Percutaneous fixation for displaced proximal humeral fractures in adolescents and young adults

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Background

Closed reduction and percutaneous pinning of proximal humerus fractures is a reliable method for stable fixation in certain patients. Although it is less rigid biomechanically than plate and screw constructs, percutaneous pinning may be used in patients younger than 45 years of age with good bone quality and noncomminuted fracture fragments.

Patients and methods

Twenty-three patients with displaced proximal humeral fractures (after high-energy trauma), mean age 26.4 years (range 14–45 years), were treated by closed (nine patients) or open (14 patients) reduction and percutaneous pinning with smooth pins. Pins were removed after 6–8 weeks and followed up for a mean of 6.7 months (range 6–14 months).

Objectives

Evaluation of the results of treatment of displaced surgical neck fractures in adolescents and young adults.

Results

According to the Constant scoring system, the mean score was 89.65 points. Seventeen patients (73.9%) had an excellent score, three patients (13%) had a good score, and three patients (13%) had a fair and poor score. Twenty patients (87%) were satisfied with the result of the treatment and three patients (13%) were not satisfied.

Conclusion

Displaced proximal humeral fractures could be treated by closed or open reduction and percutaneous pinning, yielding good fracture positioning and adequate temporary stabilization. No major complications such as avascular necrosis, nonunion, deep infection, or neurovascular deficit were associated with this method of treatment.

Keywords:

adolescent, displaced, humeral, percutaneous, proximal

Introduction

Proximal humeral fractures account for almost 4–5% of all fractures. These fractures have a bimodal age distribution, occurring either in young individuals following high-energy trauma or in those older than 50 years with low-velocity injuries such as a simple fall [1–3]. Most of the proximal humeral fractures are nondisplaced or minimally displaced and stable. These can be treated nonoperatively successfully with early rehabilitation [4].

Various methods of osteosynthesis have been suggested for proximal humeral fractures including plate fixation, screw and wire fixation, intramedullary nailing, percutaneous pinning, and external fixation. However, both plate fixation and screw and wire fixation require exposure of the fracture site. In addition, plate fixation is often made difficult by poor bone quality. Intramedullary nailing has the potential risk of violating the rotator cuff or elbow joint function [5–8].

Closed reduction and percutaneous pinning of proximal humerus fractures is a reliable method for fixation in certain patients. Although it is less rigid biomechanically than plate and screw constructs, percutaneous pinning may be used in patients with good bone quality and noncomminuted fracture fragments. It is essential that an acceptable reduction be obtained by closed means or open ones. Percutaneous methods of fixation have a major advantage over open reduction and internal fixation in that there is essentially no soft tissue dissection and minimal risk of iatrogenic avascular necrosis [9–12].

Entrapment of soft tissue such as the long head of the biceps tendon, periosteum, deltoid muscle, or neurovascular structures between the fracture fragments is uncommon. Biceps tendon entrapments are likely only with 100% anterior displacement of the shaft fragment. The humeral shaft fragment may button-hole through the capsule or periosteum, becoming entrapped in muscle. Whenever this situation arises, open reduction is indicated [13].

Patients and methods

Between 2006 and 2010, 23 patients with displaced fractures of the surgical neck of the humerus were treated at the orthopedic department of Benha University and Health insurance Hospitals. There were 19 (82.6%) men and four women, mean age 26.4 years (range 14–45 years). The right side was affected in 11 patients and the left side was affected in 12 patients. The mechanism of injury was car accident or motor cycle accident in 17 patients (73%) whereas fall from height was the mechanism of injury in the other six patients (26%). All fractures were closed (no open fracture). Follow-up of the patients was performed weekly for the first 8 weeks and then monthly until the end of follow-up, with a mean follow-up of 6.7 months (range 4–14 months).

The inclusion criteria for this study were a displaced two-part surgical neck fracture according to the Neer classification system in patients younger than 45 years old after high-energy trauma such as accidents and falls from heights.

Exclusion criteria were polytrauma with multiple fractures, noncompliant patients, and diabetic patients.

The diagnosis was made by clinical and radiographic examination. Anteroposterior and scapular lateral radiographs were used to classify fracture type using the Neer classification system [14]. Anteroposterior, lateral scapular views of the patient were taken to detect the fracture displacement and angulations.

A written concent was taken from the patient or one of his parents to be included in the study.

Surgical technique

Under general anesthesia and under radiographic control, a trial of closed reduction was performed. If reduction was satisfactory, percutaneous pin fixation was carried out. If closed reduction was not satisfactory, or anatomy could not be restored because of soft tissue interposition, open reduction through a limited deltopectoral approach was performed. Soft tissue interposition was defined and disimpaction was performed to reduce the fracture. The bicepital groove was used as a landmark for reduction.

Two or three pins were inserted through the skin from distal to proximal with special care to avoid penetrating the articular cartilage by the pins and the pins were bent just outside the skin to avoid pin migration. If open reduction was performed, closure of the wound was carried out (Fig. 1).

