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Results of Medullary Fixation of Fracture of Forearm Bones in Children by K-Wires

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ABSTRACT

Background:More than 90% of forearm fractures in children are treated conservatively with good results. Therefore, it is very important to recognize those fractures that cannot be successfully treatedconservatively.Operative management includeeither intramedullary fixation or plates and screws fixation.The aim of the present study was to evaluate short term results of intramedullary fixation for management of diaphyseal forearm fractures in children.Patients and methods:prospective study included 30 skeletally immature patients with forearm fractures who were treated by intramedullary k wires. In all patients, a detailed motor and sensory examination of the ulnar, radial, and median nerves was done to exclude associated nerve injury. Patients were followed up for 6 months.Results: The mean age of was 9.53 ± 2.2years, with the youngest being 6 years and the oldest 14 years. The distribution of the gender in the current study was 25 males (83.3%) and 5 females (16.7%). Regarding the mechanism of trauma; majority of our studied cases (93.3%) bones forearm fractures resulting from falling on outstretched hand (FOOSH), one patient (3.3%) was resulting from road traffic accidents (RTA) and one patient (3.3%) was resulting from directtrauma. Twenty eight patients were right-handed and 2 patients were left handed. The Right side was affected in 22 patients (73.3%) and the left side was affected in 8 patients (26.7%). Majority of fractured bones were middle 1/3 fracture, while five cases were lower 1/3 fracture and only 2 cases were proximal 1/3 fracture.Two cases only had open fracture (6.7%) while the majority of cases had closed fracture (93.3%).Days from injury to operation was ranged from (0) to (5) days with an average of (1.97 ±1.79) days. Majority of our studied cases underwent open reduction (86.79%) while only 4 cases (13.3%) underwent closed reduction of the fractured bones. The patients were assessed three months post operatively using the Outcome Grading System. Twenty two cases (73.3%) showed excellent outcome. Eight cases (26.7%) showed good outcome. No cases with fair or poor outcomes. Conclusion:Intramedullary nailsseems to be safe, more easily not expensive and effective in the management of both bone forearm fractures in children between 4 and 14 years of age.

Keywords:Forearm Bones Fracture; Medullary Fixation; K-Wires

INTRODUCTION

Diaphyseal forearm fractures comprise 13% of all pediatric fractures and are the second most common fracture types among adolescents **[1, 2]**.Diaphyseal forearm fractures are known to remodel poorly, with a high incidence of mal-union **[3]**.

Residual angulation or rotational deformity can lead to a significant reduction in prono-supination**[4]**, particularly in older children in whom there is less potential for bone remodeling. Anatomical reduction may therefore be of greater importance in this age group as they can tolerate a lesser degree of mal-union. It is thought that restoration of the position and magnitude of the radial bow is the most important factor in preserving forearm range of motion**[5]**.

Although closed reduction and casting is the preferred treatment method, outcomes remain variable and patients may require additional fracture manipulation or formal surgical intervention due to residual angulation and some children can be left with a loss of forearm rotation after conservative management **[6,7]**. Internal fixation may be indicated if conservative treatment fails to maintain alignment, in children nearing skeletal maturity, and in open fractures **[8, 9]**.

The proportion of pediatric forearm fractures treated with internal fixation has increased. Traditionally, internal fixation of unstable pediatric forearm fractures has been achieved by open reduction and rigid internal fixation with plate and screws (ORIF) with good results **[7, 9]**, especially in terms of restoration of anatomy. IMN has become popular due to improved cosmoses, shorter operative time, less soft tissue dissection and ease of removal, with good results **[10, 11, 12]**.

Therefore, this study aimed to evaluate short term results of intramedullary fixation for management of diaphyseal forearm fractures in children aged between 4and 14 years.

PATIENTS AND METHODS

This prospective study included 30 skeletally immature patients with forearm fractures who were treated by intramedullary k wires.The study lasted May 2019 to February 2020. All patients were admitted to the department of orthopedic surgery in Zagazig university hospital, Zagazig University.Follow up range was (6-9 months).

Inclusion criteria:

Patients with simple diaphyseal forearmfracture in age of 4 to14 yearsold.Closed fractures or open fractures Gustilograde1.

Exclusion criteria:

Open fractures ≥ Gustilograde1, comminutedfractures, pathologicalfractures and monteggiaand Galeazzifractures.

