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Management of both bone forearm fracture using titanium elastic nailing system in pediatric age group

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ABSTRACT

Background: The management of pediatric forearm fracture has been a dilemma to surgeon. Conservative treatment with cast still is the preferred treatment. Never the less old children and proximal fracture warrants some form of internal fixation. **Aims and Objective:** The aims of this were to analyze the role of titanium elastic nailing system in fixation of pediatric forearm fractures and its associated complications. **Materials and Methods:** Over 3 years, 103 patients were enrolled in our institute. After obtaining consent and preanesthetic check-up, patients were scheduled for surgery, where internal fixation was done using titanium elastic nailing system. Patients were followed up every month for 3 months and then every 3 months interval for 8 months. The time to union and functional score were assessed using modified Flynn score. **Results:** Among the 103 patients, 63 (61.16%) were in the age group of 7–13 years. Mean age was 11.72 ± 3.50 years (range 4–18 years). Seventy-eight (75.72%) patients were male and fall from height was the most common 66 (64%) mode of injury. Radiological union occurred in most 54 (52.42%) of the patients at average 5–7 weeks. As per the modified Flynn criteria, 82 (79.61%) cases had excellent functional outcome, 11 (10.67%) cases good, 4 (4.12%) fair, and 6 (5.82%) had poor outcome. Neuropraxia was seen in 8 (7.76%) cases and rupture of extensor pollicis brevis was seen in 4 (4.12%) patients and treated accordingly. All the patients regained full functional recovery. **Conclusion:** TENS is an effective, safe, reliable, and easily reproducible technique for the management of pediatric forearm fractures. It has advantage of preserving the fracture hematoma, providing relative stability to ensue early rehabilitation and minimally invasive nature.

Key words: Conservative; Forearm; Fractures; Internal fixation; Pediatric; Titanium elastic nailing system

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INTRODUCTION

The fracture of the forearm bones are common in the pediatric population, with an incidence of around 1 in 100 children each year. The peak incidence occurs in the 5–14 years age group which accounts for nearly 34% of the cases. Both bone diaphyseal forearm fractures constitute around 5.4% of all fractures in under 16 children.[1] Among the pediatric age group, higher incidence of cases is seen in children between 12 and 16 years of age.[2] As these fractures are seen in somewhat older children, their management becomes difficult. To add to the surgeon's misery, the proximal location of the fracture leads to displacement even after a successful closed reduction.[3]

Historically, the standard management of these fractures remains conservative treatment with closed manipulation and immobilization with above-elbow plaster cast for 4–6 weeks. Although the fracture unites readily, malunion and stiffness of joints are very common.[4] Chances of re-displacement, particularly in older children, are also a troublesome complication.[5]

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Some mode of internal fixation is advocated to maintain the fracture reduction until bony union and achieve good functional outcome. Extramedullary devices like plates have various disadvantages such as large incisions, more soft-tissue dissection, more chances of infection, and a re-surgery of almost similar magnitude for removal of implant which is not advisable for a children. The ideal fixation mode should maintain alignment, be minimally invasive, and should have least complications.[6] This encouraged the surgeons for use of intramedullary fixation devices. Titanium elastic nailing system (TENS) is a minimally invasive procedure that spares physis, which provides three point fixation and hence mostly does not requires Plaster of Paris (POP) splint/cast, thereby allowing early mobilization to achieve excellent functional outcomes. Other devices for intramedullary fixation such as Kirschner wires/pins/nails lack these advantages and, hence, are inferior to TENS.[7]

The purpose of this study is to determine the incidence of age and sex distribution of this type of fractures, and analysis the fracture treatment by flexible titanium elastic nails, to analyze the results with incidence of complications. The results are graded with cosmetic and functional factors.

Aims and objectives

The aims of this study were to analyze the role of titanium elastic nailing system in fixation of pediatric forearm fractures.

MATERIALS AND METHODS

This prospective observational study was conducted in our department of orthopedics during the period July 2016 –August 2019 comprising 103 patients. It included all the patients who are in the pediatric age group who were having displaced diaphyseal forearm fracture. All cases, in which the age of the patient was >18 years, having compound fracture, polytrauma, having physeal injury, and parents who did not give consent were excluded from the study.

