The depressor function of biceps on the head of the humerus in shoulders with tears of the rotator cuff

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We investigated the function of biceps in 18 patients (19 shoulders) with lesions of the rotator cuff. Their mean age was 59 years. Another series of 18 patients (19 shoulders) with normal rotator cuffs as seen on MRI acted as a control group. Their mean age was 55 years. A brace was used to maintain contraction of biceps during elevation. Anteroposterior radiographs were obtained with the arm elevated at 0°, 45° and 90° with and without contraction of biceps. The distance between the centre of the head of the humerus and the glenoid was compared in the two groups.

We found that in the group with tears there was significantly greater proximal migration of the head of the humerus at 0° and 45° of elevation without contraction of biceps but depression of the head of the humerus at 0°, 45° and 90° when biceps was functioning. We conclude that biceps is an active depressor of the head of the humerus in shoulders with lesions of the rotator cuff.

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Radiographs of shoulders with tears of the rotator cuff show characteristic changes with cysts in the head of the humerus,¹ the formation of spurs on the greater tuberosity, the acromion and the glenoid² and superior migration of the head of the humerus.³⁻⁸ The last occurs as a result of loss of the function of the cuff as a depressor of the head of the humerus and also of the structures which lie between the head of the humerus and the acromion.⁹ Warner and McMahon¹⁰ have reported superior migration during eleva-

tion of the arm in isolated rupture of the long head of biceps in otherwise normal shoulders, which is indirect evidence that biceps acts as a depressor. Our aim was to show directly that active contraction of biceps prevented superior migration of the head of the humerus in shoulders with tears of the rotator cuff.

Patients and Methods

Between November 1996 and October 1997 we treated surgically 18 patients (19 shoulders) with tears of the rotator cuff which had been diagnosed by arthrography or MRI. There were 14 men and four women with a mean age of 59 years (44 to 77). Eleven shoulders had full-thickness tears, five of which were large (>3 cm), three medium (1 to 3 cm) and three small (<1 cm). Eight shoulders had partial-thickness tears of which seven were medium and one small. The long head of biceps was intact in all of these patients. A control group of 19 shoulders was asymptomatic with normal rotator cuffs as seen on MRI. There were 15 men and four women with a mean age of 55 years (17 to 77). There was no significant difference in age ($p = 0.38$) and gender ($p = 0.99$) between the two groups.

Anteroposterior radiographs were taken with the arm elevated at 0°, 45° and 90°, the elbow flexed and the forearm supinated, and a brace applied which allowed active contraction of biceps without the other muscles (Fig. 1). The resistant force produced by the band was approximately 1.5 kg. The distance between the centre of the head of the humerus and the glenoid was measured and processed using National Institute of Health software¹¹ (NIH Image; National Institute of Health, Bethesda, Maryland) (Fig. 2). In four volunteers with a mean age of 30 years (29 to 31) EMG was performed using the brace and activity in the anterior, middle and posterior deltoid, triceps, trapezius and pectoralis major recorded at 0°, 45° and 90° of elevation. We were able to confirm that when using the brace, only biceps was contracting significantly. These activities were measured as percentages of the maximum voluntary contraction (% MVC).^{12,13}

Statistical analysis. The results in the two groups were compared using a one-way between-group analysis of variance (ANOVA), with statistical significance set at the 5% level.

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Fig. 1

Arm elevation with a brace. The elbow is flexed at 90° and the forearm is supinated. The brace is attached to the upper arm and the patient asked to grasp a rubber band, pull it proximally, and keep the elbow flexed against the resistant force.

Fig. 2

Measurement on radiographs. Using the method of Sharkey and Marder¹¹ three points arbitrarily chosen on the surface of head of the humerus and two at the supraglenoid and infraglenoid tubercles were digitised. The centre of the head of the humerus (C) from the former was calculated, and the distance from the perpendicular bisector of the glenoid was measured. The distance (D) was expressed as positive (+) if the centre was above the perpendicular bisector of the glenoid, and negative (-) if it was below the bisector.

Fig. 3

The relationship of the position of the head of the humerus to the angle of elevation (degrees). The position of the head of the humerus was significantly higher in the group with tears than in the control group without contraction of biceps at 0° ($p = 0.0101$) and at 45° of elevation ($p = 0.0020$). The head of the humerus was depressed significantly in those with tears with contraction of biceps at 0° , 45° and 90° ($p = 0.0082$, $p = 0.0259$, $p = 0.0059$, respectively) (RCT, rotator-cuff tear; CON, control; BC(-), without contraction of biceps; BC(+), with contraction of the biceps).

