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Operative Treatment of Displaced Both Bone Forearm Diaphyseal Fractures in Children by Elastic Intramedullary Nail

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ABSTRACT

Background: Injuries to the shafts of radius and ulna are one of the most common reasons for children to receive orthopedic care. The purpose of this study was to evaluate the radiological and clinical outcome of fracture both bone forearm in children treated by elastic nail.

Patients and methods: This clinical trial was conducted on 18 patients with fracture shaft of both bone forearm treated by elastic stable intramedullary nail (ESIN) in Zagazig University Hospital, Egypt, and Emhamed Almaqrif Hospital Educational Center, Ajdabia, Libya. It was conducted to evaluate the radiological and clinical outcome of fracture both bone forearm in children treated by elastic stable intramedullary nail.

Results: The mean time to union was 9.94 (SD 2.01) weeks with minimum 7 and maximum 14 weeks. According to the Mayo score majority were excellent 61.1%, then good 27.8% and finally fair 11.1%, and only 4 cases 22.2% had complication (2 surgical site infections, 1 superficial radial nerve injury, and 1 nonunion).

Conclusion: ESIN is secure and suitable for young children for the treatment of displaced forearm fractures.

Keywords: ESIN, Forearm Diaphyseal Fractures, Children**.**

INTRODUCTION

Diaphysis fractures of the forearm are among the most frequent fractures in children, accounting for up to 14–40% of all pediatric fractures. The most frequent cause of this sort of fracture is falling on an extended hand [(1-3)]. The most effective method of treating juvenile forearm fractures with little displacement and stability is still closed reduction and immobilization with a cast [(4,5)]. In earlier trials, surgical intervention was advised for angulation >10°, malrotation >50%, and displacement >60% [(6)].

The possible surgical treatments are closed reduction and internal fixation with titanium elastic nailing, open reduction and plate osteosynthesis, and kirschner-wire pinning. **Metaizeau and Ligier**[(7)] were the first to report the surgical therapy of pediatric both bone forearm fracture using an elastic intramedullary nail.Elastic Stable Intramedullary Nail (ESIN) nails have become more common for fixing forearm fractures, with supporters claiming that nailing reduces surgical dissection and preserves biologic variables at the fracture site [(8)].

The use of ESIN to fix the two forearm bone fractures had numerous benefits, including a smaller incision, minimal soft tissue interference with the fracture fixation process, prompt osseous healing, maximum range of motion at the earliest possible time, a decrease in the complication rate, and excellent clinical and radiological outcomes [(9)].

Early forearm mobilization and less invasiveness compared to plate osteosynthesis are the main advantages of ESIN treatment over conservative treatment [(9)]. About 3–4 weeks of post-operative immobilization by back slapping above the elbow, then early mobilization. The quantity of callus is equivalent to callus formation following conservative therapy after 3 weeks [(8,9)]. Thus, titanium elastic nailing used intramedullary is an effective treatment option for the treatment of unstable both bone forearm fractures in pediatric population [(9)]. Recently, however, there has been a trend towards increased surgical management of these fractures in an effort to improve clinical outcomes. So, the purpose of this clinical trial was to evaluate the radiological and clinical outcome of fracture both bone forearm in children treated by elastic nail.

PATIENTS AND METHODS

This clinical trial was conducted on 18 patients with fracture shaft of both bone forearm treated by intramedullary elastic nail in Zagazig University Hospital, Zagazig, Egypt, and Emhamed Almaqrif Hospital Educational Center, Ajdabia, Libya.

Inclusion criteria: Children aged 5-15years with unaccepted displaced diaphyseal forearm fracture. Children aged 5-15years with compound forearm fracture (Grade 1 and Grade 2).

Exclusion criteria included: Children older more than 15 years age. Children younger than 5 years of age. Pathological fractures, malunion, nonunion, and patient unfit for surgery.

Pre-operative:

Detailed history was taken to know the age, sex, type, and mode of trauma mechanism and time of injury. Proper clinical examination, Forearm radiographs were examined to determine fracture pattern (complete or greenstick), location (proximal, middle, or distal third), displacement, angulation, and rotation. Displacement and angulation are fairly easy to document on AP and lateral views. Laboratory evaluation included Complete blood count (CBC), Liver function tests (SGOT, SGPT, and Albumin), Coagulation profile, Serum creatinine, Random serum glucose (RSG), Virology tests (HBV, HCV, and HIV).

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Surgical technique:

Broad spectrum prophylactic intravenous antibiotic (3rd generation cephalosporin) was given for the patients with simple fracture within two an hour before operation. Proper patient positioning was on the operating table. The procedure was done with the patient in a supine position with use of C arm guide. The image intensifier was placed parallel to the patient's body. It was putted directly vertical for the AP view entering from the axillary side of the patient. Then adjusted for the lateral view, internal rotation of the patient's whole upper limb and the motion comes from the shoulder to avoid displacement of the fracture. Patient anesthetized under general anesthesia and placed supine on the operation table, the sterile preparation by draping was placed.

