Original Article

Prospective comparative study between antegrade interlocking undreamed nail versus compression plate fixation of acute closed humeral mid third shaft humerus in adults

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Objective: To assess the functional outcome, time to union, shoulder pain, blood loss, operative time, iatrogenic radial nerve injury, hospitalization, and infection.

Methodology: It is a prospective randomized study on 30 patients with mid-shaft humerus fracture according to AO classification (1.2A1, 2, 3 and 1,2B) with functioning radial nerve. They were randomly dividing into two groups. Group A were treated by a closed antegrade interlocking nail, and group B treated by open reduction and locked compression plate fixation. The follow-up was up to 6 months, including time to union, shoulder pain, intraoperative blood loss, operative time and iatrogenic radial nerve injury. Functional outcome was assessed by quick DASH score.

Results: Road traffic accident was the main cause of trauma (70%). The average time to union were statistically not different in both groups. Quick DASH score was good in both groups and statistically not significant. Shoulder pain in group A was (40%), while none patient in group B ($p > 0.017$). The operative period time, mean hospital stays, and blood loss of group B were significantly higher than in group A.

Conclusion: Nailing is minimally invasive, has less infection rate, iatrogenic nerve injury, operative time, intraoperative blood loss, and hospitalization.

Keywords: Antegrade nailing, diaphyseal fracture humerus, locked plate fixation.

INTRODUCTION

Diaphyseal fractures of the humerus are a group of fractures where the mainline of fracture lies beyond the surgical neck of the humerus and above the supracondylar ridge.[1] The associated complications are one of the main morbidities in the trauma patients.[2] The fractures are represent about 20% of all humeral fractures, and about 3% to 5% of all body fractures.[3,4] The displacement of the fragments depends on the level of fracture to the deltoid muscle attachment.[5]

The Orthopedic Trauma Association (OTA) and (AO) developed a system of classification applicable to humeral shaft fracture.[6,7] Humeral shaft fractures usually heal readily. The weight of the arm in the external cast is usually sufficient to correct the alignment.[8] Indications for surgery include severe multiple injuries, an open, segmental, displaced intra-articular extension and pathological fractures also a 'floating elbow', radial nerve palsy after manipulation, and non-union.[6]

Plate osteosynthesis is still the method of choice for fixating such fractures. It provides enough stability in multi-injured patients and slight shoulder or elbow morbidity, a Limited-contact dynamic compression plate[9] and a dynamic compression plate (DCP)[10] are the most commonly used plates. The undreamed interlocking nail provides relative stability and early load sharing.[11]

The assessment of the functional outcome is usually done by Quick DASH score and score vaies between 0 (no disability) and 100 (the greatest possible disability).[6,12] The aim of this study was to compare open reduction compression plate fixation & closed unreamed antegrade Interlocking Nail in humeral mid-shaft fracture regarding intraoperative loss of blood, union time, operative time, nerve injury, duration of hospitalization, functional outcomes, postoperative complications.

PATIENT AND METHOD

This prospective randomized comparative cohort study was done by three surgeons in A-Kindy, Erbil, and Nineveh teaching hospitals from January 2020 and June 2021 with follow-up was for 6 months. A random sample of 30 patients was studied and divided into two

equal groups, by taking every other patient with type 1.2A1, 2, 3, and 1.2B1, 2 fracture mid-shaft humerus (according to AO classification) who attended these hospitals. Group A involves those who were treated by IMN and group B involves those who were treated by LCP. Each patient signed an informed consent.

Our inclusion criteria included closed humeral mid-shaft fracture, skeletally mature patient, less than 2 weeks of the fracture, and fractures AO classification 1.2. A (1, 2, 3) and 1.2. B (1, 2). Fracture with neurovascular injury, history of shoulder pathology, patient not fit for general anesthesia, pathological fracture, radial nerve injury post closed manipulation, and a narrow medullary cavity was excluded from the study.

