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ORIGINAL STUDY

Rotator cuff strength following open subscapularis tendon repair

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The purpose of this study was to evaluate supraspinatus and subscapularis strength following repair of either isolated or anterosuperior subscapularis tears associated with a supraspinatus tear.

Open subscapularis repairs were done in 24 patients, 12 isolated and 12 anterosuperior. At an average follow-up of 40 months, UCLA, ASES, and Constant scores were recorded. Subscapularis and supraspinatus strengths were tested using a spring gauge. Ultrasound scanning was performed in 20 patients.

Average scores were 27 UCLA, 77 ASES and 90 relative Constant. Subscapularis strength was 92% of the non-operated shoulder. Supraspinatus strength was 90%. Statistical analysis showed a significant decrease in supraspinatus strength in the anterosuperior group. No other significant differences were noted.

Ultrasound scanning showed an intact subscapularis tendon in all. Full thickness supraspinatus tears were found in 5 and partial thickness in 1.

Not the subscapularis, but the supraspinatus determines the outcome of anterosuperior repairs, with more re-tears and decreased strength.

Keywords : shoulder ; rotator cuff ; subscapularis ; supraspinatus ; rotator cuff repair.

INTRODUCTION

Full thickness isolated tears of the subscapularis tendon are uncommon. They are associated with rotator cuff tear in less than 2% of cases (*8*), with an even lower incidence of isolated subscapularis tears (*9*). Tears can be traumatic or degenerative, but an acute onset of pain followed by functional impairment of the limb is present in most patients (*6*). Clinically, increased external rotation combined with weakness in internal rotation is often present. Ultrasound can be used to confirm the clinical diagnosis. If conservative treatment fails, surgical repair remains the treatment of choice. Results of surgical repairs of isolated and anterosuperior tears can be good, especially when tears are treated within six months of injury (*6,11*). The lift-off and belly press tests (*6*) are usually used to test the integrity and strength of subscapularis repairs. To our knowledge no study to date has used formal strength testing to compare subscapularis

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strength following isolated or anterosuperior tears. The purpose of the present study was to evaluate supraspinatus and subscapularis strength following repair of isolated subscapularis tears and subscapularis tears combined with a supraspinatus tendon tear.

MATERIAL AND METHODS

Twenty-four patients underwent open surgical repair of a full-thickness subscapularis tendon tear by a single surgeon (SNB). Twelve patients had isolated tears and the other twelve were associated with a full thickness tear of the supraspinatus tendon as anterosuperior (AS) tears. Patients were included either in the isolated or AS group according to intraoperative findings. Tears associated with bony avulsion, instability, and massive rotator cuff tears with complete detachment of at least two tendons were not included.

Twenty-two patients recalled a specific incident at which the injury occurred. Sixteen patients reported the injury to have occurred as a result of a fall. One of these patients fell while carrying a 52 kg bag of concrete.

All patients had pre-operative recording of active forward elevation and passive external rotation range of motion, rotator cuff strength, impingement and lift-off tests. Supraspinatus and subscapularis strength was manually evaluated. Pre-operative imaging in the form of standard radiographs and ultrasound scanning were done in all patients to confirm the diagnosis and to evaluate potential bony pathology. Patient demographics and results of preoperative assessment are shown in tables I and II.

A routine shoulder arthroscopy in lateral decubitus, with the arm in traction, was performed. Following arthroscopy, patients were turned supine and a standard deltopectoral approach was performed for isolated subscapularis tears. For the patients with an AS tear, a superior transverse approach was used with mobilisation of the deltoid from the acromion. In two cases both a superior and a delto-pectoral approach were necessary to gain sufficient access to repair both the subscapularis and supraspinatus tendons.

The ruptured subscapularis tendon was mobilised and the insertion to the lesser tuberosity was freshened using a motorised burr. The extent of the subscapularis and supraspinatus tears was evaluated and recorded at this stage. All subscapularis tears were full thickness tears, but not all tears involved the entire width of the tendon. The mobilised subscapularis tendon was reattached to the lesser tuberosity, with transosseous polyester sutures or suture anchors. Biceps tendon pathology was addressed surgically in six patients (50%) in the isolated group and eight patients (67%) in the AS group.

Postoperatively, a sling was worn for six weeks. Passive elevation to 90° and limited external rotation to neutral were permitted during this time. Active exercises were introduced over the next six weeks, and resisted activities were allowed from three months following the repair.

