

Treatment of 2- and 3-part fractures of the proximal humerus using external fixation

A retrospective evaluation of 62 patients

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Submitted 05-03-17. Accepted 05-08-18

Background Treatment of fractures of the humeral head remains controversial. We reviewed the outcome of our treatment of 2- and 3-part fractures of the proximal humerus using external fixation as a way of preventing damage to the vascularity of the humeral head and of reducing the risk of infection associated with open techniques.

Method We retrospectively evaluated 2- and 3-part fractures of the humeral head, both clinically and radiographically, in 62 consecutive patients who were treated using external fixation. The mean follow-up time was 1.5 (1–2) years.

Results The reduction was considered to be good in 50 cases, and 8 cases were consolidated in varus and 4 cases in valgus. The fracture healed in all patients. Except for 1 case of superficial infection around the screws and 1 redisplacement after a new fall, there were no early complications. Necrosis of the humeral head was not observed. 2 of the patients underwent shoulder replacement because of severe pain. The mean Constant score was 84 points, with satisfactory results (≥ 80 points) in 49 of the 62 patients. Sex, age, side, or type of fracture had no influence on the outcome.

Interpretation This procedure provides satisfactory early functional results, simplifies rehabilitation by limiting postoperative motion to a lesser degree than other techniques, is less aggressive than open reduction techniques and osteosynthesis, and leads to few complications.

Fractures of the proximal segment of the humerus represent around 5% of all fractures (Montiel et al. 2001), and their incidence in patients over 75 years of age increases to around three-quarters. The male-female ratio is 1:4. Up to 85% of these injuries are minimally displaced or not displaced at all, and they respond effectively to simple non-operative treatment using slings and early mobility exercises (Anchuela-Ocana et al. 1997).

Since Neer (1970 a, b) published his classic study of fractures of the proximal third of the humerus, in which he described methods for their classification and a scale for the evaluation of results, there has been considerable controversy about the management of fractures with severe displacement. For comminuted fractures that affect the joint surface, total or partial prosthetic replacement seems to be currently accepted as the treatment of choice (Kralinger et al. 2004); nevertheless, there is no consensus regarding treatment of two- and three-part displaced fractures. The use of closed reduction, percutaneous fixation using Kirschner wires (Herscovici et al. 2000), open osteosynthesis with plates or cerclage (Cornell et al. 1994, Gerber et al. 2004), rigid or flexible intramedullary nailing (Sanz et al. 2003), and interfragmentary suture (Park et al. 2003) have provided satisfactory results in 50–70% of cases.

The use of open techniques may aggravate the damage to vascularity already caused by the injury. The use of percutaneous techniques has been suggested to avoid this situation. In 1987, Kristiansen



Figure 1. A 2-part fracture preoperatively and after 5 weeks.

described a new technique for the treatment of displaced fractures of the proximal humerus using transcutaneous reduction with Steinman pins and external fixation with Hoffmann clamps, which gave excellent or satisfactory results in 80% of cases (Kristiansen and Kofoed 1987, 1988).

We reviewed clinical and radiographic results obtained by using a modification of the Kristiansen technique for the treatment of displaced 2- and 3-part fractures of the proximal humerus as a way of reducing the damage to the vascularity of the humeral head and the risk of infection associated with open techniques.

Method

We studied 62 consecutive patients (46 women) retrospectively, all of whom had had 2- or 3-part fractures of the humeral head treated with external fixation between January 2000 and January 2004. Mean age was 70 (33–88) years. The most common etiology was a fall (50 cases), followed by a road accident (12 cases). The indications for the use of this technique were 2- or 3-part fractures without detachment of the lesser tuberosity. Contraindications were concomitant diseases which would make them unsuitable for this operation (e.g. dementia).

According to Neer's classification, 40 patients had 2-part injuries and 22 had 3-part injuries. According to the AO classification, the distribution was 40 type A, 15 type B and 7 type C fractures. One of them was an AO C.3.2 type, with anteroinferior glenohumeral dislocation. The mean follow-up time was 1.5 (1–2) years. The radiographic con-

trols included anteroposterior and axial projections in the postoperative period and at 4 and 6 weeks, 3 and 6 months and 1 year. Clinical evaluation was by the Constant-Murley scale (Constant and Murley 1987), assessed 1 year after the operation in both the affected limb and the healthy limb. The radiographic evaluation of the reduction of the fracture used the criteria published by Neer (1970 a, b).

Statistics

The chi-square test was used for qualitative variables and Student's t-test and analysis of variance was used for the comparison of means. P-values ≤ 0.05 were considered significant.

