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Elastic intramedullary nailing in paediatric diaphyseal both bone forearm fractures

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Abstract

Both bone forearm fractures are prevalent orthopaedic injuries. Optimal treatment in paediatric population remains conservative management with closed reduction and immobilization with above elbow cast application. Although fracture unites readily with acceptable alignment due to structural realignment owing to its ability to remodel with remaining growth, malunion is very common. Stiffness of joints and compartment syndrome are other complications with conservative management. Irreducible, unstable, and open fractures usually require operative stabilization with K wires, Plate and screws, or intramedullary nailing. Plating has the advantage of being familiar to many surgeons and theoretically superior in its ability to restore radial bow with added disadvantages. Recently intramedullary nailing has changed the treatment scenario of diaphyseal both bone fractures in the children and adolescents.

The study aims to analyze the outcome and complications after elastic stable intramedullary nailing in paediatric diaphyseal forearm fractures.

Material and methods: Our series present 23 patients aged 5-15 years with displaced both bone forearm fractures with closed reduction and elastic stable intramedullary nailing under the C arm image intensifier. Among 23 patients, 15 patients were males, and 8 were females with a mean age of 11 years having 4 cases as open fractures.

Result: Most of the fractures healed within 5-8 months. We analyzed the results using the reference to union, symptoms, and range of motion of adjacent joints using Price *et al.* criteria for outcome evaluation. In our series, 18 cases (78.26%) had excellent, 3(13.04%) cases had good, 1(4.34%) case had fair, and 1(4.34%) had poor result due to delayed union. There was one case of delayed union, one case of transient palsies of the superficial radial nerve and 1 case with skin irritation over prominent ulnar hardware requiring early removal and infection in external nail insertion site in Radius in 1 patient and one case of tendon injury. At the final follow up after 8-9 months, we did implant removal with pain-free and without limitation of ADL.

Conclusion: One can achieve better functional and cosmetic outcomes by elastic stable intramedullary nailing. It is simple, cost-effective, less time consuming and having fewer complications.

Keywords: Elastic nailing, intramedullary, paediatric forearm fractures

Introduction

Diaphyseal fractures of both bone forearms are the third most common fractures in paediatric population and account for 13-40% of all paediatric fractures [1]. Fracture severity falls along a continuum from plastic deformity to significant displacement. The standard treatment of these fractures remains closed reduction and immobilization with the above-elbow cast application for 4-6 weeks. Although fracture unites very readily, malunion is very common. Stiffness and compartment syndrome are other complications with conservative management. Operative treatment is indicated for irreducible, unstable open or closed fractures, and those which displace in a cast either with closed reduction and k wire fixation or open reduction with the plate and screws. K wires don't provide stability. Plating has the advantages, being familiar to many surgeons, and it provides an excellent rigid fixation. But it is associated with a prolonged hospital stay, big scar, extensive periosteal stripping, compartment syndrome, and intraosseous membrane damage. The elastic nail has revolutionized the treatment of displaced fractures of both bone forearm in children and adolescents. Surgical management with elastic nail has been first described by Mataizeau and Ligor [2]. This provides a 3 point fixation and adequately prevents rotation. It acts as an internal splint and maintains alignment. The elastic nature of the

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nail maintains the radial bow throughout the bone healing process as it has the benefits of immediate stability to the involved bone segment. This permits early mobilization and returns to normal activities with fewer complications.

Material and Methods

A prospective study was done from March 2014 to September 2019. 23 paediatric and adolescent patients with displaced diaphyseal forearm fractures were treated with stainless/titanium elastic nail in Hi-Tech Medical College, Rourkela, Orissa. Among 23 patients, 15 patients were males and 8 were females.

Inclusion criteria

Age: 5-15 years

Displaced and open diaphyseal fractures

Exclusion criteria

Children <5 and > 15 yrs.

