

## ORIGINAL RESEARCH

**Study of management of fracture shaft humerus by the antegrade interlocking nail in adults****Nilesh Joshi<sup>1</sup>, Shantanu S. Deshmukh<sup>2</sup>, Yash S. Shewale<sup>3</sup>, Nikhil A. Halmare<sup>4</sup>**

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**ABSTRACT**

**Background:** Fracture shaft humerus make up to approximately 1% of all fractures. Surgeons are now trying to balance the disadvantages of conservative and operative management by minimal surgical intervention (biological fixation by closed intramedullary nailing). The present study was aimed to study antegrade interlocking intramedullary nailing of the humerus in adults. **Material and Methods:** Present study was hospital based, prospective & observational study, conducted in patients > 18years, either gender, with fresh fracture shaft of humerus underwent antegrade interlocking intramedullary nailing of the humerus. **Results:** Out of 30 patients, commonest age group affected was between 31 to 40 years (30%). Majority of patients 12(40%) had simple transverse type of fracture followed by bending wedge fracture in 7(23.33%) patients. Majority of patients 15 (50.00%) were operated on due to associated multiple injuries of the axial or appendicle skeleton, 23(76.67%) Acute fracture, 1(3.33%) delayed unions, 4 non-union and 2 pathological fractures were treated. There were 25(83.33%) closed fractures and 5(16.67%) open fractures at admission. The commonest associated injury was trauma to the contralateral Colle's fracture 4 (2 1%) femoral shaft fracture 4 (13.2) followed by associated injuries to the appendicular or axial skeleton. Excellent to good results were seen in 93.33% patients. Out of the 30 cases followed up, one patient had pain in the shoulder in abduction and forward flexion, symptoms of the impingement syndrome which were relieved after removal of implant. All 4 cases of radial nerve palsy had excellent function return at the end of 6 months. **Conclusion:** Management of fracture shaft humerus by the antegrade interlocking nail in adults had advantages of a closed over an open procedure are, short operative time, immediate postoperative mobilization of patient, the biomechanical advantages and low complication rate.

**Keywords:** fracture shaft humerus, antegrade interlocking nail, biomechanical advantages, intramedullary nail

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## INTRODUCTION

Trauma has been the leading cause of morbidity and mortality since the beginning of mankind and is on the rise in the present age. Early restoration of joint motion, return to normal physiologic function and minimal morbidity is now regarded as ideal fracture treatment. Fracture shaft humerus make up to approximately 1% of all fractures. Typically, they are as a result of direct trauma.<sup>1,2</sup>

Fractures of the shaft of humerus have been treated conservatively since ages, with good results. However, conservative treatment cannot be recommended in every case. Prolonged limb immobilization leads to stiffness, instability, deformity, rarely nonunion and the need for constant cooperation and repeated hospital visits are the obvious demerits.<sup>3</sup> Moreover, unstable (spiral/long oblique) fractures, comminuted fractures, segmental fractures, pathological fractures, open fractures, fractures with delayed or nonunion and fractures associated with radial nerve injury or major vascular injury are essentially to be treated operatively.<sup>4</sup>

Surgeons are now trying to balance the disadvantages of conservative and operative management by minimal surgical intervention (biological fixation by closed intramedullary nailing) . Rotatory and torsional stability and alignment are most reliably achieved by transverse locking screws at each end, thus allowing early mobilization and its obvious advantages.<sup>4,5</sup> Even shaft fractures with severe comminution, bone loss and pseudoarthrosis can be effectively-treated by this method. The present study was aimed to study antegrade interlocking intramedullary nailing of the humerus in adults.

## MATERIAL AND METHODS

Present study was hospital based, prospective & observational study, conducted in department of Orthopedics, at tertiary care hospitals, India. Study duration was of 3 years (July 2018 to June 2021). Ethical approval was taken from the Institutional Ethics Committee.

