Systematic Review

Outcomes of Arthroscopic and Open Surgical Repair of Isolated Subscapularis Tendon Tears

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Purpose: Reports of the results of subscapularis repairs make up a very small minority of the published literature on rotator cuff repairs, yet subscapularis tears cause significant pain and dysfunction for patients. The goals of this study were to systematically review the published results after subscapularis repair and to compare arthroscopic versus open techniques when appropriate. **Methods:** The Cochrane, PubMed, and Embase databases were reviewed for studies evaluating isolated subscapularis repairs. If a study reported outcomes for both subscapularis and supraspinatus tears, a subgroup analysis of isolated subscapularis tears was necessary for inclusion in this review. Other inclusion criteria included a minimum of 1-year follow-up. **Results:** We found 3 arthroscopic repair studies and 6 open repair studies that met all inclusion criteria. The mean patient age was 49.2 years, and the mean time from injury to surgical repair was 11.1 months. Constant scores were consistent between groups, with a mean postoperative score of 88.1. Pain scores improved significantly after repair, with a mean of 13.4 (on a scale ranging from 0 to 15, with 15 being no pain) in the arthroscopic repair group and 11.5 in the open repair group. Concomitant procedures were common, with biceps tenodesis being the most common, having been performed in 54.8% of shoulders, followed by biceps tenotomy and biceps recentering. Healing was reported in 90% to 95% of shoulders. **Conclusions:** Subscapularis tears can cause significant morbidity and often occur as traumatic injury in a younger population. Pain and function can be restored with repair, with excellent healing rates. The characteristic injury pattern suggested by a review of the literature is 1 where such tears are full thickness yet involve a portion of the tendon in the craniocaudal dimension. Concomitant procedures are common and can affect the results, because biceps tenotomy and tenodesis have been shown to significantly improve pain as well. All studies were Level IV, which introduced selection bias. **Level of Evidence:** Level IV, systematic review of Level IV studies.

Tears of the subscapularis tendon (isolated and combined) were initially documented in a postmortem analysis by Smith[1] in 1834, and the first repair technique was described by Hauser in 1954.[2,3] Despite the relatively early description of this injury, the subscapularis muscle-tendon unit has received relatively less attention compared with the remainder of the rotator cuff. Lo and Burkhart[4] have suggested that the subscapularis often remains the "forgotten tendon" of the shoulder joint. However, over the last 2 decades, the importance of the subscapularis muscle-tendon unit has been recognized through the work of Gerber and Krushell.[5] The importance of surgically repairing the subscapularis tendon relates to its intrinsic biomechanical and functional properties, which include active internal rotation of the shoulder, force coupling in

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the transverse plane, and a contribution to the dynamic anterior stability of the glenohumeral joint.[2,6]

Autopsy and cadaveric series have determined the incidence of subscapularis tears to be between 3% and 13%, the latter being partial-thickness degenerative tears.[7] Whereas 1 large arthroscopic study of patients with symptomatic rotator cuff tears (mean age, 56 years) also reported the incidence of isolated subscapularis tendon tears to be 3%,[8] another arthroscopic diagnosis study showed an incidence of 27%.[2] The heterogeneity in observed rates can be partially explained by the variety in the way these tears present clinically—as isolated complete tears, isolated partial-thickness tears, anterosuperior tears involving the supraspinatus tendon, complete rotator cuff tears or avulsions, and rotator interval lesions with instability of the long head of the biceps.[7,9] However, the true incidence of subscapularis tears is likely unknown because many patients lack the classic rotator cuff symptoms[10] and magnetic resonance imaging (MRI) diagnosis of subscapularis tears is poor, with 1 study showing a sensitivity of only 36%.[11]

Although initial outcomes studies were performed after open repair, more recent research has documented the results of arthroscopic repair, after the initial technique and results were published by Burkhart and Tehrany[12] in 2002. To our knowledge, there are no systematic reviews that have looked at outcomes after the surgical repair of subscapularis tendon repairs. Given the large number of injury permutations and clinical heterogeneity that is associated with this injury pattern, the purpose of this systematic review was to describe patient and injury characteristics of isolated subscapularis tears, as well as to analyze functional outcomes in patients undergoing repair of isolated subscapularis tendon tears. We hypothesized that isolated subscapularis repair would yield excellent results, with reduction in preoperative pain, improved strength, and improved outcome scores.