Post-operative follow-up:

Antibiotics were given, postoperative X-ray including elbow and wrist joints in both AP and lateral view was done. Postoperative immobilization was used from 4 to 6 weeks according to age and radiological study. Patients were followed with radiographs at regular intervals; initially at 2 weeks postoperatively for remove the stitches, then approximately every 2 weeks, 4weeks, 6weeks, 8weeks, 12weeks. At the end of the follow up period, patients were assessed from 4-6months by the assessment range of motion (ROM) by Mayo Elbow Performance Score (MEPS) and the pain by Visual Analogue Score (VAS).

Ethical consent:

The study was approved by the Research Ethical Committee of Faculty of Medicine, Zagazig University. Written informed consent was obtained from all children's guardians. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 20 for Windows® (IBM SPSS Inc, Chicago, IL, USA). According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean and standard deviation (SD), the following tests were used to test differences for significance; difference and association of qualitative variable by Chi square test (X^2). Differences between quantitative independent groups by t test. P value was set at $\leq$0.05 for significant results and $\leq$0.001 for high significant result.

RESULTS

Table 1 shows that the mean age was 8.88 (SD 2.92) years. Most of them (10 cases) were above age of 8 years and with regard to sex, distribution male were majority with 72.2% and female were 27.8%.

Table (1): Age and sex distribution among studied group (N=18)

Variable		Age	
Mean± SD		8.88±2.92	
Median (Range)		9.0 (5-15)	
		N	%
Sex	Female	5	27.8
	Male	13	72.2
	Total	18	100.0

Table 2 shows that the right side was the major side with 72.3% and left 27.7%, regarding mode of injury **FD** was majority with 12 patients (66.7%), **DT** 4 patients (22.2%) and **RTA** with 2 patients (11.1%).

Table (2): Injury characters distribution among studied group (N=18)

Variable		N	%
Side	Left	5	27.7
	Right	13	72.3
Mechanism of Injury	DT	4	22.2
	FD	12	66.7
	RTA	2	11.1
	Total	18	100.0

DT: Direct trauma, **FD**: Fall down, **RTA**: Road traffic accident

Union time was distributed as 9.94 (SD 2.01) weeks (Table 3).

Table (3): Time to union distribution among studied group (N=18)

Variable	Time to Union/ weeks
Mean ± SD	9.94 ± 2.01
Median (Range)	9 (7-14)

Table 4 showed that the majority of postoperative ROM is Excellent.

Table (4): Movement assessment distribution among studied group

Variable		N	%
Supination	Fair	3	16.7
	Good	5	27.7
	Excellent	10	55.6
Pronation	Fair	2	11.1
	Good	6	33.3
	Excellent	10	55.6
Elbow movement	Fair	2	11.1
	Good	5	27.8
	Excellent	11	61.1
Wrist movement	Fair	1	5.55
	Good	5	27.8
	Excellent	12	66.6
	Total	18	100.0

Regard VAS it was distributed as the mean 2.27 in range of mild pain (Table 5).

Table (5): The VAS score distribution among studied group.

Variable	VAS
Mean ± SD	2.27 ± 0.38
Median (Range)	2.03 (1-6)

According to Mayo score which is tested 4 subscales (pain, ROM, stability and daily function) Excellent (61.1%) were majority followed by good (27.8%) then finally fair (11.1%) as shown in (Table 6).

Table (6): Mayo score of outcome distribution among studied group.

Variable		Mayo score	
Mean± SD		89.30±7.64	
Median (Range)		91.0 (68-98)	
		N	%
Mayo score	**Fair**	2	11.1
	Good	5	27.8
	Excellent	11	61.1

Table 7 showed that 14 (77.8%) patients had no complications (**NO**), while 4 (22.2%) patients had complications. Two of them had superficial skin infection (**SSI**), but one of them had superficial radial nerve injury (**SRNI**) and the other one had residual radius nonunion of the fracture side.

Table (7): Complication distribution among studied group (N=18).

Variable			N	%
Complications	**NO**		14	77.8
	SRNI		1	5.55
	SSI		2	11.1
	Nonunion	**Radius**	1	5.55
		Ulna	0	
	Total		18	100.0

DISCUSSION

The current study showed that the mean age was 8.88 (SD 2.92) years and regard sex distribution male were majority with 72.2% and female were 27.8%. which in agreement with the study of **Zfthekar *et al.*** [10] who found that majority of patients were males accounting to 78.12% (n=25). Male to Female ratio was 3.6:1. Mean age of patients was 9.4 years.

