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# Randomized Controlled trial Comparing Single Bone and Both Bone Fixation for Forearm Fracture in Children

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## ABSTRACT

**Background:** Fractures of shaft of the radius and ulna are one of the commonest injuries seen in the paediatric age group. Single bone intramedullary fixation has been advocated in the treatment of unstable diaphyseal forearm fractures. We conducted this study to evaluate the radiological and functional outcome in single bone and both bone fixation in forearm fracture in children. **Methods:** We designed a prospective randomized trial to compare single bone and both bone fixations in forearm fracture in aged 8-15 years. Fifty patients were presented to our institution during the period from May 2016 to May 2017 and randomly assigned a group with 25 patients in each group. Patients in Group A (SBF) were fixed with intramedullary Rush pin in ulna and those in Group B (DBF) were both radius and ulna were fixed. The patients were followed up for a period of twelve weeks. A radiological and functional outcome was evaluated and was compared and graded using Price *et al.* (1) criteria. **Results:** Among the 50 patients analyzed, randomization was successful. ROM of elbow at the final follow up was not statistically significant differences between two Groups. There were no statistically significant differences of radiological parameters at the final follow-up. Final assessment with Price *et al.* (1) criteria showed no statistically significant differences between two groups (*P* value- 0.1). **Conclusion:** Single bone ulna intramedullary fixation was comparable in terms of function and radiological parameter for both-bone forearm diaphyseal fracture in children.

**Key words:** Paediatric, Single bone intramedullary fixation, Double bone intramedullary fixation.

## INTRODUCTION

Forearm fractures are common injuries in children which account for 45% of all fractures in childhood. Approximately, 75 to 84% of forearm fractures occur in the distal third, 15 to 18% occur in the middle third and 1 to 7% occurs in the proximal third of the forearm (2). It can be treated conservatively with POP cast. Single bone intramedullary fixation has been advocated in the treatment of unstable diaphyseal forearm (3). Intramedullary fixation is minimally invasive, simple procedure to do, its maintains bony alignment, and promotes rapid bony healing, in addition there is decreased surgical morbidity compared with open reduction and plating, and implant removal is simpler, so intramedullary fixation of diaphyseal forearm fractures has becomes popular as a means of maintaining reduction and avoiding remanipulation in older child (3, 4-8). Single bone ulna intramedullary fixation has been used by some Authors who claimed equally beneficial result (9). Titanium elastic nails are increasingly used for intramedullary nailing but they are expensive for most of the patients in developing countries and hence we have designed this randomized controlled trial to evaluate the functional and radiological outcome between single bone ulna intramedullary stainless Rush pin fixation and double bone intramedullay Rush pin fixation in diaphyseal both bone forearm fracture in Children.



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# METHODS

Patients of age 8-15 years with displaced diaphyseal fracture both bone forearm reporting to the emergency or Outpatient department of our hospital from 1st May 2016 to 30th May 2017 were enrolled in the study. Loss of reduction on follow-up after closed reduction and casting of diaphyseal both-bone forearm fractures, Open fracture and unacceptable fracture reduction after closed reduction were included and Segmental fracture, Monteggia and Galeazzi fracture dislocation, Pathological fracture , Associated Radial head fracture and Metaphyseal both bone forearm fractures were excluded in study. Fifty patients were presented to our hospital during the mentioned period. Ethical clearance was obtained from the institutional ethics committee and informed consent was granted from the parents. Patients clinically assessed for any associated injury, status of swelling of involved limb, sign of neurovascular deficit and compartment syndrome prior to treatment. When acceptable closed reduction was not achieved in the orthopaedic inpatient room, the patients were taken to the operating room. All the included patients were taken to operating room and under general anesthesia, a closed reduction was performed by Orthopaedic team and evaluation was done by C-arm imaging. In cases, where instability after closed reductions was seen, single-bone intramedullary fixation was done in the skeletally immature patient. Our first choice was to fix the ulna with a Rush pin, as this was the least invasive and most easily removed internal fixation. A small incision were made over the olecranon and appropriately sized Rush pin were driven distally down the ulnar shaft, across the reduced fracture, stopping almost equal to 2 cm proximal to the distal ulna physis as shown in Figure 1. After the ulna fixation, the forearm was again manipulated until malrotation and displacement of the radius was corrected. In the cases where radius was anatomically reduced and stable, single bone fixation was considered sufficient and arm was placed in a long-arm cast for 6 weeks and named SB IM fixation group as shown in Figure 2. Internal fixations of the radius by dorsal approach were done when closed reduction of the radius was impossible. For those cases DB IM Fixation group was made and A/E mid-prone slab was applied. Active Range of motion was stated after 6 wk. Total duration of follow-up was 3 months.