METHODS

Literature Search

With the aid of an experienced librarian, we searched the Cochrane Central Register of Controlled Trials (second quarter of 2011), Medline (1948 to week 2 of August 2011), and Embase (1980 to week 32 of 2011) using the following key words: subscapularis tendon, subscapularis tendon repair, subscapularis AND surg*, and subscapularis AND (arthroscopic OR open). General search terms were used to prevent the possibility of missing relevant studies. The references of all applicable studies and review articles were also manually cross-referenced to ensure completeness.

Inclusion criteria were (1) studies that reported clinical outcomes after arthroscopic or open repair of isolated subscapularis tendon tears, (2) adult patients aged 18 years or older, and (3) minimal clinical follow-up of 12 months. We excluded (1) case reports, (2) technique articles with outcomes described for a single participant, and (3) outcome studies that reported results for anterosuperior rotator cuff tears or combined rotator cuff tears without a separate analysis for isolated tears of the subscapularis tendon.

Data Abstraction

The data from each study that met the inclusion criteria were abstracted by 2 independent reviewers (N.A.M., J.C.). Study data collected included the year of publication, type of clinical study, level of evidence (I to IV), type of repair (open *v* arthroscopic), study period, inclusion/exclusion criteria, number of patients enrolled, number of patients available for follow-up, age, length of follow-up, proportion of dominant extremities involved, proportion of traumatic tears, time from symptoms to surgery, number of surgeons, classification scheme used, amount of fatty infiltration, status of the long head of the biceps, number of anchors used for repair, anchor types, and concomitant procedures performed. Preoperative and postoperative data including range of motion, strength (liftoff test, belly-press test), complications, and clinical outcome scores were extracted. Functional outcomes that were of interest included the University of California, Los Angeles outcome score,[13] Constant-Murley outcome score,[14] Pennsylvania Shoulder Score,[15] American Shoulder and Elbow Surgeons (ASES) outcome score,[16] Simple Shoulder Test (SST),[17] L'Insalata scoring system,[18] visual analog scale (VAS) for pain, and overall patient satisfaction rates. Information pertaining to postoperative imaging and healing of subscapularis tendon tears was also abstracted if available. Finally, the presence of bias was determined and analyzed for each eligible study.

Statistical Analysis

Weighted averages were used where appropriate. Results of dichotomous variables were combined where appropriate and presented as percentages of the larger group. Constant scores were measured and pain scores were reported in the majority of studies. Be-

Table 1. *Characteristics of Included Studies*

Author	Technique	Type of Study	Level of Evidence	No. of Shoulders at Final Follow-up	Effective Follow-up (%)	Mean Follow-up Length (Range) (mo)	Bias
Bartl et al.[25] (2011)	Arthroscopic	PCS	IV	21	95	27 (24-36)	Selection
Bennett[24] (2003)	Arthroscopic	PCS	IV	8	100	NR (24-48)	Selection, detection
Lafosse et al.[26] (2007)	Arthroscopic	PCS	IV	17	100	29 (24-39)	Selection
Bartl et al.[28] (2011)	Open	PCS	IV	30	91	46.2 (25-72)	Selection
Fuchs et al.[23] (2006)	Open	RCS	IV	10	100	38 (24-53)	Selection, detection
Edwards et al.[29] (2005)	Open	RCS	IV	84	83	45.2 (24-132)	Selection
Kreuz et al.[30] (2005)	Open	RCS	IV	16	100	36 (24-48)	Selection, detection
Deutsch et al.[10] (1997)	Open	RCS	IV	14	100	24 (19-48)	Selection, detection
Gerber et al.[27] (1996)	Open	RCS	IV	16	100	43 (24-84)	Selection

Abbreviations: NR, not reported; PCS, prospective case series; RCS, retrospective case series.

cause the majority of the studies reported their results as a mean only or a mean with a range rather than a standard deviation, a comparison of the weighted means could not be performed with statistical accuracy. Therefore a meta-analysis could not be performed.

