FRACTURES OF THE SHAFT OF THE HUMERUS

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This paper reviews a series of fractures of the shaft of the humerus with particular reference to deformity after conventional methods of immobilisation and to the disability that may result from angulation at the fracture site.

Reviews by Ghormley and Mroz (1935), O'Shea (1936), Eve and Daniel (1941), Stewart and Hundley (1955), Kennedy and Wyatt (1957), and the Scientific Research Committee Pennsylvania Orthopaedic Society (1959) have dealt with the treatment of fractures of the shaft of the humerus by hanging plasters, shoulder spicas, abduction splints, Thomas's arm splints and Velpeau bandages. I have been unable to find a report of a series treated by the relatively simple splintage of a U-shaped plaster and a collar-and-cuff sling, or by a sling alone.

FIG. 1
Histogram showing age distribution.

CLINICAL MATERIAL

There were ninety-eight patients with fractures of the shaft of the humerus, defined as that part below the surgical neck and above the level of the epicondyles. Injuries in children and pathological fractures were excluded. Fifty-five patients were men and forty-three were women. Most of the patients were treated at the Middlesex Hospital and the London Hospital; a third smaller group came from King Edward VII Memorial Hospital, Ealing. The age distribution is shown in Figure 1.

METHOD OF STUDY

The notes and radiographs of the patients were reviewed. Letters were written to all the patients and thirty-two patients were interviewed and questioned regarding any disability in relation to the fracture. Examination was carried out with particular reference to deformity and the range of movements at the elbow and shoulder, and radiographs were taken. The time that had elapsed since injury ranged from four months to nine and a half years.

VARIETIES OF FRACTURE

In seventy-three patients the fractured humerus was the only injury, but twenty-five had other injuries as well. Five had injuries to the same limb which made treatment more difficult: namely fractures of the olecranon, fracture of the clavicle, posterior dislocation of the shoulder with fracture of the greater tuberosity of the humerus, dislocation of the elbow, and compound

Monteggia fracture-dislocation. The patient with fracture of the clavicle had the humeral fracture stabilised by the insertion of a four-hole plate and screws. The patient with the Monteggia fracture-dislocation, after wound excision and skin grafting, was treated conservatively until the local sepsis had subsided, but the humeral fracture failed to unite and required bone grafting. In the remainder of these five patients the humeral fracture was treated conservatively.

Level of fracture—The fractures were subdivided according to their level in the shaft, as shown in Table I. The middle third of the shaft was by far the commonest site.

Type of fracture—The type of fracture, whether transverse, oblique or spiral, and the association of a butterfly fragment as distinct from a minor degree of comminution was recorded (Table II). The common occurrence of spiral fractures in patients over fifty may be related to the brittleness of the bone.

TABLE I
LEVEL OF FRACTURE

Uppermost third of shaft	22*
Junction of middle and uppermost thirds	4
Middle third of shaft	44
Junction of middle and lowest thirds .	12*
Lowest third of shaft	17
Total	99

* One patient had a double fracture.

TABLE II
PATTERN OF FRACTURE

	Total number of patients	Patients over 50 years	Butterfly fragments
Transverse fracture	33	10	3
Oblique fracture .	26	14	5
Spiral fracture .	39	26	8

TREATMENT

Eighty-seven patients were treated conservatively. In most, a U-shaped plaster and a collar-and-cuff sling were applied, generally without anaesthesia (Fig. 2). Eight patients were treated by a collar-and-cuff sling alone, two by a shoulder spica and two by a hanging plaster. In eleven patients internal fixation was carried out because of multiple injuries, distraction of the fragments or difficulty in maintaining adequate alignment.

Compound fractures—Six fractures were compound. One patient developed infection with delayed union and bone grafting was necessary. Of the remaining five patients two had intramedullary fixation of the fracture after the primary wound had healed, and three, after wound excision, were treated by closed methods and the fractures united satisfactorily.

Radial nerve palsy—Ten patients had a radial nerve palsy. All were recognised at the time of injury and none occurred later. In seven there was gradual recovery until full motor power returned, but in two failure to recover was considered an indication for exploration. One

nerve was found to be divided, and the other recovered after it had been mobilised and removed from a bed of callus and placed in healthy tissue. Two patients with normal motor function had hypoaesthesia in the distribution of sensory branches of the radial nerve. One involved the lateral cutaneous nerve of the forearm, and the other the superficial radial nerve. One patient failed to attend before completion of this treatment.