## Follow up

Follow up was done on at 2 wks, 6 wks, and 12 wks for evaluation as per Performa. Final Range of motion, any complications were observed as shown in Figure 3 and angulation in both AP and Lateral projection was measured using a goniometer.

## Statistical methods

All data were collected in a Microsoft Excel 2007 worksheet. Comparison of distribution of sex, mechanism of injury, injury side in two groups was done by chi - square test. Comparison of radiological parameters, range of motion in the two groups was done by chi-square test by using Statistical Program for Social Science (SPSS) 16.0 for windows. The data were analyzed using SPSS (version 16.0) software program. The significance level of the *P* value was set at $< 0.05$.

# RESULTS

The ages (*P* - 0.395*)* and gender (*P*-0.269) was not statistical significance among the two groups. The right side was the dominant limb in Group A and left side limb in Group B but were not statistical significane (*P*- 0.571) as shown in Table 1.

**Table 1:** Patient details

| CHARACTERISTIC | CATEGORY | IM FIXATION SB (N, %) | IM FIXATION DB (N, %) | *P*-VALUE |
|---|---|---|---|---|
| AGE | 8-11 yrs | 15(55.6) | 12(44.4) | 0.395 |
| | 12-15 yrs | 10(43.5) | 13(56.5) | |
| SEX | Female | 3(33.3) | 6(66.7) | 0.269 |
| | Male | 22(55.7) | 19(46.3) | |
| SIDE | Right | 13(54.2) | 11(45.8) | |

| | | | | |
|---|---|---|---|---|
| | Left | 12(54.2) | 14(53.8) | 0.571 |
| ETIOLOGY | FOOSH | 19(51.4) | 18(48.6) | 0.747 |
| | RTA | 6(46.2) | 7(53.8) | |
| INJURY TYPE | Close | 23(51.1) | 22(48.9) | 0.637 |
| | Open | 2(40.0) | 3(60.0) | |
| IMPLANT SIZE(mm) | 2 | 3(60.0) | 2(40.0) | 0.816 |
| | 2.5 | 10(52.6) | 9(47.4) | |
| | 3 | 12(46.2) | 14(53.8) | |
| ADDITIONAL SUPPORT | A/E Cast | 25(100.0) | 0(0.0) | 0.000 |
| | A/E Slab | 0(0.0) | 25(100.0) | |
| OPERATIVE TIME(MIN) | <50 | 25(100.0) | 0(0.0) | 0.00 |
| | <120 | 0(0.0) | 25(100.0) | |
| CRIF/0RIF+RUSH PIN | CRIF+ Rush pin | 24(96.0) | 22(88.0) | 0.297 |
| | ORIF+ Rush pin | 1(4.0) | 3(12.0) | |

There was no statistical significant difference among various variable between two groups: Age (*P* value- 0.395), Sex (*P* value- 0.269), Side (*P* value- 0.571), Etiology (*P* value- 0.747), Implant Size (*P* value- 0.816), Injury type (*P* value- 0.637), except Operative time (*P* value- 0.000) and Additional support (*P* value- 0.000) which showed statistical significant difference as shown in Table 1.

**Table 2:** $12^{th}$ weeks period of Range of motion in two study groups (Intramedullary Fixation)

| **CHARACTERSTIC** | **PRICE CRITERIA** | **IM FIXATION SB (N, %)** | **IM FIXATION DB (N, %)** | ***P* – VALUE** |
|---|---|---|---|---|
| FLEXION ($12^{th}$ weeks) | EXCELLENT | 18(72.0) | 7(28.0) | 0.002 |
| | GOOD | 7(28.0) | 18(72.0) | |
| EXTENSION ($12^{th}$ weeks) | EXCELLENT | 2(66.6) | 1(33.3) | 0.552 |
| | GOOD | 23(48.9) | 24(51.1) | |
| SUPINATION ($12^{th}$ weeks) | EXCELLENT | 10(58.8) | 7(41.2) | 0.370 |
| | GOOD | 15(45.5) | 18(54.5) | |
| PRONATION ($12^{th}$ weeks) | EXCELLENT | 11(52.4) | 10(47.6) | 0.774 |
| | GOOD | 14(48.3) | 15(51.7) | |
| TOTAL LOSS OF ROTATION ($12^{th}$ weeks) | EXCELLENT | 23(47.9) | 25(52.1) | 0.149 |
| | GOOD | 2(100.0) | 0(0.0) | |

