COMPUTERISED ARTHROTOMOGRAPHY OF PRIMARY ANTERIOR DISLOCATION OF THE SHOULDER

W. J. RIBBANS, R. MITCHELL, G. J. TAYLOR

From Northwick Park Hospital and Clinical Research Centre, Harrow

Computerised arthrotomography was performed on 33 patients four to six weeks after acute primary anterior dislocation of the shoulder. Seventeen patients were under, and 16 over 50 years of age.

Damage to the anterior glenoidal labrum was seen in all the younger patients and in 75% of the older ones. A large redundant capsular pouch, seen in the older patients, was present in 35% of the younger ones, and a posterior humeral head defect was seen in 82% of the younger patients and only 50% of the older.

Associated fractures were more common in the older patients, and a tear of the rotator cuff was demonstrated in 63% of the older patients and in none of the younger ones.

Over the last century there has been considerable debate over the pathological anatomy of anterior shoulder dislocation (*Journal of Bone and Joint Surgery* (editorial) 1948), including a fruitless search for the 'essential lesion'. Previous studies have relied upon dissections, operative findings, plain radiographs, arthrograms (Reeves 1969) and conventional thin-section tomography (Goldman and Ghelman 1978; Tijmes, Loyd and Tullos 1979; Braunstein and O'Connor 1982; Deutsch et al 1984).

Computerised arthrotomography clearly delineates abnormalities of both bone and soft tissue (Von Cramer et al 1982; Danzig, Resnick and Greenaway 1982; Resch, Benedetto and Zur Nedden 1985; Seltzer and Weissman 1985; Randelli and Gambrioli 1986), and is now increasingly used in the investigation of the shoulder (Shuman et al 1983; Deutsch et al 1984; Haynor and Shuman 1984; Kinnard et al 1984; Beltran et al 1986; Rafii et al 1986; Singson, Feldman and Bigliani 1987; Zlatkin et al 1988). These workers have concentrated on defining the normal anatomy and investigating recurrent dislocation and other chronic pathologies.

We have used computerised arthrotomography in an attempt to determine the pathological anatomy after a first shoulder dislocation.

PATIENTS AND METHODS

We investigated 47 consecutive patients who presented with a primary anterior dislocation of the shoulder at Northwick Park Hospital in 1987. Fourteen patients were excluded from the study because of age, infirmity or non-compliance: 33 patients were scanned. Of these, 17 were under 50 years of age and 16 were 50 or more.

Initial standard radiographs included an anteroposterior and an axial or lateral scapular view. The dislocations were reduced in a conventional manner and the arm immobilised for three weeks or more in the younger patients and for two weeks in the older group. An anteroposterior radiograph was taken to confirm reduction.

Computerised arthrotomography of the shoulder was performed between the fourth and sixth weeks on an I.G.E. 9 000 3rd generation unit (Reed and Heys 1988), using 2 ml of non-ionic contrast material (Hexabrix 320). This was injected, under image intensifier control, into the shoulder joint via a 22-gauge spinal needle and followed by 20 to 25 ml of air. This volume of contrast material was found to be optimal for coating the structures without interfering with resolution. Scanning was then performed with the patient in the supine 45° oblique position, which facilitates positioning of the larger patients, reproduces the position of the plain radiograph and allows the field of interest to be central. A series of 5 mm slices were taken at 5 mm intervals. The radiation exposure is much less in computerised than in conven-

W. J. Ribbans, BSc, FRCS Ed, Senior Orthopaedic Registrar
Central Middlesex Hospital, Acton Lane, Park Royal, London NW10
7NS, England.

R. Mitchell, FRCR, Consultant Radiologist
Northwick Park Hospital, Watford Road, Harrow, Middlesex, HA1
3UJ, England.

G. J. Taylor, FRCS, FRCS Orth (Ed), Senior Orthopaedic Registrar
St. Thomas's Hospital, Lambeth Palace Road, London SE1 7EH,
England.

Correspondence should be sent to Dr R. Mitchell.

© 1990 British Editorial Society of Bone and Joint Surgery
0301-620X/90/2050 \$2.00
J Bone Joint Surg [Br] 1990; 72-B: 181-5.

tional arthrotomography. The timing of this examination was designed to minimise the risk of air embolism during the hypervascular phase and to avoid the presence of a haemarthrosis which would obscure fine soft tissue detail.

RESULTS

The results for both age groups are set out in Table I. Bankart lesions (detachment of the anterior glenoid labrum) were seen in all of the younger patients and in 12 of the 16 patients over 51 years of age; they were usually in the superior part of the labrum. The normal anterior labrum appears as a triangular or rounded area attached to the glenoid rim (Fig. 1). The absence of this indicates a tear of the labrum; the detached portion is often visualised lying free within the joint (Fig. 2).

