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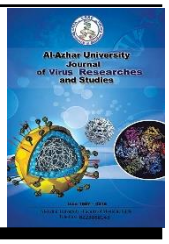

Comparative Study between Elastic Intramedullary Nail versus Compression Plate in Fracture Both Bone Forearm in Adolescent

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Abstract

Fractures of forearm bones in children and adolescents have traditionally been treated conservatively by closed reduction and slab. When acceptable closed reduction cannot be achieved or maintained, surgical intervention is required. To compare the clinical and radiological outcome of Adolescent Both Bone Forearm Diaphyseal fractures treated with Elastic nails and Compression plates fixation aged between 10-16 year, and to clarify the benefits and complications of both procedures. A prospective work to compare two groups of patients, the first group included patients treated by elastic stable intramedullary nails. The second group included patients treated by open reduction and internal fixation by plates and screws, and above elbow slab for 6 weeks. The results of this study were described as found at last follow-up visit ranged from 1 to 3 months. There was no statistically significant difference between the two studied groups regarding the time lapsed. There was not statistically significant between the two studied groups regarding the duration of radiological union. There was not statistically significant between the two studied groups regarding the duration of radiological union (P> 0.05). There was no statistically significant difference between two studied groups regarding the incidence of complications and duration of hospital stay. Elastic intramedullary fixation for the management of adolescent closed unstable forearm fractures as well as type 1 open fractures is the method of choice because minimal invasive osteosynthesis, shorter operating times, and easier hardware removal.

Keywords: Compression Plate; Elastic Intramedullary Nail; Fracture Both Bone Forearm.

1. Introduction

Among the pediatric population, fractures of the radius and ulna diaphysis, (commonly referred to as both-bone forearm fractures), are the third most common fractures in the pediatric population. These injuries comprise 5 % of all pediatric fractures. Fracture of both bone forearm needs urgent care, primary care, and orthopedic practices [1].

With the advancement of new fixation techniques (Flexible intramedullary nailing and plating), interest and controversy has increased regarding the standard of care [2].

The Fracture of Both Bone Forearm is complicated in adolescent patients (10–16 years old) where such fractures may be less frequently amenable to non-operative

management due to decreased remodeling potential in children approaching skeletal maturity [3]. Among all fractures, forearm fractures in the pediatric population are relatively common. On average, 63 % of boys and 39 % of girls sustain a fractured bone by the age of 15 [4]. Fractures involving the radius and ulna account for 40 % of all pediatric fractures, with 5 % involving the diaphysis [5].

The age of peak incidence of fracture varies between genders, with boys sustaining such injuries at two peaks, 9 and 14 years, whereas girls present at a median age of 9 years [1].

Most forearm fractures occur as an isolated injury with roughly 15 % associated with supracondylar fractures and 1 % accompanied by neurologic injuries, most frequently the median nerve, Monteggia and Galeazzi fractures are less common, with a peak incidence between 4 and 10 years, and 9 and 12 years, respectively [6]. Children's forearm fractures are managed differently than similar injuries in adults. Treatment alternatives for irreducible unstable pediatric forearm fractures are closed manipulation under general anaesthesia and casting, Kirschner wire and casting, closed or mini-open reduction and intramedullary fixation, and open reduction and internal fixation with plates [7]. The intramedullary nail fixation is preferable in many circumstances to open reduction and plating of the forearm bones as it prevents stripping of the soft tissues; in addition, there is little in the way of surgical scar tissue and is therefore cosmetically acceptable [8]. This article studies the treatment for both-bone fractures in the adolescent population using intramedullary nail fixation and open reduction and internal fixation with plates. The aim of this work is to compare the clinical and radiological outcome of Adolescent Both Bone Forearm Diaphyseal fractures treated with Elastic nails and Compression plates fixation aged between 10-16 year, and to clarify the benefits and complications of both procedures.

2. Patients and Methods

Thirty (30) patients with diaphyseal fractures of both bones forearm who met the inclusion and exclusion criteria were randomly chosen for a prospective study. Fifteen (15) patients were treated by plate osteosynthesis and fifteen (15) patients were treated by closed intramedullary nailing in Al-Zahraa University Hospital. All study participants were followed up for a minimum of six months.

