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Outcome of fixation for humeral mid-shaft fractures in adults by elastic nails on 40 patients postoperatively

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Abstract

Background & objectives: Surgical intervention is increasingly used for treatment of humeral mid-shaft fractures nowadays. The aim of study was to identify the outcomes of titanium elastic nailing and exploring the relevance of carrying weight to these outcomes in adults. **Methods:** This study was a prospective follow up study conducted in Erbil teaching hospital in Erbil city from 1st of January, 2010 to 30th of November, 2013 on sample of 40 eligible injured patients who were non-randomly selected. The fractured patients were operated surgically using titanium elastic nails in both retrograde and ante grade ways. Postoperatively, carrying weight was used with follow up x-rays to check the union of bone. **Results:** mean timeto return to previous activity after elastic nail surgery was 15.7weeks and mean union duration of fractures after surgery was 12.2 weeks. The main adverse outcomes after surgery were shoulder pain (30%), shoulder stiffness (17.5%), supraspinatus pain (30%), superficial infection (27.5%), mal-union (7.5%), non-union (5%), delayed union (2.5%) and conversion to internal fixation (5%). Mal-union, non-union, delayed union and conversion to internal fixation were significantly prevalent among patients not carrying weight after surgery.**Conclusions:** titanium elastic nails represented the good treatment option for adulthood mid-shaft humeral fractures with promising outcomes of carrying weight postoperatively.

Keywords: Humeral mid-shaft; Elastic nails; Erbil.

Introduction

The mid-shaft humeral fractures are uncommon adulthood fractures especially stress (displaced) type which widely reported injuries among athletics[1]. Fractures of humeral mid-shaft represented 1-2% of all fractures; affecting individuals with different age groups with predominance of elderly age group[2, 3]. These fractures are the results of severe trauma such as direct blow, bending force and fall from outstretched hand; stress fractures mainly occur in special sports like basketball, tennis and swimming [4]. The first choice of humeral mid-shaft fracture treatment is conservative and the priority in treatment is pain relief [5, 6]. The conservative ways included splinting, casting, bracing, and traction. Shoulder and elbow stiffness, nonunion, delayed union and malunion are highly remarked after conservative treatment of humeral mid-shaft fractures; however, many authors reported union rates of more than 90%[7]. Types of malunion include overlap and shortening, angulation, rotation and cross-union. Surgical intervention is increasingly used for treatment of humeral mid-shaft fractures nowadays, especially for open fractures[8], neurovascular damage complications[9], mal-union, non-union and delayed union[10], multiple injuries[11], shoulder and/or elbow early mobilization[8]. The most public surgical techniques used were plates[11], intramedullary nails[2,3,12], and external fixators[8] with frequent postsurgical complications such as radial nerve injury, posterior cutaneous antebrachial nerve damage, rotator cuff lesion and shoulder pain with proximally inserted nails, cosmetically poor scars, shoulder stiffness, nonunion and infection[13,14].

The healing of fractures is a specific type of wound healing that requires bone regeneration which is needed to complete restoration of skeletal integrity. Annually in USA, 5-10% of the estimated 5.6 million fractures had delayed union and/or non-union[15]. Carrying weight or cyclical movements after surgical treatment of fractures were proved to initiate healing in the tibia and humerus fractures. Others suggested that absence of axial loading is the potential risk factor for nailing failure of humeral mid-shaft fractures[15,16]. Another explanation is might be attributed to obtain adequate fixation caused by bony erosion and osteopenia, in addition to fact that the humerus is subjected to more distractive and torsional forces than the tibia or femur in which most of the forces are compressive[17]. The evolving rates of road traffic accidents and war injury cases transferred to hospitals in Erbil city in the last years disclosed increased cases of humeral mid-shaft fractures presented to emergency department of these hospitals that need safe surgical techniques for treatment of mid-shaft humeral fractures. This study was performed to identify the outcomes of titanium elastic nailing and exploring the relevance of carrying weight to these outcomes in adults.