Stripping of the periosteum, the capsule and the subscapularis from the anterior aspect of the glenoid neck, leaving a bare area of varying size, was a feature of all but one of the patients with a Bankart lesion (Fig. 2) and was seen in only one patient in the absence of a Bankart lesion. A large baggy anterior capsular pouch, creating a very capacious joint cavity was seen in six of the younger patients.

A Hill-Sachs lesion was seen in 14 of the 17 patients under 50 (82%) and in eight of the 16 aged 50 or over (50%), either as a depression or as a well-defined pit on the posterolateral aspect of the humeral head (Fig. 3). Other associated fractures were well demonstrated (Fig. 4) and were more prevalent in the older patients (11 of 16, 69%).

Tears of the rotator cuff, as demonstrated by leakage of air and contrast material into the subacromial bursa (Fig. 5), were seen only in the older group (10 of 16, 63%). The actual site of rupture was hard to define accurately, but occurred either at, or close to, the insertion into the greater tuberosity. Similar problems of accurate localisation occur in conventional arthrography (Fig. 5).

Difficulties of interpretation occurred in four patients. In two, the presence of a large fracture of the greater tuberosity made it impossible to assess the area of a suspected Hill-Sachs lesion. In one examination carried out on the day after the injury, a haemarthrosis obscured fine tissue detail but it was still possible to identify damage to the labrum and an associated area of stripping of the anterior structures. In one elderly patient there was an extensive extravasation of air and contrast material through a capsular and rotator cuff tear; the joint did not fill and the labrum was not visualised.

DISCUSSION

The high sensitivity and accuracy of computerised arthrotomography of the shoulder has been confirmed by several authors (Shuman et al 1983; Deutsch et al 1984; Kinnard et al 1984). We found the technique relatively quick and easy, particularly when compared to conven-

tional tomography. It was well tolerated by all the patients and caused no undue discomfort or complications.

Of the patients in our study 52% were under 50 years of age. Reeves (1969) believed that in the younger patient the weakest part of the anterior capsule was at its labral attachment. As dislocation occurs, the labrum is lifted forward with the periosteum and capsule; they strip off the front of the neck of the glenoid to leave a bare area and an anterior pouch, first described by Broca and Hartman in 1890. Tijmes et al (1979) confirmed this by arthrography.

Table I. Results of computerised arthrotomography in 21 right shoulders, and 12 left shoulders after first anterior dislocation

	Age in years	
	< 50	50 and above
Male	16	5
Female	1	11
Fractures	2	9
Greater tuberosity	2	9
Lesser tuberosity	0	1
Surgical neck of humerus	0	1
Rotator cuff tear	0	10
Anterior labral tear	17	12
Stripping of neck of glenoid	16	13
Hill-Sachs lesion		
Severe/moderate	8	5
Mild	6	3
Redundant anterior capsule	6	0

Detachment of the anterior labrum was first described by Bankart (1923, 1938). We identified damage to the glenoid labrum in all of our younger patients. Previously reports of the overall incidence of Bankart lesions (in primary and recurrent dislocations) have varied widely from 27% to 100% (Rowe, Patel and Southmayd 1978). We were able to demonstrate redundant anterior capsules only in our younger patients, where, presumably, the tissues have been stretched; in the older patients the tissues appear to tear rather than stretch and may then be capable of healing. None of the younger patients had sustained a tear of the rotator cuff, though in one there was avulsion of the greater tuberosity.

A posterior humeral head defect (Hill and Sachs 1940) was seen in 82% of our younger patients, although of varying degrees of severity. Rowe (1963) found such a defect in 38% of initial anterior dislocations and in 57% of recurrent dislocations; other estimates have varied from 25% to 100% (Rowe et al 1978). Of our younger patients, 82% had both a Bankart and a Hill-Sachs lesion.

Fig. 1

Fig. 2

Fig. 3

Figure 1 - Computerised arthrotomogram of a normal right shoulder. The anterior labrum is seen as a triangular or rounded area attached to the glenoid rim (arrow). Figure 2 - The anterior labrum is damaged (arrow). The periosteum, capsule and subscapularis have been stripped from the anterior aspect of the glenoid neck (arrow). Figure 3 - The anterior labrum is torn. A Hill-Sachs lesion is seen on the posterolateral aspect of the humeral head (arrow).

Fig. 4a

Fig. 4b

Fracture of the greater tuberosity shown by CT arthrogram (a) and by AP radiograph after reduction (b).

