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Anterior and posterior shoulder instability

A cadaver study

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In a cadaver study of 10 glenohumeral joint specimens, the anterior and posterior displacement of the humeral head was recorded after cutting parts of the rotator cuff and capsular structures applying a constant force to the humerus. The posterior structures were important for anterior stability in the first 40° of abduction. Anterior subluxation was changed to luxation in the first half of abduction, but only after lesions to the anterior part of the rotator cuff and upper half of the anterior capsule. For posterior displacement, the posterior part of the rotator cuff was found significant from 0–90° of abduction, and the posterior capsule between 40° and 90° of abduction. The anterior part of the rotator cuff and the upper part of the anterior capsule were essential in the first 40° of abduction.
Cutting the capsular structures only, we found that the entire anterior capsule resisted anterior displacement for 70–90° of abduction, and the entire posterior capsule from 50–90° of abduction. For posterior displacement, the entire posterior capsule was important from 60 to 90° of abduction.
Clinically, a large lesion to the posterior structures seems to be essential for any major anterior displacement, and posterior displacement leading to subluxation only seems possible in connection with a major anterior injury.

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In recent years several authors have become aware of the combined instability of the glenohumeral joint and its clinical significance (Gerlev & Gantz 1984, Neer & Foster 1980). The clinical diagnosis and especially the treatment is often difficult (Neer & Foster 1980).

The purpose of the present study was to measure anterior and posterior translatory movements of the humeral head in an experimental set-up when the humerus was abducted and a constant anterior or posterior force was applied. The set-up by progressive cutting of the individual structures of the anterior and posterior part of the rotator cuff and capsule allowed calculation of the contribution of these structures to the anterior and posterior translatory stability of the shoulder joint.

Material and methods

The investigation was carried out on 10 shoulder joint specimens consisting of humerus, scapula, capsule, the coracohumeral ligament and all rotator cuff muscles and tendons. The tendon of the biceps muscle was divided just below the intertubercular groove. All the specimens were without signs of earlier trauma or degeneration.

The scapula was suspended with the medial border in vertical position. A lever fitted with strain gauges was fixed to the humerus in order to measure the anterior or posterior force being applied with a handle (Figure 1). The handle was fitted to the lever terminating in a ball bearing, whereby the humerus was free to rotate. The rotation angle as well as the abduction angle were measured by potentiometers. A sliding potentiometer, fixed to the specimen by a thread, measured anterior and posterior displacement of the humeral head with application of a constant anterior or posterior force of 25 N to the humerus abducted 0–90° in the plane of the scapula. At the same time, the spontaneous rotation of the hu-

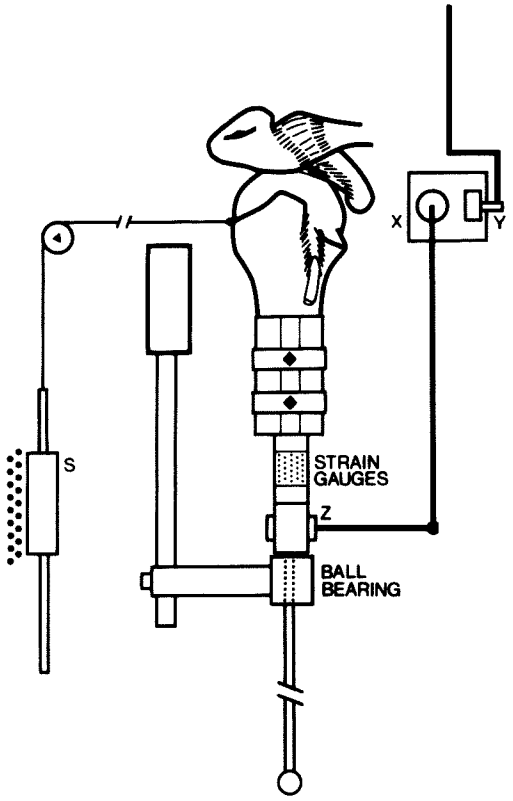


Figure 1. Lateral view of experimental set-up. X-Y potentiometer measures the abduction, Z potentiometer the rotation, and S potentiometer anterior and posterior displacement.

merus was measured. The signals were fed to a microcomputer (R.C. 702). The movement curves were finally calculated for 25 N and plotted at the regional computer service center (RECAU). The measured displacements were corrected observing the displacement caused by the rotation.