Inclusion criteria

- Patients > 18years, either gender, with fresh fracture shaft of humerus, willing to participate in study

Exclusion criteria

- All grades of compound fractures of shaft of humerus.
- Proximal and Distal Humeral fractures having articular extensions.
- Medically unfit for surgery

Study was explained to patients in local language & written consent was taken for participation & study. On admission, patients underwent detailed history taking & physical examination. A detailed systemic and general examination was carried out to evaluate the complete status of the patient. A detailed examination of the fractured limb and also of any associated injury, status of skin and soft tissue, presence or absence of edema, presence of stretch pain distal neurovascular status.

X ray (Antero-Posterior & Lateral views.) of injured arm was done & diagnosis was confirmed. Primary care of wound was given. Patient's injured arm was immobilized in a plaster of Paris U- slab, analgesics were given. Pre-operative hematological & other investigations were done & patients were posted as early as possible. Written & informed consent was obtained from the patient for surgery.

In the present study, solid interlocking nails of the Russel-Taylor type were used to achieve rigid fixation of humerus shaft fractures. These nails, fabricated of 316 L stainless steel, were solid nails have a 2 mm thick wall diameter, with a tapered tip designed for easier insertion, so that the nail would slide smoothly along the length of the medullary canal.

The nail allowed cross locking at both ends so that locking bolts could be placed through bone and nail both above and below the fracture site. The proximal locking hole enabled purchase in metaphyseal bone. The proximal locking was done from lateral to medial direction, taking care not to over penetrate the medial cortex. The distal locking facility presented two slots for parallel screws perpendicular to the long axis of the nail. These screws were inserted from anterior to posterior cortex. Preoperative estimation of nail size was done by preoperative roentgenograms in both antero-posterior and lateral view.

The operative procedure was performed under general anaesthesia in all cases. All cases in this series were operated by the antegrade approach using the proximal entry portal. Nail entry point was checked under image intensifier in Anteroposterior and lateral view. With careful rotational movement without using hammer, the nail is advanced by hand up to the fracture site. The fracture is reduced then the nail was gently passed across the fracture to avoid comminution and advanced distally after confirming nail position in the distal canal in both AP and lateral views under the image intensifier.

Postoperative management: Check X-ray was taken after surgery and operated extremity was elevated on a Thomas arm splint or by suspension with abduction and external rotation at shoulder. Rehabilitation of the patient began immediately.

From the second post-operative day active assisted and passive movements are begun, including pendulum exercises and assisted full forward flexion within the limits of pain.

From the seventh post-operative day overhead abduction, external rotation and internal rotation exercises were begun. Discharge was usually on the 11<sup>th</sup> post-operative day, after removal of sutures. Patients were advised strictly to continue the exercises after discharge.

The patient was called back for follow up on the 6<sup>th</sup>, 10<sup>th</sup> and 16<sup>th</sup> postoperative week. Thereafter depending on the X-ray picture at 6<sup>th</sup>, 10<sup>th</sup> and 16<sup>th</sup> postoperative weeks and functional status of the upper limb further follow up visits were advised. Advice regarding lifting of weights and heavy work was given based on the X-ray picture and not before 3 post operative months.

A scoring system was used to evaluate shoulder function as devised by Constant and Murley. Functional status of the upper limb as a whole was assessed using the ASES. (American Shoulder and Elbow Surgeons). Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Statistical analysis was done using descriptive statistics.

## RESULTS

The youngest patient in this series was 18 years and oldest 68 years old. The commonest age group affected was between 31 to 40 years (30%). The mean age affected was 40.46 years. A male preponderance 25 (83.33%) was seen in this study. The majority of fractures 20 (66.67%) were the consequence of road traffic accidents, followed by fall from a height 7 (23.33%). Higher incidence of fracture was seen on the right side 16 (53.33%).

