Systematic Review

Treating Subscapularis and Lesser Tuberosity Avulsion Injuries in Skeletally Immature Patients: A Systematic Review

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Purpose: To develop evidence-based recommendations for the diagnosis and treatment of skeletally immature patients with subscapularis and lesser tuberosity avulsion injuries. **Methods:** We searched the online databases PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Embase, Cochrane Central Register of Controlled Trials (CENTRAL), and Cochrane Database of Systematic Reviews (CDSR) for relevant publications on subscapularis and lesser tuberosity injuries in skeletally immature patients. All publication dates and languages were included. From studies identified, data were extracted to identify patient characteristics, history and physical examination findings, time to diagnosis, results from imaging studies, and treatment outcomes. These findings were combined and descriptively analyzed. **Results:** We identified 32 publications on 60 patients with a mean age of 13.5 ± 1.7 years. The most common physical examination finding at the time of diagnosis was anterior shoulder pain, followed by subscapularis muscle weakness. The sensitivity of imaging was 16% for radiographs and 95% for magnetic resonance imaging. The median time to diagnosis was 2 months (interquartile range, 1 to 7 months). Of 60 patients, 10 (17%) underwent successful nonoperative treatment. Fifty patients (83%) underwent surgical repair, without differences in clinical outcomes after open versus arthroscopic repair. Five cases (8%) were identified where delayed treatment was associated with suboptimal outcomes and ongoing shoulder pain. **Conclusions:** Subscapularis and lesser tuberosity avulsion injuries in skeletally immature patients are most commonly seen in male patients during early adolescence. A high index of suspicion should be maintained in patients with anterior shoulder pain and subscapularis muscle weakness, especially after a fall on an outstretched arm or an eccentric external rotation injury. Magnetic resonance imaging should be considered early, even if radiographic findings are negative. Both open and arthroscopic repairs are effective in restoring function, if fixation respects the soft bone of the lesser tuberosity. **Level of Evidence:** Level IV, systematic review of low-quality studies.

The understanding of injuries to the subscapularis has evolved considerably over recent years. Early publications reported subscapularis injuries to be a rare finding.[1] In their landmark article introducing the lift-off test, Gerber and Krushell[2] noted that subscapularis tears were rare and were unheard of in women. However, with more widespread use of and improvements in magnetic resonance imaging (MRI), Mall et al.[3] estimated the percentage of subscapularis tears among rotator cuff tears to be around 27%. Garavaglia et al.[4] published a review of 348 rotator cuff repairs performed between 2006 and 2009 and found 129 subscapularis tears (37%). Lo and Burkhart,[5] in defining the "comma sign," described the interdependence of the subscapularis and supraspinatus. Finally, Denard and Burkhart,[6] Lafosse and colleagues,[7] and Toussaint et al.[8] reported on successful repair techniques for subscapularis injuries.

As in adults, awareness of subscapularis injuries in pediatric and skeletally immature patients is changing. With increased participation in athletic activity, injury incidences have grown, especially in younger patients. During adolescence, subscapularis trauma leads more often to osseous avulsion of the subscapularis tendon/lesser tuberosity, rather than intrasubstance tendinous injury as seen in adults.[9] Indeed, the subscapularis and

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lesser tuberosity may be considered a single functional unit in the skeletally immature patient.[10] Although often missed because of variable presentations and subtle clinical and radiographic findings, these "transitional fractures" of the shoulder can have significant long-term consequences.[11] This systematic review aimed to develop evidence-based recommendations for the diagnosis and treatment of skeletally immature patients with subscapularis and lesser tuberosity avulsion injuries.

Methods

This systematic review was performed following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement, formerly known as the QUOROM (Quality of Reporting of Meta-analysis) statement.[12]

Eligibility Criteria

Studies were included if they reported on the clinical outcomes of surgical or nonsurgical treatment of subscapularis tendon/lesser tuberosity avulsion injuries in skeletally immature patients. Patients were considered skeletally immature if their physes were open or if they were Tanner stage IV or less. If neither factor was reported, a biological age of 18 years was chosen as the cutoff, with patients younger than 18 years considered for inclusion.[13]

Data Sources

The online databases PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Embase, Cochrane Central Register of Controlled Trials (CENTRAL), and Cochrane Database of Systematic Reviews (CDSR) were searched for relevant publications. All publication dates and languages were included. The last search was performed on December 1, 2014.

