

## Original Research Article

# Functional outcome of humeral shaft fractures in adults treated with titanium elastic nailing

Ishani Patel\*, Dhaval R. Modi, Mansi Patel

Department of Orthopaedics, NHL Medical College, Ahmedabad, Gujarat, India

**Received:** 20 April 2018

**Revised:** 06 May 2018

**Accepted:** 08 May 2018

**\*Correspondence:**

Dr. Ishani Patel,

E-mail: [dr.ishani26@gmail.com](mailto:dr.ishani26@gmail.com)

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

### ABSTRACT

**Background:** This study was done to analyse the functional outcome of humeral shaft fractures (upper and middle third) managed with closed ante-grade intramedullary titanium elastic nailing.

**Methods:** This was a prospective study of 20 patients, aged between 18 and 60 years, with humeral shaft fractures treated with titanium elastic nailing from May 2016 to April 2018 at our institute. Upper and middle humeral shaft fractures of both sexes were included in the study.

**Results:** Eighteen (90%) fractures united in 12-20 weeks. Two (10%) patients had delayed union which ultimately united without any intervention. Two (10%) patients developed shoulder stiffness due to nail impingement. By evaluating ASES score, good to excellent results were noted in 18 (90%) and moderate in 2 (10%). There were 15 males and 5 females with an average age 32.75 years (range: 18-60 years).

**Conclusions:** Titanium elastic nailing is a good method for treatment of humeral shaft fractures in adults. It provides early fracture union, high union rates, minimal soft tissue damage, early rehabilitation and short hospital stay.

**Keywords:** Titanium elastic nailing, Humeral shaft fractures, Intramedullary, Closed reduction, Internal fixation

### INTRODUCTION

The ever growing population combined with an increasing number of automobiles have made motor vehicle accidents common. This has increased the incidence of fractures of all parts of the body and humeral shaft fractures are not an exception. These type of fractures account for 3-5% of all fractures.<sup>1</sup>

It is generally admitted that most humeral shaft fractures can be managed successfully by non-operative methods but since it requires prolonged immobilization, operative treatment is a better option.<sup>2</sup> The two options for operative treatment are plate osteosynthesis and intramedullary nailing.

Titanium elastic nails are biomechanically better implants which are subjected to smaller bending loads. They also act as load sharing devices so stress shielding with resultant cortical osteopenia is minimum, refracture after implant removal is less and they do not require extensive exposure.<sup>1</sup>

Treatment of humeral shaft fractures has been the subject of controversy because of possibilities of fat embolism, concern of damage to medullary circulation and a lack of understanding of the biomechanical principles of intramedullary nail fixation.<sup>3,4</sup>

With the use of an image intensifier, these devices can be inserted in a closed manner without exposing the fracture site, with minimal soft tissue scarring and low infection

rates. This preserves the fracture hematoma, which provides early fracture consolidation with higher union rates. They achieve rotational stability, provide early mobilization of the neighbouring joints, decrease the morbidity and reduce the hospital stay. Keeping all these aspects in mind, this study was done to assess the role of closed intramedullary nailing with Titanium elastic nails in managing humeral shaft fractures.

**METHODS**

This is a prospective study carried out from May 2016 to April 2018. The data was collected from the Department of Orthopaedics in V.S Hospital. This study consisted of 20 patients with traumatic humeral shaft fractures, treated with closed ante-grade intramedullary titanium elastic nailing were included in the study. Assessment of the result was done by ASES (American Society of Shoulder & Elbow Surgeon) functional score.

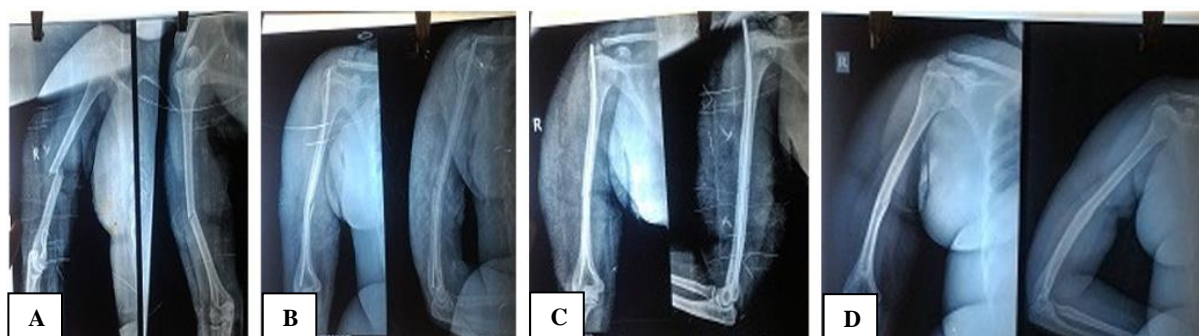
Adults more than 18 years of age (skeletally matured), closed acute traumatic diaphyseal humeral fractures, patients with head injury not associated with any paraparesis or paraplegia, chest or abdominal injury with humeral shaft fractures were included in the study.