The study was approved by the Institutional Ethical Committee and before enrolling any patient written and informed consent was obtained from the parents/guardian of the patients.

Detailed preanesthetic evaluation was carried out and all required investigations were done before getting the patient to the operating room.

Operative technique

Under general anesthesia, closed reduction was done under image intensifier. We preferred fixing the radius first by retrograde nailing through dorsal aspect of distal radius proximal to radial physis and just medial to lister's tubercle. Care was taken not to harm the extensor tendons and superficial radial cutaneous nerve. After fixing radius, ulna was fixed by ante grade nailing through the lateral surface of olecranon about 1–2 cm distal to physis. The nail had a gentle bend, so as the apex of bend overlaps with fracture site. The length and diameter of nails were varied as perceived under image intensifier control with the diameter being not more than 40% of the narrowest canal diameter. Wherever required, limited open reduction was carried out to achieve accurate reduction. The ends were bent and cut flush to the bone leaving enough length for subsequent removal and buried under the skin in all cases. In the immediate post-operative period, majority of patients required no external immobilization. However, depending on fracture stability, in some patient's POP splint was given maximum up to 21 days.

Patients were followed up every month for 3 months and there after every 3 months interval for 8 months. Radiographs were taken at regular interval to access the union status, malaligment, etc. Full activity of the limb was allowed after union of the fracture which was ascertained both clinically as well as radiographically. The functional score was assessed by Flynn criteria (Table 1) as modified by Templeton and Graham.[8]

Statistical analysis

All the statistical analysis was done using Microsoft Excel v2013.

RESULTS

The following observations were made from data collected during the study. The demographics of the patient studied are given in Table 2.

In our study of 103 patients, maximum patients 63 (61.16%) were seen in the age group 7–13. The mean age of all the patients was 11.72±3.50 (range 4–18 years).

There were 78 (75.72%) boys and 25 (24.27%) girls. Fall from height was the most common 66(64%) mode of injuries among which 61 (92.42%) were simple fracture and 37(36%) cases were due to RTA. Ninety (87.37%) cases were presented immediately after injuries and surgery was done within 7 days of injuries. In these cases, closed reduction of both bone forearm fracture was possible. In 13 (12.62%) cases, surgery was done more than 7 days of injuries, in which closed reduction was not possible, so a limited open reduction was done. Thirty-three (32.03%) cases even though presented early and surgery was done within 1 week of injuries still have to undergo open reduction of both bone or single bone which could be due to soft-tissue interposition.

Table 1: Modified Flynn criteria for functional scoring

Rating	Loss of elbow (flexion/extension)	Loss of forearm (pronation/supination)	Loss of wrist flexion/extension	Change in carrying angle
Excellent	0–5	0–15	0–15	0–5
Good	6–10	16–30	16–30	6–10
Fair	11–15	31–45	31–45	11–15
Poor	>15	>45	>45	>15

Table 2: Demographics of the patient

Sl. No	Criteria	Observation	Percentage
1	Age		
	• 4–7	• 14	• 13.59
	• 7–10	• 27	• 26.21
	• 10–13	• 36	• 34.95
	• 13–15	• 15	• 14.56
	• 15–18	• 11	• 10.68
2	Sex		
	• Male	• 78	• 75.72
	• Female	• 25	• 24.27
3	Mode of Injury		
	• Fall from height	• 66	• 64.07
	• RTA	• 37	• 35.92

Table 3: Radiological union time in weeks

Time in weeks	Number of cases	Percentage
4–5	34	33.00
5–6	25	24.27
6–7	29	28.15
7–8	9	8.73
8–9	5	4.85
9–12	1	0.97

Table 4: Functional outcome

Functional out come	Number of cases	Percentage
Excellent	82	79.61
Good	11	10.67
Fair	4	4.12
Poor	6	5.82

Most of the patients 54 (52.42%) went on to osseous union at average 5–7 weeks and regained a full range of movement (Table 3). There was one case of non-union at 16 week. However, afterward, the patient was lost to follow-up. Eighty-eight (85.43%) cases were united in 4–7 weeks. One case was united in >9 week.

