The 'dropping' and 'hornblower's' signs in evaluation of rotator-cuff tears

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We studied 54 patients operated on for combined supraspinatus and infraspinatus rotator-cuff tears. The presence or absence of the dropping and hornblower's clinical signs of impaired external rotation were correlated with Goutallier stage-3 or stage-4 fatty degeneration of infraspinatus and teres minor. These grades of fatty degeneration have previously been correlated with a poorer outcome from reconstructive surgery.

We found that hornblower's sign had 100% sensitivity and 93% specificity for irreparable degeneration of teres minor and the dropping sign 100% sensitivity and 100% specificity for similar degeneration of infraspinatus.

In seven patients, teres minor showed hypertrophy. This muscle can give useful function for the activities of daily living in patients with rotator-cuff tears in whom it is intact.

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The external rotators of the shoulder are the posterior fibres of the deltoid, the infraspinatus and the teres minor.¹ The contribution of each can be determined clinically, electromyographically or from the moments of the forces around the centre of the humeral head.²⁻⁵ EMG has identified positions at which infraspinatus and teres minor work independently of the posterior fibres of the deltoid, but a position has not been found which isolates the individual actions of these two muscles.^{3,4}

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The diagnosis of a rotator-cuff tear is made by clinical examination. This is not precise; large tears are easily diagnosed, but smaller tears of single tendons may be difficult to detect. In biomechanical terms, teres minor is responsible for up to 45% of the power of external rotation,^{2,5} but is often ignored during clinical examination because there are no clear clinical signs to show its integrity.⁵⁻⁸

Goutallier et al⁹ have shown that in ruptured rotator cuffs, fatty degeneration of the muscles can be correlated with both the age of the rupture and the age of the patient. Stage-3 and stage-4 fatty degeneration is often irreversible after surgical repair of the cuff and is thus associated with a poorer clinical outcome.

Our aim was to correlate the 'dropping'¹⁰ and 'hornblower's'¹¹ signs with the stage of fatty degeneration as shown on CT. These data can be determined preoperatively and used to predict the surgical outcome more accurately in patients with combined ruptures of supraspinatus and infraspinatus.

Patients and Methods

Between 1988 and 1995 the senior author (GW) operated on 161 patients with combined tears of supraspinatus and infraspinatus. Retrospective review of their records led to the retrieval of 54 cases which fulfilled the following criteria: 1) tear more than one year old; 2) full passive range of movement preoperatively; 3) normal anterior rotator cuff with no tear of subscapularis and no rupture or subluxation of the long head of biceps; 4) no previous surgery on the affected shoulder; and 5) a full set of preoperative radiographs (AP views in internal, neutral and external rotation) and a preoperative CT arthrogram.

There were 33 men and 21 women with a mean age at operation of 66 years (47 to 80). The right shoulder was involved in 43 and the dominant side in 41. There was a history of trauma in 19 patients. The mean time between the onset of symptoms and surgery was 5.6 years (1 to 14). The preoperative symptoms which led to surgery were night pain preventing the patient from lying on the affected shoulder and disturbed sleep. Loss of strength and the rapid onset of fatigue were reported by 30 of the 54 patients.

At surgery, 28 patients had arthroscopic articular debridement and resection of the long head of biceps; eight also

Fig. 1

Fig. 2

Figure 1 – Power of external rotation in 90° of abduction in the scapular plane. The examiner supports the patient's arm with the elbow flexed to 90° and the shoulder in maximal external rotation. The examiner's other hand is then used to assess the power of external rotation. Figure 2 – A patient with a rotator-cuff tear and a positive hornblower's sign in one arm (arrow). She was asked to bring both hands to her mouth, but was unable to do so without abducting the affected arm.

Fig. 3

Fig. 4a

Fig. 4b

Figure 3 – Power of external rotation at 0° of abduction. The examiner places the forearm at 45° of external rotation. The patient is then asked to push against his hand. Figure 4 – The dropping sign. With the patient seated the shoulder is placed in 0° of abduction and 45° of external rotation with the elbow flexed to 90° (a). The examiner holds the patient's forearm in this position and instructs the patient to maintain it when he lets go of the forearm. On releasing the forearm a positive test is recorded when the patient's forearm drops back to 0° of external rotation, despite efforts to maintain external rotation (b).

had an acromioplasty. The other 26 patients had open subacromial decompression with reinsertion of the ruptured tendons. In all patients a combined rupture of the tendons of supraspinatus and infraspinatus was confirmed, the width of which was between 2.5 and 5.0 cm. The state of teres minor was not recorded.

