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# Comparison of functional status, outcome of patient and complications in dynamic compression plating & interlocking nail in fixation of fracture shaft humerus

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***Abstract*---**Background: Management of fractures is ever evolving and humeral shaft fractures are no exception to this. Historically, management of fractures was centred around conservative methods. Treatment methods for these injuries continue to evolve as advances are made in both non-operative and operative management. Objective: To compare functional status and outcome of patient and complications in Dynamic Compression Plating & Interlocking Nail in fixation of fracture shaft humerus. Methodology: The present study was conducted in the Department of Orthopaedics, Govt. multispecialty Hospital, Sec. 16, Chandigarh during the years 2010-12. In this study 15 patients for each group i.e. Dynamic Compression Plating and Interlocking Nail were studied. Results: Functional outcome was assessed according to ASES Score. 46.7% cases in group I and 73.3% cases in group II had score of grade I. The incidence of complications like non-union, shoulder stiffness, implant failure was higher in group I. Conclusion: Complications are less with plating as compared with nailing. Incidence of shoulder stiffness, impingement is associated with nailing. Nailing has higher incidence of non union.

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***Keywords***---functional status, outcome of patient, complications, Dynamic Compression Plating, Interlocking Nail in fixation, fracture shaft humerus.

## Introduction

Fractures of shaft of humerus account for nearly 3% of all fractures[1,2,3] and 20% of fractures to the humerus.[3] Humeral shaft fractures result from direct or indirect trauma. Motor vehicle accidents being the most common cause. Falls on outstretched hand and direct load to the arm are other common mechanisms for humeral shaft fractures. It can also occur due to extreme muscle contraction or even throwing a ball or javelin.[4]

Elderly patients who suffer a humeral shaft fracture as a result of a fall often have less comminuted fracture patterns. Greater amounts of comminution and soft tissue trauma result from high energy injuries. Pure compressive forces result in proximal or distal humeral fractures. Bending forces result in transverse fracture of the shaft. Torsional forces result in spiral fracture pattern. The combination of bending and torsion results in oblique fracture often with an associated butterfly fragment.[5]

Key to understanding the deforming forces at work on a humeral shaft fracture are the muscle insertions and the effect of gravity. Displacement of the proximal fragment will depend in large part on whether the fracture occurs proximal or distal to the insertions of the deltoid and pectoralis major muscles.[6] The distal fragment is always distracted to some degree by the weight of the limb, and this phenomenon is the key to some methods of non-operative fracture management. The energy by the humerus during the fracture is an important determinant of the amount of displacement. Low energy fractures may be held in position by the internal splinting of the intermuscular septa. High energy fractures result in comminution of bone and disruption of soft tissues, with loss of internal splinting effect.

Plating can be used for fractures with proximal and distal extension. It provides enough stability to allow early upper extremity weight bearing in polytrauma patients and produces minimal shoulder or elbow morbidity. Commonly used plate for fixation of humeral shaft fractures is the 4.5-mm Dynamic Compression Plate, could be narrow or broad, Limited-Contact Dynamic Compression Plate, either of stainless steel or titanium. Locking plates are the recent advances in management of the fractures and have shown lot of promise especially in proximal 1/3rd fractures[7] and osteoporotic bones.[8]

Intramedullary Nailing made significant progress in management of fracture shaft of Humerus in early 90s. There has been a gradual advancement in modification of designs of nails from earlier Seidel nail to latest ILN. Seidel nails with spreading fins have the advantages of Intramedullary nailing[9] but their use is complicated by iatrogenic comminution, torsional instability and shoulder impairment.[10] The newly developed locked nails with transfixing screws have the advantage of

adding to rotational stability which is very much required in Humerus because of high amount of torsional stress in shoulder joint.[11] These nails are usually used in segmental fractures, pathological fractures, can be used for fractures especially in females because of aesthetics of surgery as it leaves little/no surgical scar. The present study is intended to come out with some better understanding about the fixation modalities of fractures of shaft of humerus.

**Materials and Methods**

The present study was conducted in the Department of Orthopaedics, Govt. multispecialty Hospital, Sec. 16, Chandigarh during the years 2010-12. In this study 15 patients for each group i.e. Dynamic Compression Plating and Interlocking Nail were studied. Each patient was subjected to detailed history, clinical examination and necessary investigations including X-rays of the part. The fracture was classified as per A.O. classification. The affected limb was immobilized by U-slab till the time of surgery.

