Lateral approach to the humeral shaft: approach for special situations

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Received 14 October 2013
Accepted 25 December 2013

The Egyptian Orthopaedic Journal
2016, 51:180–185

Background
In situations where simultaneous exploration of the anterior, the lateral, and the posterior surfaces of the shaft of the humerus is needed, or when radial nerve exploration is required, it is beneficial to find an approach that allows good exposure of the humeral surfaces and good exploration of the radial nerve. The objective of this study was to assess the results of using the lateral approach of the humerus in such situations.
Patients and methods
Between January 2008 and December 2010, 18 displaced humeral shaft fractures in 18 patients were treated in Mansoura University Hospitals with open reduction and plate fixation using lateral approach. Fractures were classified according to the OTA classification, and preoperative and postoperative assessments of the radial nerve were done. The follow-up included assessment of the range of motion of shoulders, elbows, and wrists; the muscular strength of the shoulders; and hand grip were assessed as compared with the other uninjured side.
Results
All fractures healed within a mean time of 14 weeks (11–17 weeks). Of 11 patients with preoperative radial nerve palsy, nine (82%) had complete spontaneous recovery within few months after surgery, and the other two had near-complete recovery. There was one case of superficial infection that resolved after wound debridement and antibiotic therapy. No patient had delayed union, nonunion, or implant failure.
Conclusion
Lateral approach for the humerus is an excellent way for radial nerve exploration and for cases where the lateral, the anterior, and the posterior surfaces of the humerus needed to be approached simultaneously. This approach allows supine positioning of the multiply injured patients and proper visualization of the radial nerve without muscle splitting; however, it does not allow exploration of the radial nerve in the proximal third of the humerus.

Keywords:
fracture humerus, lateral approach, plating of the humerus, radial nerve

Egypt Orthop J 51:180–185

1110-1148

Introduction

When open reduction and internal fixation of humeral shaft fracture are indicated, a posterior triceps splitting approach has been recommended by several authors [1–3].

In cases where the lateral or the anterior surfaces of the humerus needed to be approached simultaneously with the posterior surface, this triceps splitting approach will not be sufficient.

In cases where fracture humerus is associated with radial nerve injury, this posterior approach will not allow proper nerve exploration, hence there is a need for another approach to allow proper exposure of the humeral surfaces and proper radial nerve exploration.

The posterior approach cannot be easily practiced in supine positioning, and this approach is beneficial in multiple trauma patients, particularly if there is pulmonary insult, spinal fractures, or the need for concomitant surgical procedures, as it exposes only the posterior surface of the humerus, and iatrogenic radial nerve injury was also reported with this approach [1,3,4].

Anterior plating through an anterolateral approach allows supine positioning, but the radial nerve is vulnerable; moreover, it does not allow exposure of the posterior surface of the humerus [3–8].

In this study, the lateral approach of the humerus was used; it has the advantages of supine positioning and allows better exposure of the radial nerve for

 DOI: 10.4103/1110-1148.203153

exploration or repair; allows simultaneous exposure of the posterior, the anterior, and the lateral surfaces of the humerus; it is not a muscle splitting approach with readily identified intermuscular planes; and finally, it is extensile both proximally (anteriorly) and distally [4,5].

The purpose of this study was to assess the results of using the lateral approach of the humerus for simultaneous exposure of the anterior, lateral and posterior surfaces of the humerus and radial nerve exploration.

Patients and methods

Between January 2008 and December 2010, 18 displaced humeral shaft fractures in 18 patients were treated in Mansoura University Hospitals with open reduction and plate fixation using lateral approach. Informed consents were given by all the patients before the study. The study was authorized by the local ethical committee and was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki as revised in 2000.

Patient demographics including age, sex, and mechanism of injury were collected; there were 10 female and eight male patients. The patients' average age was 32 years (range: 18–56 years). The mechanism of injury was motor vehicle accident in eight patients and falls in 10.

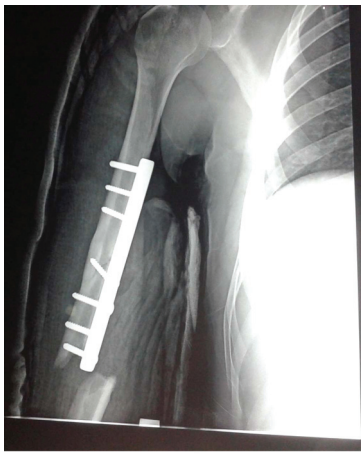
Seven patients in this study had a history of united humeral shaft fractures fixed with plates through the anterolateral approach; these patients developed recent fractures in the lower third of the humerus at the lower end of plates (Figs 1–3).

