MANAGEMENT OF COMMINUTED FRACTURE OF SHAFT OF HUMERUS BY ANTE-GRADE CLOSED INTERLOCK NAILING

Abstract:

Background: Open reduction and internal fixation (ORIF) with plates and intramedullary nailing are both advocated for treating comminuted humerus fractures. AO Group recommended anatomical reduction and stable internal fixation with plates osteosynthesis for these fractures. However, plating has following dis-advantages, as compared to closed intramedullary nailing by ante-grade method mainly - Extensive soft tissue dissection, Periosteal stripping, Loss of fracture hematoma, Significant blood loss, Dissection of radial nerve in middle third fracture, which may endanger the nerve, at the time of surgery or at the time of plate removal after fracture union, Risk of infection and non-union, Less secure fixation in osteoporotic bones. Due to above mentioned reasons, this study is taken up to evaluate clinical & radiological outcome of comminuted fractures of shaft of Humerus treated with closed ante-grade interlocked intramedullary Nailing.

Materials and Methods: We prospectively followed a series of 30 consecutive patients with comminuted humeral shaft fracture treated at Govt. Medical College, Latur, Maharashtra, between November 2007 to October 2015 with closed reduction and Ante-grade interlocking intramedullary Humerus nail fixation.


Results and Discussion: Nail prevents complications found with other osteosynthesis system such as DCP (Dynamic Compression Plate) and unlocked nails. The literature regarding this treatment option has been inconsistent. And has raised some concern based on complications noted. ORIF (Open reduction and internal fixation) with plating has disadvantages as mentioned previously in Introduction. Closed Intramedullary nailing prevents dis-advantages of plating in comminuted fracture.

Conclusion: Based on our experience we conclude that closed ante grade intramedullary nailing with interlock nail is safe and reliable method of treating humeral shaft fracture. Essentially all comminuted humerus shaft fractures extending between 5 cm from surgical neck to 2 cm proximal to olecranon fossa can be stabilized by ante-grade closed intramedullary interlock nailing. It is excellent method of managing comminuted and unstable humerus shaft fracture. Long butterfly fragment consolidate early at 4-6 weeks as closed nailing is done. It is best surgical method available to fix comminuted humerus shaft fracture in patients with poly trauma and osteoporosis where reduction in operating time and early rehabilitation are the primary objectives.

Key-words: Comminuted humerus fractures, Interlock nailing of humerus, Closed nailing humerus, Disadvantage of Plating in humerus
Introduction:

Operative treatment envisioned by AO Group (in1958) was a major development in 20th century and the base for evolution of internal fixation in skeletal surgery was set. They advocated internal fixation as modality of fracture fixation and since then it has been refined & with that, many new ideas and concepts have evolved.¹

Fracture of shaft of humerus accounts for 1-2 % of all fracture occurring in the human body.² ³ 4 and 14% of them are shaft of humerus, 30-40% of shaft of humerus fractures are comminuted.⁵

With shoulder and elbow at risk of stiffness due to prolonged immobilization, malposition possibility in conservative management, operative treatment is indicated in todays modern orthopedics.⁶

Open reduction and internal fixation (ORIF) with plates and intramedullary nailing are both advocated for treating humerus fractures.

In accordance with AO Principle, of anatomical reduction and stable internal fixation with plates and screw osteo-synthesis, seemed to be appropriate choice.⁷

However, plating has following dis-advantages, as compared to closed intramedullary nailing by ante-grade method.

- Extensive soft tissue dissection,
- Periosteal stripping,
- Loss of fracture hematoma,
- Significant blood loss
- Dissection of radial nerve in middle third fracture, which may endanger the nerve, at the time of surgery or at the time of plate removal after fracture union.
- Risk of infection and non-union
- Less secure fixation in osteoporo tic bones.

Due to above mentioned reasons; this study is taken up to evaluate clinical & radiological outcome of comminuted fractures of shaft of Humerus treated with closed ante-grade interlocked intramedullary Nailing.

Materials and Methods:

We prospectively followed a series of 30 consecutive patients with comminuted humeral shaft fracture treated at our Hospital between November 2007 to October 2015 with closed reduction and Ante-grade interlocking intra medullary Humerus nail fixation.

Inclusion criteria:

1. Age groups (Above 18 yrs.)
2. Patients of both sexes.
3. Comminuted shaft fractures of humerus

Exclusion criteria:

1. Simple – Transverse, oblique, long spiral fractures without comminution.
2. Unstable proximal fracture of shaft humerus.
3. Fracture of distal part of humerus with intra articular extension.
4. Fracture of shaft humerus – below 18 years of age.
5. 01 patient was lost to followup. The patients had a minimum follow up of 09 months.

