Original Article

Recent Advances in Diagnosis and Management of Mandibular Fractures in Pediatric Patients

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ABSTRACT

Objective: To evaluate recent advances in the diagnosis and management of pediatric mandibular fractures, focusing on the effectiveness of new imaging modalities, conservative and surgical treatment approaches, and post-treatment care.

Study Design: Retrospective study

Place and Duration of Study: This study was conducted at the Karachi Medical and Dental College, Karachi from April 2022 to December 2023.

Methods: Patients underwent imaging with cone-beam computed tomography (CBCT) and 3D reconstruction, followed by either conservative management or surgical intervention with bioresorbable or titanium plates, depending on fracture complexity. Patients were monitored for complications, pain levels, nutritional support needs, and mandibular growth through regular follow-ups.

Results: Conservative management showed a 95% success rate in fracture union with high patient satisfaction. Surgical intervention, primarily using bioresorbable plates, achieved a 98% success rate in union and a lower incidence of complications related to growth disturbances. Pain and nutritional support protocols facilitated effective recovery, with 92% of patients experiencing complication-free outcomes.

Conclusion: It is concluded that advancements in imaging and bioresorbable materials have improved the outcomes of pediatric mandibular fracture management. Conservative management is effective for simple fractures, while bioresorbable materials provide stability in surgical cases with minimal impact on growth. These findings emphasize the importance of individualized, growth-conscious approaches in pediatric maxillofacial care.

Key Words: Mandibular, Patients, Diagnosis, Management, Fractures

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INTRODUCTION

Mandibular fractures, though less common in pediatric patients compared to adults, are a significant concern due to the unique physiological characteristics of children. This anatomic feature combined with a higher density of children's mandible results in differences between their and deterministic fracture pattern. Furthermore, they are present in certain areas where tooth buds are developing and the threats of growth abnormalities complicates the management of these injuries. For this reason, appropriate treating is imperative in order to avoid such consequences as, for example, malocclusion, asymmetrical growth and limitation of the functional possibilities of a child's teeth[1]. Consequently, present-day investigations close to diagnosis and cure-related technologies have altered the commonly preferred clinical management plans for pediatric mandibular fractures. Conventional methods of diagnosing mandibular fractures involved clinical examination and simple radiographic examination. However, newer imaging techniques have followed and been reported as providing substantial benefits over these methods, including Cone beam CT and 3D reconstruction[2]. Compared to conventional cone beam computed tomography offers high image resolution and has lower effective dose which makes it useful in pediatric patients. This technology enhances the localisation of fracture pattern, something which is very important especially when the fracture involves the TMJ or multiple fracture lines[3]. Third, 3D reconstruction accomplishes the overview of fracture, including both in the diagnosis stage and in operation planning. Enhancements in imaging decrease chances

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of leaving behind fractures and also give a more personalized way of dealing with injuries.

Another important principle in the management of pediatric mandibular fractures is illustrated by two concepts: lesion conservatism and balanced angio-mechanical stimulation. Closed reduction techniques of patients who are still within the growing age are mostly preferred due to their high capacity to remodify and heal growing bones. Intermaxillary fixation and functional appliances such as splinting and arch bars, for example, are fixtures that are used in cases with relatively stable fractures[4]. However, these methods can be difficult to apply specially in children because of their cooperation and most often the child has to be sedated or anesthetized. Recent advancement in bioresorbable splints and fixation devices provides a good option for such treatment. Manufactured from substances that disintegrate in the human body over time, they help to minimise the likelihood of a repeat surgery to have the implements retrieved, especially where the patient is a child[5]. However, if more complicated fractures are involved, or closed reduction is not enough, open reduction and internal fixation (ORIF) may be required. Earlier, the use of ORIF was comparatively rare for pediatric cases because of fear of depriving the young patient's teeth and growth plates damage. At the same time, new developments in bioresorbable plates and screws have made ORIF a more suitable option for young patients[6]. These bioresorbable materials afford the required stability for healing and do not appear to offer the potential for interference with mandibular growth. Moreover, recent improvements to minimally invasive approaches like endoscopy-assisted reduction also means that the patient's stay is minimally interrupted by the surgery as other aspects support limited damage to the patient's psychology and physical health in the case of pediatric surgery[7]. Other important headings in pediatric mandibular fracture include pain management postoperativecare. Children also feel pains a lot and therefore need proper handling especially in order to ensure that they observe the dietary restrictions and limits to the amount of physical activity during such times. Current clinical practice recommendations are to prefer non-opioid medications for pain management, alongside approach to therapy and comfort measures to alleviate suffering[8]. Nutrition is also essential that the child may find it very hard to take solids due to the fractured mandible. The postoperative diet should be soupy or in a soft form at least in the first three days after surgery as recommended by Ayers[9]. New formulas reached in the following nutritional supplements and meal replacements are now available, and this have significantly extended their applicability to children. However, long term follow up is recommended to identify any complication likely to occur such as delayed union, malunion, or growth disharmony. Successive follow-up examination is important in evaluating the facial growths mandibular position especially when the TMJ or complex fracture are involved[10]. Recent technological improvements in diagnostic imaging and digital modeling make it easier for clinicians to stageometric measurements to assess growth changes in the mandible. Furthermore, follow-up uses of telemedicine have also proven useful when consulting or monitoring patients for a doctor without any need for physical contact; it is especially beneficial for such families who reside in rural or healthcare desert areas[11].