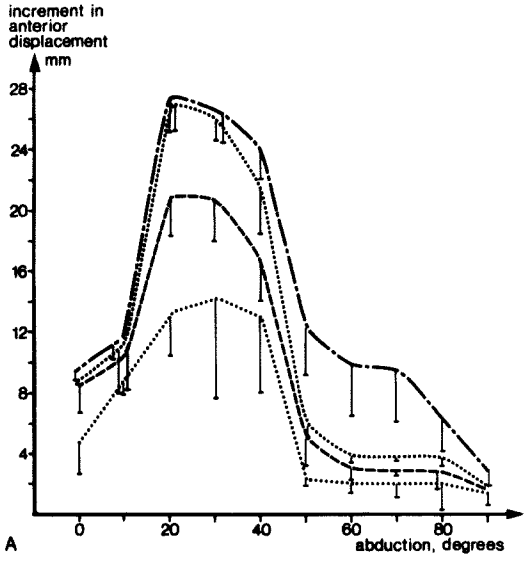
There were two series in the study, each with five specimens. In the first series, anterior and posterior displacement was measured before and after cutting subsequently the teres minor and infraspinatus muscles in the tendinous part, the upper half of the posterior capsule, the entire posterior capsule, the subscapular muscle tendon, and the upper half of the anterior capsule.

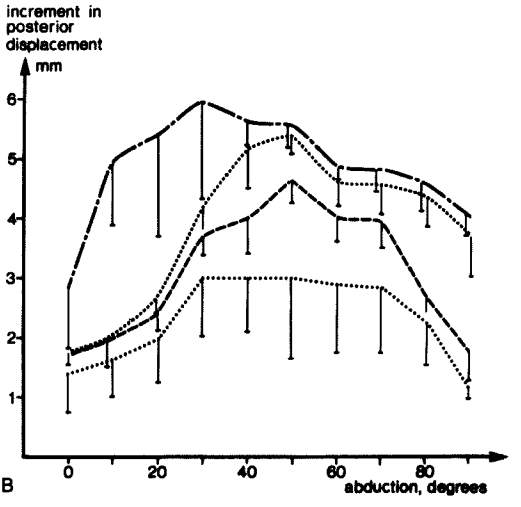
In the second series, only capsular structures were cut, and the anterior and posterior displacement was recorded after subsequent lesion to the lower half of the anterior capsule, the entire anterior capsule, the lower half of the posterior capsule, and the entire posterior capsule.

The curves (Figures 2 and 3) show the mean increment in displacement in millimeters after cutting each of the structures. In the statistical analysis, a probability level of 5 per cent was considered significant.

Caput humeri was considered subluxated if half or more, but not all of the caput was observed outside the glenoid cavity, and luxated if all of the head was displaced outside.

Figure 2. Increment of A, anterior and B, posterior displacement after subsequent severance of rotator cuff and capsular structures. Standard error of the mean indicated.
. . . . Teres minor and infraspinatus tendons cut
– – – – Proximal half of posterior capsule cut
. . . . . Entire posterior capsule cut
– · – Subscapularis and proximal half of anterior capsule cut