Table I. Mean ($\pm$ SD) % MVC of each muscle with and without biceps loading

Muscles	Elevation angle (degrees)	%MVC		p value*
		Without biceps loading	With biceps loading	
Anterior deltoid	0	6.72 $\pm$ 1.86	12.50 $\pm$ 4.41	0.1058
	45	8.53 $\pm$ 1.43	13.80 $\pm$ 2.63	0.0387
	90	14.78 $\pm$ 3.75	15.30 $\pm$ 0.92	0.8478
Middle deltoid	0	6.95 $\pm$ 2.34	5.64 $\pm$ 0.92	0.4202
	45	8.44 $\pm$ 0.85	9.56 $\pm$ 1.83	0.3913
	90	7.54 $\pm$ 2.06	10.28 $\pm$ 2.64	0.2307
Posterior deltoid	0	5.02 $\pm$ 3.88	5.57 $\pm$ 2.10	0.8385
	45	6.38 $\pm$ 3.73	5.78 $\pm$ 2.12	0.8220
	90	6.47 $\pm$ 4.26	8.28 $\pm$ 4.93	0.6544
Biceps	0	2.78 $\pm$ 0.59	12.36 $\pm$ 2.16	0.0018
	45	4.71 $\pm$ 0.52	10.85 $\pm$ 1.48	0.0025
	90	5.24 $\pm$ 1.37	12.10 $\pm$ 2.52	0.0143
Triceps	0	2.04 $\pm$ 0.45	3.69 $\pm$ 0.73	0.0292
	45	2.66 $\pm$ 0.92	3.30 $\pm$ 1.62	0.5859
	90	2.29 $\pm$ 0.66	3.37 $\pm$ 1.47	0.3135
Trapezius	0	3.15 $\pm$ 2.08	5.36 $\pm$ 1.13	0.1812
	45	4.46 $\pm$ 2.72	6.49 $\pm$ 1.90	0.3481
	90	9.76 $\pm$ 4.54	13.30 $\pm$ 6.54	0.4835
Pectoralis major	0	3.98 $\pm$ 1.67	6.31 $\pm$ 0.78	0.0934
	45	4.69 $\pm$ 1.68	6.83 $\pm$ 0.67	0.1103
	90	5.63 $\pm$ 2.06	8.85 $\pm$ 0.49	0.0586

* one-way ANOVA

Results

The position of the head of the humerus was significantly higher in the group with tears of the cuff without contraction of biceps ($p = 0.0011$), and lower with contraction of biceps ($p = 0.0012$) (Fig. 3). EMG showed significant increases in the % MVC at all angles of elevation only in biceps ($p < 0.0143$; Table I), although there were increases in the activity of anterior deltoid and triceps.

Discussion

Warner and McMahon¹⁰ found increased superior migration of the head of the humerus during elevation in patients

with rupture of the long head of biceps. Itoi et al¹⁴ showed that this tendon was wider in cuff-deficient shoulders. Our study has shown that contraction of biceps depressed the head of the humerus both in normal shoulders and those with lesions of the rotator cuff, and that this effect was greater in the group with tears. The movement of the head in cuff-deficient shoulders approached that of normal shoulders after contraction of biceps. This suggests that active contraction of biceps may compensate for the depressor function of the cuff. Kido et al¹³ showed that EMG activity in biceps increased during elevation in one-third of patients with tears of the cuff. In these patients, biceps may have contracted to stabilise the humeral head. Although pain influences muscle function¹⁵ it does not

Fig. 4a

Fig. 4b

A 45-year-old carpenter with a massive tear of the rotator cuff of the left shoulder. He could not lift his left arm without biceps loading because of pain (a) but with biceps loading he could do so without pain (b).

affect superior migration of the head of the humerus during elevation in shoulders with lesions of the cuff.¹⁶ Although high-resolution MRI has a rate of accuracy of 95% for the diagnosis of tears of the cuff,^{17,18} it may be difficult to differentiate between complete and incomplete tears. We therefore combined all tears together and were thus not able to relate the effect of the size of the tear to the depressor function of the long head of biceps.

Raised subacromial impingement can only be avoided with adequate depressor function. Payne et al¹⁹ reported that subacromial pressure decreased by 10% after contraction of biceps, and that patients with tears of the cuff may have better function when biceps contracts. Figure 4 illustrates a patient with a large lesion of the cuff who had limited elevation. With a 1 kg weight in his hand and his elbow flexed, however, functional elevation could be achieved. He was able to work comfortably as a carpenter if he wore a light-weight (0.5 to 1 kg) wrist band.

The long head of biceps may be damaged or ruptured in association with tears of cuff and in such cases tenotomy or tenodesis has been recommended.^{20,21} On the basis of our findings, however, we would recommend preservation of biceps.

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