**Table 1: General characteristics**

	<b>No. of patients</b>	<b>Percentage</b>
Age groups (in years)		
10-20	1	03.33%
21-30	7	23.33%
31-40	9	30.00%
41-50	5	16.67%
51-60	5	16.67%
61-70	3	10.00%
Gender		
Male	25	83.33 %
Female	5	16.67 %

Mode of injury		
Road traffic accident	20	66.67 %
Blunt trauma/ Assault	3	10 %
fall from height	7	23.33 %
Side		
Right	16	53.33 %
Left	14	46.67 %

Majority of fractures 23 (76.67%) were in the region of the middle third of shaft of humerus followed by fractures at the middle third – lower third junction 4 (13.33%)

**Table 2: Anatomical level**

	No. of patients	Percentage
Upper third	1	03.33%
Upper 1/3- middle 1/3 junction	2	06.67 %
Middle third	23	76.67%
Middle 1/3- lower 1/3	4	13.33%
Lower third	-	-

Majority of patients 12(40%) had simple transverse type of fracture followed by bending wedge fracture in 7(23.33%) patients.

**Table 3: Type of fracture**

	No. of patients	Percentage
A1- simple spiral fracture	3	10 %
A2- simple oblique fracture	5	16.67%
A3- simple transverse fracture	12	40 %
B11- spiral wedge fracture	2	06.67 %
B2- bending wedge fracture	7	23.33%
B3- fragmented wedge fracture	0	0
C11- complex spiral fracture	0	0
C2- complex segmental fracture	1	03.33%
C3- complex irregular fracture	0	0

Majority of patients 15 (50.00%) were operated on due to associated multiple injuries of the axial or appendicle skeleton, 23(76.67%) Acute fracture, 1(3.33%) delayed unions, 4 nonunion and 2 pathological fractures were treated.

**Table 4: Indication for surgery**

Indication for surgery	No. of patients	Percentage
Pathological fracture	2	06.67 %
Nonunion	4	13.33%
Delayed union	1	03.33%
Multiple injuries	15	50 %
Forearm fracture	3	10 %
Unstable closed reduction	2	06.67 %
Obesity	2	06.67 %
Elderly patient	1	03.33%

There were 25(83.33%) closed fractures and 5(16.67%) open fractures at admission.

**Table 5: Closed and Open fracture**

	<b>No. of patients</b>	<b>Percentage</b>
Closed	25	83.33 %
Open	5	16.67 %
Gustilo type		
I	2	06.67 %
II	2	06.67 %
III A	0	0
III B	1	03.33%
III C	0	0

The commonest associated injury was trauma to the contralateral Colle's fracture 4 (2 1%) femoral shaft fracture 4 (13.2) followed by associated injuries to the appendicular or axial skeleton.

**Table 6: Associated injuries**

<b>Associated injury</b>	<b>No. of patients</b>	<b>Percentage</b>
Head injury	2	06.67 %
Associated fracture		
Rib fracture	1	03.33%
Hip fracture	1	03.33%
Bilateral shaft femur	2	06.67 %
Shaft femur fracture (ipsilateral)	2	06.67 %
Scapula neck fracture	2	06.67 %
Radius ulna fracture (ipsilateral)	3	10 %
Colles's fracture (Contralateral)	4	13.33%
Proximal humerus fracture(ipsilateral)	1	03.33%
Metacarpal fracture	1	03.33%
AC joint dislocation	1	03.33%
Ipsilateral shaft tibia	3	10 %

3 (10.00%) of patients had radial nerve injuries at admission one patient developed after attempting close reduction and all 4 patients recovered normal function within 6 months, with appropriate physiotherapy in a dynamic cock-up splint after the fracture was stabilized with rigid fixation.

**Table 7: Radial nerve injuries**

<b>Radial nerve palsy</b>	<b>No. of patients</b>	<b>Percentage</b>
On admission	3	10 %
After attempted CMR	1	03.33%

Most of the patient 26(80%) united in period less than 16 weeks. Average period of radiological union was 13.4 weeks.

**Table 8: Time taken for union**

<b>Time (weeks)</b>	<b>No. of patients</b>	<b>Percentage</b>
< 10	9	30 %
10-16	17	56.67 %
16-20	2	06.67 %
20-24	1	03.33%
24-30	0	0
30-36	1	03.33%

Using the Constant Murley scoring (80%) patients had a score between 50 — 60 implying good to excellent 0) patient shoulder function and no patient had a score less than 40 implying poor shoulder function.