RESULTS

Literature Search

Initial review found 7 studies that met the initial search criteria for arthroscopic subscapularis repair. Four of these studies were excluded because they were technique articles,[12,19,20] did not analyze the isolated subscapularis repairs separately,[12,19-21] or did not have greater than 1 year of follow-up.[12] This left 3 arthroscopic subscapularis repair studies for inclusion in this review.

After initial inclusion and exclusion criteria were applied, 9 studies of open subscapularis repair underwent further review. There were 3 studies that reported the outcomes of open repair that were excluded because they reported results of both subscapularis and 2-tendon tears without analyzing these groups separately[8] or because the same patient population was reported twice.[5,22] This left 6 studies for the open repair group of this review. Table 1 displays the results of the search.

Study Demographics

All studies reported mean age and percent of dominant extremity. One study did not report gender,[23] 2 studies did not report the percentage of traumatic injuries,[23,24] and 3 studies did not report the time from injury or symptoms to surgery.[10,23,24] The mean age of patients was 47.1 years in the arthroscopic repair group and 49.7 years in the open repair group. The mean age of both groups combined was 49.2 years. The percentage of patients who were men, the percentage of dominant extremities, and the percentage of traumatic injuries were 81.6%, 78.2%, and 83.3%, respectively, for the 2 groups combined. The mean time from injury or symptoms to surgery was 11.1 months. Table 2 displays the demographic data collected for each study.

Tear Characteristics

Two of the three arthroscopic repair studies used classification systems,[25,26] but each used a different system. Combining the data from these classification schemes, we found that there were 46 shoulders and 4 partial-thickness tears, 31 full-thickness tears of part of the tendon, and 11 complete tears of the entire tendon.

The majority of the studies on open repair predate the classification systems for subscapularis tears. Of the 6 studies, 2 did not report the type of tear.[23,27] In 2 studies, tears were divided into superior one-third tears, superior two-thirds tears, and complete tendon tears.[28,29] When these 2 studies were combined, there were 30 superior one-third tears, 52 superior two-thirds tears, and 32 complete tendon tears. Another study described all tears as full thickness but further classified them as either partial tears or complete tears.[30] Therefore the total number of complete tendon

