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Ahmad Shawakat Rizk
Benha University

Hassan Hussein Ahmad Abdallah
Benha University

Mohammed Gamal el din Al Ashahab
Benha University

Said Ibrahim Said Abdelmotalb
Orthopedics Specialist Benha Teaching Hospital, saideltamry@yahoo.com

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Original Article

Results of compression plating versus locked intramedullary nailing fixation in the treatment of humeral shaft fractures in adults

Hassan Hussein Ahmad Abdallah[a], Mohammed Gamal el din Al Ashahab[a], Ahmad Shawakat Rizk[a], Said Ibrahim Said Abdelmotalb[b]

[a]Department of Orthopedics, Faculty of Medicine, Benha University, Benha, [b]Orthopedics Specialist Benha Teaching Hospital, Imiay, Tokh, Egypt

Abstract

Background

Most humerus shaft fractures can be treated successfully using the conservative methods. When choosing surgical fixation, there is a debate between the use of plate and screws and intramedullary nails.

Aim

The aim of this study was to compare the results of the dynamic compression plate and the antegrade interlocked humeral nail in the fixation of humerus shaft fractures.

Patients and methods

A total of 40 patients were selected by a randomized method to be treated by either method; there were 20 patients in each group and patients were followed up for at least 6 months until union.

Results

The results showed superiority of the plate in terms of the union rate and shoulder function and the use of the nail was better in terms of the infection rate and radial nerve palsy.

Conclusion

The plate is still the standard of treatment of the humerus shaft fracture and the nails better be used for more comminuted or open fractures. More future studies with large numbers required to overcome our relatively small number.

Keywords: Fixation, fracture, humerus, nail, plate

Introduction and background

Humeral shaft fractures are commonly encountered and comprise 1–3% of all fractures [1]. The vast majority of humeral shaft fractures can be managed successfully by nonoperative means [2]. Surgical treatment of humeral shaft fractures should be considered for unacceptable alignment with closed treatment, polytraumatized patients, a progressive or a new onset of a radial nerve palsy after the beginning of a nonoperative treatment, ipsilateral upper extremity fractures, segmental humeral shaft fractures, pathological fractures, bilateral humeral fractures, and open fractures [3]. There is a debate about the choice of operative intervention in humerus shaft fractures requiring surgical intervention [4], and the different alternatives have their own pros and cons. This study will compare the dynamic compression plate (DCP) and the antegrade interlocking nail in the treatment of humeral shaft fractures.

The humeral shaft is defined as the expanse between the proximal insertion of the pectoralis major and the distal metaphyseal flare of the humerus. Important osseous landmarks of the humeral

Correspondence to: Said Ibrahim Said Abdelmotalb, MSc, Orthopedic Specialist, Benha Teaching Hospital, Imiay, Tokh, Egypt, Tel: 0133230066.
E-mail: saideltamry@yahoo.com

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shaft include the deltoid tuberosity at the mid-anterolateral aspect, which serves as the insertion for the deltoid muscle, and the spiral groove posteriorly, which houses the profunda brachii artery and the radial nerve as they traverse proximally to distally in a posterolateral direction [5]. The humerus shaft has three surfaces (posterior, anterolateral, and anteromedial) bound by three borders (anterior, medial, and lateral borders). The humeral shaft serves as the insertion and origin site for several major muscles of the upper extremity. These play an important role in the biomechanical consequences of different fracture patterns. Muscles inserting on the shaft include the deltoid, pectoralis major, teres major, latissimus dorsi, and coracobrachialis; those originating on the shaft include the brachialis, brachioradialis, and the medial and lateral heads of the triceps brachii [5]. The arm can also be divided into anterior and posterior compartments by thick fibrous bands – the medial and lateral intermuscular septa. The brachial artery, the median nerve, and the musculocutaneous nerve remain in the anterior compartment for their entire course and are rarely encountered in surgical exposures to the humerus. In terms of important neurologic structures, the axillary nerve maintains a close relationship with the inferior capsule. In the quadrilateral space, it is accompanied by the posterior circumflex humeral artery turn around the humerus neck. It lies between 4.3 and 7.4 cm distal to the lateral edge of the acromion [6,7]. The musculocutaneous nerve penetrates the coracobrachialis muscle and passes obliquely between the biceps brachii and the brachialis to the lateral side of the arm [7].

The radial nerve is one of the terminal branches of the posterior cord. This nerve begins anteromedially and travels along the subscapularis to join with the deep brachial artery at the triangular interval. The nerve and artery then travel along the spiral groove, separating the medial and lateral heads of the triceps. The nerve exits the spiral groove 101–148 mm proximal to the lateral epicondyle and then passes into the anterior brachium through the lateral intermuscular septum [8].

