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Tens (Titanium elastic nail system): A good option for managing both bone forearm fracture

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Abstract
Introduction: Forearm is considered as a functional joint, therefore near anatomical reduction is essential to regain normal supination and pronation. In older children many forearm fractures can be treated conservatively, but failures continue to occur despite good orthopaedic intentions. The fracture which are irreducible or unstable fracture which tends to re-displace needs surgical interventions. Among various surgical treatment one is internal fixation using TENS. Various studies in the recent shows excellent to good clinical outcomes using TENS.
Aims: Our study is intended to evaluate the clinical and radiological outcomes in paediatric both bone forearm fracture using TENS.
Materials and methods: A total of 60 patients are included in our prospective study under some inclusion and exclusion criteria. All are investigated, undergone preanesthetic check-up and taken for TENS application under image intensifier. All patients are followed upto 24 week, when implant removal was done.
Results: In our study 95% patients show excellent to good functional results. A total of seven patients developed complications, three out of them developed superficial infection and four reported implant related skin irritation.
Conclusion: TENS can be used in paediatric both bone forearm fracture safely with good clinical outcomes.

Keywords: Paediatric forearm fracture, internal fixation, TENS, Fractures, forearm injuries

Introduction

The forearm is considered as a functional joint, as supination and pronation occur in between radius and ulna. For this reason anatomical or near anatomical reduction after their displaced fracture is a necessity to regain normal function. Forearm fractures are the most common injuries in paediatric age group, accounting 45% of all fractures in childhood. Approximately, 75 to 84% of forearm fractures occur in the distal third, 15 to 18% occur in the middle third and 1 to 7% occurs in the proximal third of the forearm [1].

The incidence of fractures shaft forearm bones is more common in 6-16-year-old children, with higher incidence in children between 12-16 years of age.[2] As the child becomes older the site of fracture moves proximally, and proximal diaphyseal fracture is difficult to treat due to increased chance of re-displacement even after successful closed reduction [3].

In older children Many shaft injuries are effectively treated with skilful closed fracture care with pop casting, but failures continue to occur despite good orthopaedic intentions. The failure rate is about 7 to 32% and hence there is a subset of fractures that demands surgical interventions, and these are irreducible fractures, unstable fractures and open fractures [4, 5]

There are multiple surgical techniques to achieve adequate stabilization of these types of fractures, including plating, external fixation and intramedullary nailing [6-9]

Shoemaker *et al*. suggested that the ideal mode of fixation of paediatric forearm fractures should maintain alignment, be minimally invasive and inexpensive and carry an acceptable risk profile [4] As compared to intramedullary fixation, ORIF with plates and screws has got several disadvantages such as large incisions with poor cosmesis, more soft tissue dissection, higher incidence of infections and second surgery for removal of implant with similar large incision and soft tissue dissection which is difficult than naïve surgery. As far as devices like k-wire, Steinmann pin, and Rush nail are considered, it can be used as intramedullary device, but these are rigid and have difficulty in insertion particularly in radius. To overcome this problem flexible intramedullary nail i.e. TENS (Titanium elastic nail system) is devised which

provide three bony point fixation to maintain bony alignment.[10] Due to flexibility, insertion becomes easier and there is also increased micromotion at the fracture site leading to enhanced callus formation. These are added advantages over other rigid intramedullary devices like k-wire, Steinmann pin and, rush nail. Our study is intended to evaluate the clinical, radiological and functional outcome of Flexible Intramedullary Titanium Elastic Nailing of Fracture Shaft of Radius and Ulna in paediatric age group.

Materials and methods

In this prospective study sixty cases of fracture both bone forearm was studied with inclusion criteria of age < 15yrs, displaced fracture or grossly rotated fractures, failed close manipulation and patients who gave their consent to undergo the procedure. Patients with single bone either radius or ulna fracture, compound fractures, fracture with neurovascular injury or any associated fracture in the ipsilateral limb were excluded. Shaft fractures with associated disruption of the radio-capitellar joint (Monteggia fracture and equivalents) and the distal radioulnar joint (Galeazzi fracture and equivalents) were also excluded.