Patients & Methods

This study was a prospective follow-up study conducted in the Erbil teaching hospital in Erbil city from 1st of January, 2010 to 30th of November, 2013. The patients age of more than and equal to 18 years and mid-shaft humeral fractures of stress type were the inclusion criteria. The exclusion criteria were non-stress mid-shaft humeral fractures, severe infection of second and third degree open fractures, associated with lower extremities fractures, loss of consciousness, previous mid-shaft humeral fracture treated with another method, strenuous medical diseases and steroid drugs users. All adult

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inured patients with mid-shaft humeral fractures presented to emergency department during the study period and filling inclusion and exclusion criteria were included in the study (40 patients). After full history, examination and resuscitation by applying ABC measures if required, the patients were referred to Radiology department in hospital for anterioposterior and lateral view x-rays to have an accurate diagnosis of humeral mid-shaft fractures and for evaluation the treatment methods. The preoperative care of injured patients included the preparation of fluids and blood as the surgery was conducted as soon as possible. Two patients had open fractures and managed accordingly. The Arbeitsgemeinschaft für Osteosynthesefragen–Association for the Study of Internal Fixation (AO-ASIF) classification is based on the amount of commination, as follows:

• Type A fractures - No commination has occurred.
• Type B fractures - A butterfly fragment is present.
• Type C fractures - Commination has occurred.

Surgical technique for longitudinal incision, 1cm longitudinal incision was done laterally at lateral epicondyle level. The cortex is opened with a 3.2- or 4.5mm drill bit or awl that is dependent on size of the implant desired and the advancement of the drill. Generally, the implants were in the range of 2.5–3.5 mm. The nail is present and driven to the fracture site, reduction is then obtained mostly in a closed manner or sometimes in open manner, and the implant is subsequently driven proximally to stabilize the fracture. A second small incision is then made over the medial epicondyle. This is extended adequately to both visualize and protect the ulnar nerve. Elbow was in degree less than 90° & place thumb over nerve. Again, a 3.2- or 4.5-mm drill is used to open the cortex and drill through the medial column into the medullary canal. A second nail is then selected, prebent and advanced to the fracture site, advanced across the fracture site, and impacted into the proximal humerus. The nails are driven proximally to within 1–2 cm of the proximal humeral physis, cut as close as possible to the insertion site and impacted into place. For ante grade insertion, 1 cm longitudinal incision is made over the proximal humerus at greater tuberosity level. The deltoid muscle is incised in line with the fibers. Image intensification is used to confirm the starting point. The cortex is entered using a 3.2- or 4.5-mm drill bit and the opening subsequently enlarged using a clamp. A single flexible nail is inserted into the bone and passed into the distal fracture fragment as far as possible into the supracondylar area. The procedure is repeated to add a second implant. Postoperatively, mobilization out of bed without restriction was permitted for patients with isolated injuries in all patients unless if there is a big wound or multiple fractures or loss of consciousness. Patients with lower extremity fractures were permitted to bear weight on the upper extremity as tolerated; arm sling during rest period without any splint. Passive and active flexion of elbow were permitted and encouraged. Since first day postoperatively, carrying weight of 500 gm, then increasing by 500 gm for each week or as tolerated till reach state of union. Radiographs were typically obtained 2 weeks postoperatively to check for loss of reduction, 6 and 12 weeks postoperatively to evaluate healing, and as needed after 12 weeks. This study was approved by the research ethics committee of the college of medicine/Hawler medical university. An informed oral consent was obtained from each selected patients before being enrolled in the study. The statistical analysis was conducted by using Statistical Package for Social Sciences (SPSS) version 23. Multiple contingency tables and appropriate statistical tests were performed. Chi-square test was used to compare categorical variables. Fisher`s exact test was used when total of expectant variables was less than 20%. In all statistical analysis, p value ≤ 0.05 was considered statistically significant.

Results

Forty injured patients with humeral fractures were included in present study with mean age as 40.1years (19-70 years), with male to female ratio as 2.3:1. In 75% of patients, humeral fractures were in right side; 65% of fractures were type A, 22.5% type B and 12.5% of them were type C Figure 1. Fall from height (FFH) was the mechanism of injury for 52.5% of fractures and only 5% of patients had open fractures Table 1. Titanium elastic nails surgery was done for 82.5% of the patients at 1-3 days after injury, Ante grade portal of nails was done for 20% of patients, retrograde for 70% Figure 2 and both portals for 10% of patients. The size of nails was 3.5mm for 60% of injured patients; 10% of patients had primary radial nerve injury and 10% of them had secondary radial nerve injury postoperatively. Gap at fracture site was present in 10% of operated patients after surgery and 12.5% of operated patients did not carrying weight after surgery Table 2. The mean time to return to previous activity after elastic nail surgery was 15.7weeks and mean duration of fractures union after surgery was 12.2weeks. The main adverse outcomes after surgery were shoulder pain (30%), shoulder stiffness (17.5%), supraspinatus pain (30%), superficial infection (27.5%), mal-union (7.5%), non-union (5%), delayed union (2.5%) and conversion to other techniques of internal fixation (5%) table 3. A significant association was observed between carrying weight postoperatively with lower postoperative shoulder and supraspinatus pain ($p=0.009$). Mal-union, non-union, delayed union and conversion to internal fixation were significantly prevalent among patients not carrying weight after surgery ($p<0.001$, $p<0.001$, $p=0.007$, $p<0.001$, respectively) Table 4. The time to return to previous activity and union time were significantly longer among patient not carrying weight after surgery ($p<0.001$) Table 5.