Physeal injury

With proximal and distal radio ulnar joint disruption

Surgical Technique

We put the patient in a supine position on OT Table with the affected forearm placed on a radiolucent table. In diaphyseal fracture forearm in children and adolescents 2mm, 2.5 mm, 3 mm diameter nail was used after calculating medullary diameter. Forearm nail size-2X medullary canal diameter in the midshaft forearm, the nail diameter should not be more than 40% of the width of the medullary canal size. Fixation usually starts with the bone that is easier to reduce. (Figure 1: showing 7 Years old child having compound fracture both bone forearm and Figure 5: showing preoperative x-ray showing fracture both bone forearm). A small 1 cm long incision performed on the lateral margin of the forearm, 1 cm proximal to the distal growth cartilage of radius. An entry hole is made at this level, avoiding radial vascular injury. Then the nail is advanced into the radius up to the fracture site. By positioning the elbow in extension and forearm in pronation or supination position at maximal angulation is detected. The nail tip is oriented towards the radial head and is impacted by using the hammer. A similar procedure is carried out for the ulna, using the antegrade technique with the entry point on the medial margin of olecranon or retrograde way on medial side 1 cm proximal to the distal ulnar epiphysis (Figure 2 and 3: showing elastic nail in both bones forearm). After insertion of the IM Nail, we examined the limitation of the forearm pronation and supination intra operatively to avoid potential rotational malunion. The distal end of the nails was buried under the skin in all the cases. Closure of the wound was done. A/ E Slab applied for 6 weeks (Figure 4: shows the follow up).

Results

A total of 23 patients, 15 patients (65.2%) males and 8(34.78%) female with diaphyseal fractures of the forearm were included in this study. The mean age of the patients were 11 years old (Range 5-15 years). Out of 23 patients, 18 patients (78.26%) had right sided fractures and 5 patients(21.73%) had fractures on the left side. 17 cases presented early i.e. within 7 days and 6 cases presented late i.e. after 1 week. The fracture pattern was transverse in 16(69.56%), oblique in 4 (17.39%), comminuted in 2 patients (8.69%) and spiral in 1 (4.34%) patient. The fracture location was middle third in 18 (78.26%) patients, proximal third in

3(13.04%) and distal third in 2(8.69%) patients. 3 (13.04%) were open type 1 fractures due to RTA and the remainder (86.95%) were closed fractures due to fall on outstretched hand (FOOSH) and were irreducible or seemed to be of an unstable configuration requiring proper reduction and stabilization. The mean diameter of nail used was 2.5(72%). CRIF was done for 15 patients and ORIF was done for the remaining 8 cases. 5 out of 6 patients presenting late were reduced by ORIF with limited opening and all compound fractures were reduced by ORIF. The patients were followed up at 4, 8, 12, 24, maximum up to 12 months (Figures 6,7 and 8: showing follow up). Early exercises were started. The average time to fracture union, defined as presence of a bridging callus [3] on anteroposterior (AP) and Lateral view was 7.9 weeks (Range 6-12 weeks). Functional outcome was evaluated as per Price *et al* (Table1) criteria taking pain and measuring ROM around elbow (Supination/Pronation) and wrist (Dorsiflexion/Palmar flexion) into consideration. The supination was > 60° in 18 patients (78.26%) and pronation was > 60° in 17 patients (73.91%). In 5 patients, it was 45-60°. The pain in 3rd postoperative day was compared with preoperative pain in terms of VAS Score. The pain was relieved in most of the cases. Removal of implants was performed in 12 patients (52.17%) and remaining cases are still under follow up. The average time of hardware removal was 9 months (Range 8-10 month).

Table 1: Price [4] *et al* criteria

Outcome	Symptoms	Loss of Forearm Rotation°
Excellent	No complaints with strenuous activities	< 15°
Good	Mild complaints with strenuous activities	15-30°
Fair	Mild complaints with daily activities	31-90°
Poor	All other results	> 90°

Case 1



Fig 1: Showing compound fracture



Fig 2: Preoperative X-ray



Fig 3: Immediate Postoperative X-ray



Fig 4: After 4 weeks

Case 2



Fig 5: Preoperative X-ray



Fig 6: Immediate Postoperative X-ray



Fig 7: After 4 weeks



Fig 8: After 16 weeks

Complication

Out of the 23 patients, 4(17.39%) patients had minor complications, such as neuropraxia involving radial nerve (Tourniquet palsy) in 1(4.34%) case, skin irritation over prominent ulnar hardware in 1 patient requiring early removal and infection in external nail insertion site in Radius in 1 patient (4.34%) and 1 case of tendon injury. One case presented with delayed union. Major complications such as limb length discrepancy affecting the limb functions, angular or rotational deformity, synostosis or restricted elbow, and wrist movement were not encountered. In this study, 18 cases (78.26%) had excellent, 3(13.04%) cases had good, 1(4.34%) case had fair, and 1(4.34%) had poor result due to delayed union.

Discussion

Closed reduction and cast application is still an effective method of treatment of diaphyseal forearm fractures of children and adolescents, but it has many drawbacks like failure of reduction [5], refractures, prolonged immobilization, associated with stiffness, compartment syndrome, disuse muscle atrophy, and malunion. Following failure of closed reduction, intramedullary nailing is well performed. Flynn and Myers in their studies recommended intramedullary nailing in which cast failed [6].