Clinical evaluation:

Each patient in this study was carefully assessed clinically in the form of detailed clinical history and physical examination. It includes systemic examination of the body by primary, secondary survey and resuscitation. Complete and meticulous local examination of the involved limb was our routine with particular emphasis on: In all injured limbs, vascular examination was done by assessing vascular status and pulsation over the radial artery. In all patients, a detailed motor and sensory examination of the ulnar, radial, and median nerves was done to exclude associated nerve injury. In all patients, the soft tissue envelope around the extremity is inspected for areas of swelling, open wounds with exposed bone, and other soft tissue findings

such as bleeding, abrasions, and tissue loss. The radius and ulna are palpated along their lengths, and the ipsilateral elbow and wrist joints are assessed for swelling, tenderness, and painful or limited range ofmotion. All patients had anteroposterior (AP) and lateral radiographs of the entire forearm, including the elbow and wrist to evaluate forearm fractures effectively.

Preoperative investigations:

Thirty patients with displaced unstable Type 22-A3 fractures by AO/Müller Classification (simple diaphyseal fractures of both the radius and ulna), without epiphyseal involvement, were recruited in the current study.

Every patient had the following laboratory investigations done before surgery: (prothrombintime and concentration).

Patient counseling and consenting:

Patient`s parents counseling was a crucial part of the procedure. It was explained that the decision of performing this procedure was based on the benefits of the technique, clarifying its potentialcomplications.

Operative technique

The timing of surgery varied depending on type of fracture, availability of an image intensifier and an initial trial for closed reduction tried in somecases. The procedure was performed under general anesthesia in all patients. Prophylactic intravenous antibiotic (3^{rd} generation cephalosporin) was given for all the patients.A standard K-wire was used (diameter, 1.5-2.0 mm) depending on the age and medullary canal size. Open reduction of the radiusis performed utilizing a 1–2 cm incision at fracture site; proper muscle dissections till bone appear. Open reduction of the ulna is performed utilizing a 1–2 cm incision made on the subcutaneous border of the ulna at the fracture site. Fracture was exposed with the help of bone holders and leavers. Tourniquet was removed, haemostasis secured and both wounds were closed.

Postoperative care:

Patient stay at hospital for 24 hours after operation.Observation of post-operative complication such as edema, compartmental syndrome or any complications post anesthesia.Checking of peripheral pulsations and neurological examination after complete recovery from anesthesia.Post-operative medications are giving (analgesics, anti-edematous injections and proper IV antibiotics).

Follow up:

The patients were immobilized post operatively in an above elbow splint in neutral rotation at the end of the operation for 4 weeks. After that below elbow splint for another 2 weeks

Statistical analysis:

Data collected and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD. Differences between quantitative independent multiple by ANOVA or Kruskal Wallis,. P value was set at <0.05 for significant results &<0.001 for high significant result.

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RESULTS

Data of the studied patients were presented in **Table (1).**The mean age of was 9.53 ± 2.2years, with the youngest being 6 years and the oldest 14 years **(Table 2).**The distribution of the gender in the current study was 25 males (83.3%) and 5 females (16.7%)**(Figure 1)**.Regarding the mechanism of trauma; majority of our studied cases (93.3%) bones forearm fractures resulting from falling on outstretched hand (FOOSH), one patient (3.3%) was resulting from road traffic accidents (RTA) and one patient (3.3%) was resulting from directtrauma **(Figure 2)**. Twenty eight patients were right-handed and 2 patients were left handed. The Right side was affected in 22 patients (73.3%) and the left side was affected in 8 patients (26.7%) **(Figure 3)**.Majority of fractured bones were middle 1/3 fracture, while five cases were lower 1/3 fracture and only 2 cases were proximal 1/3 fracture **(Table 3)**.Two cases only had open fracture (6.7%) while the majority of cases had closed fracture(93.3%) **(Table 4)**.Days from injury to operation was ranged from (0) to (5) days with an average of (1.97 ±1.79) days **(Figure 4)**. Majority of our studied cases underwent open reduction (86.79%) while only 4 cases (13.3%) underwent closed reduction of the fractured bones **(Figure 5)**.

The patients were assessed three months post operatively using the Outcome Grading System**.** Twenty two cases (73.3%) showed excellent outcome. Eight cases (26.7%) showed good outcome. No cases with fair or poor outcomes **(Table 5)**.

