

North American Academic
Research | Volume 5 | Issue 2 |
February 2022 | Monthly Journal
by TWASP, USA | Impact Factor:
3.75 (2021)

North American Academic Research

Monthly Journal by **The World
Association of Scientists & Professionals**
TWASP, United States

Treatment of Adult Humeral Shaft Fractures Using Titanium Elastic Nail System

DC Gopal Sagar^{1*}, Shriwastav Ravi¹, Prakash Chand Yadav², Sujeet Kumar shah³

¹ Department of Orthopedics Nepalgunj Medical College, Nepal

² Xi'an Jiaotong University, Xi'an, P.R china

³ Nepalgunj Medical College, Nepal



Accepted February 26,2022

Published March 08, 2022

Copyright: © The Author(s); Conflicts of Interest: There are no conflicts to declare.

*Corresponding Author: DC Gopal Sagar. sagargopal@gmail.com

Funding: None

How to cite this article: DC Gopal Sagar, Shriwastav Ravi, Prakash Chand Yadav, Sujeet Kumar shah (2022). Treatment of Adult Humeral Shaft Fractures Using Titanium Elastic Nail System. *North American Academic Research*, 5(2), 302-308. doi: <https://doi.org/10.5281/zenodo.6335846>

ABSTRACT

Introduction: Humeral shaft fractures can be treated both conservatively and surgically, options being plate osteosynthesis and intramedullary nailing. Titanium elastic nail system (TENS) that act as load sharing and stress shielding devices has advantages in terms of being minimally invasive, no risk of radial nerve palsy, preserving fracture hematoma and avoids complications like malunion, delayed union, rotational problems and joint stiffness seen with fractures managed non-operatively. We studied the rate and time of union along with the functional outcome and advantages/shortcomings of such fractures using TENS in our center.

Methods: This prospective study was done in Nepalgunj Medical College Hospital, Nepalgunj between January 2018 to January 2019. It included 43 patients (age >18 years) with closed or open (grade 1) acute traumatic diaphyseal fractures of humerus. All fractures were fixed with two titanium elastic nails of appropriate size in a retrograde fashion from distal humerus using C-arm under general anesthesia. Cases were followed up at 2, 4, 8 weeks and 3, 6, 12 months after surgery and functional outcome was evaluated using Constant shoulder score and Mayo elbow performance score at 6 months. Data were entered in structured pro forma and statistical analysis was carried out using SPSS 20.0.

Results: Out of 43 cases, mean age of patient was 35.39 years (range 21-61 years). 23 (53.5%) were males and 20 (46.5%) were females. 35 (81.4%) cases had closed fracture and 8 (18.6%) had grade I open fracture. Fractures were of proximal 3rd in 13 (30.23%) cases, middle 3rd in 19 (44.18%) and distal 3rd in 11 (25.58%) cases. All 43 (100%) cases were operated by closed technique. Average duration of surgery was 15.48±5.5 minutes (ranging 9-31 minutes). Average hospital stay was 1.9±0.6 days (ranging 1-3 days). Radiological union was achieved in 12.4±2.7 weeks (8-24weeks). Functional outcome in final follows up at 6 month using Constant Shoulder Score was excellent in 40 (93.02%) cases, good in 2 (4.6%) and fair in 1 (2.3%) case. Mayo elbow score was excellent in 41 (95.34%) cases and

good in 2 (4.6%) cases. Superficial surgical site infection was seen in 2 cases (4.6%) and exposure of nail tip and neuropraxia was seen in 1 case. Radiological union was seen in 100% patients at final follow up after 1 year.

Conclusion: TENS is a superb minimally invasive option in treatment of adult diaphyseal humerus fractures with excellent and timely union with minimal complications and preserving joint function.

Keywords

Titanium elastic nail system (TENS), Humeral shaft fractures

Introduction

Humeral shaft fractures account for 3-5% of all fractures [1]. Age distribution is bimodal; young patients with high energy trauma and elderly patients with low energy injuries. These can be treated conservatively using U-slab, hanging cast and functional brace or surgically using plate/screw osteosynthesis and intramedullary nailing.