All open fractures, unstable fracture patterns (comminuted, unstable large butterfly fragment),

skeletally immature bones, associated radial nerve palsy, pathological fractures, peri-prosthetic fractures, pre-existing shoulder or elbow pathology were excluded from the study.

Primary stabilisation of the fractures in all patients was done by U-slab. After taking a written consent, all the patients were operated on within 24 to 72 hours.

Patients were placed in supine position under anaesthesia on a radiolucent table with a pack below the scapula. All the cases were treated by closed intramedullary titanium elastic nails (Ti-6Al-7Nb titanium alloy) of varying sizes. (2 mm to 4 mm) (Nebula Ortho Care, Ahmedabad, India) with an ante-grade entry point. ‘‘C’’ contouring of the nail (nail contoured into a bow with nail tip pointing to the concave side of the bowed nail) was done before insertion so as to achieve three-point fixation. Entry point was at the greater tuberosity just lateral to the insertion of supraspinatus tendon, through a lateral incision approximately 2 cm long, after splitting the deltoid in line of its fibres. Two titanium elastic nails of appropriate size so as to fill the canal were inserted with two separate entry points through the same incision. The nails were negotiated across the fracture site after closed reduction under fluoroscopic guidance. Distal fanning of the nail tips were done medially and laterally in the coronal plane fixing in the medial and lateral pillar. Proximal ends of the nails were cut flush to the bone and buried in it.



**Figure 1: (A) Preoperative X-ray; (B) immediate postoperative X-ray; (C) 12 weeks follow up; (D) 1 year follow up after removal of nail due to impingement.**



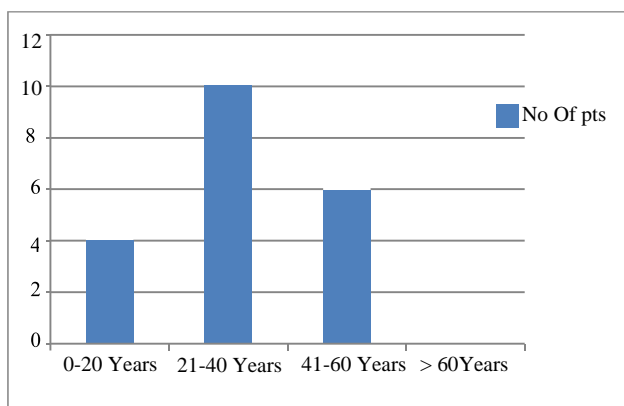
**Figure 2 (A-D): Range of motion at the end of follow up.**

All patients were given humerus U-slab in the post-operative period and elbow mobilisation with slab was started from the second post-operative day. Stitches were removed on the 10th post-operative day and functional humerus brace was applied. Patients were started on physiotherapy with the humerus brace. The patients were followed up 6, 12 and 24 weeks postoperatively (mean follow-up of patients was 20 months). Radiographs were taken during follow-ups for clinical and radiological assessment of fracture healing (Figure 1 and 2).

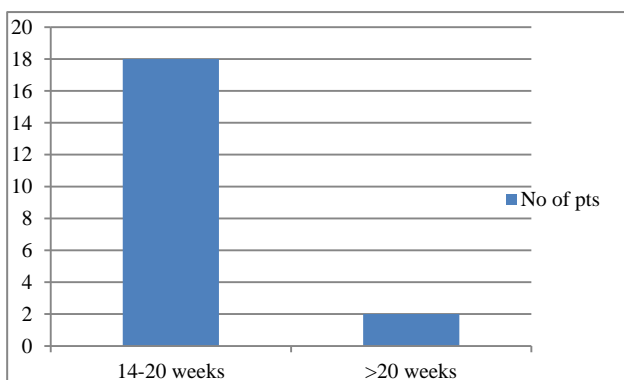
The clinical criteria for fracture healing was absence of pain and tenderness at fracture site with free shoulder and elbow activity. Radiological criteria was presence of bridging callus and disappearance of the fracture line on serial follow-ups. Assessment of the result was done by ASES (American Society of Shoulder & Elbow Surgeon) functional score.

**RESULTS**

The age of the patients in our study was from 18 years to 60 years with an average of 32.75 years (Figure 3). Majority of the patients 15 (75%) were male and only 5 (25%) were females. The most common mode of injury was road traffic accident, accounting for 16 (80%) patients. The remaining four (20%) patients presented with the history of fall.



**Figure 3: Age wise distribution of patients.**



**Figure 4: Time of union.**

In our study, eleven (55%) patients had a fracture at the middle third of the humeral shaft, five (25%) patients at the lower third of the humeral shaft and four (20%) patients at the proximal third of the humeral shaft.