Primary open reduction and plate fixation is one of the commonly employed methods of treatment of forearm fractures. Various authors have shown good to excellent results with union rate ranging from 96% to 98% with 85% satisfying results [7], 97% union and 80% satisfactory function [8] and 98% union rate and 93% patient satisfaction [9]. The limited contact dynamic compression plate (LCDCP) and

point contact fixator has been termed as biological fixation^[10]. Excellent results are reported by Leung and Chow^[11]. Complication of plates such as compartment syndrome in 10%^[12], sepsis in 3 to 9%^[13], delayed union/ nonunion in 2%⁷ and refractures after plate removal in 3.5 to 22% of the cases have been described^[14]. High frequency of intraoperative nerve injuries has also been reported^[15].

The reported incidence of transient radial nerve palsy is 7 to 10% of all patients with radius fracture treated by plate^[9]. Incidence of radio ulnar synostoses after plate fixation reported in literature is 2 to 9%^[16]. The results with intramedullary nailing by Kirschner wires, Steinmann pins and Rush pins have been disappointing with a very high rate of nonunion (20%) has been reported by various authors^[15, 17]. Myers *et al.* reviewed a series of 55 cases with elastic stable intramedullary nailing of Radius or ulna or both^[6] They recommended percutaneous internally fixation of the bone that had the most initial displacement then checking the stability clinically by pronation and supination. VAS pain score was assessed by comparing pain on 3rd postoperative day with preoperative pain and there was significant improvement in 74% cases. The average radiological union time in our study was 6-8 weeks. Time taken for open fractures to unite was slightly more compared to closed fractures. Kapoor, Theruvil B, Edwards SE, Taylor GR achieved bony union of all fractures by an average 7 weeks^[18] In present study, 72% cases were treated with 2.5 diameter titanium elastic nail. Metaizeau *et al.* described the elastic stable intramedullary nailing of paediatric forearm fractures with small diameter 1.5-2.5 diameter nails^[19]. In our study CRIF was performed for 15 patients under C arm IITV and ORIF was done for 8 cases. 5 out of 6 patients presenting late were reduced by ORIF with limited opening and all compound fractures reduced by ORIF. Kirkos JM, Papavasiliou VA did a retrospective study on 50 children with unstable diaphyseal both bone forearm fractures where closed reduction was a failure and open reduction and internal fixation to a single bone was done^[20]. Results proved to be excellent after follow up including good alignment of ulna. Complication-In present study, 4(17.39%) patients had minor complications such as neuropraxia involving radial nerve (Tourniquet palsy) in 1 case (4.34%), skin irritation over prominent ulnar hardware in 1 patient requiring early removal and superficial nail insertion site in Radius infection in 1 (4.34%) patient and 1 case of Extensor pollicis brevis tendon injury.

Major complications such as limb length discrepancy affecting the extremity functions, angular or rotational deformity, synostoses or restricted elbow or wrist movement were not encountered. Only one case (4.34%) presented with delayed union, which later healed. Atul Bhaskar^[21] described intramedullary nailing as an excellent technique in children as it is safe, less invasive and associated with fewer complications. Garg NK, Ballal MS, Malek IA, Webster RA, Bruce CE has achieved good functional outcome and complications were modest and transient^[22] Removal of implants was performed in 12 patients (52.17%) and remaining cases are still under follow up. The average time of removal was 9 months (8-10 months).

In this study, 18 cases (78.26%) had excellent, 3(13.04%) cases had good, 1(4.34%) case had fair and 1(4.34%) had poor result due to delayed union. Finally all cases achieved good range of movement with no functional deformity or complaints. Lascombes *et al* obtained excellent results and full range of movement in 92% of 85 forearm fractures treated

with intramedullary nail¹. In the study done by Houshian S, Bajaj SK in single bone fixation of both bone forearm with radiological union at a median of 6-7 weeks and at follow up, a full range of elbow and wrist movement were found in all cases^[23].

Conclusion

Conservative management is still the first line of treatment for diaphyseal forearm fractures especially in children and adolescents. Presently if operative intervention is required, both plate fixation wires and elastic flexible nailing are acceptable treatment options. We think that cosmesis is perhaps the most important to our patients because the wounds are small and less conspicuous than the traditional operative approach for plating which leaves a long unsightly forearm scar. Elastic intramedullary nailing is simple, time sparing, acceptable and attractive treatment of displaced and unstable diaphyseal forearm fracture in children and adolescents.

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