ISOLATED RUPTURE OF THE TENDON OF THE SUBSCAPULARIS MUSCLE

CLINICAL FEATURES IN 16 CASES

CHRISTIAN GERBER, ROBERT J. KRUSHELL

From the University of Berne

Traumatic rupture of the tendon of the subscapularis muscle was documented as an isolated lesion in the shoulders of 16 men. The injury was caused either by forceful hyperextension or external rotation of the adducted arm. The patients complained of anterior shoulder pain and weakness of the arm when it was used above and below the shoulder level. They did not experience shoulder instability.

The injured shoulders exhibited increased external rotation and decreased strength of internal rotation. A simple clinical manoeuvre called the 'lift-off test', reliably diagnosed or excluded clinically relevant rupture of the subscapularis tendon. Confirmation of the clinical diagnosis was best achieved by ultrasonography or MRI, but arthrography or CT arthrography were also useful.

Surgical exploration confirmed the diagnosis in every case. Repair of the ruptured tendon was technically demanding and required good exposure to identify and protect the axillary nerve.

Only a few cases of isolated subscapularis tendon rupture have been reported (Hauser 1954; White and Riley 1985; McAuliffe and Dowd 1987; Biondi and Bear 1988; Neviaser, Neviaser and Neviaser 1988; Patte and Goutallier 1988). We observed 16 cases who presented with a characteristic clinical syndrome which has not been previously described.

PATIENTS AND METHODS

Isolated, post-traumatic rupture of the tendon of the subscapularis muscle was diagnosed in 16 men, all of whom were then operated upon by the senior author (CG). In 13 patients the injured shoulder was previously healthy. The other three patients had each undergone a previous shoulder operation through a deltopectoral approach, with division and reattachment of the subscapularis tendon. Early postoperative trauma had caused the symptoms in these three men.

The 13 patients who had no previous shoulder surgery were aged between 35 and 64 years (average 51).

Table I. Mechanism of injury in 16 patients with rupture of the subscapularis tendon. The numbers in parentheses denote patients who have had previous surgery

	Number
Violent external rotation of the adducted arm	7 (2)
Violent hyperextension	6
Motor-vehicle accident	2 (1)
Traumatic anterior dislocation	1

The dominant right arm was affected in eight patients, the non-dominant left arm in five. The diagnosis was made immediately after the injury in two cases and in 11 it was delayed by an average of 18 months (range 7 to 38).

The three patients who had had previous shoulder surgery were aged between 25 and 32 years. The diagnosis was delayed in them all (1, 2 and 4 months). The diagnostic and surgical findings in these three cases were identical with those in the other 13. The mechanisms of injury are summarised in Table I. The hyperextension injuries were sustained by falls on the outstretched arm; the motor-vehicle accidents were both head-on collisions in which the injured drivers were wearing seat belts.

The 'lift-off test'. All patients had comprehensive clinical examination of their shoulders. In addition, we developed a new clinical test to diagnose tears of the subscapularis tendon.

C. Gerber, MD, Associate Professor
R. J. Krushell, MD, Fellow of the M. E. Muller Foundation
Department of Orthopaedic Surgery, University of Berne, Inselspital,
3010 Berne, Switzerland.

Correspondence should be sent to Dr C. Gerber.

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Fig. 1a

Fig. 1b

Fig. 2

The 'lift-off' test. Figure 1a - Normal test on the left. Figure 1b - Pathological test on the right. The subscapularis tendon is torn and full internal rotation cannot be maintained in hyperextension. This is manifested by the patient's inability to lift the hand off the back. Figure 2 - Isolated rupture of the right subscapularis tendon. External rotation of the painful, right shoulder is increased.

Table II. Pathology and test results in 162 patients studied to validate the lift-off test for subscapularis rupture

Pathology	Number	Lift-off test	
		Pathological	Normal
Normal shoulder	100	0	100
Full thickness rotator cuff tear not involving subscapularis	27	0	27
Full thickness cuff tear involving subscapularis tendon	9	8	1
Recurrent anterior dislocation	17	0	17
Recurrent posterior subluxation	4	0	4
Calcific tendinitis involving subscapularis tendon	2	0	2
Acute external rotation injury of the adducted arm	3	not valid due to pain	

This test is based on our observation that weakness of internal rotation is most easily demonstrated at the limit of the amplitude of contraction of the muscle, namely, when the arm is fully extended and internally rotated. A patient with subscapularis rupture is unable to lift the dorsum of his hand off his back, a finding which we call a 'pathological lift-off test' (Fig. 1). The test was performed on all but the first three patients in this study.

