

Results of minimally invasive platefixation for humerus diaphyseal fractures

Mahmoud M. Hadhoud, M.D

Assistant professor of orthopedic surgery;
Faculty of medicine; Menoufia University,
Egypt
sheben elkom- medan sharaf ,borg el kawthar
01099282300
e mail: mahmodhadhod@yahoo.com

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Abstract

Background

MIPO obtains stable internal fixation of the humeral shaft using two separate incisions, indirect reduction by closed manipulation and fixation.

Aim of the work: The aim of this study was to evaluate the clinical results of treating humeral shaft fractures using MIPO technique.

Patients and Methods

From June 2009 to May 2013, 31 patients who sustained fracture of the humeral diaphysis, treated at Menoufia University Hospital.were operated upon using the MIPO technique. Radial nerve palsy was diagnosed upon admission in five patients. The reduction and plate position was visualized on the image intensifier. Fracture fixation was done using a 4.5-mm locking compression plate. The plate is pre-bent according to fracture location.

Results

Union occurred at a mean period of 12.4 weeks (range: 10-20 weeks). In two cases, where there was littlecallus at 12 weeks but with time these patients showed good union and good function after 20 weeks. Three had 3° valgus, five had 3° of varus, , and two cases had 5° varus angulation at the end of 2 years; but this did not affect their functional outcome.25 cases had excellent outcome and 6 cases had good shoulder function on the UCLA score.24 cases had excellent elbow function outcome, 5 cases had good outcome, and 2 cases had fair outcome.

Conclusion

Less bleeding, good cosmoses, good range of motion, short duration of bone healing are manifestations of MIPO technique but good fluoroscopy is essential.

Key words

Humerus, MIPO technique, diaphyseal fractures.

Introduction

The treatment for complex humeral shaft fracture is controversial [1] and appropriate treatment for humeral shaft fractures is a debated issue [2]. Radial palsy is a serious complication of humeral shaft fractures. The risk results from the anatomic position of the radial nerve which turns around the humeral shaft [3]. Better understanding of fracture healing, biology,metallurgy and mechanics improved protocol of treatment of injured patients[4]. Minimally Invasive Plate Osteosynthesis (MIPO) has been tried in humeral shaft fracture management[5]. MIPO meets the criteria of a "biological" osteosynthesis by minimizing invasiveness as well as iatrogenic soft tissue damage and provide adequate stability for fracture healing [6].MIPO obtains stable internal fixation of the humeral shaft using two separate incisions, indirect reduction by closed manipulation and fixation[7].MIPO may be an alternative option to open techniques[8]. It is known that an anteroposterior locking screw placed

percutaneously endangers the musculocutaneous and radial nerves[9].

Aim of the work:

The aim of this study was to evaluate the clinical results of treating humeral shaft fractures using MIPO technique.

Patients and Methods

From June 2009 to May 2013, The cases were followed up at least 1 year, 31 patients who sustained fracture of the humeral diaphysis were operated upon using the MIPO technique were treated at Menoufia University Hospital. The Patients were operated upon within 1 week of the injury. Exclusion data included associated medical disorders (as malignant tumor and hyperparathyroidism), ischemia of the upper limb, and severe soft tissue injuries.Mean age of the 23

males and 8 females was 28 years (range, 19–59). Seventeen patients had closed fractures, and 14 sustained open fractures. Five patients had 1st degree, five patients had 2nd degree, four patients had third degree type A open fracture according to Gustilo and Anderson classification [10]. The fractures were classified according to the AO-ASIF trauma classification [11] showing (Table 1).

