

## Comprehensive Management of Pediatric Mandibular Fracture

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### ABSTRACT

In the pediatric population, the incidence of maxillofacial trauma accounts for 1-15%, out of which mandibular fractures ranges from 5% to 50%. Mandibular fractures occur rarely in newborns and infants, as the ramus and condyle are rudimentary in form at this stage and temporomandibular joint is poorly developed. These fractures (ramus and condyle) are common in adults, but not in children, as in young age the space between the developing condyle and the glenoid fossa cushions a blow to the mandible. The leading causes of these fractures are fall from height (64%), motor vehicle collisions (22%), and sports-related injuries (9%). The examination of facial fractures in pediatric patients is challenging both clinically and radiographically, due to extensive soft tissue injury and developing dentition which obscure the fracture lines. In recent years, the use of CT imaging for radiographic examination of pediatric maxillofacial fractures has been quite helpful as it provides detailed assessment and identification of suspected injuries. The management of maxillofacial fractures in children present with unique challenges and complications such as ankylosis, growth restrictions and associated malocclusion may occur. So, a proper treatment algorithm need to be proposed, stratified by dentition stage in order to optimize outcomes for children.

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### Introduction

Mandible fractures in pediatric patients are the most common facial skeleton injuries (often occurring in association with other severe soft tissue injuries [1]). Patients with mandibular fracture can range from a neonate (with stemming from birth trauma) to an 18-year-old (with full permanent dentition and multiple fractures). On the basis of age range and stage of dentition, the mandible fractures in pediatric patients can be divided into following:- 1) Neonate/infants – 0 to 1 year of age (developing/unerupted dentition), 2) Toddlers – 1 to 3 years of age (erupting primary dentition), 3) Children – 4 to 12 years of age (primary and mixed dentition), 4) Adolescents – 12 to 18 years of age, as the presence of developing tooth buds in the mandible can drastically affect the overall treatment plan [2]. Among the mandibular fractures, the condylar region (neck or head) is the most frequent fractured site (7-45%), because the highly vascularized pediatric condyle and thin neck are poorly resistant to impact during fall [3]. The fractures of symphysis and parasymphysis region (20-32%) occurring secondary to condyle fractures are troublesome in children, as resultant damage to tooth buds after trauma can lead to long-term dental complications and malocclusion [1]. The percentage of angle fractures ranges from 4.4% to 45%, with an increased incidence during the teenage years, coinciding with third molar development [2].

In all cases of pediatric maxillofacial fractures, the main goal of management is restoration of function and form. The conservative management is preferred in cases of nondisplaced fractures, where as severely displaced fractures can be considered for surgical intervention. Early intervention should be considered to reduce the late complications, such as ankylosis, as pediatric patient has faster healing rate and

osteogenic potential which can lead to abnormal union of fracture segments. For surgical management, the main aim of the surgeon should be to preserve the growth centres, as interference in growth centres may cause inappropriate facial height and width.

### Development and Surgical Anatomy

The relatively larger cranium and forehead effectively protects the middle thirds and small lower third of face from injury. With growing age, the facial skeleton and mandible becomes more prominent and vulnerable to injury [4]. The growth of the mandible is a complex, multifactorial process and is influenced by the growth of the alveolar process, the developing dentition, the associated muscular processes, and the mandibular condyle. Disruption in growth (either due to congenital factors or due to trauma) can lead to abnormal development, with significant cosmetic and functional consequences, including asymmetries and malocclusion [2]. The mandibular condyles react to growth requirements and therefore, should not be considered the primary centres of growth. Therefore, surgical attention in managing injuries of the mandibular condyle should be directed at preserving as scar-free envelope of soft tissue as possible and promoting function of the joint [5].

The importance of relationship of the developing dentition to alveolar growth should be taken into account, as after tooth eruption, the mechanical forces of mastication and parafunctional habits exert forces on the alveolar bone that will influence development and maintenance of bone. The surgeon should understand the interactive role that developing dentition plays in alveolar bone development and should do everything possible to minimize disruption during treatment of mandible fractures [2].

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### Preoperative Assessment

The surgical preoperative management of any injury begins with the initial examination. The clinical signs and symptoms of fractures in children are similar to that in adults, but it is difficult to evaluate in children as they become uncooperative after trauma. Most of diagnosis depends upon the history obtained from the parents or caretakers, as physical examination is difficult to perform [5].