**Inclusion criteria:**

1. Fresh fractures (less than 3 weeks old).
2. Humerus shaft fractures upto type 12- B2 according to A.O. Classification.
3. Fractures located between 5 cm distal to surgical neck or 5 cm proximal to the olecranon fossa.
4. Grade1 or 2a compound fracture.
5. Polytrauma
6. Early failure of conservative treatment.
7. Unstable fractures

**Exclusion criteria:**

1. Compound Grade III fractures.
2. Old ununited fractures whether neglected or surgically failed.
3. Pathological fractures
4. Segmental fractures

**Methods**

Initially the patient's injured arm was immobilized in a plaster of Paris U-slab, drugs were given to alleviate pain. All the patients were taken for elective surgery as soon as possible after necessary blood, urine & radiographic pre-operative work-up. The patient's attendants were explained about the nature of injury & its possible complications. Patient's attendants were also explained about the need for the surgery & complications of surgery.

Written & informed consent was obtained from the patient for surgery. Medical evaluation of the patient was done after consulting the Physician. Hygiene of the skin was maintained with regular scrub with betadine. Injection Tetvac was given, the affected arm with the axilla was scrubbed with savlon & betadine. The anaesthetist was informed, pre-operative parenteral antibiotic (preferably Cephalosporins) was administered one hour before surgery (Post-operatively continued for 48hrs & then converted into oral antibiotics till the next 5 days). The patient was shifted to the operation theatre with the x-rays & drugs.

**Operative Technique**

**Anesthesia:** Under General Anaesthesia/regional anaesthesia
**Patients Positioning:** The patient was placed in Lateral position for Posterior approach (with arm hanging on side-post) & Supine position for Antero-Lateral approach, and arm chair position (sandbag was placed in inter scapular region) for interlocking nail.
**Draping:** The arm and the axilla were cleaned with betadine scrub for 10 minutes, painted with betadine solution & spirit, draped with linen & opsite over the proposed incision site.

**Technique Of Insertion Of Interlocking Nail**

- The length of the nail was measured in cm, by measuring the length between the greater tuberosity and the lateral epicondyle and 3 cms were subtracted from it. Diameter was assessed by the x-ray of the humerus.
- Patient was put on a radiolucent table with the thorax "bumped" 30 to 40 degrees or pillow was placed under the scapular blade; this increased the exposure of the shoulder with arm in adduction as much as possible. The image intensifier unit was placed on the opposite side of the table from the surgeon;
  Table was moved so that the foot end became head end for free movement of image intensifier.
- Entry point was made under image intensifier with 2mm k-wire just lateral to tip of acromion and medial to the greater tuberosity at articular-nonarticular junction after confirming in both sagittal and coronal planes.
- Over the k-wire cannulated bone awl was passed under c-arm guidance.
- **Insertion handle (Jig)**
  The insertion handle was mounted on the proximal end of the nail using the connection screw. It was ensured that the convexity of the nail curvature pointed away from the insertion handle.
- **Nail insertion**
  The nail was advanced in the proximal shaft fragment using gentle rotatory movements. The nail was advanced just beyond the fracture site.
- **Reduction**
  Reduction was achieved by traction, forearm was kept in supination. After passing the fracture site, humeral shaft alignment, rotation, and length was adjusted under image intensifier.
- **Definitive nail position**
  Location of the proximal end of the nail under image intensification was done by inserting a K-wire, through the corresponding hole in the insertion handle. The proximal end of the nail was kept below the level of the articular cartilage.
- **Interlocking**
  Proximal interlocking with two screws or single oblique screw was placed. To prevent the nail from backing out, proximal interlocking was done first.
- **Wound closure**
  All wounds were irrigated and cleaned. Skin closure was performed with ethilon or staples.

**Technique of open reduction and DCP application**

Exposure:-

1) Antero-Lateral Approach:
2) Posterior Approach

Post-operative Management was done and results were assessed based on:

1) Deformity.
2) Range of Movements both of shoulder & elbow.
3) Fracture Union clinically & radiologically.

**Statistical analysis**

The quantitative data (age, union time) were presented as mean ± SD. T-test was applied for comparison of two groups. Pearson $x^2$ test or Fisher's exact test was used for analysis of categorical data. A *P* value of <0.05 was considered to indicate statistical significance.

**Results**

Of the 30 patients treated in our series, overall mean age in our study was 42.43 ± 12.50 years. 22 out of 30 cases (73.33%) were in the age group of 30-60 years. In our study the male to female ratio was 1.14:1. In our study 17 of 30 cases (56.7%) had injury of the right arm. The commonest mode of injury in the present series was Road Traffic Accident accounting for 83.3% of the cases, whereas only 16.7% (5 out of 30) sustained injury during fall. In our study the commonest AO type of fracture was 12-A (19 out of 30 cases) whereas, 12-B type of fractures were 11 out of 30 cases.

