



## A PROSPECTIVE FOLLOW UP STUDY OF EVALUATION OF SHOULDER FUNCTION AFTER ANTEGRADE INTERLOCKING NAILING IN HUMERUS SHAFT FRACTURES IN ADULTS

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**ABSTRACT** **INTRODUCTION:** This study was conducted to assess the shoulder function after antegrade interlocking humerus nailing in humerus shaft fractures, duration of union, complications (immediate and late) of this fixation.

**METHODS:** In this prospective study 40 cases with humerus shaft fractures were treated with antegrade interlocking humerus nailing and followed up for functional outcomes and complications.

**RESULTS:** The age of patients ranged from 18 to 57 years. The assessment of shoulder function was made according to CONSTANT score. Out of 40 patients shoulder function was excellent in 35 cases (87.5%), very good in 3 cases (7.5%) and fair in 1 case (2.5%). Period of fracture union ranged from 12 to 18 weeks, average period being 13.7 weeks. None had iatrogenic radial nerve injury and/or infection.

**CONCLUSION:** We concluded that Locked intramedullary nailing is a novel treatment option for diaphyseal fractures of the humerus. By making correct entry, repairing rotator cuff, placing the nail inside proximal end and proper physiotherapy; shoulder function outcome can be improved to excellent in cases of humerus diaphyseal fractures treated with antegrade interlocking humerus nailing.

**KEYWORDS :** Humerus shaft fractures, CONSTANT score, Shoulder function, Antegrade interlocking humerus nailing.

### 1. INTRODUCTION

Fracture shaft of humerus constitutes 1- 3 % of all fractures and is observed both in high energy injuries and, especially in elderly, in low energy trauma.<sup>1,2,3</sup> The treatment options of humerus fracture are influenced by its uniqueness in anatomy, fracture configuration and functional significance of the region. The humerus is covered by sleeve of muscles and has rich vascularity which facilitates fracture healing. Minimal degree of angulation and shortening can be accommodated due to the mobility of the shoulder and the elbow joint.

Surgical management is indicated in situations when closed reduction is unacceptable; associated with polytrauma, neurovascular injury and/or compound injury. Among the various surgical techniques available (external fixation, plate osteosynthesis and intramedullary nailing)<sup>4-12</sup>, intramedullary nailing is currently most widely used method, suitable for most diaphyseal humeral fractures. Clinical and functional outcomes of the shoulder after antegrade nailing depend upon the point of incision of the rotator cuff and of nail insertion.

### 2. AIMS AND OBJECTIVES

It was a descriptive study to determine the proportion of patients with EXCELLENT/GOOD/FAIR Shoulder function (utilizing CONSTANT score) in humerus shaft fractures in adult patients who were treated with antegrade interlocking humerus nailing; and to assess the complications, if any after this fixation.

### 3. MATERIAL AND METHODS

This prospective follow up study was hospital based and was conducted in the Department of Orthopaedics at a tertiary care hospital in western Rajasthan after getting clearance from ethical committee of institute. Written informed consent was obtained from all the patients for participation in the study. Prospectively cases over a period from June 2018 to October 2020 were included and followed up over a minimum period of four months for complications and functional outcomes. A total 40 consecutive patients of humerus shaft fractures who presented to the hospital were included in the study.

#### 3.1. INCLUSION CRITERIA:

- Patients above 18 years of age, of both sex having humerus fracture,

- diaphyseal fractures of humerus,
- compound fractures (Gustilo and Anderson Grade I and II), and
- fractures shaft humerus associated with radial nerve palsy.

#### 3.2. EXCLUSION CRITERIA:

- patients with recent infections or previous osteomyelitis of shaft of humerus,
- patients over 60 years of age, proximal fractures within 2 cm of surgical neck and those within 5 cm of junction of diaphysis and metaphysis on both AP and lateral radiographs,
- compound grade-III fractures,
- pseudoarthrosis, and implant failure.

We used AO/ASIF classification to classify humerus diaphyseal fractures.

#### 3.3. PRE OPERATIVE PROTOCOL:

Once fracture was diagnosed, informed written consent for inclusion in the study was taken. Patients were evaluated for any associated injuries and condition of the soft tissues. Antero-posterior and lateral X-rays, routine blood investigations and pre-anaesthetic checkup were conducted preoperatively. Analgesics, immobilisation and prophylactic antibiotics as indicated were provided. In patients having abrasions/clean cut or punctured wounds intravenous antibiotics (Inj. Ceftriaxone 1 gm + Inj. Amikacin 500mg) in the emergency department was administered after adequate lavage of the wound with normal saline as per the hospital protocol.