Surgical technique (Figures 1 and 2)

The mean waiting time for surgery was 24 (1–48) h. After obtaining informed consent, all patients were operated under general anesthesia in supine position and under radioscopic control. External fixation was performed with a Hoffmann II External Fixation System (Stryker Orthopaedics, Mahwah, N.J.) by percutaneous placement of two 5-mm screws in the upper lateral part of the humeral head, parallel to each other in the transverse plane (unlike the technique described by Kristiansen and Christensen (1987) where the screws were placed in the sagittal plane), avoiding penetration of the joint cartilage. In the 3-part fractures the greater tuberosity of the humerus was fixed with at least one of the screws. In those fractures in which the bone fragment involving the lesser tuberosity was large enough, it was fixed with the upper anterior screw. After placing two additional screws in the diaphysis, the fracture was reduced with placement of the external fixator. In the case of fracture-dis-



Figure 2. A 3-part fracture preoperatively and after 4 weeks.

location (type C.3.1), the insertion of the screws enabled restitution of the head of the humerus in its joint position by applying traction.

The mean operation time was 45 min, with a mean hospitalization time of 2 days. Immediately after the operation, pendulum exercises were initiated and—depending on the tolerance to pain—active assisted mobilization of the shoulder in all its arcs of motion. The fixator was removed without anesthesia at the outpatient room 4–6 weeks after the operation, when clinical and radiographic assessment showed that sufficient stability of the fracture had been achieved. Controlled progressive rehabilitation was then continued.

Results

In all cases, the fracture healed after an average of 2.5 (2–3) months. The greater tuberosity did not displace in any of the cases. Radiographically, the reduction was considered to be good in 50 cases (displacement between fragments less than 5 mm and angulation less than 10°), and 8 cases were consolidated in mean 20° (7–35) varus and 4 cases in mean 23° (10–30) valgus. No secondary displacements occurred after fixator removal. None of the operations were converted to open reduction and osteosynthesis, but 2 of the patients underwent total shoulder replacement because of severe pain due to degenerative arthritis.

At follow-up the mean Constant score was 84 (31–96) points for the injured shoulder, with scores

higher than 80 points in 49 cases. The mean abduction was 140° (50–180), with a mean abductor force of 6.2 (1–9) kg representing 65% of the contralateral shoulder.

Sex ($p = 0.3$), age ($p = 0.3$), laterality ($p = 0.3$), or type of fracture ($p = 0.6$) had no influence on these results.

1 patient suffered secondary displacement with transchondral penetration of the screws after a new fall, which was resolved by reoperation and repositioning of the fixator, and the fracture healed. 1 patient developed skin infection around the

screws, but without bone engagement. The infection healed with oral antibiotic treatment. There were no other complications such as neurovascular lesions or head necrosis.

Discussion

Treatment of Neer 3- and 4-part fractures remains controversial. Even though there is growing acceptance of hemiarthroplasty as the treatment of choice for 4-part fractures, especially in elderly patients with marked osteoporosis (Anchuela-Ocana et al. 1997, Rees et al. 1998, Gerber et al. 2004), a large number of techniques are currently used for the treatment of 2- and 3-part fractures with large displacement. The purpose of the treatment is to achieve anatomic reduction and complete functional restitution of the shoulder. The main disadvantages of closed methods for the treatment of displaced fractures of the proximal humerus are inadequate or unsatisfactory reduction and lack of stability, which may lead to a secondary displacement and prolonged immobilization and rehabilitation time (Kristiansen et al. 1989). Percutaneous osteosynthesis limits the risk of infection and avascular necrosis, but does not give enough stability to allow early motion (Herscovici et al. 2000, Gerber et al. 2004). Open reduction with osteosynthesis offers satisfactory stability but there is a high risk of damage to the remaining blood supply to the head (Gerber et al. 1998), and thus of both necrosis and infection.

The technique we used eliminates several of the problems associated with both percutaneous and open methods. Reduction is simplified by the possibility of applying traction and rotation to the fragments through the screws and it is maintained by the fixator, preventing secondary displacement (Kristiansen and Borgwardt 1992). The probability of vascular damage—and the associated risk of necrosis—minimized. This enables primary stabilization which in turn permits immediate rehabilitation, leading to an acceptable range of motion.

The possible immediate complications of this technique can be prevented by taking extra care. Damage to the axillary nerve is prevented by placing the cephalic screws in an area proximal to the head of the humerus, following the “safe corridors” described by Green (1983). Prevention of damage to the radial nerve is ensured by avoiding placing the distal screws beyond the deltoid tuberosity and not making any inappropriate movements that could push them towards the posterior face of the humerus.

Our technique gave satisfactory results in four-fifths of the patients, a rate similar to that described by other authors using open techniques (Rees et al. 1998, Park et al. 2003) and greater than that described for series with percutaneous fixation (Herscovici et al. 2000, Sanz et al. 2003), but with fewer complications. We consider that it is a useful alternative in the treatment of displaced 2- and 3-part proximal fractures of the humerus.

Author contributions

All authors operated on the patients and wrote the manuscript.

No competing interests declared.

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