TABLE 2. *Patient Demographics in Included Studies*

Author	Mean Age (Range) (yr)	Gender [n (% Men)]	Dominant Extremity [n (%)]	% Trauma	Mean Time to Surgery (Range) (mo)	Tear Type	Repair Technique	Status of LHB	Concomitant Procedures
Bartl et al.[25] (2011)	44 (18-61)	16 (76.2)	15 (71)	91	6 (0.2-14)	PT, 0; UT, 4; LT, 10; CT, 7	Anchors	N, 6; D, 3; PT, 7; R, 2	Ts (9), Ty (1), Rc (2)
Bennett[24] (2003)	57 (32-76)	5 (62.5)	8 (100)			PT, 2; CT, 6	Anchors		
Lafosse et al.[26] (2007)	47 (29-59)	13 (76.5)	16 (94.1)	77	24 (3-44)	PT, 2; UT, 4; LT, 7; CT, 4	Anchors		Ts (11)
Bartl et al.[28] (2011)	43 (15-64)	26 (86.7)	22 (73.3)	100	6 (0.2-15)	UT, 7; LT, 11; CT, 12	Anchors	N, 3; S, 11; D, 13; R, 3	Ts (17), Ty (3), Rc (7)
Fuchs et al.[23] (2006)	59 (40-75)		72				TO (10), tied over plate		
Edwards et al.[29] (2005)	53 (23-77)	70 (83.3)	65 (77.4)	68	13 (0-108)	UT, 23; LT, 41; CT, 20	Anchors (42), staples (23), TO (19)		Ts (48), Ty (13), Rc (4), DC (11)
Kreuz et al.[30] (2005)	46 (27-64)	14 (87.5)	15 (93.8)	100		UT, 7; CT, 9	Anchors (7), TO (7), TT (2)		
Deutsch et al.[10] (1997)	38 (18-64)	8 (57)	8 (57)	100		PT, 1; FT, 13	Anchors (12), TT (2)	N, 6; S, 4; D, 2; R, 1	
Gerber et al.[27] (1996)	50 (33-60)	16 (100)	13 (81.3)	100	15 (1-56)		TO (16)	N, 5; Th, 5; D, 4; Ts, 1; R, 1	Rc (4), coracoplasty (1)

Abbreviations: CT, complete tendon; D, dislocated; DC, excision of distal clavicle; FT, full thickness; LHB, long head of biceps tendon; LT, tear extending to lower third of tendon; N, normal; PT, partial thickness; R, ruptured; Rc, recentered; S, subluxated; Th, thickened; TO, transosseous; Ts, tenodesis; TT, transtendon repair; Ty, tenotomy; UT, upper-third tear.

tears was 41 in 3 studies, and the total number of full-thickness partial tendon tears was 89. The final study reporting on tear characteristics described 13 full-thickness tears and 1 partial-thickness tear but did not further define the full-thickness tears by tear size.[10]

One study reported fatty infiltration[29] using the classification of Goutallier et al.[31] This study noted only 2 shoulders with grade 3 or 4 fatty infiltration. Two studies graded the amount of retraction of the tendons.[25,28] In the arthroscopic repair study, 5 of 21 shoulders (24%) had grade III retraction, whereas in the open repair study, 10 of 30 shoulders (33.3%) had grade III retraction. In these studies retraction was defined as grade I if the tendon stump was near the lesser tuberosity, grade II if the tendon edge was at the medial edge of the humeral head, and grade III if the tendon had retracted to the glenoid or more medially.

Functional Outcomes and Satisfaction

Of the 9 studies, 7 reported preoperative Constant scores and 8 evaluated postoperative Constant scores. Of these, 2 arthroscopic repair studies[25,26] and 3 open repair studies[23,28,29] also reported age- and gender-corrected Constant scores. The weighted average preoperative and postoperative Constant and corrected Constant scores in the arthroscopic repair group were similar to those in the open repair group; however, statistical significance could not be determined based on the data presented in the articles. The weighted average preoperative Constant score and age- and gender-corrected Constant score for the 2 groups combined were 52 and 61.3, respectively. The weighted average postoperative Constant score and age- and gender-corrected Constant score for the 2 groups combined were 81.1 and 93.3, respectively. One study reported ASES scores, and 2 studies reported SST scores. Bennett[24] found a preoperative ASES score of 16.1 and a postoperative score of 74.4 in his group of 8 arthroscopic repairs. The 2 studies that used SST outcome scores reported preoperative scores of 6.3 in an arthroscopic repair group[25] and 5.8 in an open repair group,[28] and postoperative scores of 11.2 were reported in both studies.

One arthroscopic repair study[24] and 2 open repair studies[10,23] did not report satisfaction rates. Two studies reported patient satisfaction as satisfied or not satisfied,[26,28] which combined had an 89% satisfaction rate. One study reported subjective patient outcomes as satisfied or not satisfied and excellent, good, fair, or poor; therefore, there were 5 studies that used the latter scale.[25,27-30] These 5 studies together had an

89% rate of good or excellent results. Table 3 displays the outcomes of each study included in the review.