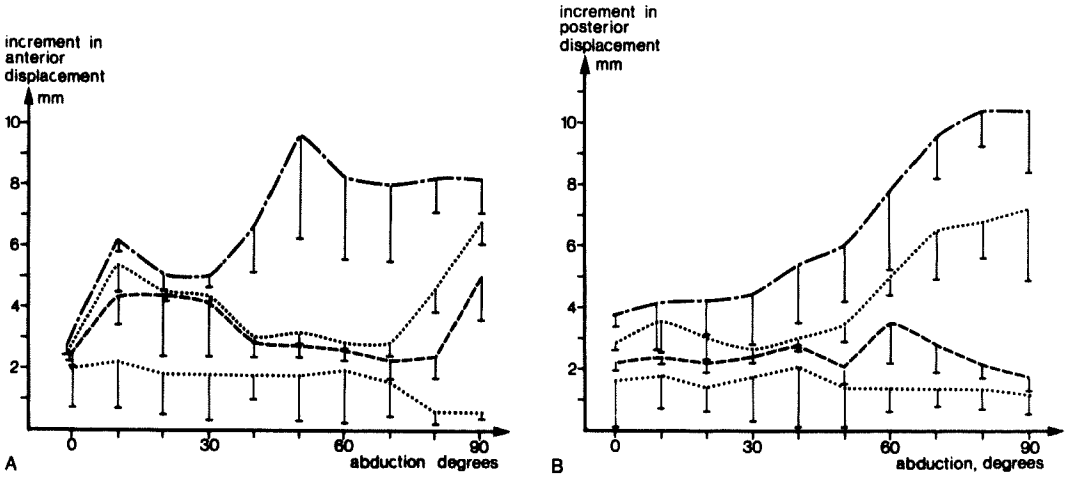


Figure 3. Increment of A, anterior and B, posterior displacement after subsequent severance of rotator cuff and capsular structures.
. . . . Lower half of anterior capsule cut
– – – – Entire anterior capsule cut
. . . . . Lower half of posterior capsule cut
– · · – Entire posterior capsule cut

Results

In the first series (Figure 2), cutting the teres minor and infraspinatus muscles in the tendinous part increased anterior displacement in the first 40° of abduction. If the entire posterior capsule was also cut, the increment in anterior displacement doubled from 20 to 40° of abduction. From 50–90° of abduction, the anterior displacement rapidly decreased, and this decrease could be reversed, though not to a significant extent by cutting also the subscapular tendon and the proximal half of the anterior capsule.

Anterior subluxation appeared after cutting the upper half of the posterior capsule, and anterior luxation took place in the first half of abduction after cutting also the subscapular muscle tendon and the upper half of the anterior capsule.

Sectioning of the teres minor and infraspinatus tendons significantly increased posterior displacement (Figure 2) from 0–90° of abduction. If the entire posterior capsule was also cut, the posterior displacement increased significantly between 50 and 90° of abduction. After cutting the subscapular tendon and the upper half of the anterior capsule too, posterior displacement took place in the first 40° of abduction, but was found significant.

Posterior subluxation was seen after lesion to the teres minor and infraspinatus muscle tendons and the proximal half of the posterior capsule, but only in the middle part of abduction. After cutting anterior structures, i.e. subscapular tendons and the proximal half of the anterior capsule, posterior subluxation took place in the entire range of abduction.

In the second series of cutting the capsular structures, lesion to the entire anterior capsule caused a significant anterior displacement between 70 and 90° of abduction (Figure 3). If the lower half of the posterior capsule was also cut, anterior displacement also increased significantly between 70 and 90° of abduction, and by cutting of the entire posterior capsule, anterior displacement increased significantly between 50 and 90° of abduction. Anterior subluxation appeared from 20 to 90° in all specimens after cutting the entire anterior capsule.

Posterior displacement (Figure 3) after lesion to the entire anterior capsule was significant from 0 to 90° of abduction. By lesion to the entire posterior capsule, a small increase was noted except in the last part of abduction, where the displacement was significant between 70 and 90° of abduction. Posterior subluxation only appeared after lesion to the entire posterior capsule, and only in the last part of abduction.

Discussion

In a recent study of stress radiography of shoulder instability (Adler & Lohmann 1984),

the glenohumeral joint was found to be noticeably stable with a ventral displacement of 0.8 mm and a dorsal displacement of 0.2. mm applying an anterior and posterior pressure of at least 20 kp (196 N).

