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Functional outcome of both bone fracture forearm managed with titanium elastic intramedullary nail system in pediatric age group

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Abstract

Background: Both bone fracture in skeletally immature patients is one of the most common fracture. This is a prospective study on functional outcome of both bone forearm fractures fixed with titanium elastic nailing system in pediatric age group.

Methods: In this study all the patients aged below 15 years of age who were admitted during the period of 2014 to 2017 in a tertiary care centre for surgical intervention for diaphyseal fracture of both bone forearm. In 42 patients admitted 27 patients were selected for the study depending on the inclusion and exclusion criteria. All patients were operated under general anesthesia and followed up for minimum period of 6 months. Functional outcome of these patients was noted by price *et al* criteria.

Results: The study included 27 pediatric patients of both bone forearm fractures that were operated. In 27 children 8 were female and 19 were male. Mean age of patients 10.2 years range 4-15 years. Average union time was about 10.5 weeks with no incidence of nonunion. Complication such as superficial infection at the entry point even though present incidence were low. Based on Price *et al.*, criteria functional outcome was calculated which showed excellent results in 20 (74%) patients, good in 5 (19%), fair in 2(7%) and no poor results.

Conclusion: Both bone forearm fractures in pediatric age group in quite challenging fracture to treat because these fractures are associated with angulations, rotation and displacement. Titanium elastic nails are provides exceptional mode of fixation providing superior union rates, promoting early callus formation and provides early functional recovery.

Keywords: Titanium elastic nail, functional outcome, fractures of both bone forearm, surgical intervention, price criteria

1. Introduction

Fractures of both radius and ulna are the most the most common diaphyseal injuries in pediatric age group which accounts for 5% to 10% of pediatric fractures^[1,2].

These diaphyseal fractures are more common distally than proximally. Reason being proximally both bone cylindrical and covered with thick envelope of muscle which give protection were as distal more ovoid and covered by tendons vowing for high risk of injury^[1,2-6]. Managing both bone forearm fracture requires both cognitive and technical skills for understanding the nature of fracture and to select ideal mode of treatment. Traditional method of treating both bone fracture forearm by closed reduction and cast immobilization which has given reasonable results but in irreducible, displaced fractures have relatively poor functional outcome. The failure rates is as high as 32 %in displaced fractures^[3,4].

Established closed reduction criteria state that complete translation is acceptable, as well as up to 15 degrees of angulations and up to 45 degrees of malrotation^[5]. More than 15 degree angulation and 45 degree malrotation may result in malunion and functional loss^[5].

Operative indication included open fractures, compartment syndrome, floating elbow, fractures with gross displacement and failure of closed reduction. Various operative techniques for fixation both bone forearm fracture include plate and screw fixation, intramedullary fixation with rush pin or titanium nails and external fixator. Use of titanium elastic nailing system for intramedullary fixation is gaining popularity.

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2. Materials and methods

In this study all the patients aged below 15 years of age who were admitted during the period of 2014 to 2017 in a tertiary care centre for surgical intervention for diaphyseal fracture of both bone forearm. A sample size of 42 patients was considered in the study. The complete data was collected from the patients in a specially designed Case Record Form (CRF) by taking history of illness and by doing detailed clinical examination and relevant investigations.

Finally after the diagnosis 27 patients were selected for the study depending on the inclusion and exclusion criteria. Post operatively all the cases were followed for the minimum period of 6 months.

The inclusion criteria

- skeletally immature patients aged between 4-15 years
- all closed both bone forearm fractures which were displaced and could not be corrected by closed reduction, angulation more than 10° and rotation of more than 45°
- both bone fracture with failed closed reduction
- open fractures type 1,2

Exclusion criteria

- age beyond 4 to 15 years
- isolated bone forearm fractures
- fractures undisplaced angulation less than 10° and rotation of less than 45° that

Could be reduced with closed manipulation and casting

- open fractures type 3
- pathological fractures
- Fractures associated radioulnar joint dislocation.

2.1 Surgical method

Preoperative planning was essential regardless of which non operative or operative method chosen. Assessment of the fracture, including rotation and the presence or absence of comminution, is important. 2.0 to 3.0 mm size flexible nail was used for either bone. By measuring the medullary diameter preoperatively in x ray appropriate size of the nail was decided.

All patients were posted for surgery after evaluating with x-ray of the forearm and routine investigation. Under general anesthesia patient was put in supine position affected arm resting on radiolucent side table. After carefully painting and draping trail closed reduction attempted and percutaneous intramedullary nailing was executed. If the fraction reduction was unacceptable then fracture site was opened through a limited incision and fixed with the titanium intramedullary nail.