The patients with nerve lesions were grouped according to the level of the fracture (Table III). Their ages ranged between the thirties and the seventies.

The relationship of the level of fracture to nerve palsy corresponds with that described by Scudder (1915) and Cubbins and Scuderi (1933). The four nerve injuries in association with fractures at the junction of middle and lowest thirds of the shaft may well have occurred as the radial nerve has least mobility at this point, where it pierces the lateral intermuscular septum (Holstein and Lewis 1963). The same factor is probably responsible for radial nerve palsy in fractures of the middle third of the humerus where there is direct contact between the nerve and the bone in the lower part of the spiral groove (Whitson 1954). It is interesting that four of the six fractures of the middle third were of the transverse variety, as were two of the four at the junction of the middle and lowest thirds of the shaft.

Union and delayed union—Of the eighty-seven fractures treated by conservative measures twenty-three were clinically united at six weeks, thirty-four after eight weeks and thirteen at ten weeks. Six united much more slowly and took from eleven to nineteen weeks (Table IV).

FIG. 2
The method of splintage used.

TABLE III
LEVEL OF FRACTURE IN RADIAL NERVE PALSY

	Number of patients
Uppermost third of shaft	1
Junction of middle and uppermost third of shaft	0
Middle third of shaft	5
Junction of middle and lowest third of shaft .	4
Lowest third of shaft	0
Total	10

Delayed union was defined as absence of clinical union eight weeks after fracture. Ten patients fell into this group and eight of them had been treated by conservative measures. The age incidence of patients with delayed union was evenly distributed (Table V). The sites of delayed union were variable but the middle third of the bone was the commonest level where three out of five fractures were transverse (Table VI). Factors considered to be likely causes of delayed union are summarised in Table VII.

The blood supply to the humerus is probably the most important single factor in relation to delayed union. The main nutrient artery usually enters the bone at the junction of the middle and lowest thirds, or in the lower part of the middle third (Laing 1956). The foramina

TABLE IV
TIME OF UNION OF EIGHTY-SEVEN FRACTURES
TREATED CONSERVATIVELY

Time of union	Number of patients
6 weeks	23
8 weeks	34
10 weeks	13
11 to 15 weeks	4
16 to 20 weeks	2
Delayed union	8
Inadequate information	3
Total	87

TABLE V
AGE OF PATIENTS WITH DELAYED UNION

Age (years)	Number of patients
31-40	3
41-50	2
51-60	3
61-70	2

TABLE VI
SITES OF DELAYED UNION

Level of shaft	Number of patients
Uppermost third	2
Junction of upper and middle thirds	1
Middle third	5
Junction of middle and lowest third	1
Lowest third	1

TABLE VII
THE LIKELY CAUSES OF DELAYED UNION

Likely causes	Number of patients
Distraction or poor apposition	3
Initial internal fixation	2
Probably interference with blood supply of the shaft	2
Open injury and infection	1
Soft-tissue interposition	1
Unknown	1

are concentrated in a small area in the region (Carroll 1963). Damage to this vessel is most likely in fractures of the middle third of the bone. It is thus significant that five examples occurred at this level, and both patients who had had internal fixation of their fractures were in this group.

Of the ten patients with delayed union seven were treated by bone grafting and three by prolonged immobilisation of the limb. The technique of grafting consisted of internal fixation and the application of slivers of iliac crest to the fracture site. Intramedullary nails were used in five patients, one fracture was plated and one fracture was held with screws. All these operations resulted in bony union.

FIG. 3
Case 11. Figure 3—Radiograph of the humerus showing 35 degrees of varus. Figure 4—Radiograph showing 10 degrees of posterior angulation.

FIG. 5
Case 23. Figure 5—Patient without apparent deformity of the left arm. Figure 6—Radiograph of the humerus showing 25 degrees of varus.

FIG. 7
Case 28. Figure 7—Patient with anterior bowing. Figure 8—Showing just perceptible varus of the left humerus. Figure 9—Radiograph of the humerus showing 35 degrees of varus.

RESULTS

In general, treatment resulted in reasonable appearance and good function. The most common radiographic deformity was varus at the fracture site (Figs. 3 and 4), irrespective of the level, and with it backward bowing was found more often than forward bowing. Valgus at the site of fracture was uncommon.