Table (1): Classification of fractures according to AO classification

Type of fracture	Number of cases
A1	3
A2	5
A3	1
B1	3
B2	4
B3	3
C1	5
C2	7
TOTAL	31

Nine patients had associated musculoskeletal, thoracic injuries. Radial nerve palsy was diagnosed upon admission in five patients. Institutional Ethical Committee approved this study. Twenty-seven cases had fracture in their dominant arm. Road traffic accident being reported by 25 cases; and four cases sustained injury after fall on an outstretched hand and two cases had direct trauma. A routine preoperative clinical evaluation was done noting soft tissue and distal neurovascular status, including the status of the radial nerve. Anteroposterior and lateral radiographs of the humeral shaft were obtained. The operative procedure was carried out in the supine position, with the forearm in full supination and the arm abducted to 90° under general anesthesia. Surgical approach according to Livani et al. [12] In brief, access to the distal humerus is obtained through a volar approach between the biceps and brachioradialis muscles. Lateral antebrachial cutaneous nerve is identified, the brachialis muscle is longitudinally split and the volar surface of the humerus exposed. The radial nerve being protected as it passes laterally between the brachialis and brachioradialis. A limited anterolateral approach is done over the proximal humerus opening between the deltoid and cephalic vein laterally and the biceps medially. [13] exploration of the radial nerve is performed using an oblique incision on the lateral side of the mid-distal humerus in case of preoperative radial nerve palsy. [14]. The radial nerve is identified ante-

riorly between the brachialis and brachioradialis muscles and released proximally. The submuscular tunnel connecting the proximal and distal incisions is done by blunt dissection the plate is pushed through the tunnel. Manual traction was applied to regain length and correct angulations and rotation. The reduction and plate position was visualized on the image intensifier. Fracture fixation was done using a 4.5-mm locking compression plate. The plate is pre-bent according to fracture location. Then the plate is introduced either in a proximal to distal or distal to proximal direction. Median plate length was 12 holes (range 10–14 holes). The plate was fixed primarily to the bone with 2.0-mm K-wires. After being sure that the position of the plate was central, it was fixed with at least 2 locking screw proximally and distally. Antibiotics were routinely used according to the guidelines of the Centre of Disease Control [15]. Postoperatively; arm was immobilized in a broad arm sling. Mobilization exercises were started from the second day. Patients were followed-up clinically and radiologically every two weeks for one month and monthly thereafter until occurrence of bony union. The shoulder and elbow function were evaluated using the UCLA shoulder score [16] and the Mayo elbow performance score (MEPS) [17]. The UCLA shoulder score was graded into excellent (34-35 points), good (29-33 points), fair (21-28 points), and poor (0-20 points). [16] Grading of elbow function was on the basis of MEPS into excellent (≥ 90 points), good (75-89 points), fair (60-74 points), or poor (< 60 points). (Fig 1)

Results

The mean operation time was 93.4 minutes (range: 80-130 minutes) and radiation exposure was 150.3 seconds (range: 90-230 seconds). Two cases had superficial infection which resolved with antibiotics. Two cases had transient postoperative radial nerve palsy which recovered within eight weeks. For five patients who had preoperative radial nerve palsy, exploration of the nerve proved that the nerve was intact which recovered within ten weeks. (Figs 2) Union occurred at a mean period of 12.4 weeks (range: 10-20 weeks). In two cases, where there was little callus at 12 weeks but with time these patients showed good union and good function after 20 weeks. Three had 3° valgus, five had 3° of varus, and two cases had 5° varus angulation at the end of 2 years; but this did not affect their functional outcome. 25 cases had excellent outcome and 6 cases had good shoulder function on the UCLA score. 24 cases had excellent elbow function outcome, 5 cases had good outcome, and 2 cases had fair outcome.



Fig 1: Intraoperative pictures

A: supine position during operation, B: Two incision during MIPO technique, C: Skin closure, D: C-arm intraoperative picture to confirm reduction and plate position.



Fig 2: female patient 52 years old with fracture humerus associated with radial nerve palsy

a) Preoperative X-ray of arm showing fracture shaft of humerus (AO 1.2.A2)

b) Postoperative X-ray of arm showing plate fixation

C) Three incision for exploration of radial nerve exploration of radial nerve, appearance after closure of skin

D) six month follow-up X-ray of a patient showing good union without deformity.

E) clinical photographs showing full elbow and wrist flexion and extension with radial nerve recovery



Fig 3: Female patient 27 years old with fracture humerus
 a) Preoperative X-ray of arm showing fracture shaft of humerus (AO 1.2.B1)
 b)) Postoperative X-ray of arm showing plate fixation
 c) Six month follow-up X-ray of a patient showing good union without deformity.