The radial bone entry is made proximal to radial styloid or listers tubercle making a small incision of one centimeter. Using bone awl entry made in to medullary cavity. Titanium nail of appropriate size is introduced into bone, proximal end of the nail being present for smooth passage in medullary canal. Using a T

handle nail is pushed or hammered to fracture site, fracture reduced manipulating externally guided by fluoroscopy. Nail advanced till proximal metaphysis. The ulna entry point was through lateral surface of olecranon 2-3 cms distal to olecranon physis or 2 cms proximal to distal ulna physis depending on the fracture site. Fracture reduced manipulating externally, nail passed to reach the other end. Skin closed with one or two stitches. An above elbow slab applied for 3 weeks and changed to below elbow till the radiological signs of union is seen. Physiotherapy was started at elbow in form flexion and extension at 3 weeks supination and pronation was started after 6-8 weeks depending on 6 week follow up x-ray. All patients were followed up for a minimum period of 30 weeks. Functional outcome of these patients was noted by price *et al* criteria table 2.

3. Results

This study was a prospective, time bound, hospital based study conducted in tertiary care centre in rural Karnataka for a period of 3 years from 2014 to 2017. The study included 27 pediatric patients of both bone forearm fractures that were operated. In 27 children 8 were female and 19 were male. Mean age of patients 10.2 years range 4-15 years. Mechanism of injury being 18 had fall while playing sports, 4 had road traffic accidents and rest 5 had history of fall from height. Right forearm involvement 16 patients and left forearm in 11 patients. Site of fracture most common was distal third 8 patients, middle third 15 patients and proximal third 4 patients. Closed fractures were 18 cases and open fracture (gustillo classification type 1 and 2) were 9 patients. Type of fractures transverse 15, oblique fractures 10 and 2 patients had comminuted fractures. Closed reduction without opening the fracture site was done in 20 patients and mini open approach opening at the fracture site was done in 7 patients who had difficulty in closed reduction. Average operation time was 45 minutes and average fluoroscopy time was 120 seconds. Period of immobilization with above elbow splint after operation was 3 weeks latter converted into below elbow splint depending on radiological signs of union and type of fractures, patients who were immobilized for less than 6 weeks 24 and more than 6 weeks were 3. Time taken for fracture to unite was calculated from time of operation 10 patients had union achieved by less than 10 weeks, 15 patients achieved union between 10 and 12 weeks and 2 patients took 14 weeks to attain fracture union. Mean time of implant removal 6.5 months after the operation between 4 months to 7 months depending on fracture union. Complication such as superficial infection was noted in 3 patients who were treated with oral antibiotics, refracture seen in 1 patient were reoperation was done and limb length discrepancy of less than 1 centimeter was seen in 2 patients. No incidence of fracture non union. Based on Price *et al*, criteria functional outcome was calculated which showed excellent results in 20(74%) patients, good in 5(19%), fair in 2(7%) and no poor results.

Table 1: Demographics data of 27 patients.

Criteria	Number
Gender:	
Male	19(70%)
Female	8(30%)
Mean age:	10.2 years
Site of Fracture:	
Proximal third	4(14%)
Distal third	8(30%)
Middle third	15 (56%)
Side	
Left Radius/Ulna fracture	11(41%)
Right radius/ ulna fracture	16(59%)
Type of fracture	
Close	18(67%)
Open fracture GA type I	6(22%)
Open fracture GA type II	3(11%)
Mechanism of injury:	
Road traffic accident	4(14%)
Sports injury	18(67%)
Fall from height	5(19%)
Fixation method:	
Close reduction and IM nail fixation	20 (74%)
Mini Open reduction and IM nail fixation	7 (26%)
Complication:	6 (22%)
Average follow up	30 weeks
Average time for union	10.4 weeks

Table 2: Grading system for functional outcome according to Price *et al.* criteria.

