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COMPARISON BETWEEN CAST AND FLEXIBLE INTRAMEDULLARY NAILING IN THE MANAGEMENT OF PAEDIATRIC FOREARM FRACTURES.

Orthopaedics

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ABSTRACT

Introduction: Forearm fractures are common among children. Traditionally they are managed with closed reduction and cast immobilization. The last decade there is an increasing trend towards operative treatment, including plate and screws, flexible intramedullary nailing and external fixation devices. The aim of this study was to compare the outcome of cast and flexible intramedullary nailing in the management of paediatric forearm fractures. **Materials and methods:** In this study comparison of closed reduction and cast immobilization to flexible intramedullary nails in 7-14 year old children with > 10° of angulation and/or > 10mm of shortening in displaced both bone forearm fractures was done. A total of 24 patients with forearm fractures were enrolled and were distributed randomizedly in 1:1 ratio to either treatment group. **Results:** Final assessment of functional score using Price CT et al scoring, among the patients treated with flexible intramedullary nailing 11 (91.67 %) of patients showed excellent results and 1 (8.33 %) good results. None of the patients had fair or poor results. In the patients managed with conservative treatment, 8 (66.67 %) of patients showed excellent results, 1 (8.33 %) good, 2 (16.67%) fair and 1 (8.33 %) poor. **Conclusion:** Non-operative management with closed reduction and casting is still the gold standard of treatment for the majority of pediatric forearm fractures, especially in children less than 10 years old. However, in older children with less remodeling potential, the decision to surgically intervene is on the rise. Flexible intramedullary nailing is advantageous because of less soft tissue disruption and decreased surgical times, but surgeons must be aware of the slightly need for hardware removal after bony union.

KEYWORDS

Paediatric, Fracture, Forearm, Management, Reduction, Cast immobilization, Flexible intramedullary nailing

INTRODUCTION

Fractures of the forearm are one of the most common injuries seen in paediatric population [1, 2]. It is estimated that the forearm fractures account for 6-10% of children's fractures [3]. 81% of forearm fractures happen to children over the age of 5, with the peak of incidence between 10 and 12 years of age in females and 12 and 14 in males. The mechanism of trauma is directly related to falling on the palm of the hands [4].

Understanding pediatric forearm anatomy offers important guidelines for treatment in the non-operative and operative settings. Most of these fractures can be treated by closed means with reduction and cast immobilization. However unstable or open injuries often require surgical treatment to maintain adequate alignment [5,6].

Conservative treatment:

Conservative management (reduction and casting) is the golden standard in closed paediatric forearm fractures, especially in children younger than 12 years of age. There is abundant evidence, that non-operative treatment of most forearm fractures gives satisfactory long-term cosmetic and functional outcomes [7-11].

Operative management:

Recent articles reported a more surgical management for pediatric forearm fractures. Operative treatment is warranted in patients with unacceptable alignment/loss of reduction following closed methods of treatment, nonunion, most open fractures, displaced floating elbow injuries, or those associated with severe soft tissue injury and re-fracture [12] and especially in the adolescent population (i,e, children older than 8-10 years old), the limits of acceptable displacement become more stringent and the likelihood of surgical intervention increases [13, 14]. Currently, there are 2 commonly employed methods of surgical fixation: flexible intramedullary nailing and ORIF with rigid plating or hybrid fixation.

Plate and Screw Fixation:

ORIF with plates and screws remains a commonly used surgical option in the pediatric population and may provide several advantages, including maximal ability to obtain an anatomic reduction and restore normal radial bow, which is thought to be critical for regaining forearm rotation. In addition, the mechanical stability of the construct may permit early range of motion, which may be important especially in an adolescent population who are more prone to elbow stiffness with prolonged immobilization. Disadvantages of this technique include more extensive dissection, slower rates of bony union, and cosmetically unappealing scars [15]. Although exact indications for ORIF are still debated, many authors advocate for plate fixation in older adolescents with less remodeling potential, in the setting of significant comminution, after re-fracture, or with loss of reduction after attempt at conservative treatment as callous formation may prevent easy passage of flexible nails.