#### 3.4. OPERATIVE PROCEDURE (ANTEGRADE HUMERAL NAILING BY CLOSED METHOD)

Informed written consent for the surgery and anesthesia were obtained from all the patients. The type of anaesthesia administered to the patient was based on his consent, associated medical conditions and the preoperative evaluation performed by the anaesthetists. Patient was positioned in beach chair position on a radiolucent table with a sand bag under the affected shoulder for better exposure of the entry site. Open fractures were irrigated and debrided. The whole of the affected upper limb and the axilla was prepared. For lateral approach incision was made from 1cm anterior and lateral to the point of acromion and extended 2-3cms distally resulting in exposure of multi-pinnate deltoid muscle and white glistening rotator cuff. Rotator cuff

was splited at the tendon of supraspinatus just medial to its insertion into the greater tuberosity. Entry point site was just medial to the greater tuberosity which was seen per operatively as a depression of the anatomical neck. The entry point was also checked by image intensifier. The entry point was opened up with a sharp awl and reamed by reamer. The nail, mounted on to the jig, was inserted through the entry point into the bone. Distal and proximal screws were locked under image intensifier and closure was done in layers.

**3.5. POST OPERATIVE MANAGEMENT**

Antibiotics were given up to the fifth postoperative day. On the 15<sup>th</sup> postoperative day suture were removed. Patient was taught passive and active range of motion exercises for the shoulder and elbow and was made to perform the same as the pain permitted. At 2 weeks pendular motion exercises (straight and circular) of shoulder and active mobilization of elbow was started. At 4 weeks diameter of circular pendular motion exercise was increased and supported abduction exercise started. At 6 weeks active guided mobilization of shoulder comprising of pendular motion exercises, the supported and active abduction exercises involving the shoulder, the circumduction exercise for the shoulder and flexion exercises involving the elbow were started. With time progressively increasing weight lifting was promoted. Serial radiographs were taken at monthly interval to note for the fracture union.

The patients were assessed at all follow ups and all findings recorded and maintained. Our scheduled follow ups were at two weeks of surgery for stitch removal, at 1 month, 3 month, 6 month and 12 months after surgery.

**4. OBSERVATIONS AND RESULTS:**

CONSTANT scoring system for individual parameters<sup>13</sup> was used to assess shoulder function in patients and grading of shoulder function according to constant score system<sup>14</sup> was done. Physiotherapy was started after 15 days of surgery or whenever patient is comfortable. Shoulder function was excellent in patients who followed physiotherapy properly. Out of 40 patients shoulder function was excellent in 35 cases (87.5%), very good in 3 cases (7.5%) and fair in 1 case (2.5%) as he had nail protruding from proximal end which irritated rotator cuff. Patients age range from 18-57 years with an average of 31.85 years. Majority of patients (31/40) were males and 9 were females. Right humerus was involved in 22 patients and left was involved in 18 patients. 36 were closed fractures and 4 were grade-I open fractures with most common mode of injury being road traffic accidents. Fractures were classified according to AO classification system (Table 1). Out of 40 patients 12 patients had associated injuries. One patient did not return for follow up and was lost.

**Table 1.: Distribution of humerus fractures according to AO Classification system**

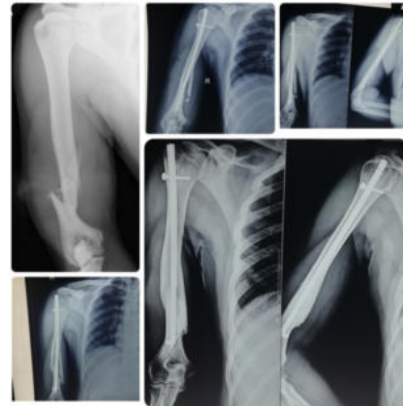
AO type		Number of patients
A	1	1
	2	11
	3	15
B	1	3
	2	9
C	1	1
Total		40

Period of fracture union ranged from 12 to 18 weeks, average period being 13.7 weeks. One patient of delayed union united at 18 weeks. Out of 40 patients, 4 patients had preoperative radial nerve injury which recovered completely in a period of time. Two patients had distraction at site and ended up in non union. One patient had nail protruding from proximal end (as it was not buried into bone) which was irritating rotator cuff and led to limitations of shoulder movements resulting in fair outcome of shoulder function. 3 patients had Very good outcome of shoulder function according to CONSTANT score, inspite of slight protrusion of nail from proximal end as they followed physiotherapy properly.

One patient had diminished movements at wrist joint as he had radius and ulna fracture in same limb and extensor tendon injury with open wound. One patient had diminished movements at elbow as he had fracture radius and ulna and elbow dislocation in same limb. Radiographs and shoulder movement of a 23 year male (case number 21) with excellent shoulder function outcome are shown in figure 1 and 2 respectively.