Patients were included according to the following criteria: Adolescents aged from 10 to 16 years old, diaphyseal and Metaphyseal both bones forearm fractures, all closed and open Gustilo Type 1 fractures, absence of associated vascular and neurological injuries in the same forearm, and adolescents without any ipsilateral limb congenital Deformity. While the Exclusion criteria were Children aged younger than 10 years and older than 16 years old, epiphyseal fractures, open Gustilo Type 2 and 3 fractures, presence of associated vascular or neurological injuries in the same forearm, adolescents with any ipsilateral limb congenital deformity, and single bone fractures.

The files and preoperative X-ray were studied, all adolescents were evaluated clinically and radiologically.

The clinical examination and radiological evaluation were collected from the files of the patients.

2.1 Methods of treatment

Two groups of patients were assessed. The first group included patients treated by elastic stable intramedullary nails that were inserted percutaneous following closed reduction under fluoroscopic guide, and above elbow slab for 6 weeks. The other group includes patients treated by open reduction and internal fixation by plates and screws, and above elbow slab for 6 weeks. Informed consent was taken from every patient in the study.

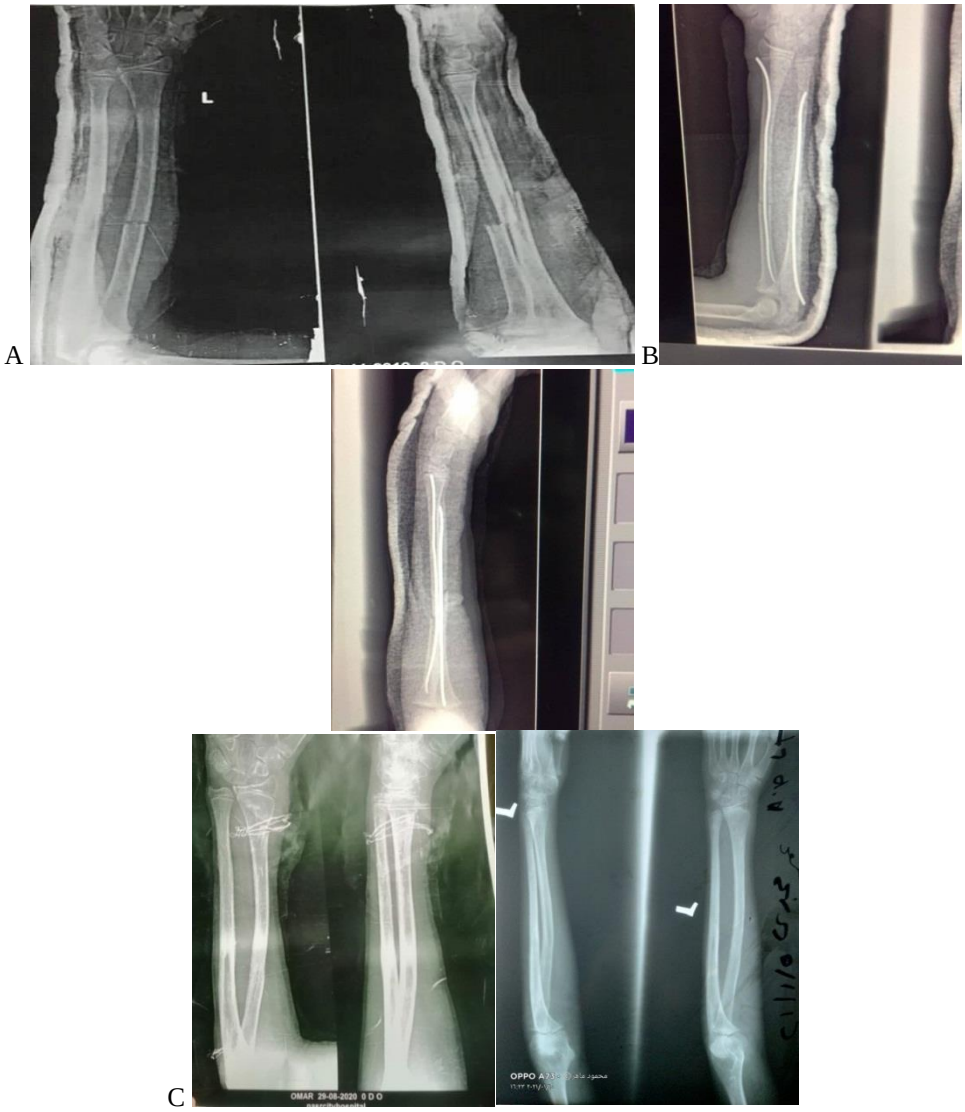

Figure (1): A 14-year-old male, falling on outstretched hand while running with left both bones forearm bones Fractures (middle third radius and ulna). Time from injury to surgery was 2 days. The method of fixation used was flexible intramedullary nail with 6 months follow up and final score excellent. **A)** Preoperative anteroposterior and lateral views. **B)** Postoperative X-ray. **C)** Anteroposterior and lateral views at six months follow up after removal of nails.

