

EXTERNAL FIXATION OF DISPLACED FRACTURES OF THE PROXIMAL HUMERUS

TECHNIQUE AND PRELIMINARY RESULTS

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A new technique for the treatment of displaced fractures of the proximal humerus is described. Twelve fractures in 11 patients were managed by transcutaneous reduction using a Steinmann pin, and external fixation with a Hoffmann-type neutralising bar connected to two half-pins in the humeral head and three half-pins in the shaft. The pins were removed after four weeks.

Two patients sustained redisplacement after a further injury, but in the others reduction was maintained. Two cases of pin-track infection resolved after antibiotics, but delayed union resulted. There were no neurovascular injuries and at follow-up of 6 to 12 months no refractures had been seen. The early functional results were excellent or satisfactory in nine cases.

Since Neer published his classic study of fractures of the proximal humerus, in which he described methods of classification (1970a) and an assessment of the results of treatment (1970b), there has been disagreement on the management of severe displacement. For badly comminuted fractures which involve the articular surface, either total or partial joint replacement seems to be the treatment of choice (Neer 1970b; Tanner and Cofield 1983; Stableforth 1984), but there is no consensus on the treatment of displaced two-, three- and four-part fractures. Using the Neer assessment, only 50% to 60% of results are reported to be excellent or satisfactory after any of a range of methods of treatment. These include: closed methods (Clifford 1981; Leyshon 1984; Mills and Horne 1985), open reduction and internal fixation (Sturzenegger, Fornaro and Jacob 1982; Paavolainen et al. 1983; Kristiansen and Christensen 1986) and arthroplasty (Kraulis and Hunter 1976; de Anquin and de Anquin 1982; Willems and Lim 1985). This relative failure of established methods indicates that alternative techniques should be evaluated.

This paper describes a technique for transcutaneous reduction and external fixation of these fractures and

presents the preliminary results with special emphasis on technical errors and complications related to the fixator.

MATERIAL AND METHODS

From January to July 1986 we treated 12 proximal humeral fractures in 11 patients by closed reduction and external fixation with a Hoffmann type of fixator.

Selection of cases. The Neer (1970a) classification system was used and we included in the study fractures with more than 1.0 cm of displacement or 45° angulation or rotation of the humeral head. We excluded fractures which had split the head of the humerus.

Technique of operation. With the patient under general anaesthesia and in a supine position a Steinmann pin is introduced transcutaneously under image-intensifier control into the major head fragment and used to help reduce the fracture. This reduction is maintained by an assistant, while two half-pins with continuous threads are drilled into the humeral head and two or three pins into the humeral shaft. A neutralising bar is applied and the Steinmann pin removed (Fig. 1).

The shaft pins are introduced from the lateral side and just penetrate the medial cortex. To avoid injury to the circumflex arteries, the axillary nerve proximally and the radial nerve distally, the zone of insertion is limited to from about 20 mm distal to the fracture to the level of the deltoid tuberosity. In the humeral head, pin placing is determined by the number, size and stability of the fragments. Ideally, the pins are introduced lateral to the bicipital groove and their tips just reach the opposite cortex, with care not to penetrate the articular surface.

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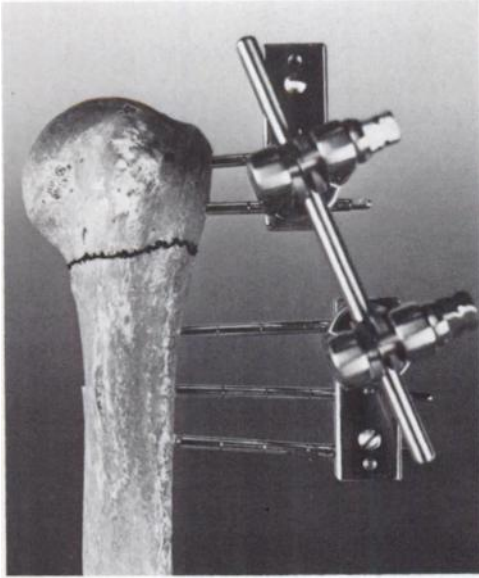


Fig. 1

The Hoffmann external fixation frame in the proximal end of the humerus, using five half-pins, two universal ball-joints and one connecting rod.

When the greater tuberosity has been separated it is reduced and fixed by one pin to the head fragment, while the other pin is placed directly into the head. The position of the pins in relation to the type of fracture is illustrated in Figure 2. The stability of the completed fixation is then tested by performing a full range of passive movement at the glenohumeral joint under vision, using the image intensifier.

Postoperative management. After operation functional exercises start early and active use of the arm is encouraged. The pin sites are cleaned daily with chlorhexidine 0.05% and the pins are removed in the outpatient department after four weeks. Clinical and radiographic assessments were made every three months.