Search

The search algorithm was "((subscapularis) OR (lesser tuberosity)) AND ((young) OR (child) OR (pediatric) OR (paediatric) OR (immature))" and was replicated using the keywords as Medical Subject Headings (MeSH) terms as well. In addition to the online searches, the bibliographies of the included studies were reviewed to identify further publications.

Study Selection

Title and abstracts from all search results were screened for eligibility. Studies were excluded if the title or abstract clearly refuted eligibility. Full texts were reviewed for all studies matching the inclusion criteria to confirm eligibility. All study selections were performed independently in duplicate and cross referenced. Disagreement was resolved by consensus.

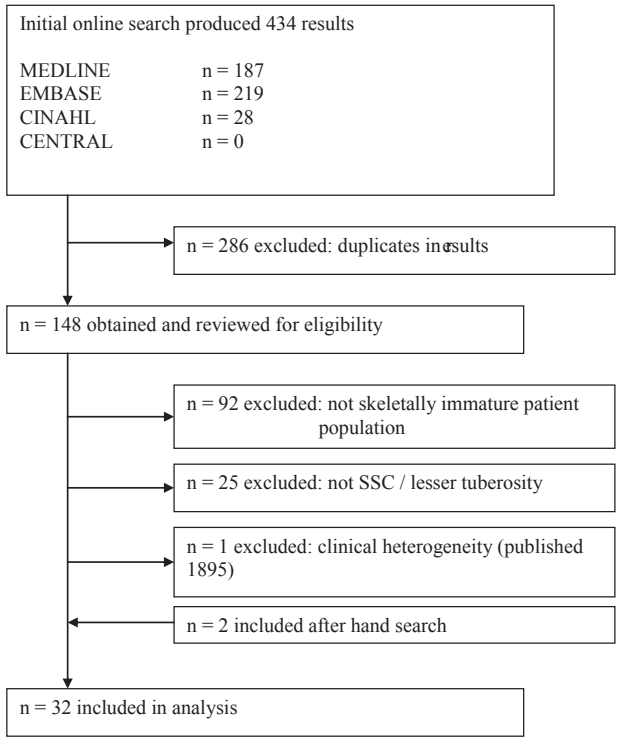

Fig 1. Flowchart of literature search and study identification. (CENTRAL, Cochrane Central Register of Controlled Trials; CINAHL, Cumulative Index to Nursing and Allied Health Literature; SSC, subscapularis.)

Data Items

Data were extracted from each study to identify patient characteristics, history and physical examination findings at the time of diagnosis, time to diagnosis, results from imaging studies, treatment pursued, and long-term results, if reported. Functional scores were extracted, if reported, and are presented as percentage of the best possible score.

Data Synthesis

Given the lower level of evidence from the overall literature, we did not perform a quantitative data synthesis; rather, we report data descriptively. The sensitivity of clinical tests was calculated as the number of true positives divided by the sum of true positives and false negatives, with intraoperative findings used as the gold standard. The specificity could not be calculated because there were no data on true-negative cases.

Results

Our search identified 33 publications published in English and German between 1985 and 2014.[9,11,14-42] One study, published in 1895,[43] was excluded because of irreconcilable clinical heterogeneity concerning diagnostic and therapeutic options, leaving 32 studies for analysis (Fig 1).

