Outcome of Flexible Intramedullary Nailing Of Displaced Diaphyseal Radius and Ulna Fracture in Children

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ABSTRACT

**INTRODUCTION:** Diaphyseal radius and ulna fracture is commonly encountered problem in children. Most of them can be treated by casting or closed manipulation and casting with excellent results. If the fracture is unstable, failed reduction or in older children, conservative treatment by casting may not have good results and there are chances of redisplacement during treatment. In such cases operative treatment is indicated. The objective of the study was to find out whether flexible intramedullary nailing is a good option for treatment in children with forearm fracture and to assess its complications.

**METHODS:** In a prospective study, 30 patients from 5 to 14 years of age with diaphyseal fracture of radius and ulna were treated with flexible intramedullary nailing and followed up weekly for 2 weeks and 2 weekly for 6 weeks and 3 weekly till radiological union was achieved. Nail was removed after the fracture consolidation.

**RESULTS:** There were 30 patients included in the study. The mean age of the patient was 11.4 years. 80% were male and 60% presented from outside Kathmandu valley. 53.3% of fracture was on the right side. 93.3% patients had closed fracture and 76.7% were transverse. Closed technique failed in 10% cases. All fractures maintained acceptable alignment postoperatively. Radiological union occurred with mean of 6.7 weeks. 7 patients had angular deformity that resulted in some degree of restriction of forearm rotation in 3 cases and 3 patients had superficial infection. 27 patients had excellent and 3 had good results. The Statistical analysis was done using SPSS version 16.

**CONCLUSION:** Treatment of diaphyseal radius and ulna fracture in children by flexible intramedullary nailing is an acceptable option for displaced, unstable and fractures that failed conservative method of treatment.

**KEY WORDS:** Flexible intramedullary nail, Forearm fracture, Pediatric.

**INTRODUCTION**

Radial and ulnar shaft fractures are among the most common injuries treated in children. It comprises 6% to 10% of all paediatric fractures. Most of the fractures can be successfully treated by closed manipulation and casting with excellent results. However, in some instances closed reduction is unacceptable and open reduction – internal fixation (ORIF) is needed. The indication for ORIF in pre teenage children is very controversial. ORIF is the accepted method of treatment for adult fracture and in adolescents who are near skeletal maturity. The primary reason for ORIF in adults and older adolescent is to obtain adequate reduction, maintain adequate forearm rotation and to prevent malunion and nonunion. Such problems rarely occur in children. Nonunion is very rare. Bony remodeling in children after union can improve forearm rotation overtime, markedly decreasing the need for anatomical reduction of alignment. The potential for remodeling generally decreases with increasing age of the child, creating a dilemma in determining what...
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is “acceptable” alignment in the younger adolescent / older child either immediately after reduction or in the first few weeks follow up. More controversy exists for treatment of older child (>8-10 years old) with diaphyseal forearm fracture. Closed manipulation and casting in this age group has a recognized failure rate with as many as 11% of fracture requiring repeat manipulation and casting. ORIF can provide accurate and stable fixation but soft tissue exposure may lead to complications such as infection, neurovascular injuries, scarring and delayed or non-union.

Intramedullary nailing of diaphyseal radius and ulna fracture has become popular as a means of maintaining reduction and avoiding re-manipulation in the older children. It is minimally invasive and simple procedure, maintains bony alignment and promotes rapid bony healing. In addition, surgical morbidity is decreased compared with open reduction and plating and implant removal is simpler. Similarly, end to end reduction helps to control rotational alignment and limited motion at fracture site promotes the formation of external callus and helps in rapid union.

METHODS

This was a prospective study conducted in three different hospitals of the Kathmandu Valley from October 2010 to February 2012. Patients were from Bir Hospital, Shree Birendra Army Hospital and Patan Hospital. Convenient sampling technique was used and 30 patient were included. Patient of age group 5 to 14 years with diaphyseal fracture of at least 3 cm away from the physis and considered unstable, old re-displaced, failure of closed reduction and open fracture Gustilo and Anderson class I and II fractures were included in the study. Written consent was taken from patient guardian and operative procedure including its complications were explained to them. Open fracture Gustilo and Anderson class III, pathological fracture, single bone fracture and fracture associated with neurovascular compromise were excluded.

Demographic data of the patient, type of fracture, intraoperative complications, time for radiological union, final range of motion and postoperative complications were recorded in subsequent follow up. Radiological union was defined as presence of bridging callus at least in 3 cortices in anteroposterior and lateral views in radiography. Clinical results were evaluated according to scale developed by Price criteria according to which results were considered excellent if no complaints with strenuous physical activity or a loss of pro-supination of <10°; good if mild complaints with strenuous activity and/or 11°-30° loss of forearm rotation; fair if subjective complaints during daily activities or 31°-90° loss of forearm rotation and all other results were considered poor.