All the 30 patients had fresh fractures in the age group of 20 to 70 years (average age 42.69 years).

The series had 20 men and 10 women; and 22 right sided and 08 left sided fractures.

The commonest mode of injury was from Road traffic accident (RTA) 24 cases (80.00%)

All patients were treated by closed ante-grade interlocked Nailing.

The most proximal fracture in our series was located 5 cm from the surgical neck, while the most distal fracture was located 2 cm from the tip of the olecranon fossa.

A) Pre-operative management:

The clinical diagnosis was confirmed radiologically by taking x-ray of humerus including shoulder and elbow, in antero-posterior and lateral views. From the x-ray, the situation and the character of the fracture were assessed.

Radial nerve was specifically tested by looking for wrist and finger drop and testing the sensation in the autonomous zone for radial nerve on the dorsum of 1st web space.

In this series 02 patients (6.66%) had pre-operative radial nerve injury which improved after Application cock up splint application and Neuro-tonics in the form of Methyl-cobalamin given. During follow up by 6-8 weeks it got recovered.

Operative technique:

Under anaesthesia, closed reduction and internal fixation by ante grade intra medullary locked nailing was done.

The surgery is performed in the supine position, sandbag under medial aspect of scapula with the head rotated to contra lateral side on a radiolucent table.

1. Approach and Preparation of the humerus:

A. The upper limb was adducted over the chest to make the greater tuberosity more prominent.

B. A longitudinal skin incision 1-2 cm over the antero-lateral edge of the acromion obliquely forward near the tip of the greater tuberosity. Deltoid is split longitudinally along its fibers to reveal sub-acromial bursa and the
rotatorcuff.
C. Incise rotator cuff in the direction of supraspinatus muscle;
D. Entry point is at junction of articular surface and non-articular surface i.e., greater tuberosity and head, means it is just medial to tip of greater tuberosity. The direction of awl kept 20-25 degrees pointing down at floor, to enter into the direction of medullary canal.
E. The straight awl must penetrate for at least 4 to 5 cm to create pathway for guidewire.
F. The entry portal should be centered on the antero-posterior and lateral views to ensure that the nail will be in the mid-plane of the humerus. This is confirmed with the help of image-intensifier.

2. Guide wire insertion:
A. Straight awl is withdrawn and a 2.4mm ball nosed reamer guide wire is inserted.
B. The position of the guide wire in the center of the medullary canal is confirmed with the help of the C-arm.
C. The correct alignment was obtained by closed reduction maneuver of Traction was applied in with Supination of forearm, and 90 Degrees elbow flexion. And maintained by assistant. Assistant also corrects abduction of proximal fragment by pushing the proximal fragment medially.
D. Guide wire was advanced into the distal fragment through the comminuted fragments until its tip was 1 cm to 2 cm proximal to the olecranonfossa.

3. Determination of the nail length:
Appropriate nail length was measured by placing another guide wire OR By directly placing nail over the extremity under C arm control.

4. Reaming:
Was done with the help of flexible reamers with increments of 0.5 mm starting from 5 mm No reaming was done at comminuted fragments. Reamer just passed through the comminuted fragments, in to the distal fragment.

5. Nail insertion:
A. Fracture reduction tried with closed manipulation and nail is pushed into the distal fragment over guide wire through comminuted fragment and confirmed using C-Arm.

6. Proximal locking:
Nail is locked proximally and distally with locking screws. Proximal screws are inserted using the zig attached to thenail.

Before distal locking the fracture site is compressed by placing axial load on elbow. (Gentle thumping on flexed elbow)

7. Distal Locking:
The screw is inserted using the free hand technique under C arm guidance.

8. Technical difficulties and complications during surgery:
In few cases, we encountered technical difficulties during the surgery. In 01 case we had iatrogenic minor comminution of the fracture, actually it was opening of undisplaced fracture fragment and no surgery was abandoned or no other alternative method chosen because of technical difficulties.

9. Post-operative management:
Dressing done and the limb was kept in collar and cuff support and Cock-up splint for the patient with radial nerve palsy.

In our series, none of the patients had post-operative radial nerve palsy, and no cases had deep infection after the surgery. All wounds healed without any complication.

10. Rehabilitation Protocol
A. Patients were followed up at regular intervals at 4, 6, 12 wks and 3, 6, 12 months. Assessment was done based on clinical assessment and radiological examination with particular advices regarding active assisted shoulder and elbow exercises.
B. Clinical assessment was done based on severity of pain on operated limb (Pain Scale: Nil / Slight / Moderate / Severe) and active range of motion of shoulder and elbow. (MI, MII, MIll, MIV)
C. Functional assessment as per system of American Shoulder and Elbow Surgeon’s Score. (ASES)
The collected data was statistically analyzed. The results were graded as Excellent, Good, Fair, and Poor as follows.

