

Comparative study of radiological and clinical outcomes by using single and double interlocking distal screws for humerus shaft fractures

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Abstract

Background: The aim of this study was to make a comparative analysis of radiological and clinical outcomes of using either one or two interlocking distal screws on a humerus intramedullary nail for the internal fixation of humeral shaft fractures. **Methods:** From April 2010 to April 2015, 30 patients were enrolled with humeral shaft fractures who were operated on using intra medullary humerus nails. The patients were divided into 2 groups according to how many interlocking distal screws were used to lock the humerus nail: in group 1, a single interlocking distal screw was used in 16 patients; and in group 2, double interlocking distal screws, in 14 patients. We compared the degree of recovery of the displaced fracture fragments between the two groups. Shoulder function of patients were assessed by modified American Shoulder and Elbow Surgeons (ASES) score. **Results:** We found that 15 (93.7%) fractures achieved union in group 1, and 13 (92.8%) of fractures, in group 2. There was no meaningful difference in the time to bone union and the recovery of displaced fracture fragments between the two groups. At the final follow-up, we found that the scores for shoulder joint modified ASES was 76.2 for group 1 and 79.1 for group 2. **Conclusions:** This study shows that if locked appropriately, even a single screw on a humerus nail can provide satisfactory radiological union and improved clinical outcome after intramedullary nailing of humeral shaft fractures.

Key words: Humeral fractures; Intramedullary nailing; Locking screws, Radiological union

Introduction

Humeral shaft fractures compose around 3% of fractures. Mildly displaced humeral shaft fractures will be effectively treated by conservatively [1,2]. But additional severe displacements, like those seen in multiple, comminuted, and open fractures, needs surgical treatments and also the demand that has been on the rise [3]. Modalities of surgical treatment include locking plates, intramedullary nailing, external fixation, and etc. Although locking plates provides swift useful recovery by providing sturdy fixation [4,5]. Intramedullary nailing that additionally provides decent fixation has the added advantages of minimal soft tissue damage and low infection rate, making it the preferred alternative treatment in recent years [6,7]. The technical problem demanded for the intramedullary nailing using

distal interlocking screws can delay surgery time, exacerbate patient condition, and increase radiographic exposure to the surgeon [8]. In general, most surgeons suggest the utilization of two distal interlocking screws to lock intramedullary nails; nonetheless, in many reported incidents we discover that surgeons have had to favour to using just one screw for surgical ease. To deal with the significance of the number of screws employed in intramedullary nailing, we tend to investigate the effect of the number of distal interlocking screws used during intramedullary nailing on the clinical outcome of humeral shaft fractures.

Material and Methods

Type of study: Retrospective study design

Sampling methods: Simple random sampling technique

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Sample Collection: In the present study, we included 30 patients with humeral shaft fractures, according to the AO/OTA classification, who were operated on using intramedullary nails from April 2010 to April 2015. From all individual participants informed consent was obtained. The patients were divided into two groups according interlocking distal screws were used to lock the intramedullary nail. In group-1, a single interlocking distal screw was used in 16 patients; and in group-2, double interlocking distal screws was used in 14 patients. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and /or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Selection criteria

Inclusion criteria: With humeral shaft fractures, according to the AO/OTA classification, who were operated on using intramedullary nails.

Exclusion criteria: Those with pathologic fractures, with type III open fractures, with combined radial nerve injury, and who had had their treatment delayed by at least 2 weeks were excluded from the study.

Scoring system: Modified American Shoulder and Elbow Surgeons (ASES) score to assess patient shoulder function and the progress of treatment

Surgical Procedure: All surgeries were performed by a single surgeon. Under general anesthesia, the patient was placed in a Fowler's position on a beach chair; then, a 3-4 cm skin incision from the anterolateral edge of the acromion to the posterior side was made. At the incision site, the deltoid muscle was temporarily separated to expose the greater tuberosity of the humeral bone. Bone awl was used to make entry in the medullary canal just medial to greater tuberosity and confirmed under image intensifier.

Guide wire was inserted and then fracture site reduced and guide wire pushed into the distal fragment. Position of the guide wire was confirmed on antero-posterior and lateral views on image intensifier. Reaming was done with 6mm, 7mm and 8 mm flexible reamers. Then humerus nail of one size smaller than the last reamer was used. Humerus nail of 6mm diameter was solid nail, while 7mm and 8 mm were cannulated.

After confirming that the intramedullary nail was inserted correctly, we locked the nail in position by inserting either single or double 3.4mm for 6 mm nails

and 3.9-mm interlocking screws for 7mm and 8mm nails at the distal site without the use of target devices. With regard to the choice of screw numbers, we inserted, from the uppermost oval portal, one screw when it alone could prevent traction of the fractures, but if it could not, we inserted two screws. Postoperatively, an arm sling pouch was given for 4 weeks, while elbow, wrist, and finger joint exercises were allowed. Methods of Assessment For each patient, we assessed the mechanism of injury using past medical records. Bone union was confirmed using radiographic findings and the time to bone union was noted.

