaw bones increased by the presence of tooth buds within them and the lack of sinus pneumatization in maxilla during childhood. The Para nasal air sinuses provide a cushioning effect onfacial skeleton and play important role in treatment of facial fractures in children. The specific facial fracture pattern and its management are based on development of sinuses like maxillary, ethmoid, and frontal sinuses [21, 22].

The type of fracture sustained in children is quite different tha n that of adults as children are more prone for green stick type of fracture. A green stick fracture is a fracture in which one cortex of the bone is broken and other cortex is bent. The high elasticity of thin cortical bone with large amount of medullary bone, which covered by thick adipose tissue results in green stick fractures in children and this type of fractures ensures the stab ility of displaced segments [23,24].

The osteogenic potential of the periostium is very high leading to rapid and easier hea ling under masticatory forces even if there is imperfect apposition of fractured bony segments [6]. Hence the treatment of undisplaced green stick fractures is by close observation, liquid soft diet and avoidance of physical activities. In the case of minimally displaced green stick fractures, using occlusal splints, circumferential wiring, arch bars and gunning splints recommend conservative closed reduction. These closed reduction techniques prove good reduction of fractured segments, continuity of periosteal sleeve and maintenance of soft tissue, all then create a favorable environment for rapid osteogenesis and bone remodeling and preventing healing complications like fibrous union and non union in children. Further splinted bony segments reduced pain and tenderness during child"s daily activities [1, 25].

At birth, the maxillary and ethmoid sinuses are present and the maxillary sinus undergoes significant growth around 3 years of age, The inferior floor of the maxillary sinus undergoes significant development around 7-8 years of age when the permanent teeth begin erupting it completes its growth around 16 and hence increase in midfacialfractures.The frontal sinus begin their development around 3 years of age and completes its growth 12-14 years of age in girls and 16-18 years of age in boys [23].

Figure-4:Diagrams and radiographs depicting the characteristic protrusion of the child"s forehead and relative to midface. The skull- to-face ratio decreases to almost four times with normal growth and development from birth and adulthood [20].



From physiological point of view, children have a higher surface-to-body volume ratio, metabolic rate, and oxygen demand and cardiac output compared to adults. They also have lower total blood and stroke volumes, posing them risk of hypothermia, hypotension and hypoxia after blood loss.

Even mild airway swelling or mechanical airway obstruction can q uickly compromise the airway and respiratory stability. For these reasons, maintenance of the airway and breathing, control of hemorrhage and early resuscitation of fluid imbalance are even more critical and time dependent in children than in adults. According to professor Alex Haller, there is well known"golden hour" in adult advanced trauma life support, but in children it is " platinum half hour" when immediate and meaningful assessments and treatments must takes place to resuscitate theseverely injured child [26]Fluid and electrolyte resuscitation is important component of perioperative management of pediatric trauma as children are more susceptible to disorders of fluid balance and acid- base equilibrium. Tachycardia is the earliest response to hypovolemia.Changes in mental status, respiratory compromise, delayed capillary refill, delayed or absent peripheral pulses and hypothermia are signs of shock and requires immediate fluid resuscitation with warm intravenous fluids to prevent hypothermia [22, 26, 27,28].

V. Concept Of The Direction Of The Bone Growth:

Growth at the nasomaxillary complex occurs in an inferior and anterior direction and the septum is the coordinating center of midfacial growth. According to Scott cartilaginous theory, nasal septum is growth center for midfacial region and studies done on primates where the septum of the young primate was removed early in life resulted in midface hypoplasia. Hence, any injury affecting the integrity of the septum in a pediatric patient should be evaluated for any disturbance in growth. Growth of the mandible occurs in a lateral and anterior direction resulting in the widening and elongation of the face. The condyle is growth center for mandibular growth and injury here may result in delayed growth, facial asymmetry, mandibular deviation, and malocclusion [29].The facial fractures in children can be studied under following sections [30]:

Upper Facial Fractures:
1. Naso- orbital – ethmoidal fractures.
2. Nasal complex fractures.
3. Orbital floor fractures.
4. Zygomatico maxillary complex fractures.

Lower facial fractures:
1. Maxillary fractures
2. Mandibular fractures.
3. Dentoalvelolar injuries.