At final follow-up, patients were contacted by telephone and were asked to complete a University of California at Los Angeles (UCLA) shoulder score questionnaire (*1,5*), which was mailed out to them. Subjective patient satisfaction scores were recorded.

Patients were also invited for a follow-up assessment in our upper extremity clinic. T-tests were used to statistically assess differences in range of motion between both groups. A lift-off test was performed to assess subscapularis function (*7*). Objective supraspinatus and subscapularis strength testing was performed using a spring gauge. Subscapularis strength was tested using a spring gauge as a modification of the belly press test (*7*). The spring gauge was attached to the wrist and the wall at an appropriate level. The patient was then instructed to press towards the lower part of the abdomen with the palmar aspect of the wrist whilst keeping the elbow in front of the coronal plane, limiting the effects of shoulder extension. Average values were calculated and recorded from three repetitions. The results of the operated arm were expressed as a percentage of the strength in the non-operated arm. A paired t-test was used to compare the differences in subscapularis and supraspinatus strength between the operated and non-operated extremities.

The Constant score (*3*), relative Constant score (*2*) and American Shoulder and Elbow Surgeons (ASES) shoulder score (*10*) were calculated. The results of the UCLA, ASES, Constant, and relative Constant scores of both groups were compared using a t-test. Significance level of all statistical tests was set at $p < 0.05$.

Ultrasound scanning using a 5-12 MHz linear transducer with a HDI 5000 unit (Advanced Technology Laboratory, Bothell, Washington, USA) was performed in all patients that returned for clinical examination. All postoperative scans were performed by a single experienced musculoskeletal radiologist (AH) and the results were recorded on a specific datasheet. An assessment was done of the integrity of the rotator cuff tendons with particular reference to the subscapularis repair, supraspinatus and long head of biceps (LHB) tendons.

Table I. — Patient demographics, duration of preoperative symptoms and mechanism of injury
(AS : anterosuperior, M : Male, F : Female, R : Right, L : Left)

Isolated tear	Age	Sex	R/L	Dom arm	Pre Op symptoms (months)	Mechanism of injury	Work cover
1	53	M	R	Yes	3	Lifting	Yes
2	74	M	R	Yes	9	Throwing	No
3	53	M	L	No	48	Traction	Yes
4	53	M	R	Yes	1	Hammering	No
5	49	M	R	Yes	8	Lifting	Yes
6	55	M	R	Yes	2,5	Fall	No
7	58	M	R	Yes	1,5	Fall	No
8	82	M	L	No	3	Fall	No
9	37	M	R	Yes	1	Fall	Yes
10	66	M	R	Yes	24	Chronic	No
11	58	M	R	Yes	1	RTA	Yes
12	64	M	R	Yes	3	Fall	Yes
Average	*58,5*				*9*		
AS tear	Age	Sex	R/L	Dom arm	Pre Op symptoms (months)	Trauma	Work cover
1	63	M	L	Yes	3.5	Fall	No
2	68	F	R	Yes	6	Fall	No
3	56	M	L	No	3	Fall	No
4	67	M	L	No	2	Fall	No
5	62	F	R	Yes	2	Fall	No
6	59	M	R	Yes	6	Fall	Yes
7	85	M	R	Yes	8	Fall	No
8	66	M	L	No	2	Fall	No
9	50	M	R	Yes	4	Pulling	Yes
10	45	M	R	Yes	1	Fall	Yes
11	61	M	R	Yes	9	No	Yes
12	58	M	L	No	3	Fall	Yes
Average	*62*		*17/7*	*18/6*	*4*		*11/13*

RESULTS

At an average follow-up of forty months (range 24-105 months), all patients returned the UCLA End-Result score questionnaire. Twenty (83%) patients, eleven from the isolated tear group and nine patients from the AS group attended clinical assessment and ultrasound scanning of the operated shoulder. Of the twenty-four, one had a severe, unrelated illness and three lived in a different state and were unable to attend for clinical assessment.

Patients from both groups reported high levels of satisfaction with their result. Results of objective and subjective scores are shown in tables III and IV. Statistical analysis of the UCLA ($p = 0.72$), ASES ($p = 0.76$), Constant ($p = 0.33$) and relative Constant ($p = 0.79$) shoulder scores did not show any significant difference between the isolated and anterosuperior tear groups.