A successful union was considered when the following criteria were fulfilled:

- 1) At least 3 sites of calluses on humeral cortical bone on either the anteroposterior or the lateral radiograms; and
- 2) No soreness at the site of fracture.

The following radiological parameters were used:

The mean postoperative distance between fracture fragments, the degree of recovery of the displaced fracture fragments, and the improvement in angulation of fracture fragments. To assess the improvement in angulation of fractures, we measured the immediate postoperative and post-union levels of angulation on anteroposterior radiograms of the humerus. The angle of angulation was measured as the angle that forms between the normal humeral cortical line and that of the most displaced fractured bone.

The change in angulation was calculated as the difference between angle of postoperative angulation and the angle of post-union angulation over the angle of postoperative angulation. For the clinical and functional parameters, we assessed at every follow-up for soreness around the region of fracture, the range of motion of the shoulder such as maximum flexion, external rotation, and internal rotation, and lastly, the modified American Shoulder and Elbow Surgeons (ASES) score to assess patient shoulder function and the progress of treatment. We also kept the record further to note any delayed complications in this study.

Statistical analysis: Descriptive statistics such as mean, SD and percentage was used to present the data. Comparison between two groups was performed by unpaired t-test for quantitative data and chi-square test for qualitative data. A p-value less than 0.05 were considered as significant. Statistical analysis was performed by using software SPSS v16.0

Results

The mean age of the patients in group-1 was 36.56years (range, 22-58years) and in group-2, 39.07years (range, 18-66 years). There is no significant difference of average age (years) between two groups (p=0.57). The ratio of gender was 14 males to 2 females in group 1 and 12males to 2 females in group 2. There is no significant difference of sex between two groups (p=0.88). The mechanism of injury in all the cases was due to road traffic accidents (high velocity injury). The mean follow-up period was 18 ± 8.7 months (range, 12–42 months) for group 1 and 15 ± 6.7months (range, 12–36 months) for group 2. There is no significant difference of average follow up between two groups (p=0.31)(Table 1).

Table-1: Basic characteristics

	Group-1 (n=16)	Group-2 (n=14)	p-value
Age			
< 20	0	1 (7.1)	0.57
20-30	4 (25.0)	2 (14.3)	
30-40	7 (43.7)	5 (35.8)	
40-50	3 (18.7)	3 (21.4)	
> 50	2 (12.4)	3 (21.4)	
Average	36.56 ± 10.37	39.07 ± 13.44	
Sex			
Male	14 (87.5)	12 (85.7)	0.88
Female	2 (12.5)	2 (14.3)	
Follow up (month)			
10 – 20	11	12	0.31
20 – 30	3	1	
30 – 40	1	1	
> 40	1	0	
Average	18.0 ± 8.7	15.0 ± 6.7	

Table-2: Comparison of clinical parameters between group 1 and 2

Clinical parameters	Group-1 (n=16)	Group-2 (n=14)	p-value
Fracture site gap (mm)	2.4 ± 0.96	2.31 ± 0.60	0.76
Fracture site angle (°)	6.11 ± 1.97	5.01 ± 2.11	0.15
Union period (week)	11.31 ± 1.54	12.03 ± 1.67	0.23
Non-union rate (%)	1 (6.25%)	1 (7.14%)	0.92
ASES score	76.2	79.1	0.51

Through postoperative radiography, we found that 15 fractures (93.75%) achieved union in group 1, and 13 fractures (92.9%), in group 2. The mean postoperative distance between fracture fragments was 2.4±0.12mm in group 1 and 2.36±0.13 mm in group 2. There is no significant difference of fracture fragments between two groups (p=0.76). There was one case of non-union in each group.Non-union was considered when the distance between the two fragments was atleast 10 mm post operatively. Additional procedure such as bone grafting to treat the non-union were carried out in those cases.There was one complication in group 2, where anundisplaced supracondylar fracture occurred while inserting distal most locking screw.It was treated conservatively by above elbow slab for 6 weeks. The mobilization in this case was delayed for 6 weeks, however both the fractures healed and the patient had good range of shoulder and elbow motions. It was observed that no significant difference found in the meantime to union between the two groups (p=0.23), which were 11.33 weeks for group 1 and 12.61 weeks for group 2. When we radiologically measured the change in mean angulations of fractures from post operation to post-union, there was no significant difference in both the groups (p=0.15). At the at end of follow up, we found that the no significant difference of scores for shoulder joint modified ASES between 76.2 for group 1 and 79.1 for group 2 (Table-2).

Discussion

In the present study, we compared the outcomes of intramedullary nailing for humeral shaft fractures between those which had a single distal interlocking screws fixed to humerus nail (Fig-1) and those which had double screws (Fig-2). In this study, it was found that accurate reduction of the fractures with good impaction and minimal angulation at fracture site is a must, irrespective of whether single or double distal locking screws are applied.

Humeral shaft fractures, unlike fractures of shafts of other long bones, can be treated with good clinical outcomes using conservative measures [9,10].

This is known to be because the axial force and muscle contraction help retain the correct alignment of the fracture and the large range of motion of the shoulders can acclimate to the changes after bone union [11]. Sometimes, the condition of the shoulder can deteriorate during conservative treatment when the fracture displaces such as in a distraction. This delay in bone union may induce angular and rotational deformity and limited postoperative shoulder movement [12,13].