Eighty-two (79.61%) cases had excellent functional outcome in present study. Eleven (10.67%) case had well, 4 (4.12%) case fair, and 6 (5.82%) had poor outcome (Table 4).

In total, 8 (7.76%) cases of neuropraxia involving the radial nerve were detected due to tourniquet palsy. All of them resolved after several weeks with no long term complication. Four (4.12%) cases had partial rupture of extensor pollicis brevis tendon and it was repaired at time of nail removal. Ten (9.70%) patients presented with protrusion of the nail through the skin during follow-up, although they had been buried at the time of surgery. These nails required removal before the planned date of removal. After removal of nails, all patients were regained full function and all complications resolved.

DISCUSSION

In pediatric, both bone fractures closed reduction and POP cast immobilization have been the mainstay of treatment since time immemorial. However, the disadvantage of this treatment is secondary fracture displacement especially in older children and fractures of proximal location. The limits of malreduction are yet to be defined which would deem acceptable. Fynn et al., found that angular deformity >10° and complete displacement of fracture fragments account for unacceptable reduction.[9] The remodeling potential of younger children is much better, so they tend to tolerate greater deformity than the older ones.[10]

In the present study, the mean age of the case was 11.72 years average, age of the male case being 11.78 years and female case being 13.8 years. The previous studies conducted by Qidwai and Garg et al., found mean age to be 11 and 11.8 years. Hence, you infer that the mean age of incidence is around 11 years.[11,12] Male children were found to be more 78 (76%) affected than female children. Similar observation was made by Landin in his landmark study of 30 years in Sweden.[13] In majority of case 66 (64%), the mode of injury was fall on an outstretched hand due fall from height. The other mode was road traffic accidents. Tredwell et al., obtained similar findings.[14]

According to the orthopedic trauma classification, type 22A3 (80%) was simple fracture of both bone forearm. Other fractures were 22B3 (8%), 22A2 (8%), 22A1 (2%), and 22C3 (1%). Comminution was rare which implies that most of the injuries are of low velocity.

In majority 54 (52.42%) cases, fracture union was seen in was 5–7 weeks. Among rest of the cases, fracture union was seen in 4-5weeks (in 22% cases), 7–8 weeks (in 14.3% cases), 8–9 weeks (in 7% cases), and more than 12 weeks (in 4.28% cases). Most of the cases united in 6–7 weeks

due to biological compatibility of nail and fracture hematoma being undisturbed. Our results are better than the study done by Ali et al., in which bony union was seen in 10 weeks.[15]

In the present study, most 82 (79.61%) of the patient had excellent functional outcome. Eleven (10.67%) case had good, 4 (4.12%) case fair, and 6 (5.82%) had poor outcome due to late presentation, open reduction, and nerve injury. Eventually, all cases achieved a good range of movements and had no functional deformity or complaints. The final result has a resemblance with study conducted by Parajuli et al., in which 94% patients had excellent results and 6% had good results.[16]

In our study, eight (7.76%) cases were having neuropraxia due to superficial radial nerve injuries, 4 (4.12%) cases had partial rupture of extensor pollicis brevis tendon, and 10 (9.70%) case of nail protrusion due to infection. Seventeen (16.50%) patients had difficult in the range of motion of the pronosupination arc due to rotational instability. Complications were all modest and transient. It may be avoid by doing surgery in gentle care and step-wise and with help of C-arm. Yuan et al., observed in his study that intramedullary fixation has a higher chance of Compartment syndrome, though we did not see any case of compartment syndrome.[17]

Limitations of the study

The limitations of our study being a study of less sample size, shorter follow-up period, and exclusion of compound fractures. In future, large scale multicenter studies should be done to better delineate the efficacy of this method.

CONCLUSION

Based on our experience and results, we conclude that elastic stable intramedullary nailing technique is an ideal method as it is a simple, easy, rapid, reliable, and effective method for management of pediatric forearm fracture between 5 and 18 years with shorter operative time, less blood loss, lesser radiation exposure, shorter hospital stay, and cosmetically valuable. It has excellent fracture union rate with acceptable bony alignment, good functional and clinical outcome, modest and transient complication rate, and best prognosis.

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