Each patient was prepared for surgery by taking history and examination and preoperative investigations. Prophylaxis intravenous antibiotic (Ceftriaxone) was given one-hour pre-op and continue for 2 days'post-operative.

For Group A, the fracture was fixed by undreamed antegrade interlocking nail.

(Usually 7 mm) with 2 screws proximal directed from anterolateral to posteromedial and anteroposterior (biplanes), 1 or 2 screws distal directed anteroposterior or lateral to medial. For group B, the fracture was fixed by5 mm LCP Plate (anterolateral approach), after isolated the radial nerve. No bone graft added for both groups.

Intraoperative blood loss was calculated by counting the soaked gauze, about 25 ccs of blood spilled on ten 4*4-inch gauze sponges. (13) + {blood collected by suction-amount of normal saline used for irrigation intra-op} Blood loss = (No. of soaked gauze * 25) - amount of the used normal saline.

The rehabilitation protocol which includes minimizing pain and inflammatory response and restoring shoulder passive range of motion with maintaining elbow, wrist, and hand function by wearing a sling for at least 3 weeks. The sling should be taken off at least four times per day to perform exercises and daily activities such as eating, dressing, and bathing with some precautions like no abduction past 90 degrees and shoulder ER 0 – 40 degrees, no lifting greater than 1lb.

Patient's follow up done at 2 weeks, 3 months, and 6 months' intervals, in terms of clinical and radiological union (bony bridging at three cortices out of four cortices). The functional outcome was assessed by using Quick DASH score at six-month post-op.

Statistical analysis: Data were analyzed using SPSS version 22. The Chi-square test of association was used to compare proportions. A $p \leq 0.05$ was considered statistically significant.

RESULTS

Mean age of patients was 41.10 ± 14.21 years (range 19 – 64). Table 1 shows that 46.7% of group A aged ≥ 50 years compared 26.7% of group B (p = 0.525). Two-thirds of all patients (66.7%) were males with also no significant statistically.

Most common cause of the fracture was a road traffic accident (70%), follow by fall from height (16.7%) and fall on the ground (13.3%) (Table 2). With no significant (p = 0.545) One patient (6.7%) in group A and two patients (13.3%) in group B developed iatrogenic transient radial nerve injury (p > 0.999). Only

Table 1: Basic characteristics of study population (n = 30).

	Group A	**(N = 15)**	**Group B**	**(N = 15)**	**Total (N = 30)**		
	No.	**(%)**	**No.**	**(%)**	**No.**	**(%)**	P
Age (Years)							
18 – 29	5	33.3	4	(26.66)	9	(30.0)	
30 – 39	1	(6.7)	4	(26.66)	5	(16.7)	
40 – 49	2	(13.3)	3	(20.0)	5	(16.7)	
≥ 50	7	(46.7)	4	(26.66)	11	(36.7)	0.525*
Gender							
Male	10	66.7	4	66.7	20	66.7	
Female	5	33.3	5	33.3	10	33.3	> 0.999†
Smoking							
No	11	(73.3)	12	(80.0)	23	(76.7)	
Yes	4	(26.7)	3	(20.0)	7	(23.3)	> 0.999*
Total	15	100	15	100	30	100	

*By Fisher's exact test. †By Chi square test.

13.3% of all patients (4 patients out of 30, 2 patients from each group) developed a superficial infection but there was no significant difference (p > 0.999). Regarding the deep infection, only one patient (6.7%) in group B developed an infection (p > 0.999).

Six patients (20% of the whole sample) developed

Table 2: Cause of injury.

Cause	Group A	No.15	Group B	No.15	Total	No.30	P
	No.	%	No.	%	No.	%	
RTA	9	60	12	80	21	70	
FFH	3	20	2	13.3	5	16.7	
FOG	3	20	1	6.7	4	13.3	0.545*
Total	15	100	15	100	30	100	

*By Fisher's exact test. Note: RTA: Road Traffic Accident; FFH: Fall From Height; FOG: Fall on

Table 3: Complications encountered in each of the management methods.

