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Intramedullary Nailing Vs Plate Fixation for the Treatment of Humeral Shaft Fractures; which One is Better?

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ABSTRACT

Introduction: Humeral shaft fractures are among the most common long bone fractures. Intramedullary nailing (IMN) and Plate fixation are common approaches with diverse outcomes. The aim of the current study is to compare the outcomes of the mentioned modalities in the treatment of Humeral shaft fractures in a twelve-month follow-up study.

Methods: 90 patients with traumatic fractures of the humeral shaft were randomized into two groups: those treated by IMN and those treated by Plate fixation approach. Intraoperative blood loss was evaluated by hemoglobin test before and within three days after the surgery. Incidence of the complications, including delayed union, nonunion, and nerve injury, were evaluated using questionnaires. The functional outcomes were evaluated using the American Shoulder and Elbow Surgeons (ASES) score and pain score.

Results: Patients in the IMN group showed higher ASES score and better overall shoulder function (P-value<0.05); however, pain score was lower in patients treated with Plate fixation (P-value=0.003). Three patients in nailing group and two in plating group had delayed union. Nonunion occurred in none (%0) of the IMN compared to two (%5) of the DCP group. The union rate was found to be similar in both groups. Postoperative radial nerve injury occurred in 9 patients of the Plate fixation group and 5 patients in the IMN group, including three radial and two brachial plexuses (P-value=0.001).

Conclusion: The current study showed better postoperative function, lower rate of complications, blood loss, and nerve injury in patients treated with IMN; however, it is more preferable to use Plate fixation approach since the incidence of significant complications in patients treated with IMN i. e, brachial plexus injury, iatrogenic fractures, and shoulder pain.

Keywords: Humerus; Shaft; Fracture; Nail; Plate; Outcomes

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INTRODUCTION

Humeral shaft fractures are among the most common bone fractures accounting for 3% of all fractures [1, 2]. This fracture usually occurs after a low energy trauma, mostly due to ground-level falls in older people; however, it can be seen in high energy traumas such as a motor to vehicle collisions [3].

Humeral shaft fractures are usually closed; however, previously conducted studies reported that 2-25% of these fractures are open, and up to 8% of them are pathologic. Midshaft fractures are the most common humeral fractures regarding the site of the fracture with the prevalence of 45%, followed by proximal fractures, which account for 40% of total humerus fractures [4-6].

The majority of the humeral fractures can just be cured by functional bracing, while surgical approaches are usually considered for those with articular or neurovascular damage or unacceptable alignment following the bracing [7, 8].

Plate fixation is one of the most favored surgical techniques for the treatment of humeral shaft fractures due to the negligible rates of nonunion and malunion. The notifying disadvantage of Plate fixation is its negative impact on the surrounded soft tissue [9, 10].

Intramedullary nailing is an alternative approach for plate fixation due to the perseverance of fracture biology, earlier time of rehabilitation, decreased operative time, lower intraoperative blood loss and less damage to the soft tissue. Factors including reoperation requirement, postoperative pain, impingement and injury to rotator cuffs have limited this approach [11-13].

Although some conditions may make the surgeons prefer a specific approach, to the best of our knowledge, the indications for the use of intramedullary nailing or plate fixation for the treatment of humeral shaft fractures have not been discussed, yet. In this study, we aimed to assess the outcomes of nailing and plating techniques for the treatment of humeral shaft fractures.

METHODS

90 patients with traumatic humeral shaft fractures who referred to Shahid Beheshti Medical University affiliated hospitals from April 20th, 2014 to August 2016 were recruited for the current study. All closed humeral shaft fractures were included in this study. Exclusion criteria were segmental and open fractures, neurovascular involvement, pathologic fractures, history of previous humerus fractures, and skeletally immature patients.

Patients who attended this study were recruited through consecutive sampling and randomly assigned to two groups: intramedullary nailing and plate fixation using

Random Allocation software. A number was provided by the software for each patient and they were put in one of the mentioned groups. Of 90 patients who were recruited for the current study, 80 met the inclusion criteria and completed the study.