Intramedullary nails can be interlocking nails, Enders or titanium elastic nails. Titanium elastic nail system (TENS) is often used in paediatric long bone fractures (Femur, tibia, humerus) but its use in adult fractures is limited. Nails act as load sharing and stress shielding devices [2,3]. These are subjected to smaller bending loads and are less likely to fail due to fatigue. Cortical osteopenia occurring at ends of plates is rarely seen with intramedullary nails; refracture after implant removal is also rare. The other advantages being minimally invasive, minimal postoperative pain, no risk of radial nerve palsy, early union due to retention of fracture hematoma; however, concern of damage to medullary circulation, risk of fat embolism and inadequate understanding of the biomechanical principles of intramedullary fixation has led to less of its surgical practise [4,5].

In this study, we prospectively followed adult diaphyseal humerus fractures treated with TENS to identify the advantages and shortcomings along with functional outcome in terms of range of motion and study the time to union of the fractures along with post-operative complications; if any, following titanium nailing.

Materials and methods

This prospective descriptive study was done in department of orthopedics in Nepalgunj Medical College Hospital, Nepalgunj after appropriate ethical clearance from January 2018 to January 2019. Adults more than 18 years of age with closed or open (grade 1) acute traumatic diaphyseal fractures of humerus were included in the study. Open fractures (grade 2/3), unstable fracture patterns, skeletally immature patients, associated radial nerve palsy, pathological fractures, pre-existing shoulder or elbow pathology were excluded from the study. Forty-three cases fulfilled the inclusion criteria and were included in this study. Demographic variables, mode of injury, fracture pattern was noted in proforma.

Preoperative AP and lateral radiographs of humerus including shoulder and elbow joints were taken. Titanium elastic nails of varying sizes (2-4 mm) were used.

Cases were taken up for surgery under general anesthesia and were operated by first author. Intravenous antibiotics (Cefuroxime, 750mg) stat dose was given to all cases. Closed reduction under c-arm was done in all cases after standard painting and draping. In supine position, after giving mini-incision, using awl/perforator, entry point was made in lateral epicondyle. Then TENS of appropriate size was inserted using T-handle and gradually forwarded and manipulated through fracture site reaching up to the humeral head. Similar procedure was performed making entry through medial epicondyle after properly palpating the ulnar nerve. The whole procedure was performed under C-arm guidance. Antiseptic dressing was applied at mini-incision site. Postoperative U-slab was applied to all cases for pain relief. Cases were usually discharged after 48 hrs. Cases were followed up in 2, 4, 8 weeks and 3, 6, 12 months after surgery. After 4 weeks, U-slab was removed and gentle range of movement at shoulder and elbow was started. Check X-ray was mostly done at day 1, at 4, 8 weeks, 6, 12 months of surgery (Fig.1,2); if no radiological union was seen then X-ray were repeated at 8, 10 and 12 weeks sequentially to look for radiological union and same was noted. At 6-month follow-up functional outcome was evaluated using Constant Shoulder Score and Mayo Elbow Performance Score (Fig 3,4). Data were then entered in Microsoft excel and analyzed for frequency distribution and mean where appropriate using SPSS 20.0 version.