The clinical diagnosis of mandibular fracture should be confirmed by radiographic evaluation [6]. The radiographs include:-

- Panoramic tomograms [5]
- Lateral oblique views [7]
- Cone Beam computed tomography (CBCT) [4].

### Management

The main goal for managing mandibular fractures in children is to establish an understanding of the growing mandible which is necessary to treat these fractures in an appropriate manner, with knowledge of the location of the underlying tooth buds and the inferior alveolar nerve during each phase of development [4].

While planning treatment for mandible fractures in pediatric patients various factors should be considered: the age of the patient, the anatomic site and complex pattern of fracture, the time elapsed since injury, and other associated injuries. The conservative management is mostly preferred in pediatric patients to avoid potential complications associated with internal fixation with open approach that requires subperiosteal dissection which interrupts the osteogenic potential of the periosteum, creates scarring and may further lead to growth restriction [8].

Acrylic splints, fabricated intraoperatively, are effective to provide stability to the mandible. In young patients, it is possible to use a single-arch splint and circum-mandibular wires to stabilize the lower jaw. Transnasal wiring, combined with circum-mandibular wires also effectively immobilise the patient's jaws. Although this technique is effective, but there is a risk to injure developing teeth along with piriform aperture [4].

The Risdon wire splinting can also be used in the management of pediatric mandible fractures. The Risdon wire splint is made from simply twisting together a long circumdental 24-gauge stainless steel wire. Because full sized arch bars can be too bulky for working around the short bulbous teeth of pediatric patients, the Risdon wire splint offers a more malleable and low-profile substitute for the adult arch bars. It extends from one side of the dental arch to the opposite side and is secured to each tooth with circumdental 24-gauge wires [4].

Open reduction and internal fixation of symphysis, body, or ramus is indicated when there is significant skeletal displacement resulting in malocclusion, limited range of motion, and the possibility of airway compromise [2].

### A) Symphysis/Parasymphysis Fracture

In pediatric patients, the fractures involving symphyseal region are more varied in presentation because of the changing craniofacial skeletal anatomy and diverse pattern injury occurring in children [6]. Due to elasticity of the mandible and presence of developing tooth buds, the majority of mandibular symphysis and body region fractures are nondisplaced, as the embedded tooth buds in the bone holds the fracture segments 'like a glue' [9]. The management of symphysis and parasymphysis fractures varies with stage of dentition [1].

- The pediatric patient with **mixed or deciduous dentition** are conservatively managed i.e. soft diet, closed reduction with use of arch bars and pre-fabricated acrylic splints and maxillomandibular fixation for 21 days (in displaced fractures with mixed dentition) [1].

- In patients with **permanent dentition**, invasive treatment like open reduction internal fixation (ORIF) with titanium plates, bioresorbable plates can be done [1].

### B) Body and Angle Fracture

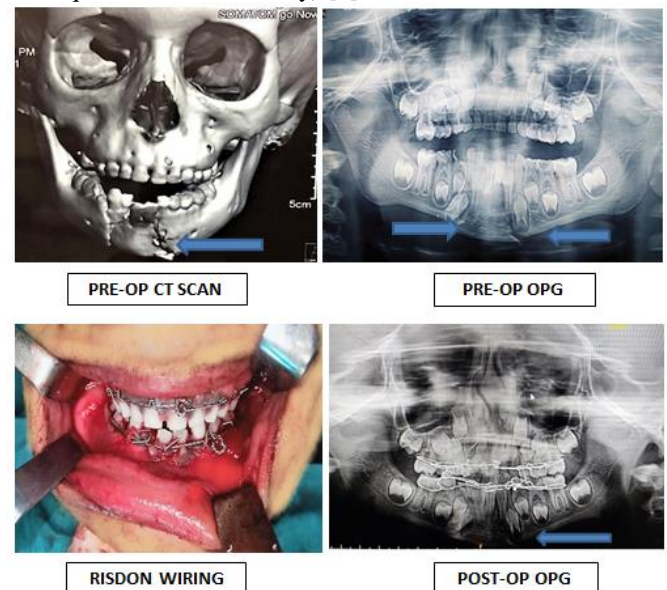
Fractures of the mandibular angle increase with the development of the third molar – thus inducing a weak point at the angle of the mandible. The body and angle fractures in pediatric patients are usually managed conservatively, with maxillomandibular fixation [2].