Repair Technique

All 3 studies evaluating arthroscopic repair used suture anchor constructs. In the open group, suture anchors were used in every patient in 1 study,[28] transosseous sutures were used in all patients in 2 studies,[23,27] and 3 studies used a mixture of transosseous sutures and suture anchors in their patient population.[10,29,30]

Concomitant Procedures

Of the 9 studies, 6 reported concomitant procedures.[10,25,26,28-30] Biceps tenodesis was the most frequently performed concomitant procedure. It was reported in 5 of the studies and was performed in 91 of 166 shoulders (54.8%). Biceps tenotomy and biceps recentering were the next most frequently reported procedures and were performed in 17 of 135 shoulders (12.6%) (3 studies) and 17 of 151 shoulders (11.3%) (4 studies), respectively. Distal clavicle excision was only reported in 1 study and was performed in 11 of 84 shoulders (13.1%).[29] Inferolateral coracoplasty was also reported in 1 patient in 1 study (1 of 16 shoulders [6.3%]).[27]

Range of Motion

Of the 3 arthroscopic repair studies, 2 reported range-of-motion results. Both of these studies reported active forward flexion and active external rotation. Lafosse et al.[26] showed an increase in active forward flexion from 145.6° to 174.7° postoperatively and external rotation from 50° to 60.3° postoperatively. Bartl et al.[25] also showed an increase in forward flexion and external rotation, with motion improving from 134° to 171° and 42° to 55°, respectively.

One open repair study reported motion as an insignificant increase in forward flexion from a preoperative mean of 130° to 147° postoperatively and a decrease in external rotation from 55.6° to 46° at final follow-up.[23] Three open repair studies recorded preoperative motion as normal, increased, or decreased compared with the contralateral extremity.[10,27,28] When these 3 studies were combined, there were 41 shoulders with normal preoperative forward elevation and 19 with reduced active forward elevation. Twenty-nine shoulders had increased external rotation, 21 had normal external rotation, and 10 had decreased external rotation preoperatively. Another open repair study recorded the mean increase in external rotation as 15° (range, 5° to 30°) but did not publish postoperative

TABLE 3. *Outcomes After Operative Repair of Isolated Subscapularis Tears*

Author	First Outcome Measure			Second Outcome Measure			VAS Score [Mean (Range)]		Satisfaction [n (%)]	Postop Imaging (% Intact)	Belly-Press Test (No. Positive)		Liftoff Test (No. Positive)		Complications
	Score	Preop [Mean (Range)]	Postop [Mean (Range)]	Score	Preop [Mean (Range)]	Postop [Mean (Range)]	Preop	Postop			Preop	Postop	Preop	Postop	
Bartl et al.[25] (2011)	Constant	50.3 (39-62)	82.4 (65-98)	SST	6.3 (3-11)	11.2 (7-12)	4.4*	13.3*	G/E, 19 (91)	MRI (91)	19	5	16	1	Stiff (1), RT (1), LHB (1)
Bennett[24] (2003)	Constant	43.3 (32-51)	74.2 (66-88)	ASES	16.1 (3-30)	74.4 (48-100)	9 (8-10)†	2 (0-5)†							
Lafosse et al.[26] (2007)	Constant	52	84.9	UCLA	16.2	32.1	5.9*	13.5*	S/VS, 16 (94)	CTA (88)					RT (1), LHB (1)
Bartl et al.[28] (2011)	Constant	51.3 (39-62)	82.2 (65-98)	SST	5.8 (3-11)	11.2 (6-12)	4.2*	12.6*	G/E, 27 (90)	MRI and U/S (93)			17	3	Stiff (2), RT (2), LHB (1)
Fuchs et al.[23] (2006)	Constant	51.8	72.9				5*	11.8*		MRI (100)					
Edwards et al.[29] (2005)	Constant	55 (14-84)	79.5 (25-101)				4.6*	11.2*	G/E, 74 (88)		76	15	60	17	Stiff (4), RT (5), LF (3), CRPS (2), NP (2), LHB (1)
Kreuz et al.[30] (2005)	Constant	44 (35-65)	88.7 (79-98)						G/E, 15 (94)				13		Stiff (1)
Deutsch et al.[10] (1997)	Constant												14	0	
Gerber et al.[27] (1996)	Constant		82				10.4*		G/E, 13 (81)		8 (of 8)	5	13	3	

