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Original Research Article

A prospective study of management of diaphyseal forearm fractures in paediatric age group with intramedullary titanium elastic nail system

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Abstract

Aim of the study: The aim of this study is to asses management of diaphyseal forearm fractures in paediatric age group with intramedullary titanium elastic nail system.
Materials and Methods: The study was conducted from July 2019 to October 2021 at Dr BR Ambedkar medical College and Hospital with follow up period of six months. 30 children fulfilling the inclusion criteria with displaced diaphyseal forearm fracture were surgically treated with titanium elastic nail system. The clinical assessment was conducted for atleast a period of 6 months post operatively using Price *et al*. criteria.
Results: At six months of follow-up 27 patients had excellent results, 3 had good results according to price *et al*. criteria, which is based on the amount of restriction of forearm rotational movements. According to this criterion, excellent results were achieved after elastic nailing of forearm fractures in children with less than 15 degree of loss of forearm rotation. In the present study, Radiological union of fracture was observed in about 60% of patients before 8 weeks and more than half of patients achieved radiological union before 8 weeks.
Conclusion: Based on our experience and results, we conclude that ELASTIC STABLE intramedullary nailing technique is an ideal method for treatment of paediatric forearm bone diaphyseal fractures. It gives elastic mobility promoting rapid union at fractures site and stability which is ideal for early mobilization. It gives lower complication rate, good outcome when compared with other methods of treatment**.** It is a simple, easy, rapid, reliable and effective method for management of paediatric forearm bone diaphyseal fractures between the age of 5 to 16 years, with shorter operative time, lesser bloodless, lesser radiation exposure, shorter hospital stay, and reasonable time to bone healing. Because of early mobilisation, rapid healing and minimal disturbance of bone growth, ESIN may be considered to be a physiological method of treatment.
Keywords: diaphyseal forearm fractures, paediatric and intramedullary titanium elastic nail system

Introduction

Fractures of both bones of forearm are very common orthopaedic injuries in the paediatric age group [1, 2]. Forearm fractures comprises 40% or more of paediatric fractures [3, 4]. Injuries to the shafts of radius and ulna are the most common reasons for children to receive

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orthopaedic care [2]. The forearm is a fascinating anatomical structure that redistributes forces from the hand to the upper part of the extremity and allows the hand to rotate. The forearm is not only an axle but also a non-synovial joint. Majority of these fractures are usually treated by traction, reduction and above elbow casting [5, 6]. It is generally accepted that the closer the fracture is to the distal physis, the greater is the potential for remodeling. As a result more deformity can be accepted in the distal one third of diaphysis when compared to the middle and proximal one third of forearm [7]. Failures continue to occur with this method of treatment. In some patients, reduction achieved initially may be lost due to loosening of cast and movement at the fracture site which may lead to angulations, malrotation or over-riding of the fracture fragments, necessitating operative intervention [6, 8]. Forearm fracture fixation with flexible nails has gained popularity in the past two decades, since it requires minimal surgical dissection and also tries to retain the biological factors at the fracture site [8, 9]. Elastic stable intramedullary nailing (ESIN) has become very common in the treatment of children's long bone shaft fractures [10]. It was first reported for the treatment of long bones by French and Spanish surgeons at the late 1970s and early 1980s [11-14]. The procedure is under active research and new innovations are being developed, for example by using biodegradable implants [15]. Titanium nails are more likely to be used due to its inherent elastic property, thus allowing better insertional and rotational stability [6]. Titanium elastic nail system (TENS) is not only cost-effective but also involves simple technique with minimal need for soft tissue dissection. Hence, it becomes the choice of stabilization of forearm fractures in skeletally immature patients. The major advantage of this technique is not only fracture fixation without disturbing the biology at the fracture site, but also early fracture union due to this biologic fracture fixation and repeated micro-motion at the fracture site [16-18]. Also, there are less chances of physeal injury, early elbow mobilization and easy implant removal with minimal associated complications. Early return of the child to school and decreased duration of post-operative hospital stay are also added advantages of this technique [19, 20]. Various treatment methods such as closed reduction under sedation, plate fixation, intramedullary fixation using kirschner wire, Rush rod, Steinman pin or elastic stable intramedullary nailing are available for diaphyseal fractures of radius and ulna in the paediatric age group. As far as Intramedullary fixation is concerned, implants such as k- wires, Steinmann pin and rush rods have their own disadvantages. For example, Kirschner wires [6] and Rush nails are rigid and difficult to insert through the metaphysis of children's bones. Because of these disadvantages, flexible intramedullary nail (TENS) were devised to overcome this problem which produces a three-point fixation to maintain bony alignment and has now become a very popular method for managing forearm fractures in children. The flexibility of titanium nail (TENS) allows for micromotion at the fracture site and seems to result in rapid fracture healing. The elastic deformation of the nail within the medullary canal creates a bending moment within the long bone that is not rigid, albeit stable enough to reduce and fix the fracture. The concept of using two pre-bent intramedullary flexible Titanium nails to recreate the interosseous space and provide dynamic internal three-point fixation was popularized by Metaizeau, from Nancy, France. This not only allows for biological fracture healing but is also more convenient during implant removal [8].