Immobilization in an arm to chest sling was performed for all patients for 3 weeks. The patients were initiated on physiotherapy 3 weeks after the operation. Pendulous exercises were performed for 1 week, followed by passive range of motion for other 2 weeks. Active range of motion was started during the sixth postoperative week under supervision.

In cases of closed reduction, removal of the pins was performed after 6 weeks. In cases of open reduction, removal of the pins was delayed to the eighth week. Cases in which the pins became loose or pin-tract infection was recorded, removal of the pins was performed early but not during the first 3 weeks to avoid displacement of the fracture.

Active exercises for the muscles around the shoulder were started after removal of the pins until the patient recovered his/her shoulder power in comparison with the other healthy side.

Follow-up

Follow-up by plain radiographs was performed immediately postoperatively and every week (to detect displacement or pin migration) until fracture union was detected both clinically and in the radiograph.

Evaluation

Every patient was evaluated at the end of the follow-up period according to the Constant score, which is a 100-point score system developed by Constant and Murley [15]. This scoring system (Table 1) consists of four variables that are used to assess the function of the shoulder. The right and left shoulders are assessed separately. The subjective variables are pain and activity of daily living (sleep, work, recreation, and sport), which yield a total of 35 points. The objective variables are range of motion and strength, which yield a total of 65 points.

The score was graded according to the total points obtained by the patient taking the normal side for every patient as a standard (100 points). A score between 90 and 100 points was graded excellent. A score between 80 and 89 points was graded good. A score between 70 and 79 points was graded fair and a score less than 70 points was graded (poor) [16].

Table 1 Constant score

Subjective	
Pain	15 points
ADL (sleep, work, recreation/sport)	20 points
Objective	
Range of motion	40 points
Strength	25 points

ADL, activity of daily living.

Figure 1
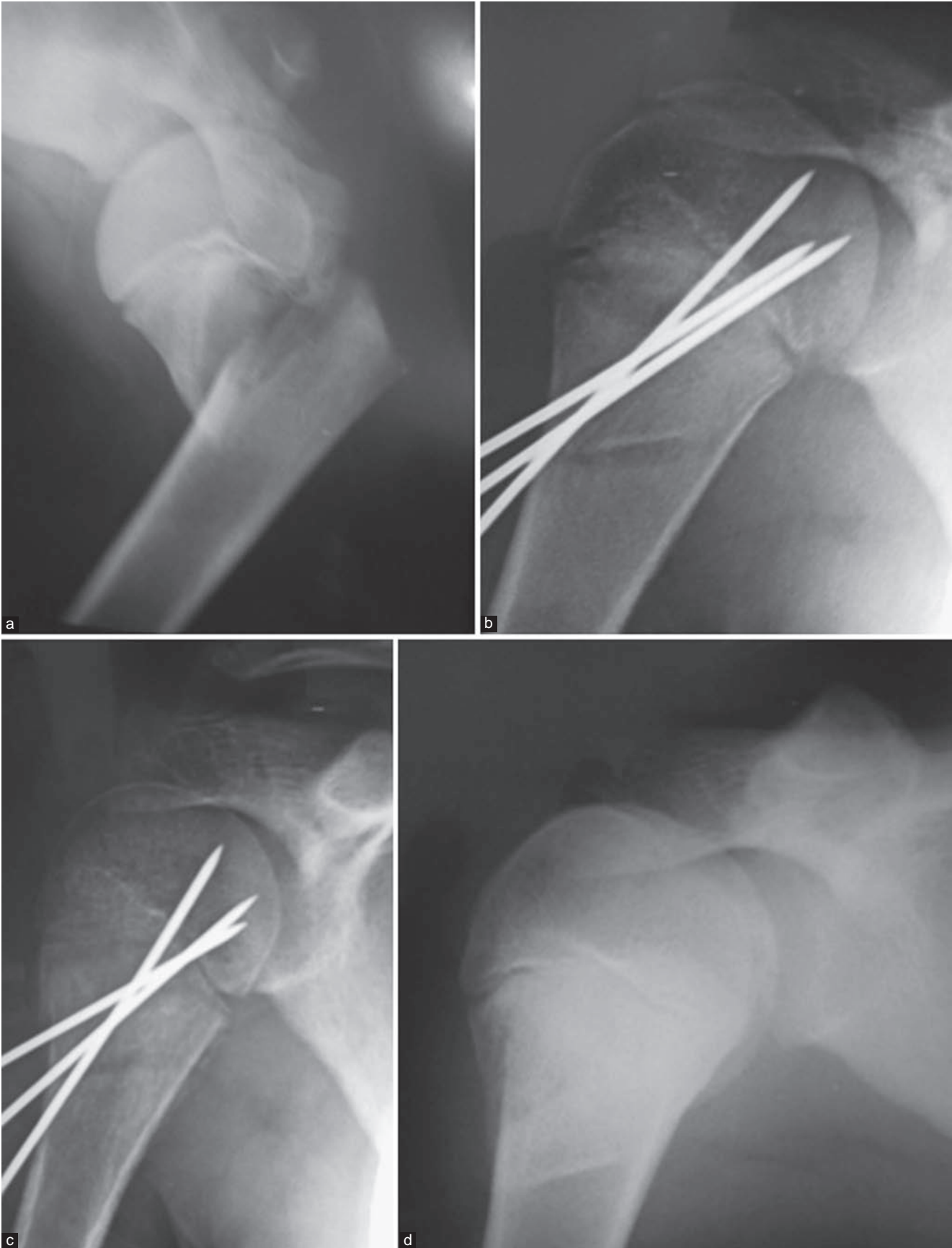
(a) Preoperative, (b) postoperative, (c) 6 weeks postoperatively (d) after removal of pins.