Fig. 5a

Fig. 5b

Fig. 5c

Figure 5a - Plain AP radiograph taken before reduction of an anterior dislocation. An avulsed bony fragment is demonstrated but its origin is unclear. Figure 5b - An arthrogram in the same patient shows contrast in the subdeltoid bursa indicating a rupture of the rotator cuff. Figure 5c - The CT arthrogram shows a tear of the rotator cuff. Air and contrast material have escaped into the subdeltoid bursa (arrow). In addition, the anterior capsule has been stripped and there is a shallow head defect and an adjacent avulsed fragment.

In all, 48% of our patients were aged 50 or more, similar to the age distribution reported by Rowe (1963). McLaughlin (1963) and Johnson and Bayley (1982) have suggested that in older patients the posterior capsule gives way, leading to the higher incidence of rotator cuff rupture, fracture of the greater tuberosity and associated neurapraxia of the axillary nerve. Reeves (1969) demonstrated that the elderly rotator cuff is weaker and tends to rupture during dislocation; he found a 57% incidence by conventional arthrography. Standard computerised tomography will not demonstrate the actual site of the tear: this would require sections taken in the sagittal plane (Beltran et al 1986). In our series, 10 of the older patients (63%) sustained a rupture of the rotator cuff, but we were unable to demonstrate any damage to the posterior capsule or labrum.

In the Tijmes et al (1979) series of 14 patients with rotator cuff lesions, 11 were elderly. Codman and Akerson (1931) demonstrated an incidence of 39% of rotator cuff lesions in the shoulders of elderly cadavers but only 21% were significant tears which communicated with the subacromial bursa. Similarly, Keyes (1935) demonstrated cuff tears in 13% of shoulders. The incidence of rotator cuff tears in our series is higher than expected in the normal elderly population. Johnson and Bayley (1982) have shown that disruption of the rotator cuff in patients referred to their specialised unit can lead to chronic stiffness and pain which may be amenable to surgical treatment.

The overall incidence of fractures of the greater tuberosity was 39% compared to 30% quoted by Watson-Jones (1955) and 24% by Johnson and Bayley (1982). In addition, we found one patient with an avulsion of the lesser tuberosity at the insertion of the subscapularis tendon; this was not seen on the initial radiographs but was evident on an axial view taken later. McLaughlin (1963) has shown that more than 1 cm displacement of a lesser tuberosity fragment leads to a poor functional result. Apart from this lesser tuberosity avulsion, all other fractures were visible on the plain radiographs, but computerised tomography provides for accurate assessment of fragment size, displacement and rotation. In no case did we see a fracture of the anterior glenoid rim as reported by others (Deutsch et al 1984; Seltzer and Weissman 1985; Rafii et al 1987; Singson et al 1987) – this may be a more common complication of recurrent dislocation.

In our series, 31% of the 50 and over age group had both a rotator cuff tear and a fracture of the greater tuberosity, and only one of them had neither of these complications.

Reeves (1969) believed that in the elderly the predominant injury during dislocation is an acute anterior or antero-inferior rupture of the capsule at its weakest point, and that this involves a partial rupture of the subscapularis tendon. He reported that such ruptures appeared to have healed at the time of repeat arthro-

graphy at 10 days. The rapid healing of this defect may account for the fact that, apart from one patient who showed extravasation of the contrast material through a presumed anterior capsular tear, the capsule appeared to be intact in all our older patients.

Eight of our older age group (50%) had a Hill-Sachs lesion. Reeves (1969) found only one elderly patient with such a lesion, and he subsequently had recurrent dislocations.

Conclusions. Computerised arthrotomography provides a well tolerated method of clearly defining the bone and soft tissue pathology after a shoulder dislocation. The incidence of pathological damage appears to be higher than previously reported; several important differences have been demonstrated between our younger and older patients.

Conventional treatment by immobilisation will help promote healing of the capsular tears but is unlikely to affect the healing of the labral and humeral head defects. A prospective study would help to establish whether any one, or combination, of these lesions selectively predisposes to recurrence.

At present we do not advocate that every patient with a primary anterior dislocation should have a CT arthrogram. The technique is a useful research tool and has demonstrated the complexity of the problems that may complicate a primary dislocation. In the future, if risk factors can be identified confidently, earlier investigation of selected individuals may be indicated. This would provide a more accurate prognosis and, if necessary, the indication for earlier surgical intervention than is practised at present.