The other 11 cases had fractures in the middle or lower thirds of the humerus associated with radial nerve injury: of these 11 patients, three had Gustilo type III open fractures, two had bilateral humeral fractures, three had hemothorax with chest tubes, one patient had hepatic tear and head injury, one patient had hepatic tear, and the remaining one had associated ipsilateral fracture of the forearm bones [9].

Fractures in this study were classified according to the OTA classification [10]. The follow-up included an assessment of the range of motion (ROM) of shoulders, elbows, and wrists.

The muscular strength of the shoulders and hand grip were assessed, and the preoperative and postoperative neurological examinations were performed with particular attention to the radial nerve.

Figure 1



A radiograph for a 46-year-male patient with fracture humerus at the lower end of a plate humerus.

Figure 2

The same patient in Fig. 1, with the fracture in the distal third and requires posterior plating.

Figure 3

Immediate postoperative radiograph of the same patient with the plate removed, and a posteriorly placed contoured plate is applied.

The patient is placed in the supine position under general anesthesia, with the entire limb prepared and draped freely; no tourniquet was applied to avoid limiting the proximal exposure.

A longitudinal skin incision is made from a point just proximal to the lateral epicondyle in line with the center of the deltoid insertion (Fig. 4); a posteriorly based flap is developed along the plane between the subcutaneous fat and the fascia of the posterior compartment of the arm. A longitudinal incision is made in the fascia overlying the lateral head of the triceps just posterior to the lateral intramuscular septum (Fig. 5).

The humerus is exposed by elevation of the lateral head of the triceps from the lateral intramuscular septum and its insertion on the posterior aspect of the humerus in the distal-to-proximal direction. Proximally, the intermuscular septum separates the lateral head of the triceps and the brachialis, and distally it lies between the medial head of the triceps and the brachioradialis. The radial nerve pierces the intramuscular septum in the proximal extent of the wound near the humerus at the junction of its middle and distal thirds (Fig. 6).

The radial nerve then lies anterior and medial to the brachioradialis origin, and thus, is protected in the distal portion of the operative field. Proximally, the radial nerve is dissected carefully from the region of the spiral groove and gently retracted (Fig. 7).

The anterior and posterior surfaces of the humerus are exposed by subperiosteal dissection. This approach may be extended proximally through Henry's posterior approach to the proximal humerus, or distally through Kocher's approach to the forearm.

The fracture is stabilized using a 4.5-mm contoured plate. The distal portion of the plate is bent to create a

Figure 4

The incision for the lateral approach of the humerus.

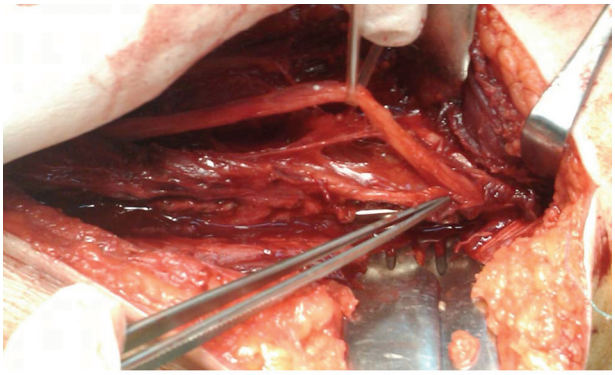
Figure 5

A posteriorly based flap is developed along the plane between the subcutaneous fat and the fascia of the posterior compartment of the arm.

Figure 6

The radial nerve piercing the lateral intermascular septum.

Figure 7



The radial nerve is explored.

gentle curve that fits the lateral column; the wound is then closed in layers over a drain [4,11] (Fig. 3).

Results

In this study, there were 10 women and eight men, with a mean age of 32 years (18–56 years); the average follow-up was 28 months (17–51 months), and the mechanism of injury was motor vehicle accident in eight patients and falls in 10.

The OTA classification for these fractures was as follows: 12 cases had OTA type 12A fractures, 2 cases had type 12B fractures, and 4 patients had type 12C fractures (Table 1).

All fractures healed within a mean time of 14 weeks (range: 11–17 weeks). There were 11 (61%) patients with preoperative radial nerve palsy, and at the final follow-up, nine (82%) of these patients had complete spontaneous recovery within a few months after surgery and the other two patients had near-complete recovery with only slight weakness of wrist extension.

Only one (6%) patient with Gustilo type III open fracture developed superficial infection that resolved after wound debridement and antibiotic therapy. No patient had delayed union, nonunion, or implant failure.