40 patients were assigned to the intramedullary nailing group. 25 of them were male and 15 were female, 25 and 15 patients suffered from right side and left side humerus fractures, respectively. The fractures were located at the proximal third, middle third and distal third of the humerus in 12, 24 and 4 patients, respectively. The nail contained two proximal and two distal screws. A 3 cm longitudinal incision was made in line with greater tuberosity, and the deltoid muscle was put aside. The entry hole was made with an awl just medial to the greater tuberosity and 1.5 cm posterior to bicipital groove. The canal was gradually enlarged by reaming. The distal screws were fixed by the freehand technique.

40 patients were assigned to the plate fixation group. 22 patients were male and 18 were female, 23 suffered from right side fractures and 17 had left side fracture of the humerus. The fractures were located at the proximal third in 8, middle third in 17 and distal third of the humerus in 15 patients.

The functional results were assessed one year after the surgery using the American Shoulder and Elbow Surgeons (ASES) score for 10 daily routine activities requiring the shoulder and elbow movement. Each activity had a maximum of 3 points (0=unable to do; 1=very difficult; 2=somewhat difficult and 3=normal). Furthermore, this test evaluates pain score with a 10-point scoring scale in which 0 was considered as no pain to 10 that was for the most severe pain [14].

The complications, including delayed union, malunion, nonunion, iatrogenic fractures, hardware failure, and radial nerve palsy and reoperation requirement, were evaluated by a checklist. The union was assessed through anterior-posterior radiography taken within six months after the surgery. For the evaluation of radial nerve palsy, physical examinations were implemented immediately and within six months after the operation.

Intraoperative blood loss was evaluated by comparison of preoperative hemoglobin level with postoperative level.

The obtained data were entered into the Statistical Package for the Social Sciences (SPSS) version 22. Descriptive data were presented using mean, standard deviation, percentages, and absolute numbers. For analytics, T-test was used. P-value of less than 0.05 was considered as a significant level.

RESULTS

40 patients were assigned to each group. Mean age for the patients treated with intramedullary nailing (IMN) and plate fixation (PF) were 31.3 and 29.8, respectively (P-value=0.02).

American Shoulder and Elbow Surgeons (ASES) score was measured within 12 months after surgery for all of the participants. Mean score for IMN group and PF group were 28.6 and 20.175, respectively which was significantly better in IMN than the plating (P-value=0.001).

The mean of shoulder pain score was 6.8 in the IMN group and 2.5 in PF group (P-value=0.003)

Delayed union2(5%) and nonunion were found in 2 (5%) patients in the PF group, while 3 (7.5%) of the cases experienced delayed union and nonunion did not occurred in the patients of the IMN group. The mean hemoglobin decline in the IMN group was 1.2 gr/dl which was significantly lower in comparison with the PF group in which 2.6 gr/dl mean hemoglobin decline was observed (P-value=0.004).

Postoperative radial nerve injury was found in 9 of the PF group patients, among which eight patients recovered conservatively, and one was a candidate for tendon transfer open surgery. No one experienced brachial plexus injury in this approach; however, five patients in IMN group presented nerve injury, including three patients with radial and two patients with brachial nerve injuries. Radial nerve injuries were all treated conservatively while patients with brachial nerve injury underwent reoperation. Comparison of two groups regarding nerve injury demonstrated a significantly higher rate in patients treated with PF (P-value<0.001). The details of nerve injuries are presented in the Table-2.

5 Patients in the IMN group and two patients in the PF group presented superficial infection that all were treated with oral antibiotics. There was no case of deep infections requiring intravenous antibiotic therapy or hospitalization.

Three patients in IMN group (two patients with midshaft fracture and one with distal fracture) had iatrogenic fractures at the distal end of the nails that required fixation with locking plate.

One patient in the IMN group developed screw back out, but the outcome of the surgery was not affected. Two patients in the PF group endured plate bending and screw back out.