Flexible intramedullary nailing:

Intramedullary (IM) fixation with titanium elastic nails (TENS) has emerged as the most common method for fixation of forearm fractures in skeletally immature patients [12,16]. The use of FIN by Metaizeau from Nancy, France, changed the trend of addressing long bone fractures. Proponents of this surgical technique cite preservation of local biology at the fracture site due to less surgical dissection, thus promoting the robust and expedient bony healing often seen in children [17].

This prospective study compared the clinical outcomes of cast and flexible intramedullary nailing in the management of paediatric forearm fractures.

MATERIALS AND METHODS

This prospective study was conducted at the govt. Bone and Joint Hospital Barzulla, an associated Hospital of Govt. Medical College, Srinagar from January 2020 to December 2020. In this study comparison of closed reduction and cast immobilization to flexible intramedullary nails in 7-14 (mean 10.5) years old children with > 10° of angulation and/or > 10mm of shortening in displaced both bone forearm fractures was done. A total of 24 patients with forearm fractures were enrolled and were distributed randomizedly in 1:1 ratio to either treatment group. There were 17 (70.83%) males and 7 (29.67 %) females among enrolled population (Table 1).

Table 1: Demography of patients

Parameters		Frequency	Percentage
Gender	Male	17	70.83
	Female	7	29.67
Age group	7-10 years	11	45.83
	11-14 years	13	54.17

Fracture type	Simple/closed	21	87.50
	Compound/open	3	12.50
Fracture location	Distal	13	54.17
	Mid diaphyseal	9	37.50
	Proximal	2	8.33
Fracture pattern	Transverse	21	87.50
	Oblique	3	12.50

Both treatments were performed under general anesthesia. In the cast group a long arm cast is applied for 6 weeks. The flexible intramedullary nail group was immobilized in a collar and cuff sling for 4 weeks.

Regular follow ups were done for both groups. Radiographs were taken at 6 weeks and bony union analyzed. The limb was immobilized till tricortical union was obtained.

Surgically managed patients were advised to follow-up at 1 week, 2 weeks, 6 weeks, 6 months and 1 year. Cast was removed at 6 weeks in most of the cases but had to continue for 8 weeks in few cases which were sequentially followed up with weekly radiographs. Implant removal was done at 6 months.

Conservatively managed patients were followed up at intervals of 1, 3 and 6 weeks and 3, 6 and 12 months. The position of reduction was check at each follow-up.

Functional outcomes were assessed using Price et al criteria [7] (Table 2). Complications like infection, restriction of movement, neurologic deficits were recorded during follow up visits.

Table 2: Outcome scoring as per Price CT et al

Symptoms	Loss of forearm rotation	Outcome
No. complaints with stemous exercises	15	Excellent
Mild complaint with stemous exercises	15-30	Good
Mild complaint with daily activity	30-90	Fair
All other results	>90	Poor

RESULTS

In surgical fixation group, tricortical union was seen by 6 weeks in 56% cases and by 8 weeks all the patients had tricortical union on radiographs (mean-6.32) weeks. On final evaluation there was no pain in all the patients. Loss of forearm supination and pronation movements was seen in 1 (8.33%) of patients (15-30 degrees loss of motion). No significant complications were observed except for superficial pin tract infections at site of entry of nail in 3 (25%) patients. However, no deep infection, malunion, non-union, nerve palsy, refracture and nail migration were observed.

In the second group (patients managed with conservative treatment) the fracture remained in acceptable reduction at final follow-up. Loss of reduction was noted in 2 (16.67 %) of patients. Mean union time was 7.87 (range 6-12) weeks. Delayed union occur in 2 (16.67%) and non-union in 1 (8.33%) of patients. However no infection, nerve palsy and nail migration were observed.

At the follow-up of one year assessment of functional score using Price CT et al scoring, among the patients treated with flexible intramedullary nailing 11 (91.67 %) of patients showed excellent results and 1 (8.33 %) good results. None of the patients had fair or poor results. In the patients managed with conservative treatment, 8 (66.67 %) of patients showed excellent results, 1 (8.33 %) good, 2 (16.67%) fair and 1 (8.33 %) poor (Table 3).