RESULTS

There were six men aged from 31 to 65 years, and five women aged 36 to 85 years, one of whom had bilateral fractures. Two fractures involved the surgical neck only, eight also had detachment of the greater tuberosity, while two were four-part with separation of the lesser tuberosity. Two cases are illustrated in Figures 3 and 4.

There were no open fractures. In 10 cases, the fracture was reduced to leave only minimal displacement (Neer 1970b). In two cases reduction was not optimal, but was accepted because solid bony contact was obtained.

Secondary displacement was seen in two patients, both of whom sustained direct injury to the Hoffmann apparatus about two weeks after its application and

suffered displacement of the pins as well as the fracture. In one of these patients re-reduction and re-fixation was performed, with eventual healing in near-anatomical position. In the other patient severe pin-track infection and loosening of the pins in the humeral head required their removal and parenteral antibiotic therapy. Infection was controlled but there was delayed union, though by six months callus was visible and there was functional stability.

In one other patient there was pin-track drainage with positive cultures after two weeks and, although the infection resolved after a week of extra pin care and antibiotics, there was some delay in union. No cases of neurovascular injury were seen and after follow-up of six to 12 months, no refracture or radiographic evidence of avascular necrosis has been seen.

The early functional results were assessed according to the Neer numerical score system. Three cases were excellent, six satisfactory, two unsatisfactory and none were poor. One patient had died from chronic cardiac and hepatic failure.

DISCUSSION

The major disadvantages of closed methods in the treatment of displaced fractures of the proximal humerus have been reported to be poor reduction, instability leading to secondary displacement and a prolonged

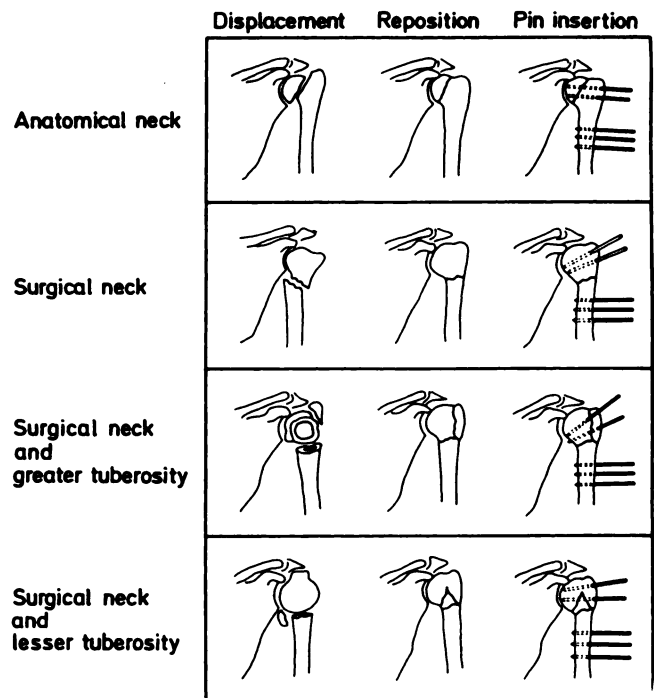
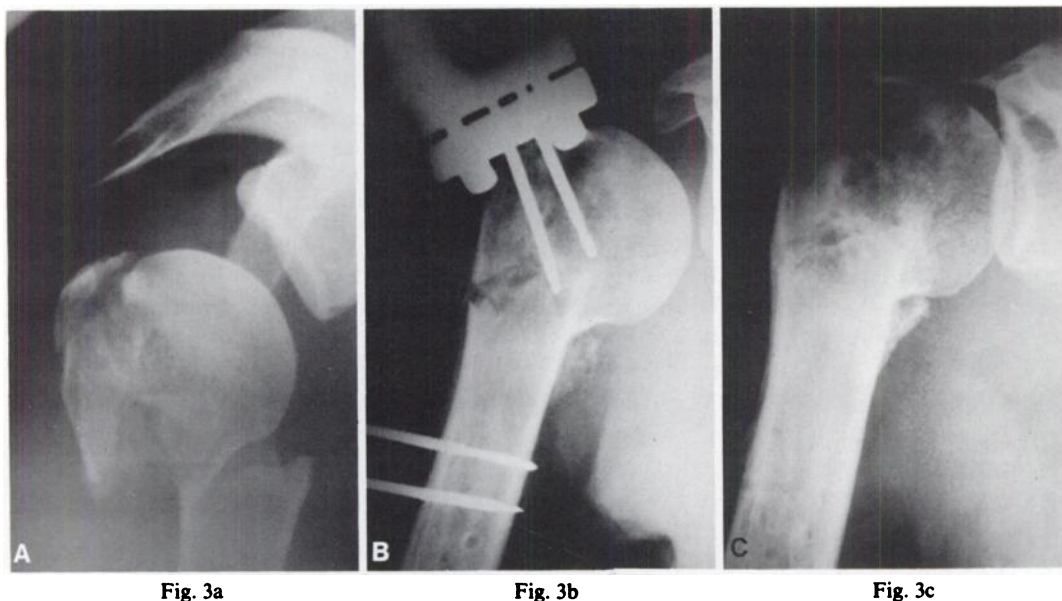
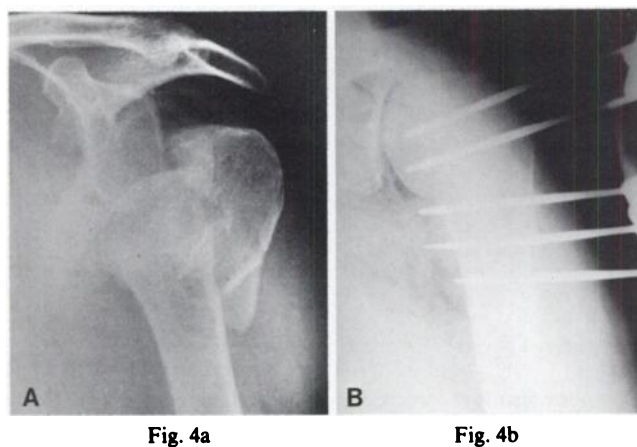