Figure (2): (a) Full elbow flexion, (b) Full elbow extension, (c) forearm supination, (d) forearm pronation.

Figure (3): A 16-year-old male, falling on outstretched hand while running with left both bones forearm Fractures (middle third radius and ulna) Time from injury to surgery was 2 days. The method of fixation was plate and screw with 6 months Follow up and final score Excellent **A)** Preoperative anteroposterior and lateral views. B) Anteroposterior and lateral views at two months follow up. C) Anteroposterior and lateral views at six months follow up.

2.2 Surgical technique of treatment of forearm fractures by flexible intramedullary nails

The Patient was positioned supine on the operating table with the injured upper limb placed on a radiolucent arm table, the shoulder abducted 90 degrees and the forearm was extended and supinated. General anaesthesia was used in all patients. Antibiotic prophylaxis against infection was given prior to the beginning of the operation. The image intensifier was placed parallel to the patient's body. It was positioned directly vertically for the AP view. For the lateral view, the patient's whole upper limb was internally rotated, to avoid displacement of the fracture. Sterilization the entire arm down to the fingertips by betadine. Draping and toweling was performed.

2.3 Nail selection and preparation

Titanium nails were used in all cases. One nail was used for each bone, and radial and ulnar nails were identical in all cases. Following the rule of thumb for nail diameter choice: nail diameter = 40% of IM

canal diameter. In some circumstances, the nail diameter may reach 50% of the IM canal. There will be one nail for each bone. Both nails are gently contoured to achieve a curvature of 40–50°. The apex of the curve should be located at the level of the fracture site at the end of the procedure. Contouring was done manually. The nails were applied overlying the bone, planned for nailing, under fluoroscopic control so that the tip of the nail was at the neck of radius and the distal metaphysic of ulna, for the radius and the ulna respectively. Then the nail was marked using a mousquito over the fracture site under fluoroscopic control, and contouring was done at this site which corresponds to the fracture site.

2.4 Flexible intramedullary nailing (FIN) for radius

Radial intramedullary fixation was performed using a distal nail entry site through the radial-side metaphysic proximal to the physis.

2.5 Antegrade flexible intramedullary Nailing for Ulna

A proximal apophyseal entry point was used. The elbow was flexed, and the arm was internally rotated to afford access to the olecranon.

2.6 Technique of surgical treatment by plate and screws

Tourniquet was applied to the upper arm in all cases of open reduction internal fixation with plate and screw. Anterior approach to the radius (Henry approach) is the usual used approach for fixation of the radius. Meanwhile, posterior approach to the radius (Thompson approach) is preferred for proximal and middle third radial shaft fractures. However, posterior or subcutaneous approach to the ulna appropriate for all ulnar shaft fractures. Postoperative follow up to assess degree of reduction and stability of fixation and radiological union (Healing).

2.7 Methods of assessment

Adolescents were assessed for at least six months following surgery. Results were assessed according to range of motion and duration of union.

2.8 Statistical analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 20 and the following were done: Qualitative data were presented as number and percentages while quantitative data were presented as mean, standard deviations and ranges. The comparison between two groups with qualitative data was done by using the Chi-square test. The comparison between two independent groups with quantitative data and parametric distribution was done by using an independent t-test. The confidence interval was set to 95% and the margin of error accepted was set to 5%.