Methods

Preoperative external rotation. This was evaluated at 0° and 90° of abduction according to the Medical Research Council (MRC) scale.¹²

External rotation at 90° of abduction¹³ (Fig. 1). The examiner supports the patient's arm at 90° of abduction in the

scapular plane. The elbow is then flexed to 90° and the patient is asked to rotate the forearm externally against the resistance of the examiner's hand. If the shoulder cannot be externally rotated in this position 'hornblower's sign' is said to be present. This was first reported in obstetric brachial plexus palsy,¹¹ and indicates the difficulty in raising the hand to the mouth in the absence of external rotation of the shoulder (Fig. 2).

External rotation with the arm by the side. The examiner places the patient's elbow in 90° of flexion with the arm by the side. The shoulder is externally rotated 45° (Fig. 3). The patient is then asked to rotate externally against resistance,

and the power is graded according to the MRC scale. If the patient is unable to maintain the externally rotated position the arm drops back to the neutral position (Fig. 4). This is called the 'dropping sign'.¹⁰

CT arthrography. All 54 patients had a CT arthrogram which delineated the tear in both the frontal and sagittal planes.

Fatty degeneration. This was classified on the CT scans according to Goutallier et al⁹ (Table I). Analysis of infraspinatus was at the level of the infraspinatus fossa and of teres minor on the transverse cuts below the midpoint of the

glenoid. Teres minor is fusiform and inserts directly into the humeral head which differentiates it morphologically from infraspinatus. In five patients with severe muscle wasting EMG was performed, and in all a neurological lesion was excluded.

Results

On the basis of their clinical signs the patients were divided into three groups (Table II) and the clinical signs were then compared with the CT findings.

Group 1. Thirteen patients had both dropping and hornblower's signs, with no active external rotation at either 0° or 90° of abduction. All showed stage-3 or stage-4 fatty degeneration of infraspinatus (Fig. 5) on CT. In six patients, teres minor was not visible on the CT scan; four had stage-3 or stage-4 degeneration and three had stage-2 degeneration of teres minor.

Group 2. Twelve patients with a positive dropping sign had a negative hornblower's sign. The mean grade of external

Table I. Grading of fatty degeneration of the rotator cuff (Goutallier et al 1994)⁹

Stage	Appearance
0	Normal
1	Fatty streaks
2	Significant fat, but muscle > fat
3	Muscle = fat
4	Fat > muscle

Table II. Details of the three groups of patients with torn rotator cuff (see text)

	Group 1	Group 2	Group 3
Number of patients	13	12	29
Mean age in years	64	63	59
Mean time to presentation (month; range)	33 (12 to 120)	77 (12 to 168)	50 (12 to 120)
Hornblower's sign present (%)	100	0	0
Dropping sign present (%)	100	100	0
Infraspinatus fatty degeneration			
Stage 0 to 2	0	0	29
3 to 4	13	12	0
Teres minor degeneration			
Stage 0 to 2	3	12	29
3 to 4	4	0	0
Disappeared	6		
Mean strength at 0° abduction (MRC grade)	<2	<2	3.8 (3 to 5)
Mean strength at 90° elevation (MRC grade)	<2	3.5 (3 to 4)	4.3 (4 to 5)

Fig. 5

CT scan showing stage-3 fatty degeneration of both teres minor and infraspinatus.

rotation at 90° of abduction was 3.5 (3 to 4). On the CT scan infraspinatus showed stage-3 or stage-4 degeneration in all 12 patients. None showed any degeneration of teres minor and in seven there was hypertrophy of teres minor (Fig. 6).

Group 3. Twenty-nine patients had neither the dropping nor hornblower's sign. The mean grade of external rotation at 0° was 3.8 (3 to 5), and at 90° of abduction 4.3 (4 to 5). None had fatty degeneration of infraspinatus beyond stage 2 or of teres minor beyond stage 1 (Fig. 7).