• Excellent
• Good
• Fair
• Poor

11. Management of Radial nerve injury:
Expectant line of management was followed with EMG (Electromyography) and NCV (Nerve Conduction study) done at the end of 12-14 day of injury.
As EMG changes of denervation of muscle are evident after 12-14 days in the form of denervation (fibrillations) waves, No changes are evident in first 10-12 days. Thats why, we do EMG/NCV after 12-14 days of pt’s injury.
As a protocol, if pt. has radial nerve injury pre-operatively we gave dynamic Cock up splint, and neurotonics. If it reveals neuropraxia or axonotemesis, We continued conservative line of management.

For patients having Neuropraxia/axonotemesis, we went for nailing and continued with conservative line of management in the form of Dynamic Cock-up Splint till recovery. Methyl cobalamin and Neurotonics in the form of Tablets were prescribed for 3 months or till recovery. Progress of recovery is judged every 4 weekly by clinical examination and EMG/NCV can be repeated after 3 months.

We routinely do not expose radial nerve in cases neuropraxia and axonotemesis.

In case of neurotemesis, pt. was referred to plastic surgeon for microscopic nerve repair.

In this series 02 patient (6.66%) had pre-operative radial nerve injury which improved after Application cock up splint application and Neuro-tonics in the form of Methylcobalamin given. During follow up by 6-8 weeks it got recovered.

**Intra-Operative Images:**

- Skin incision (1.5 cm size) tip of acromion
- Entry with straightawl
- Preparation of canal with reamer
- Guide Wire Placement
- Nail length Measurement
- Nail introduced over guide wire
- Nail crossing fracturesite
- Guide Wire passed
- Entry Point

- Final placement of Distal locking 3 mm K-wire
- Distal locking bolt tied with Vicryl
- Proximal locking in progress to avoid accidental slippage in muscles.
Entry Broacher passed

Reaming of proximal fragment till fracture over guide wire to widen canal

Guide Wire in distal Fragment after maintaining reduction at fracture site

Distal locking Bolt in Place locking

Guide wire passed in distal fragment

Nail passed over Guidewire

Proximal Locking with two bolts with nail tip subchondral by 2-3mm

Round holes Adjustment for across fracture site

K-wire placement for distal

Observations And Results

Statistical analysis of the study was done, and following observations were made during the study. The collected data was analysed by arranging purposively, in order to bring out the important points clearly and strikingly.

The present study thus had following observations:-

Age Distribution: The highest incidence was found in the age group of 20 to 50 years. The mean age of all patients was 42.69 years.

Mode of injury: Out of 30 patients sustaining fracture the most common mechanism of injury was Road traffic accident (RTA) which account for 80.00% (24 patients), followed by Fall From height 20.00% (06 Patients).

Associated Injuries: are tabulated as follows
Table 01:- Associated injuries

<table>
<thead>
<tr>
<th>S.N</th>
<th>Associated Injuries</th>
<th>No. of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Head Injury</td>
<td>02</td>
</tr>
<tr>
<td>2.</td>
<td>Chest Injury</td>
<td>01</td>
</tr>
<tr>
<td>3.</td>
<td>Abdomen Injury</td>
<td>01</td>
</tr>
<tr>
<td>4.</td>
<td>Fracture Clavicle</td>
<td>02</td>
</tr>
<tr>
<td>5.</td>
<td>Fracture D3 Radius</td>
<td>01</td>
</tr>
<tr>
<td>6.</td>
<td>Polytrauma</td>
<td>01</td>
</tr>
<tr>
<td>7.</td>
<td>Fracturefibula</td>
<td>01</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>09</td>
</tr>
</tbody>
</table>

Post Operative complications:

02 patients developed post op superficial infection at incision site which was treated by daily dressing and IV 3rd Gen. Cephalosporin antibiotics. Wounds healed without any complications.

01 patient had Malunion (angulation less than 10 degrees). Pt. had poor compliance with physiotherapy and So, Less ASES score of 22 with FAIROutcome.

Radiological Union:

Table No. 02: Duration of radiological Union

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Average Duration of Union (Weeks)</th>
<th>No. Of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Up to 16</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>16-20</td>
<td>06</td>
</tr>
<tr>
<td>3</td>
<td>20-26</td>
<td>03</td>
</tr>
<tr>
<td>4</td>
<td>&gt;26</td>
<td>01</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>

Functional Outcome criterion:

Patients were assessed as per Pain, Deformity, and Range of movement, fracture union & functional outcome as per American Shoulder And Elbow Surgeons Score.