VI. Naso-Orbito-Ethmoid (Noe) Fractures [30]:

Naso-orbital-ethmoid fractures are rare in children and occur mainly due to high velocity trauma. The NOE complex consists of medial orbital walls, the nasal bones and nasal projection of frontal bone. The prevalence increases with the development of paranasal air sinuses [30].

The signs of an NOE injury include a flattened nasal root, telecanthus, rounding of the medial canthus, periorbital edema and ecchymosis, epistaxis, and CSF leak. In patients older than 5 years, an intercanthal distance longer than 35 mm is suggestive of a naso-orbital-ethmoid fracture and a distance longer than 40 mm is diagnostic.

Surgical management is complex and requires secondary reconstruction. Initial management includes restoration of orbital volumes, re- creation of nasal contours and restoration of midfacial projection [31].

Nasal Complex Fractures [30]:

Nasal complex fractures are most common in both adults and children due to its prominent exposure [21, 24]. The clinical symptoms include depressed nasal symptoms and nasal bleeding. The treatment consists of closed reduction of fracture segments and drainage of septa l hematoma, cosmetic deformity and functional impairment [32].

Orbital floor Fractures:

Orbital floor injuries result from the transmission offorces directly from a blow to the bonyorbital ring to the thin orbital walls and/or due to effect ofindirect forces from a hydraulic pressure from displaced orbital soft tissues, resulting in blow out fractures in children [33, 34].

Clinical features include periorbital ecchymosis and edema, subconjunctival hemorrhage, enophthalmos, crepitus on palpation, extraocular muscle entrapment, and diplopia and infraorbital nerve paresthesia.A pediatric trapdoor fracture, or "white-eyed" fracture in which, o rbital soft tissue prolapse through the fracture site and become trapped when the fractured bony segments. If entrapment is present, surgical intervention is required, and should be performed within 2 -3 days of injury. The reason for this intervention is to prevent orbital soft tissue necrosis and fibrosis that will result in a permanent functional disability [35].

Zygomatico Maxillary Complex (Zm C) Fractures[24]:

Zygomatico maxillary complex fractures are rare in young children but their prevalence increases as the maxillary sinuses increase in size, deciduous teeth are replaced by permanent teeth, and the face undergoes a downward and forward projection with the midface becoming more prominent and less protected by the skull. The signs and symptoms of ZMC fractures include a depressed zygomatic arch, pain, periorbital hematoma, epistaxis, subconjunctival hemorrhage, and ecchymosis of the overlying skin [30].

Non-displaced or minimally displaced fractures are managed by conservatively, but in cases with coronoid impingement, enophthalmos or with significant displacement o f fracture segments require intervention [36, 37].

Surgical repair must takes place as early as possible, within 7 days. The healing of fracturesite occurs,which further necessitates refracture, which could lead to tearing of pterygoid plexus. The fracture site is approached through intra oral Keene incision in the maxillary vestibule the fracture segments are reduced by two-point fixation [38].

VII. Lower Facial Fractures:

Maxillary Fractures:

Maxillary fractures are rare in children and occur as a part of complex fractures. The clinical signs and symptoms are hypoesthesia, malocclusion and maxillary mobility. The treatment protocols include correction of midface projection and restoration of occlusal harmony. Maxilla mandibular fixation (MMF) FOR 1-2 weeks reduce the fracture segments.

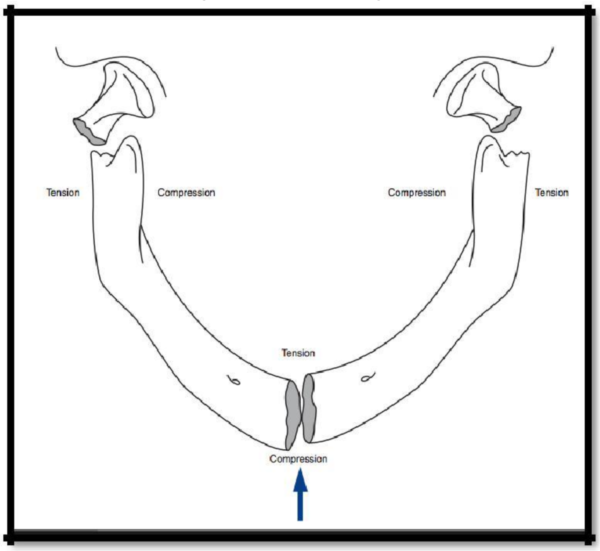
Mandibular Fractures:

According to Posnick et al, mandibular fractures are 2^{nd} most common facial fractures in children and account for 39% and prevalence of the each site included the condyle (55%), parasymphysis (29%), body (10%) and angle (9%) [39].