All the patients were subjected to clinical and radiological examination. Antero-posterior (AP) and lateral view of forearm including elbow and wrist joint was obtained. After preanesthetic check-up patient were posted for surgery for titanium elastic nailing under general or regional anaesthesia. Every patient was given preoperative antibiotics, which included a 3rd generation cephalosporin and an aminoglycoside 30 min prior to operation. Surgery is performed in supine position with tourniquet applied on arm and under image intensifier. A flexible nail size 2.0 to 3.0 mm was used for either bone. Proper size flexible nail as decided preoperatively by measuring the medullary canal in X-ray was used. The diameter of bone in anteroposterior added with diameter in lateral radiograph divided by 2 approximately gave the size of nail to be used.

Because the radius is often more difficult to reduce, it was splinted first. The radius is approached through one cm longitudinal incision performed on the dorsum just medial to Lister's tubercle of the distal metaphysis carefully avoiding damage to the superficial branch of the radial nerve and extensor tendons. A hole is drilled in the bone with an awl, first perpendicularly and then obliquely towards the elbow just proximal to the distal radial epiphysis. Then an appropriate size flexible intramedullary nail with its proximal 5mm pre-bent at 30° is introduced. The fracture was reduced by external manipulation and the prebent nail was pushed proximally and advanced through fracture site and was stopped short of the physis, at the level of bicipital tuberosity. If an acceptable reduction cannot be obtained, then open reduction is performed. The distal end of the nail was bent and cut 5-10 mm from the bone. For the ulna fracture, the stab incision was made on the tip of olecranon. An awl was introduced through olecranon. Fluoroscopy was used during reduction. If required, fracture site was exposed by a small incision and reduction accomplished. The bent tip of nail aided in the reduction and the nail was pushed into the distal ulna, stopping short of the physis under the guidance of fluoroscopy. The nail was cut close to the bone, leaving enough ends for easy removal later but without any tenting the skin.

All patient had given long arm posterior splint for two weeks at that time stitches were removed and patient advised for simple sling for 6 weeks. The patient was instructed to avoid excessive loading of the involved limb until adequate callus formation is observed on radiographs made at approximately four weeks and is advised to refrain from sports for 6-8 weeks. Physiotherapy was started as early as possible. Supination and pronation was allowed only after six weeks. Patients were followed up at two weeks, four weeks, six weeks, nine weeks, three months and six months for clinical and radiological evaluation. Radiographic union was defined as bony trabeculae traversing the fracture on anteroposterior (AP) and lateral radiographs [11] Functional outcome is evaluated using Price *et al*. [12] criteria as listed in Table 1.

Table 1: Grading system for functional outcome according to Price *et al*. criteria.

Outcome	Symptoms	Loss of forearm rotation
Excellent	No complaint with strenuous activity	< 15°
Good	Mild complaint with strenuous activity	15° - 30°
Fair	Mild complaint with daily activities	31° - 90°
Poor	All other results	> 90

Results

Table 2: Demographic data and outcome of 60 patients

Variables		Number (percentage)
Gender	Male	41(68.66)
	Female	19(31.33)
Mean Age		10.5yrs
Side	Right	36(60)
	Left	24(40)
Site	Distal 3rd	13(21.66)
	Middle 3rd	40(66.66)
	Proximal 3rd	07(11.66)
Type of surgical procedure	Closed reduction and internal fixation	53(88.33)
	Open reduction and internal fixation	07(11.66)
Outcome	Excellent	57(95)
	Good	03(05)
	Fair	00
	Poor	00
Complications		07(11.66)
Average time of union		09 weeks
Average time for implant removal		06 months

In our prospective study which is conducted in between Nov 2014 to Nov 2017, there were 60 patients of fracture both bone forearm included out of which 41(68.66%) patients were male and 19(31.33%) were female. The mean age of the patient was 10.5 years. 36 (60%) patients had right side fracture and 24 (40%) had left side fracture. Out of 60 patients seven (11.66) patients need open reduction due to soft tissue interposition. Outcome was measured according to Price *et al*. criteria and 57 (95%) patients had excellent outcome and rest of them had good outcome. Among 07 patients which developed complications three patients developed superficial infection and were managed by oral antibiotics. The rest four patient had implant related irritation at entry portal which get relieved only after removal of the implant. The average time for union was nine weeks and the average time for implant removal was six months. Fig 1- Fig 4 shows the fracture pattern, immediate postoperative x-ray after TENS, x-ray showing union at 9 weeks and the functional outcomes.