Table (1): General characteristics of patients and humeral fractures.

Variable	No.	%
Age (19-70 years)		
<30 years	12	30.0
30-39 years	9	22.5
40-49 years	8	20.0
≥50 years	11	27.5
Gender		
Male	28	70.0
Female	12	30.0
Fracture side		
Right	31	77.5
Left	9	22.5
Fracture type		
A	26	65.0
B	9	22.5
C	5	12.5
Mechanism of injury		
FFH	21	52.5
RTA	12	30.0
Direct blow	6	15.0
Others	1	2.5
Open fractures		
Yes	2	5.0
No	38	95.0
Total	**40**	**100.0**

Table (2): Surgical and post-surgical fixation techniques.

Variable	No.	%
Surgery performed at		
1-3 days	33	82.5
4-7 days	5	12.5
> 1 week	2	5.0
Portal for elastic nails		
Antegrade	8	20.0
Retrograde	28	70.0
Both	4	10.0
Size of elastic nails		
3 mm	11	27.5
3.5 mm	24	60.0
4 mm	3	7.5
4.5 mm	2	5.0
Injury to radial nerve		
No	32	80.0
Primary	4	10.0
Secondary	4	10.0
Gap at fracture site		
Yes	4	10.0
No	36	90.0
Carrying weight		
Yes	35	87.5
No	5	12.5
Total	**40**	**100.0**

Table (3): Post surgery outcomes.

Variable	No.	%
Time to return to previous activity mean±SD (15.7±4.3 weeks)		
Union duration mean±SD (12.2±3.8 weeks)		
Shoulder pain after two weeks		
Yes	12	30.0
No	28	70.0
Shoulder stiffness after two weeks		
Yes	7	17.5
No	33	82.5
Supraspinatus pain		
Yes	12	30.0
No	28	70.0
Superficial infection		
Yes	11	27.5
No	29	72.5
Mal-union		
Yes	3	7.5
No	37	92.5
Non-union		
Yes	2	5.0
No	38	95.0
Delayed union		
Yes	1	2.5
No	39	97.5
Conversion to other techniques of internal fixation		
Yes	2	5.0
No	38	95.0
Total	**40**	**100.0**

Table (4): Distribution of elastic nail surgery outcomes according to carrying weight after surgery

Surgical procedure outcome		Carrying weight		P value
		Yes	No	
Shoulder pain	No. (%)	8 (22.8)	4 (80.0)	**0.009***
Shoulder stiffness	No. (%)	6 (17.1)	1 (20.0)	0.8*
Supraspinatus pain	No. (%)	8 (22.8)	4 (80.0)	**0.009***
Superficial infection	No. (%)	10 (28.5)	1 (20.0)	0.6*
Mal-union	No. (%)	0 (0)	3 (60.0)	**<0.001***
Non-union	No. (%)	0 (0)	2 (40.0)	**<0.001***
Delyed-union	No. (%)	0 (0)	1 (20.0)	**0.007***
Conversion to internal fixation	No. (%)	0 (0)	2 (40.0)	**<0.001***
Total	**No. 40**	**35**	**5**	

* Fishers exact test.

Table (5): Distribution of union means according to carrying weight after surgery.

Carrying weight	Time to return to activity	Union time
	Mean±SD	Mean±SD
Yes	14.3±2.3 weeks	10.9±1.6
No	25.2±2.5 weeks	21.2±1.8
P value	<0.001**	<0.001**