3. Results

This is a randomized clinical trial to compare fifteen adolescents with fractured both bones forearm treated by open reduction and internal fixation by plates and screws, and other fifteen adolescents treated by elastic stable intramedullary nails. The results of this study were described as found at last follow-up visit ranged from 1 to 3 months. Two groups of patients were studied: The first group: included patients treated by elastic stable intramedullary nails that were inserted percutaneously following closed reduction under fluoroscopic guide, and above elbow slab for 6 weeks. The second group: included patients treated by open reduction and internal fixation by plates and screws, and above elbow slab for 6 weeks. In group I, the age range 10-13 were 10 (66.67%) cases and age 14-16 were 5(33.33%) cases while in group II, age range 10-13 were 11(73.33) cases and age 14-16 were 4(26.67%) cases. There was no statistically significant difference between the two studied groups regarding age (P> 0.05) as shown in **Table .1**. Males in group I were

13 (86.67%) and females were 2(13.33%) while in group II males were 14(93.33%) and females were 1(6.67%). There was no statistically significant difference between the two studied groups regarding sex (P > 0.05) as shown in **Table .2**. Right side cases in group I were 8(53.33%) and left side cases were 7(46.67%) with the same proportion for group II. There was no statistically significant difference between the two studied groups regarding side (P >0.05) as shown in **Table .3**. The right dominant hand side in group I was 13(86.66%) and left side cases were 2(13.34%) with the same proportion for group II as shown in **Table .4.** In group I, falling on outstretched hand cases were 10(66.67%), direct trauma cases were 3(20%) and R.T.A cases were 2(13.33%) while in group II, falling on outstretched hand cases were 8(53.33%), direct trauma cases were 4(26.67%) and R.T.A cases were 3(20%). There was no statistically significant difference between the two studied group regarding mechanism of injury (P > 0.05) as shown in **Table .5**. In group I, middle third level were 7(46.66%) cases, lower third level were 4(26.67%) cases and upper third level were 4(26.67%) cases while in group II, middle third level were 6(40%) cases, lower third level were 5(33.33%) cases and upper third level were 4(26.67%) cases. There was no statistically significant difference between the two studied groups regarding level of fracture (P >0.05) as shown in **Table .6**. In group I, time lapsed ranged 1.0-8.0 days with mean value 4.02±2.65 while in group II, it ranged 1.0-7.0 days with mean value 4.65±2.84. There was no statistically significant difference between the two studied groups regarding the time lapsed (P> 0.05) as shown in **Table 7.** In group I, radiological union ranged from 8 weeks to 20 weeks with mean value 12.6±2.85 while in group II, it ranged from 8 weeks to 16 weeks with mean value 11.10±3.21. There was not statistically significant between the two studied groups regarding the duration of radiological union (P> 0.05) as shown in **Table .8.** In group I, forearm rotation (pronation - supination) ranged from 75-85^{o} with mean value 79.80±3.38 while in group II, it ranged from 75-80^{o} with mean value 77.93±2.09. There was not statistically significant between the two studied groups regarding the duration of radiological union (P> 0.05) as shown in **Table .9.** In group I, superficial infection cases were 1(6.67%), delay union cases were 2(13.33%) and there were no un-union cases while in group II, superficial infection cases were 1(6.67%), delay union cases were 1(6.67%) and there were no un-union cases. There was no statistically significant difference between two studied groups regarding the incidence of complications (P > 0.05) as shown in **Table .10.** In group I, the duration of hospital stays ranged 1-2 days with a mean value 1.40±0.51 and in group II, it ranged 1-2 days with a mean value 1.53±0.52. There was no statistically significant difference between the two studied groups regarding the duration of hospital stay (P > 0.05) as shown in **Table 11.** Regarding POSNA score, in group I, excellent score was 10(66.7%), good score was 2(13.3%), fair score was 3(20.0%) and no patient with poor score while in group II, excellent score was 13(86.7%), good score was 1(6.7%), fair score was 1(6.7%) and no patient with poor score. There was no statistically significant difference between the two studied groups regarding final score at end of follow up (p> 0.05) as shown in **Table .12**.

Figure (4): (a) Forearm pronation. (b) Forearm supination. (c) Full elbow flexion. (d) Full elbow extension. (e) two different scars after fixation of radius and ulna respectively.

Table (1): Comparison between the two studied groups regarding age.

Age (years)	Group I		Group II	
	No.	%	No.	%
10-13	10	66.67	11	73.33
14-16	5	33.33	4	26.67
p-value (chi square test)	0.723 (non-significant difference)			

Group I = Elastic stable intramedullary nails, Group II = Open reduction and internal fixation by plates and screws.

Table (2): Comparison between the two studied groups regarding sex.

Sex	Group I		Group II	
	No.	%	No.	%
Male	13	86.67	14	93.33
Female	2	13.33	1	6.67
P-value	0.52			

Table (3): Comparison between the two studied groups regarding side of affection.

