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## FRACTURES OF THE HUMERUS FROM MUSCULAR VIOLENCE

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Accepted 15.x.71

According to the literature, fractures of the shafts of long bones due to muscular violence alone are uncommon. There are reports from the United States, Finland and Germany of fractures of the shaft of the humerus sustained while throwing the javelin, the baseball or hand grenades (Bingham 1959, Clemmons & Hammond 1947, Heiss 1960, Herzmark & Klune 1952, Krainz 1939, Peltokallio 1968).

The aetiology of these fractures has been in doubt. Most authors attribute them to violent uncoordinated muscular action on the bone, but some believe that they are just due to stress (Bøje 1942, Petersen 1970).

The following four cases are described as further examples of fractures caused by throwing.

### CASE HISTORIES

1. The first patient was a well trained soldier of 24 years of good previous health and of medium height and weight. The incident occurred when he was trying to throw a hand grenade as far as possible. He suddenly experienced a painful crack in the right upper arm which then fell limply to his side. On arrival at hospital he was found to have a simple fracture of the lower third of the right humerus without vascular or neural lesion. Radiography showed this to be a spiral fracture with a large butterfly fragment at the junction between the middle and distal third of the humerus (Figure 1). The arm was treated in a hanging cast for seven weeks, after which the fracture was found to be united clinically and radiologically in a satisfactory position. Three weeks later there was full movement in the upper limb with no sign of nerve injury.



*Figure 1. Fracture initially.*

2. The second case too was a well trained soldier of 21 of normal previous health. While throwing a hand grenade in a competition he suddenly got a spiral fracture of the right humerus. Clinically and radiologically the fracture was quite similar to the one in the first patient. There was no sign of vascular or neural lesion. The patient was treated in a hanging cast for six weeks, when it was clinically and radiologically found to be united in good position. A few weeks later he had full movement in the upper limb.

3. The third case too was a soldier of 27 of previously good health. For several years he had played handball. During a match, on throwing the ball violently he got a spiral fracture with a large butterfly fragment in his right humerus. The level and appearance of the fracture were similar to the two previous cases. After six weeks' treatment in a hanging cast the fracture was found to be united in good position. There was considerable limitation of movement at the shoulder and at the elbow but no sign of nerve injury. A few weeks later full movement had returned to the arm.

4. The fourth patient was a 17-year-old girl of normal previous health. She had been an active handball player for the previous five years. During a violent throw in a match she suddenly had a pain in the right elbow and the upper arm. She stopped playing and attended

*Figure 2. Fracture initially. The fracture has been set off with ink.*

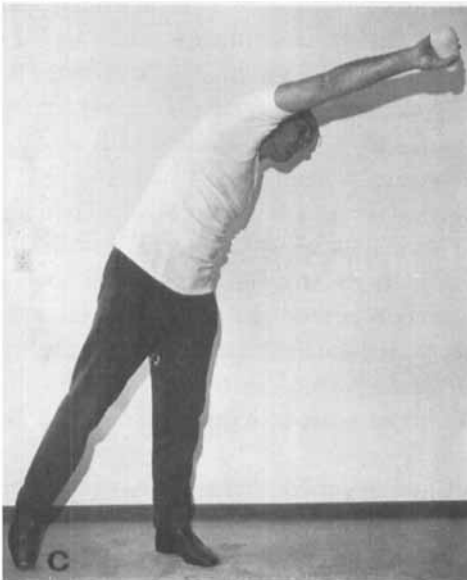
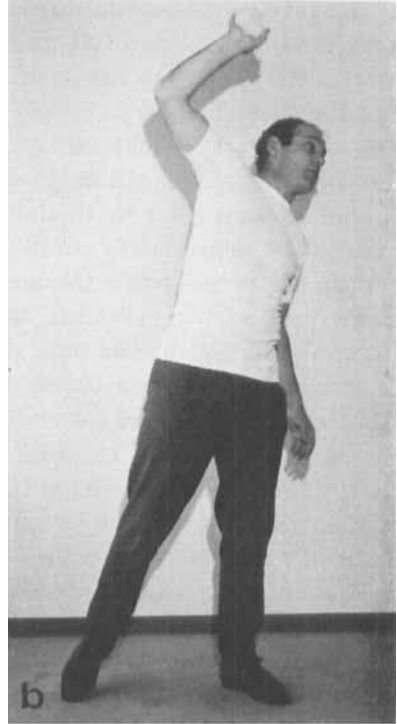


our accident department because of persistent pain in the upper arm. Examination showed there to be some swelling and tenderness just above the elbow but no other sign of fracture or of neural injury. Radiography showed a fine but distinct fracture line at the junction of the middle and lower third of the humerus (Figure 2). The arm was treated in a simple sling. Eleven days after the accident she complained of slight paraesthesia on the dorsum of the fingers of the right hand. The site of the fracture was still sore and radiography showed the fracture to be unchanged. Four weeks later the fracture was found to be healed and there was full movement in the upper limb with no sign of nerve injury.