Table 1. Patient Demographic Data

Author	LOE	Patients, n	Mean Age (SD), yr	Female Patients, n	Mean Time to Treatment (SD), mo	Sport at Time of Injury	Reported Mechanism of Injury	Additional Injuries	Initial Examination Findings			Imaging Results	
									Pain	Apprehension Testing	Subscapularis Testing	XR	MRI
Bhalla et al.[16] (2011)	V	1	8	0	2	Motorcycle	Unspecified fall	SSP	Yes	Positive	Positive	Negative	Positive
Coates and Breidahl[17] (2001)	IV	3	15 (2)	0	36	Skateboarding, baseball	ABD/ER, repetitive (baseball)	Cartilage/ IGHL	Yes	Positive	Negative	Negative	Positive
Echlin et al.[18] (2006)	V	2	14 (1)	0	4 (7)	Hockey	Unknown	Glenoid	Yes	Positive	Positive	Positive	NR
Garrigues et al.[19] (2013)	IV	5	14 (1)	0	5 (2)	Baseball, wrestling, football, skateboarding	ABD/ER	HAGL	NR	Positive	Positive	NR	Positive
Gibson et al.[20] (2013)	V	1	13	0	0.5	Football	ABD/ER	None	NR	Negative	Positive	Negative	Positive
Goeminne and Debeer[21] (2012)	IV	3	14 (3)	0	180 (158)	Volleyball, soccer, skateboarding	Unspecified fall	Exostosis/ LHBT	NR	Negative	Positive	NR	NR
Gouron et al.[22] (2013)	V	1	11	0	1	Hockey	ER	None	Yes	Negative	Positive	Negative	Positive
Harper et al.[23] (2013)	IV	5	14 (1)	0	NR	Hockey, skateboarding, skiing, football	Unspecified fall	None	NR	NR	NR	Positive	Positive
Heyworth et al.[24] (2008)	IV	3	13 (1)	1	5 (6)	Hockey, lacrosse, soccer	ABD/ER	None	NR	NR	Positive	NR	Positive
Kato et al.[25] (2012)	V	1	17	0	1	Tennis	Repetitive (tennis)	None	Yes	Positive	Negative	Negative	Positive
Klasson et al.[26] (1993)	V	1	13	0	6	Hockey	ER	None	Yes	Positive	Positive	Negative	Positive
Kunkel and Monesmith[27] (1993)	V	1	13	0	1	Baseball	Repetitive (baseball)	None	Yes	Positive	Positive	Positive	NR
Lehmann et al.[28] (2002)	IV	2	13 (1)	0	NR	Snowboarding, in-line skating	ABD/ER	NR	Yes	Negative	Positive	Negative	Positive
Le Huec et al.[15] (1994)	V	1	15	0	2	Volleyball	ER	None	Yes	Positive	Positive	Positive	Positive
Levine et al.[29] (2005)	V	1	14	0	1	Lacrosse	ER	None	Yes	Positive	Positive	Negative	Positive
Malone and Mair[30] (2014)	V	1	13	0	NR	Lacrosse	Fall	Labrum	Yes	NR	NR	Negative	Positive
Neogi et al.[31] (2013)	V	1	14	0	2	Rugby	Unknown	None	NR	Positive	Positive	Negative	Positive
Ogawa and Takahashi[11] (1997)	IV	5	14 (2)	1	124 (84)	NR	Unspecified fall	None	Yes	Negative	Positive	Positive	Positive

(continued)

Table 1. Continued

Author	LOE	Patients, n	Mean Age (SD), yr	Female Patients, n	Mean Time to Treatment (SD), mo	Sport at Time of Injury	Reported Mechanism of Injury	Additional Injuries	Initial Examination Findings			Imaging Results	
									Pain	Apprehension Testing	Subscapularis Testing	XR	MRI
Paschal et al.[42] (1995)	V	1	14	0	14	Football	ER	LHBT	Yes	Negative	Positive	Negative	Negative
Polousky and Harms[32] (2011)	V	2	13 (1)	0	5 (5)	Baseball, boxing	Repetitive (baseball)	NR	Yes	Negative	Negative	Negative	Positive
Provance and Polousky[14] (2010)	V	1	13	0	6	Dodge ball	ER	LHBT	Yes	NR	Positive	Negative	Positive
Rickert and Loew[33] (2000)	V	1	14	0	NR	Bike	ABD/ER	Labrum, SSP	Yes	Positive	Positive	Negative	Positive
Ross and Love[34] (1989)	V	2	12 (0)	0	0.5 (0)	Wrestling, skateboarding	ABD/ER	None	Yes	NR	Positive	Positive	Positive
Shah et al.[35] (2006)	V	1	14	0	1.5	NR	Unspecified fall	None	Yes	NR	Positive	Positive	NR
Shibuya and Ogawa[36] (1986)	V	1	12	1	0.25	NR	Unknown	None	Yes	NR	Positive	Positive	NR
Sikka et al.[37] (2004)	V	1	14	0	9	Wrestling	ABD/ER	None	Yes	Positive	Positive	Negative	Positive
Sugalski et al.[38] (2004)	V	1	15	0	2.5	Baseball	Repetitive (baseball)	None	Yes	Positive	Negative	Positive	Positive
Teixeira et al.[39] (2012)	V	1	14	0	4	Fishing	Repetitive (fishing)	None	Yes	Positive	Positive	Positive	NR
Thielemann et al.[40] (1992)	V	1	15	0		Gymnastics	Unspecified fall	None	Yes	Positive	Positive	Negative	NR
Vezeridis et al.[9] (2011)	IV	8	13 (1)	0	2 (1)	Basketball, hockey lacrosse, skateboarding, football, baseball	ABD/ER	NR	Yes	NR	NR	NR	NR
White and Riley[41] (1985)	V	1	12	0	0.25	Climbing	ABD/ER	None	Yes	Positive	Positive	Positive	NR