TABLE VIII
CORRELATION OF DEFORMITY AND FUNCTIONAL LIMITATION

Case number	Deformity	Fracture level	Radiological deformity (degrees)	Functional limitation (degree of movement)
1	Nil	Uppermost third	15 varus	Nil
2	Nil	Lowest third	10 varus, 6 posterior bowing	Nil
3	Nil	Midshaft	9 varus, 15 posterior bowing	Nil
4	Nil	Uppermost third	Nil	Nil
5	Palpable lump	Midshaft	15 varus	Nil
6	Nil	Lowest third	10 varus, 10 posterior bowing	Nil
7	Nil	Midshaft	Nil	Nil
8	Nil	Midshaft	Nil (open reduction)	30 limitation of abduction of shoulder
9	Nil	Uppermost third	Nil	Nil
10	Nil	Uppermost third	10 varus	Nil
11	Obvious	Lowest third	35 varus, 10 posterior bowing	Elbow flexion lacked 30. Extension lacked 20. Abduction of shoulder to 120 only
12	Nil	Midshaft	3 varus, 3 posterior bowing	Elbow extension lacked 15
13	Nil	Midshaft	12 anterior bowing	Elbow extension lacked 15
14	Nil	Uppermost third	Nil	Elbow extension lacked 10. Internal rotation of shoulder two-thirds normal
15	Nil	Junction of middle and uppermost thirds	10 varus	Nil
16	Nil	Lowest third	10 valgus	External rotation of shoulder increased by one-third
17	Nil	Uppermost third	20 valgus	Nil
18	Nil	Middle third	Nil	Nil
19	Nil	Uppermost third	3 valgus	Nil
20	Nil	Lowest third	2 varus	External rotation of shoulder two-thirds normal
21	Nil	Midshaft	15 varus	Nil
22	Nil	Lowest third	Nil	Elbow extension lacked 30. Terminal restriction of abduction and internal rotation of shoulder
23	Nil	Uppermost third	20 posterior bowing, 35 varus	Nil
24	Nil	Middle third	Nil	Nil
25	Nil	Middle third	Posterior displacement of distal fragment by whole diameter of shaft	Nil
26	Nil	Junction of middle and uppermost thirds	15 valgus	Nil
27	Nil	Midshaft	12 varus	Nil
28	Obvious	Midshaft	35 varus, 35 anterior bowing	Elbow extension lacked 20
29	Nil	Lowest third	Nil	Nil
30	Nil	Midshaft	Nil (open reduction)	Terminal restriction of shoulder movements
31	Obvious	Junction of middle and lowest thirds	30 varus, 18 anterior bowing	Nil
32	Obvious	Middle third	20 anterior bowing	Elbow flexion and extension lacked 10

None of the thirty-two patients examined had any significant disability. Despite radiological evidence of angulation the limb usually looked normal (Figs. 5 and 6). One patient with anterior bowing of 20 degrees showed an obvious bony prominence, but varus of 30 degrees or more was necessary before it became clinically apparent (Figs. 7, 8 and 9). Rotation deformity was noted in two patients only, confirming the observations of Perkins (1958) that rotation is prevented by supporting the hand on the lower part of the chest. Four patients had an obvious deformity and three were engaged in heavy work. Progressive anterior bowing despite clinical union at six weeks was seen in one patient with a transverse fracture, thus illustrating the need for protection of this type of fracture until consolidation has occurred (Perkins 1958).

Details of the correlation of deformity and functional limitation are shown in Table VIII.

SUMMARY AND CONCLUSIONS

1. It appears that fracture of the humeral shaft occurs more often in persons over fifty. This incidence corresponds with that found in a study carried out by the Pennsylvania Orthopaedic Society in 1959.
2. The middle third of the bone is the most vulnerable portion of the shaft, where transverse fracture and radial nerve palsy most commonly occur.
3. Most fractures of the shaft of the humerus are best treated by simple splintage. The degree of radiological deformity that can be accepted is far greater than in other long bones. In this group anterior bowing of 20 degrees or varus of 30 degrees was present before it became clinically obvious and even then the function of the limb was good.
4. Internal fixation is only occasionally indicated but operation on the middle third of the bone increased the chances of delayed union.
5. In the treatment of delayed union intramedullary fixation and the application of slivers of iliac bone is effective in stimulating the fracture to join.

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