DISCUSSION

In the current study, two conventional surgical approaches for the treatment of humeral shaft fractures were assessed and compared based on postoperative functional outcomes and complications. The union rates of these two approaches were comparable as patients treated with nailing represented 92.5% union rate and those who underwent plate fixation showed a 90% union rate. The findings of this study are compatible with the previous ones which demonstrate a union rate of 91-100% following plate fixation approach [9, 15], and a union rate of 87-97% among those underwent IMN approach for the humeral shaft fractures [16].

The postoperative shoulder function was better in the IMN group, while postoperative complications were considerably higher among the patients in the PF group i. e. intraoperative blood loss, radial nerve injury, infection, and device failure. Despite the lower rates of complications and the better functional scores in the IMN group, the remarkable complications including brachial plexus injury, shoulder pain and iatrogenic fractures in the IMN approach made us prefer the plating approach.

Most of the studies in the literature such as the studies conducted by McCormack et al. [17], Gongol et al. [18], Tingstad et al. [19] and Pansey et al. [8] have presented similar postoperative shoulder function of IMN approach versus plating. Moreover, recent meta-analysis have declared similar outcomes of both approaches regarding postoperative functional status of shoulder [12]. These results oppose our findings as the postoperative shoulder function was better among those treated with IMN.

The significance of IMN-related complications has made some of the orthopedists prefer plate fixation instead of IMN. Plate fixation technique results in more intraoperative blood loss, longer duration of surgical procedure, higher rate of infection, nonunion and radial

nerve palsy [20-23]; however, complications associated with IMN include restricted shoulder movements, impingement syndrome, rotator cuff violation and adhesive capsulitis that are dramatically more serious and less compensable [17, 24, 25]. In this regard, Putnam et al. conducted a study in order to compare the short-term outcomes of IMN versus plating for the surgical treatment of humeral shaft fracture. In line with the results of the current study, they affirmed the superiority of plating to IMN due to its fewer complications [6]. Schoch et al. conducted another study and presented similar outcomes as plating accompanies with less severe complications [22]. Gottschalk et al. confirmed these findings, as well [23].

On the other hand, there are limited studies which prefer IMN. In contrast with the current study, Martínez et al. evaluated similar techniques and claimed IMN as the superior technique. They conducted their study on patients who referred with the chief complaint of nonunion following the humerus fracture and preferred IMN for earlier union following IMN [26]. Other studies preferring IMN emphasized on the lower risks of this surgery as IMN duration of the surgical procedure, and amount of blood loss is less. Therefore, they indicated this technique for those who are at higher risks for operation complications [10, 11, 13, 27].

CONCLUSION

In conclusion, although we found better postoperative function and fewer rates of union complications, blood loss, and nerve injury following IMN compared with PF, more significant complications of IMN such as brachial plexus injury, iatrogenic fractures, and shoulder pain made us prefer plating for the treatment of humeral shaft fractures.

By consideration of the limitations in the studies conducted in this term, we recommend further multicentral studies with longer follow-up duration and with a higher number of patients. Besides, studies that address and compare the values of using plate fixation approach and IMN for the treatment of humeral shaft fractures are strongly suggested.