To validate the test we examined a group of patients who had either normal shoulders or surgically proven shoulder lesions other than isolated subscapularis rupture. The results of this separate study are presented in Table II.

Imaging. Imaging studies confirmed the clinical diagnosis

in every case. We used a variety of methods. Conventional anteroposterior, lateral and axillary radiographs were taken in all patients. In addition, arthrography was performed in nine shoulders, ultrasonography in 14, CT arthrography in eight, MRI in five and arthroscopy in one. In one patient we used only one method, in nine patients two, in five patients three. One patient had four imaging methods.

Table III. Complaints in 16 patients with an isolated rupture of the subscapularis tendon

	Number
Pain when using the arm overhead	16
Pain with use below shoulder level	16
Anterior shoulder pain at night	16
Pain radiating to the forearm	6
Swelling of the forearm (subjective)	6
Weakness of the upper limb	16

Operation. The indication for operation was persistence of pain and weakness of the upper limb. The operations were carried out through a superolateral approach (McLaughlin 1944) in three cases and through a deltopectoral approach in 13. Isolated full thickness tears of the subscapularis tendon were found in them all. Cases of avulsion of the lesser tuberosity are not included.

RESULTS

Symptoms. On questioning, all patients could remember a significant, painful injury which had resulted in a period off work. Initially, treatment had been directed to symptomatic relief of 'a strained muscle'. The symptoms

Table IV. Clinical findings in 16 cases of isolated rupture of the subscapularis tendon

	Number
Range of active flexion	
Normal	11
Reduced (90° to 140°)	5
Range of passive external rotation*	
Normal	3
Reduced (2 acute cases, 1 stiff shoulder)	3
Increased (by 10° to 30°)	10
Range of passive internal rotation*	
Normal	15
Reduced	1
Strength of external rotation†	
Normal	12
Grade 4 (painful while tested)	4
Strength of supraspinatus muscle‡	
Normal	9
Grade 4 (all mildly painful)	7
Strength of internal rotation†	
Normal	1
Grade 4	14
Not recorded	1
Lift-off test	
Pathological	12
Not tested	3
Not interpretable (limited passive internal rotation)	1
Impingement and modified impingement tests§	
Painless	9
Slightly painful	7
Apprehension test	
Negative	8
Slightly positive	6
Painful	2

* tested with the arm at the side

† MRC grades 0 to 5, manually tested with the arm at the side in neutral rotation

‡ Jobe and Jobe 1983

§ Neer and Welsh 1977; Hawkins and Kennedy 1980

which persisted and were present at the time of referral to us are summarised in Table III. It is emphasised that in every case, pain was made worse by active use of the limb not only above but also below the shoulder level. No patient complained of instability of the shoulder or apprehension of dislocation.

Clinical findings. The clinical findings are presented in Table IV. The most important were weakness of internal rotation with a pathological 'lift-off test' (Fig. 1), and increased passive external rotation (Fig. 2) with an indistinct end-point and pain at the extreme. Passive external rotation, performed with the arm at the side, provoked some apprehension and discomfort, but abduction of the arm caused this discomfort to wane and only in six patients was the apprehension test recorded as slightly positive.

The lift-off test was pathological in all 12 patients who had isolated subscapularis tears and a full range of passive internal rotation. The test had reverted to normal in all nine patients who, when they were followed up, had regained normal passive internal rotation after a successful repair of the ruptured tendon. The specificity of the test is reflected in the results in Table II.

Imaging studies

Conventional radiographs were not helpful.

Arthrography invariably showed extravasation of dye into the subacromial bursa. Six of the anteroposterior arthrograms would have been compatible with a diagnosis of supraspinatus rupture (Fig. 3a); but the lateral view revealed that the filling of the subacromial bursa was through a ventral defect and that the supraspinatus tendon was intact (Fig. 3b). The anteroposterior arthrogram revealed medial dislocation of the biceps tendon in three shoulders; this finding is diagnostic of rupture of the subscapularis tendon (Fig. 3c).