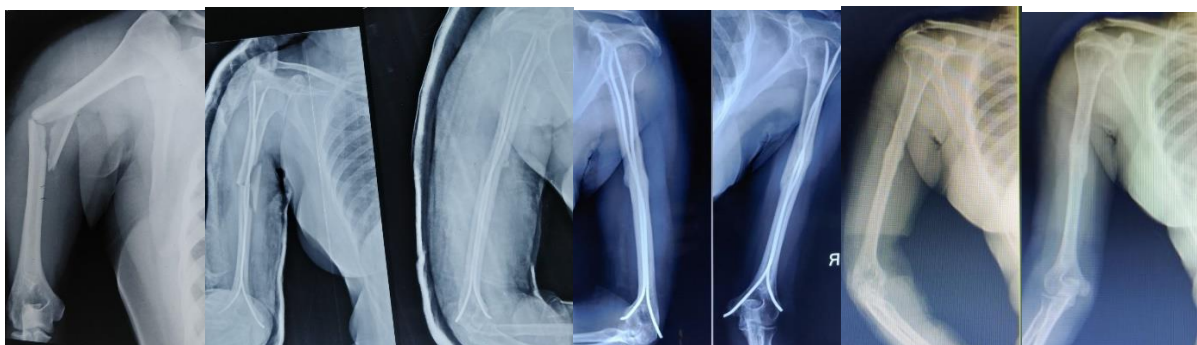


Fig 1a

Fig 1b

Fig 1c

Fig1d

Fig.1: X-rays of 35 year old female with humerus fracture: after injury (fig1a), after 1 month (fig1b), after 3 months (fig1c), after 1 year and implant removal (fig1d)

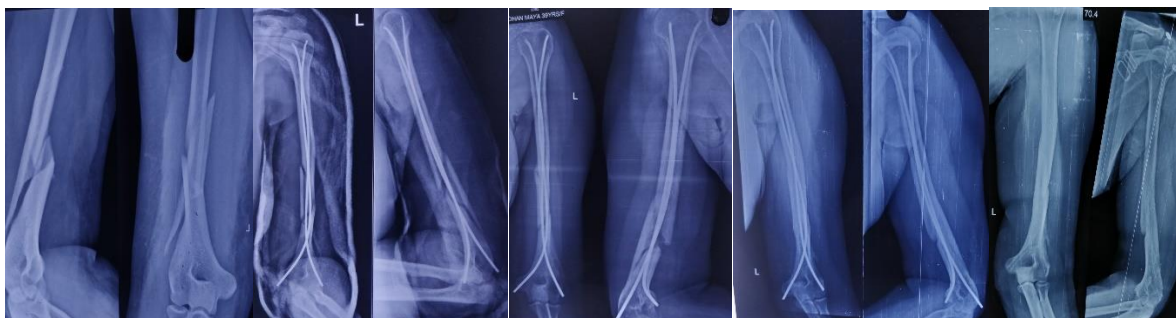


Fig2a

Fig2b

Fig2c

Fig2d

Fig2e

Fig.2: X-rays of 42 year old patient with humerus fracture: after injury (fig2a), after 1 month (fig2b), after 3 months (fig2c), after 6 months (fig2d), after 1 year and implant removal (fig2e)



Fig 3: Shoulder and elbow range of motion in a 35-year-old female of humerus fracture after 6 months of injury

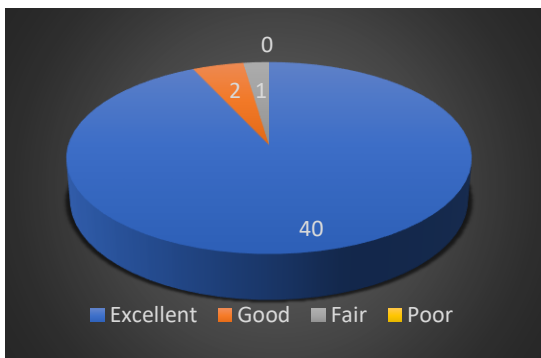


Fig 4a

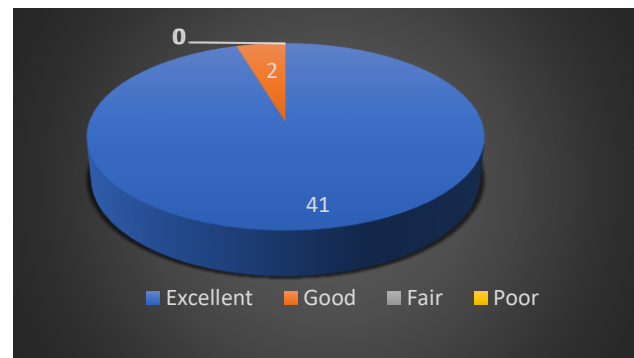


Fig4b

Fig 4: Evaluation of joint function at 6 months follow up: Constant shoulder score (fig4a) and Mayo elbow performance score (fig 4b)