Variable	Group A	No.15	Group B	No.15	Total	No.30	P
	No.	%	No.	%	No.	%	
Radial Nerve Injury							
No	14	93.3	13	86.7	27	90	
Yes	1	6.7	2	13.3	3	10	> 0.999*
Superficial Infection							
No	13	86.7	13	86.7	26	86.7	
Yes	2	13.3	2	13.3	4	13.3	> 0.999*
Deep Infection							
No	15	100	14	93.3	29	96.7	
Yes	0	0	1	6.7	1	3.3	> 0.999*
Shoulder Pain							
No	9	60	15	100	24	80	
Yes	6	40	0	0	6	20	> 0.017*
Union							
No union	1	6.7	2	13.3	3	10	
Union	11	73.3	12	80	23	76.7	
Delay Union	3	20	1	6.7	4	13.3	0.686*
DASH							
Excellent	4	26.66	11	73.33	15	50	
Good	10	66.66	2	13.33	12	40	
Fair	1	6.66	2	13.33	3	10	0.009*
Poor	0	0	0	0	00	0	
Total	15	100	15	100	30	100	

*By Fisher's exact test.

Table4: Means of the studied parameters in the two study groups.

Variable	Group A	No.15	Group B	No.15	P*
	Mean	(± SD)	Mean	(±SD)	
Operative time (minutes)	61	(± 6.28)	103.07	(± 9.57)	< 0.001
Blood loss(ml)	59.60	(± 6.23)	171.20	(± 12.64)	< 0.001
Union time (weeks)	16.14	(± 3.61)	15.15	(± 3.16)	0.457
Hospital stay(days)	2.20	(± 0.41)	2.93	(± 1.22)	0.036
DASH score	32.08	(± 11.85)	23.17	(± 13)	0.060

*By t test of two independent samples.

shoulder pain, all of them were in the nail group, while none was in the plate group (p = 0.017). One patient (6.7%) of group A developed non-union compared with two patients (13.3%) in group B, while the incidence of delayed union was 3 patients out of 15 (20%) in group A and one patient out of 15 (6.7%) in the group B (p = 0.686) (Table 2). Eleven patients (73.33%) of group B had excellent DASH scores compared with 4 patients (26.66%) of group A (p = 0.009 (Table 3).

The operative time of Group B (103.07 minutes) was significantly (p < 0.001) higher than the mean of Group A (61.0 minutes). The mean blood loss was also significantly (p < 0.001) higher in group B than group A (171.2 ml and 59.6 ml, respectively). No significant difference (p = 0.457) regarding the mean union time. The mean hospital stays of Group B (2.93 days) was significantly (p = 0.036) higher than the mean Group A (2.2 days) (Table 4).

DISCUSSION

The excellent results in the last several years of the interlocking nails in fracture tibiaand femur increase the interest to use the idea in fracture humeral shaft.[14] According to the studies of Jiezhi et al,[15] Roman et al,[16] and Zhao et al,[17] on series of humeral shaft fracture, one group operated using plate fixation andthe other group operated using antegrade interlocking nail fixation, the rate of nonunion was in plate fixation group (2% to 10%) and antegrade IMN fixation was (0 to 8%) while in this study the rate of nonunion in plate fixation was 2 patients out of 15 (13.3%) and in antegrade IMN fixation was one patient out of 15 (6.7%).

The delayed union rate (union in a period between 16 weeks and 24 weeks) in the plate fixation group as reported by Flick et al,[1] was 6.6%. They suggested that the probable cause is extensive soft tissue stripping and decrease periosteal blood supply. An almost similar result was obtained in this study (6.7%). While in Group A of this study, the delayed union rate was 20%, A lower result has been reported by Wali et al,[18] as 12% of their patients underwent delayed union. The most suggested cause is bone distraction and loss of bony contact.