Side of affection	Group I		Group II	
	No.	%	No.	%
Right	8	53.33	8	53.33
left	7	46.67	7	46.67
P-value	0.214			

Table (4): Comparison between the two studied groups regarding dominant hand.

Dominant hand	Group I		Group II	
	No.	%	No.	%
Right	13	86.66	13	86.66
left	2	13.34	2	13.34
P-value	1.000			

Table (5): Comparison between the two studied groups regarding mechanism of injury.

Mechanism of injury	Group I		Group II	
	No.	%	No.	%
Falling on hand	10	66.67	8	53.33
Direct trauma	3	20	4	26.67
R.T.A.	2	13.33	3	20
P-value	0.148			

Table (6): Comparison between the two studied groups regarding level of fracture.

Level of fracture	Group I		Group II	
	No.	%	No.	%
Middle third	7	46.66	6	40
Lower third	4	26.67	5	33.33
Upper third	4	26.67	4	26.67
P-value	0.561			

Table (1): Comparison between the two studied groups regarding the time lapsed before surgery.

Time lapsed (days)	Group I	Group II
Range	1.0 – 8.0	1.0-7.0
Mean	4.02	4.65
S.D.	2.65	2.84
P (independent t-test)	0.45	

Table (2): Comparison between the two studied groups regarding the duration of radiological union.

Radiological union (weeks)	Group I	Group II
Range	8 – 20	8 – 16
Mean	12.6	11.10
S.D.	2.85	3.21
P-value	0.366	

Table (3): Comparison between the two studied groups regarding the range of motion.

Range of motion	Group I	Group II
Range	75 – 85	75 – 80
Mean	79.80	77.93
S.D.	3.38	2.09
P	0.080	

Table (4): Comparison between the two studied groups regarding the incidence of complications.

Complication	Group I		Group II	
	No.	%	No.	%
Superficial infection	1	6.67	1	6.67
Delay union	2	13.33	1	6.67
P-value	0.225			

Table (5): Comparison between the two groups regarding the duration of hospital stay.

Hospital stays (days)	Group I	Group II
Range	1 – 2	1 - 2
Mean	1.40	1.53
S.D.	0.51	0.52
P	0.481	

Table (6): Comparison between the two studied groups regarding final score at end of follow up.

Final score at end of follow up.	Group I		Group II	
	No.	%	No.	%
Excellent	10	66.7	13	86.7
Good	2	13.3	1	6.7
Fair	3	20.0	1	6.7
Poor	0	0	0	0
P-value	0.422			

4. Discussion

This work aimed to compare the results of internal fixation of forearm fractures in adolescents by elastic stable intramedullary nails and open reduction and internal fixation by plates and screws.

In the current study, there was no statistically significant difference between the two studied groups regarding age and sex. In agreement with our study many studies reported that the incidence of pediatric forearm fractures was more common in males than in females **[9]**. While others reported almost equal incidence **[10]**. This observation can be explained by the fact that in our community males are more involved in sports and traffic than females, so they are more prone to injuries.

In our study, there was no statistically significant difference between the two studied groups regarding side.

Many studies reported that, the incidence of fractures of both forearm bones in children was more common in right side than in left side, while others reported higher incidence of left side over right side **[11]** and others reported equal incidence **[12].**

Regarding mechanism of injury, there was no statistically significant difference between the two studied group regarding mechanism of injury, this also was reported by **Afifi [13]** and **Adam et al. [14]** this may be explained by the increased rate of sports practice and increased activities during this age group.

In this study, regarding the level of fracture, there was no statistically significant difference between the two studied groups regarding level of fracture. Many studies reported that the incidence of diaphyseal fractures of both forearm bones in children was more common in the middle third than in upper and lower thirds **[12,15]**.

In the current study, in group I, time lapsed ranged 1.0-8.0 days with mean value 4.02±2.65 while in group II, it ranged 1.0-7.0 days with mean value 4.65±2.84. There was no statistically significant difference between the two studied groups regarding the time lapsed (P> 0.05).