Table (1):Data of the studied patients

Case	Age	Sex	Side	Mode Of Trauma	Time to Do Surgery	Single or Both Bone	Level of Fracture	Closed or Open Fracture	Type Of Reduction Open Or Closed	Image During Operation (Sec.)	Operative Time (Min.)	Time of Union (weeks)	Range Of Supination	Range Of Pronation	Functional Outcome
1	9	1	1	1	2	1	2	1	2	5	45	8	85	68	1
2	10	1	1	1	1	1	2	1	2	7	50	7	85	65	1
3	12	1	1	1	1	1	2	1	2	5	45	8	85	68	1
4	12	2	1	1	1	1	2	1	2	7	60	10	85	64	1
5	7	2	1	1	0	1	2	1	1	20	50	6	85	68	1
6	7	1	1	1	1	2	2	1	2	3	45	7	85	62	2
7	8	1	1	1	5	3	3	1	2	3	45	6	85	68	1
8	7	1	2	1	3	2	2	1	2	3	45	9	85	65	1
9	10	1	1	2	5	1	2	2	2	10	70	10	85	65	1
10	12	1	1	1	0	1	2	1	2	10	60	10	85	62	2
11	14	1	2	1	5	1	2	1	2	5	65	12	85	62	2
12	6	2	1	1	5	1	3	1	1	15	45	6	85	70	1
13	13	1	2	1	0	1	2	1	2	10	65	11	85	65	1
14	8	1	2	1	3	2	2	1	2	3	45	7	85	68	1
15	9	1	1	1	1	1	2	1	2	4	50	9	85	65	2
16	10	1	2	1	1	1	2	1	2	5	60	8	85	68	1
17	13	1	2	1	0	1	2	2	2	7	65	12	85	62	2
18	8	1	2	3	1	2	3	1	2	3	45	8	85	68	2
19	10	1	1	1	5	3	2	1	2	5	50	8	85	65	1
20	9	1	1	1	1	1	2	1	2	6	60	9	85	68	1
21	8	2	1	1	1	1	2	1	1	10	55	8	85	68	1
22	10	1	1	1	3	1	3	1	2	5	60	9	85	65	1
23	14	1	1	1	0	1	2	1	2	7	70	13	85	62	2
24	7	1	1	1	1	1	2	1	2	3	50	6	85	70	1
25	10	1	1	1	1	1	1	1	2	5	60	8	85	68	1
26	9	1	1	1	5	1	2	1	2	3	50	8	85	68	1
27	7	1	1	1	0	3	3	1	1	6	45	6	85	70	1
28	8	1	2	1	4	2	2	1	2	2	45	6	85	68	1
29	10	1	1	1	3	1	2	1	2	5	55	8	85	68	1
30	9	2	1	1	4	1	1	1	2	6	55	10	85	62	2

Codes: Sex: 1=Male, 2=Female,Number; 1= both bones, 2= Ulna, 3=Radius, Mode of trauma; 1= FOOSH, 2=RTA, 3=Direct trauma; Side 1=Rt., 2=Lt; Level of fracture; 1=Upper 1/3, 2=middle 1/3, 3=Lower 1/3; Closed or open fracture; 1=Closed, 2=Open; Reduction; 1=Closed, 2=Open (G1); Functional Outcome: 1=Excellent, 2=Good.

Table (2):Age distribution among the studied patients

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	Mean	SD	Median	Minimum	Maximum
Age (years)	9.53	2.2	9.00	6.00	14.00

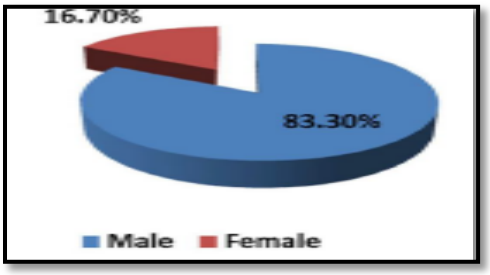

Figure (1): Gender distribution among the studied patients

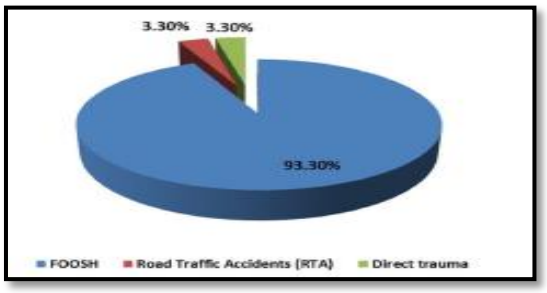

Figure (2): Frequency of the mode of injury

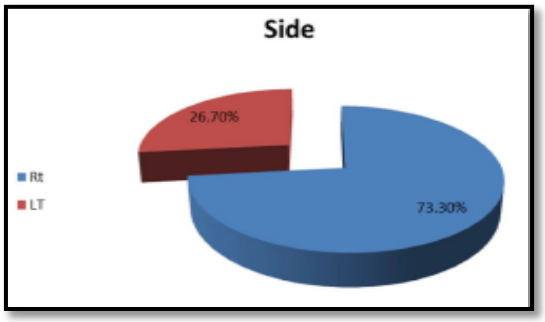

Figure (3): The affected side of injury.

