Minimally Invasive Nailing Technique for Diaphyseal Humerus Fractures

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ABSTRACT

1.1 Background and objectives
There are three modality of operative treatment of fracture shaft humerus, external fixator, plate osteosynthesis and intramedullary interlocking nailing. External fixator is used for compound fracture. For close fracture operative treatment is either plate osteosynthesis or interlocking nailing. Interlocking nailing have less infection rate as it is inserted in close manner and good union rate because fracture hematoma preserved. Major disadvantage is effect on shoulder function because of rotator cuff damage.

In this study we have analysed outcome in tern of union rate, functional result and complication in fracture of shaft of the humerus managed with interlocking antegrade nailing using mini invasive surgical technique.

1.2 Methods
We took 60 patients (60 cases) of close fracture shaft of the humerus treated with closed interlocking nailing in antegrade manner. There were 50 males and 10 females with an average age of 34.95 years (18-65 years). All the patients were followed over a minimum period of 6 months and results were analyzed.

1.3 Results
57 (95%) fractures united with an average consolidation time of 13.78 weeks (11-16 weeks), 3(5%) fracture ended in nonunion. There were 3(5%) cases of intra operative fracture comminution which did not affect fracture healing. Nail impingement was seen in 3 (5%) cases, shoulder stiffness in 3 (5%) cases and 3(5%) cases had superficial infection. Functional results were excellent in 54(90%) cases, moderate in 3(5%) cases and poor in 3(5%) cases.

1.4 Conclusion
Closed intramedullary interlocking nailing provide higher union rate and good functional outcome and reduced the hospital stay.

1.5 Keywords: Humeral shaft fracture; Closed interlocking nailing; Mini invasive surgical technique.

1. INTRODUCTION
Fracture of the shaft of the humerus are not uncommon in this era of automobiles. It represent 3-5 % of all fractures. Though knowledge for management of fracture of shaft of the humerus are increasing day by day, still non operative treatment remain treatment of choice for uncomplicated humeral shaft fracture¹²³ . The two modalities of internal fixation in fracture of shaft of the humerus are plate osteosynthesis and intramedullary interlocking nailing.

But still it is generally believed that interlocking nailing may not be the best choice.²⁻⁵,⁶,⁷,⁸ It is a paradox that a surgical technique that is so successful in the treatment of diaphyseal femoral and tibial fractures cannot produce similar results when applied in the humerus. A possible explanation is that the complex anatomy and the unique biomechanical characteristics of the humerus are overlooked. Further, violation of the rotator cuff during antegrade humeral nailing has been considered to be responsible for suboptimal clinical outcomes and discomfort in the shoulder joint.⁴⁻⁹,¹⁰ Recent reports have proposed modifications of the antegrade surgical technique or introduced 'sophisticated' nail designs in order to overcome this problem but so far these proposals have not been validated with further studies.¹¹ Interestingly, shoulder joint problems have been reported in patients following humeral shaft fractures, which were treated by therapeutic modules that did not interfere with the shoulder anatomy, e.g., bracing or plating. In these cases, prolonged immobilization (either before plating or during bracing) was considered to be the precipitating factor.⁴,¹² So we took up this study to evaluate the end results of 60 cases using mini invasive surgical technique to identify the advantages, difficulties,
complications and as to prepare guidelines for treatment or fracture of shaft humerus.

2. MATERIAL AND METHODS
This study was a prospective study, conducted at department of orthopaedics and govt rehabilitation and research centre Dr.S.N. medical college Jodhpur over a period of 2 years i.e. , from July 2014 to June 2016. 60 adult patients with 60 traumatic humeral shaft fracture were included in this study to evaluate functional outcome , the time of union and union rates and the complications of antegrade interlocking nailing. Patients having compound fracture and ipsilateral humerus and forearm fracture were excluded from study. Assessment of the patients was done on the basis of clinical and radiological union, range of motion at shoulder and elbow joints and subjective complication like pain in the shoulder and elbow joints . Shoulder and elbow functions were graded excellent, moderate or poor depending upon the loss of range of motion in any direction according to Rommens et al criteria.

2.1 Mini invasive surgical technique – we used 1 cm stab incision in direction of rotator cuff fibre, just anterolateral to acromian process. Through this, entry with the help of an awl was made. Close reduction achieved with manipulation technique and reamer then guide wire passed in distal fragment. Then reaming with sequential size reamers was done. Distal antero-posterior locking done with free hand technique . Proximal static locking done with help of zig. The whole procedure performed under C-arm guidance.