Grade	Symptoms	Loss of forearm rotation	Results in present study
Excellent	No complaints with strenuous activity	< 15°	23(85%)
Good	Mild complaint with strenuous activity	15° - 30°	3(11%)
Fair	Mild complaint with daily activities	31° - 90°	1(4%)
Poor	All other results	> 90°	0

4. Discussion

Restoring stability and early mobilization are the keys steps in reducing malunion and provide full functional range in pediatric both bone forearm fracture. Traditional method of treatment with closed reduction and casting of fixing both bone fracture had its own fallacy such failure of reduction, malunion, angulation and loss of function. In studies conducted by Thomas *et al*, Kay *et al*, Eric N. Bowman *et al*, showed failure of reduction was 39%,64%and 51% respectively and failure rates were more in children more than 10 years of age as bone remodeling is less [7-9]. Causes for these complication were complete displacement of fracture ends with no contact, angulations of more than 10° and malrotation of more than 45° [7]. Failure rates were more in middle and proximal third forearm fractures [7-9]. Malunited fracture with angulation or malrotation leads to limb length discrepancy and loss of function such as supination and pronation causing limitation in daily activities as described by Daruwalla *et al.*, and Morrey *et al.*, in their respective studies [10, 11]. In rare instances radio ulna synostosis is also been absorbed [12].

In our present study 47 patients were considered in which 27 patients met inclusion and exclusion criteria. In present study we included all both bone forearm fractures which were displaced and could not be corrected by closed reduction, angulation more than 10° and rotation of more than 45°.

Male patients were significantly higher about 70% in our study which was same as other studies [3, 4]. Fractures of middle third forearm were more common (56%). Most of the forearm fractures were closed fractures and were related to sport related to activities. Selecting the patients for conservative or operative

depended on displacement, rotation and angulation of fracture fragments. Fractures with more than 10° angulation and rotation of more than 45° were selected for operative management rest were treated conservatively. These parameter was obtained by the experience of cadaveric studies conducted Matthews LS *et al* [15] and Daruwalla JS [10] were they concluded the rotation more than 45° and angulation more than 10° leads to malunion and restriction of forearm rotation from 5% - 30 %.

Many methods of internal fixation were available such as open fixation with plate and screw commonly used in adults. In children fixation with rigid intramedullary nail like k nails, rush nails were used. More recently with advent of titanium elastic intramedullary nailing system its becoming more favored by surgeons. Advantages being provides a stable three point fixation, minimally invasive, preserve fracture hematoma and periosteal blood supply which promotes early fracture union. Three point fixation provides rotational stability, end to end reduction of the fracture fragments elasticity provides micro motion at the fracture site promotes early callus formation [13]. Three point fixation includes entry site at metaphysis, second point at opposite cortex inner wall of cortex at diaphysis at apex of nail near fracture site and third contact at other metaphysis were nail ends [13]. intramedullary nailing although not free of complication such skin irritation and infection at the nail insertion site, migration or implant breakage, refractures after implant removal, nerve and tendon injury decreased range of pronation and supination, nonunion, delayed union and compartment syndrome [4, 14]. infection, unsightly surgical scar, deformity and radio ulna synostosis will be significantly reduced.

In our study out 27 patients 20 underwent close reduction and 7 patients were close reduction was difficult due to soft tissue interposition and cannulation were opened minimally at the fracture site and fixed with titanium nails. Results of the present study was promising with 95 % good to excellent according to Price criteria, good union rates at 3 months and 6 months interval with average union time 10.2 years, no incidence of non union. complications were relatively few 3 patients had

superficial infection at entry site which subsided after oral antibiotics, one patient ha refracture for which reoperation was done which healed well, 2 patients 1 cm limb length discrepancy cause may be fracture comminution. 2 patients noted hardware irritation at entry site. No patient had limitation of movement, compartment syndrome, pin back out, nonunion or deformity. Our present results were comparable with other studies by Flynn *et al*, Richter D *et al*, Jeffery *et al* which has been summarized.



Fig 1: right bone bone fracture of 12 year old boy



Fig 2: right both bone fracture of 9 year old boy

Table 3

Study	Number of patients	Mean age (years)	Implant used	Average time of union radiologically	Functional criteria	Functional outcome	Complication
Flynn JM <i>et al</i> ⁴	103	10.6	Titanium nails	6.9-8.6 weeks	Children hospital of Philadelphia forearm fracture fixation outcome classification	Excellent= 77.7% Fair = 14.6% Poor= 7.8%	Major – 4 (3.8%) Minor-11(10.6%)
Richter D <i>et al</i> ¹⁶	30		Titanium Nails	13 weeks	Tscherne score	Excellent= 80% Good= 16.6% Fair= 3.3%	Minor= 4(13.3%)
S.-N. Kang <i>et al</i> ¹⁷	90	8.4(2-15)	Elastic nails	2.9 months (1.1 to 8.7)	Daruwalla criteria	Excellent 59 Good 17 Fair 5 Poor 9	Superficial radial nerve palsy 2 Compartment syndrome Delayed union 1 Malunion 1 Remodelled Wound-related problems 7 Failure to remove implant 1
Jeffrey E. Martus <i>et al</i> ¹⁸	203	9.7	TENs 97% 3% k=wires or Steinman pins		Clavien-Dindo classification with modifications	Excellent 163 Good 24 Fair 5 Poor 13	Overall complication 21% 17% were grade 2 or greater
Our study	27	10.2	TENS	10.4 weeks	Price et at	Excellent 16 Good 7 Fair 2 Poor 0	6 Minor complications