**Table 3:** Radiological union at $6^{th}$ weeks and $12^{th}$ week's period in two study groups (Intramedullary Fixation)

| **CHARACTERISTIC** | **PRICE CRITERIA** | **IM FIXATION SB (N, %)** | **IM FIXATION DB (N, %)** | ***P*- VALUE** |
|---|---|---|---|---|
| RADIOLOGICAL UNION ($6^{th}$ weeks) | EXCELLENT | 5(62.5) | 3(37.5) | 0.440 |
| | GOOD | 20(47.6) | 22(52.4) | |
| RADIOLOGICAL UNION ($12^{th}$ weeks) | EXCELLENT | - | | a* |
| | GOOD | 25(50.0) | 25(50.0) | |

a* represent no statistics are computed (constant)

At 6th weeks Radiological union in two groups did not show any statistical significant differences (*P* value- 0.440). At 12th weeks all fracture healed in both group as Good Price criteria as shown in Table 3.

**Table 4:** Complication between two groups (SB ulna IM Fixation and DB IM Fixation)

| **COMPLICATION** | **CATEGORY** | **IM FIXATION** | | ***P*- VALUE** |
|---|---|---|---|---|
| | | **SB FIXATION (N, %)** | **DB FIXATION (N, %)** | |
| COMPARTMENT SYNDROME | NO | 25(50.0) | 25(50.0) | a* |
| | YES | 0(0.0) | 0(0.0) | |
| INFECTION | NO | 24(49.0) | 25(51.0) | 0.312 |
| | YES | 1(100.0) | 0(0.0) | |
| MALUNION | NO | 25(50.0) | 25(50.0) | a* |
| | YES | 0(0.0) | 0(0.0) | |
| NONUNION | NO | 25(50.0) | 25(50.0) | a* |
| | YES | 0(0.0) | 0(0.0) | |
| NEURAPRAXIA | NO | 25(50.0) | 25(50.0) | a* |
| | YES | 0(0.0) | 0(0.0) | |
| SYNOSTOSIS | NO | 25(50.0) | 25(50.0) | a* |
| | YES | 0(0.0) | 0(0.0) | |
| STIFFNESS | NO | 25(50.0) | 25(50.0) | a* |
| | YES | 0(0.0) | 0(0.0) | |
| RE-FRACTURE | NO | 25(50.0) | 25(50.0) | a* |
| | YES | 0(0.0) | 0(0.0) | |

a*represent no statistics are computed (constant).

**Table 5:** Comparison between Intramedullary Fixation (Rush pin) among two groups by Price *et al.* (1) criteria

| **CHARACTERSTIC** | **PRICE CRITERIA** | **IM FIXATION SB (N, %)** | **IM FIXATION DB (N, %)** | ***P*-VALUE** |
|---|---|---|---|---|
| IM FIXATION (Rush pin) | EXCELLENT | 23(47.9) | 25(52.1) | 0.149 |
| | GOOD | 2(100.0) | 0(0.0) | |

**Figure 1:** Intra-operative Rush pin insertion for ulna

Among 50 patients one Patient had infection in Single bone fixation group which did not show any statistical significant difference (*P* value- 0.312) as shown in Table 4.

Intramedullary fixation by Rush pin between Single bone ulna fixation group and Double bone fixation group by Price *et al.* (1) criteria did not show any statistical significant difference (*P* value- 0.149) as shown in Table 5.