Abbreviations: CRPS, complex regional pain syndrome; CTA, computed tomography arthrography; G/E, good/excellent; LF, loss of fixation; LHB, complications of long head of biceps; NP, neurapraxia; Preop, preoperative; Postop, postoperative; RT, retear; S/VS, satisfied/very satisfied; Stiff, stiffness; UCLA, University of California, Los Angeles; U/S, ultrasound.

*VAS using a scale from 0 to 15, with 0 being severe pain and 15 being no pain.

†VAS using a scale from 0 to 10, with 0 being no pain and 10 being severe pain.

motion data.[30] One study reported postoperative external rotation motion as normal in 18 patients, decreased in 11, and increased in 1 (compared with normal in 12, increased in 12, and decreased in 6 preoperatively).[28] The single patient with increased range of motion had a retear of the subscapularis.

Pain

Of the 3 arthroscopic repair studies, 2 measured pain using the Constant score on a VAS, with minimum pain rated as 15 and severe pain rated as 0. In these 2 studies the preoperative weighted mean was 5.1 and the weighted mean improved postoperatively to 13.4. The other arthroscopic study used a standard VAS pain score (ranging from 0 [no pain] to 10) with preoperative pain of 9 improving to 2 postoperatively. In the group of open repair studies, 3 reported the preoperative Constant score for pain; 4 reported the postoperative Constant score for pain; 1 used a score of mild, moderate, or severe; and 1 did not report pain scores. The weighted average preoperative pain score for open repair studies using the Constant score was 4.5, and the weighted average for postoperative pain was 11.5. The study by Kreuz et al.[30] had 13 patients with moderate pain and 3 with severe pain preoperatively, which improved to 12 patients with no pain, 3 with mild pain, and 1 with moderate pain.

Strength

One study measured strength using a force measurement plate on the abdomen or on the wall to simulate a belly-press test and liftoff test. Belly-press strength improved from 65.2 N to 86.6 N at final follow-up, and liftoff strength improved from 44.1 N preoperatively to 68.4 N. Lafosse et al.[26] graded the strength for belly press and liftoff (out of 5), finding an improvement in belly-press strength from 2.5 to 4.4 and an improvement in liftoff strength from 2.4 to 4.1 postoperatively. Other studies reported the presence or absence of positive belly-press and liftoff tests. When we combined the 3 studies that reported the belly-press findings preoperatively and postoperatively, 103 of 113 shoulders (89%) were positive before surgery and 25 (21%) were positive postoperatively.

The liftoff test was used more commonly, with 6 studies (1 arthroscopic and 5 open) reporting results of the test before surgery and 5 studies reporting postoperative findings. The liftoff test was found to be positive in 121 of 181 preoperative shoulders (67%); however, for an additional 29 shoulders (16%), the examination was equivocal or the patient had too much pain to assume the liftoff position. Postoperatively, there were only 24 shoulders (15%) with a positive liftoff test, and 5 equivocal examinations (3%).

Return to Work or Sport

Only 4 of the 9 studies published their results with regard to return to work or sports participation. Bennett[24] described an increase in percent function from 25% to 82.5% at final follow-up. Another study reported that 14 of 16 patients returned to full work capacity, 1 to 75% capacity, and 1 to 50% capacity.[27] Deutsch et al.[10] showed a return to sport in 12 of 13 patients, whereas Bartl et al.[28] found a 75% rate of return to preinjury level of sports participation.