5. Conclusion

Both bone forearm fractures in pediatric age group in quite challenging fracture to treat. With advent of titanium elastic nailing system treating pediatric both bone forearm fractures which were unable to achieve reduction under closed manipulation, fractures with angulations, rotation and displacement has become simple. Titanium elastic nails are provides excellent union rates promoting early callus formation and provides early functional recovery. Hence titanium nailing system is a excellent method of managing pediatric both bone forearm fractures

References

1. Mann DC, Rajmaira S. Distribution of physeal and nonphyseal fractures in 2,650 long-bone fractures in children aged 0-16 years J Pediatr Orthop. 1990; 10:713.
2. Worlock P, Stower M: Fracture patterns in Nottingham children. J Pediatr Orthop, 1986; 6:656.
3. Shoemaker S, Comstock C, Mubarak S, Wenger DR, Chambers HG. Intramedullary Kirschner wire fixation of open or unstable forearm fractures in children J Pediatr Orthop. 1999; 19:329-37.
4. Fynn JM, Jones KJ, Garner MR, Goebel J. Eleven years' experience in operative management of pediatric forearm fracture, J Pediatr orthop. 2010; 30:313-19.
5. Price CT, Scott DS, Kurzner ME, Flynn JC. Malunited forearm fractures in children J Pediatr Orthop. 1990; 10:705-712.
6. Reed MH: Fractures and dislocations of the extremities in children J Trauma. 1977; 17:351.
7. Eric N Bowman, MPH, Charles T Mehlman, DO MPH, Christopher J. Lindsell, PhD, and Junichi Tamai, MD. Non-operative treatment of both-bone forearm shaft fractures in children: Predictors of early radiographic failure, J Pediatr Orthop. 2011; 31(1):23-32.
8. Thomas EM, Tuson KW, Browne PS. Fractures of the radius and ulna in children Injury 1975; 7(2):120-124.
9. Kay S, Smith C, Oppenheim WL. Both-bone midshaft forearm fractures in children J Pediatr Orthop. 1986; 6(3):306-310.
10. Daruwalla JS. A study of radioulnar movements following fractures of the forearm in children Clin Orthop. 1979; 139:114-120.
11. Morrey B, Askew L, An K *et al.* A biomechanical study of normal functional elbow motion, J Bone Joint Surg [Am]. 1981; 63:872-877.
12. Vince K, Miller J. Cross-union complicating fracture of the forearm Part II Children J Bone joint Surg. 1987; 69A:654-661.
13. Schemitsch EH, Jones D, Henley MB *et al.* A Comparison of Malreduction after Plate Fixation and Intramedullary Nail Fixation of Forearm Fractures, J Orthop Trauma. 1995; 9:8-16.
14. Akash Patel, Lily Li, Amarjit Anand. Systematic review: Functional outcomes and complications of intramedullary nailing versus plate fixation for both-bone diaphyseal forearm fractures in children Injury, Int J Care Injured. 2014; 45:1135-1143.
15. Mathews LS, Kaufer H, Garner DF, Sonstegard DA. The effect on supination- pronation of angular mal-alignment of fractures of both bones of the forearm J Bone joint Surgery Am. 1982; 64:14-7.
16. Richter D, Ostermann P, Ekkernkamp A, Muhr G, Hahn MP. Elastic intramedullary nailing: a minimally invasive concept in the treatment of unstable forearm fractures in children, J Pediatr Orthop. 1998; 18:457-61.
17. Kang SN, Mangwani J, Ramachandran M, Paterson JMH, Barry M. Elastic intramedullary nailing of paediatric fractures of the forearm. A decade of experience in a teaching hospital in the United Kingdom, J Bone Joint Surg [Br]. 2011; 93-B:262-5.
18. Jeffrey E Martus, Ryan K Preston, Jonathan G Schoenecker *et al.* Complications and Outcomes of Diaphyseal Forearm Fracture Intramedullary Nailing: A Comparison of Pediatric and Adolescent Age Groups J Pediatr Orthop. 2013; 33:598-607.