Table (3): Level of fracture among studied population

		Frequency	Percent
Level of fracture	Proximal 1/3	2	6.7
	Middle 1/3	23	76.7
	Lower 1/3	5	16.7
	Total	30	100.0

Table (4):Open or closed trauma among studied patients

		Frequency	Percent
Open or closed trauma	Open	2	6.7
	Closed	28	93.3
	Total	30	100.0

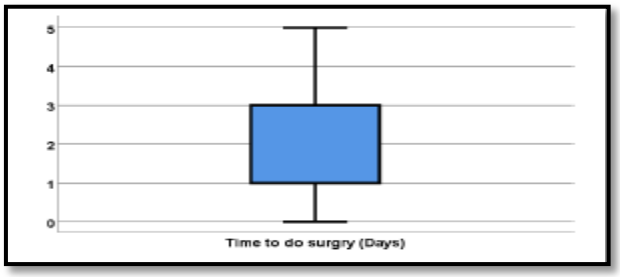

Figure (4):Boxplot illustrates Days from injury to operation

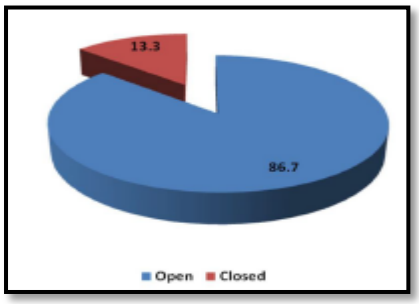

Figure (5):Type of reduction among population

Table (5): Functional Outcome among studied cases (N= 30)

	Frequency	Percent
Excellent	22	73.3
Good	8	26.7

DISCUSSION:

Diaphyseal forearm fractures comprise 13% of all pediatric fractures and is the second most common fracture type among adolescents **[1, 2]**. Treatment of forearm fractures is generally is age-dependent and must be individualized. Thanks to the thick periosteal envelope and higher potential to remodel in children, the majority of these fractures can be managed conservatively with cast immobilization **[13]**.

All cases in our study were classified as simple displaced unstable diaphyseal fractures of both the radius and ulna, without epiphyseal involvement and all of these cases were managed by internal fixation using Intramedullary K WIRES.

Any method of treatment must satisfy certain criteria. First, the treatment should be simple and reasonably inexpensive, and the material required for treatment is also easily obtainable in every center dealing with trauma. Secondly, the treatment should

be effective. Over the last two decades, Intramedullary nailing for forearm fractures has been a popular technique **[12]**.

The ideal device for fixation in diaphyseal forearm fractures would be a simple internal splint allowing mobilization and maintenance of alignment for a few weeks tell bridging callus forms. Biological and mechanical improvements of osteosynthesis make intra-medullary nailing an attractive alternative to bone plate fixation**[14]**.

Intra-operative methods of forearm fractures differ according to type of fracture, level of fracture, closed or open fracture, age of patient and number of bones. Intramedullary fixation technique either open or closed.**Nielson and Simonsen[15]** agree that open reduction is indicated in older children when several attempts of closed reduction had failed.

Kapoor et al. [16]analyzed the results of (50) patients (24) patients were reduced closed, followed by nailing, while (26) fractures requiredopenreductionofeitheronebone(16cases)orbothbones (10 Cases) prior to nailing.

Loss of forearm rotation is one of the foremost concerns in the management of forearm fractures in children.**Sinikumpu et al. [17]** studied radiographic outcome of both-bone diaphyseal middle- third forearm fractures in 168 patients (<16 years) according to the type of treatment. They concluded that intramedullary fixation of both-bone forearm fractures is a good mode of primary treatment of mild and severe middle- third diaphyseal both-bone forearm fractures. The authors identify immature patients who lost significant range of motion when treated non operatively .Assessment of forearm rotation in children is difficult because the relative lack of a bicipital tuberosity in children makes the quantification of rotational mal alignment problematic. In general, restoration of angular and rotational alignment at open reduction optimizes final forearmrotation**.**

Yuan et al.[18] evaluated the incidence of compartment syndrome after treatment of forearm fractures in 285 patients and found that patients who were treated with intra-medullary nailing for open or closed injuries had an increased incidence of compartmental syndrome compared with patients who were treated with closed reduction and plating. Also, patients with longer operative time and increased use of fluoroscopy were at higher risk of developing compartmentsyndrome.

Intramedullary nailsare load shearing devices that do not induce significantstress shielding.Thisloading of the fracture site has been demonstrated to enhance fracture union and callus maturation.