Open reduction and internal fixation of humeral shaft fractures may be carried out by many surgical approaches; the posterior and anterolateral approaches are used mostly because of their relative familiarity to surgeons and generally good exposure of the entire humerus [9]. In the posterior approaches, a midline, longitudinal incision is made along the posterior aspect of the arm, extending from a point 8–10 cm below the acromion to the olecranon fossa [9]. The posterior approaches involve either mobilizing the triceps from lateral to medial (paratricipital) or splitting the muscle belly along its fibers (tricepse splitting). The anterior approach provides broad exposure to most of the humerus. An incision is made along the deltopectoral interval from the coracoid process to the lateral aspect of the humerus at the distal insertion of the deltoid. For exposure of the distal half of the humerus, a curvilinear incision is continued distally along the lateral aspect of the biceps to the level of the olecranon fossa [9]. Proximally, the internervous plane between the deltoid and biceps muscles is then used, and splits the brachialis muscle along the middle and lateral thirds of the muscle belly; the radial nerve is similarly at risk from the distal extension and must be identified between the brachialis and the brachioradialis muscles [7].

For approaches for the antegrade humeral nail, the patient is placed in the beach-chair position. A small incision is made in line with the fibers of the deltoid muscle anterolateral to the acromion. After splitting the deltoid muscle, the supraspinatus tendon is incised in line with its fibers; both parts of the tendon are spread with the help of sutures and clamps. The greater tuberosity is located, and the fibers of the rotator cuff insertion are identified. The entry point is close and medial to the greater tubercle and is marked with a k-wire under fluoroscopic control [10].

More approaches have been attempted by others as the claimed to decrease hazard to the rotator cuff and postoperative shoulder pain such as the anterior acromial approach, which involves making an incision anterior to the acromion and involves cutting of the coracoacromial arch. Another modification of the approach is through the rotator interval with or without biceps tenodesis [11]. Dimakopoulos *et al*.[12] described an extra-articular, extrarotator cuff entry point for antegrade humeral nailing, which preserves the articular surface and rotator cuff integrity. A modified insertion point located 1 cm below the crest of the greater tuberosity, in a region outside the articular surface and rotator cuff area [12].

The IM nails act as internal splints with load-sharing characteristics. The amount of load borne by the nail depends on the stability of the fracture/implant construct. This stability is determined by several factors, including nail size, number of locking screws or bolts, and distance of the locking screw or bolt from the fracture site. The IM nails are considered to bear most of the load initially, and then gradually transfer it to the bone as the fracture heals [13]. Indirect (secondary) fracture healing is the most common form of fracture healing and consists of both endochondral and intramembranous bone healing. It does not require anatomical reduction or rigidly stable conditions. On the contrary, it is enhanced by micromotion and weight bearing. However, too much motion and/or load are known to result in delayed healing or even nonunion.

The plates and screws are used to stabilize bone fractures using one of the two following methods and principles: the open direct anatomic reduction of the fracture and interfragmentary compression to achieve absolute stability or restoration of the axis and splinting of the fracture zone to achieve the relative stability principle [14]. The internal fixation implant acts as a load carrier from one fragment to the other and thus assists bone (or even replaces it) temporarily in its mechanical function. The mechanical loads on the implant recede as bone healing proceeds. The bone fracture healing process is dependent on the stability of motion between the bone fragments. Direct fracture healing can only be achieved under conditions of absolute stability.

Patients and methods

Forty patients with humeral shaft fractures were selected randomly for treatment by either an antegrade interlocking

nail or by a DCP plate and screws; after obtaining consent, 20 patients were included in each group.

The criteria used for selection were as follows:

(1) The fractures were located between 5 cm distal to the surgical neck or 5 cm proximal to the olecranon fossa.
(2) Patients with grade 1 and 2 open fractures.
(3) Unstable fractures.
(4) All patients were skeletally mature adults.

The following patients were excluded:

(1) Patients with grade 3 compound fractures.
(2) Patients with pathological fractures.
(3) Patients who had been noncompliant for follow-up.

Clinical and radiological assessments for 6 months were performed as a minimum in the follow-up of the patients. The primary outcome measure included early complications because of surgery (e.g. nerve injury and infection). Also, the primary outcomes will measure function and pain. The secondary outcomes of the study were the incidence of late complications and the need for further operation. To assess the function, the American Shoulder and Elbow Surgeons' score was used.