Biomechanical Considerations:

Unlike other bones in human body, the mandible is not a smooth curve of uniform bone, rather it has discontinuities due to the presence of foramina, sharp bends, ridges, and re gions of subcondylar area where reduced cross-sectional dimension. Due to this, certain parts of the mandible develop greater force per unit area resulting in greater tensile strain gets concentrated in these locations [40].

Picture 5:As the force is directed at the symphysis of mandible, an axial plane is distributed along the arch of the mandible. As the tension gets dissipated along the mandible, and the fracture occurs bilaterally in the area of least stability, which is condylar neck [41].



As the force is directed along the parasymphysis, body of the mandible, there is development of compressive strain along the buccal aspect and tensile strain along the lingual aspect of the mandible.Hence the fracturebegins in the lingual region and spreads toward the buccalaspect. Onone side fractured condylar process moves in a direction away from the impact point until it is limited by the bony fossa and/or soft tissue. This creates tension on the other opposite side of the condyle resulting in bilateral condylar fractures [40].

VIII. Treatment Protocols For Mandibualr Fractures In Children:

Children have greater osteogenic potential and faster healing rates than adults. Therefore, anatomic reduction in children must be accomplished as early as possible and immobilization times should be shorter (2 weeks versus 4–6 weeks in adults) [45]. Non-union and fibrous union rarely occurs in children and excellent remodeling occurs under masticatory forces even there is imperfect apposition of fracture segments [46].

Most of the pediatric mandibular fractures are managed through closed technique and observation. If the open reduction and internal fixation is mandatory due to highly displaced fractures, it is very important align all suture lines and avoid extensive periosteal elevation as this leads to growth disturbances. Non-displaced condyle fractures are usually managed with a liquiddiet, observation or by closed reduction with maxillomandibular fixation (MMF) and displaced fractures with malocclusion require various modalities of immobilization. MMF done using teeth is difficult in children as fewer teeth will be present, which are in the stage of resorption and partially erupted permanent teeth will be in unfavorably shaped for the fixation [48].

Tooth buds and (erupting) teeth in the line of fracture should not be traumatized during placement of screws and plates. According to Koenig et al, 82% of tooth buds in the line of fracture normally erupted regardless of the open or closed reduction treatment [49].

Cond Ylar Fractures:

Condylar fractures comprise of approximately 25% of all mandibular fractures in children.Falls on the chin region and trauma to pre-auricular region are potential causes ofcondylar fractures in children [50]. Condyle fractures are considered as natural protectivemechanism, meant to prevent brain damage, which can occur due to penetration of the condyle in the cranium. During impact, there is fast deceleration force, which act on most vulnerable anatomical structure of the mandible, which is condylar process [34].

As the anatomy and physiology of the condylar region varies with age, the location and type of fractures in each age group varies and also the treatment strategies.In children under theage of 2 years, the condyle is short and thin, which fills shallow articular fossa. So fractures result in intra- articular flattening (crush injuries). In older age children the condyle is short and stout, which in relatively resistant to fractures. As the mandible grows and develops with age, i.e at age of 7 to 8 years, which resembles to the adult mandible, fractures are extra-capsular and involve the neck of the condyle. The condyle has enormous potential for regeneration and reshaping in thegroup aged 3–12 years. In adolescence age group (13-18 years) the capacity of bone regeneration is similar to children but bone remodeling is less than in children. This results in abnormally shaped condylar head and short ramus, both leads to persistent malocclusion [35].

Condylar fractures are classified into three groups depending on the fractured site [36]:

(1) Intracapsular (articular cartilage) condylar fractures
(2) High condylar fractures, which occur above the sigmoid notch and
(3) Low subcondylar fractures, which usually are greenstick fractures in children and are theNmost common type of pediatric mandibular fracture overall.