**Table 1: Functional outcome (based on ASES score).**

ASES score	Outcome	No. of patients	%
>90	Excellent	18	90
70-90	Good	2	10
50 to 70	Poor	0	0
<b>Total</b>		20	100

The union rate was 100% in the present study at the final follow-up. Complete union was achieved in eighteen patients (90%) at 20 weeks. There were two patients (10%) with delayed union in the present study which eventually healed at 30 weeks without any intervention (Fig 4). There were no cases of non-union in this study. No bone grafting was done in any patient either primarily or secondarily. The functional outcome was assessed by ASES score which resulted in good to excellent in 18 (90%) and good in 2 (10%) (Table 1).

Elbow stiffness was observed in 1 patient. Patient had terminal loss of 20° to 25° lag of extension due to associated elbow degloving injury. Shoulder stiffness was observed in 2 patients due to impingement of nails. In both the cases overhead abduction was not possible. After removal of the nails and proper physiotherapy full range of motion with good shoulder function was achieved. Superficial or deep infections were not observed in any of the patients. There were no cases of iatrogenic radial nerve palsy or iatrogenic comminution during nail insertion in our study.

**DISCUSSION**

Treatment of humeral shaft fractures in adults remains a challenging issue. Non-operative treatments are still considered an option.<sup>5,6</sup> Union rates of more than 90% are often reported.<sup>4,7</sup> Acceptable alignment of humeral shaft fractures is considered to be 3 cm of shortening, 30° of varus/valgus angulation, and 20° of anterior/posterior angulations. Varus/valgus angulation is tolerated better proximally, and more angulations may be tolerated better in patients with obesity.<sup>8,9</sup> There is no universal agreement on optimal modality of fixation when surgical intervention is chosen.<sup>10</sup> Plating carries the risk of infection, neurological insults and non-union.<sup>11,12</sup>

Stern et al reported 70 humeral shaft fractures stabilized with several types of non-locked intramedullary devices. They reported complications in 67% of fractures with 15% of fracture going for delayed union and 8.3% for non-union. Adhesive capsulitis of shoulder developed in 56% of patients.<sup>13</sup>

Hall and Pankovich reported a prospective series of 89 humeral shaft fractures stabilized with Ender nails. Middle and proximal third fractures were fixed by retrograde nailing and distal third fractures by antegrade nailing. 99% of fractures united at an average of 7.2 weeks. There were no infections or malunions. Two patients had post-operative radial nerve palsy which recovered completely. Nail back out was reported in 8 patients. The authors concluded that closed intramedullary Ender nailing could be performed safely and effectively in selected humeral shaft fractures.<sup>14</sup>

McCormack et al treated 44 patients with humeral shaft fractures by open reduction and internal fixation, using dynamic compression plate (DCP) or intramedullary nails. They found that there was no significant difference in the function of the shoulder and elbow as determined by American Shoulder and Elbow Surgeons (ASES) score. They performed intramedullary nailing using Russell-Taylor locked nails in 21 patients, of which 13 were antegrade and 8 were retrograde insertions. In 23 patients, fractures were fixed by DCP. In nail group 2 patients went for non-union which was treated by bone grafting. There was one case of infection, one radial nerve palsy and 2 impingements. At the end of 6 months follow-up, they found that there was not much difference in functional outcome of shoulder and elbow as determined by ASES score. The authors concluded that fixation with DCP remains the best treatment for unstable fractures of the humeral shaft. Fixation by intramedullary interlocking nail may be indicated for specific situations but is technically more demanding.<sup>15</sup>

In a retrospective study treating closed humeral shaft fractures with titanium elastic nail, all the fractures healed in good alignment with no intraoperative complications including neurological injury, vascular injury and infection.<sup>16</sup> At the end of the study of diaphyseal humeral fractures using titanium elastic nails, the authors concluded that the titanium elastic nails offer a number of potential advantages over traditional ways of treating long bone fracture including early immobilization, shorter hospital stay and less risk of loss of fracture position.<sup>17</sup> In two comparative studies treating closed diaphyseal humeral fractures with elastic nail and plate osteosynthesis, the authors concluded that elastic stable nail is applicable for routine use in appropriate selected humeral shaft fractures.<sup>18,19</sup>

Brumbeck et al reported 2.2% incidence of iatrogenic comminution at the fracture site with the use of Ender nail, and Jinn reported a 5.5% incidence of iatrogenic fractures with the use of Seidel interlocking nail.<sup>20,21</sup> There was no incidence of iatrogenic fractures in our study. Titanium elastic nails bend while passing through the bone, tension is increased within the nail which improves the three-point fixation.

The limitation of this study is the small sample size and long term follow-up. Use of titanium elastic nails is not

recommended in unstable fracture pattern or comminuted fractures.

