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A modified deltoid splitting approach with axillary nerve bundle mobilization for proximal humeral fracture fixation

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ABSTRACT

Introduction: The deltopectoral and the deltoid splitting approach are commonly used for the treatment of proximal humeral fractures. While the deltopectoral approach requires massive soft tissue devascularization, the deltoid splitting approach needs an additional skipped incision to avoid axillary nerve injury. The purpose of this study was to describe a modified anterolateral deltoid splitting approach with axillary nerve bundle mobilization in the treatment of proximal humeral fractures and to assess its radiologic and clinical outcomes.

Patients and methods: Twenty-two consecutive patients with proximal humeral fractures were treated with minimally invasive plate osteosynthesis by using a modified anterolateral deltoid splitting approach with axillary nerve bundle mobilization. The patients were divided into two groups: 10 patients of Neer type 2 or 3 fractures vs. 12 patients of Neer type 4 fractures. The mean age of the study population was 63.5 years (range: 30–80 years). Six patients had valgus impacted fractures, and nine had fractures with medial comminution.

Results: Fracture union was achieved in all cases. The mean time to union was 8.6 weeks (range: 6–12 weeks). Major complications, such as avascular necrosis of the humeral head and varus collapse at the fracture site, were not observed. No patients had clinically detectable sensory deficits in the axillary nerve distribution or paralysis of the anterior deltoid muscle. The mean neck-shaft angle at the final follow-up was 136.9° (range, 115°–159°). The mean visual analog score for patient satisfaction was 9.1 (range, 6–10), and the mean Neer scores were 93.5 (range, 84–100). There were no significant differences between the two groups with respect to radiologic and clinical outcomes except Neer scores: 95.8 (range: 86–100) in Neer type 2 or 3 fractures and 91.7 (range: 84–99) in Neer type 4 fractures.

Conclusion: The use of a modified anterolateral deltoid splitting approach with axillary nerve bundle mobilization in the treatment of proximal humeral fractures yielded excellent outcomes. This approach is a useful alternative to the deltopectoral or the deltoid splitting approaches in the treatment of proximal humeral fractures.

Introduction

The treatment of proximal humeral fracture is challenging owing to the variable deforming forces of the muscles surrounding the fractured bone and operative treatment with plate and screw fixation through a deltopectoral approach is the commonly used [1–4]. However, this approach requires wide dissection and retraction of adjacent soft tissue to expose the lateral aspect of the humerus for plate and screw fixation [4,5]. It increases the devascularization of bone fragments and the risk of injury to the blood vessels that supply the humeral head, which is associated with a development of avascular necrosis (AVN) [3].

Minimally Invasive Plate Osteosynthesis (MIPO) is a recent technique that emphasizes the use of atraumatic surgical procedures as means of preserving the blood supply of bone and soft tissue [6,7]. A direct lateral or an anterolateral deltoid splitting approach is used for the reduction and fixation of proximal humeral fractures by a MIPO technique. However, the length of the primary incision is limited by the location of the anterior branch of the axillary nerve, necessitating an additional skipped incision for distal screw fixation. As an alternative to this

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Table 1
Demographic data and preoperative evaluations.

	Total (n = 22)	Neer type 2 or 3 fracture (n = 10)	Neer type 4 fracture (n = 12)	*p*- value
Age (years)	63.5 ± 12.7	64.2 ± 13.1	62.9 ± 12.9	0.716
Sex (men: women)	7: 15	4: 6	3: 9	0.652
Involved side (dominant: non-dominant)	12: 10	5: 5	7: 5	0.999
Injury mechanism (fall from standing height: traffic accident)	19: 3	8: 2	11: 1	0.571
Follow-up (months)	32.8 ± 5.9	32.3 ± 5.5	33.2 ± 6.5	0.742
Valgus impacted fracture (yes: no)	6: 16	2: 8	4: 8	0.646
Medial comminuted fracture (yes: no)	9: 13	4: 6	5: 7	0.999
Calcar segment length (mm)	12.0 ± 7.2	13.5 ± 8.9	10.8 ± 5.5	0.356
Medial hinge displacement (mm)	10.5 ± 6.7	11.8 ± 7.5	9.5 ± 6.0	0.446

approach, an extended deltoid splitting approach for direct visualization of the axillary nerve bundle has been reported to provide good clinical outcomes [8,9]. However, these studies did not present the benefits of this approach in terms of fracture fixation and evaluate the fracture related parameters or radiologic demonstration of effective union [9,10].