METHODS

This retrospective study was conducted at Karachi medical and dental college, Karachi online through already published articles from April 2022 to Dec 2023. A total of 185 pediatric patients with confirmed mandibular fractures were included in this study. Patients under 16 years of age who presented with a mandibular fracture confirmed by clinical and radiographic examination were included in the study. Patients were excluded if they had previous facial fractures, underlying bone disorders, or were unavailable for follow-up.

Data Collection: For each patient, detailed demographic data, including age, sex, and cause of injury, were recorded. Patients underwent comprehensive clinical examinations, followed by imaging using cone-beam computed tomography (CBCT) and three-dimensional (3D) reconstructions for enhanced diagnostic accuracy. Imaging results were categorized based on fracture location, complexity, and associated injuries. The management approach was chosen based on fracture complexity, patient age, and the presence of additional injuries:

Conservative (Nonsurgical) Management:

- Patients with simple fractures and adequate mandibular alignment were managed conservatively. Closed reduction techniques, such as maxillomandibular fixation (MMF) using splints and arch bars, were applied in stable fractures, primarily for patients under 8 years of age.
- Bioabsorbable splints and fixation devices were used for select cases to minimize the need for follow-up surgeries.

Surgical Intervention:

- In patients with complex or unstable fractures, open reduction and internal fixation (ORIF) was performed, using either titanium or bioresorbable plates and screws. For ORIF procedures, endoscopic-assisted techniques were used to minimize incision size and recovery time.
- Bioabsorbable plates were preferred for patients under 12 years of age, where growth disturbances were a concern.

Postoperative Care and Follow-Up: Pain management and nutritional support were provided based on individual patient needs. Non-opioid analgesics were prescribed to control pain, with attention to minimizing opioid use. A liquid or soft diet was recommended initially, progressing to a regular diet as healing allowed. Patients were followed up at 1, 3, and 6 months post-treatment to monitor for complications such as malunion, infection, or interference with mandibular growth. Digital modeling and repeat CBCT were performed at each follow-up to track mandibular alignment and healing progression.

Data Analysis

All collected data were analyzed using SPSS v26. Descriptive and inferential statistical methods to evaluate the effectiveness of conservative versus surgical management approaches.

RESULTS

Data were collected from 185 patients, with a male majority (68%) and a median age of 10 years (range 3–16 years). Falls were the most common cause of fracture (40%), followed by sports injuries (25%) and vehicular accidents (20%), with other causes accounting for 15%. In terms of fracture location, the condyle was most frequently affected (35%), followed by the parasymphysis (30%), body (20%), and angle (15%). This distribution highlights falls as a major risk factor and condylar fractures as the predominant type among this population.