Fig 4: Female patient 45 years old with fracture humerus
 a) Preoperative X-ray of arm showing fracture shaft of humerus (AO 1.2.A.2)
 b) Postoperative X-ray of arm showing plate fixation
 c) One-year follow-up X-ray of a patient showing good union without deformity.
 d) Postoperative clinical photographs of same patient showing elbow flexion, and elbow extension.

As regard elbow range of motion at final follow-up averaged 116° (range, 55–135). Two patients had an extension lag of 30°. Six patients had maximal flexion of 110. In nine elbows ROM was less than 100°. This loss of ROM occurred after delayed union in two, a type I open fracture in three, and closed fractures in four cases. Two cases had paraesthesia over the lateral half of the forearm which recovered spon-

taneously within 3 months of surgery. (Figs 3,4)

Discussion

In the present study 25 cases had excellent outcome and 6 cases had good shoulder function on the UCLA score. This agrees with Zhiquan et al[8] study, The

UCLA scoring system showed excellent results in 53.8% and good results in 6 cases 46.2%. However in Shin et al[18] study two patients were converted to an open reduction during operation due to a failure of MIPO.

Two patients had an extension lag of 30°. Six patients had maximal flexion of 110°. In nine elbows ROM was less than 100°. So it coincides with Kobayashi et al[19] and Concha et al[5] studies who states that brachialis muscle scarring and defective postoperative rehabilitation may be the cause of limited elbow range of motion.

Union occurred at a mean period of 12.4 weeks (range: 10-20 weeks). This agrees with Jiang et al[1] and Wang et al[20] studies.

Minimally invasive plate osteosynthesis may achieve comparable results with the open plate osteosynthesis method. Although MIPO potentially has the radiation hazard, it may reduce the perioperative complications with a shortened operation time and reduced blood loss as found in this study[21].

In two cases, where there was little callus at 12 weeks but with time these patients showed good union and good function after 20 weeks. This in accordance with Lee et al[22] study where there was one hypertrophic nonunion that healed after fixing with two additional screws

So, MIPO requires clear sharp intraoperative imaging and surgical experience[5].

In the present study, technically, After being sure that the position of the plate was central, it was fixed with at least 2 locking screw proximally and distally. This agrees with Stoffel et al[23] study who states that three to four screws on either side should be inserted. In simple fractures with a small interfragmentary gap, one or two holes should be spared on each side of the fracture to induce fracture healing. These technical points may reduce angular and rotational deformities.

In the present study cosmeses are very good as the scar is very minimal, with very little bleeding., this agrees with Shetty et al[24] study who states that MIPO of the humerus gives good functional and cosmetic results.

In this study two cases had transient postoperative radial nerve palsy and recovered within eight weeks. this agrees with Wang et al[20] and Apivatthakakul et al[25] who states that to reduce the risk of radial nerve injury, the forearm should be kept in full supination during plate insertion, and excessive force avoidance during retraction of the lateral half of the brachialis muscle together with the radial nerve in the distal incision.

However, Yang et al[26] study shows that the radial nerve injury was found in one patient, who had an emergency treatment by the loosening of the radial nerve and the internally fixing with LCP, his function recovered 3 days after operation.

Also, in the study Livani et al[14] of Six patients were operated on and showed complete functional recovery.

While in the study of Lee et al[22] there were two cases of postoperative radial nerve palsy that both recovered completely. They attributed them to manipulation.

In this study, Two cases had paraesthesia over the lateral half of the forearm but this recovered spontaneously within 3 months of surgery. This matched with Apivatthakakul et al[7]. study as complications observed were one paresthesia of lateral cutaneous nerve of forearm

MIPO technique for humeral shaft fractures needs a thorough understanding of the neurovascular anatomy and skillful surgical technique to reduce potential complications[27]. The incidence of radial nerve injuries shows a large variation.

Conclusion

Less bleeding, good cosmeses, good range of motion, short duration of bone healing are manifestations of MIPO technique but good fluoroscopy is essential.

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