**Table 9: Functional assessment of shoulder function**

Constant score	No. of patients	Percentage
55-60	10	33.33%
50-59	14	46.67%
45-49	4	13.33%
40-44	2	06.67%

Using shoulder and elbow surgeon score to assess patients had scores between 46 Using the American function of the whole upper limb, 96.66% and 52, implying good to excellent upper limb functional status at the end of treatment,

**Table 10: Functional assessment of whole upper limb function**

ASES score	No. of patients	Percentage
47-52	19	63.33%
42-46	10	33.33%
36-41	1	03.33%
31-35	0	0
<30	0	0
Total	30	100%

In one case we had shattering at fracture site while inserting the nail into distal fragment. The commonest complication encountered was shoulder stiffness in 4 (13.33%) followed by delayed union 2(06.67%) iatrogenic radial nerve palsy 1 (03.33%) impingement syndrome, 1 (03.33%), elbow stiffness 1 (03.33%) and superficial infection in 1 case (03.33%) each.

**Table 11: Intraoperative difficulties & Complications**

	No. of patients	Percentage
Intraoperative difficulties		
Iatrogenic fracture/ shattering while inserting nail	1	03.33%
Complication encountered		
Infection		
• Superficial	1	03.33%
• Deep	0	0
Delayed union	2	06.67%
Iatrogenic radial nerve palsy	1	03.33%
Shoulder stiffness	4	13.33%
Impingement syndrome	1	03.33%
Elbow stiffness	1	03.33%

Excellent to good results were seen in 93.33% patients. Out of the 30 cases followed up, one patient had pain in the shoulder in abduction and forward flexion, symptoms of the impingement syndrome which were relieved after removal of implant. All 4 cases of radial nerve palsy had excellent function return at the end of 6 months

## DISCUSSION

Ultimately the best treatment should be determined by thoughtful analysis of the morphology of the fracture, the amount of energy imparted to the extremity by the trauma, the mechanical characteristics of the bone and age of the patient.

Though plate fixation has given high rates of union, it requires extensive surgery, with stripping of the soft tissues from bone, increased chances of infection or nerve damage, less secure fixation in osteopenic bone, and delayed mobilization of shoulder and elbow, further, there is stress shielding of bone by the plate, and reduced strength of union due to primary osteal healing compared to callus healing seen otherwise. Plate osteosynthesis requires extensive dissection with risk of radial nerve damage,<sup>6</sup> this has been reported in 3 to 29% of cases,<sup>7</sup> besides, other disadvantages like the increased risk of infection and drainage of the fracture hematoma are obvious.

Intramedullary nailing with a conventional 'V' nail of Kutscher, rods of Rush, Ender or Hackethal have been used with varied results.<sup>3</sup> These devices however act merely as internal splints and do not provide rotational stability, so that unrestricted movements cannot be allowed in every patient and external protection in some form or other is needed.

The Russel-Taylor humeral nail<sup>8</sup> is smaller in diameter (6-9mm.) and is slightly curved proximally, so the insertion portal is away from the articular surface, while two locking screws give reliable rotational stability. It can be inserted by either antegrade or retrograde approach, which is totally extraarticular. In this series 30 cases of fracture shaft humerus were stabilized with unreamed solid interlocked intramedullary nails of the Russel-Taylor type & studied.

In this study 53.33% of patients were in the 3<sup>rd</sup> and 4<sup>th</sup> decade, the commonest age group affected and the mean age affected was 40.46 years. This compares favorably with findings of Lal et al.,<sup>9</sup> in whose series 55% of patients were in the 20-40 age group and mean age was 39.6 years.

In the present study, fracture of the middle third of the shaft had the maximum incidence (76.67 %), followed by the junctional areas of middle 3<sup>rd</sup> & lower 3<sup>rd</sup> (13.33%). This is comparable to the series of Robinson et al.,<sup>10</sup> & Rommens at al.,<sup>6</sup> Predominant involvement of the middle third of shaft was probably due to the direct impact of trauma.