The characteristics of the patients were as follows: they ranged in age from 19 to 56 years, both men and women. In terms of the sex distribution, there were 33 (82.5%) men, and seven (17.5%) women. Closed fractures were present in 31 (77.5%) patients, and open fractures in nine patients, six (15%) open type one and three (7.5%) type 2. In 23 (57.5%) cases, isolated humerus fractures were present, and in 17 (42.5%) cases, other fractures were present. Primary radial nerve injuries were present in six (15%) cases, and one (2.5%) case occurred after a trial of closed reduction, spared in 33 (82.5%) cases (Table 1).

Results

In the group in which fixation was performed by the plate and screws, three patients had postoperative radial nerve palsy and in two patients operated using the anterolateral approach and one patient with the posterior approach, the incidence was 15%. In comparison, the group in which fixation was performed by the nail, only two patients had radial nerve palsy and the incidence was 10%. In terms of infection, two cases in the plate group had a superficial infection in the early postoperative period; in one of them, the fracture was an open grade two and in the second case, it was a closed type. Both cases after debridement infection subsided early incidence was 10%. In contrast, in the nail group, no postoperative infection cases were recorded, 0%. In the early postoperative period, about 12 cases had shoulder pain that persisted for a few weeks in eight cases and subsided with medical treatment and physiotherapy. However, in four cases, the pain only decreased, but was still present; in three cases, pain was mild, 15%, but in one patient, pain was moderate 5% total incidence about 20%. In contrast, in the plate group, only one patient had mild shoulder pain of unknown cause postoperatively, mostly not directly related to the plate incidence 0–5%. 'One' (5%) case in the nail group was complicated by intraoperative comminution during a nail insertion (Fig. 1). During the follow-up period, three patients from the nail group had delayed union, the healing was delayed after 5 months in contrast to plate group, only one case had delayed union. Nonunion was recorded in three cases in the nail group that needed further active intervention; the incidence was 15%. In contrast to the plate group, in only two cases there was nonunion and needed revision. The rate of reoperation and the need for further intervention were higher in the nail group than in the plate group in a total of five (25%) cases; in contrast, four (15%) cases in the plate group two because of nonunion and two because of debridement.

Assessment of the overall functions of the shoulder joint and range of motion (ROM) of the shoulder and elbow joints, along with muscle strength and return of normal daily living functions using the American Shoulder and Elbow Surgeons' score, indicated an increase in the score results in patients treated by the plate and screws compared with the patients treated by the antegrade interlocking nail humerus. In the plate group, the score was 82.35 in comparison with 74.75 in the nail group (Table 2).

Discussion

In our study, we compared between two groups of patients with humeral shaft fractures; one of the groups was treated by a DCP and included 20 patients and the other group was treated by an antegrade interlocking nail and also included 20 patients. Our results showed better outcome in the plating group in terms of the union rate and improvement in shoulder ROM than in the nail group. Better outcome was observed in the nail group than in the plating group in terms of the rate of infection and iatrogenic radial nerve palsy.

Several similar studies have been carried out to compare the results of DCP and antegrade interlocking nailing in the treatment of humeral shaft fractures. One of these studies was carried out by Chapman and colleagues[15] comparing both the nail versus plate and, in their results, shorter time to bone healing was observed in the plate group than in the nail

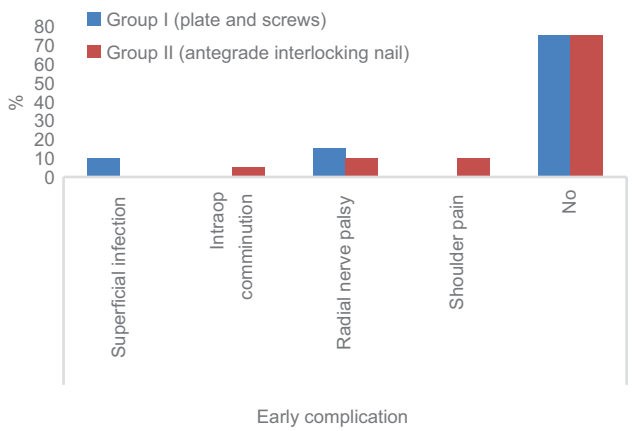

Figure 1: Chart comparing the incidence of early complications in each group.

