Systematic Review With Video Illustration

An Evidenced-Based Examination of the Epidemiology and Outcomes of Traumatic Rotator Cuff Tears

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Purpose: The purpose of this study was to systematically review the literature to better define the epidemiology, mechanism of injury, tear characteristics, outcomes, and healing of traumatic rotator cuff tears. A secondary goal was to determine if sufficient evidence exists to recommend early surgical repair in traumatic rotator cuff tears. **Methods:** An independent systematic review was conducted of evidence Levels I to IV. A literature search of PubMed, Medline, Embase, and Cochrane Collaboration of Systematic Reviews was conducted, with 3 reviewers assessing studies for inclusion, methodology of individual study, and extracted data. **Results:** Nine studies met the inclusion and exclusion criteria. Average patient age was 54.7 (34 to 61) years, and reported mean time to surgical intervention, 66 days (3 to 48 weeks) from the time of injury. The most common mechanism of injury was fall onto an outstretched arm. Supraspinatus was involved in 84% of tears, and infraspinatus was torn in 39% of shoulders. Subscapularis tears were present in 78% of injuries. Tear size was <3 cm in 22%, 3 to 5 cm in 36%, and >5 cm in 42%. Average active forward elevation improved from 81° to 150° postoperatively. The weighted mean postoperative UCLA score was 30, and the Constant score was 77. **Conclusions:** Traumatic rotator cuff tears are more likely to occur in relatively young (age 54.7), largely male patients who suffer a fall or trauma to an abducted, externally rotated arm. These tears are typically large and involve the subscapularis, and repair results in acceptable results. However, insufficient data prevent a firm recommendation for early surgical repair. **Level of Evidence:** Level IV, systematic review Levels III and IV studies.

Rotator cuff tears are a source of significant morbidity for patients.[1] A study examining 200 patients regardless of symptoms discovered that those with ultrasound-proven rotator cuff tears had worse Simple Shoulder Test (SST) and Constant scores than those with an intact cuff.[2] Another recent study of the natural history of rotator cuff tears found that outcome scores were significantly lower for symptomatic tears than asymptomatic tears.[3] When rotator cuff tears occur in the younger, working population, these injuries can cause significant lost wages or time lost from work. Recently, information regarding the morphology and natural history of chronic or atraumatic rotator cuff tears has been reported.[3,4] Several studies have revealed that the prevalence of these injuries increases with age.[5-7] Also, tears appear to begin in an area posterior to the biceps and propagate in both directions.[4] Although many of these tears begin asymptomatically, at least 20% progress to symptomatic tears in only a few years.[3] Unfortunately, very little has been published on the epidemiology, prevalence, or natural history of traumatic, acute rotator cuff tears.

In many cases, a trial of nonoperative management prior to surgical repair is indicated for patients with atraumatic but symptomatic rotator cuff tears. However, the short- and long-term success rates after conservative care remain poorly defined. Contemporary literature suggests that irreversible fatty atrophy and ultrastructural changes occur after rotator cuff discontinuity.[8-10] As a result, there is a need to delineate the indications and timing for surgical intervention to avoid any controversy and to establish the direction for treatment.

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After traumatic rotator cuff tear, early surgery may be indicated to preserve tissue quality and mobility while minimizing tear retraction to maximize structural healing and functional outcomes. However, reported outcomes after rotator cuff repair often combine traumatic and atraumatic tears, resulting in a loss of specific outcomes after repair of isolated traumatic tears; for this, further clarification is required between the different categories.

The goal of this Systematic Review was to better delineate the epidemiology, mechanism of injury, tear anatomy, and outcomes of traumatic rotator cuff tears to determine if the literature supports the early repair of traumatic rotator cuff tears. The hypothesis was that traumatic rotator cuff tears would occur in a younger patient population, be more likely to include the subscapularis tendon, and exhibit significant improvement in pain, range of motion, and clinical outcome scores, with concomitant high rates of structural integrity after repair. Nonetheless, we believe the evidence supporting acute repair of traumatic rotator cuff tears will not be sufficient to recommend for or against early repair.

Methods

Search Strategy

An independent systematic review of the literature was conducted of evidence Levels I to IV. A literature search of PubMed, Medline, Embase, and Cochrane Collaboration of Systematic Reviews was conducted using *traumatic rotator cuff tear* or *acute rotator cuff tear*. The terms were individually queried, Boolean terms were not incorporated, and no limits were set on the dates of studies. The references to each article were also reviewed for possible study inclusion. Studies considered for evaluation were acute or traumatic rotator cuff tears and follow-up periods longer than 6 months (Table 1). Studies must have ensured all patients were asymptomatic with respect to the affected shoulder prior to the injury or specific date of pain onset. Potentially inclusive papers were discussed and decisions were made regarding inclusion. A hand search for studies meeting the inclusion criteria was performed using relevant review articles. Case reports on fewer than 10 patients, technique articles, editorials, guidelines, animal and cadaver studies, and review articles were excluded (Table 1). A CONSORT diagram illustrates the study selection algorithm (Fig 1).