Ultrasonography showed the absence in all cases of the

Fig. 3a

Fig. 3b

Fig. 3c

Figure 3a – Anteroposterior arthrogram of a shoulder with an isolated subscapularis tear. This view could be misinterpreted as showing a supraspinatus rupture. Figure 3b – A lateral view of the same shoulder shows the dye escaping into the bursa anteriorly; the intact supraspinatus tendon is outlined. Figure 3c – This anteroposterior arthrogram shows the long head of the biceps dislocated medially into the shoulder joint. This sign is diagnostic of rupture of the subscapularis tendon.

convex outline of the subscapularis at its insertion into the lesser tuberosity (Fig. 4). The supraspinatus was always demonstrably intact.

CT arthrography was diagnostic in five shoulders, revealing a crescent of injected air or dye continuously along the anterior aspect of the humeral head and into the bicipital groove (Fig. 5). Differences in the shape of the musculotendinous unit were also seen in the other three shoulders studied by this method, but they were not diagnostic.

MRI scanning accurately detected the ruptures in all five shoulders studied (Fig. 6) and yielded important information on the extent of medial retraction of the subscapularis stump.

Arthroscopy was performed in one case and confirmed the absence of the subscapularis tendon. The anterior capsule was unnaturally soft and elastic.

clinically unimportant and the lesion of the subscapularis was therefore classified as 'isolated'. None the less, the detached part of the supraspinatus tendon was sutured back to a small trough cut in the greater tuberosity. In all other cases the supraspinatus was normal.

The long head of the biceps was intact but dislocated medially in nine shoulders, ruptured in the bicipital groove in two, and held in place by the inferior fascicle of the coracohumeral ligament in three.

Technique of repair. The repair of the ruptured subscapularis tendon was technically difficult but was achieved in all but the first case. In this patient, the superolateral approach made it impossible to identify and mobilise the retracted muscle from the brachial plexus. In the other 15 cases the infraclavicular plexus and specifically the musculocutaneous and axillary nerves were identified. In five, the subscapularis stump had to be formally dissected

Fig. 4

Ultrasonography of both shoulders of one patient. On the left the convex outline of the thick subscapularis tendon is visible where it inserts into the lesser tuberosity. On the right, the tendon is ruptured and the image is thin and flattened.

Surgical findings. The subacromial space was scarred in all patients. In three shoulders the lesser tuberosity appeared bald and entirely devoid of tendon attachment. In the other cases there was a thin layer of scar tissue over the humerus, which could have been mistaken for the tendon. When this tissue was incised along the medial border of the lesser tuberosity (Fig. 7a), it was found to be continuous with the subscapularis tendon medially and with the fascial covering of the biceps tendon and the greater tuberosity laterally, but it had no attachment to the lesser tuberosity (Fig. 7b). In 10 shoulders the entire width of the tendon was avulsed; in three the superior two-thirds of the tendon were ruptured; and in two the superior three-quarters. In one case there was complete rupture of the deep layers of the tendon with preservation of the more superficial fibres. The tendon of the long head of the biceps had dislocated between the two layers.

In three cases there was a small tear of the insertion of the supraspinatus. These tears were considered to be

Fig. 5

CT arthrography shows a crescent of injected air extending without interruption into the bicipital groove. This is proof that the subscapularis tendon has been separated from the lesser tuberosity. Note that the anterior labrum is normal.

free from the neurovascular structures, particularly the axillary nerve.

The tendon was fixed with sutures into a bony trough at the site of the lesser tuberosity (Fig. 7c).

Clinical results. It is not the purpose of this paper to report the results of repair of the subscapularis tendon. The surgical findings are repeated as proof of the accuracy of the diagnoses.

Only 13 patients have been reviewed more than six months after surgery; the other three cannot be commented on. The one patient in whom the tendon could not be repaired experienced no change in his symptoms from the operation; his lift-off test remains pathological. In the other 12 patients the postoperative course was

similar to that after successful supraspinatus repair: they all had pain relief, gradual functional improvement and recovery of strength. Nine patients have already regained normal passive internal rotation and they have all recovered the ability to lift the hand off the back though not yet with normal strength.

The final results of surgical repair will be fully reported at the appropriate time.