NOTE. Aggregate data are presented. Studies are shown in alphabetical order.

ABD, abduction; ER, external rotation; HAGL, humeral avulsion of glenohumeral ligament; IGHL, inferior glenohumeral ligament; LHBT, long head of biceps tendon; LOE, level of evidence; MRI, magnetic resonance imaging; NR, not reported; SD, standard deviation; SSP, supraspinatus; XR, radiographs.

Table 2. Sensitivity for Reported Testing

Test	Sensitivity	Patients Tested, n
Anterior shoulder pain	100%	45
Subscapularis testing	87%	45
Increased external rotation	62%	45
Apprehension testing	54%	37
Plain radiographs	16%	40
MRI	95%	43

MRI, magnetic resonance imaging.

Epidemiology

The literature reported on 60 patients with a mean age of 13.5 ± 1.7 years. There were 57 male patients (95%) and 3 female patients (5%). The most commonly reported mechanism of injury was an unspecified fall on the affected arm (18 patients, 30%); the second most common mechanism was an external rotation event (16 patients, 27%). An interesting finding was that 7 patients (12%) sustained a lesser tuberosity avulsion injury without direct acute trauma; rather, the injury was due to repetitive overuse including pitching and fly fishing.[39] There was no significant age difference between patients with a traumatic avulsion injury and those with an overuse avulsion injury ($P = .418$) (Table 1).

Clinical Examination, Imaging, and Time to Diagnosis

The primary complaint at presentation was pain, both acute and chronic, as well as limited shoulder range of motion. Subscapularis strength was tested in only 45 of 60 patients (75%), and in 39 cases, muscle weakness was noted (87% sensitivity). Twenty-eight patients were reported to have increased passive external rotation of the shoulder compared with the unaffected contralateral upper limb (62% sensitivity). Thirty-seven patients were reported to have undergone apprehension testing, but only 20 had positive findings (54% sensitivity) (Table 2).

In 43 patients (72%), plain radiographs of the shoulder were obtained. Typically, an internal rotation anteroposterior view or axillary view (or both) was obtained, although in many cases the radiographic views obtained were not described. Seven patients had radiographic findings consistent with or indicative of a lesser tuberosity avulsion, consistent with a sensitivity of 16%. MRI was performed in 40 patients (67%). Of these, 38 were correctly diagnosed with a subscapularis/lesser tuberosity avulsion based on MRI, consistent with a sensitivity of 95% (Fig 2).

The time to diagnosis (defined as the time from the date of initial presentation to the date of definitive diagnosis) was reported for 45 patients. The median time to diagnosis was 2 months, with an interquartile range of 1 to 7 months. The total range was between 1 week and 300 months. The most common diagnoses made before detection of the lesser tuberosity avulsion injury were Salter-Harris type I injuries to the proximal humerus, rotator cuff tendinitis in acute cases, and osteochondroma or myositis ossificans in chronic cases.