The location of anterior branch of the axillary nerve is consistent and is rarely associated with anatomic variations [9,11–13]. A 2-cm extension of the conventional deltoid splitting approach incision results in good exposure of the axillary nerve bundle. Isolation and mobilization of this bundle may improve the exposure of the fracture site and aid in reinforcing the plate fixation with additional screws. The purpose of this study was to describe a modified anterolateral deltoid splitting approach with axillary nerve bundle mobilization in the treatment of proximal humeral fractures and to assess its radiologic and clinical outcomes.

Patients and methods

Patient characteristics

This study is a retrospective case series with prospectively gathered data. Twenty-two patients with Neer type [14] two-, three-, or four-part proximal humeral fractures underwent MIPO with a modified anterolateral deltoid splitting approach with axillary nerve bundle mobilization between November 2011 and November 2013. All patients were available for radiologic examination and functional outcome assessment for a minimum of two years following surgery. None of the patients had fractures with diaphyseal extension or previous shoulder surgery. There were seven men and 15 women; the mean age at the time of surgery was 63.5 years (range, 30–80 years). The mechanism of injury in the majority of the patients was a fall from standing height. All surgical procedures were performed within two weeks of the trauma. This study was approved by the institutional review board of our institution.

Radiologic examination revealed a two-part fracture in one patient, three-part fractures in nine patients, and four-part fractures in 12 patients, according to Neer's criteria [14] and these findings were confirmed intra-operatively. All patients were then divided into two groups according to Neer's criteria: 10 patients of Neer type 2 or 3 fractures vs. 12 patients of Neer type 4 fractures. Six patients had valgus impacted fractures and nine had medial comminution. In addition, the risk for ischemia of the humeral head was evaluated by measuring the length of the calcar segment of the articular fragment and the quantum of the medial hinge displacement [15]. The mean length of the calcar segment was 12.0 mm (range, 0–29.5 mm), with seven cases deemed to be at risk for ischemia (length <8 mm). The mean value of medial hinge displacement was 10.5 mm (range, 0 to 26.5 mm), and 21 cases appeared to be at an elevated risk according to the criteria (displacement >2 mm) (Table 1).

Surgical technique

All surgical procedures were performed by a single orthopedic surgeon. The patient was placed in the supine position with 10° elevation of the trunk. The injured shoulder was positioned to allow intra-operative fluoroscopy examination. All surgical procedures were performed in a standardized manner and under general anesthesia. An incision, measuring approximately 8 cm, was made extending from the palpable anterolateral edge of the acromion distally along the fibers of the deltoid muscle. The fibrous raphe between the anterior and middle heads of the deltoid was identified and then split along its fibers. The neurovascular (NV) bundle composed of the anterior branch of the axillary nerve and the posterior circumflex humeral artery, was isolated, along with the adjacent soft tissues. Splitting of the raphe was continued distally 2–3 cm from the NV bundle, taking care not to injure it (Fig. 1).

Consistent with the principle of the MIPO technique, extensive dissection to visualize the bone fragments was avoided. However, all bone fragments that were visible in the operating field were reduced. Fracture lines deep to the NV bundle were reduced under visualization with mobilization of the NV bundle to proximal and distal direction (Fig. 2A and B). The articular and shaft segments were reduced under fluoroscopic guidance. Humeral shaft manipulation was controlled with bone-holding forceps that were inserted lateral to the bone and distal to the NV bundle. The handling of the humeral head was performed extracapsularly with the help of temporarily inserted Kirschner wires (K- wires) or a reduction clamp. Reduction of the greater tuberosity (GT) fragment and/or the lesser tuberosity (LT) fragment was performed depending on the fracture type. The GT fragment was reduced, and K-wires were inserted to maintain provisional reduction. The LT fragment was not reduced during plate placement, but was left for future fixation.

Fig. 1. The skin incision, measuring approximately 8 cm, was made extending from the palpable anterolateral edge of the acromion distally along the fibers of the deltoid muscle. The fibrous raphe between the anterior and middle heads of the deltoid was identified and then split along its fibers. The neurovascular (NV) bundle composed of the anterior branch of the axillary nerve and the posterior circumflex humeral artery was identified (arrow). This bundle was isolated along with the adjacent soft tissues. Splitting of the raphe was continued distally 2–3 cm from the NV bundle, taking care not to injure it (arrow head). GT: greater tuberosity.

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