OPERATIVE PROCEDURE

All cases of fracture of radius and ulna presented during the study period with inclusion criteria were included. Patients were admitted after examination and initial management with above elbow posterior slab application. Management of the pain and preoperative investigations were done.

Preoperative antibiotics -Injcefazolin 500 mg in every cases half an hour prior to operation. General anesthesia was used in every cases and surgery was done with patient in supine position. Image intensifier was adjusted to obtain appropriate AP and lateral views of forearm. Closed reduction of fracture was done. The size of nail was decided by preoperative radiographic analysis by calculating average of diameter of bone in anterioposterior and lateral radiograph. We used flexible nail with proximal 5 mm bent to 30 degree at the tip that is 0.5 mm smaller than the calculated size.

For radius, 1 cm longitudinal incision on the lateral side of distal metaphysis was given. Hole was made in the bone first perpendicularly and then obliquely towards the elbow by an awl. Similarly for ulna, 1 cm incision on proximal metaphysis was given. Hole was made with an awl in the bone first perpendicularly and then obliquely towards the wrist. Flexible nail was pushed to the fracture site. Fracture reduced by external manipulation under fluoroscopy and nail was pushed up to the metaphysis and fixedunder image intensification. Proximal end bent and cut 5-10 mm from the bone, skin closed with one stitch.

Dressing and sling was applied for 5 days. Check x-ray was done in next day. Elbow and wrist mobilization was done in second day as tolerated. Patient was discharged in 2nd day on oral antibiotic. Patients were followed up after 1 week of discharge and evaluated for any complications. Suture was removed at the same follow up. Patients were followed up weekly for 2 weeks and two weekly for 6 weeks. 6th follow up was
done on 12 weeks and 7th and final follow up was done in 24 weeks. Evaluation was done by x-ray and clinical examination. Implant was removed after fracture was consolidated. Functional outcome was measured and graded according to criteria given by Price11.

**RESULT**

The age of the patient ranged from minimum of 6 years to maximum of 14 years. The mean age was 11.40(2.486) (Table 1).

<table>
<thead>
<tr>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>30</td>
<td>6</td>
<td>14</td>
</tr>
</tbody>
</table>

Majority of the patient 24(80%) were male and 6(20%) were female.

60% of patients were from outside the Kathmandu valley. 53.3% of patients had fracture on the right side and 46.7% were on the left side. Majority of patient 93.3% had closed fracture and 6.7% had open fracture Gustilo and Anderson type 1(Figure 2).

Most of the patients 56.7% had fall from tree and height as mechanism of injury. Time take for surgery varied from 45 to 85 minutes with mean time 67 minutes( 13.62).Only 3(10%) of patient had failed closed reduction which were managed by minimal opening at the fracture site. Besides that there were no other complications during surgery.

There were no complications during treatment in 20(66.7%) patients, while 7(23.3%) patients developed angular deformity and 3(10%) patient developed superficial infection which was managed by antibiotics. Radiological union occurred in all cases with minimum of 5 and maximum of 9 weeks with mean of 6.7 weeks (1.14921). Similarly maximum angular deformity that was noted was 7 degrees. Angular deformity was noted in seven cases. At the final follow up there was restriction of pronation of 15 degrees and supination of 10 degree in one patient while pronation only was restricted in 2 patients.
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DISCUSSION

Almost all cases of forearm fracture in children can be managed by closed reduction and casting. There is excellent potential for remodeling of the fracture especially in younger child and if the fracture is near the joint. Fractures that are in the midshaft and especially in the older children need anatomical reduction for good functional outcome. Besides the fractures that are redisplaced, failed closed reduction, open fracture and in older children operative treatment is indicated. Controversy exists as to what amount of angulation, displacement and rotation constitutes acceptable reduction. However younger patient tolerate more deformity than older.

Age of the patient varied from 6 to 14 years with the mean age of 11.4 years which is comparable to other several studies. The reason behind the similarity may be because most of the children below 10 years can be managed by conservative methods and the patient who are adolescent near skeletal maturity have more chances of failure of closed technique and chances of operative management in such cases is high. We found that 80% of patients were male and majority from outside Kathmandu valley. This may be because the hospitals where the study was conducted are the tertiary referral centre with patient presented from all over the country.

In this study 2 cases were open fracture while 28 cases were closed fracture. Study conducted by Carmichael KD, English C had similarity with 2 cases of open fracture. They reported 15 patients treated with flexible intramedullary nailing group with 14 excellent and 1 good outcome. In other study conducted by Kang et al, out of 90 children eight (9%) had open fractures. So fracture type of this study was comparable to these studies. This signifies that open fractures are not so common in children. Time to radiological union in this study was minimum of 5 weeks to maximum of 9 weeks, mean of 6.7 weeks (1.14921). Study conducted by V. Kapoor showed that union was achieved on an average of 7 weeks.

