FUNCTIONAL BRACING FOR COMMINUTED EXTRA-ARTICULAR FRACTURES OF THE DISTAL THIRD OF THE HUMERUS

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From 1982 to 1987 we treated 85 extra-articular comminuted distal third humeral fractures in adults with prefabricated plastic braces. Of these, 15% were open fractures and 18% had initial peripheral nerve injury. On average, the sleeve was applied 12 days after injury and used for 10 weeks.

There was 96% union, with no infections. All nerve injuries resolved or were improving at the latest examination. At union there was varus deformity averaging 9° in 81% of patients, but loss of range of movement was minimal and functional results were good.

The brace management of humeral shaft fractures has been reported to give a high rate of union with good functional results (Sarmiento et al 1977; Balfour, Mooney and Asby 1982; Kujat and Tscherne 1984; Ricciardi-Pollini and Falez 1985). However, fractures in the distal third of the humerus in adults can cause problems because of difficulty in controlling angulation, and the incidence of radial nerve damage and residual stiffness of the shoulder and elbow (Horne 1980; Aitken and Rorabeck 1986). We therefore reviewed our experience of functional bracing in the treatment of these fractures.

PATIENTS AND METHODS

From 1982 to 1987 a total of 85 extra-articular comminuted distal third humeral fractures in adults were treated with prefabricated functional braces at LAC/USC Medical Centre. Thirteen patients (15%) were lost to follow-up while still wearing the plastic sleeve brace and are excluded. We have reviewed the medical records and radiographs of the other 72 retrospectively. Of these, 65 (76%) had complete clinical and radiographic records, and seven (8%) had only complete radiographic records.

Of the 65 patients with complete data, 37 (57%) were men and 28 (43%) were women. Their average age was 28 years (17 to 62). The right humerus was fractured in 43 (66%) and the left in 22 (34%). The mechanism of injury included: 18 falls (27.6%), 18 automobile accidents (27.6%), eight gunshot wounds (12.3%), eight motorcycle accidents (12.3%), four assaults (6.1%), two at sport (3%) and seven uncertain (10.7%). Fifty-four fractures (83%) were closed and 11 (17%) were open. The average time from injury to application of the sleeve was 12 days (4 to 45).

The initial management of closed fractures was usually by the application of a hanging cast, a ‘U’ splint and sling, or a sling and swathe, most having a hanging cast. The patients were then referred to an out-patient clinic, and when initial fracture swelling and pain had settled a plastic sleeve brace was applied. The plastic sleeves used for these patients were prefabricated with two adjustable Velcro tightening straps (Fig. 1). When properly fitted, the sleeve compressed the soft tissues of the arm, and patients were carefully instructed to maintain a snug fit by adjusting the Velcro straps. Too snug a fit may cause swelling of the distal arm and require loosening of the straps.

Patients were taught pendulum shoulder exercises and elbow flexion/extension exercises. They were forbidden to rest the elbow on an armchair, a table or their own lap, so as to avoid varus angulation at the fracture site. The sleeve was worn at all times except for bathing. All patients initially had a collar and cuff for comfort, but were encouraged to remove it temporarily several times a day to passively flex and extend the elbow.

One week after the sleeve had been applied, patients
were reviewed; use of the collar and cuff was then discouraged, except during sleeping hours, to allow gravity to assist in fracture reduction. Pendulum shoulder movements and active and passive elbow exercises were encouraged. Active flexion and abduction of the shoulder were forbidden to avoid angulatory deformity. Further review was at three to four weeks.

Anteroposterior and lateral radiographs were obtained at each visit and the range of movement of the elbow and forearm was measured. Once there was early clinical evidence of union and radiographic callus, active shoulder abduction and flexion were permitted. The use of the plastic sleeve was discontinued when there was definite clinical and radiographic evidence of healing.

Patients with low-velocity gunshot wounds were admitted for three days of intravenous antibiotics. Patients with other types of open fracture were treated by irrigation and debridement and also had three days of intravenous antibiotics. Open fractures were then treated as for closed fractures. One open fracture required reverse saphenous vein grafting of the brachial artery with simultaneous application of an external fixator. The fixator was removed at six weeks and a sleeve applied. The fracture united and a full range of shoulder movement was regained, but with limitation of 10° of flexion/extension at the elbow.

Patients with closed fractures or low-velocity gunshot wounds and evidence of radial nerve injury had no special treatment, except that passive exercises for the wrist and fingers were added to the shoulder and elbow exercises. Splints were not used because we felt that early extension of the elbow helped to prevent the development of flexion contractures of the wrist and fingers; they are in extension when the arm is dependent. Twelve patients (18%) had some initial nerve damage on physical examination, three caused by gunshot wounds. Ten had injury of the radial nerve alone and two had radial and partial median nerve involvement.

RESULTS

Five (7%) patients of the 72 with radiographic follow-up were excluded: three because of non-union (4%), one with a congenital brachial plexus palsy and one who had suffered an earlier fracture of the proximal humeral shaft. For the 65 patients with complete clinical and radio-

Fig. 1
Humeral sleeve brace with collar and cuff sling.