In spite of significant regeneration and remodeling in children, the long-term effects of condylar fractures in growing individuals must be considered. If condylar fractures in children are not properly managed, there is growth disturbance, asymmetry of face at various regions like orbits, cheeks, maxilla, and mandible and TMJ disorders like ankylosis and dysfunction, malocclusion, chronic dislocation [37].

High intracapsular fractures and fracture dislocations results in damage to the articular cartilage and its underlying germinal cell layer, which are key in bone regeneration, especially in very young children. The condylar fractures leads totearing of the ligaments and capsule, whichresult in hemorrhage or edema in the intra articular space. Later, the hematoma is replaced by granulation tissue, and then by fibrous connective tissue that transforms into bone tissue leading a fusion of the joint to glenoid fossa (ankylosis). Approximately 8% of the patients with condyle fractures develop severe mandible growth disorders [38].

Clinical evidence supports condylar fractures in children over the age of 4 years have less danger of growth impairment from damage to the condylar center. The experimental evidence suggests that the glenoid fossa grows downward and becomes shallow to adapt to the new position of the condyle [39]. Hence early diagnosis and an adequate treatmentreduce the trauma impact onthe facial growth and excellent results can be obtained both on a functional and aesthetical standpoint [40].

The management of mandibular condylar fractures depends on various factors in children [41]:

(i) The age of the child.
(ii) The co-existence of other facial fractures.
(iii) Unilateral or bilateral in nature.
(iv) The amount of displacement of the fracture.
(v) The dentition and the dental occlusion status.

New diagnostic technologies and a deeper understanding of the face growth process have brought to a more conservative approach of condylar injures in children.
There are two main therapeutic approaches for condylar fractures in children [42].

1. Conservative treatment with intermaxillary fixation followed by functional therapy.
2. Surgical intervention to reposition and stabilize the fragments.

In literature, the treatment of condyle fractures byfunctional orthodontic treatment yielded good results [43, 44, 45]. The use of functional appliances in the immediate post condylar trauma treatment allows the mandible to relate to the maxilla thus stimulating muscular activity, which is within the pain threshold of the patient. It also helps in reduction in edema and also removal of metabolites following muscular spasm. The appliance must be used as many hours as possible and also in the following two years, when bone regeneration and compensatory growth expected to take place. After establishing normal occlusalfunction during functional orthopedic treatment, the articular surfaces will regenerate and remodel [46]. The best regeneration can be seen in patients in an active growth stage, under the age of 12.An incomplete remodeling is very frequent (56%) in case of displaced fractures (80%) and the main sign being a flattened or irregular surface of the condyle head, with neck deformity [47].

Though the traumatized TMJ in children, completely functional and asymptomatic after just a short period of time, remodeling of head and neck takes many years in order to establish the healthy contra- lateral joint.The results obtained with functional appliances are more effective than those obtained through traditional physiotherapy exercises, which are much more difficult to carry out in young children [48].

Picture 6& 7: Functional appliance holding both arches together reducing fracture segmentstogether in centric occlusion.


Experimental and clinical studies have shown the great potential for compensation and remodelling of the condyle in children [49, 50]. Li *et al* investigated the mechanism of healing of pediatric condylar fractures in Wistarrats.The entire healing process was investigated and authors concluded that the growth potential and remodeling capability of a condyle during its growing period is the intrinsic factor. This is the important factor for the favorable prognosis of condyle fractures in children, which are managed by conservative procedures like functional appliance treatment [50].

The histomorphometric studies proved that during active growth at condylar region, trabecular bone remodeling with successive enchondral ossification takes place.Lindahl and Hollender in 1977 stated that a genetic guidance system exists to rebuild the fractured condylar process in children. Remodelling of the dislocated distal stump occurs with formation of an anatomically normal condyle [51]. According to Dahlstro m et al, irrespective of age, remodeling can interpreted as a process directed to meet the demands of function and growth. As the skeletal growth ceases, the condylar cartilage are matures, there is no increased cellular activity for remodeling activity. The ability of the adult to remodel and adapt is more impaired and lesspredictable following dislocation of the condyle and the need for open reduction is thus greater inthe postpubertalpatient [52].Hence pediatric condylar fractures can be effectively managed by closed procedures with good prognosis, as long as there was no damage to the fibrous attachments of the capsule, disc, and condylar cartilage [51, 53,54].