Materials and Methods

This prospective study was conducted in patients fulfilling inclusion criteria treated for diaphyseal forearm fracture in the department of orthopedics from July 2019 to October 2021 at Dr BR Ambedkar medical College and Hospital with follow up period of six months after obtaining patients consent.

Inclusion criteria

1. Patients aged between 5- 16 years.
2. X ray shows Diaphyseal fracture of forearm.
3. Patients of either Sex.

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4. Segmental fractures.
5. Closed and Open type 1 & 2.

Exclusion criteria

1. Patients aged below 5 years and above 16 years.
2. Patients with open fracture grade 3.
3. Patients with Pathological fracture.
4. Patients not willing to give consent for the study.
5. Patients who are not fit for the surgery.

The patients were initially assessed in the emergency, Once other injuries were ruled out and patients was haemodynamically stable, the injured limb was immobilized and x-ray of the affected limb, forearm AP & Lateral views were taken & fracture pattern classified according to AO classification.

Surgical technique

Pre-Operative Planning

- The injured forearm was immobilized in above elbow POP slab during preoperative period in position depending on the level of fracture.
- Consent of the parents/guardian was taken prior to the surgery.
- Appropriate diameter to be used was assessed with the help of conventional radiographs. The isthmus diameter is measured and 60% of that is calculated as the required diameter of nail.
- All the Instruments to be used were checked prior to the surgery and sterilized.
- A dose of tetanus toxoid and antibiotic as per weight were given preoperatively just before surgery.
- Routine investigations for fitness for surgery with serology for HIV and HBsAg.
- Patients kept nil per orally overnight.

Position

- Pneumatic tourniquet is to be used.
- Patient placed supine on the operating table with a supporting arm-rest placed for the arm to be operated on.

Operative procedure

- Type of anesthesia: General anesthesia / Brachial block.
- Scrubbing, Painting of the upper limb done.
- Pneumatic tourniquet was applied: Time noted.
- Draping of the upper limb done.
- Retrograde entry point for radius was taken & Antegrade entry point for ulna was taken in our study. For radius it was near listers tubercle.
- Clinically and radiologically the deformity was assessed & closed reduction was tried.
- If reduction was not achieved even after 3-4 attempts by closed means then with the help of small incision at the fracture sites identified using C-ARM for one or both the bones the fracture site was exposed, reduction was achieved after appropriate manipulation and nailing done.
- Radius was first fixed after which ulna was fixed.
- The concept of 3 point fixation should be applied while nailing done.

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- Care should be taken to maintain concavity of both the bones facing each other & to maintain the radial bow after final reduction as this maintains the interosseous membrane.
- The nail tip should be placed in the subchondral bone but should not enter the epiphysis so as to not to damage the growth plate. The nails are partially withdrawn and bent with the help of nail bender or "T" handle and cut off using Harrington cutter after which the retracted part is reinserted so that only about 5mm of nail is left outside of bone. The cut end should be smoothened so as not to irritate the skin.
- The incision sites are sutured and sterile dressing done.
- After closure of wound and dressing, moderate thumps are given at the elbow so as to achieve compression at the fracture site.