Treatment and Outcomes

Ten patients (17%) were treated nonoperatively with rest and immobilization, followed by physical therapy for strengthening and range of motion and a gradual return to activities. Thirty-three patients (55%) were treated with an open repair through a deltopectoral approach. After open reduction, internal fixation was achieved with screws or suture anchors in most cases. Ten patients (17%) were treated with a combined approach of a diagnostic arthroscopy followed by an open repair. Seven patients (11%) were treated by arthroscopic reduction and internal fixation with suture anchors. No perioperative complications were reported in the included studies. The median follow-up period was 12 months (interquartile range, 6 to 24 months) (Table 3).

In 5 patients the diagnosis was missed during initial treatment and definitive treatment was delayed for between 1 and 25 years. These patients initially complained of pain and loss of motion that subsequently improved with nonspecific conservative treatment. However, after returning to sports and other activities, these patients complained of continuous anterior shoulder pain. Subsequently, all 5 complained of a painful anterior mass and limitations in shoulder function. All eventually underwent surgical treatment that consisted of resection of the callus and repair of the subscapularis (Fig 3).

Clinical scores were available for 13 patients who underwent open repair, 6 who underwent arthroscopic repair, and 5 who underwent diagnostic arthroscopy and open repair. The scores presented included the Western Ontario Shoulder Instability index; American Shoulder and Elbow Surgeons score; Constant-Murley score; and University of California, Los Angeles score. The results of all scores were combined and are given in our report as the percentage of the best possible outcome. The group of open repairs scored 92.4% ± 6.5% of the maximum possible scores. The group that underwent arthroscopy alone reached 95.7% ± 3.7%, and the combined group scored 96.6% ± 5.3%. These findings are consistent with no statistically significant difference ($P = .270$). There are insufficient data in the literature to formally compare patients who had a significant delay in diagnosis before surgery and patients who were treated more acutely (Table 4).