Table No 03: Result of the study

<table>
<thead>
<tr>
<th>S.N</th>
<th>Criteria</th>
<th>No. Of patients</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excellent</td>
<td>18</td>
<td>60.00</td>
</tr>
<tr>
<td>2</td>
<td>Good</td>
<td>06</td>
<td>20.00</td>
</tr>
<tr>
<td>3</td>
<td>Fair</td>
<td>05</td>
<td>16.67</td>
</tr>
<tr>
<td>4</td>
<td>Poor</td>
<td>01</td>
<td>3.34</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>30</td>
<td>100.00</td>
</tr>
</tbody>
</table>

24 (80.00%) patients had Excellent to Good result and 05 cases (16.67%) had Fair result. 01 cases (3.34%) had poorresult.

Case study No. 01:

Follow Up AP and Lateral United Fracture

Case No. 03

Pre-op and Post op. CLOSED NALING

Case No. 02

Fracture Consolidation at 2 years AP, Lateral view Healed scar of surgery

Case No. 01:

Post-operative

Pre-op and post op X rays AP And Lateral

Comminuted fragment away from main bone
Radiological union with good incorporation of comminuted fragment

Case No. 04:

Pre op         post op

Final union

Clinical Photos:

Full Abduction at Shoulder

Full External rotation

No rotational Mal-alignment

Dorsiflexion at Wrist Palm Facing Shoulder (No Radial Nerve Palsy)

Internal rotation - Full Elbow Extension

Discussion:

Operative management is viable treatment in comminuted shaft fractures in the appropriate setting with the indications previously discussed. The decision regarding use of implant for humerus osteosynthesis is controversial, with some authors reporting favorable evolution with low complication rates while other series report mainly treatment associated complications. The ideal surgical treatment for these fractures continues to be the topic of debate.

Nail is designed to prevent complications found with other osteosynthesis system such as DCP (Dynamic Compression Plate) and unlocked nails. The literature regarding this treatment option has been inconsistent at best and has raised some concern based on complications noted. ORIF (Open reduction and internal fixation) with plating has disadvantages as mentioned previously in Introduction.

Closed Intramedullary nailing prevents disadvantages of plating in comminuted fracture and in addition has following advantages:

1. Biomechanically intramedullary nails are load sharing devices, yields good results.
2. Advantage of controlled impaction over nail in comminuted fracture.
3. Reaming gives internal bone graft of endosteum at fracture site.
4. Two screws in proximal and one distal fragment gives better rotational stability.
5. Shorter operative time, less soft tissue dissection, less blood loss & hence reduced rate of infection.
6. Nail gives better mechanical stability by spanning severe comminution and being intramedullary position gives stability in osteoporotic bone.
7. Early mobilization is possible which gives Excellent functional outcome in comminuted fractures.
8. Nails are subject to smaller bending load and less likely to fail due to fatigue in comminuted fracture with long fracture span.
9. No risk of re-fracture after implant removal as there is no stress riser or no osteopenia beneath the implant. (Cf. Osteopenia beneath the plates).

Locked Closed antegrade Intramedullary Nails are preferably used in the treatment of Complex, comminuted fractures of Shaft, which are difficult to stabilize with plates and screws, because fracture configuration calls for massive stripping of soft tissue attachment of comminuted fracture fragments for plate fixation or lag screw screw placement.

Conclusion:

Based on our experience we conclude that closed antegrade intramedullary nailing with interlock nail is safe and reliable method of treating humerus shaft fracture.

Prevalence of comminuted fracture humerus was more in males than in females.

Road traffic accident followed by fall from height was the major cause of fracture in our study.

Majority of patients in our study were having fracture shaft humerus in middle 1/3rd region.

Essentially all comminuted humerus shaft fractures extending between 5 cm from surgical neck to 2 cm proximal to olecranon fossa can be stabilized by antegrade closed intramedullary interlock nailing.

It is excellent method of managing comminuted and unstable humerus shaft fracture. Long butterfly fragment consolidate early at 4-6 weeks as closed nailing is done.

It is best surgical method available to fix humerus shaft fracture in patients with poly trauma and osteoporosis where reduction in operating time and early rehabilitation are the primary objectives.

References:
7. Pol M Rommens, Donald P. Endrizzi. Jochen Blum, Raymond R. White AO Manual Of fracture Fixation .4.2.2 Humerus Shaft Page291-305