At the last follow-up, there were no differences in the ROMs of the shoulder and elbow between the affected and healthy sides greater than 10° in any direction. All patients claimed that they nearly regained their prefracture ranges of motion of the shoulder and elbow.

Postoperative radiologic assessment showed good alignment in all cases. All cases healed with less than 10° of angulations; no case had shortening greater than 1 cm assessed by plain radiographs or rotation greater than 10° in either direction assessed clinically.

Discussion

Humeral shaft fractures are common injuries in trauma patients and represent between 3 and 5% of all fractures [12].

Table 1 OTA classification for fractures in this study

OTA classification	Number of cases
12A	
2.2	5
2.3	3
3.2	4
12B	
2.2	2
12C	
3.2	2
3.3	2

Radial nerve palsy is the most frequent associated lesion in diaphyseal humeral fractures. Its incidence varies between 1.7 and 20% [13].

Exploration of the nerve is recommended at the time of fracture fixation in cases with open fractures associated with radial nerve injury, where as in cases with closed fractures, there still some controversy [14].

In cases of fractures of the shaft of the humerus associated with radial nerve injury, where the radial nerve exploration is needed, it is beneficial to find an approach that allows good exploration of the radial nerve.

Also in certain cases where there is a fracture at the lower end of a plate fixed anteriorly for a previous humeral shaft fracture, plate removal, and posterior plating for the recent fracture can be done simultaneously through the lateral approach.

Surgical fixation of the humerus may be approached posteriorly, although there is a trend toward anterior plating through an anterolateral approach [1,2,7,8,15].

The posterior approach requires prone or lateral positioning, which may be difficult or even contraindicated in patients with multiple trauma, particularly if there are pulmonary insults, spinal fractures, or the need for concomitant surgical procedures; iatrogenic injury to the radial nerve was also reported with the posterior approach.

The anterolateral approach to the humerus with the patient in a supine position maintains spinal precautions, limits pulmonary complications during surgery, and allows other procedures to be performed without repositioning.

The anterolateral approach is technically difficult to use for plate application to the most distal portion of the humeral shaft, as the converging soft tissue structures make an anterolateral dissection of this region somewhat hazardous [1,3,11].

The lateral approach may have a greater risk to the radial nerve than is present with the triceps splitting approach. However, in fractures that require proximal extension of a plate, the triceps splitting approach also requires visualization and mobilization of the radial nerve [16].

In this study, all the 11 patients with radial nerve injuries had their injuries in continuity, and no

repair procedures were done; nine (82%) patients had complete spontaneous recovery within a few months after surgery and the other two patients had near-complete recovery with only slight weakness of wrist extension at the last follow-up.

This study like others confirm the high spontaneous recovery rate of primary radial nerve lesions in patients with closed humeral shaft fractures; radial nerve palsy should not be regarded as an isolated indication for primary surgical intervention [1,14,17,18].

Although spontaneous nerve recovery usually occurs, there are still occasional patients with lacerated nerves; in these cases, the primary operation is the best chance for nerve exploration and reconstruction. Secondary exploration for nonrecovered nerves after the primary internal fixation is a more technically demanding procedure as the nerve could be embedded in callus [19].

Ekholm found that the rate of recovery of radial nerve lesions is higher in closed than in open fractures, especially in patients treated nonoperatively. He stated a complete recovery of nerve function in 89% of his patients, and only minor persisting symptoms in the remaining 11%. Among patients treated primarily operatively, 73% had a complete recovery, 13% had minor sequelae, and 13% major sequelae [14].The results for ROM in the shoulder, elbow, and wrist are comparable with those of the noninjured side; the muscular strength and hand grip are also within the average as compared with the uninjured side taking in account the considerations of the dominant and nondominant limbs. These results are in conformity with those of Sarmiento *et al.* [20], who reported no more than 10° of loss of motion in the shoulder and elbow in almost 90% of the patients after closed functional treatment.

The rate of union in this study was 100%, within an average of 14 weeks (11–17 weeks), which is comparable with fractures managed with other treatment modalities [1,7,15,20–23].

There was only one case of superficial infection in a patient with an open fracture; all patients had either complete or near-complete recovery of the radial nerve. All patients claimed that they had restored their previous ROM and muscular strength and hand grip.

Conclusion

Lateral approach for the humerus is an excellent way for radial nerve exploration and for cases where the lateral, the anterior, and the posterior surfaces of the humerus needed to be approached simultaneously. This approach allows supine positioning of the multiply injured patients and proper visualization of the radial nerve without muscle splitting; however, it does not allow exploration of the radial nerve in the proximal third of the humerus.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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