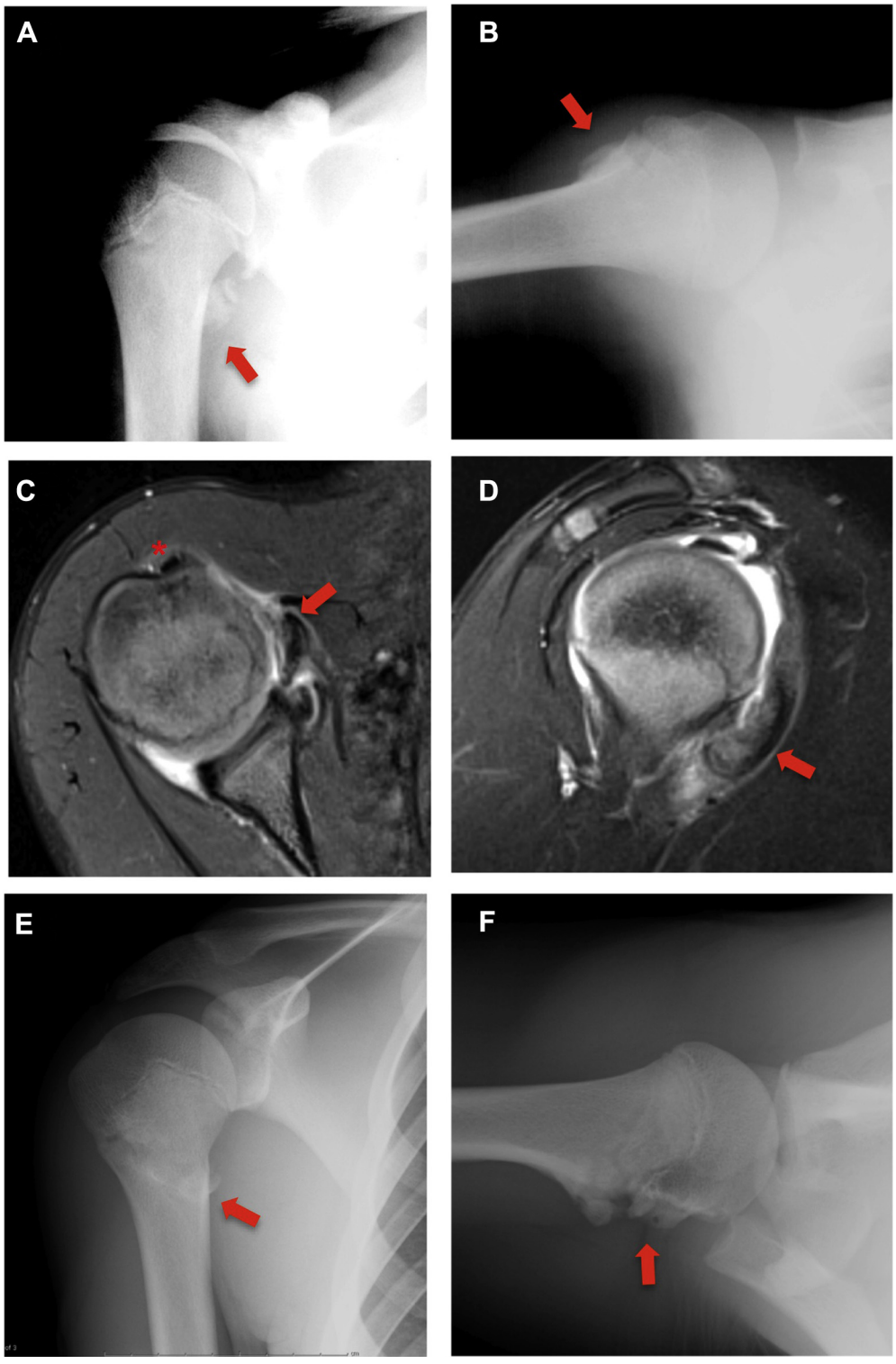

Fig 2. Lesser tuberosity avulsion injury in an 11-year-old lacrosse player. (A) Anteroposterior and (B) axillary radiographs obtained at the time of injury. Injury to the lesser tuberosity is visible on both views (arrows). (C) T2 axial and (D) T2 coronal magnetic resonance images obtained preoperatively show a complete avulsion of the lesser tuberosity with inferior displacement (arrows). The long head of the biceps is present and reduced in the bicipital groove (asterisk). (E) Anteroposterior and (F) axillary radiographs obtained postoperatively show the lesser tuberosity reduction and fixation after open transosseous suture repair (arrows).

Discussion

Our findings show that radiographic imaging has a low sensitivity in skeletally immature patients with subscapularis and lesser tuberosity avulsion injuries. Clinical testing of subscapularis function has a sensitivity of 87%. A high level of suspicion should be maintained in patients with anterior shoulder pain after an eccentric external rotation trauma; MRI should be considered early on. The current literature describes good results after surgical treatment, but no studies are available to compare surgical and nonsurgical treatment. Arthroscopic and open treatment results in equivalent clinical scores.

Table 3. Clinical Characteristics of Different Treatment Groups

Treatment	n	Mean Age (SD), yr	Positive SSC Testing	Positive Apprehension Testing
Conservative treatment	10	13.1 (1.1)	88%	60%
Open repair	33	13.7 (1.5)	81%	47%
Diagnostic arthroscopy and open repair	10	13.0 (1.9)	100%	88%
Arthroscopic treatment	7	13.4 (1.7)	86%	20%
P value (ANOVA)		.588	.599	.098

ANOVA, analysis of variance; SD, standard deviation; SSC, subscapularis.

Analysis of the epidemiology showed that this injury pattern is almost exclusively reported in male patients. The age range was very narrow, at 14 ± 2 years, supporting the premise that these are transitional fractures.[9] Of note, a subgroup of patients (12%) sustained subscapularis/lesser tuberosity avulsion injuries from repetitive overuse without trauma. This subgroup was not of a different age than the patients with traumatic injuries. An interesting finding was that the subscapularis tendon was involved in the injury pattern in 13%, which contradicts the classic teaching that skeletally immature patients exclusively undergo bony avulsion injuries.

The current best evidence on physical examination findings shows that making the diagnosis can be challenging. This is not surprising, considering that clinical examination of the subscapularis has repeatedly been shown to be fraught with problems in both sensitivity and specificity.[44] The initial chief complaint in most patients was simply pain and painful active and passive range of motion. With avulsion of the lesser tuberosity, a partially intact soft-tissue sleeve may remain that could allow for some internal rotation, which could diminish the reliability of classic subscapularis tests.[18] An interesting finding was that about half of all patients had positive apprehension testing.