There was no post-operative impingement in any patient and the lift-off test was negative in all. Again, no significant differences were found between the isolated and AS groups for forward

Table II. — Pre-, per- and postoperative findings in patients with an isolated or anterosuperior (AS) subscapularis tear. (ER : external rotation, Ssc : subscapularis, Ssp : Supraspinatus, IN : intact, PT : partial thickness tear, FT : full thickness tear, *= previous repair, NC= not completed. Patient satisfaction : 0 = completely dissatisfied, 1 = somewhat dissatisfied, 2 = somewhat satisfied, 3 = completely satisfied)

	Preoperative evaluation			Ultrasound		Operative evaluation	Postoperative evaluation				Relative strength of operated arm		Ultrasound	
Isolated	ER	Elevation	Lift off	Ssc	Ssp	Ssc tear	Follow-up (months)	ER (°)	Elevation (°)	Lift off	Ssc	Ssp	Ssc	Ssp
1	70	180	-	FT	IN	75%	105	20	130	-	163	250	IN	IN
2	90	150	+	PT	IN*	66%	25	60	120	-	86	117	IN	FT
3	60	180	+	FT	IN	100%	53	60	145	-	45	68	IN	IN
4	80	180	+	FT	FT	100%	49	45	150	-	75	107	IN	IN
5	70	180	+	FT	IN	33%	28	85	170	-	104	88	IN	PT
6	30	60	+	FT	FT	100%	24	45	150	-	81	94	IN	IN
7	40	180	+	IN	IN	100%	31	40	170	-	90	75	IN	IN
8	70	130	+	FT	IN	66%	30	55	115	-	105	180	IN	IN
9	90	180	+	FT	IN	66%	52	70	180	-	106	92	IN	IN
10	100	180	+	FT	IN	100%	50	60	145	-	75	64	IN	IN
11	70	180	+	FT	FT	33%	49	65	145	-	93	53	IN	IN
12	20	180	+	FT	IN	50%	34	NC	NC	NC	NC	NC	NC	NC
Average	*66*	*163*				*74%*	*44*	*55*	*147*		*93*	*108*		
AS	ER	Elevation	Lift off	Ssc	Ssp	Ssc tear		ER	Elevation	Lift off	Ssc	Ssp	Ssc	Ssp
1	90	90	+	FT	FT	100%	39	40	140		89	100	IN	FT
2	20	180	+	PT	IN *	50%	24	40	135	-	70	63	IN	FT
3	30	150	+	IN	IN	33%	23	45	170	-	108	38	IN	IN
4	80	180	+	FT	IN	50%	36	60	150	-	164	56	IN	IN
5	30	100	+	IN	FT	100%	44	65	170	-	73	57	IN	IN
6	70	180	-	FT	FT	33%	28	70	160	-	100	92	IN	IN
7	100	180	+	FT	IN	100%	47	90	160	-	100	90	IN	IN
8	70	90	-	IN	FT	100%	43	80	140	-	40	33	IN	FT
9	90	90	+	IN	FT	33%	50	65	45	-	75	Too painful	IN	FT
10	30	90	+	FT	FT	50%	47	62	141	-	91	66	NC	NC
11	80	180	-	FT	FT	50%	25	NC	NC	NC	NC	NC	NC	NC
12	70	30	+	IN	FT	50%	31	NC	NC	NC	NC	NC	NC	NC
Average	*67*	*128*				*62%*	*36*	*58*	*142*		*91*	*66*		

Table III. — Objective and subjective scores of patients following an isolated or anterosuperior (AS) subscapularis tear

Isolated	UCLA	ASES	Constant	Relative Constant %	Satisfaction
1	33	100	86	104	2
2	19	65	55	73	2
3	24	62	64	71	2
4	33	90	81	90	3
5	30	85	89	99	3
6	31	98	84	93	3
7	33	82	91	101	3
8	35	100	79	120	3
9	33	85	92	100	2
10	17	41	69	83	2
11	10	24	54	65	3
12	27	NC	NC	NC	NC
Average	*27*	*76*	*77*	*91*	*2.5*
AS	UCLA	ASES	Constant	Relative Constant %	Satisfaction
1	35	97	80	96	3
2	32	92	69	99	3
3	29	75	75	83	3
4	29	100	74	89	3
5	29	54	67	93	2
6	19	100	93	112	3
7	30	88	76	115	3
8	30	78	67	81	3
9	6	43	23	26	0
10	22	NC	NC	NC	2
11	20	NC	NC	NC	NC
12	30	NC	NC	NC	NC
Average	*26*	*81*	*69*	*88*	*2.5*