3. RESULTS
In Our study we had 60 patients with 60 close fractures of shaft of the humerus treated by closed antegrade interlocking nailing. All the patients were followed for a minimum period of 6 months. The following observations were made. Age range of our patients was from 18-65 years with an average of 34.95 years. Majority of patients 50 (83.33%) were males and 10 patients (16.67%) were females. Right side was involved in 33 (55%) patients a left side in 27(45%) patients. Road traffic accident was the commonest mode of injury accounting for 33 (55%) patients (Table 3). Remaining 27 (45%) patient presented with history of fall. In our study 35(58.33%) patients had fracture at middle third shaft of humerus,7(11.66%) patients had fracture at proximal third of shaft of humerus and18(30%) Patients had fracture at distal third. 18 (30%) patients had transverse fracture, 3(5%) patient had spiral fracture, 21 (35%) patient had oblique fracture, 18 (30%) patient had comminuted fracture. Most of the patients were operated within a week of trauma, on an average time interval was 4.8 days. Delay in surgery was due to time required for managing associated injuries. In our study, in 18 patients (30%) fracture united within 12 weeks, while in 39 patients had fracture union at 13-16 weeks post operatively.(Table 1) 3 patients had non union for which secondary procedure with open reduction and plating and bone grafting was done. Function outcome was excellent in 90% , moderate in 5% and poor in 5% (table 2, 3).

<table>
<thead>
<tr>
<th>Period of union</th>
<th>Number of Patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 – 12 wks</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>13 – 16 wks</td>
<td>39</td>
<td>65</td>
</tr>
<tr>
<td>Non union</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
<th>Shoulder No. of pt's</th>
<th>Shoulder %</th>
<th>Elbow No. of pt's</th>
<th>Elbow %</th>
<th>Total No. of pt's</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>54</td>
<td>90</td>
<td>56</td>
<td>95</td>
<td>54</td>
<td>90</td>
</tr>
<tr>
<td>Moderate</td>
<td>3</td>
<td>10</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Poor</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 1. 1 cm skin incision for entry
### Table 3: Stratification of various factors according to AO / OTA classification

<table>
<thead>
<tr>
<th>AO type</th>
<th>Mean age</th>
<th>Gender</th>
<th>Mean range of motion of shoulder at final follow up</th>
<th>Mean range of motion of elbow at final follow up</th>
<th>Function status at final follow up</th>
<th>Radiological union</th>
</tr>
</thead>
<tbody>
<tr>
<td>AO type A</td>
<td>33.62±11.27</td>
<td>Male 36</td>
<td>Abduction 169.52±23.17</td>
<td>138.75±1.85</td>
<td>Excellent 37</td>
<td>14±1.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female 4</td>
<td>Internal rotation 64.62±9.49</td>
<td>140.18±3.44</td>
<td>Moderate 0</td>
<td>12.75±1.18</td>
</tr>
<tr>
<td>AO type B</td>
<td>37.18±13.91</td>
<td>Male 13</td>
<td>Abduction 172.75±5.44</td>
<td>139.75±3.86</td>
<td>Excellent 13</td>
<td>12.75±1.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female 3</td>
<td>Internal rotation 65.31±4.54</td>
<td>139.75±3.86</td>
<td>Moderate 3</td>
<td>12.75±1.18</td>
</tr>
<tr>
<td>AO type C</td>
<td>36±6.63</td>
<td>Male 1</td>
<td>Abduction 172.5±1.91</td>
<td>139.75±3.86</td>
<td>Excellent 4</td>
<td>11.5±1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female 0</td>
<td>Internal rotation 64±2.82</td>
<td>139.75±3.86</td>
<td>Moderate 0</td>
<td>11.5±1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Male 1</td>
<td>Abduction 83.5±1.91</td>
<td>139.75±3.86</td>
<td>Excellent 0</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female 0</td>
<td>Internal rotation 83.5±1.91</td>
<td>139.75±3.86</td>
<td>Moderate 0</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Male 0</td>
<td>Abduction 83.5±1.91</td>
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<td>Excellent 0</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female 0</td>
<td>Internal rotation 83.5±1.91</td>
<td>139.75±3.86</td>
<td>Moderate 0</td>
<td>0.003</td>
</tr>
</tbody>
</table>