Study Selection

Full articles of citations adhering to the inclusion criteria and those that were uncertain were downloaded. Three authors (N.A.M., J.C., A.S.L.) independently reviewed all titles and abstracts of pertinent citations. Reference lists of all full articles were reviewed against the inclusion criteria, and any disagreement on eligibility was resolved with the senior author (B.J.C.). Bibliographies of all reviewed articles were referenced to assess for potentially inclusive articles that were missed by the initial search.

Table 1. Inclusion and Exclusion Criteria of Search

Inclusion Criteria	Exclusion Criteria
English language	Case−control studies, case series, expert opinions, commentaries, surgical technique articles, letters to editors
Evidence Levels I-IV	Basic science or animal studies
Results of studies describing rotator cuff repair	Evidence Level V
Studies with no pre-existing shoulder malfunction	Results for which validated clinical outcome measures were not used
Studies investigating acute symptoms or pain onset, functional impairment of limb	Results of studies with no follow-up
Studies with minimum time to repair of 1.5 years	Evaluation of joints other than the shoulder

Data Extraction

Data were extracted from investigations that satisfied the eligibility criteria. Details of study design, sample size, and patient demographics, including sex, age, indication, and length of follow-up, were recorded. Surgical factors such as mechanism of injury, tendons involved, tear size, and surgical technique were abstracted. Additionally, timing of the repair, follow-up time, healing rates, and outcome variables were tabulated. Patient-based and functional outcomes scores were grouped by test used in each study. The Constant,[11] University of California, Los Angeles (UCLA),[12,13] Western Ontario Rotator Cuff (WORC),[14] American Shoulder and Elbow Surgeons (ASES),[15] visual analog scale (VAS),[16] Disabilities of the Arm, Shoulder, and Hand (DASH),[17] and Japanese Orthopaedic Association (JOA)[18] scores were variably identified in the studies included for this review.

Results

Initial literature search of *rotator cuff tear* resulted in 2,687 studies, for which the search was narrowed by including *rotator cuff repair,* decreasing the results to 257 studies. The limit of English language was applied, decreasing the number of studies to 205. *Traumatic rotator cuff tear* and *acute rotator cuff tear* further decreased the results respectively to 106 and 211 published studies. In total, the 3 latter search terms combined allowed for a total of 522 abstracts to be reviewed. Three of the authors appraised abstracts and selected any potentially eligible study for further review and analysis. Basic sciences and cadaveric studies were excluded and references were reviewed leading to a potential pool of 52 studies (Fig 1). Several studies without proper follow-up or those that contained chronic rotator cuff repairs were excluded, resulting in 9 studies identified for this report.[3,5,7,15,16,20,27,30,34,38]

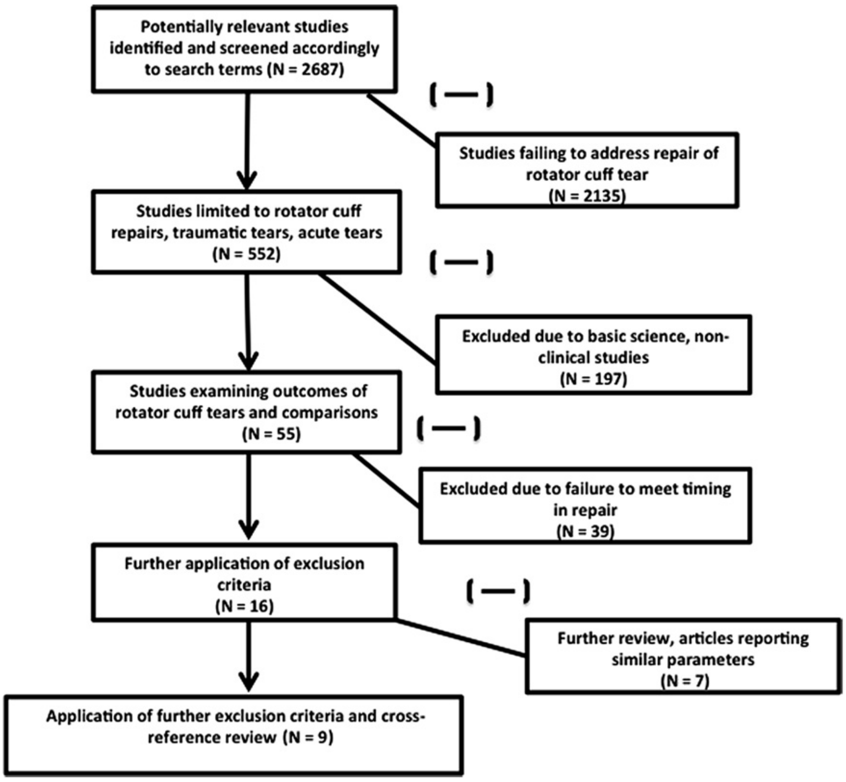

Fig 1. Search strategy results.

Patient Demographics

The weighted average age of patients with acute rotator cuff tears in this review was 54.7 years (average range, 34 to 61) (Table 2). Seventy-seven percent of the patients were male. The study by Braune et al.[19] was the only included study that evaluated the difference between traumatic and nontraumatic tears, and for this group, age was significantly younger (34.2 years) in the traumatic group than in the atraumatic group (54.1 years). Both groups had few women, and thus, there was no difference in gender between the groups.[19] The weighted percentile of men in the included studies was 76.7%.