16.67 % open fracture were encountered in the present series, incidence is less than other series of Lin et al.,<sup>11</sup> and Lal et al et al.,<sup>9</sup> However in the present series (3.33 %) of patients had Gustilo type IIIB soft tissues injury, which was 5% in the series of Lal et al et al.,<sup>9</sup>

In this study, radial nerve palsy was seen in 4 (13.33%) of the cases. Three patients (10%) presented with the paralysis at the time of first examination, and in one case paralysis (3.33%) developed after attempted closed reduction. All four cases had neuropraxia type of injury and recovered in due course of time.

In the series of Flinkkila et al.,<sup>12</sup> out of 126 cases (8%) had a primary radial nerve palsy of which 5 (4%) required exploration. Lin et al.,<sup>11</sup> in his series recorded 4 cases of preoperative radial nerve palsy (21%). All but one case resolved within 1-9 months after fixation. The one remaining case showed evidence of nerve laceration on exploration. In Ingmanns et al.,<sup>13</sup> series, there were 6 cases of preoperative nerve palsy i.e., 15%

Holstein and Lewis<sup>14</sup> described oblique fracture of the distal third of the shaft of humerus in which radial nerve palsy occurred due to a displaced spike of the distal bone fragment. The nerve has least mobility at this place where it pierces the lateral intermuscular septum, most nerve injuries represent a neurapraxia or axonotmesis and 90% will resolve within 3 to 4 months.

Most of the fractures united within 16 weeks in most reported studies. In this study, 86.67 united within 16 weeks. In the series of Lal et al.,<sup>9</sup> 100% cases united within 16 weeks.

Average time taken for union in this series was 13.67 weeks. This is comparable to 13.7 and 13.4 week respectively in the series of Rommens et al.,<sup>6</sup> and Ingmann et al.,<sup>13</sup>

Iatrogenic fracture of the medial cortex at fracture site occurred while inserting the nail into distal fragment in one patient. This problem was encountered in 10% cases in the series of Robinson et al.,<sup>10</sup> Flinkkila et al.,<sup>12</sup> noticed intraoperative fracture of the greater tuberosity in cases, which required wire fixation at the same sitting.

The commonest complication in four patients (13.33%) encountered in the present series was shoulder stiffness of varying degree as assessed by the Constant score. However, this was not functionally limiting in any of the patient. Robinson et al.,<sup>10</sup> reported this complication in 5 patients (17%). In the series of Srivastava et al.,<sup>15</sup> 15% patients were found to have shoulder stiffness; 18% patient in the series of Lal et al.,<sup>9</sup> and 11% in Lin J et al.,<sup>11</sup>

The average time to return of full shoulder function was six weeks with adequate compliance to the rehabilitation program. The cause of the stiffness is mostly damage to the rotator cuff at the time of nail insertion and lack of patient cooperation with the postoperative physiotherapy regimen. With adequate physiotherapy and rehabilitation, there was definite improvement in the range of motion. Riemer et al.,<sup>16</sup> state that residual irritation or thickening of the rotator cuff tendon or coracoacromial ligament is the cause of shoulder stiffness.

Impingement syndrome at the shoulder was encountered in only one patient (3.33%) due to proximal protrusion of the nail. Full shoulder function returned in this patient after removal of the nail. Such a complication was seen in 9% cases in the Lal et al.,<sup>9</sup> series, 32% cases in the series of Mc Cormack et al.,<sup>17</sup> and 40% cases in the series of Robinson et al.,<sup>10</sup>

The antegrade approach produces shoulder stiffness in few patients but is technically less demanding than the retrograde technique; shoulder stiffness recovers in due course of time with physiotherapy and rehabilitation. There are obvious disadvantages including a high learning curve, the risk of violating the rotator cuff with the antegrade procedure, and of damaging neurovascular structures unless due care is taken; the necessity of the use of image intensifier thereby increasing the risk of radiation exposure to the surgeon, and the cost of equipment.