DISCUSSION

All patients in our series were men and to date there has been no report of a rupture of the subscapularis, as opposed to an avulsion of the lesser tuberosity, occurring in a woman. As with other tears of the rotator cuff, subscapularis ruptures occur usually after the age of 40 years (McAuliffe and Dowd 1987; Biondi and Bear 1988; Neviasser et al 1988).

The *mechanism of injury* which led to the subscapularis avulsions in the series of Patte and Goutallier (1988) was not specified. The two cases reported by White and Riley (1985) and McAuliffe and Dowd (1987) were not associated with dislocation of the shoulder but they both had avulsion of the lesser tuberosity and therefore differ from our patients. Ten other reported cases (Hauser 1954; Neviasser et al 1988) were all associated with traumatic anterior dislocation of the shoulder. In only one case (Biondi and Bear 1988) was there an external rotation injury without dislocation of the shoulder and without avulsion of the lesser tuberosity.

Thirteen of our 16 patients sustained either a forceful hyperextension or external rotation of the adducted arm, an injury quite different from the mechanism which typically causes anterior dislocation of the shoulder, but

Fig. 6

An MRI scan of a shoulder with a ruptured subscapularis tendon. The fascia covering the front of the humeral head has a high water content and appears white.

Fig. 7a

Fig. 7b

Fig. 7c

Diagrams of a right shoulder with a ruptured subscapularis tendon. Figure 7a – The humeral head is covered with thin scar tissue which can be mistaken for intact tendon. The biceps tendon may be dislocated medially into the joint. The scar which has replaced the subscapularis tendon is incised vertically (dotted line). Figure 7b – The lesser tuberosity is found to be bald. Scar tissue is excised to reveal the tendon (dotted line), the axillary nerve being carefully protected. Figure 7c – The subscapularis tendon is transfixed with heavy sutures and the musculotendinous unit is mobilised and prepared for reinsertion.

biomechanically likely to lead to rupture of the subscapularis (Reeves 1968; Turkel et al 1981).

Most reported subscapularis tears have been associated with traumatic anterior dislocation and have been followed by symptoms of recurrent instability (Hauser 1954; Neviaser et al 1988). None of our patients complained of instability after their injuries but all suffered from pain and weakness of the arm. Pain and weakness when the arm is used below shoulder level would be unusual symptoms of supraspinatus tears but were constantly reported by our patients with subscapularis tears.

The most important and consistent clinical findings were an increased range of external rotation, loss of strength of internal rotation and a pathological lift-off test. The increased external rotation is readily explained; it could always be demonstrated under general anaesthesia. The decreased strength of internal rotation, also reported by Patte and Goutallier (1988), was most obvious at the limit of the amplitude of the muscle's contraction as demonstrated by the lift-off test. The validation study showed that this test can only be interpreted accurately if the patient has a full range of passive internal rotation (the hand can be passively lifted off the back) and if active internal rotation is not limited by pain. If these two prerequisites are fulfilled, a normal lift-off test seems to rule out rupture of the subscapularis, either as an isolated lesion or in combination with a supraspinatus tear, and a pathological lift-off test reliably diagnoses rupture of the subscapularis.

The imaging studies were all helpful. Arthrography was diagnostic when the tendon of the long head of the biceps was dislocated. The lateral projection was required to outline the anterior aspect of the humeral head and to demonstrate an intact supraspinatus tendon. Ultrasonography, CT arthrography and MRI scans all correctly predicted the surgical diagnosis. We currently use the ultrasound examination first and add an MRI scan only in questionable cases.

The surgical pathology was similar in all cases. The rupture often spared a few strands of the tendon inferiorly. As the inferior border of the tendon inserts above the insertion of the inferior glenohumeral ligament (Turkel et al 1981), the latter structure is not injured. It was often

difficult to isolate this ligament and evaluate it surgically because of the retraction of the subscapularis tendon and the attached capsule but no shoulder showed a complete capsular tear. This may explain the lack of complaints of instability of the shoulder in this series.

Adhesions between the brachial plexus and the subscapularis made mobilisation of the retracted muscle difficult. The axillary nerve had to be identified and protected since it lies close to the inferior and lateral border of the muscle. The operation should be performed through a deltopectoral approach as the dissection is almost impossible through the superolateral approach.

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