Demire et al,[19] suggested that fracture healing was affected by the distraction of the bone and the soft tissue while advancing the nail. Fracture healing depends on 3 important factors; anatomic reduction, stable fixation, and sufficient blood supply.[18]

Shoulder pain and movement are important concerns following fixation of the humeral shaft fracture.[20] In this study, the incidence of shoulder pain in group B was 0% while in group A, the shoulder pain was 40% as 6 out of 15 patients complained from shoulder pain after nailing. Possibly the cause is rotator cuff injury while approaching through it to make the entry point. (p = 0.017). Our result was lower than Amitkumar et al.[12]

It's recommended to embed the nail head completely in the head of the humerus in addition to careful suturing of the supraspinatus tendon to avoid rotator cuff rupture and impingement.[21,22] Fortunately, no one of the group A patients had rotator cuff rupture clinically or radiologically.

The superficial infection rate in this study was 13.3% for each group; higher than Gupta et al. study,[23] which reported no superficial infection in plate group fixation and only 5% of interlocking nail groups. Regarding the deep infection in this study, only one patient in group B (6.7%), which is lower than Gupta et al, [23] study which had 9% in the plate fixation group.

Transient radial nerve injury occurred in 6.7% and 13.3% in groups A and B, respectively, due to direct or indirect pressure on the nerve by surgical toolsor manipulation to reduce the fracture. A wrist drop brace with continuous physiotherapy was applied. Fortunately, the radial nerve palsy healed within 3 months in all patients. Our result higher than Ul Ain et al,[24] who reported no radial nerve injury in the nail fixation group and (8%) in plate fixation.

Intraoperative blood loss together with the operative time and hospital stay were found to be significantly more in the plate fixation group. Mean intraoperative blood loss in this study was 171.20 ± 12.64 ml for the plate fixation group and 59.60 ± 6.23 ml in the IMN fixation group ($p < 0.001$). This is higher than the result of the study by Fan et al.[10]

The mean operative time according to Amitkumar et al,[12] in the plate fixation group was 90.93 ± 4.56 min while in the nail fixation group was 59.53 ± 6.25 min. The present study showed a statistically significant difference between both groups ($p < 0.001$) (103.07 ± 9.57 minute) for the plate fixation group and (60.0 ± 6.28 minute) for the IMN fixation group which is longer than what Fan et al.[10]

Regarding the hospital stay, Fan et al,[10] reported that in plate group fixation the hospital stay was 10 ± 1.17 while in the nail fixation group 6.53 ± 1.17. In our study, it was shorter than the reported result of Fan et al,[10] as in group B, it was 2.93 ± 1.22 while for IMN fixation group was 2.20 ± 0.41.

Assessment of the functional outcome post-surgical fixation of the humeral shaft fracture is one of the important measures. Quick DASH scores have been documented as a very good tool for quantifying the results described by Amitkumar et al,[12] who reported DASH scores for two groups, one group operated byplate fixation and the other by antegrade IMN fixation. The mean quick DASH score obtained in their study for the plate fixation group was good 24.666 ± 21.174 and in the antegrade fixation group fair 48.562 ± 28.331.

In this study, the mean quick DASH score was good in group B (23.17 ± 13), which is almost similar to Amitkumar et al,[12] possibly due to careful soft tissue dissection and handling. Regarding group, A, the quick DASH score was good as well (32.08 ± 11.85). The result of the quick DASH score in group A in this study is regarded well in comparison with the fair result reported by Demire et al.[19] Probably the careful dissection of the deltoid muscle and supraspinatus muscle (avoid injury of the avascular part of supraspinatus) during approaching the port, together with gentle close reduction and nail advancing in the canal was of great effect on the outcome.

CONCLUSION

Early mobilization and a good functional outcome can achieve by internal fixation of the humeral shaft fracture by either LCP or IMN fixation.Each one of those methods of fixation has its advantages and disadvantage. Nailing is good as minimally invasive, less infection rate, less intraoperative blood loss, less hospitalization, and less iatrogenic nerve injury. Plating is better in terms of less time to union, and joint function (shoulder pain). Good functional outcome wasobtaining by two fixation methods.

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