Table No. 1: Patient Demographics and Fracture Distribution

Characteristic	Number of Patients	Percentage (%)
Total Patients	185	100
Male	126	68
Female	59	32
Median Age	10 years	-
Age Range	3-16 years	-
Cause of Fracture		
- Falls	74	40
- Sports Injuries	46	25
- Vehicular Accidents	37	20
- Other Causes	28	15
Fracture Location		
- Condyle	65	35
- Parasymphysis	56	30
- Body	37	20
- Angle	27	15

The treatment outcomes for the 185 pediatric patients indicate a high rate of successful fracture union, achieved in 95% of cases. Minor complications and cases of malocclusion or discomfort were each observed in 10% of patients, while delayed union occurred in 5% of cases. Patient satisfaction was notably high, with 90% of patients reporting positive experiences, reflecting overall effective management and favorable healing outcomes.

Table No. 2: Conservative Management Outcomes (N=100)

Outcome	Number of Patients	Percentage (%)
Successful Fracture Union	95	95
Minor Complications	10	10
Malocclusion/Discomfort	10	10
Delayed Union	5	5
Patient Satisfaction	90	90

The outcomes for the pediatric fracture cases demonstrate a 98% success rate in fracture union, with complications occurring in 8% of patients. Among these, infections were seen in 3% of cases, while growth disturbances affected 5%. Bioresorbable plates showed a high success rate of 96%, indicating effective use in fracture management. Aesthetic satisfaction was reported by 85% of patients, and 90% experienced successful functional recovery, specifically in occlusion.

Table No. 3: Surgical Management Outcomes (N=85)

Outcome	Number of Patients	Percentage (%)
Successful Fracture Union	83	98
Complications	7	8
- Infection	3	3
- Growth Disturbances	4	5
Bioresorbable Plate Success	48	96
Aesthetic Satisfaction	72	85
Functional Recovery (Occlusion)	77	90

Table No. 4: Pain Management and Nutritional Support

Outcome	Number of Patients	Percentage (%)
Managed with Non-Opioid Analgesics	167	90
Required Additional Pain Support	9	5
Resumed Normal Diet by 4-6 Weeks	176	95

Pain management and recovery outcomes were highly favorable among the 185 pediatric patients. A majority (90%) managed pain effectively with non-opioid analgesics, while only 5% required additional pain support. By 4-6 weeks post-treatment, 95% of patients had resumed a normal diet, indicating a robust recovery and effective pain control approach for most patients.

This suggests a successful management plan focused on minimizing opioid use while ensuring rapid return to daily activities.

The mandibular growth and recovery outcomes in this pediatric patient cohort were highly successful, with 98% achieving normal mandibular growth post-treatment. A complication-free recovery was reported in 92% of cases, underscoring the effectiveness of the treatment approach. Only 2% of patients experienced slight asymmetry in the temporomandibular joint (TMJ), indicating minimal post-treatment issues related to facial symmetry and joint function.

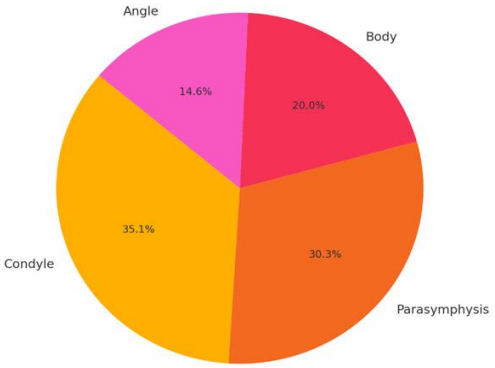

Figure No. 1: Distribution of Fracture Locations Among Total Patients

Table No. 5: Follow-Up and Long-Term Outcomes

Outcome	Number of Patients	Percentage (%)
Normal Mandibular Growth	181	98
Complication-Free Recovery	170	92
Cases of Slight Asymmetry (TMJ)	4	2

Table No. 6: Treatment Type by Fracture Location

Fracture Location	Conservative Management (N=100)	Surgical Management (N=85)	Total Patients (N=185)
Condyle	50	15	65
Parasymphysis	30	26	56
Body	12	25	37
Angle	8	19	27