Although the technique has a high learning curve and is best in experienced hands, it is less technically demanding than open reduction and internal fixation with plate and screws. The final functional outcome is good to excellent in majority (96.66%) of patients, with a relatively low complication rate compared to other methods of internal fixation. The results of the present study indicates that in the presence of proper indications, solid unreamed antegrade intramedullary interlocked nailing appears to be one of the best modality of treatment among the available methods today.

## CONCLUSION

Management of fracture shaft humerus by the antegrade interlocking nail in adults had advantages of a closed over an open procedure are, short operative time, immediate postoperative mobilization of patient, the biomechanical advantages and low complication rate of inter locking nail make it a preferred procedure for fixing fractures of the shaft of humerus. When indicated, internal fixation of fractures of the shaft of the humerus with solid unreamed interlocked intramedullary nail gives good results.

**Conflict of Interest:** None to declare

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## REFERENCES

1. Blum J, Rommens PM, Jansing N: The unreamed humerus nail — a biological osteosynthesis of the upper arm. *Acta Chir.Belg.*1997 Aug; 97(4):184-9



2. Crates J, Whittle AP: Antegrade interlocking nailing of acute humeral shaft fractures. *CORR* May 1998; 350:40-50.
3. Dalton JE, Salkeld SI, Satterwhite YE, Cook SD: A biomechanical comparison of intermedullary nailing systems for the humerus. *J. Orthop. Trauma*, 1993;7(4):367-74.
4. Damron TA, Rock MG, Choudhary SN, Grabowski JJ: Biomechanical analysis of prophylactic fixation for middle third humeral impending pathological fractures. *Clin. Orthop.* June 1999; 363:240-8.
5. Dijkstra S, Stapert J, Boxma H, Wiggers T: Treatment of pathological fractures of the humeral shaft due to bone metastases — a comparison of intramedullary locking nail and plate osteosynthesis with adjunctive bone cement. *J. Surg.Oncology* 1996 Dec;22(6):621-6.
6. Rommens PM, Verbruggen J, Broos P: Retrograde interlock nailing of fracture of the humeral shaft- A clinical study. *Unfallchirurg.* March 1995; 98(3) : 133-38.
7. Nast-Kolb D, Knoefel WT, Schweiberer L: Die behandlung der ober armschaft fracktur- ergebnisse eine prospektwen AO- Sammelstudie *Unfallchirurg.* 1991; 94 : 447-54.
8. Russel TA, Taylor JC: Surgical technique manual- Russel Taylor humeral interlocking nail system, Smith and nephew Richards.
9. Lal Y, Sharma S, Krishna LG, Ahmed A: Humeral shaft fractures treated by unreamed interlocking nail. *Indian Journal of Orthopaedics.* July 1999; 33(3).
10. Robinson CM, Bell KM, Court Brown CM, McQueen MM: Locked nailing in humeral shaft fracture. *JBJS.* July 1992;74B(4) : 558-62.
11. Lin J, Hou SM, Hang YS, Chao EYS : Treatment of humeral shaft fractures by retrograde locked nailing. *Clin. Orthop.* 1997; 342: 145-147,
12. Flinkkila T, Pekka H, Martti L, Teppo L: Intramedullary nailing of humeral shaft fractures. *Acta. Orthopaedica Scand.* 1999; 70(2):133-6.
13. Ingmann AM, Waters DA: Locked intramedullary nailing of humeral shaft fractures. *JBJS.* 1994; 76B: 23-29.
14. Holstein A, Lewis G- Fractures of the humeral shaft with radial nerve paralysis. *JBJS* 1963; 454: 1382-88.
15. Srivastava A, Srivastava KP: Locking nails in humeral fractures. *Indian Jr. of Orthopadics* vol 33(4)Oct. 1999;
16. Riemer BL, Butterfield SL, Ambrosia R, Kellam J: Seidel Intramedullary nailing of humeral diaphyseal fracture. *Orthopaedics.* 1991; 14 : 239.46.
17. McCormack RG, Brien D, Buckley RE, McKee MD: Fixation of fractures of the shaft of humerus by dynamic compression plate or Intramedullary nail- a prospective randomized trial. *JBJS* 2000; 82A: 336-339.