Plain radiographs often miss a lesser tuberosity avulsion fracture. The plane of injury and the size of the avulsed fragment make radiographic detection difficult. Chondro-epiphyseal injuries can only be appreciated on MRI. Moreover, the subscapularis tendon is not one well-defined insertion; rather, it is multiple small insertions of individual bundles.[45] As such, rather than presenting with one well-defined avulsion, plain radiographs may only show some patchy mineralization, representing numerous small avulsions.[21] Subtle glenohumeral subluxation and a widened joint space on radiographs can be indicative of a lesser tuberosity avulsion but are difficult to appreciate reliably.[33]

Looking for associated injuries, we found only 3 reported cases of biceps tendon instability. Although this finding could be because of under-reporting, it can also be explained by the location of the avulsion line. This line typically splits the lesser tuberosity into a mobile medial half and a remaining lateral half that supports the biceps. Similarly, coexisting

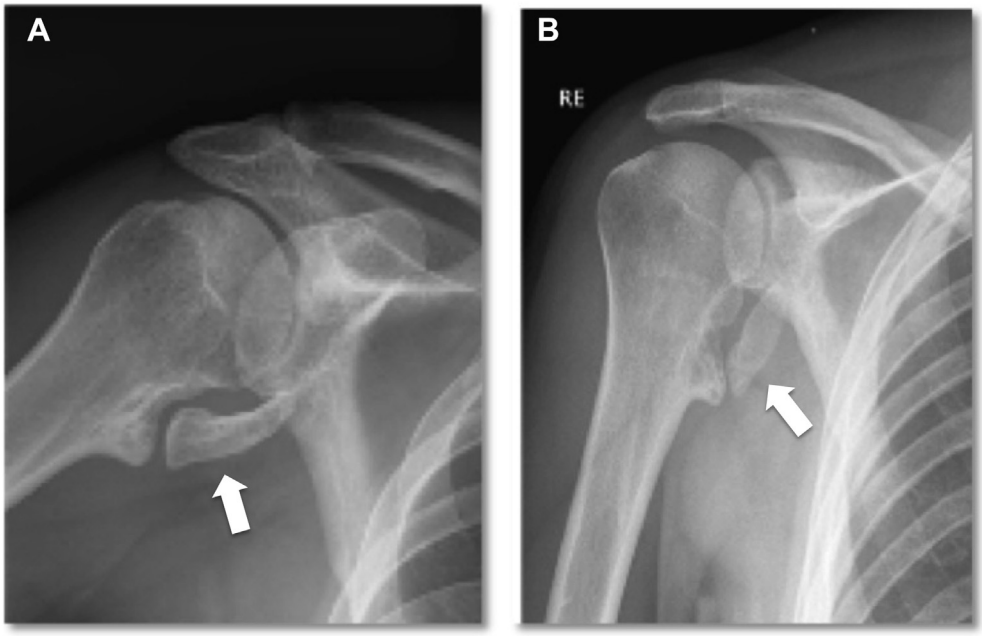

Fig 3. Anteroposterior radiographs of 2 patients (A) 20 years and (B) 25 years after untreated lesser tuberosity avulsion injuries. One should note the massive exostoses (arrows) causing anterior pain and impingement symptoms. Both patients were successfully treated with open excision of the ossicle and subscapularis fixation. Reprinted with permission.[21]

Table 4. Surgical Outcomes From Studies Reporting Clinical Scores

Author	n	Mean Age (SD), yr	% Male	Mean Time to Diagnosis, mo	Concurrent Injuries	Treatment	Mean Follow-up, yr	Score Used	Mean Results of Scoring (SD)
Kato et al.[25] (2012)	1	17	100	48	0%	ARIF with anchor	2	UCLA	33
Heyworth et al.[24] (2008)	3	13 (1)	66	7	0%	ARIF with anchors	2	ASES	97 (2)
Lehmann et al.[28] (2002)	2	13 (1)	NR	0.5	0%	Diagnostic AS and ORIF with single-row anchors	2	Constant-Murley	92 (1)
Garrigues et al.[19] (2013)	5	14 (1)	100	6	40%	Diagnostic AS and ORIF with double-row anchors	4	WOSI ASES	94 (8) 96 (5)
Goeminne and Debeer[21] (2012)	1	12	100	1	0%	ORIF with 3 transosseous sutures	1	Constant-Murley	85
Vezeridis et al.[9] (2011)	8	13 (1)	100	1.5	25%	ORIF with anchors or sutures	2	SSV SST ASES qDASH	93 (8) 11.8 (0.3) 95 (5) 2 (4)
Polousky and Harms[32] (2011)	2	13 (1)	100	3	50%	ORIF with single-row anchors	1	ASES UCLA	30 (0) 35 (0)