Assessment of Healing

Postoperative healing was evaluated in 2 of the 3 arthroscopic repair studies and 5 of the 6 open repair studies. In the arthroscopic group 34 of 38 patients (90%) had intact repairs by use of MRI or computed tomography arthrography.[25,26] In 3 of the 5 open repair studies that reported postoperative healing rates, routine diagnostic testing was not performed for retears. One of these studies used physical examination findings to evaluate 8 potential retears in a group of 84 patients and confirmed these findings with computed tomography arthrography in 5 patients.[29] The 2 open repair studies that used physical examination findings noted 29 of 30 intact repairs.[10,30] The 2 open repair studies that evaluated for retears using diagnostic imaging showed 38 of 40 intact repairs (95%).[23,28] MRI was used in both studies, and 1 used a combination of both MRI and ultrasound.

Bias

All studies were Level IV case series. Because of this, selection bias could compromise the integrity of these studies' results. Only 1 study mentions being a consecutive series,[26] which minimizes this selection bias. Four studies collected their data in a prospective manner.[24-26,28] Only 5 of the 9 studies mention the use of an independent examiner,[25-29] which can introduce detection bias. None of the studies had a control group. The power of the majority of these studies was weak, with patient populations of less than 20 in 6 of the 9 included studies (67%). Attrition bias was negligible; the study with the lowest rate of follow-up had 83% of eligible patients return for final follow-up.[29] The high number of patients with concomitant procedures introduces performance bias.

TABLE 4. *Pooled Demographic and Outcome Statistics for Included Studies*

	Arthroscopic			Open			Combined		
	No. of Studies	No. of Shoulders	Weighted Average	No. of Studies	No. of Shoulders	Weighted Average	No. of Studies	No. of Shoulders	Weighted Average
Demographics									
Age	3	46	47.1	6	170	49.5	9	216	49.0
Male gender	3	46	73.9	5	160	83.8	8	206	81.6
Dominant	3	46	84.8	6	170	76.5	9	216	78.2
Traumatic	2	38	84.2	5	160	83.1	7	198	83.3
Time from injury	2	38	13.9	4	146	10.4	6	184	11.1
Outcomes									
Preoperative Constant score	3	46	49.7	4	140	52.7	7	186	52.0
Postoperative Constant score	3	46	81.9	5	156	80.8	8	202	81.1
Preoperative age- and gender-adjusted Constant score	2	38	58.6	3	124	62.1	5	162	61.3
Postoperative age- and gender-adjusted Constant score	2	38	95.0	3	124	92.7	5	162	93.3
Pain preoperatively (0-15 scale)	2	38		3					
Pain postoperatively (0-15 scale)	2	38		4					
Good/excellent/satisfied	2	38	92.1	4	146	88.4	6	184	89.1

DISCUSSION

Studies evaluating the results after isolated subscapularis repairs are rare compared with the body of literature on rotator cuff tears. The subscapularis muscle-tendon unit is the only anterior force couple and plays several other important roles. The goal of this study was to systematically review the available data after isolated subscapularis repair.

This review was able to show that surgical repair of subscapularis tears can provide patients with significantly enhanced function, as well as marked pain relief (Table 4). The subscapularis has been shown to have an important role as the only anterior contributor to the force couple that allows for glenohumeral joint motion. In addition, the subscapularis is important in biceps stability,[32,33] and it is well known that biceps instability and tendon pathology can be major sources of pain for patients.[34] Postoperative pain scores were better in the arthroscopic repair group compared with the open repair group; however, because the studies included in this review did not report standard deviations, we were unable to statistically evaluate this difference for significance. The Constant scores were similar between the 2 repair types and were similar to those reported for supraspinatus and infraspinatus tears. Lafosse et al.[35] reported a preoperative Constant score of 43.2 with a postoperative Constant score of 80.1 in patients undergoing double-row repairs of multiple-tendon rotator cuff tears. In several studies evaluating single- versus double-row repairs of supraspinatus and infraspinatus tears, postoperative Constant scores ranging from 74.4 to 82.7 were found,[36,37] which again is similar to the results after subscapularis repair. The excellent Constant scores may be related to the good healing rate reported by several studies.[38]