## CONCLUSION

Titanium elastic nailing of humeral shaft fractures in adults is less invasive with minimal blood loss, less chances of infection, with rotational as well as torsional stability and good functional outcome. Thus, it may be considered a procedure of choice in humeral shaft fractures in adults.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: Not required*

## REFERENCES

1. Garvanos C. Humeral shaft fractures. Rockwood and Green's Fractures in adults. In: Court-Brown CM, Heckman JD, McQueen MM, Ricci WMTorretta P III, eds. 8th ed. Philadelphia: Wolters Kluwer Health; 2015: 1287–1336.
2. Crenshaw AH Jr, Perez EA. Fractures of shoulder, arm and forearm. In: Canale ST, Beaty JH, eds. Campbell's Operative Orthopaedics. 11<sup>th</sup> ed. Philadelphia: Mosby Elsevier; 2008;3:3389-98.
3. Dalton JE, Salkeld SL, Satterwhite YE, Cook SD. A biomechanical comparison of intramedullary nailing systems for the humerus. *J Orthop Trauma.* 1993;7:367–74.
4. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. *Clin Orthop.* 1987;214:160–4.
5. Ward EF, Savoie FH, Hughes JL. Fractures of the diaphyseal humerus. In: Browner BD, Jupiter JB, Levine AM (eds). *Skeletal trauma: Fractures, dislocations, ligamentous injuries* (2nd edn). Philadelphia, Pa: WB Saunders; 1998: 1523-1547.
6. Sarmiento A, Zagorski JB, Zych GA, Latta LL, Capps CA. Functional bracing for the treatment of fractures of the humeral diaphysis. *J Bone Joint Surg Am.* 2000;82:478-86.
7. Marchetti PG, Vicenzi G, Impallomeni C, Landi S, Surdo V. The use of elastic nails for intramedullary fixation of humeral fractures and nonunions. *Orthopedics.* 2000;23:343-7.
8. Klenerman L. Fractures of the shai of the humerus. *J Bone Joint Surg Br.* 1966;48:105-11.
9. Xie F, Wang S, Jiao Q, Shen Y, Ni XY, Ying H. Minimally invasive treatment for severely displaced proximal humeral fractures in children using titanium elastic nails. *J Pediatr Orthop.* 2011;31:839-46.
10. Rosenbaum A, Uhl R. Nonunion of humeral shaft fractures following flexible nailing fixation. *Orthopedics.* 2012;35:512-5.
11. Kumar M, Kaushik YS. Functional outcome of humerus shaft fractures in adults treated by flexible

- nails using retrograde technique. *IJOS.* 2017;3:176-8.
12. Sheng ZJ. Elastic intramedullary nailing for children with fracture of shaft of humerus. *J Clin Orthop.* 2012;5:44-9.
  13. Stern PJ, Mattingly DA, Pomery DL, Zenni EJ Jr, Kreig JK. Intramedullary fixation of humeral shaft fractures. *J Bone Joint Surg.* 1984;66:639-46.
  14. Hall RF, Pankovich AM. Ender nailing of acute fractures of the humerus. A study of closed fixation by intramedullary nails without reaming. *J Bone Joint Surg.* 1987;69:558-67.
  15. McCormack RG, Brien D, Buckley RE, McKee MD, Powell J. Fixation of fractures of the shaft of the humerus by dynamic compression plate or intramedullary nail. *J Bone Joint Surg Br.* 2000;82(3):336-9.
  16. Garg S, Dobbs MB, Schoenecker PL, Luhmann SJ, Gordon JE. Surgical treatment of traumatic humeral diaphyseal fracture with titanium elastic nails. *J Child Orthop.* 2009;3:121-7.
  17. Carroll EA, Schweppe M, Langfitt M, Miller AN, Halvorson JJ. Management of humeral shaft fractures. *J Am Acad Orthop Surg.* 2012;20:423-33.
  18. Heineman DJ, Poolman RW, Nork SE, Ponsen KJ, Bhandari M. Plate fixation or intramedullary fixation of humeral shaft fractures. *Acta Orthop.* 2010;81:218-25.
  19. Chen F, Wang Z, Bhattacharyya T. Outcomes of nails versus plates for humeral shaft fractures: A medicare cohort study. *J Orthop Trauma.* 2013;27:68-72.
  20. Brumback RJ, Bosse MJ, Poka A, Burgess AR. Intramedullary stabilization of humeral shaft fractures in patients with multiple trauma. *J Bone Joint Surg Am.* 1986;68:960-9.
  21. Jinn L. Treatment of humeral shaft fracture with humeral locked nail and comparison with plate fixation. *J Trauma.* 1998;44(5):859-64.

**Cite this article as:** Patel I, Modi DR, Patel M. Functional outcome of humeral shaft fractures in adults treated with titanium elastic nailing. *Int J Res Orthop* 2018;4:582-6.