**Independent sample t-test.

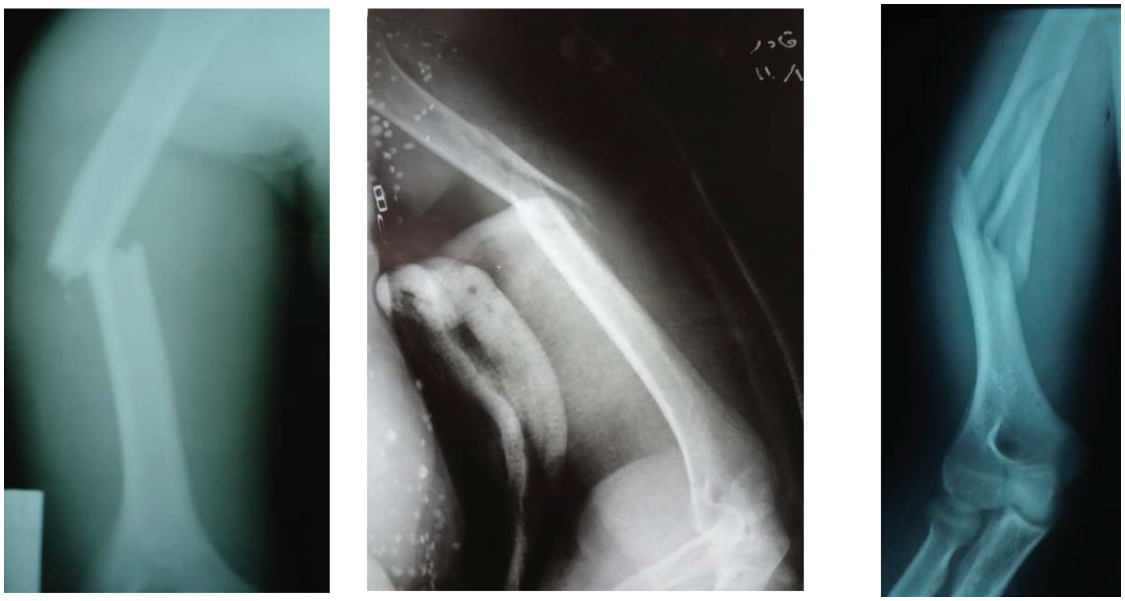

Figure (1): Humeral fracture before intervention.

Figure (2): Humeral fracture after insertion of titanium elastic nails.

Discussion

Mid-shaft humeral fractures are uncommon fractures[18] with good outcome results of non-operative treatment in children reaching 90% union rate and functional recovery[19]. However, adulthood mid-shaft humeral fractures had low outcome of conservative treatment which complicated with reduction failure that leads to shortening and malrotation[20]. Open reduction and internal fixation for severe and untreated cases had many adverse effects such as bleeding, infection and others[18]. For that reasons, titanium elastic nailing represented the good method for adult s humeral mid-shaft fractures[21]. In present study, the union rate mid-shaft humeral fractures after elastic nailing was 95% with mean duration of union as 12.2 weeks and of returning to previous activity as 15.7 weeks. These findings are close to results of studies conducted by Zatti et al[22] and Lee et al[23] which reported union rate 95-100% with union duration range of 10-11 weeks. These findings are not different from union time of non-operative methods, but elastic nailing provides more movement range and flexibility and prevents the limitations accompanied by non-operative ways[22]. Moreover, elastic nailing had comparatively good outcomes in comparison to plating method[24]. The common reported operative and postoperative complications in present study were radial nerve injury, pain (shoulder & supraspinatus), stiffness and superficial infection. These findings are similar to those results found by Khurana et al study[25]. Although half of cases with radial nerve injury in our study were secondary, these complications especially the radial nerve injury represented the major obstacle for wide use of elastic nailing in comparison to plating which is considered safer technique[22]. In high proportion of cases of this study, retrograde nailing was used. This finding is consistent with that of Stannard et al study 26 which stated that both insertion portals are effective in providing static nailing of mid-shaft humeral fractures but the majority of surgeons preferred the retrograde portal. Retrograde portal prevents shoulder pain and dysfunction[27],[28]. Despite that, many authors discourage retrograde portal use because of high risk of radial nerve injury[22]. This study showed the significant association of postoperative carrying weight postoperatively with better outcomes of titanium elastic nailing of mid-shaft humeral fractures. This finding is similar to the results of many studies that explored the main causes of union failure after surgical treatment of humeral fractures and revealed that carrying weight and appropriate axial rotation movements are essential in bone healing of humerus[15-17]. Mid-shaft humeral fractures had high rates of non-union[29] that needs adjuvant physiotherapeutic techniques added to optimum surgical intervention to acquire better outcomes[30]. Absence of complete bone reduction, absence of stable and rigid fixation in addition to high muscular load on humerus was the main reasons for late healing 17. In conclusion, titanium elastic nails represented the good treatment option for adulthood mid-shaft humeral fractures. To overcome the associated ulnar nerve injury and non-union, it is better to use the ante grade portal nailing technique operatively and carrying weight with physiotherapy postoperatively.

Conclusions: Titanium elastic nails represented the good treatment option for adulthood mid-shaft humeral fractures with promising outcomes of carrying weight postoperatively.

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