Open reduction is indicated in very rare in children and indications are [54]

1. Displacement in middle cranial fossa.
2. Unacceptable occlusion after closed technique trail failed or mechanical obstruction is present.
3. Avulsion of the condyle from the capsule.
4. Bilateral fracture of condyle with comminuted midface fracture
5. Penetrating wound.

IX. Body And Symphysis Fractures:

In many instances**,** fractures of the body of mandible in children are undisplaced due to elasticity of mandible in pediatric age group anddeveloping tooth buds within jaws, hold the fracturesegments from getting displaced [55].Undisplaced fractures without causing disturbance in occlusion are treated by close observation, soft diet and avoidance of physical activity [51, 52, 53]. If fracture segments are displaced closed reduction, immobilization is performed and exact method of immobilization is depending on child's chronological age and stage of dental development [56].

Mandibular fractures, which are limited to the alveolar process are treated by open or closed reduction and immobilization by splints and arch bars for 2–3 weeks [52,53]. For the non-displaced fractures, closed reduction with splints fixed with circummandibular wires is the commonly recommended treatment. Circum mandibular wiring is advantageous, as it does notcauses damage to the tooth germs nor requires intermaxillary fixation (IMF). Another advantage it do not interfere with condylar growth, but it is indicated only for anterior mandibular fractures without significant displacement but severely displaced fractures and mobile fragments are common indications for open reduction and internal fixation [57].

When considering the methods of immobilization of fractured jaws, Rowe in 1969 divided patients in 4 groups based on the state of dentition at the time of injury [58].

Table-2: showing sub divisions of children based upon the state of developing dentition asmethods of immobilization of the fractured jaws depend on dental development.

AGE IN YEARS	DENTAL DEVELOPMENT
0-2 years	Eruption of deciduous dentition is incomplete
2- 4 years	Before the roots of the deciduous incisors show marked resorption, although many of the permanent teeth are partly formed.
5-8 years	Resorptions of the deciduous molars are initiated and the roots of the permanent incisors adequately developed.
9-11 years	After adequate formation of the roots of the permanent incisors and first molar teeth, but before eruption of the premolars.

Children Younger Than 2 Years:

At this age group, very little anchorage can be obtained from unerupted or incomplete formed teeth. Fro the point of immobilization, two categories of injuries are considered.

1. Fracture at tooth bearing area (e.g: symphysis of the mandible).
2. Fracture that had occurred proximal to the tooth bearing area (e.g. Angle of the mandible).

In treating fracture at tooth bearing area, Mac Lennan in 1956 described a technique using pre fabricated acrylic gunning splint. Acrylic splint pressed down over the lower teeth and alveolus followed by manual disimpaction and reduction of displacement. This splint is retained with circummandibular wires placed and complete healing occurs within 3 weeks [57].

The pre fabricated acrylic splints have several advantages. They are cost effectiveness, ease of application and removal, reduced operating time, maximum stability during healing period,and minimal trauma to adjacent anatomical structures and maximum comfort to young children.

FIGURE 7: The splint holds and reduces fracture segments together by circummandibula r wiring.

Children Aged Between 2-4 Years [57]:

Sufficient number of teeth is formed at this age, which facilitates interdental eye let wiring to stabilize fractured segments.If the fracture is within tooth bearing of the mandible, a single one-piece lower cap splint is advantageous and complete immobilization of lower jaw is avoided.

Children Aged Between 5-8 Years [57]:

At this age group, primary teeth are in a state ofresorption, showing mobility and permanent teeth are still in erupting condition poses difficulty in fixation of fractured segments. The pattern of eruption of teeth in this age group is such that lower molars have no opposing teeth in the upper jaw or vice versa, so the establishment of occlusion is extremely difficult and stability of fracture segments is precariously maintained. These difficulties are addressed by constructing partial maxillary and mandibular " gunning splints with occlusal blocks" which are secured by circumferential splints.

Children Aged Between9 –11 Years [57]:

In this age group, MMF using arch bars is possible,because enough permanent dentition is present to secure maxillomandibualar fixation.