We found that all patients progressed to union without the need for anyfurther surgical intervention with good functional outcome as regards forearm rotation.

CONCLUSION

Intramedullary nails seems to be safe, more easily not expensive and effective in the management of both bone forearm fractures in children between 4 and 14 years of age.

No Conflict of interest.

REFERENCES:

1. **Myers, G. J. C., Gibbons, P. J., &Glithero, P. R. (2004).** Nancy nailing of diaphyseal forearm fractures: single bone fixation for fractures of both bones. The Journal of bone and joint surgery. British volume, 86(4), 581-584.
2. **Sinikumpu, J. J., Lautamo, A., Pokka, T., &Serlo, W. (2012).** The increasing incidence of paediatricdiaphyseal both-bone forearm fractures and their internal fixation during the last decade. Injury, 43(3), 362-366.
3. **Hadizie, D., &Munajat, I. (2017).** Both-Bone Forearm Fractures in Children with Minimum Four Years of Growth Remaining: Can Cast Achieve a Good Outcome at Skeletal Maturity?. Malaysian orthopaedic journal, 11(3), 1.
4. **Hussain, S. (2014).** Ipsilateral fracture of the supracondylar humerus and forearm in children. IJCRI, 5(3), 189-94.
5. **Hassini, L., Saidi, A., Touati, B., Fradj, A. B., Aloui, I., &Abid, A. (2018).** An unusual Monteggia equivalent type 1 lesion: diaphyseal ulna and radius fractures with a posterior elbow dislocation in a child. Chinese Journal of Traumatology, 21(2), 122-124.
6. **Price, C. T., Scott, D. S., Kurzner, M. E., & Flynn, J. C. (1990).** Malunited forearm fractures in children. Journal of Pediatric Orthopaedics, 10(6), 705-712.
7. **Acharya, B. M., Devkota, P., Thakur, A. K., &Gyawali, B. (2019).** Intramedullary Flexible Nailing for Diaphyseal Fractures of Forearm Bones in Children. Revistabrasileira de ortopedia, 54(5), 503-508.
8. **Vainionpää, S., Böstman, O., Pätiälä, H., &Rokkanen, P. (1987).** Internal fixation of forearm fractures in children. ActaOrthopaedicaScandinavica, 58(2), 121-123.
9. **Ortega, R., Loder, R. T., & Louis, D. S. (1996).** Open reduction and internal fixation of forearm fractures in children. Journal of Pediatric Orthopaedics, 16(5), 651-654.
10. **Lascombes, P., Prevot, J., Ligier, J. N., Metaizeau, J. P., &Poncelet, T. (1990).** Elastic stable intramedullary nailing in forearm shaft fractures in children: 85 cases. Journal of pediatric orthopedics, 10(2), 167-171.
11. **Westacott, D. J., Jordan, R. W., & Cooke, S. J. (2012).** Functional outcome following intramedullary nailing or plate and screw fixation of paediatricdiaphyseal forearm fractures: a systematic review. Journal of children's orthopaedics, 6(1), 75-80.
12. **Calder, P. R., Achan, P., & Barry, M. (2003).**Diaphyseal forearm fractures in children treated with intramedullary fixation: outcome of K-wire versus elastic stable intramedullary nail. Injury, 34(4), 278-282.
13. **Bhaskar, A. R., & Roberts, J. A. (2001).** Treatment of unstable fractures of the forearm in children: IS PLATING OF A SINGLE BONE ADEQUATE?. The Journal of Bone and Joint Surgery. British volume, 83(2), 253-258.
14. **Lee, S., Nicol, R. O., & Stott, N. S. (2002**). Intramedullary fixation for

pediatric unstable forearm fractures. Clinical Orthopaedics and Related Research®, 402, 245-250.

15. **Nielsen AB, Simonsen(2008).** Intramedullary nailing versus plate fixation for unstable forearm fractures in children. J PediatrOrthop; 18:9-13.

16. **Kapoor, V., Theruvil, B., Edwards, S. E., Taylor, G. R., Clarke, N. M. P., &Uglow, M. G. (2005).** Flexible intramedullary nailing of displaced diaphyseal forearm fractures in children. Injury, 36(10), 1221-1225.

17. **Sinikumpu, J. J., Lautamo, A., Pokka, T., &Serlo, W. (2013).** Complications and radiographic outcome of children's both-bone diaphyseal forearm fractures after invasive and non-invasive treatment. Injury, 44(4), 431-436.

18. **Yuan PS, Pring ME, Gaynor TP, Mubarak SJ, Newton PO. (2004)** Compartment syndrome following intramedullary fixation of pediatric forearm fractures. J PediatrOrthop. (4):370–5.