The authors would like to thank Professor L. Klenerman, Mr C. J. McCullough and Mr I. Fyfe for permission to report their patients.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

REFERENCES

- Bankart ASB. Recurrent or habitual dislocation of the shoulder-joint. *Br Med J* 1923; II:1132-3.
- Bankart ASB. Pathology and treatment of recurrent dislocation of shoulder-joint. *Br J Surg* 1938; 26:23-9.
- Beltran J, Gray LA, Bools JC, et al. Rotator cuff lesions of the shoulder: evaluation by direct sagittal CT arthrography. *Radiology* 1986; 160:161-5.
- Braunstein EM, O'Connor G. Double-contrast arthrotomography of the shoulder. *J Bone Joint Surg [Am]* 1982; 64-A:192-5.
- Codman EA, Akerson IB. The pathology associated with rupture of the supraspinatus tendon. *Ann Surg* 1931; 93:348-59.
- Danzig L, Resnick D, Greenway G. Evaluation of unstable shoulders by computed tomography. *Am J Sports Med* 1982; 10:138-41.
- Deutsch AL, Resnick D, Mink JH, et al. Computed and conventional arthrotomography of the glenohumeral joint: normal anatomy and clinical experience. *Radiology* 1984; 153:603-9.
- Goldman AB, Ghelman B. The double-contrast shoulder arthrogram: a review of 158 studies. *Radiology* 1978; 127:655-63.

- Haynor DR, Shuman WP.** Double contrast CT arthrography of the glenoid labrum and shoulder girdle. *RadioGraphics* 1984; 4:411-21.
- Hill HA, Sachs MD.** Grooved defect of humeral head: a frequently unrecognized complication of dislocations of shoulder joint. *Radiology* 1940; 35:690-700.
- Johnson JR, Bayley JIL.** Early complications of acute anterior dislocation of the shoulder in the middle-aged and elderly patient. *Injury* 1982; 13:431-4.
- Journal of Bone and Joint Surgery** (editorial). Recurrent dislocation of the shoulder joint *J Bone Joint Surg [Br]* 1948; 30-B:6-8.
- Keyes EL.** Anatomical observations on senile changes in the shoulder. *J Bone Joint Surg* 1935; 17:953-60.
- Kinnard P, Gordon D, Lévesque RY, Bergeron D.** Computerized arthrotomography in recurring shoulder dislocations and subluxations. *Can J Surg* 1984; 27:487-8.
- McLaughlin HL.** Dislocation of the shoulder with tuberosity fracture. *Surg Clin North Am* 1963; 43:1615-20.
- Rafii M, Firoozonia H, Golimbu C, Minkoff J, Bonamo J.** CT arthrography of capsular structures of the shoulder. *AJR* 1986; 146:361-7.
- Rafii M, Firoozonia H, Bonamo JJ, Minkoff J, Golimbu C.** Athlete shoulder injuries. *Radiology* 1987; 163:559-64.
- Randelli M, Gambrioli PL.** Glenohumeral osteometry by computed tomography in normal and unstable shoulders. *Clin Orthop* 1986; 208:151-6.
- Reed DP, Heys J.** Computerised arthrotomography of the shoulder joint. *Radiography* 1988; 54:49-51.
- Reeves B.** Acute anterior dislocation of the shoulder: clinical and experimental studies. Hunterian Lecture delivered at Royal College of Surgeons of England 18 May 1967. *Ann R Coll Surg Engl* 1969; 44:255-73.
- Resch H, Benedetto KP, Zur Nedden D.** Computertomographische Diagnostik bei habitueller Schulterluxation. *Unfallchirurg* 1985; 88:204-7. (Eng. abstr).
- Rowe CR.** Anterior dislocations of the shoulder: prognosis and treatment. *Surg Clin North Am* 1963; 43:1609-14.
- Rowe CR, Patel D, Southmayd WW.** The Bankart procedure: a long-term end-result study. *J Bone Joint Surg [Am]* 1978; 60-A:1-16.
- Seltzer SE, Weissman BN.** CT findings in normal and dislocating shoulders. *J Can Assoc Radiol* 1985; 36:41-6.
- Shuman WP, Kilcoyne RF, Matesen FA, Rogers JV, Mack LA.** Double-contrast computed tomography for the glenoid labrum. *AJR* 1983; 141:581-4.
- Singson RD, Feldman F, Bigliani L.** CT arthrographic patterns in recurrent glenohumeral instability. *AJR* 1987; 149:749-53.
- Tijmes J, Loyd HM, Tullos HS.** Arthrography in acute shoulder dislocations. *South Med J* 1979; 72:564-7.
- Von Cramer BM, Kramps H-A, Laumann U, et al.** CT-diagnostik bei habitueller schulterluxation. *Fortschr Röntgenstr* 1982; 136:440-3.
- Watson-Jones R.** *Fractures and joint injuries*. 4th ed. Edinburgh: E & S Livingstone Ltd, 1955.
- Zlatkin MB, Bjorkengren AG, Gyls-Morin V, Resnick D, Sartoris DJ.** Cross-sectional imaging of the capsular mechanism of the glenohumeral joint. *AJR* 1988; 150:151-8.