Results

In our study out of 43 cases of humeral shaft fracture managed by TENS, 23(53.5%) cases were males and 20(46.5%) were females. Mean age of patient was 35.39 years (age range 21-61 years). Mode of injury was road traffic accident in 32 (74.4%) cases, fall/slip injury in 5 (11.6%) cases, sports injury in 4 (9.3%) cases and direct blow to arm in 2 (4.6%) cases. Right humerus was fractured in 24 cases, left humerus was fractured in 19 cases. Humeral shaft fractures were of proximal 3rd in 13 (30.23%) cases, middle 3rd in 19 (44.18%) cases and distal 3rd in 11 (25.58%) cases. Of them 35 (81.4%) cases were closed fracture and 8 (18.6%) cases were grade I open fracture. 12 (27.9%) cases were transverse type, 14 (32.55%) were oblique and 17 (39.5%) cases were spiral type fractures. Of them anatomical reduction and fixation with TENS was done by closed reduction technique in all 43 (100%) cases. Average duration of surgery was 15.48 ± 5.5 minutes (ranging 9-31 minutes).

Average length of hospital stay in these cases was 1.9 ± 0.6 days (ranging 1-3 days).

On follow-up x-ray radiological union was achieved on mean duration of 12.4 ± 2.7 weeks (8-24weeks) (Fig. 1, 2).

Functional outcome evaluated by Constant Shoulder Score showed excellent result in 40 (93.02%) cases, good result in 2 (4.6%) cases and fair in 1 (2.3%) case. Also, Mayo elbow score showed excellent result in 41 (95.34%) cases and good result in 2 (4.6%) cases (Fig.3, 4).

Post-operative complications noted were superficial surgical site infection in 2 cases (4.6%) managed with oral antibiotics. Exposure of nail tip was seen in 1 case (2.3%) and was managed with regular dressing and neuropraxia of ulnar nerve was seen after implant removal in 1 case which recovered within 2 months.

At final follow up after 1-year, radiological union was seen in 100% patients and TENS removal was done after a year.

Discussion

Humerus is a long tubular bone well covered in vascularized muscle, is non weight-bearing, and is subjected to rotational, rather than axial forces which make the management of humeral fractures rather different. Most humeral fractures are treated non-operatively in a functional brace and heal in 9-12 weeks with satisfactory results but residual angulation, malrotation, joint stiffness and limb length discrepancy are well established [6]. It is advised to consider operative treatment when early mobilization is desired and to avoid complications like malunion, delayed union, rotational problems, joint stiffness (shoulder and elbow), limb length inequalities and psychological issues [7].

There are basically two options for surgical stabilization of humerus, open reduction and internal fixation with plate and screws and nailing (antegrade or retrograde). The principle of TENS is based on the symmetrical bracing action of two elastic nails inserted into the metaphysis, each of which bears against the inner bone at three points which provides axial, translational and rotational stability [8]. The titanium nails can be inserted in humerus either in antegrade or retrograde fashion. Entry point is proximal and lateral part of humerus just inferior to insertion of deltoid muscle in antegrade technique and in retrograde technique; nail can be inserted via lateral and medial entry portals at the distal end of humerus [9]. In our study, we used retrograde technique.

In a study by Verma et al., there were 2 (10%) cases of superficial infection, 4(20%) cases of non-union, 2 (10%) cases of elbow stiffness and the average time taken for union was 10-16 weeks in 50% patients and 16-20 weeks in 25% patients in using TENS for adult diaphyseal fractures [8]. In another similar study by Upadhyay AS et al., there were no cases of superficial infection, 1 case of delayed union which ultimately united at final follow up (100% union), 2 (10%) cases of nail impingement and 22 (88%) patients had excellent shoulder function and 100 % had excellent elbow function at final follow up. Also the mean period of fracture union was 14.98 ± 4.08 weeks (range 10-32 weeks) [10]. However in our study, there were 2 (4.6%) cases of superficial infection. Union rate was 100% like Upadhyay AS et al. with mean duration of 12.4 ± 2.7 weeks (8-24weeks) and shoulder function was excellent in 40 (93.02%) cases and elbow function excellent in 41 (95.34%) cases.