Fig. 2a

Fig. 2b

Figure 2a – Gunshot injury with a comminuted distal third fracture of the humerus. Figure 2b – Radiographs at 10 months showing healing with mild varus angulation and a satisfactory range of flexion/extension.
cases was unsuccessful because many of the patients were from a non-compliant social group.

**Range of movement.** The most commonly lost movement was external rotation of the shoulder: 26 patients (45%) having lost from 5° to 45° (Fig. 3). Shoulder abduction was limited by 10° to 60° in nine patients (15.5%), and shoulder flexion by 5° to 20° in eight (13%). Elbow flexion was reduced by 5° to 25° in 15 patients (26%), and extension was limited by 5° to 25° in fourteen (24%). All these limitations of motions were recorded at the time of the latest review but may have improved with continued use of the limb.

**Nerve injury.** Nine of the 12 cases of nerve injury had complete resolution at follow-up, and the other three had improving nerve function at latest follow-up, two, four and six months after injury.

**Malunion.** After union in 69 cases, radiographs were measured for angulatory deformity. On the anteroposterior views, 11 patients (16%) had no deformity, there was varus angulation in 56 (81%) and valgus deformity in

graphic records, the ranges of shoulder and elbow movement were known in 58 (90%). The average time in the plastic sleeve was 10 weeks. Radiographic union occurred in 69 of the 72 fractures (96%).

Of the 11 open fractures (including gunshot wounds) none had early or late infection and all the gunshot wounds united (Fig. 2). One of the other three open fractures failed to unite. Long-term follow-up of these two (3%). An example is shown in Figure 4 and details of the angulations are given in Figure 5.

On the lateral views, 14 had no angulation (20%), and 55 (80%) had a median angulation of 4°. Posterior angulation ranged from 3° to 22° in 27 patients (39%), and anterior angulation in 28 (41%) ranged from 1° to 30° (Fig. 6).

Shortening at the fracture site averaging 5 mm (2 to
15) was seen in 25 patients (36%); one patient had 5 mm lengthening.

DISCUSSION

It is generally agreed that fractures of the mid-shaft of the humerus are best treated by closed methods. Open treatment has shown higher rates of non-union, nerve injury and infection (Rüedi et al 1974; Rockwood and Green 1984). However, because of the belief that distal humeral fractures are difficult to accurately reduce and hold or because of initial radial nerve injury, open treatment of distal third fractures has been advocated (Hostein and Lewis 1963; Rüedi et al 1974; Horne 1980; Aitken and Rorabeck 1986). Our experience does not support those arguments, since the deformities seen in the vast majority of our patients did not preclude very good functional results and initial radial nerve damage resolved spontaneously in most instances.

There are also problems, however, with closed management (Dowden 1980). Treatment of distal humeral fractures in casts frequently results in loss of elbow movement. Our use of a functional sleeve attempts to avoid this (Sarmiento et al 1977; Latta, Sarmiento and Tarr 1980; Sarmiento and Latta 1981; Balfour et al 1982). Our early results were satisfactory and we suspect that the ranges recorded will continue to improve with the passage of time.

The functional humeral sleeve is an unsatisfactory concept to those orthopaedic surgeons who feel that immobilisation of fractures is an important prerequisite for healing. Fracture brace treatment requires acceptance of the premise that gradual functional activity and the resulting controlled motion at the fracture site are conducive to osteogenesis (Sarmiento et al 1977; Sarmiento and Latta 1981). Immobilisation of the adjacent joints is specifically avoided. The sleeve compression of the surrounding soft tissues and the effect of gravity on the arm, both tend to improve the alignment of the fragments, correcting the initial angulatory deformities.

Angulatory deformities are more likely to develop in transverse fractures, particularly if they are anatomically reduced. The fact that most distal humeral fractures are comminuted may well contribute to uneventful healing. Transverse diaphyseal fractures of long bones appear to heal more slowly (Sarmiento and Latta 1981). This is why patients should be instructed to let the arm hang to the side without support as soon as symptoms permit. In our experience this is possible one week after application of the sleeve. Leaning on the elbow must be strictly avoided.

In our series, deformity in the lateral plane did not correlate with loss of range of movement. The varus angulation seen on radiographs was often difficult to detect clinically; the resulting loss of the carrying angle has not been associated with unsightly appearance or functional impairment. Loss of the last few degrees of external rotation of the shoulder is common but of no significance, and is probably due to capsular contracture in most instances. We suspect that malrotation at the fracture site is corrected significantly by active contractions of the flexors and extensors of the elbow (Sarmiento and Latta 1981).

Our clinical and radiographic results demonstrate that closed treatment using a prefabricated plastic sleeve gives satisfactory results in most patients with comminuted extra-articular fractures of the distal third of the humerus. They also strongly suggest that early nerve
exploration for nerve injury is not justified. There seems to be no basis for the belief that open treatment is needed to obtain acceptable alignment; reduction is adequate with compression by the sleeve and gravity pulling downward. Open fractures, including gunshot wounds, may also be successfully treated in this manner after debridement and antibiotic treatment.

The functional sleeve is lightweight, adjustable, removable and well tolerated; it allows for an early and comfortable range of movement at both shoulder and elbow. The gradual early use probably produces physiologically-controlled movement at the fracture site which enhances osteogenesis.

A small benefit was received from a commercial party related to the brace described in this article.

REFERENCES