Statistical analysis showed that if stage-3 or stage-4 fatty degeneration or complete absence of teres minor is taken as diagnostic, hornblower's sign is 100% sensitive and 93% specific for a lesion of teres minor. Similarly, the dropping sign is both 100% sensitive and 100% specific for significant fatty degeneration of infraspinatus. The latter was also associated with fatty degeneration of teres minor (sensitivity 100%), but was sometimes present

Fig. 6

CT scans showing stage-4 fatty degeneration of infraspinatus with compensatory hypertrophy of teres minor.

Fig. 7

CT scans showing stage-1 fatty degeneration of both infraspinatus and teres minor.

despite the absence of stage-3 or stage-4 fatty degeneration (specificity 66%).

Discussion

The clinical evaluation of rotator-cuff tears is not straightforward, and even for a normal rotator cuff there is disagreement on the optimal position for testing individual muscles. For example, Jenp et al³ concluded that the best position for testing infraspinatus was in 90° of abduction in the sagittal plane with the arm in half maximal external rotation while Kelly et al⁴ recommended 45° of internal rotation with the arm by the patient's side.

Goutallier et al⁹ have shown the importance of fatty degeneration for prognosis after repair of the rotator cuff. Fatty degeneration is only rarely reversible, and repair of a cuff in which there is fatty degeneration of infraspinatus of stage-3 and above does not improve the range of active external rotation after surgery. Furthermore, the rate of re-

rupture is 50% if degeneration in infraspinatus is stage-2 or more as opposed to 10% if it is stage-1 or less.

Hornblower's sign had a sensitivity of 100% and a specificity of 93% for the presence of stage-3 or stage-4 fatty degeneration of teres minor on the CT scan. The dropping sign has a 100% sensitivity and specificity for the presence of stage-3 or stage-4 fatty degeneration of infraspinatus. These signs indicate irrecoverable degeneration which will have a re-rupture rate of 50% after surgical repair. The dropping sign indicates an irreparable tear of infraspinatus and hornblower's sign an irreparable tear of infraspinatus and teres minor. The presence of these two signs should be a warning to surgeons when considering operation.

All the patients whom we studied had a combined tear of the supraspinatus and infraspinatus tendon, and it is difficult to explain why the dropping sign should be present only in patients with fatty degeneration of infraspinatus. The negative dropping sign may indicate the integrity or

otherwise of the posterior part of infraspinatus, which is not always seen at the time of surgery. It may also be that when only the posterior part of the tendon is intact, enough activity is maintained to prevent fatty degeneration.

Teres minor has been largely ignored in evaluation of rotator-cuff injuries, because of the difficulty of assessing it clinically. We have shown that it is an important external rotator of the shoulder, contributing up to 45% of the power of external rotation.^{2,5} An intact, or even hypertrophied, teres minor can contribute enough power to external rotation to avoid the hornblower's sign, and may be important in maintaining the ability to perform the activities of daily living, such as eating and drinking, and reduce the symptoms of the cuff tear.

We selected our patients at more than one year after cuff rupture because some signs resolve with physiotherapy and retraining, but our study is retrospective and has certain limitations. First, the state of teres minor was not always recorded at operation because the importance of this muscle was not fully appreciated. The integrity of infraspinatus and teres minor cannot always be established at surgery. Secondly, we have only established the relationship between the state of the muscle belly on CT and the clinical signs, since we did not document the appearance of the muscle bellies at operation.

We have not examined the 'lag' signs recently described by Hertel et al,⁷ which have a high diagnostic value for ruptures of the cuff. They describe a 'drop' sign which is different from the dropping sign described by Neer,¹⁰ and is similar to hornblower's sign. It has a sensitivity of only 36% for a combined rupture of the supraspinatus and infraspinatus tendon. In the series of Hertel et al,⁷ as in ours, tears of infraspinatus and teres minor were not differentiated, but they did not take fatty degeneration into account. This may explain the lack of sensitivity of their drop sign.

Conclusions. We used CT evidence of fatty degeneration to analyse the contribution of infraspinatus and teres minor to external rotation of the humerus. Teres minor does not

participate in external rotation at 0° of abduction, but does contribute at 90° of abduction in the plane of the scapula. Its function can be determined by the presence or absence of hornblower's sign. The state of the intact teres minor may be an important contribution to function after large tears of the rotator cuff. The absence of Neer's dropping sign indicates that infraspinatus is suitable for surgical repair.

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