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Posterior instability of the shoulder

A cadaver study

In a cadaver study of 15 shoulder specimens, the internal rotation of the joint was measured applying a constant internal torque of 1.5 Nm to the humerus. The specimens were suspended with the medial border of the scapula in vertical position. A lever fixed to the humerus was fitted with strain gauges for measurement of internal torque and sensors for measurement of internal rotation at different degrees of abduction from 0–90°. Cutting the teres minor and infraspinatus muscle tendons increased internal rotation in the first 40° of abduction. Internal rotation was further increased in this range by cutting also the proximal half of the posterior capsule. Lesion to the posterior capsular structures alone increased internal rotation from 40° of abduction.

In conclusion, among the posterior structures of the shoulder joint, the teres minor and the infraspinatus muscle tendons stabilize the joint for internal rotation in the first half of abduction, and the lower half of the capsule in the last part.

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Posterior instability of the shoulder joint is rare, and only few authors (Warren et al. 1984) hold that the posterior structures contribute to the stability of the joint. We have measured the increment in internal rotation of the abducted humerus during successive cutting of the posterior structures of the shoulder.

Material and methods

Our experiments included three series with five cadaver specimens in each. Each specimen consisted of both the anterior stabilizing structures, i.e. capsule and the subscapular muscle, the coracohumeral ligament, and the supraspinatus muscle, as well as the posterior structures, i.e. the infraspinatus and the teres minor muscles, and the posterior capsule. The long head of the biceps muscle tendon was divided just below the intertubercular groove.

Each specimen was suspended with the medial border of the scapula in vertical position (Figure 1). A lever was fitted with strain gauges for measurement of internal torque. The internal rotation angle was measured by the Z-angle sensor at right angles to the X–Y angle sensor, which measures the abduction angle. The humerus was abducted 0–90° in the same plane as the scapula with application of a constant internal rotary torque of 1.5 Nm. Corre-

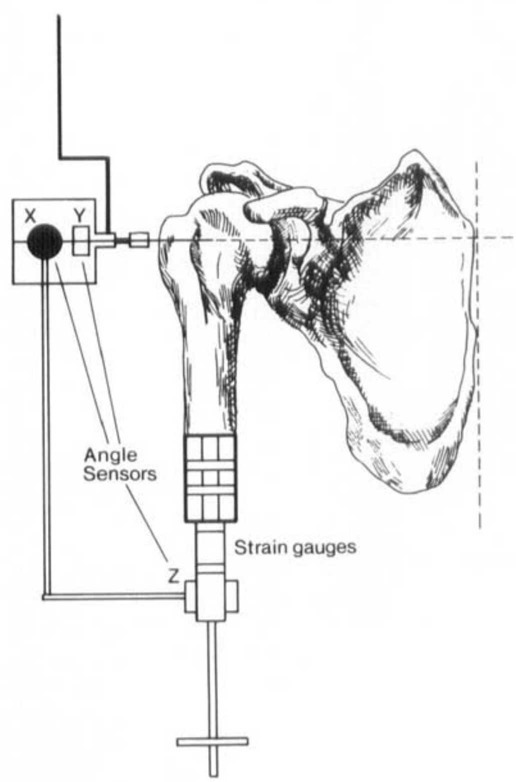
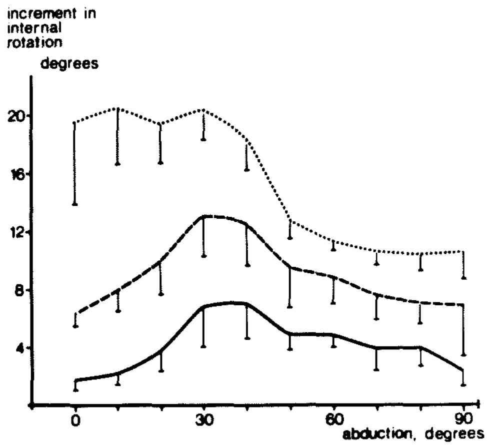
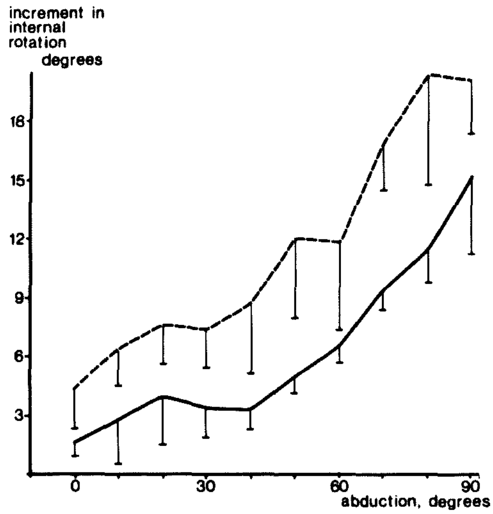


Figure 1. Experimental set-up.



A



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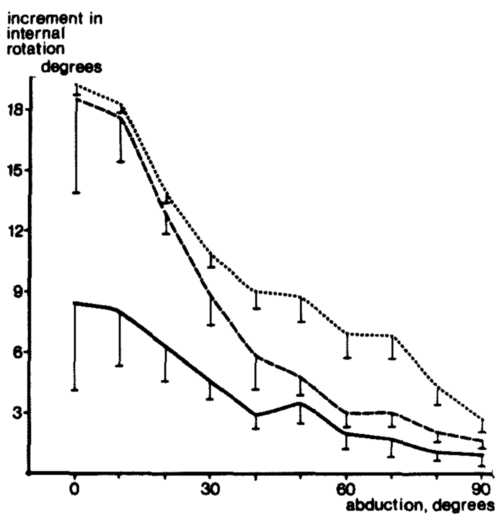

C

Figure 2. Increment in internal rotation after cutting of various structures. Standard error of the mean indicated.