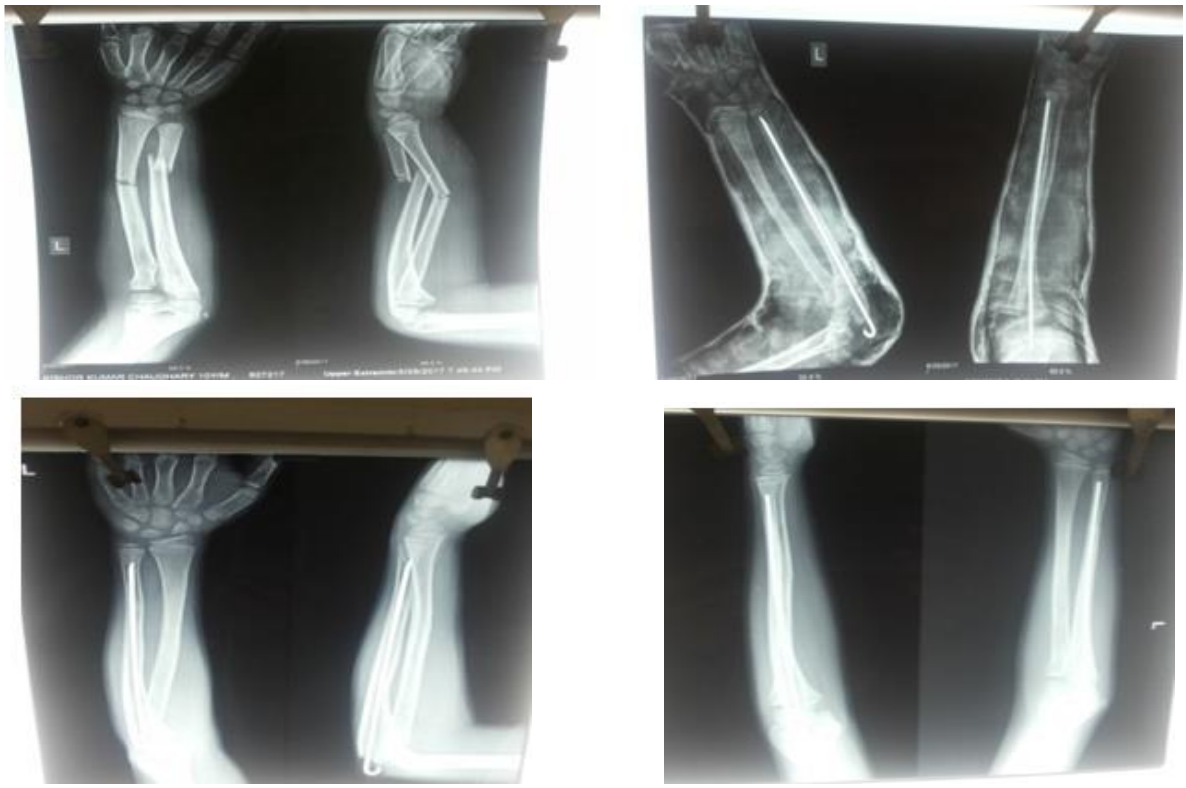

**Figure 2:** Immediate and follow-up X-rays of both-bone forearm fracture with Rush pin in situ with A/E Cast

**Figure 3:** Range of motion at the final follow-up

## DISCUSSION

Pediatric forearm fractures can be managed non-operatively by closed reduction and casting (2). Midshaft diaphyseal forearm fractures and those that are proximal do not remodel as predictably, therefore, these require more anatomic reduction. Younger patients can tolerate more deformity than older children (2, 5).The SB intramedullary ulna fixation ( Group A) and Double Bone intramedullary fixation (Group B) were similar with respect to age, gender, dominant limb, and injured limb, which indicate that the randomization had been effective. In our country, the time from injury to hospital admission and treatment is longer due to constrained facilities and economic status of the people. Average time to radiological union at least three bridging cortical callus was 45 days. In our study, there was no statistically significant differences in the two intamedullary fixation group with regard to change in translation and angulation of the ulna and radius in AP and Lateral radiographs at the time of fracture union 3 months. However, there was a statistically significant difference in the radial angulation in lateral view (SBF Group A- Excellent: 11(35.5%) Good: 14 (73.7%) and DBF Group B - Excellent 20 (64.5%) Good: 5(26.3%) (*P* value- 0.009). There was no statistically significant difference in total loss of rotation between the two groups which was comparable with study done by Flynn and water's (9) as shown in Table 2. Close reduction or open reduction before intramedullary nailing yield similar functional result with similar complication profile in paediatric diaphyseal fracture (10). In the present study, 4 patients required open reduction because of soft tissue interposition or difficult. Though we did not compare the results of Open vs. Close technique but we included both techniques, where results are good to excellent. Although axis deviation and loss of interosseous space may be more important to rotation of the forearm than angular deformity (11, 12). Therefore, many authors stress the importance of maintaining radiographic alignment of <10 degrees to ensure optimal outcome (12-15). Our results were similar to other published series (9,

15). The importance of appropriate cast molding after single bone IM fixation remains vital. In our study, minor complication was noted in 1 (2%) case. One patient in single bone ulna intramedullary fixation group showed infection which was superficial at ulna entry surgical incision site at 14th post-operative period which was treated by Incision and drainage and oral antibiotic. Final assessment with Price *et al*. criteria showed no statistical significant difference( *P* value- 0.149) but better outcome in Double bone intramedullary fixation group with excellent results in 52.10% of patients as compared to excellent ( 47.9% ) to good (100.0%) result in single bone ulna intramedullary fixation group. There were no patients in either group with poor result in the final follow-up.

One of the drawbacks of this study was small sample size and short duration of follow up. Our randomized controlled trial concluded that single bone ulna intramedullary fixation is equally effective compared to double bone intramedullary fixation for diaphyseal both bone forearm fracture.

## CONCLUSION

Single bone ulna intramedullary fixation was comparable in terms of function and radiological parameter for both-bone forearm diaphyseal fracture in children to Double bone intramedullary fixation. Owing to the increased risk of loss of radial reduction, however, consideration should be made for IM fixation of both-bones in older children.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the study or this article.

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