Fig 1: AP view left forearm showing 100% translation at radius

Fig 2: AP view left forearm in immediate postop period

Fig 3: AP view left forearm showing union at 9 week

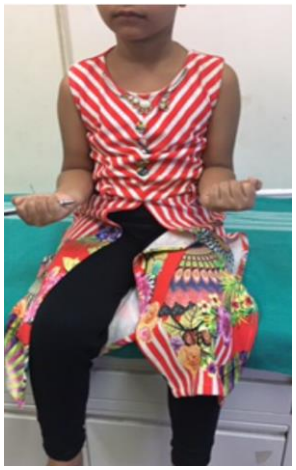

Fig 4: Showing near full supination of left forearm at 9week

Discussion

Many shaft injuries in children can be effectively treated with skilful closed fracture care but failures continue to occur despite good orthopaedic intentions. Difficulty occur when the fracture is either irreducible or re-displaced after reduction. Now question arises that how much mal-reduction is acceptable, because the supination and pronation of forearm may be hampered if there is angulation, translation, or rotation, Shoemaker *et al* and Flynn *et al* in their literature have suggested that a reduction is unacceptable if the patient has an angular deformity >10° or complete displacement [4, 5] considering rotational deformity, remodelling is not predictable, and acceptable range of rotational deformity is 30-45 degree to none [4, 13, 14]

Rodriguez- Merchan in their literature clearly mentioned that rotational deformity does not remodel at all [15].

Also, younger children tend to tolerate greater deformity much better than older ones due to better remodelling potential. [1, 13, 16, 17].

In our study the patients range from four years to fourteen years of age, but majority of them was older than 10 years, with mean age of 10.5 years. Similar observations were also made by Kapilla R *et al*., (11.2 years), Qidwai SA (11 years) and Garg NK *et al*., (11.8 years) [18-20] So, mean age of incidence can inferred to be 11 years.

In this study, fracture is proximal 1/3rd in 07 patients (11.66%) out of which 05 patients were among age group of 11-14 years. There was fracture forearm at middle 1/3rd in 40 (66.66%) and 35 among these were of age group of 11-14 years. Fracture forearm at distal 1/3rd in 13 (21.66%) who were in age group of 4-10 years. These findings are indicative of the fact that proximal fractures are more likely to occur in older children (>10 years) and distal fractures are more common in younger children (<10 years).

In our study, 53(88.33%) patients were treated with closed reduction and only 7(11.66%) patients needed open reduction due to soft tissue interposition. This is comparable to studies by Ruhullah M *et al*. [21] (closed reduction 90%), Richter *et al*. [14] (closed reduction 84%) and Alam W *et al*. [22] (closed reduction 72%). Though we did not compare the results of open Vs close technique but results in both techniques were good to excellent.

In this study at 24 weeks follow-up 57(95%) patients had excellent function and three (05%) patients had good results according to price criteria. Similar results have been reported in literature in study by Parajuli NP *et al*. [23], in which 94% patients had excellent results and 6% had good results, by Kapilla R *et al*. [18], in which 92% patients had excellent results and 8% had good results. These excellent clinical results support the use of this technique in the management of irreducible or unstable both bone forearm fractures in the pediatric patient.

In our study average time for union of fracture was 9 weeks which is comparable to study done by Ruhullah M [21] (mean time for union 09 week), Kapilla R [18] (mean time of union 9.2 week) and Ali AM [24] (mean time for union 10 weeks).

The procedure of inserting intramedullary nails is not without the possibility of complication. In this study, we have reported a complication rate of 11.6%. This is similar to the complication rate reported by Ruhullah M *et al*. [21], Lascombes *et al*. [8] and Parajuli NP *et al*. [23] The most common complication occurring in our study were superficial infection and skin irritation by hard ware.

Conclusion

In paediatric both bone forearm fracture, particularly in proximal 3rd fracture in older children where chance of re-displacement is high remodelling potential is low, TENS is a good option, as it is minimally invasive, having low complications, and excellent clinical outcomes. It also permits early mobilization and return to normal activities. Hence, we recommend this procedure for managing irreducible and re-displaced both bone forearm fractures in paediatric age group.

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