Operative treatment is considered in severely displaced fractures, comminuted fractures, co-sustained injuries that make early rehabilitation difficult, pathologic fractures, and vascular damages [14,15]. There are different modalities of fixation like plating, intramedullary nailing, and external fixator; of these, the intramedullary nailing has received the most recognition for its efficacy in treating fractures of shaft of many long bones, such as the femoral and tibial bones.

Intramedullary nailing is known to be a relatively non-invasive method with a short surgery time, low infection rate, minimal soft tissue damage, and high resistance to flexion force [15,16]. In the study, 28 (93.3%) of humerus shaft fractures had satisfactory bone union using intramedullary nails and favourable modified ASES scores, our clinical marker for shoulder function. Despite these advantages, the only technical difficulty of intramedullary nailing of the humeral bone is the fixation of distal interlocking screws without the use of target devices.

This technical difficulties become more problematic when 2 screws, compared to 1, are used, causing delay of surgery time and sometimes even forcing surgeons to drop the use of one screw. Although most authors recommend the use of 2 distal interlocking screws during intramedullary nailing, there are no studies, to the best of our knowledge, exist that actually present poor outcomes with a single screw [17].

In our study aimed at addressing exactly this issue, we found that there is no significant difference in the results of the time to bone union, restoration of displaced fracture fragments, and shoulder function between patients who receives different numbers of distal interlocking screws.

Choy et al. used cadaveric humeral bones to compare the resistance to twisting after intramedullary nailing and reported that the number of distal interlocking screws did not make a difference to the resistance [18]. From their study, we can conclude that there is no significant correlation between the number of distal interlocking screws and the stability of the rotational force.

Thus, we may consider distraction of fractures caused by strain from the upper body and not the rotational stability as the more important contributory factor to bone non-union after intramedullary nailing of a humeral bone.

In our sample of patients, we found a total of 2 cases of nonunion: 1 in group 1 and 1 in group 2. We noted that the postoperative distance between the fracture fragments was a least 10-mm in all 2 cases of non-union, which was larger than the postoperative average. It is more likely that the cause of the non-union is because of the distraction of the fracture site after the closed reduction of the fracture rather than the number of screws used.

However, with a mild distraction, when elbow exercises are commenced after surgery, micromovements and axial force at the fracture site has been shown to promote callus formation—promoting bone healing [19]. Limitations of this study are the small sample size and the absence of a quantitative or qualitative measure of the influence of the trauma-induced soft tissue. Our study is meaningful addition to the current literature as we have analysed the different parameters in intramedullary nailing with single or two distal screws, as there are very few current literatures stating the clinical outcomes using different numbers of distal interlocking screws.

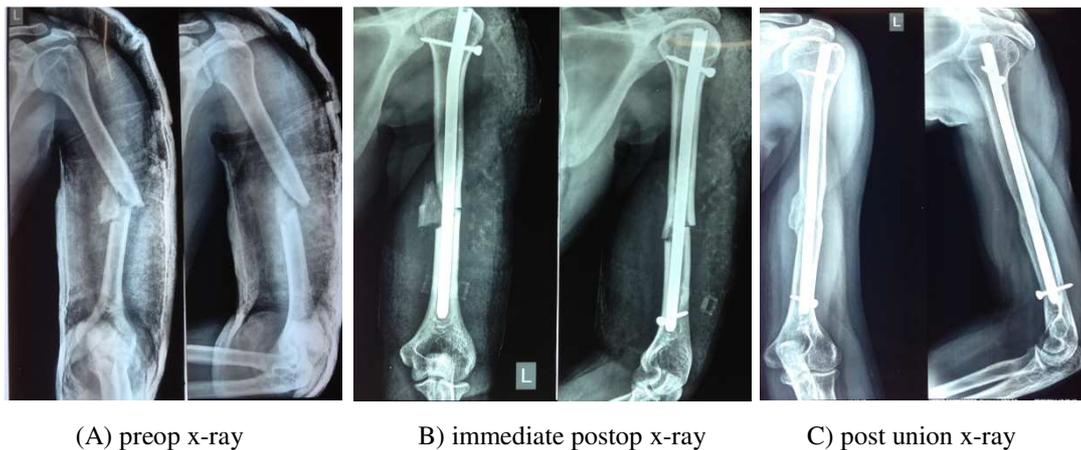


Figure-1: Fracture shaft humerus treated by humerus intramedullary nail with single distal locking screw.



Figure-2: Fracture shaft humerus treated by humerus intramedullary nail with two distal locking screws

Conclusion

We conclude that when accurate reduction of the fracture site and impaction at the fracture site is present, even a single distal locking screw on a humerus nail can provide satisfactory radiological union and improved clinical outcome after intramedullary nailing of humeral shaft fractures.

What this study add to existing knowledge:

Many literatures emphasize on using two distal interlocking screws for better stability. The present study concludes a single distal interlocking screw which is bicortical is sufficient in humerus nails, which makes a meaningful adding in existing literature.

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