Plate fixation leads to extensive soft tissue damage, risk of iatrogenic radial nerve palsy with higher incidences of wound infection which can be avoided using TENS. Kumar in his study on patients treated with plate osteosynthesis reported 13.3% rate of both infection and transient radial nerve injury [11]. There are literatures suggesting iatrogenic comminution at fracture site by use of nailing devices like enders nail and interlocking nails, however there were no iatrogenic fractures in our study similar to that of study by Upadhyay AS et al. Titanium nails are easily negotiable through the bone and as they bend while passing through the bone, tension is increased within the nail which improves the three-point fixation.

The limitations of our study were relatively small sample size and longer duration of follow up is needed.

Conclusion

TENS is a wonderful alternative to plate osteosynthesis in treatment of adult diaphyseal humerus fractures as it is minimally invasive with minimal soft tissue damage and scar and can achieve excellent and timely union without hampering fracture biology and there are almost no chances of radial nerve palsy along with the preservation of shoulder and elbow function.

References

1. Sahu RL, Ranjan R, Lal A., et al., Fracture union in closed interlocking nail in humeral shaft fractures. *Chin Med J.* 2015;128(11):1428–32.
2. Garvanos C., et al., Humeral shaft fractures. In Court-Brown CM, Heckman JD, McQueen MM, Ricci WM, Tornetta PIII, eds. *Rockwood and Green's Fractures in adults.* 8th ed. Philadelphia: Wolters Kluwer Health; 2015:1287-336.
3. Langer P, Born CT., et al., Intramedullary fixation of humeral shaft fractures. In: Tornetta P III, Williams GR, Ramsey ML, Hunt TR III, eds. *Operative Techniques in Orthopaedic Trauma Surgery.* Philadelphia, PA: Lippincott Williams & Wilkins; 2011: 197-205.
4. Dalton JE, Salkeld SL, Satterwhite YE, Cook SD., et al., A biomechanical comparison of intramedullary nailing systems for the humerus. *J Orthop Trauma.* 1993; 7: 367-74.

5. Constant CR, Murley AHG., et al., A clinical method of functional assessment of the shoulder. Clin Orthop.1987; 214: 160-4.
6. Jaiswal A, Pruthi KK, Goyal RK, Singh VP., et al., Stack nailing for management of diaphyseal fractures of humerus: analysis of 65 cases. International Journal of Contemporary Medical Research. 2016;3(9):2526–30.
7. Christensen S., et al., Humeral shaft fractures, operative and conservative treatment. Acta Chir Scand.1967; 133(6):455–60.
8. Amit Verma, Sudhir Shyam Kushwaha, Yasir Ali Khan., et al., [Clinical Outcome of Treatment of Diaphyseal Fractures of Humerus Treated by Titanium Elastic Nails in Adult Age Group](#). J Clin Diagn Res. 2017 May; 11(5): RC01–RC04.
9. Garnavos C., et al., Diaphyseal humeral fractures and intramedullary nailing: Can we improve outcomes? Indian Journal of Orthopaedics. 2011;45(3):208–15
10. Upadhyay AS, MBBS, Lil NA, MS Orth., et al., Use of Titanium Elastic Nails in the Adult Diaphyseal Humerus Fractures. Malaysian Orthopaedic Journal 2017 Vol 11 No 2.
11. Kumar R, Singh P, Chaudhary LJ, Singh S., et al., Humeral shaft fracture management, a prospective study; nailing or plating. J Clin Orthop Trauma.2012; (3): 37-42.



© 2022 by the authors. Author/authors are fully responsible for the text, figure, data in above pages. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>)

Author(s) have identified their affiliated institutions or organizations, along with the corresponding country or geographic region. NAAR, TWASP remains neutral with regard to any jurisdictional claims.