After treatment

- Postoperatively a crepe bandage and above elbow POP slab was applied over the affected forearm and arm pouch was given. The patient was instructed to keep the limb elevated and move the affected side fingers and shoulder joint. Wound was inspected & dressed on the 2nd post-operative day. Post-operative x ray was taken on 2nd post-operative day. IV antibiotics were given for 2 days post operatively if it was closed reduction and for 5 days if it was open reduction followed by oral antibiotics for 5 days. Patient was discharged on post-operative day 2 for closed reduction and on post-operative day 5 after wound inspection and dressing with forearm in arm pouch. Patient was advised to perform shoulder and finger movements. On 12th post-operative day the wound was inspected and sutures were removed.

Follow-up

- All the patients were followed up at 4, 8, 12 weeks and till one year or till the implant is removed whichever is earlier. At each follow-up x-rays of forearm in anteroposterior and lateral views were taken and analyzed for union i.e. presence of bridging periosteol callus in three or four cortices. Patients were checked clinically for wrist, elbow Flexion - extension and supination, pronation movements. Union was assessed radiologically.

Results

Table 1: In our current study 70% of the patients were boys and remaining 30% were girls. Male to female ratio is 7:3.

Gender	No. of patients	Percentage
Male	21	70
Female	`9	30

Table 2: There were 27 simple (closed) fractures constituting 90% of total patients, 3 compound (open) fractures (Gustilo and Anderson grade I) constituting 10% of total patients.

Type of fracture	No. of cases	Percentage
Open/compound	3	10
Closed	27	90

Table 3: The average time taken for fracture union in our study is 7.76 weeks with a range of 6- 12 weeks. We did not come through any case of delayed union or non-union.

No. of patients	Time taken of radiological union in weeks	Percentage
24	6-8	80
4	9-10	13.33
2	11-12	6.66

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Table 4: Our study noted that 27(90%) cases had excellent results while 3(10%) cases had good results at the end of 4 months by PRICE *et al*. criteria.

Functional outcome (Price *et al*. criteria)	No. of patients	Percentage
Excellent	27	90
Good	3	10
Fair	0	0
Poor	0	0

Fig 1: Pre & post op x-ray

Discussion

In our current study 70% of the patients were boys and remaining 20% were girls. Male to female ratio is 7:3. The high rate of involvement of boys might be attributed to the fact that boys of this age group are much more commonly involved in outdoor activities like sports and bicycling which results in higher percentage of both bone forearm fractures in boys. Mohammad Ruhullah *et al*. (2016) [21] in their study had 65.8% boys and 34.2% girls. Kishorchand Naorem *et al*. [22] during 2015 to 2017 series had 73.3% boys and remaining girls. Siddaram patil (2011 -2013) [23] case series consisted of 70% boys and 30% girls.

There were 27 simple (closed) fractures constituting 90% of total patients, 3 compound (open) fractures (Gustilo and Anderson grade I) constituting 10% of total patients. This is in accordance to study conducted by Kang SN *et al*. [8] (2011) in which 9% 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.

In this study, bony union was achieved in a mean time of 7.76 weeks, range being 6 weeks to

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12 weeks. Radiological union of fracture was observed in about 60% of patients before 8 weeks and more than half of patients achieved radiological union before 8 weeks. Mohammad Ruhullah *et al*. (2016) [21] in their study had an average union time of 9 weeks. Kishorchand Naorem *et al*. (2015- 2017) [22] series had all fractures united by 16 weeks.

The functional outcome was graded according to Price *et al*. criteria which is based on the amount of restriction of forearm rotational movements. According to this criteria, excellent results were achieved after elastic nailing of forearm fractures in children with less than 15 degree of loss of forearm rotation. Our study noted that 27(90%) cases had excellent results while 3(10%) cases had good results at the end of 4 months by PRICE *et al*. criteria. Mohammad Ruhullah *et al*. (2016) [21] had excellent results in 94% and good in 6% cases by PRICE *et al*. criteria. Kishorchand Naorem *et al*. (2015- 2017) [22] series had excellent results in 80% and 20% had good results by PRICE *et al*. criteria.

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