**P value**
- Mean age: 0.584
- Gender: 0.003
- Abduction: 0.836
- Internal rotation: 0.943
- External rotation: 0.867
- Excellent: 0.041
- Moderate: 0.041
- Poor: 0.041
- Weeks: 0.003

![Figure 2. Post operative and follow up x rays showing union](image)

![Figure 3. Excellent Range of motion at final follow-up](image)
4. DISCUSSION

The management of fracture of shaft of the humerus is always a challenge to orthopaedic surgeons as they are frequently associated with complications like malunion, delayed, non union etc. The aim of management is to maintain length and alignment and produce favourable environment for bone and soft tissue healing. Most of the fracture of shaft of the humerus can be treated with conservative method. Operative treatment required in certain fracture with unsatisfactory close reduction and multiple injury. Plate osteosynthesis has high success rates but it requires extensive dissection with the risk of radial nerve damage and refracture after implant removal. Intramedullary nailing has the advantages of less soft tissue trauma and less chances of radial nerve injury, but the use of unlocked flexible nails had been complicated by poor rotational stability and slipping out of nails causing joint irritation. Interlocking nailing overcomes those deficiencies and has produced satisfactory clinical results. Results of present study are comparable with previous studies. We attribute early fracture consolidation and higher union rates of closed nailing technique because in close reduction fracture hematoma preserved. The most frequent criticism of antegrade interlocking humeral nailing has been its potentially effect on shoulder function. This can be due to impingement of proximal nail tip & this can be prevented by burying proximal tip into the bone. In most of the studies with antegrade nailing 85% to 95% of patients regained their normal shoulder function.

Fractures of shaft of the humerus are commonly seen in middle age adults. Crates et al13 treated 73 cases of humerus shaft fracture with antegrade interlocking nailing with Russel-Tauylor nail, an average age of patients was 32 years. Jinn lin14 treated 48 patients of humerus shaft fracture with locked intramedullary nailing, an average age was 48years. Rommens et al15 treated 39 patients of fracture shaft humerus with retrograde interlocking nail, average age was 43.8 years.

Road traffic accident was commonest mode of injury in all previous studies.In our study 33 cases (55%) present with history of RTA.

In Crates et al study 60 patients sustained multiple injury. In Jinn lin study 12 patients (out of 48) had multiple injury. In Rommens et al study 20 patients (out of 39) had multiple injury. In present study 25 patients (43.33%) had associated injury.

In most of series humerus shaft fractures were of category A of AO classification system. In Jinn lin serirs 34 cases (out of 48) were of category A . In Rommens et al series 25 cases (out of 39) were of catogery A . In our study 42 cases out of 60 (70%) were catogery A.

In S Ragvendra et al17 study 3 cases out of 36 patients had radial nerve palsy(8.33%).In our study 6 patients (10%) had preoperative radial nerve palsy. Out of 6 cases 5 had complete recovery. One patient showed no sign of recovery and advised nerve exploration but he refused for surgery. None of our patients had iatrogenic postoperative radial nerve palsy.

Rommens et al reported union in 95% of fractures with a mean time of 13.7 weeks. Jinn lin reported 100% union with a mean time of 8.6 weeks. Crates et al reported 97% union of fracture with a mean time of 3.2 months. In present study in 57 cases (96%) out of 60, fractures united with a mean time of 13.78 weeks(range 11 to 16 weeks).

Rommens et al reported 84.6% excellent function outcome . Crates et al reported 90% excellent result. Jinn lin reported 87.5% excellent result. In present study 90% patients had excellent function result.

Rommens et al reported 3 cases of iatrogenic fracture comminution during nail insertion. Crates et al reported no case of iatrogenic fracture comminution. Jinn lin reported 1 case of iatrogenic fracture comminution. In present study we encountered 3 cases of intra operative fracture comminution but this did not affected fracture healing and all fractures united well within 4 months.

Rommens et al reported nonunion in 5.1% case. Crates et al reported 2.7 % nonunion . Kropfl et al15 reported 4.6 % non union. In present study 3 cases gone to non union(5%).

5. CONCLUSION

Based on our experience and results we conclude that closed interlocking nailing with mini invasive surgical technique is a safe and reliable method for treating fractures of shaft of the humerus. It is an excellent method of managing comminuted and unstable humeral shaft fractures. In available surgical modalities, closed interlocking nailing is the least invasive surgical technique and has got the least chance of postoperative infection. It reduces the hospital stay.

6. BIBLIOGRAPHY