**5. DISCUSSION**

In a study by F. Pogliacomì<sup>15</sup> 40 patients were evaluated with a mean age of 33 years (range 17–58). Crates et al<sup>16</sup> treated 73 acute humeral shaft fractures in 71 patients with intramedullary nailing. There were 43 male and 28 female patients with an average age of 32 years (range 13-75 years). Jinn Lin<sup>17</sup> treated 48 patients of acute humeral shaft fractures with humeral locked nails. There were 29 men and 19 women with a mean age of 48 years (range 21-76 years). In our series out of 40 patients, 31 were males and 9 were females. The average age of the patients in our study was 31.85 years (range 18 to 57 years). Patients over 60 years of age were not included in the study to make sure that results were not negatively affected



**Figure 1.: Radiographs at different intervals of a 23 year old male who had excellent Outcome**

by any preexisting degeneration of the rotator cuff, the frequency of which increases with age. Road traffic accidents has been described the commonest mode of injury in majority of the studies. In study conducted by Crates et al<sup>16</sup> out of 73 patients, 48 presented with history of road traffic accident. In Rommens et al<sup>18</sup> series out of 39 patients, 21 have history of road traffic accident. In study by Jinn Lin<sup>17</sup> road traffic accident was the commonest mode of injury. In our study 34(85%) patients out of 40 patients presented with history of road traffic accident.



**Figure 2.: Shoulder function outcome of a 23 year old male who had excellent outcome**

In most of the series humeral shaft fractures were of category A of AO classification system. In a study by F. Pogliacomì et al 15 29(72.5%) out of 40 patients were of category A. In Jinn L 17 series 34(70%) out of 48 fractures were of category A. In Rommens et al 18 series 25(64%) out of 39 fractures were of category A. In our study out of 40 cases 27(67.5%) fractures were of category A of AO classification system.

Rommens et al<sup>18</sup> reported a union rate of 95% with a mean time for union of 13.7 weeks. Similarly 97% union rate of fractures treated with antegrade Russell-Taylor nailing with a mean time of 12.8 weeks was reported by Crates et al 16 reported. In our series 37(92.5%) out of the 40 fractures united while two cases went for nonunion. One case had delayed union at 18 weeks. Two cases which went in non union had distraction at the fracture site. In these cases distraction at the fracture site acted against fracture union. One patient did not turn up for follow up.

Our union rate was 92.5%. The average time of union in our series was 13.7 weeks. Compression of the fracture site, achieved by reverse banging of the nail after distal locking screw insertion along with static locking system, resulted in a better union rate. The problem of nonunion can be avoided by selecting appropriate size nail, avoiding distraction at fracture site, static locking and reverse banging the nail to reduce distraction. These factors reduce nonunion rate and promote faster healing. None of our patient developed iatrogenic nerve pals. Four patients had preoperative radial nerve injury which recovered completely in a period of time.

With Russell-Taylor antegrade nailing, Crates et al<sup>16</sup> reported 90% of patients regaining full shoulder function. In a study by F. Pogliacomì et al<sup>15</sup> results were excellent in 33(82.5%) out of 40 patients. In our study out of 40 patients shoulder function was excellent in 35 cases (87.5%), very good in 3 cases (7.5%) and fair in 1 case (2.5%) as he had nail protruding from proximal end which irritated rotator cuff. It was observed that the movements and functional ability of the shoulder depended on the level of proximal end of nail, consolidation of the fracture site and the rehabilitation programme used. Three patients treated with interlocking nailing had slight protrusion of nail from proximal end and had some restriction of movement. Impacting the nail deep into the bone before locking it can prevent the impingement at the shoulder joint. In our study rotator cuff in all patients was carefully repaired. Postoperatively no evidence of shoulder instability was present in any of our patients. One case had severe restriction as the nail was protruding out and impinging on the rotator cuff. To minimise the problem of shoulder impingement making correct entry point, placing the nail flush with the bone at the entry site, adequate repair of the rotator cuff, and by educated motivated rehabilitation program promoting good functional outcome are necessary.

Biological fixation by unreamed nailing, closed reduction, static locking and fracture site compression promotes early and adequate fracture union. Comminuted and segmental humeral fractures are effectively treated by closed humeral nailing. Minimal soft tissue exposure associated with closed reduction helps in fracture healing and early rehabilitation resulting in reduction in complication like iatrogenic radial nerve palsy and infection as evident in our series.

The insertion area of the rotator cuff being highly vascular, hemostasis must be achieved for easier identification of the entry point. Proper repair of the rotator cuff is necessary to prevent future shoulder pain. In attaining the full range of movements of the shoulder, post operative mobilization programme of the shoulder and elbow are very critical and important determinants. Patients who strictly adhered to the mobilization programme had a better functional result compared to others who did not.

## 6. CONCLUSION

Locked intramedullary nailing is a novel treatment option for diaphyseal fractures of the humerus. In osteoporosis and polytrauma patients with diaphyseal fractures of the humerus, where reduction in operating time and early rehabilitation are primary objective; intramedullary nailing is an ideal treatment option. In comminuted and segmental humeral fractures treated by closed method, avoidance of periosteum stripping and non violation of fracture haematoma lead to better and faster fracture healing.

By making correct entry, repairing rotator cuff, placing the nail inside proximal end and proper physiotherapy; shoulder function outcome can be improved to excellent in cases of humerus diaphyseal fractures treated with antegrade interlocking humerus nailing.

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