

Original Research Article

Evaluation of Clinical Outcomes of Management of Paediatric Bone Forearm Fractures using Titanium Elastic Nailing System: A Prospective Study of 30 Cases

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Abstract

Introduction:

Forearm fractures are common injuries in children. In children, their management is difficult due to high chances of re-displacement after closed reduction.

Aim:

The aim of present study was to assess the clinical and radiological outcome of managing paediatric forearm fractures using TENS with special reference to movements at wrist, elbow, forearm and time taken for radiological union.

Materials and Methods:

A total of 30 patients in the age group 5 to 15 years with fractures in both bones of forearm were managed by internal fixation using TENS and prospective follow-up were done for six months.

Results:

On final evaluation in terms of symptoms and range of motion of adjacent joints using Andersons criteria, Price criteria and union time for results, we had excellent outcomes in 90% patients and good in 10% of total patients. There were no significant complications except for superficial pin tract infections at entry site of nail in only 10% of patients.

Conclusion:

We conclude that all potentially unstable and grossly displaced fractures of forearm shaft in children should be approached surgically and treated with TENS as it is an effective and minimally invasive method of fixation of forearm fractures with excellent results in terms of bony union and functional outcomes with minimal complications.

Keywords:

Functional outcome, Radiological outcome, Re-displacement

Introduction:

Forearm fractures are very common in paediatric population with incidence around 1 in 100.1 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. Forearm fractures in older children are difficult to manage as they tend to occur comparatively

more proximally and have more tendency of re-displacement even after a successful closed reduction 3,4.

Hence in management of such cases requires internal fixation with devices such as TENS. There are various methods of management of fractures in both bones of forearm in children. Historically, gold standard of management of forearm shaft fractures in

children was closed reduction and cast immobilisation⁵, however because of higher incidence of re-displacement, particularly in older children, there has been a rising trend in management of such fractures towards closed reduction and internal fixation. Fracture fixation can also be done by extra-medullary devices like plates which have got various disadvantages as compared to TENS such as large incisions, extensive soft tissue dissection, higher chances of infection. Ideal fixation mode should maintain alignment, with minimal soft tissue stripping and should have minimal complications. This has led us to the use of intra medullary fixation devices. TENS (Titanium Elastic Nailing System) is a minimally invasive procedure that spares physis, provides 3 point fixation and hence mostly does not require Plaster of Paris (POP) splint/cast, thereby allowing early mobilization to achieve excellent functional outcomes. Other devices for intra medullary fixation such as Kirschner wires/pins/ nails lack these advantages and hence are inferior to TENS^{6,7,8,9,10}.

Aims

The aim of present study was to assess the clinical and radiological outcome of managing paediatric forearm fractures using TENS with special reference to movements at wrist, elbow, forearm and time taken for radiological union.

Materials and Methods

This prospective study was conducted in department of orthopaedics of Rajindra hospital, GMC Patiala, Punjab, India on 30 children of age group 5-15 years admitted here for diaphyseal forearm fractures. The study was approved by the ethical committee of the institute. Proper pre-

operative anaesthetic check-up and investigations were conducted in all patients. Pre and post-operative cephalosporin antibiotics were administered for 3 days with dosage as per weight of patient.

SAMPLE SIZE- was estimated based on previous study, has been calculated using formula:

$$n=2a^2(x+y)^2/z^2$$

n=sample size, a=2.56 for 95% CI, x=1.96, y=0.84, z=1.38

Thirty patients were included in the present study with inclusion criteria of age 5–15 years, closed fracture, highly displaced fractures >50%, angulation > 10 degrees, failed closed manipulation and patients were subjected to minimum follow-up of six months. Patients with pathological fractures, compound fractures, isolated forearm bone fracture and fractures with neurovascular injury were excluded. If fracture fragments were grossly displaced more than 50 percent, angulated or mal-rotated more than 10 degree, such patients were planned for operative treatment. If child had displacement less than 50 percent and angulation less than 10 degrees then closed reduction was attempted following which post reduction x-rays were obtained, further if fracture fragments remained displaced in post reduction x-rays these patients were also planned for surgical management.

Early range of motion exercises were started as soon as patients were pain free and results were evaluated at 3, 6, 9, 12 and 24 weeks. Clinical results were evaluated as per scale developed by Anderson criteria, price criteria and union in weeks.

Minimum (26.78) 27 sample is required for the study.