ARIF, arthroscopic reduction—internal fixation; AS, arthroscopy; ASES, American Shoulder and Elbow Surgeons; NR, not reported; ORIF, open reduction—internal fixation; qDASH, Quick Disabilities of the Arm, Shoulder and Hand questionnaire (short version); SD, standard deviation; SST, Simple Shoulder Test; SSV, Subjective Shoulder Value; UCLA, University of California, Los Angeles; WOSI, Western Ontario Shoulder Instability.

supraspinatus injuries may be rare if the avulsion spares the insertion of the supraspinatus. Nevertheless, additional injuries to the rotator cuff or labrum should be ruled out (Fig 4). In this population, about half of the additional injuries were only found during the surgical repair.

Treatment of mildly symptomatic, nondisplaced injuries, especially in the older publications included in

Fig 4. Radiographs of a 12-year-old, right hand—dominant male wrestler who was picked up and thrown on his abducted, internally rotated right shoulder during a wrestling match 1 week before presentation. He initially complained of pain and swelling, as well as subjective instability. The examination of his range of motion, rotator cuff function, and stability was limited by pain. Radiographs showed lesser tuberosity (arrow) and greater tuberosity (arrowhead) avulsion. A magnetic resonance imaging scan was obtained that confirmed the bony avulsion of both the subscapularis and infraspinatus and showed a small anteroinferior labrum tear. Surgical repair was performed 2 weeks later once all swelling had subsided.

this systematic review, focused on nonsurgical options consisting of rest and immobilization, followed by gradual strengthening and return to activities. This can produce good results, equivalent to treatment of other low-energy, pediatric avulsion injuries.[46] However, missed diagnoses or observation of displaced avulsion injuries can lead to chronic malunion, heterotopic ossification, and loss of shoulder function, which eventually require surgical management.

There are important technical aspects of surgical repair to consider. Transosseous suture repair or threaded suture anchors designed for cancellous bone should be used to ensure sufficient purchase in the soft bone of the lesser tuberosity.[47] Transosseous sutures should avoid accidental tenodesis of the long head of the biceps tendon, which may be inadvertently incorporated during medial to lateral suture passage. For smaller or comminuted fragments, bony excision and direct tendon repair have also been reported with good results.[47] Care should be taken not to advance the subscapularis tendon, which could potentially alter its biomechanics.

Over time, ongoing instability of the fragment may cause abundant callus formation and cause secondary impingement.[18,21,26] Imaging findings have been misinterpreted as osteochondromas or tumorous growths, which led to further observation or diagnostic studies rather than definitive treatment.[15,17,26]

Limitations

A shortcoming of all meta-analyses or systematic reviews is that they depend on the quality of the included studies. A particular weakness of our study was that it included mostly small series from heterogeneous sources, but this also adds some breadth and more general applicability to our results. Another shortcoming is the somewhat inconsistent reporting of findings and variable terminology in the included articles. Finally, our study only includes patients identified because of their complaints, but there might very well be a considerable number of unrecognized cases. Adding the examination findings and treatment outcomes of these patients might change our findings somewhat.

Conclusions

Subscapularis and lesser tuberosity avulsion injuries in skeletally immature patients are most commonly seen in male patients during early adolescence. A high index of suspicion should be maintained in patients with anterior shoulder pain and subscapularis muscle weakness, especially after a fall on an outstretched arm or an eccentric external rotation injury. MRI should be considered early, even if radiographic findings are negative. Both open and arthroscopic repairs are effective in restoring function, if fixation respects the soft bone of the lesser tuberosity.

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