Mean operative time of nailing and plating group was 70 ± 13.63 min (range 50-90 min) and 69.33 ± 12.23 min (range 60-90 min) respectively, which was almost equal. In the present series 2 out of 30 cases (6.7%) had angulatory deformity. In both the cases the deformity was less than $10^{0.}$ Mean duration of hospital stay in the nailing group and plating group was 7.80 ± 3.61 days (range 4-14 days) and 8.73 ± 1.53 days (range 6-10 days) respectively. Mean duration of hospital stay was almost equal with both modalities ~ 8 days.

Table1. Duration of Hospital Stay

| Type of Surgery | Total No. of Patients | Duration of Hospital Stay (Days) |
|---|---|---|
| NAILING | 15 | 7.8 |
| PLATING | 15 | 8.73 |

P- value .9333 Statistically Insignificant

Mean union time in nailing group was 15.27 ± 6.21wks while in the plating group it was 15.23 ± 3.32 wks.

Table 2: Time for Union

| TIME FOR UNION | NO. OF PATIENTS | | |
|---|---|---|---|
| | NAILING | PLATING | TOTAL |
| 10-16 WEEKS | 9 (81.8%) | 12 (92.3%) | 21 (87.5%) |
| 16-20 WEEKS | 1 (9.1%) | 0 (.0%) | 1 (4.2%) |
| >20-24 WEEKS | 0 (.0%) | 1 (7.7%) | 1 (4.2%) |
| > 24 WEEKS | 1 (9.1%) | 0 (.0%) | 1 (4.2%) |
| Total | 11 (100%) | 13 (100%) | 24 (100%) |
| Not -United | 04 | 02 | 06 |

P- value 0.350 Statisticallly Insignificant

83.3% of the patients (25 out of 30 cases) in our study were having functional outcome of Grade I – Grade II as per ASES Score at 6 months.

Table 3: Functional Outcome as per ASES Score

| Functional Outcome (as per ASES Score) | No. Of Patients (%) | | |
|---|---|---|---|
| | Nailing | Plating | Total |
| Grade I | 7 (46.7%) | 11 (73.3%) | 18 (60.0%) |
| Grade II | 5 (33.3%) | 2 (13.3%) | 7 (23.3%) |
| Grade III | 2 (13.3%) | 1 (6.7%) | 3 (10%) |
| Grade IV | 1 (6.7%) | 1 (6.7%) | 2 (6.7%) |
| Total | 15 (100%) | 15 (100%) | 30 (100%) |

P-value 0.474 Statistically Insignificant

In the present series 21 out of 30 cases (70%) had grade MI movements (full range) movements at shoulder joint.

Table 4: Movements at Shoulder Joint

| Movements | No. Of Patients (%) | | |
|---|---|---|---|
| | Nailing | Plating | Total |
| MI | 10 (66.7%) | 11 (73.3%) | 21 (70.0%) |
| MII | 2 (13.3%) | 2 (13.3%) | 4 (13.3%) |
| MIII | 1 (6.7%) | 1 (6.7%) | 2 (6.7%) |
| MIV | 2 (13.3%) | 1 (6.7%) | 3 (10%) |
| Total | 15 (100%) | 15 (100%) | 30 (100%) |

p value 0.944 Statistically Insignificant

In the present series none of the patients had restriction of movement at the elbow joint.

Table 5: Movements at Elbow joint

| Movements | No. Of Parients | | |
|---|---|---|---|
| | Nailing | Plating | Total |
| MI | 15 (100.0%) | 15 (100.0%) | 30 (100.0%) |
| MII | NIL | NIL | NIL |

| | | | | | | |
|---|---|---|---|---|---|---|
| MIII | NIL | | NIL | | NIL | |
| MIV | NIL | | NIL | | NIL | |
| Total | 15 | (100%) | 15 | (100%) | 30 | (100%) |

46.67% patients in the nailing group and 60% patients in the plating group had no complication in our study. Patients with more than one complication were present. Complications were more in interlocking nail as compared to plating. In our study 6 out of 30 cases (20.0%) had non-union out of which 4 cases were in the interlocking nail group and 2 cases in plating group. 5 out of 30 cases (16.7%) had shoulder stiffness of which 4 cases (80.0%) were in the nailing group and only 1 case in the plating group had this complication.