TABLE 1- Clinical and Radiological outcomes evaluation

Score	4	3	2	1
1.Anderson Criterion ¹¹				
Movement at Wrist	loss of Flexion or Extension by <10°	loss of Flexion or Extension by 11°-20°	loss of Flexion or Extension by 21°-30°	loss of Flexion or Extension by ≥31°
Movement at Elbow	loss of Flexion or Extension by <10°	loss of Flexion or Extension by 11°-20°	loss of Flexion or Extension by 21°-30°	loss of Flexion or Extension by ≥31°

Score	4	3	2	1
2.Price criteria ¹²				
Movement at Forearm	loss of Supination or pronation by <10°	loss of Supination or pronation by 11°-30°	loss of Supination or pronation by 31°-90°	loss of Supination or pronation by ≥91°
Pain	No pain even with strenuous activity	Pain with strenuous physical activity	Pain with daily routine activity	Pain at rest
Score	4	3	2	1
3.Union (in weeks)	<9	9-<12	12-<18	≥18

According to these 3 parameters i.e., 1. Anderson criteria 2. Price criteria 3. Union Time (in weeks), The maximum possible score will be 20 and minimum

possible score will be 5. The outcome will be scaled excellent, good, fair or poor according to following table-

TABLE 2- Final Outcome evaluation

Outcome	Score
Excellent	17-19
Good	16-13
Fair	9-12
Poor	≤8

Results

On final evaluation at six months, there was no pain in all the patients. At 24 weeks 27 patients had loss of movement less than 100 at wrist and elbow and 3 patients had loss of movement by 11-200 at wrist and elbow. At 24 weeks, 27 (90%) patients had loss of movement at forearm by less than 100, 3 (10%) patients. 3 patients showed radiological union at 6 weeks, 24 patients showed radiological union at 9 weeks and 3 patients showed radiological union at 12 weeks and the mean time for radiological bony union was 9 weeks.

According to our evaluation, 27 patients (90%) had excellent results and 3 patients (10%) had good results. None of the patients had fair or poor results. No significant complications were observed except for superficial pin tract infections at site of entry of

nail in 3 (10%) patients. However, no deep infection, malunion, non-union, nerve palsy, refracture and nail migration were observed.

Discussion

Historically closed reduction and POP cast immobilisation 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 accounts for unacceptable reduction. Also, younger children tend to tolerate greater deformity much better than older ones due to better remodelling potential.

In present study, majority of children were in

age group of 11-15 years with mean age of 11 years (Table 3-1). Similar observations were also made by Qidwai SA et al¹³ (11 years) and Garg NK et al¹⁴, (11.8 years). So, mean age of incidence can be inferred to be 11 years.

In present study, 25 (84%) males and 5 (16%) females were included in the study. (Table 3-2)

In present study, there was fracture of shaft of forearm bones at proximal 1/3rd in 10 patients (33%). There was fracture forearm at middle 1/3rd in 16 (53%) and fracture forearm at distal 1/3rd in 4 (14%) (Table 3-3). The incidence of proximal third fractures was similar in study conducted by Ajay kumarsankla et al¹⁵.

We achieved closed reduction and intramedullary fixation in 25 patients (84%) under image intensifier guidance. However 5 patients required open reduction and intramedullary fixation (16%) (Table 3-4). This is in accordance to study conducted by Mohammed H et al¹⁶, on 21 children with forearm fractures in which 4 patients (19%) had required open reduction and internal fixation with Elastic Stable Intramedullary Nailing (ESIN) and 19

were managed with Closed Reduction Internal Fixation (CRIF).

On final follow-up at 24 weeks, 27 (90%) patients had loss of movement at wrist and elbow by less than 10 degree, 3 (10%) patients had loss of movement at wrist and elbow by 11-20 degrees and 24 (80%) patient had loss of movement at forearm less than 10 degrees and 6 (20%) had loss of movement at forearm by 11-30 degrees. Similar results have been reported in literature in study by Kapoor V et al¹⁷, in which 16% of patients had some loss of motion at forearm over a 24 weeks follow-up period. In our study radiological union was seen in 3 (10%) patients at 6 weeks, 24 (80%) patients at 9 weeks and in 3 (10%) patients at 12 weeks follow up with average union time of 9 weeks which is in accordance study conducted by Flynn JM et al¹⁸. Among all 30 patients, 27 (90%) had excellent results and 3 (10%) patients had good results (Table 3-6). The final result is in accordance with study conducted by Parajuli NP et al¹⁹, in which 92 % patients had excellent results and 8% had good results.

TABLE 3- Table Depicting Final Results

S.No	Criteria	Observations	Percentage
1.	AGE		
	5-10 years	12	40
	11-15 years	18	60
2.	SEX		
	Male	25	84
	Female	5	16
3.	LEVEL OF FRACTURE IN SHAFT OF BOTH BONES		
	Proximal 1/3 rd	10	33
	Middle 1/3 rd	16	53
	Distal 1/3 rd	4	14
4.	TYPE OF SURGICAL PROCEDURE		
	CRIF	25	84
	ORIF	5	16
5.	COMPLICATIONS IF ANY		
	Superficial pin tract infection	3	10
6.	RESULTS		
	Excellent	27	90
	Good	3	10

Conclusion

Paediatric forearm fractures are quite common. However management tends to become difficult due to high incidence of re-displacement in older children. Herein lies the importance of internal fixation using TENS, which aids in the maintenance of radial bow and interosseous space between forearm bones while sparing the physis, thus achieving good functional results in terms of forearm movements. From the present study, we conclude that all potentially unstable and grossly displaced fractures of forearm in older children should be approached surgically and treated with TENS nailing as it has excellent results in terms of bony union and functional outcomes with minimal complications. Therefore we strongly recommend its use in management of paediatric forearm fractures.

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