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Stability of the shoulder joint

Cadaver study of stabilizing structures

In 10 cadaver shoulder joints, the increments in external rotation were measured after successive cutting of the anterior stabilizing structures while a constant external torque was applied to the humerus, abducted in the scapula plane. The subscapularis muscle prevented anterior subluxation in the lower range of abduction. As abduction increased, the lower part of the capsule was the most important stabilizing structure. The findings suggest that it may be possible to perform more selective repairs in the treatment of recurrent anterior instability.

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Clinical and anatomical studies of anterior dislocation of the shoulder have led to two different concepts of the most important anterior stabilizing structures of this joint. One is that the subscapularis muscle is the limiting factor in external rotation and the most important anterior stabilizing structure (Adams 1948), while another asserts that the anterior capsule is the primary stabilizing structure (Townley 1950).

Clinically, anterior instability of the shoulder in abduction and external rotation of the arm is characterized by lesions of the anterior capsule (Mizuno & Hirahote 1983). Thus, the anterior structures of the shoulder joint are characterized as limiting external rotation, and preventing anterior dislocation. The purpose of our experiment was to measure the increments in external rotation while cutting the stabilizing structures at different stages, in order to determine their contribution to stability and limitation of external rotation when the humerus is abducted with a constant external torque.

Material and methods

The investigation was carried out on 10 shoulder joint specimens, each consisting of humerus, scapula and capsule, including the coracohumeral ligament. The supraspinatus muscle, the infraspinatus and the teres muscles were removed. The tendon of the biceps muscle was divided just below the intertubercular groove.

The scapula was suspended with the medial border vertical, and a lever fixed to the humerus. This lever was fitted with strain gauges to measure external torque (Figure 1). The external rotation angle was measured by the Z-angle sensor, at a right angle to the X-Y angle sensor, which measured the angle of abduction. When the humerus was abducted 0–90 degrees in the scapula's plane, with a constant external torque of 1.5 Nm, the corresponding movement curves of external rotation and abduction were recorded by an amplifier and plotted in an X-Y diagram. At the same time, all the signals passed through a data acquisition system to a microcomputer (R.C. 702), which stored the measurements on floppy discs. The final movement curves were calculated for exactly 1.5 Nm and plotted at the Regional Computer Service Center (RECAU).

The investigation was divided into two series, each comprising five specimens.

In the first series the tendon of the subscapular muscle was vertically divided 1.5–2 cm medially from its insertion on the humerus. Next, the proximal one third of the capsule and proximal two thirds of the capsule were divided between the cavitas glenoidalis and its insertion on the humerus.

In the second series only the capsule was divided from below; first the distal one third, then two thirds, and finally the anterior capsule. This division was easily performed when the arm was abducted and the intact tendon of the subscapular muscle was separated from the capsule.

After each division, the increment of external rotation was measured.

Results

In the first series (Figure 2), after the subscapularis muscle had been cut, external rotation compared with that of the intact joint increased on average 4 degrees at 20 degrees of

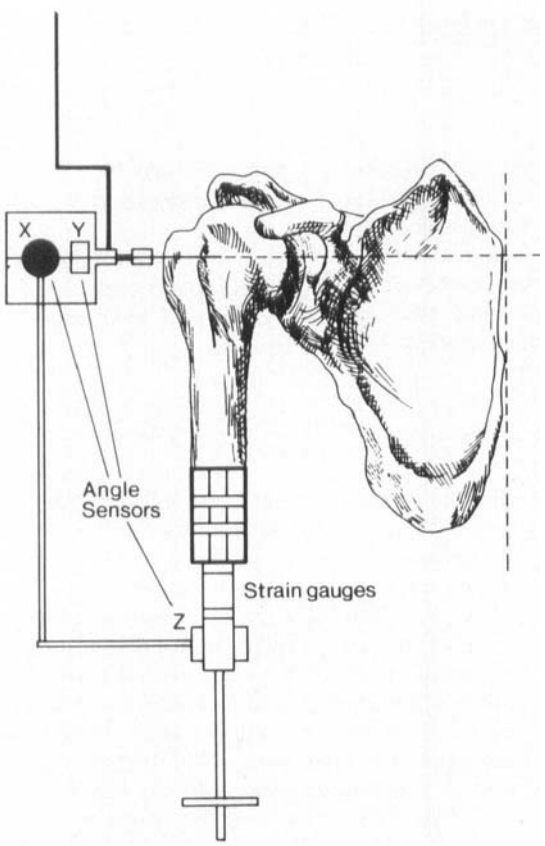

Figure 1. Outline of the experimental set-up.

abduction. After further cutting the proximal one third of the capsule, the increments were on average 5 degrees in the first 40 degrees of abduction. When the proximal two thirds of the capsule was cut, the external rotation increased to 16 degrees at 20 degrees of abduction, and then decreased to the point of origin at 90 degrees of abduction.