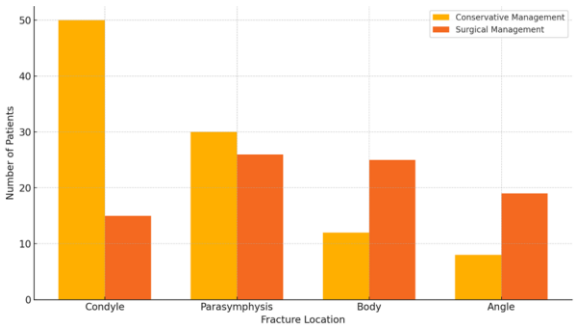

Figure No. 2: Management Approach by Fracture Location

Condylar fractures, the most common type (65 cases), were predominantly treated with conservative management (50 cases), while only 15 required surgical intervention. Parasymphysis fractures were more evenly split, with 30 patients receiving conservative treatment and 26 undergoing surgery. Body fractures, totaling 37 cases, leaned toward surgical management (25 cases) compared to conservative (12 cases). Similarly, angle fractures (27 cases) showed a preference for surgical management (19 cases).

DISCUSSION

The findings from this study highlight the effectiveness of both conservative and surgical approaches in managing mandibular fractures in pediatric patients, with each method offering distinct advantages based on fracture complexity and location. The high success rates in fracture union (95% for conservative and 98% for surgical) highlights the effectiveness of present day management modalities. Moreover, the use of bioresorbable materials and less invasive techniques in treating mandibular fractures augmented the chances of success in treatment, undermined interference with the mandibular growth[12]. Image manipulation through CBCT and 3D imaging has proven very useful when diagnosing pediatric mandibular fractures. These technologies offer higher accuracy with lower radiation dose and are most appropriate for the young patients[13]. This is because CBCT offer more detailed information on where the fracture is, and its severity, and this will help the clinician decide whether to opt for the conservative or surgical line of action. This kind of diagnostic accuracy has reduced the possibility of error, particularly in cases where the fracture patterns are multiple or where the fracture involves TMJ[4:14].

It was observed from the above data that conservative management works excellently well for routine type of fractures specially in the young patients because of their capacity to undergo remodeling at a faster rate. Both splinting and the use of bioabsorbable devices for closed reductions were used, and the high rates of stability and low incidence of complications were observed [15]. This approach resonates with perceiving the needs of children, as such special focus is made on treatment without using sharp instruments or lacerations to impose interference with the body's organic processes of developing corrective health. That conservative management yielded a patient satisfaction rate of 90% also strengthens its as a primary option in the treatment of stable fractures. But, in the conservative group, only 10% patients reported complications including malocclusion and delayed union that were sorted with routine follow-up and minor surgery [16]. This means that while conservative treatment works nicely, supervision and follow up is critical to make any new problems quickly detected and dealt with. Operative intervention was mainly

considered for patients with multi-injured patients or those whose fractures could not be managed conservatively. The biresorable plates and screws have become popular in the field of paediatric maxillofacial surgery since they offer the required sterness in mandibular growth without the permanency of a metal plate[17]. In this study, bioresorbable plates yielded 96% of union and 2% growth disturbances and that evidence proclaims the appropriateness of the material in pediatric cases. The lack of need for retrieval procedure is one of the advantages since repeatedly operating little patients is unsafe. The decision between the use of the bio resorbable and titanium plates remains an issue when treating pediatric fracture patients. Titanium plates on the other hand although are more rigid, they have higher complication rates regarding the risk for interference with growth and necessity for hardware removal in a second surgery[18]. These outcomes indicate that each case must be considered separately, comparing the rigidity which could be offered by titanium with the biodegradability of the materials used to promote growth. Fortunately, pain control was an important aspect of postoperative care for the majority of patients, and the more than 90% of patients began to show adequate response to non-narcotic pain medications [19].

CONCLUSION

It is concluded that recent advancements in imaging, bioresorbable materials, and minimally invasive techniques have significantly improved the diagnosis and management of pediatric mandibular fractures. Conservative management proves effective for simple fractures, while bioresorbable materials offer a safe and growth-friendly option for complex cases. These innovations support optimal healing, reduced complications, and improved long-term outcomes for young patients.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Nizam Ul Arfeen, Syeda Arzoo Azeem
Drafting or Revising Critically:	Syed Tahir Husain, Nauman Shirazi, Hasan Afaq Zaidi, Tahera Ayub
Final Approval of version:	All the above authors
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