The current study showed that the right were the major side with 72.3% and left 27.7%, regard mode of injury FD was majority with 66.7%, DT 22.2% and RTA 11.1%. which in agreement with the study of **Zfthekar *et al.*** [10], who found that regarding modes of injury, fall during play accounted to majority of the cases (81.25%, n=26), Road traffic accident accounted to 9.4% (n=3), and Fall from height accounting to 9.37% (n=3). In contrast, Majority of the patients in their study had fractures on the left side accounting to 62.5% (n=20).

Abdulkareem and Hwaizi [11] reported that regarding mechanism of injury in titanium elastic nail (23 patients), there were 18 patients (78.3%) fall on out stretch hand, 3(13.0%) direct trauma and 2 patients (8.7%) car accident, regarding fracture site there were 12 patients (52.2%) right side injury and 11 patients (47.8%) left side injury.

In current study patients were treated with closed reduction and internal fixation of fracture shaft of both bone forearm under guidance of image intensifier with elastic intramedullary nail and only one case (5.55 %) patients needed mini open reduction due to soft tissue interposition (difficult reduction) to pass the nail across the fracture site.

This is comparable to studies by **Richter *et al.*** [12] (closed reduction 84%) and **Cullen *et al.*** [13] (open reduction 75%) and **Luhmann *et al.*** [14] (open reduction 50%). Close reduction or open reduction before intramedullary nailing yield similar functional results, with similar complication profile in pediatric diaphyseal fracture [15].

The present study showed that the mean time to Union was 9.94 (SD 2.01) weeks. This is in agreement with the study of **Zfthekar *et al.*** [10] who found that mean duration of union was 9.5 (SD 1.3) weeks ranging from 8 to 12 weeks. Similarly, **Yalçinkaya *et al.*** [15] observed clinical and radiological union within 13 weeks after the procedure in 19 of 20 patients. Also, **Kumar *et al.*** [16] reported that the average time for union was 9 weeks.

Also, our results is comparable to study done by **Ruhullah *et al.*** [17] (mean time for union 9 week), **Kapila *et al.*** [18] (mean time of union 9.2 week) and **Ali *et al.*** [19] (mean time for union 10 weeks).

While **Acharya *et al.*** [20] reported that the average time to fracture union, which is defined as presence of a bridging callus on anteroposterior (AP) and lateral views of radiographs, was 7.9 weeks (range: 6–12 weeks).

The present study showed that according to the Mayo score majority were excellent outcome was observed in 11 (61.1%) and good in 5 (27.8%) and fair in 2 (11.1%). No poor results were observed in our study.

Richter *et al.* [12] had 24 (80%) patients with excellent results, 5 (16.6%) with good results and 1(3.3%) with fair results with no poor results noted.

Similar results have been reported in the literature. In the study of **Parajuli *et al.*** [21] 94% patients had excellent results and 6% had good results. Also, **Kapila *et al.*** [18] reported that 92% patients had excellent results and 8% had good results. These excellent clinical results support the use of this technique in the management of displaced both bone forearm fractures in the children patient.

The procedure of inserting intramedullary nails is not without the possibility of complication. In current

study of patients, we have reported a complication rate of 22.2%. This is similar to the complication rate reported by **Parajuli *et al.* [21].**

Yalçinkaya *et al.* [22] reported complications rate ranged from 4-38% in patients treated with intramedullary nailing and **Flynn *et al.* [5]** showed that the overall complication rate in patients undergoing intramedullary nailing was 14.6%.

The most common complication occurring in their series were delayed union, compartment syndrome, infection, skin irritation by hard ware and pin back out.

The current study showed that only 2 cases 11.1% had complication (SSI), one case (SRNI) and one case Nonunion 5.5%for each, which in agreement with the study of **Zfthekar *et al.*[10]** who found that the overall complication rate was reported in 12.5% of patients. Out of 32 patients, two patients had surgical site infection and two patients had nail impingement. **Kumar *et al.*[16]** reported that among 7 (11.66%) patients which developed complications three patients developed superficial infection and were managed by oral antibiotics. The rest four patients had implant related irritation at entry portal which get relieved only after removal of the implant.

In most of the published reports, refracture represents the most common complication, either with the ESIN in situ or after implant removal. This is not unexpected, as forearm fractures are known to have a higher rate of refractures than other fractures in children, and they have been frequently reported after the removal of intramedullary forearm fixation in the literature [23].

Complications after operative repair of pediatric both bone forearm fractures include a re-fracture rate of 5%–10%. This is most common in patients who have undergone implant removal. Implant removal before 6 months postoperatively is associated with an increased incidence ofrefracture.2 In this case; the implant was removed after6 months [24].

CONCLUSION

ESIN is secure and suitable for young children for the treatment of displaced forearm fractures. It remains a minimally invasive procedure which makes primary definitive management of these fractures possible. The need for repeat reductions, angulation, and corrective procedures was not observed, so that good functional results were achieved.

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