Dissection after anterior shoulder luxation (Moseley 1972) revealed anterior capsule lesions and rupture of the infraspinatus and teres minor muscles in some cases. Fractures of the tuberculum majus or rupture of the tendinous cuff also frequently occur in connection with anterior dislocation, notably in the elderly (McLaughlin 1963, McLaughlin & MacLellan 1967, Craig 1984). This corresponds with the results of our first series, where the posterior part of the rotator cuff had a significant stabilizing function in preventing anterior displacement in the first 50° of abduction. Similarly, the posterior capsule was found to stabilize the joint, although in a smaller range of abduction than the teres minor and infraspinatus muscles. Of the anterior structures, cutting of the subscapular tendon and the upper half of the anterior capsule were found to increase anterior displacement, but only to an insignificant degree in the last part of abduction. This confirms earlier observations (Turkel et al. 1981) that the lower part of the anterior capsule is an important stabilizing structure in the last part of abduction. This also applies to the clinical situation where lesions to the anterior capsule, notably the lower part, in anterior subluxation have often been reported (Rowe & Zarins 1981, Protzman 1980, Mizuno & Hirohata 1983). We found, too, that lesions to the posterior capsule significantly increased anterior displacement in the last half of abduction. This implies that in anterior instability, lesions to the posterior capsule can also be expected; an observation only made by a few authors (Pappas et al. 1983). Cutting of the posterior part of the rotator cuff and the posterior capsule were essential for posterior displacement, but posterior subluxation was only seen if the proximal half of the anterior capsule and subscapular tendons were cut. Clinically, posterior instability is often seen in combination with distal instability (Neer & Foster 1980). This corresponds with the finding that the proximal part of the anterior capsule also plays an important role in the distal instability of the joint (Ovesen & Nielsen 1985).

Stability of the shoulder joint is a result of the very complex function of both the anterior and posterior part of the rotator cuff and capsule. Our investigations show that both parts influence the stability. The role of the anterior and posterior parts of the rotator cuff should be considered in the treatment of the unstable shoulder.

References

Adler, H. & Lohmann, B. (1984) The stability of the shoulder in stress radiography. *Arch. Orthop. Traumat. Surg.* **103**: 83–84.

Craig, E. V. (1984) The posterior mechanism of acute anterior shoulder dislocations. *Clin. Orthop.* **190**: 212–216.

Gerlev, C. & Ganz, R. (1984) Clinical assessment of instability of the shoulder. *J. Bone Joint Surg.* **66-B:** 551–556.

McLaughlin, L. H. (1963) Dislocation of the shoulder with tuberosity fractures. *Surg. Clin. North Am.* **43**: 1615–1620.

McLaughlin, L. H. & MacLellan, D. I. (1967) Recurrent anterior dislocation of the shoulder. II. A comparative study. *J. Trauma* **7**: 191–201.

Mizuno, K. & Hirohata, K. (1983) Diagnosis of recurrent traumatic anterior subluxation of the should. *Clin. Orthop.* **179**: 160–167.

Moseley, J. F. (1972) *Shoulder lesions.* Churchill Livingstone, Edinburgh-London.

Neer, C. S. & Foster, C. R. (1980) Inferior capsular shift for involuntary inferior and multidirectional instability of the shoulder. *J. Bone Joint Surg.* **62-A:** 897–908.

Ovesen, J. & Nielsen, S. (1985) Experimental distal subluxation in the glenohumeral joint. *Arch. Orthop. Traumat. Surg.* **104**: 82–84.

Pappas, A. M., Goss, P. & Kleinmann, P. K. (1983) Symptomatic shoulder instability due to lesions of the glenoid labrum. *Am. J. Sports Med.* **11**: 279–288.

Protzman, C. R. R. (1980) Anterior instability of the shulder. *J. Bone Joint Surg* **62-A:** 909–918.

Rowe, C. R. & Zarins, B. (1981) Recurrent transient subluxation of the shoulder. *J. Bone Joint Surg.* **63-A,** 863–872.

Turkel, S. J., Panio, M. W., Marshall, J. L. & Girgis, F. G. (1981) Mechanisms preventing anterior dislocation of the glenohumeral joint. *J. Bone Joint Surg.* **63-A:** 1208–1217.