This was also reported by **El-Khadrawe [16]** with a mean time lapse between trauma and surgery of 1.32 days; all his patients were operated upon within three days from injury. The use of open reduction in the treatment of pediatric unstable forearm fracture remains controversial **[11]**. It appears that many authors initially aim to treat pediatric forearm fracture by intramedullary nailing with the percutaneous technique but then adopt mini open technique upon unsuccessful attempts of closed reduction **[11]**. It is known that the most common cause leading to failure of closed reduction is the interposition of the muscle bellies at the fracture site **[11,17]**.

Yung et al. [18] recommended mini-open reduction before intramedullary nailing in cases in which fracture translation exceeded 100%. Many studies have demonstrated that intramedullary nailing can be applied by the mini-open incision technique in pediatric unstable forearm fractures and that successful anatomic and functional results can be achieved with open reduction **[11,17]**. This was concomitant with Ozkaya et al recorded of

35 children with unstable both-bone forearm, 14 patients (group 1) 4 girls, 10 boys with mean age 13 years (range from 10 to 15 years) underwent open reduction and plate-screw fixation, and 21 patients (group 2) 5 girls, 16 boys with mean age 11.5 years (range from 8 to 13 years) underwent closed reduction and intramedullary fixation. All the fractures in group 1 were closed, while, in group 2, there were 15 closed and six type 1 open fractures. The mean time to surgery was 4.3 days in group 1, and 3.1 days in group 2.

In the current study, in group I, radiological union ranged from 8 weeks to 20 weeks with mean value 12.6±2.85 while in group II, it ranged from 8 weeks to 16 weeks with mean value 11.10±3.21. There was no statistically significant between the two studied groups regarding the duration of radiological union (P> 0.05).

This was in agreement with **Upasani and Li [19]** study who recorded 21 patients treated with elastic intramedullary nail (ESIN) between 1997 and 2005. There were 14 boys and 7 girls with a median age of 11.8 years which followed up for an average of 12.8 months (Range, 12–21.5 months). Clinical and radiologic union was achieved within 13 weeks after the procedure in 19 children. One patient had delayed union of the ulna which finally united at 9 months after operation without any further intervention. Another patient had nonunion of ulna that required autologous bone marrow injection after 1 year before full consolidation occurred.

Also, our study was in agreement with **Ozkaya et al. [20],** they recorded that nonunion was observed in only one patient in group 1. The mean time to union was 7.2 weeks (range 6 to 11 weeks) in group 1, and 6.5 weeks (range 6 to 10 weeks) in group 2.

Also, in agreement with our results, the results of Shah **et al. [11]** trial which studied sixty-one patients (mean age, 13.9 years; range, 11.5– 16.9 years), 47 males and 14 females. Thirty-eight percent of the fractures (62%) occurred during sports participation. Fifteen patients, 10 males and five females, were treated with IM nailing. Forty-six patients, 37 males and nine females, were treated with ORIF. The mean age at the time of injury was 13.3 years (range, 11.5–14.9 years) in the IM nailing group and 14.1 years (range, 11.5–16.9 years) in the ORIF group and reported No statistically significant difference was found for mean time to fracture union between the IM nailing (8.5 weeks; range, 5–16 weeks) and ORIF (8.9 weeks; range, 6–33 weeks) groups, 60 patients (98%) had no residual angulation, translation, or radial malrotation. There was one patient with an ulnar malunion in the ORIF group.

Also, **Reinhardt et al. [21]** study was between 1996 and 2005 recorded 31 patients between 10 and 16 years of age with fracture shaft both bones forearm, 12 patients who were treated with plate-and-screw fixation with a mean age of 14.5 years (range, 11.9Y-16 years) and 19 who were treated with intramedullary nailing with a mean age of 12.5 years (range, 10Y-14.6 years). The average age was 10 years (range, 5-15) evaluating No differences were found between the groups for fracture union at 3 or 6 months. No patients in either group had residual angulation, translation about the fracture sites, or radial malrotation.

Regarding the range of motion, in the current study, in group I, forearm rotation (pronation - supination) ranged from 75-85^{o} with mean value 79.80±3.38 while in group II, it ranged from 75-80^{o} with mean value 77.93±2.09. There was no statistically significant between the two studied groups regarding the duration of radiological union (P> 0.05)**.**

This came in agreement with **Shah et al. [11]** who reported that 83% of patients in both groups demonstrated full forearm rotation with 17% of patients in both groups demonstrating a loss of rotation of at least 10 when compared with the contralateral forearm and reported more complications with ORIF (30%) as compared to IMN (20%). They concluded that Flexible Intramedullary nailing of

both-bone form fractures in adolescents was safe and effective, they had less complications when compared with conventional ORIF.