Fig. 2

Diagrams showing the recommended position of the half-pins in relation to the level of the fracture. The Neer (1970a) classification system is used and reposition is performed transcutaneously with a Steinmann pin.



Case 3. Figure 3a—A three-part fracture in a 31-year-old man, showing medial and anterior displacement of the shaft due to the pull of the pectoralis major; 3b, after reposition and external fixation; 3c, after three months the fracture had healed in good position and function was excellent.



Case 7. Figure 4a—A displaced four-part fracture in a 57-year-old man. The articular surface is subluxated downward with impaction at the level of the surgical neck; 4b, after transcutaneous elevation and reposition with external fixation. The fracture healed in unchanged position, giving an excellent functional result at six months.

rehabilitation time (Leyshon 1984; Stableforth 1984; Mills and Horne 1985). Open reduction and internal fixation offers satisfactory stability, but it is a demanding technique sometimes leading to technical error, with a risk of damage to the remaining blood supply to the head of the humerus and avascular necrosis (Sturzenegger et al. 1982; Paavolainen et al. 1983; Kristiansen and Christensen 1986). Infection is seen in about 10% of cases (Paavolainen et al. 1983; Kristiansen and Christensen 1986).

The immobilisation of fracture fragments by the insertion of pins connected externally is not new. In the shoulder region pins in the clavicle or scapular spine proximally and the humeral shaft distally have been

advocated for arthrodesis, comminuted open fractures and infected non-union (Mears 1979; Burny 1985), but we have found no earlier report of pinning the humeral head.

The technique we describe can, in theory, eliminate many of the problems associated with closed methods and with internal fixation. Reduction is facilitated by the transcutaneous insertion of a Steinmann pin and is maintained by the external neutralisation bar. Immediate movement of shoulder, elbow and hand is facilitated, thereby reducing oedema and capsular fibrosis (Sisk 1983). The insertion of pins within the anatomically safe corridors described by Green (1981) should avoid neurovascular lesions and the danger of transfixing

tendons. If redisplacement occurs, the fixator can be loosened and a re-reduction performed. Pins can be removed without anaesthesia in the outpatient clinic.

Fracture reduction succeeded in 10 of our 12 cases and was maintained in all except the two patients who sustained traumatic redisplacement. This indicates that the simple one-plane fixation is mechanically adequate.

Our major problem was pin-track infection leading to delayed union; the incidence in this series is comparable to that in most other reports on external fixation (Green 1983). Prophylactic measures include meticulous daily care and the aggressive treatment of any local reaction.

The early functional results are very satisfactory, and further recovery can be expected up to one year after injury (Lundberg, Svenungsson-Hartwig and Wikmark 1979; Lentz and Meuser 1980; Young and Wallace 1985). Avascular collapse of the humeral head occurs most frequently after more than 12 months' follow-up (Neer 1970b), so knowledge of its incidence in our series will have to await the late results.

Conclusion. Satisfactory fracture reduction and stability, a fairly low rate of complications and good early functional results have been obtained by the technique of transcutaneous reduction and external fixation. This is a useful alternative in the treatment of displaced fractures of the proximal humerus and is to be further evaluated in a controlled clinical trial.

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