Results

Nine patients (39%) were treated by closed reduction and percutaneous pinning under radiographic control and the other 14 patients (61%) were treated by open reduction after a failed trial of closed reduction and fixed by smooth pins. During open reduction, the cause of failure of closed reduction was soft tissue interposition in 11 patients and impaction of the fracture in three patients.

The postoperative Constant score was between 50 and 100 points (mean 89.65 points). Seventeen patients (73.9%) had an excellent score, three patients (13%) had a good score, and three patients (13%) had a fair and poor score.

The mean postoperative range of motion at the end of follow-up was 32 points (range 18–40 points). The mean forward flexion was 173° (range 50–180°) and the mean abduction was 167° (range 40–180°).

Healing was observed during follow-up on radiographs in 8–15 weeks (mean 10.3 weeks): 9 weeks (range 8–15 weeks) for closed pinning and 11 weeks (range 8–15 weeks) for patients treated by open reduction.

Twenty patients (87%) were satisfied with the result of the treatment and three patients (13%) were not satisfied.

Pin-tract infection occurred in six patients (26%). Loosening of one pin occurred in four patients and loosening of two pins occurred in three patients.

Mild acceptable displacement occurred in one patient and moderate displacement occurred in one patient.

Wound infection was not observed in any patient during follow-up.

Stiffness of the shoulder and limitation of movements occurred only in one patient and better after manipulation was achieved under anesthesia. No deep wound infection was recorded. Also, there was no axillary nerve affection.

Discussion

The incidence of fracture of the proximal humerus is increasing because of increased number of geriatric individuals and increase in high-energy trauma. A conservative treatment in a sling, followed by functional rehabilitation under supervision yields satisfactory results in minimally displaced fractures. However, displaced two-part and three-part fractures need to be reduced and stabilized [12].

Recent trends are shifting away from open reduction and massive internal fixation (by plates and screws) toward closed reduction and percutaneous fixation as this method is less invasive and causes less soft tissue damage. Another complication associated with open reduction and massive fixation is the risk for avascular necrosis of the humeral head because of impairment of the anterior circumflex humeral artery and consecutive devascularization of the fracture fragments, which causes significant functional impairment. Percutaneous pinning seems to be a suitable alternative to other operative techniques such as intramedullary nailing or open/mini open reduction and internal fixation using wires or plates [9,17].

In the current study, the mean Constant score at the end of the follow-up period, which may be considered short (6.7 months), was 89.65 points. Overall, 87% of the patients had excellent and good scores, and they were satisfied with the method of treatment because there was no permanent hardware (plates or nails) in their shoulders and there was no need for a second operation to remove the hardware. The healing time in patients treated by closed reduction was better than that in patients treated by open reduction.

The results of the current study are comparable with the results of Fenichel et al. [18] using threaded pins for two-part fractures as they achieved an average Constant score of 86 points (range 78–100 points) and also for the range of motion. Rosa et al. [19] reported a Constant score between 33 and 84 points using two elastic smooth pins inserted through the head at the level of the physes.

The results are comparable with those of other techniques such as minimally invasive PHILOS plates performed by Acklin et al. [20], with a mean Constant score of 78 (range 28–93). The difference between our study and the study of Akin et al. is the wide age range of patients (16–90 years) in the study of Acklin et al. [20]. Also, these results are comparable with Acklin results according to the Constant score for two part fractures which was 86 (range 78–100).

Pin-tract infection is the most common complication with percutaneous pinning [18]. We did not remove the pins until they became loose or after 3 weeks to avoid displacement of the fracture.

The other common complications reported in the literature are stiffness, loss of fixation, axillary nerve injury, secondary displacement, and deep infection [18–20]. One patient among the three

patients who were not satisfied with the results developed postoperative stiffness and limitation of movement in all directions. The other two poor patients experienced mild and moderate displacement (3–5 mm) of the fracture but with physiotherapy, they gained a good range of motion but still different from the unaffected side.

Conclusion

Displaced proximal humeral fractures can be treated by closed or open reduction and percutaneous pinning, achieving good fracture positioning and adequate temporary stabilization. No major complications such as avascular necrosis, nonunion, deep infection, or neurovascular deficit were associated with this method of treatment.

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