Also, the current study results agreed with **Fernandez et al. [22]** who studied 64 children aged 9- 15 years with unstable forearm fractures 19 were treated with plating of the ulna and radius and 45 by stable elastic intramedullary fixation. The study evaluated the functional outcomes with respect to mobility of the elbow and wrist as in both groups showed free mobility of the elbow and wrist. In Group I, 1 of the 19 patients showed restriction of mobility of more than 30^{o}. This was the patient who had experienced two refractures. There were no significant differences (P = 0.303) in the range of motion of the forearm between the two groups.

Also, **Reinhardt et al. [21]** study was in agreement with our results that there was no difference in loss of forearm rotation between groups.

In the current study, regarding POSNA score, in group I, excellent score was 13(86.67%), good score was 1(6.67%), fair score was 1(6.67%) and no patient with poor score while in group II, excellent score was 10(66.67%), good score was 3(20%), fair score was 2(13.33%) and no patient with poor score. There was no statistically significant difference between the two studied groups regarding final score at end of follow up (p> 0.05).

This was in agreement with **Ozkaya et al. [20],** who revealed that the results in group 1 were perfect in 11 patients (78.6%), good in two patients (14.3%), and fair in one patient (7.1%). In group 2, 18 patients (85.7%) had excellent, three patients (14.3%) had good results.

In our study, in group I, superficial infection cases were 1(6.67%), delay union cases were 2(13.33%) and there were no nonunion cases while in group II, superficial infection cases were 1(6.67%), delay union cases were 1(6.67%) and there was no un-union cases. There was no statistically significant difference between two studied groups regarding the incidence of complications (P > 0.05).

This was in agreement with **Upasani and Li [19]** study complications were all modest and transient and eventually all patients achieved a good functional clinical outcome. They included that ESIN is an attractive treatment option for displaced and unstable diaphyseal forearm fractures in children.

Also, the results of **Ozkaya et al. [20]** were accommodated with the current study results that complications were major in three patients (21.4%) and minor in two patients (14.3%) in group 1, compared to one major (4.8%) and eight minor (38.1%) complications in group 2. None of the patients had limb-length discrepancy, joint deformity, angular or rotational deformity, or complications such as synostosis and infection. They concluded that intramedullary nailing was safe, effective, and easy to perform in the management of unstable both-bone forearm fracture in children.

In agreement with our study, **Fernandez et al. [22]** evaluated the complications of nail was 2 major (4%) (1 refracture, 1 nonunion) and 9 minor (20%) (2 delayed union, 3 neuropathies, 2 rod migration, 2 skin infections) and of plates 2 major (11%) (2 refractures) and 1 minor (5%) (1 neuropathy). They concluded that Elastic intramedullary fixation for the management of the closed unstable forearm fractures as well as type I open fractures is the method of choice because minimal invasive osteosynthesis creates stable circumstances that permit early functional follow-up treatment. Plating has clearly lost much of its importance for the treatment of forearm fractures in children.

In accordance to our study results, **Van der Reis et al. [23]** who studied 41 patients with fracture shaft both bones forearm, 23 patients who were treated with plate-and-screw fixation and 18 who were treated with intramedullary nailing. The average age was 10 years (range, 5-15) evaluating

the complications of nail was 5 (21%) and of plates 6 (33%). They concluded that the functional results, rate of union, and rate of complications were statistically similar for the two groups.

Also, **Reinhardt et al. [21]** study showed that complication rates were also similar between groups, with 1 ulna nonunion, 1 compartment syndrome, and 2 refractures in the nailing group and 1 radius and ulna nonunion, 1 broken plate, and 2 refractures in the plating group. They included that based on similar functional and radiographic outcomes, nailing of length-stable forearm fractures remains an equally effective method of fixation in skeletally immature patients 10 to 16 years of age when compared with plating and is our treatment of choice.

5. Conclusion

Whenever surgical treatment is indicated for fractures of forearm bones in adolescents, operative stabilization by plates and screws and elastic intramedullary nails proved to be safe and effective. However, elastic intramedullary fixation for the management of adolescent closed unstable forearm fractures as well as type 1 open fractures is the method of choice because minimal invasive osteosynthesis, shorter operating times, and easier hardware removal.

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