In this study the mechanism of injury was mainly due to the fall from tree and height and only few cases with road traffic accident. But the similar studies from the western countries report RTA being the major cause of injury besides the fall from tree. This may be due to
the geographic condition of our country where most of the children have to walk in hilly areas and have to climb the trees for their household purposes.

We had 3(10%) failed closed reduction which required minimal opening at the fracture site. Soft tissue interposition at the fracture site was the major cause of failed closed reduction. Study conducted by Mohamed Asraf Khalid, 58 children with radius and ulna fracture who were treated by percutaneous intramedullary K-wires fixation, closed reduction was possible in 43 cases and required open reduction in 15(25.8%) cases. Similarly Cumming D et al showed that in 19 consecutive paediatric patients with diaphyseal forearm fractures over a one year period 4 of the fractures required open reduction due to difficulty in reduction and soft tissue interposition. Thus the rate of failure of closed reduction was comparable to our results. There were few complications during overall treatment. 10% patient developed superficial nail site infection. Though they caused significant concern to the parents of the child they were controlled in due course of time with dressing and adequate oral antibiotics. Similar studies have reported few incidence of major complications like forearm compartment syndrome requiring fasciotomy. However there were no such complications during our treatment. This can be due to small sample size and short duration of study.

Superficial skin infection was the common problem in this study as in the other studies. In similar study conducted in our country by Parajuli NP et al used intramedullary rush nail. Out of total 50 patients 8 patients had minor complications including skin irritation over prominent hardware, backing out of ulnar pin, superficial skin break down with exposed hardware. Complications like irritation and skin break down were similar to this study however we did not encounter the problem like backing of the nail. This can be because rush nail does not engage in the metaphysis as does the flexible nail.

There was angular deformity in 7(23.3%) patients. In this study the maximum angular deformity was up to 7 degrees. This led to the restriction of pronation of 15 degrees and supination of 10 degrees in one patient and pronation restriction of 15 degrees in 2 patient. The outcome was graded according to the criteria given by Price in 1990, 27 patients had excellent and 3 patients had good results and is comparable to various other studies (Table 4).

### Table 4: Comparison of this study with similar studies conducted for radius and ulna fracture in children

<table>
<thead>
<tr>
<th>Study author</th>
<th>Study period (Years)</th>
<th>Total patients (n)</th>
<th>Sex</th>
<th>Mean age of fixation (years)</th>
<th>Type of Implant Used</th>
<th>Average time to Radiological union</th>
<th>Functional outcome assessment criteria</th>
<th>Functional outcome</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flynn JM et al</td>
<td>11 yrs</td>
<td>103</td>
<td></td>
<td>10.6</td>
<td>Titanium nails, Kirschner wire</td>
<td>6.9 - 8.6 weeks</td>
<td>Children hospital of Philadelphia forearm fracture fixation outcome classification</td>
<td>Excellent= 77.7% Fair = 14.6% Poor= 7.8%</td>
<td>Major = 4 (3.8%) Minor= 11 (10.6%)</td>
</tr>
<tr>
<td>Yalcinkaya M et. Al18</td>
<td>8 yrs</td>
<td>45</td>
<td>M=35 F=10</td>
<td>10</td>
<td>Rush pins, Kirschner wire</td>
<td>6 -10 weeks</td>
<td>Price criteria</td>
<td>Excellent= 82.2% Good = 17.8%</td>
<td>Major= 2 (4.44%) Minor= 15 (33.3%)</td>
</tr>
<tr>
<td>Richter D et al19</td>
<td>2 yrs</td>
<td>30</td>
<td>M=18 F=12</td>
<td>Not mentioned</td>
<td>Titanium Nails</td>
<td>13 weeks</td>
<td>Tscherne score</td>
<td>Excellent= 80% Good= 16.6% Fair= 3.3%</td>
<td>Minor= 4(13.3%)</td>
</tr>
<tr>
<td>Parajuli N6</td>
<td>3 yrs</td>
<td>50</td>
<td>M=38 F=12</td>
<td>10.4</td>
<td>Rush pins</td>
<td>8 weeks</td>
<td>Price criteria</td>
<td>Excellent= 94% Good = 6%</td>
<td>Minor= 8 (16%)</td>
</tr>
<tr>
<td>This study</td>
<td>1.5 yrs</td>
<td>30</td>
<td>M=24 F=6</td>
<td>11.40</td>
<td>Flexible intramedullary nail</td>
<td>6.7 weeks</td>
<td>Price criteria</td>
<td>Excellent=90% Good=10%</td>
<td>Major=0 Minor=10 (33.33%)</td>
</tr>
</tbody>
</table>

**Conclusion**
This study concludes that whenever indicated flexible intramedullary nailing is a safe and effective treatment option for the diaphyseal fracture in children. It is minimally invasive, yield good to excellent results and complications are minor that does not affect the final outcome.

Small sample size, short duration and noncomparative nature of study is limitation of this study. Similar study with nonoperative control groups or comparative study with another operative technique of longer duration can be ideal for further conclusion.

REFERENCES