Table 6: Complication

| Complication | | No. Of Patients | | |
|---|---|---|---|---|
| | | Nailing | Plating | Total |
| Infection | Superficial | NIL | 2 (13.3%) | 2 (6.7%) |
| | Deep | NIL | NIL | NIL |
| Delayed Union | | 1 (6.7%) | NIL | 1 (3.3%) |
| Non-Union | | 4 (26.7%) | 2 (13.3%) | 6 (20.0%) |
| Iatrogenic Radial Nerve Injury | | 1 (6.7%) | 2 (13.3%) | 3 (10%) |
| Shoulder Stiffness | | 4 (26.7%) | 1 (6.7%) | 5 (16.7%) |
| Implant Failure | | 3 (20%) | NIL | 3 (10%) |
| Iatrogenic Fracture | | 1 (6.7%) | NIL | 1 (3.3%) |
| Impingement | | 1 (6.7%) | NIL | 1 (3.3%) |
| No complication | | 7 (46.67%) | 9 (60%) | |

In our study 70% of the patients (21 out of 30 cases) had excellent to good results. 12 patients had excellent to good results in the plating group and 9 patients had excellent to good results in the nailing group.

**Discussion**

In our study mean operative time was almost equal in both the groups. Mean operative time for nailing and plating in our study was 70 ± 13.63 min (range 50-90) and 69.33 ± 12.23 min (range 60-90) respectively. In the studies of McCoarmack et al[12], and Chao et al[13] the mean operative time for both the groups was almost equal but was higher in comparison to our study. In the present series mean duration of hospital stay in the nailing and plating group were 7.8 ± 3.61 days (range 4-14 days) and 8.73 ± 1.53 days (range 6-10 days) respectively. The results were comparable with the study of Chao et al.[13] Duration of hospital stay was almost equal with both the treatment modalities.

In the study of Singisetti et al[14] time taken for union in interlocking nail patients was <16 weeks in 50% of patients and >16 weeks in 50% of patients, while in plating group it was <16 weeks in 75% cases and >16 weeks in 25% cases All the

studies, except Raghavendra et al[15], showed mean union time of 8- 10 weeks for both nailing and plating groups.

In our study 46.7% (n=7) of patients in the nailing group and 73.3% (n=11) of the patients in the plating group were in grade I. 5 cases (33.3%) in the nailing group and 2 cases (13.3%) in the plating group were in grade II. 1 case in each group was in grade IV. Overall 60% cases (n=18) were in grade I. Study of Putti et al[16] had mean ASES Score 45.2 (Grade I) in the nailing group and 45.1(Grade I) in the plating group. Study done by McCormack et al[12] reported mean ASES Score of 48 & 47 in the plating & nailing group respectively. Study done by Changulani et al[17] showed mean ASES Score of 44 in the nailing group and 45 in the plating group. In comparison with the ASES Scores of the above mentioned studies the functional outcome of our study was not good, especially for the nailing group. Low ASES Score in the nailing group could be attributed to nail impingement, rotator cuff violation, adhesive capsulitis. Flinkilla et al[18] claim that a correctly placed nail is not responsible for postoperative shoulder problems.

There were only 2 cases that developed infection (superficial). Both the cases were in the plating group and both were open (grade I) fractures. This difference was statistically insignificant (p value 0.483). Infection was treated with antibiotics and dressings. There was no incidence of infection in the nailing group. The results are comparable to the reported studies of Chapman et al[19], Changulani et al[17] and Lin et al[20]. In our study incidence of shoulder stiffness was 26.7% (4 cases) in the nailing group and 6.7% (1 case) in the plating group. However, this difference was statistically insignificant (p value 0.330). Overall incidence was 16.7%. Increased incidence of shoulder stiffness in the nailing group is comparable with other studies as depicted above. 1 case with shoulder stiffness in the plating group was a known case of diabetes mellitus and was non-compliant with physiotherapy.

In our study only one patient had iatrogenic fracture. During nail insertion the patient had undisplaced fracture of the lateral cortex. The incidence was statistically insignificant on comparison with the plating group (p value 1.000). Putti et al[21] reported 2 cases of iatrogenic fracture in the nailing group. One had minimally displaced fracture of greater tuberosity and the other had comminution at fracture site due to hoop stress. McCormack et al[12] reported one case of intra-operative comminution with a slightly displaced fracture at the distal end of the plate.

The final result in the plating group were 73.3% excellent, 6.7% good, 6.7% fair and 13.3% poor, and in the nailing group it was 46.7% excellent, 13.3% good and 40% poor. Overall, in comparison to plating, result of the nailing group was not good, though this was statistically insignificant (p value 0.238). In the study of Kesemenli et al[22] the results in the plating group were 88% good, 8% moderate and 4% poor, and in the nailing group 81% good, 7% moderate and 12% poor.

**Conclusion**

Prerequisite of plating is good compression and adequate fixation because stresses at humerus are too much because of versatility of shoulder joint.

Complications after nailing can be avoided by improving the surgical technique like choosing appropriate diameter and length of the nails, ensuring that the entry portal is correctly placed and the nail is buried adequately to avoid impingement.

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