A, first series
——— *Teres minor tendon cut.*
----------- Teres minor and infraspinatus tendon cut.
········· Teres minor and infraspinatus tendon and proximal half of the posterior capsule cut.

B, second series
——— Lower half of posterior capsule cut.
----------- Entire posterior capsule cut.

C, third series
——— Infraspinatus tendon cut.
----------- *Infraspinatus tendon and proximal half of posterior* capsule cut.
········· Infraspinatus tendon, proximal half of the posterior capsule and teres minor tendon cut.

sponding movement curves of internal rotation were traced. Simultaneously, the signals were fed through a data acquisition system to a microcomputer R.C. 702. The movement curves were finally calculated for exactly 1.5 Nm and plotted at the regional computer service center RECAU.

In the first series, the teres minor and infraspinatus muscles and the proximal half of the posterior capsule were successively cut. In the second series, the lower half and the upper half of the capsule were cut. In the third series, the lesions included the infraspinatus muscle, the proximal half of the capsule and the teres minor. In all cases, the muscle tendons were cut at the insertion of the tuberculum majus, and the capsule midway between its insertion at the scapula and the humerus.

For each of the specimens the internal rotation was measured before cutting the structures. From this record again, the further increased internal rotation could be measured. The curves (Figure 2) show the mean increment in internal rotation after cutting each of the structures. A standard error of the mean was calculated for each 10° of abduction. In this way a possible statistical difference at the 95 per cent level will appear if the distance between the curves is redoubled or more than redoubled in relation to the indicated standard error of the mean. The humeral head was considered subluxated if half or more, but not all the caput was observed outside the glenoid cavity.

Results

In the first series (Figure 2), cutting the teres minor muscle tendon caused internal rotation to increase by 7° at the most from 30 to 40° of abduction compared with the internal rotation of the intact joint. From 40° of abduction, internal rotation decreased slowly and was back to the starting point at 90°. If the infraspinatus muscle tendon was also cut, the increase in internal rotation nearly redoubled in the entire abduction range with a maximum at 30°. Cutting also the proximal half of the posterior capsule, the increment in internal rotation more than doubled in the first 40° of abduction, after which it was only in the order of a few degrees in the rest of the abduction. This first series shows that lesions to the teres minor and the infraspinatus muscles and the upper half of the posterior capsule increase the internal rotation of the joint in the first part of abduction. By abduction beyond 30–40° internal rotation again diminished, especially with only the distal half of the capsule intact. In all cases, anterior subluxation was noted from 10° to 80° of abduction after cutting the infraspinatus muscle tendon and the proximal half of the posterior capsule.

In the second series lesion of the lower half of the posterior capsule increased internal rotation by a few degrees in the first 40° of abduction, and substantially in further abduction (Figure 2). When lesions included the proximal half of the posterior capsule, internal rotation was only a few degrees in the first 40° of abduction, and then increased rapidly, but insignificantly in the rest of the abduction. It appears from the experiments of the second series that the lower part of the posterior capsule is significant in stabilizing the joint by increased abduction measured by the more increased internal rotation. In the second series, anterior subluxation was only noted in a single case after cutting the entire posterior capsule.

In the third series (Figure 2), internal rotation was increased from 0 to 50° of abduction only by lesion to the infraspinatus muscle tendon. Cutting also the proximal half of the posterior capsule more than doubled internal rotation in the first part of abduction, and the increment in internal rotation was significant within the first 30° of abduction. Additional cutting of the teres minor muscle tendons caused an increment in internal rotation of only a few degrees in the first part of abduction, but in the range of 30 to 70° of abduction, a significant increment was seen. The experiments from the third series confirmed the stabilizing function of the infraspinatus muscle and the proximal part of the capsule in the first part of abduction. In the third series, anterior subluxation was observed in 4 cases after cutting the teres minor muscle tendon.

All cases of anterior instability were caused by the anterior structures acting on abduction of the humerus.

Discussion

Posterior dislocation only accounts for about 1–3% of all shoulder joint dislocations (McLaughlin 1952, Walter et al. 1984). This kind of instability is notably reported in lesions to the posterior capsule (Moseley 1972) or the posterior part of the rotator cuff and capsule (Warren et al. 1984).

Normally, in a ball-and-socket joint three types of surface motion – rotation, rolling, and translation – may occur in a given plane (Frankel et al. 1980). In our experimental set-up by abducting the humerus in the scapular plane only, two types of motion may occur, i.e. rolling and rotation. Internal rotation after cutting the posterior structures and rolling resulted in some cases in anterior subluxation. In these cases tightening of the anterior structures in internal rotation caused the head of the humerus to roll forward, an observation only rarely made (Turkel et al. 1981). In measuring exclusively the translatory movement of the humeral head, lesions also of the posterior cuff and capsule caused anterior subluxation of the humeral head (Ovesen & Nielsen 1986).

In our first and third series, anterior subluxation was noted in all cases except one after cutting the entire posterior cuff and the proximal half of the posterior capsule. Otherwise, only a single case of anterior subluxation appeared after exclusively cutting the entire posterior capsule. Lesions to the posterior cuff were found to increase internal rotation in the first part of abduction, and lesions to the capsule only in the last part of abduction. Clinically, traumatic posterior dislocation is reported with lesion to the posterior capsule (McLaughlin 1952) as well as lesion to the anterior cuff and anterior capsule (Samilson et al. 1964). Our observations that in no cases posterior subluxation occurred with intact anterior stabilizing structures is also in agreement with the clinical observations that posterior instability often occurs in combination with lesions or laxity of anterior structures (Neer et al. 1980). Our observations indicate that treatment of posterior instability of the shoulder joint, should consider also the anterior structures.

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