Healing rates of rotator cuff repairs recently have been associated with age, smoking, and quality of the tissue. The mean age of the patients undergoing isolated subscapularis repair was 49.2 years, which is relatively young and may be partly responsible for the good healing results noted. A recent systematic review of mostly posterosuperior rotator cuff repairs reported a mean age ranging from 54.4 to 63.5 years.[39] The observed healing rates in our review may also be partly because the majority of these isolated subscapularis tears resulted from traumatic injury. In an MRI study of traumatic versus atraumatic rotator cuff tears, the subscapularis was involved in 15 of 24 traumatic injuries compared with just 1 of 24 atraumatic tears.[40] Traumatic tears may have a more favorable milieu of

TABLE 5. *Key Points*

Isolated subscapularis tears frequently occur in young patients with shoulder trauma.
Subscapularis tears are a source of significant pain and loss of function.
Surgical intervention results in excellent return of function and pain reduction.
Concomitant pathology is common, and addressing these injuries improves outcomes.

growth factors for healing and typically occur in younger patients. The studies analyzed in this review did not comment on smoking; however, several did evaluate for fatty infiltration of the subscapularis muscle before repair. The subscapularis muscle is thought to undergo fatty infiltration relatively quickly after a tear, and thus most surgeons believe that it is best to repair the tear acutely before degeneration sets in. In patients without a significant trauma, the symptoms of a subscapularis tear can often be vague and examination findings inconsistent, which can lead to a delay in diagnosis and treatment as evidenced in several studies in this review. However, despite the mean length of time from injury to repair of 11.1 months, there was not substantial fatty infiltration. This may be in part because some of the patients with a longer time from injury had only partial tendon tears[41] and therefore the remaining tissue on the lesser tuberosity helped prevent atrophy. Several of the included studies in this review did find that outcome scores were worse in patients with a longer time from injury, however.[27,28,30] These results may be a reflection of the outcomes of patients with retears, which have been found to be more common in tendons with fatty degeneration,[8,42] which increases with time.[8,43]

We attempted to minimize performance bias by restricting our review to isolated subscapularis tears and repairs only. However, because of the nature of the subscapularis and its role in biceps tendon stability and pathology, we cannot account for the effect that biceps procedures had on the postoperative outcome measures. Several studies have shown that the biceps tendon can be a major pain generator in the shoulder, and patients with irreparable rotator cuff tears have achieved adequate pain relief and some return of function.[34,44,45] This review was also limited by the quality of the included studies—all 9 were case series without a comparative control group. The majority were retrospective and did not use an independent examiner, which can create additional bias. The Constant score is made up of 65% objective results (strength and range of motion), which can introduce detection bias without an independent examiner. However, Gerber et al.[27] did find a significant correlation between Constant scores and subjective outcome scores. Finally, the studies in this review either reported the mean only or the mean and range rather than the standard deviation for functional outcome measures and pain. This limited our ability to perform statistical analyses on the data to determine differences between the arthroscopic and open repair groups.

CONCLUSIONS

Subscapularis tears can cause significant morbidity and often occur as traumatic injury in a younger population (Table 5). Pain and function can be restored with open or arthroscopic repair, with excellent healing rates. The characteristic injury pattern suggested by a review of the literature is one where such tears are full thickness yet involve a portion of the tendon in the craniocaudad dimension. Concomitant procedures are common and can affect the results, because biceps tenotomy and tenodesis have been shown to significantly improve pain as well. All studies were Level IV, which introduced selection bias.

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