Table 3: Price CT et al scoring at the final follow-up of one year

Parameters	Flexible intramedullary nailing group		Closed reduction and cost immobilization group	
	Frequency	Percentage	Frequency	Percentage
Excellent	11	91.67	8	66.67
Good	1	8.33	1	8.33
Fair	0	0	0	0
Poor	0	0	3	25

DISCUSSION

The majority of pediatric forearm fractures are treated with closed reduction and casting [18]. Historically closed reduction and POP cast immobilization has been the mainstay of treatment for fractures in both bones of forearm in children. However, fractures tend to re-displace especially in older children and when at more proximal location. How much mal-reduction is acceptable has always been a matter of great debate. As mentioned in literature, angular deformity >10° and complete displacement account for unacceptable reduction [12,19].

Unacceptable reduction, segmental fractures, unstable fracture pattern, open fracture, loss of reduction, and compartment syndrome are considered as indications for surgical intervention in cases of diaphyseal fractures of the radius and ulna [20]. Recently flexible intramedullary nailing has been widely performed for pediatric forearm fractures. Intramedullary fixation of the forearm fracture is a safe, effective, and accessible technique. Re-fracture following forearm fracture in children occurs in about 5% of the cases [21]. However, re-fracture with the intramedullary nail in situ is not common.

In present study, majority of children were in age group of 11-14 years with mean age of 10.5 years. Near about equivalent observations were also made by Qidwai SA (11 years) and Garg NK et al., (11.8 years) [22, 23]. So mean age of incidence can inferred to be 11 years.

In present study, there were 21 patients with simple (closed) fractures constituting 87.50% of total patients and 3 patients with compound (open) fractures constituting 12.50% of total patients which is equivalent to the previously done studies. Kang SN et al. mentioned in his study that 9% of their patients had open fracture and remaining (91%) were closed. This can be due to the fact that the injuries in children are low energy injuries [24].

In contrast to their adult counterparts, non-operative treatment is used for the vast majority of pediatric diaphyseal forearm fractures and is still considered to be the gold standard of care [5,25]. Multiple studies in the literature seek to provide guidelines as to how much radiographic deformity can be accepted to achieve reasonable functional outcomes, and to date, there is no consensus. Generally speaking, closed reduction is indicated in patients under 8-10 years old with angulation of greater than 10° and mal-rotation greater than 30° [20]. Up to 1 cm of bayonet apposition may be accepted in patients under 10 years old with satisfactory outcomes [26]. Current recommendations for what constitutes an acceptable reduction are based on the remodeling potential (i,e, proximity of the fracture to the distal physis and the age of the patient. If closed manipulation can maintain reduction within this range, functional outcomes are usually satisfactory. Several cadaveric studies have demonstrated loss of forearm motion with greater than 15-20° of residual angulation. Ultimately, however, radiographic alignment has not proven to directly correlate with clinical forearm rotation and functional outcome [7].

In this study loss of reduction was found in 2 (16.67%) of patients, which may occur in 5%-25% of these patients and usually occurs within the first few weeks following closed reduction. In a review of 282 patients treated with closed reduction and casting, Bowman et al found that most failures were likely to present within the first 3 weeks in children 10 years of age or older with proximal third radius fractures and ulnar angulation of less than 15°. This finding is consistent with earlier data that suggested older age, and greater initial angulation are predictors of early failure [13, 27]. Franklin et al found that patients who were ultimately converted to open treatment were more likely to be older, have less angulation in the coronal, have a more proximal ulnar fracture, and have a more translated or shortened radius fractures [28]. In addition, obesity has been identified as an important risk factor for failure of nonsurgical management of BBFF in children. Several recent studies have demonstrated that patients with high BMI are more likely to lose reduction, require reduction in the operating room and have more follow-up appointments with greater radiation exposure [29, 30]. Thus, providers should have a low threshold to employ surgical fixation techniques in these patients.