elevation ($p = 0.71$) and external rotation ($p = 0.77$). Range of motion and results of strength testing are shown in table II. Supraspinatus strength was not tested in one patient in the AS group due to severe pain. A paired t-test showed a significant difference between supraspinatus strength tests in the operated and non-operated shoulder in the AS group ($p < 0.05$).

A significant difference was found when comparing supraspinatus strength in the operated shoulders of both groups ($p < 0.05$). No significant difference was found for subscapularis strength ($p = 0.13$). As a comparison between groups, no significant differences were found when the same analysis was done for the non-operated shoulders ($p > 0.05$).

Postoperative ultrasound examination was performed in eleven patients of the isolated repair group and in nine patients of the AS group. Ultrasound scanning of the shoulder showed an intact subscapularis tendon in all patients. One full thickness and one partial thickness supraspinatus tear were found in the isolated repair group. This did not clearly reflect in the supraspinatus strength, which was a 117% (3.2 kg) of the non-operated site in the patient with the full thickness tear and 88% (9.5 kg) in the patient with a partial thickness supraspinatus tear. Four full thickness supraspinatus tears were found in the patients included in the AS group (44%). Supraspinatus strength was not tested in one of these due to pain and the others

Table IV. — UCLA and ASES scores compared for isolated and anterosuperior (AS) subscapularis repairs

	UCLA		ASES	
	Isolated	AS	Isolated	AS
Excellent	1	1	4	4
Good	6	7	3	3
Fair	2	1	3	2
Poor	3	3	1	0

showed supraspinatus strength in the operated arm to be 100% (5.9 kg), 63% (2.3 kg) and 33% (1.8 kg) of the non-operated arm.

DISCUSSION

Although it is believed that patients with isolated subscapularis tears usually have better outcomes when compared to anterosuperior tear repairs (*11*), this did not translate in any of the outcome scores used in the present study. There were no significant differences between either group in the UCLA, ASES, Constant and age and gender adjusted Constant scores and patient satisfaction. This may be due to the duration of preoperative symptoms (*6,11*), which was almost nine months in the isolated group versus four months in the antero superior group, potentially levelling out the scores. This difference in timing of preoperative symptoms was however not statistically significant ($p = 0.27$).

We did not compare preoperative and postoperative data. Preoperative assessment of our patients was solely directed to diagnose the shoulder pathology. We only report on a small series, however, our postoperative results for both isolated and anterosuperior subscapularis repairs are comparable to those reported from the largest series to date (*4,11*). Edwards *et al* (*4*) found an average Constant score of 79.5 (range : 25 to 101) and an average age and gender-adjusted Constant score of 94.0% (range : 27 to 139). In our series we found an average Constant score of 76.7 (range : 24 to 100) and an average age and gender-adjusted Constant score of 91.0% (range : 65 to 120). Warner *et al* (*11*) found an age- and sex-adjusted Constant score of 68.8% (range : 23 to 130). Again this is comparable to our Constant score of 69.3% (range : 23 to 93).

The goal of this study was to measure supraspinatus and subscapularis strength following subscapularis repairs in isolated subscapularis and anterosuperior rotator cuff tear containing both the subscapularis and supraspinatus tendons. A significant difference was found when comparing supraspinatus strength of the operated shoulders between groups and when comparing the operated and non-operated shoulders in the AS group. This may not be too surprising as the supraspinatus was never injured in the isolated group and therefore did not need repair. It is uncertain if the initial injury, the actual repair, or the re-injury rate in the AS group is responsible for this difference. Follow-up ultrasound showed one full and one partial thickness supraspinatus tear in the isolated group and four full thickness tears in the AS group. Subscapularis strength comparison did not show any significant differences between groups and between operated and non-operated arms in both groups.

Contrary to previous speculations (*11*), it seems that not the subscapularis, but the supraspinatus determines the outcome of anterosuperior repairs. Subscapularis repair in both isolated and anterosuperior tears is a reliable procedure and can yield close to normal internal rotation strength, with good range of motion.

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