In no case was the humeral head found to dislocate with the distal third of the capsule intact.

In the second series (Figure 2), after the distal third of the capsule had been cut, external rotation compared with that of the intact joint increased to a maximum of 8 degrees at 40 degrees of abduction. When the distal two thirds of the capsule was cut, the increment in external rotation was maximally 9 degrees at 40 degrees of abduction and then constant until 90 degrees of abduction. When the whole anterior capsule was cut, the external rotation was maximally 18 degrees at 40 degrees of abduction. At 30 degrees of abduction, in all cases after cutting all the anterior capsule, the humeral head was observed to subluxate below the subscapular muscle but without dislocating anteriorly.

Discussion

In the anterior capsule of the glenohumeral joint, three different ligamentous strengthening structures have been described, each roughly corresponding to one third of the capsule (Mosely & Overgaard 1962). In abduction and external rotation, the proximal part of the capsule is first tightened. As abduction increases, the lower part and the tendinous part of the subscapularis muscle also move proximally (Turkel et al. 1981).

We found that the increment in external rotation after cutting only the subscapularis muscle and the proximal third of the capsule was only a few degrees. Further external rotation, on average 16 degrees in the lower part of abduction, was found after additional cut-

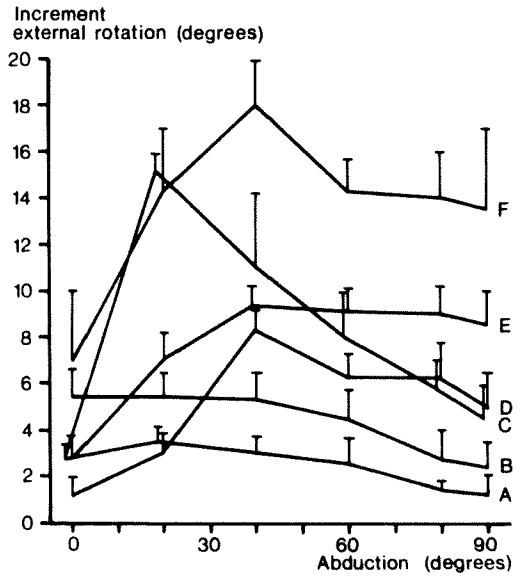

Figure 2. First series: A) The subscapularis muscle cut. B) The subscapularis muscle and proximal third of capsule cut. C) The subscapularis muscle and proximal two thirds of the capsule cut. Second series: D) Distal third of the capsule cut. E) Distal two thirds of the capsule cut. F) All the capsule cut. Bars indicate SEM.

ting of the middle third of the capsule. In increasing abduction to more than 20 degrees, external rotation again diminished, corresponding to the tightening of the distal capsule in abducting the humerus more than 20 degrees. In no case was instability observed with only the distal third of the capsule intact.

With all the anterior capsule cut, external rotation reached a maximum at 40 degrees of abduction, and anterior subluxation was observed at 30 degrees of abduction. This anterior subluxation was noted as a forward movement of the humeral head below the tendinous part of the subscapular muscle. This finding is in agreement with Symenoides (1972) who reported that it is only in the first part of abduction that the subscapularis muscle stabilizes the joint. The anterior part of the glenohumeral joint capsule, especially in anterior subluxation and recurrent anterior luxation, has been the object of clinical interest in recent years (Neer & Foster 1980), especially focusing on the lower part of the capsule (Mizuno & Hirahote 1981, Protzman 1980, Rowe et al. 1981) as the cause of subluxation. In our experimental set-up, we have found that when the humerus is abducted with a constant external torque in the lower part of abduction, only the subscapular tendon and the proximal part of the capsule limit external rotation. As abduction increases, the lower part of the capsule becomes the most important structure limiting external rotation.

In a recent study on the anterior subluxating shoulder (McGlynn & Caspari 1984), it was found at arthroscopy of the joint that attenuation of the anterior inferior part of the capsule or detachment of the capsule was a constant finding in cases with anterior subluxation of the humeral head. Our experimental findings support the opinion that the distal part of the capsule is an important structure preventing anterior subluxation when the arm is abducted.

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