Patients who have undergone reduction should be seen at weekly intervals for the first several weeks to monitor for any loss of reduction. Many risk factors are proposed for the cause of loss of reduction. Fracture related factors include location of the fracture, obliquity of fracture and severity of initial displacement. Loosening of cast as a

result of decrease in initial swelling is an important patient related factor for loss of reduction. A loosely applied and poorly moulded cast is an important surgeon related factor leading to re-displacement of fracture.

The patient and fracture related risk factors are largely beyond the surgeon's control. However a good casting technique can decrease the risk of re-displacement and improve the treatment outcomes. A well moulded cast of the forearm with adequate interosseous moulding are important. Several casting indices have been described by various authors to assess the cast quality and predict the risk of fracture re-displacement.

At that point, as long as there is sufficient evidence of bony healing, patients may be transitioned to a short-arm cast and are generally maintained in this cast until 6 weeks post injury. At this point, some authors advocate for a transition to a removable splint due to the risk of re-fracture. Re-fracture occurs in approximately 4%-7% of patients within the first year after a BBFA fracture, and most commonly occurs when there is incomplete healing at the time of cast removal [31]. Patients and families are counseled to use caution and limit high impact activities during this period. Failure of non-operative treatment of BBFF is rare, with 90% of these injuries being amenable to closed reduction and casting [12].

Unacceptable reduction, segmental fractures, unstable fracture pattern, open fracture, loss of reduction, and compartment syndrome are considered as indications for surgical intervention in cases of paediatric forearm fractures [23]. Recently, flexible intramedullary nailing has been widely performed for pediatric forearm fractures. Intramedullary fixation of the forearm fracture is a safe, effective, and accessible technique.

Although there are several small series reporting results, few have prospectively assessed the functional outcome [6, 32, 33]. In this study the reported complications were seen in 4 (33.33%) which is more stated in previously done studies where the reported range of complications of FIN ranges from 12% to 21% [12, 27, 34]. In this study the noted complications were loss of forearm supination and pronation movements in 1 (8.33%) of patients (15-30 degrees loss of motion), and superficial pin tract infections at site of entry of nail in 3 (25%) patients which were subsided with antibiotics. However, complications included by previously done studies are neurologic deficits, delayed union [35], nonunion, compartment syndrome [34, 36], extensor pollicis longus tendon rupture [37-39], and infection. Additionally, some consider the second surgery necessary to remove the implants a disadvantage of this surgical technique.

Our study is limited by a small sample size. Large prospective studies are required to establish ideal casting characteristics especially in proximal and mid diaphyseal fractures given their stricter acceptability criteria and higher impact on functional outcomes.

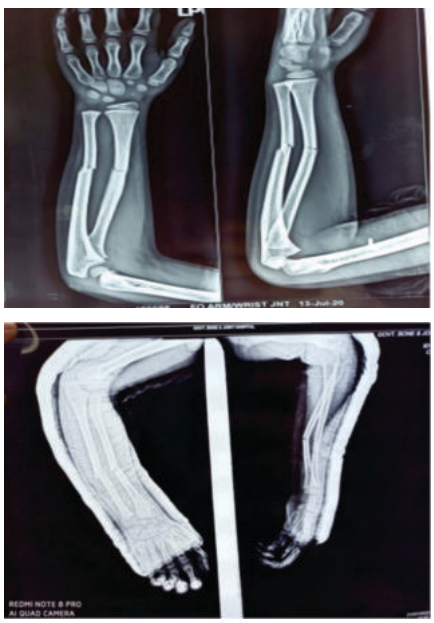

Figure 1:

CONCLUSION

Non-operative management with closed reduction and casting is still the gold standard of treatment for the majority of pediatric forearm fractures, especially in children less than 10 years old. However, in older children with less remodeling potential, the decision to surgically intervene is on the rise. Flexible intramedullary nailing is advantageous because of less soft tissue disruption and decreased surgical times, but surgeons must be aware of the slightly need for hardware removal after bony union.

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