Table 1: Statistical analysis of the characteristics of the patients included in the study

Method of fixation	Group I: plate and screws [*n* (%)]	Group II: antegrade interlocking nail [*n* (%)]	Statistical tests	*P*
Age (mean±SD) (years)	36.05±10.47	37.4±10.93	t=0.40	0.69
Sex				
Male	20 (100)	13 (65.0)	FET=6.23	0.008**
Female	0 (0.0)	7 (35.0)		
Mechanism of fracture				
Assault	1 (5.0)	1 (5.0)	FET=0.80	0.85
Fall	4 (20.0)	6 (30.0)		
RTA	15 (75.0)	13 (65.0)		
Type of fracture				
Closed fracture	17 (85.0)	14 (70.0)	FET=8.97	0.005**
Open fracture grade 1	0 (0.0)	6 (30.0)		
Open fracture grade 2	3 (15.0)	0 (0.0)		
Location				
Lower third	3 (15.0)	5 (25.0)	FET=7.15	0.017*
Middle third	17 (85.0)	10 (50.0)		
Proximal third	0 (0.0)	5 (25.0)		
Side of fracture				
Left	8 (40.0)	11 (55.0)	χ^2=0.90	0.34
Right	12 (60.0)	9 (45.0)		
Classification of fracture				
A1	1 (5.0)	0 (0.0)	FET=4.27	0.58
A2	1 (5.0)	2 (10.0)		
A3	10 (50.0)	8 (40.0)		
B1	2 (10.0)	4 (20.0)		
B2	6 (30.0)	4 (20.0)		
B3	0 (0.0)	2 (10.0)		
Associated fractures				
Yes	4 (20.0)	13 (65.0)	χ^2=8.29	0.004**
No	16 (80.0)	7 (35.0)		
Primary nerve injury				
Radial nerve injury	6 (30.0)	0 (0.0)	FET=8.46	0.008**
No but after trial closed reduction	1 (5.0)	0 (0.0)		
No	13 (65.0)	20 (100)		
Approach used				
Anterior	5 (25.0)	0 (0.0)	FET=46.77	0.001**
Incision rotator cuff	0 (0.0)	20 (100)		
Posterior	15 (75.0)	0 (0.0)		

Fischer exact test.

group. Shoulder pain and a decrease in the shoulder ROM were associated significantly with IMN. Also, the elbow ROM was decreased in the plate group than in the nail group [16]. Another study carried out by Singisetti and Ambedkar[4] compared both the nail and the plate in the treatment of humerus shaft fractures and their results indicated the general superiority of the plate outcome over the nail group in terms of the healing time, the rate of reoperation, and the incidence of shoulder pain. However, the incidence of radial nerve injury was higher in the plate group. No postoperative radial nerve palsy was observed in the interlocking nailing group. However, one (6.25%) case developed postoperative radial nerve palsy in the plating group. There was one case of deep infection each in the plating (6.25%) and interlocking groups (5%). Functional results: Thirteen out of 20 patients of the interlocking nail group achieved good to excellent results, whereas 15 out of 16 patients of the plating group achieved similar results at the final follow-up of the study. This difference was found to be statistically significant by Student's *t*-test ($P < 0.05$) [4].

Conclusion

We recommend that the plate and screw are better in terms of the general outcomes of the patient in shoulder function and the need for further operation because of delay or nonunion or for removal of hardware and another benefit of the plate that the exposure of the radial nerve in case of primary radial nerve injury case if there's need to fix the bone. The nail will be more useful in case of severely comminuted fractures and

Table 2: Statistical analysis of the study results

	Group I: plate and screws [*n* (%)]	Group II: antegrade interlocking nail [*n* (%)]	Statistical tests	*P*
Early complication				
Infection	1 (5.0)	0 (0.0)		
Intraoperative comminution	0 (0.0)	1 (5.0)	FET=4.7	0.66
Radial nerve palsy	3 (15.0)	2 (10.0)		
Shoulder pain	0 (0.0)	2 (10.0)		
Superficial infection	1 (5.0)	0 (0.0)		
No	15 (75.0)	15 (75.0)		
Late complications				
Shoulder pain				
Mild	1 (5.0)	9 (45.0)	FET=13.51	0.001**
Moderate	0 (0.0)	1 (5.0)		
Early only	0 (0.0)	2 (10.0)		
No	19 (95.0)	8 (40.0)		
Need further intervention				
Yes	4 (20.0)	7 (35.0)	χ^2=1.13	0.29
No	16 (80.0)	13 (65.0)		
Score (mean±SD)	82.35±11.24	74.75±10.7	*t*=2.19	0.035*

FET, Fischer exact test.

segmental fractures getting benefit from its biological role and also for osteoporotic bone.

Limitation of the study

More randomized studies with large numbers of patients are needed to confirm the results.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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