# A prospective study of 50 cases for management of non–physeal forearm fractures in children and adolescents

**Dhammapal S. Bhamare[1], Abhijeet Shroff[2,*], Rahul Madhukar Salunkhe[3], Sumeet Kumar[4], Sanjay Deo[5]**

[1,2,3]Associate Professor, [4]Junior Resident, [5]Professor, Dept. of Orthopaedics, D,Y. Patil Medical College, Hospital & Research Centre, Pune, Maharashta, India.

***Corresponding Author:**
E-mail: abhijeetshroff@yahoo.com

## Abstract

**Introduction:** Diaphyseal fractures of forearm in children and adolescent are extremely common and there are various treatment modalities available for the same. The aim of the study is to assess the outcome of different techniques in management of non-physeal forearm fractures in children and adolescents, to demonstrate the efficacy and complications of open method and to explore the outline of the demographic data of diaphyseal forearm fractures occurring in children and adolescent.

**Materials and Methods:** 50 patients of age group between 1-15 years were included and were treated and assessed with casting, plating or nailing according to various indications between July 2015 to September 2016.

**Results:** 29 patients were treated with casting, 18 with nailing and 3 with plating. 4 patients failed to follow up after discharge from hospital. Duration of hospital stay, operative time and rate of union were statistically significant in the various groups. Final results analysed by Price et al criteria were statistically not significant.

**Conclusion:** Closed reduction and casting yield excellent to good results and if satisfactory alignment is not achieved, surgeon should proceed for operative treatment. Nailing fixation of an unstable forearm fractures in skeletally immature patients allows early functional treatment with an excellent functional and cosmetic outcome in comparison to plate osteosynthesis. However, studies with larger population and longer follow up period are required for further analysis.

**Keywords:** Non–Physeal, Forearm Fractures, Children, Adolescents, Plating, Nailing, Casting.

## Introduction

Fractures to the shaft of the radius-ulna are the most common reasons for children and adolescent to receive orthopaedic care and are among the most challenging to the orthopaedist because of their complexity and risk of complications.(1) Fractures of forearm in children and adolescent are extremely common.(2) 10% of all diaphyseal forearm fractures in children and adolescents are irreducible and/or unstable fractures, requiring different treatment methods i.e., closed reduction & casting under general anaesthesia, fixation with pins & plaster casting, closed reduction or mini-invasive Intra-medullary nailing, open reduction & osteo- synthesis with plates & external fixators.(3) Healing occurs reliably after closed treatment but mal-union with resultant decreased rotation is common & associated with poor results.(4) The open surgical intervention is associated with complication like delayed union, cross union, non union & at worst, an osteomyelitis(1) Internal fixation requires a second surgery for implant removal. The plated forearm will require protection after the plate removal even if the fracture is united.(1) The aim of the study is to identify the factors such as angulations at fracture site, inclination of epiphyseal plate of radius with the proximal fragments, type of fractures etc. with regards to supinition & pronation in the patients treated by closed and open methods and to assess the outcome of different techniques (casting, plating and nailing) in management of non physeal forearm fractures in children and adolescents.

## Materials and Methods

Institute Scientific & Ethics Committee Clearance was obtained before the start of the study. It was a prospective study of 50 cases done between the period of July, 2015 to September, 2017 at Dr D. Y. Patil Medical College, Pimpri, Pune. Implants used were Square nail, flexible Nail, 3.5mm DCP, 2.7mm DCP. All patients with non physeal fracture up to 3 weeks old, of forearm in the age group of 1 year to 15 years included in the study. Open fractures of Type 2 and 3 of Gustillo Anderson Classification, failure to achieve close reduction after three to four attempts, patient with delayed presentation, refracture of the previously treated fractures, pathological Fractures and fractures with compartment syndrome were excluded

### Conservative Methods

Closed reduction with casting was applied to the patients with closed fractures, skeletally immature (displaced and non- displaced),(5) patients with less than 1cm(6,7) shortening and patients who came under recommended acceptable age-group and alignment parameters (angulation, malrotation and displacement) for paediatric forearm fractures.(8)

All the close reductions were done under intravenous sedation or general anaesthesia. Reduction was confirmed under C-Arm guidance in both antero posterior and lateral views. While maintaining the reduction, a well padded above-elbow cast was given in the position, in which the fracture fragments had

maximum stability and were well aligned, and the reduction was checked under C-Arm guidance. If the reduction was not acceptable in two attempts, an open reduction and internal fixation was done. While applying cast, particular care was taken to prevent crowding of fingers and plaster cast was trimmed if necessary to allow free movement of thumb and fingers. Patient was sent to the ward.