REFERNCES

1. Carroll EA, Schweppe M, Langfitt M, Miller AN, Halvorson JJ. Management of humeral shaft fractures. *The Journal of the American Academy of Orthopaedic Surgeons*. 2012;20(7):423-33. **doi**.10.5435/jaaos-20-07-423.
2. Spiguel AR, Steffner RJ. Humeral shaft fractures. *Current reviews in musculoskeletal medicine*. 2012;5(3):177-83. **doi**.10.1007/s12178-012-9125-z.
3. Ekholm R, Adami J, Tidermark J, Hansson K, Törnkvist H, Ponzer S. Fractures of the shaft of the humerus. An epidemiological study of 401 fractures. *The Journal of bone and joint surgery British volume*. 2006;88(11):1469-73. **doi**.10.1302/0301-620x.88b11.17634.
4. Sarmiento A, Zagorski JB, Zych GA, Latta LL, Capps CA. Functional bracing for the treatment of fractures of the humeral diaphysis. *The Journal of bone and joint surgery American volume*. 2000;82(4):478-86. **doi**.10.2106/00004623-200004000-00003.
5. Tytherleigh-Strong G, Walls N, McQueen MM. The epidemiology of humeral shaft fractures. *The Journal of bone and joint surgery British volume*. 1998;80(2):249-53. **doi**.10.1302/0301-620x.80b2.8113.
6. Putnam JG, Nowak L, Sanders D, MacNevin M, Lawendy AR, Jones C, McKee M, Schemitsch E. Early post-operative outcomes of plate versus nail fixation for humeral shaft fractures. *Injury*. 2019;50(8):1460-3. **doi**.10.1016/j.injury.2019.06.014.
7. Decomas A, Kaye J. Risk factors associated with failure of treatment of humeral diaphyseal fractures after functional bracing. *The Journal of the Louisiana State Medical Society : official organ of the Louisiana State Medical Society*. 2010;162(1):33-5.
8. Pansey NK, Sharma GM, Naik LG, Badgire KS, Qureshi F, Jain V. Intramedullary nailing versus plating in shaft humerus fractures: a prospective randomized study. *Int J Res Orthop*. 2017;3:578-82.
9. Kim JW, Oh CW, Byun YS, Kim JJ, Park KC. A prospective randomized study of operative treatment for noncomminuted humeral shaft fractures: conventional open plating versus minimal invasive plate osteosynthesis. *Journal of orthopaedic trauma*. 2015;29(4):189-94. **doi**.10.1097/bot.0000000000000232.
10. Fan Y, Li YW, Zhang HB, Liu JF, Han XM, Chang X, Weng XS, Lin J, Zhang BZ. Management of Humeral Shaft Fractures With Intramedullary Interlocking Nail Versus Locking Compression Plate. *Orthopedics*. 2015;38(9):e825-9. **doi**.10.3928/01477447-20150902-62.
11. Zhao G, Liu HN, Li N, He L, Wu XB. [Comparison of mid-term surgical results between plate and intramedullary nail for humeral shaft fracture]. *Zhonghua yi xue za zhi*. 2016;96(37):2988-92. **doi**.10.3760/cma.j.issn.0376-2491.2016.37.008.
12. Ouyang H, Xiong J, Xiang P, Cui Z, Chen L, Yu B. Plate versus intramedullary nail fixation in the treatment of humeral shaft fractures: an updated meta-analysis. *Journal of shoulder and elbow surgery*. 2013;22(3):387-95. **doi**.10.1016/j.jse.2012.06.007.
13. Chen F, Wang Z, Bhattacharyya T. Outcomes of nails versus plates for humeral shaft fractures: a Medicare cohort study. *Journal of orthopaedic trauma*. 2013;27(2):68-72. **doi**.10.1097/BOT.0b013e31824a3e66.
14. Putti AB, Uppin RB, Putti BB. Locked intramedullary nailing versus dynamic compression plating for humeral shaft fractures. *Journal of orthopaedic surgery (Hong Kong)*. 2009;17(2):139-41. **doi**.10.1177/230949900901700202.
15. Denard A, Jr., Richards JE, Obremskey WT, Tucker MC, Floyd M, Herzog GA. Outcome of nonoperative vs operative treatment of humeral shaft fractures: a retrospective study of 213 patients. *Orthopedics*. 2010;33(8). **doi**.10.3928/01477447-20100625-16.
16. Cheng HR, Lin J. Prospective randomized comparative study of antegrade and retrograde locked nailing for middle humeral shaft fracture. *The Journal of trauma*. 2008;65(1):94-102. **doi**.10.1097/TA.0b013e31812eed7f.
17. McCormack RG, Brien D, Buckley RE, McKee MD, Powell J, Schemitsch EH. Fixation of fractures of the shaft of the humerus by dynamic compression plate or intramedullary nail. A prospective, randomised trial. *The Journal of bone and joint surgery British volume*. 2000;82(3):336-9. **doi**.10.1302/0301-620x.82b3.9675.