**Non-invasive management** for sagittal fractures of mandibular body, include use of suture or circummandibular wiring around the cap splint (**Fig. 1**) or gunning splints can aid in reduction [5]



**Figure 1. Cap splint in two years old child with left mandibular body fracture.**

- Use of Risdon wire splint (**Fig. 2**) or Erich arch bars and wire maxillomandibular fixation for a period of 2–3 weeks followed by elastics for an additional 2–4 weeks (depending on the patient's age and severity of the fracture and subsequent occlusal stability) [2].



**Figure 2. Bilateral parasymphysis fracture in six year old child.**

- In **surgical management**, fixation can be done using single monocortical plate (along with maxillomandibular fixation for 7-10 days) to prevent injury to the permanent molars in the region [5]. Open reduction and internal fixation of angle fractures can be addressed with the use of 3D or "ladder"

plates, a single superior lateral border plate, a plate on the external oblique ridge ("Champy technique"), or with an inferior border plate [2].

- Grossly displaced fractures often require open reduction and internal fixation. A single mandibular miniplate at the inferior border with the use of a superior "tension band" of either Risdon wire splint or Erich arch bar is often sufficient and minimizes injury to tooth buds and inferior alveolar nerve. The plate can be removed after adequate healing has taken place. This can usually be accomplished in conjunction with removal of the arch bars/wires at 6–8 weeks after injury [2].

### C) Condyle Fracture

In children, incidence of condylar head fracture is more common rather than low neck fracture pattern as they have relatively short and thick condylar neck. The compression injuries involving the glenoid fossa, condylar and medial pole are also common [5]. The condylar fractures in pediatric patients are almost always managed conservatively i.e. closed reduction; as these patients have proven regenerative/healing potential. The risk of growth disturbance usually precludes open treatment [2]. The main goals for management of condylar fractures in children are to prevent ankylosis, maintain normal ramal height, symmetry and functional occlusion [5].

- The conservative therapy is preferred for treating pediatric condylar fractures even in bilateral cases [2]. The **closed reduction** remains the preferred treatment because of rapid and progressive remodelling of condylar unit. Use of maxillomandibular fixation with tight elastic traction for 1-2 weeks, physiotherapy and long term follow-up is required [5].

- Conservative therapy also includes a soft diet and anti-inflammatory medications. The soft diet should be adhered for 4–6 weeks and the anti-inflammatory medications should be prescribed for the first 5–7 days in patients [2].

- **Subcondylar fractures** are contained within the pterygomasseteric sling and most often heal without complication. The healing of a subcondylar fracture is facilitated by allowing light function using Risdon wire splint and elastics in primary and mixed dentition, whereas Erich arch bars with elastics in the growing patient with permanent dentition [2].

There are only few indications for open reduction and internal fixation in pediatric condylar fractures [4], which include :-

1. Displacement of the condyle into the middle cranial fossa or external auditory canal
2. Lateral extracapsular dislocation.
3. Contaminated open joint wound.
4. Inability to obtain adequate occlusion [2]

The surgery can be performed through a preauricular or submandibular approach depending on the specific location of the fracture [4].

### D) Dentoalveolar Injury

Dental injuries are most common in children with mixed dentition. Dentoalveolar injuries involving hard tissues (crown fracture, root fracture with pulp exposure), periodontal tissues (intrusion, extrusion, avulsion, concussion, subluxation) and fracture of alveolus result due to fall or sports related activities. The clinical examination should involve the evaluation of mobility, position and vitality of the involved tooth. The chest radiograph should be obtained to rule out aspiration, in case of any tooth, broken fragment of tooth or restoration is missing [9].

- **Dentoalveolar fractures** are reduced and immobilised with arch bars or dental splints which are placed for 3 to 4 weeks. Other methods include use of wire-composite splint, bracket splint, resin splint, or titanium splints. These are placed to stabilise the luxated and avulsed tooth, to maintain physiological mobility of tooth and help in periodontal healing [9].

- **Primary dentition** – treatment of injuries involving primary dentition depends upon the life expectancy of involved primary tooth. In case of crown-root or root fracture, the fractured tooth fragment should be removed, and the remaining root fragment if not well visualised should not be removed. Extruded or subluxated tooth should not be extracted and should be managed with symptomatic relief and observation. Intruded tooth should be allowed to erupt spontaneously, any intervention may lead to damage to underlying permanent tooth and may cause enamel abnormalities [9].