**Operative Methods**

**Patients treated operatively were the following:** Those who didn't come under recommended acceptable alignment parameters for paediatric forearms for closed reduction with casting.[7] Failure of 2 attempts of conservative treatment. Patients approaching skeletal maturity.[9] Communitted fractures.[10] Fractures with shortening more than 1 cm.[6,7] Fractures irreducible due to soft tissue interposition.[11] Unstable fracture patterns.[12]

**Closed reduction with internal fixation with nailing:** Those who didn't come under recommended acceptable alignment parameters for paediatric forearms for closed reduction with casting.[7] Failure of 2 attempts of conservative treatment. Fractures with shortening more than 1 cm.[6,7] Unstable fracture patterns.[12] Fractures which presented after 2 weeks (and less than 3 weeks).[13,14] Fractures that angulate late (between 2-3 weeks of trauma) in course of cast care.[13,14]

**Open reduction with internal fixation with plating:**

- Communitted fractures.[10]
- Fractures irreducible due to soft tissue interposition.[11]
- Patients approaching skeletal maturity, with single bone fracture.[9,12]
- Fractures located at the apex of the radial bow that cannot be maintained in alignment by intramedullary fixation.[18]

## Methods

All the operative procedures were done in supine position under anaesthesia. Approximate size of nails was taken pre-operatively. Closed nailing was done under guidance of C-Arm. In case of Extra-medullary implants, 3.5mm/2.7mm DCP was used. For open fractures, wounds were debrided and irrigated with plenty of sterile saline solution. Whenever possible, bones were exposed from the traumatic wound. The final outcome of the surgery was decided (excellent, good, fair, poor) using the criteria of Price et al[15] as it was used in the Tarmuzi NA[16] study and meta-analysis of Baldwin K study.[17]

**Fig. 1: General instruments used for the surgical procedures**

**Fig. 2: Plating and nailing set**

**Fig. 3: Patient treated conservatively with above elbow cast**

## Observation and Results

**Table 1: Shows level of fracture**

| Level | Present series | | Tarmuzi NA[16] | | Wahid MH [19] | Kose O[20] | Waqar A[21] |
|---|---|---|---|---|---|---|---|
| | Radius | Ulna | Radius | Ulna | | | |
| Upper third | 14% (7) | 20%(10) | 17% | 17% | 3.88% | 12.5% | 27.86% |
| Middle third | 66%(33) | 64%(32) | 69% | 66% | 50.48% | 71.85% | 54.87% |
| Lower third | 20%(10) | 16%(8) | 14% | 17% | 45.63% | 15.6% | 17.26% |

**Table 2: Shows type of treatment**

| Methods | | Present series | | Flynn JM[4] | Wahid MH[19] |
|---|---|---|---|---|---|
| Conservative method | | 58% (29) | | 93.3% | 75.72% |
| Operative method | IM nailing | 42% (21) | 36% (18) | 6.7% | 24.27% |
| | plating | | 6% (3) | | |

**Table 3: Shows mean duration of hospital stay, mean operative time and average period of follow up**

| | Mean duration of hospital stay | P–value by ANOVA test | Mean operative time | P-value | Average follow up period |
|---|---|---|---|---|---|
| Conservative | 1.31±0.47 days | < 0.001 | - | - | 15.33 months (2 patients did not follow up) |
| IM nailing | 3.55±3.16 days | | 59.44±9.376 min | <0.001 | 18.5 months (2 patients did not follow up) |
| Plating | 8.33±5.77 days | | 103.33±5.774 min | | 19.33 months |

**Table 4: Shows duration of immobilization**

| Duration of immobilization | Present series | | Tarmuzi NA[16] (only conservative) | Waqar A[21] (only conservative) | Mean union time |
|---|---|---|---|---|---|
| Average duration of immobilization | Conservative = 4.1 weeks | Total = 4.1 weeks | 4.6 weeks | 6 weeks | Conservative 5.51 weeks |
| | IM Nailing = 4.6 weeks | | | | IM nailing 6.06 weeks |
| | Plating = 2.33 weeks | | | | Plating 7.33 weeks |