18. Gongol T, Mrácek D. [Functional therapy of diaphyseal fractures of the humeral bone]. *Acta chirurgiae orthopaedicae et traumatologiae Cechoslovaca*. 2002;69(4):248-53.
19. Tingstad EM, Wolinsky PR, Shyr Y, Johnson KD. Effect of immediate weightbearing on plated fractures of the humeral shaft. *The Journal of trauma*. 2000;49(2):278-80. **doi**.10.1097/00005373-200008000-00014.
20. Rodríguez-Merchán EC. Compression plating versus hackethal nailing in closed humeral shaft fractures failing nonoperative reduction. *Journal of orthopaedic trauma*. 1995;9(3):194-7. **doi**.10.1097/00005131-199506000-00003.
21. Singisetti K, Ambedkar M. Nailing versus plating in humerus shaft fractures: a prospective comparative study. *International orthopaedics*. 2010;34(4):571-6. **doi**.10.1007/s00264-009-0813-2.
22. Schoch BS, Padegimas EM, Maltenfort M, Krieg J, Namdari S. Humeral shaft fractures: national trends in management. *Journal of orthopaedics and traumatology : official journal of the Italian Society of Orthopaedics and Traumatology*. 2017;18(3):259-63. **doi**.10.1007/s10195-017-0459-6.
23. Gottschalk MB, Carpenter W, Hiza E, Reisman W, Roberson J. Humeral Shaft Fracture Fixation: Incidence Rates and Complications as Reported by American Board of Orthopaedic Surgery Part II Candidates. *The Journal of bone and joint surgery American volume*. 2016;98(17):e71. **doi**.10.2106/jbjs.15.01049.
24. Chapman JR, Henley MB, Agel J, Benca PJ. Randomized prospective study of humeral shaft fracture fixation: intramedullary nails versus plates. *Journal of orthopaedic trauma*. 2000;14(3):162-6. **doi**.10.1097/00005131-200003000-00002.
25. Bhandari M, Devereaux PJ, McKee MD, Schemitsch EH. Compression plating versus intramedullary nailing of humeral shaft fractures--a meta-analysis. *Acta orthopaedica*. 2006;77(2):279-84. **doi**.10.1080/17453670610046037.
26. Martínez AA, Cuenca J, Herrera A. Treatment of humeral shaft nonunions: nailing versus plating. *Archives of orthopaedic and trauma surgery*. 2004;124(2):92-5. **doi**.10.1007/s00402-003-0608-7.
27. Smejkal K, Lochman P, Dědek T, Trlica J. [Surgical treatment of humeral diaphyseal fractures]. *Acta chirurgiae orthopaedicae et traumatologiae Cechoslovaca*. 2014;81(2):129-34.

Table 1. Comparison of postoperative complications in intramedullary nailing approach versus plating approach

	Delayed union (n (%))	**Nonunion (n (%))**	**Blood loss (gr/dl) (mean ± standard deviation)**	**Nerve injury**	**Superficial infection**	**Deep infection**	**Device failure**
Intramedullary nailing	3 (7.5%)	0 (0%)	1.2±	5 (12.5%)	2 (5%)	0 (0%)	0 (0%)
Plating	2 (5%)	2 (5%)	2.6±	9 (22.5%)	5 (12.5%)	0 (0%)	2 (5%)
P-value	0.01	0.04	0.004	<0.001	0.01	……	……

Table-2. Comparison of plating approach versus intramedullary nailing regarding nerve injury based on the site of humerus shaft fracture.

	Proximal shaft fracture			Middle shaft fracture			Distal shaft fracture		
	Intramedullary Nailing	Plate Fixation	P-value	Intramedullary Nailing	Plate Fixation	P-value	Intramedullary Nailing	Plate Fixation	P-value

Brachial plexus injury	1 (2.5%)			1 (2.5%)			0 (0%)		
Radial nerve injury	1 (2.5%)			1 (2.5%)			1 (2.5%)		
Brachial plexus injury	1 (2.5%)			4 (10%)			4 (10%)		
Radial nerve injury	0 (0%)			0 (0%)			0 (0%)		