#### DISCUSSION

Injuries to the elbow joint in people who are throwing objects are well known and have been fully described by Waris (1946). These are usually detached fractures from the olecranon or fragments from the articular surfaces and are quite frequent in javelin throwers.

Fractures in the humerus have been described in javelin throwers, baseball players and hand grenade throwers, but fractures occur much less often than joint injuries. Typically these fractures occur at the junction of the middle and lower thirds of the shaft of the humerus



*Figures 3 a, b, c. The overhand throw. Three stages.*

at the level of the radial groove; the fractures are spiral, often with a butterfly fragment of large or small size.

It is thought that the manner of throwing is the chief factor in causing these fractures. In over-arm throwing (Figures 3 a, b, c) the arm executes a violent forward and upward movement from the externally rotated position in adduction, with extended elbow and shoulder. Soon after the action begins, the elbow is flexed to a maximum of 90 degrees when half the throw has been carried out. At the end of the throw when the arm has passed the vertical position, the elbow is suddenly extended, and there is at the same time a sudden internal rotation of the arm, immediately after which the missile is released. To achieve a correct throw, there is a simultaneous movement of the trunk and lower limbs with the feet being correctly positioned and the body twisting. A torsional strain is exerted on the shaft of the humerus during the course of the throw, and the amount of this depends on the weight of the missile, (javelin 800 grams, baseball about 200 grams, hand grenade about 700 grams).

The muscles which externally rotate and lift the arm from the extended position are chiefly the deltoid, the supraspinatus and the infraspinatus and teres minor. Internal rotation at the end of the throw is chiefly due to the pectoralis major, the subscapularis, the pronator teres and brachioradialis. The flexion of the elbow is produced by the biceps and brachialis, while the extension is effected by the triceps. The whole throw is thus very complex and a successful throw requires well co-ordinated actions of all the muscles involved.

At the point of throw when external rotation is transferred to internal rotation, and when flexion of the elbow changes to extension, the torsional force acting on the humerus is at its maximum and it is at this point that fracture occurs. If, during the throw, the actions of the muscles involved become uncoordinated, so that external rotation is not completed before internal rotation starts, the chance of fracture increases. Finally, an incorrect throwing technique in which the upper arm is too violently abducted with inadequate flexion at the elbow, may predispose to fracture.

Case 4 is an example of a fatigue fracture, which resulted from frequently repeated minor traumata without the arm being heavily loaded at any time. We have discussed and tried to investigate whether the x-ray shadow is only due to nutrient vessel but we doubt that this is the case. The other three cases can be considered to lie in the borderline between fatigue fractures and those due to greater torsional

strains. As the fractures occurred when the force exerted was at its maximum, it may be argued that large stresses were involved, but fatigue fractures are perhaps more likely as these three throwers had undertaken the same movements so many times before, though the force used on each occasion was greater than the throwers were accustomed to employ.

Krainz (1939) stated that fractures resulting from throwing tended to heal slowly. We have not found this to be so in our series.

It is remarkable that radial nerve injuries have only once been reported in patients sustaining this type of fracture (Shang Liang Chao et al. 1971). The fractures are almost always situated at the level of the radial groove and the fragments may be badly displaced. Our fourth case had some paraesthesia on the dorsal surface of the radial fingers, but no motor paresis. The symptoms can be explained by hematoma developing round the radial nerve.

The radiographs did not show any pathology in the bones apart from the fractures. Healing times were normal and no patient showed any sign of abnormally brittle bone structure.

#### SUMMARY

A series of cases is presented in which similar fractures of the shaft of the humerus have occurred in four patients, all of whom were throwing over-arm. Two of these were throwing hand grenades and two were playing handball. The mechanism of the fracture is discussed in detail and it is concluded that they are stress fractures due to torsional violence.

One patient developed a transient radial nerve lesion probably due to hematoma in the radial groove. No patient seemed to have any pathological brittleness of the bones and all united in normal time.

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