**Table 5: Shows final results using Price et al[15] criteria of patients treated conservatively**

| Results | Present series | P – value | Tarmuzi NA[16] |
|---|---|---|---|
| Excellent | 88% (24) | 0.547 | 85% |
| Good | 7.4% (2) | | 12% |
| Fair | 3.7% (1) | | 3% |
| Poor | ---- | | ---- |

**Table 6: Shows final results using Price et al[15] criteria of patients treated operatively**

| Results | Present series | | P - value | Flynn JM[7] | | Wahid MH[19] | Kose O[20] | |
|---|---|---|---|---|---|---|---|---|
| | IM Nailing (16) | Plating (3) | 0.547 | IM Nailing (103) | Plating (44) | Operative method | IM Kirshner's wire | Plating |
| Excellent | 87.5% (14) | 66.67% (2) | | 81% | 75% | 79.97% | 100% | 90.96% |
| Good | 6.25% (1) | 33.33% (1) | | 19% | 25% | 16.02% | 0 | 9.03% |
| Fair | 6.25% (1) | 0 | | 0 | 0 | 3.99% | 0 | 0 |
| Poor | 0 | 0 | | 0 | 0 | 0 | 0 | 0 |

**Few Cases:**

**Case 1: Excellent result with cast showing pre op, post op, and final followup xray with range of motion**

**Case 2: Excellent result with nailing showing pre op, post op and final follow up X ray after implant removal and range of motion**

**Case 3: Excellent results with plating showing pre op and post op xray and range of motion**

## Discussion

The most common causes of forearm fracture include a fall in or near home followed by sports related injuries.[16,4,23] Other causes include fall from height or road traffic accidents suggestive of high velocity injuries. In the present series and series Wahid KH, Kose O, Tarmuzi NA, Flynn JM and Nazari Ahemad,[19,20,16,4,23] most common cause of fracture forearm was a simple fall. Our observation is comparable to the literatures.

In the present series, the maximum numbers of fractures were in middle third region i.e., 66% (33) radius and 64% (32) ulna which was comparable to Tarmuzi NA, Wahid MH, Kose O and Waqar A series.[16,19-21]

Closed reduction and cast immobilization remains the current gold standard for treating paediatric forearm fractures. In the present series, 58% (29) patients were treated with closed reduction and cast immobilization. Nowadays there is a increase in trend towards surgical management. This has largely been driven by technologic advances, sociologic changes, liability concerns, and perhaps even medical economics.[4] In the present series, 42% (21) patients were given surgical management.

Mean duration of hospital stay was comparatively lesser in IM nailing group than plating group with p – value 0.001 which was statistically significant. Mean operative time was comparatively lesser in IM nailing group than plating group. The mean difference was 43.889 minutes with p– value 0.001 which was statistically significant. 2 patients from conservative group and 2 patients from nailing group did not return for follow up. Post operative neurovascular status of every patient in our study was intact i.e., there was no distal neurovascular compromise. Average duration of immobilization in the present series was 4.1 weeks which was comparable with other series.[21,16,4,12,24]

In the present series, for conservative method mean union time was 5.51 ± 0.93 weeks. For operative

method, it was plating 7.33 ± 0.57 weeks and nailing 6.06 ± 0.85 weeks, p-value was 0.004 which was statistically significant. P-value for rate of union for different age groups was 0.633 which was statistically non-significant For Tarmuzi NA series[16] for conservative average was 4.6 weeks. In Kose O[20] average for plating was 9 weeks and for nailing was 8.8 weeks, whereas in Flynn JM series [4] it was 8.6 weeks for plating and 6.9 weeks for nailing.

At final follow-up, for closed methods, 86.9% patients had excellent results & 8.69% patients had good results. For operative method, 87.5% patients for IM nailing & 66.67% patients for plating had excellent results. No poor results were found following any mode of treatment. P-value was 0.547 which was statistically not significant.

Different authors have used different criteria for assessing final results. In the present series, we used Price et al criterion.[15]

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## Conclusion

Closed reduction and casting yield excellent to good results and if satisfactory alignment is not achieved, surgeon should proceed for operative treatment. Nailing fixation of an unstable forearm fractures in skeletally immature patients allows early functional treatment with an excellent functional and cosmetic outcome in comparison to plate osteosynthesis. However studies with larger population and longer follow up period are required for further analysis.

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