X. Recent Trends In The Treatment Of Mandibualar Fractures:

Open reduction and rigid internal fixation (ORIF) using stainless steel wires and plates has become the standard of care for management of displaced fractures. According to Zimmerman et al 2006, ORIF provides stable three-dimensional reconstruction, promotes primary bone healing, shortens treatment time and eliminates the need for or permits early release of MMF [59].Rigidmetal fixation is difficult in children as mixed dentition occupies entire vertical dimension of the bone and places teeth, inferior alveolar nerve at risk during screw insertion and alsodeveloping mandible poses risk of intra bony translocation of metal plates and screws, which disturbs the further growth of the bone [59].

To overcome above problems, the usage of resorbable plating system is advantageous inthe treatment of pediatric facial fractures. After preparing the fracture site, a 1.5- mm resorbable plate with 2 screw holes on each side of the fracture is held along the inferior border of the mandible in tooth-bearing regions. The drill holes are through the outer cortex only so as to avoid drilling into unerupted teeth. Resorbable screws, which are approximately 1.5 mm in diameter and 4 or 5 mm in length, are inserted until flushes with the plate. Unlike fixation with rigid metal plates, resorbable plates cannot be over bent and they lie passively against the bone. Onesignificant advantage of resorbable screws in the pediatric mandible is the avoidance of potential odontogenic injury during its placement. As the drill hole and tapping of the screw threadspenetrate only the outer cortex, injury to developing teeth is avoided. Even if the resorbable screw tip encroaches upon a tooth, its tip is blunt and it is nonpenetrating and its subsequent resorption removes potential obstruction to tooth eruption. As such, resorbable plates and screws may be applied in even the youngest mandible, where the entire bone is compo sed entirely of teeth and nerve [60].

These systems are made of high molecular weight poly-alphahydroxy acids, which are broken down into by-products through hydrolysis and phagocytosis. The degradation products are then excreted by respiration and/or urine. The resorbable plates and screws retain full strength within 4-6 weeks, and are completely resorbed by 12-36 months. They also do not interfere with radiographic studies. The most common complications associated with resorbable systems are edema of the tissue around the plate and visibility of the plate since they are bulkier. However, both of these complications resolve with time.According to Peterson, judicious usage of ORIF is a preferable to the closed reduction and immobilization techniques in treating mandibular body and symphysis fractures [60, 61].

In condylar fracture reduction cases, where open reduction becomes inevitable,Risdonapproach of the mandible is indicated in children. As the incision is given below the marginal mandibular nerve, which is the most crucial point in the Risdon approach, it avoids damage to facial nerve. The fractured site is visualized through the detachment of the masseter muscle, which is attached to the posterior border of the mandibular ramus. Then fractured condylar segment is reduced by threaded K-wires, which are inserted percutaneously under fluoroscopy that reduces fractured segments together, and later during postoperative period, rubber traction is used to stabilize fractures segments [62].

XI. Long Term Growth Disturbances Due To Mandibular Fractures InChildren:

Long-term sequels in children depend upon the location of the fracture site and the age of the patient at the time of the injury [63]. As the condyle is primary growth center for the mandible and injury to this area results in growth disturbance and temporomandibular joint (TMJ) bony ankylosis.Intra- articular condylar head fractures with lateral displacement are at greater risk of bony ankylosis. The ankylosis results in asymmetry, malocclusion, and limited mouth opening and in young children it leads to retrognathia [63].

Leake at al reviewed, 21 children who treated conservatively with analgesics, liquid diet and guiding elastics, found no growth disturbances in later in life [64]. According to Kaban et al, only 1 patient, out of 39 patients developed slight facial asymmetry after facial fracture that underwent conservatively [65]. A prospective study carried put by Lund in 38 patients, to evaluate the effect of injury on mandibular growth and the remodeling capacity in children. He concluded that mandibular growth is greater in the fractured site compared to normal side and this excess growth leads to reduction in disproportion between two sides over a period of time. Lund alsoconcluded that displaced condyle show greater chance of incomplete remodeling [66].

XII. Conclusion

Facial fractures are a rare type of injury suffered by pediatric trauma patients, but can result in significant morbidity if not properly managed. The majority of these fractures can be managed conservatively. If surgery is required, care must be taken to avoid further morbidity in the form of growth disturbances that may result from extensive periosteal elevation or improper fracture reduction. It is important for clinician to understand the differences between children and adultfracture patterns and understand the potential longer-term effects on the growth of the pediatric skeleton.

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