- **Permanent dentition** – dental injuries to permanent dentition have long term consequences involving the aesthetics. In crown fractured without pulp involvement, the fractured portion is restored using permanent restoration such as glass ionomer or composite resin. Fractures involving pulp require endodontic treatment such as pulp capping or partial pulpotomy in immature tooth (open root apex or incomplete root formation) and pulpectomy in mature tooth (closed root apex) depending upon the extent of pulp exposed. In case of crown-root fracture, the tooth should be splinted for 3 weeks. Root canal therapy is essential if pulp necrosis take place [5].

- In **root fracture**, the rigid splinting of tooth is applied for 2 to 3 weeks to aid in hard tissue formation, followed by endodontic treatment of tooth. In case of transverse fracture of middle third of root, the fractured segment should be removed and replaced by an implant [9].

### Use of Resorbable Plates

In case of complex fractures which show severe displacement require management with open reduction and internal fixation (ORIF). Usually metallic plates like titanium miniplates are used for ORIF, but their use may lead to occurrence of infection, foreign body reaction, increased risk of injury to developing dentition, and effect on bone growth. To avoid these complications in pediatric patients, it becomes necessary to perform secondary surgery in order to remove the metallic plates. This has led to the advent of resorbable plates as a viable alternative [10].

Bioresorbable plates with different mixtures and combinations of polymers derived from polyglycolic acid (PGA) and polylactic acid (PLA) are used for fixation. Earlier, L enantiomer of Poly(L-lactic) acid [PLA] was used for fixation, as its degradation occurred more than 5 years after initial placement, it led to occurrence of complications such as delayed presentation of swelling and foreign body reactions at the peri-implant site. Later came the use of amorphous mixtures of poly(L-lactic), poly(D-lactic) and PGA, which show complete degradation by 6 to 12 weeks [10].

Now-a-days INION plates are used which are composed of a mixture of poly-L-lactide/poly-D-lactide, trimethylene carbonate and PGA, these retain 70% of their strength 9 weeks after initial placement. The use of a tripolymer, that is, INION, a viable alternative has been shown to retain strength at greater than two months post-operatively.

However, INION plates may develop hardware exposure by 3 to 4 weeks post-operatively which resolve without the need for hardware removal [10].

### Complications

Pediatric facial fracture management present unique challenges, as it might affect the growth at the site of fracture [12]. As compared to adults, children have greater regenerative potential and capacity for significant dental compensation, so complications are less compared to adults [11]. The complications can be :-

#### 1) Ankylosis

This is a complication that occurs due to trauma to the TMJ region resulting in fracture of the condyle or high subcondylar region which can lead to bone formation in and around the condylar head/glenoid fossa. Inadequate reduction of mandible fractures can lead to fixation with resultant mandibular widening and a condyle that functions lateral to the glenoid fossa, and often result in bony ankylosis. Treatment of ankylosis involve resection of the bony ankylosis followed by reconstruction with a costochondral graft or distraction osteogenesis [2].

#### 2) Growth Disturbance

The growth disturbance following trauma to the mandible is an uncommon complication and may present as post-injury mandibular hypoplasia. This is most often noted as chin point deviation along with dental midline discrepancies. A panoramic radiograph (orthopantomogram) confirms clinical suspicion for hypoplasia of the mandible following trauma. Treatment will be dependent upon age and severity of the asymmetry – most often, surgical correction will include orthodontics in conjunction with orthognathic surgery [2].

#### 3) Malunion/Malocclusion

**4) Dental Injury** repercussions, such as pulp necrosis and periapical inflammation, pulp canal obliteration, root resorption and developmental dental anomalies, associated with trauma of the tooth germ [9].

Careful long-term follow-up and subsequent interventions by specialists are mandatory to timely diagnose and successfully treat these complications [9].

### Conclusion

The treatment of mandible fracture in children require thoughtful consideration in management to avoid further injury to developing dentition and significant growth disturbance. The evaluation and diagnosis of mandibular fractures in children is similar to adults but the treatment differs, as mandible in children is warehouse of developing dentition (tooth buds), which affects the overall treatment

plan. A surgeon should have thorough knowledge of the dentition and growth process while treating mandible fractures in growing patients. Early and timely treatment is required for managing pediatric mandible fractures as, delay in any treatment whether conservative or surgical can lead to complications such as malunion, ankylosis, or facial asymmetry, open reduction internal fixation is indicated in case of severely displaced comminuted fractures or in older compliant children.

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