Injury Mechanism

Five studies reported that an injury mechanism[20-24] such as a fall, most often onto an outstretched arm, was the most common injury pattern (Table 3). Ide et al.[23] noted 12 patients were injured in a fall, 7 had a forceful external rotation moment with an abducted arm, and 1 was injured in a motor vehicle accident. Gerber et al.[22] described a forceful external rotation of an adducted extremity in 9 patients, 1 glenohumeral dislocation, and 6 unknown injury mechanisms. Bassett and Cofield[24] reported that 22 (59%) of their patients fell onto an outstretched arm, 6 were injured by lifting a heavy object, 4 were injured during sporting activities, 3 reached out to grab a rail to prevent falling, and 1 was injured after a motor vehicle accident. Seventeen patients in the study by Bjornsson et al.[21] and 2 patients in the study by Namdari et al.[20] had rotator cuff tears as a result of glenohumeral dislocation. Both Braune et al.[19] and Hantes et al.[25] followed recommendations for diagnosis and legal assessment of traumatic rotator cuff tears from the German Association of Shoulder and Elbow Surgery as inclusion criteria, but failed to mention specific injury mechanisms. Two studies did not mention any specific injury mechanism.[26,27]

Surgical Timing

The weighted average for the 7 studies that reported mean time to surgical intervention was 66 days (3 weeks to 12 months) from the time of injury. Braune et al.[19] and Gerber et al.[22] did not provide mean time from injury to surgery; however, in their study, Gerber et al. reported more improved outcomes in the 13 patients who underwent surgery within 20 months of injury as than the 3 patients whose surgeries were delayed more than 36 months after injury. Of the other studies that evaluated time to surgery as a variable, Petersen and Murphy,[27] Bassett and Cofield,[24] and Hantes et al.[25] found that early treatment improved outcomes, whereas Bjornsson et al.[21] found no difference in healing, Constant score, DASH score, or WORC index with respect to time to repair. Petersen and Murphy[27] noted that when compared with those performed longer than 16 weeks after injury, repairs performed prior to 16 weeks from injury were associated

Table 2. Characteristics of Selected Studies

Author	Level of Study	Number of Patients	Follow-up (mo)	Average Patient Age (yr)	Time to Repair
Bassett and Cofield (1983)[24]	III	37	84	56	<3 weeks (12) 3-6 weeks (6) 6-12 weeks (19)
Gerber et al. (1996)[22]	IV	16	43	50	NR
Braune et al. (2003)[19]	III	46	41	Traumatic: 34 Atraumatic: 54	NR
Lahteenmaki et al. (2006)[26]	IV	246	73	53	NR
Namdari (2008)[20]	IV	33	56	57	4.5 ± 3.5 months >3 months: 15 6-12 months: 6
Ide et al. (2007)[23]	IV	20	36	61	2.7 months
Hantes et al. (2011)[25]	III	35	36	Group I: 54 Group II: 56	Group I (early, <3 weeks: 15 Average = 12 days Group II (late, >3 weeks: 20 Average = 131 days
Bjornsson et al. (2011)[21]	IV	42	39	62	38 days
Petersen and Murphy (2011)[27]	III	36	31	57	0-8 weeks: 15 9-16 weeks: 15 >16 weeks: 6 Average = 11 weeks

with significantly improved active elevation (140° *v* 100°), ASES score (81 *v* 65), and UCLA score (30 *v* 25). Bassett and Cofield[24] determined that those repaired within 3 weeks had significantly better forward elevation and showed a trend toward better strength in both abduction and external rotation than those repaired after 3 weeks. Hantes et al.[25] reported significantly higher mean postoperative Constant (82) and UCLA (31) scores in the acute repair (<3 weeks) group than in the delayed repair group (70 and 26, respectively).

Tear Characteristics and Tendon Involvement

The studies included in this review varied widely in terms of tear characteristics. Tendon involvement was part of the inclusion criteria for 3 of the studies: both Namdari et al.[20] and Ide et al.[23] required full-thickness tears of both subscapularis and supraspinatus tears, whereas Gerber et al.[22] restricted inclusion to those with isolated subscapularis tears. Namdari et al.[20] found that 53% of their patients also had an infraspinatus tear, whereas Ide et al.[23] reported 35% involvement of the infraspinatus. Bjornsson et al.[21] included only full-thickness tears, noting 15 of 42 (36%) with single-tendon tears, of which 14 involved the supraspinatus and 1 the subscapularis. Combined supraspinatus and subscapularis tears were present in 8 patients, and combined supraspinatus and infraspinatus tears also occurred in 8 patients. Three-tendon tears were present in 12 patients. If these 4 studies are combined, supraspinatus tears were present in 84% of tears, infraspinatus tears in 39% of tears, and subscapularis tears in 78% of tears.

The remaining 5 studies evaluated tear characteristics by size, using various classification systems. The Bateman[28] and Post et al.[13] classification systems can be compared with the sizes reported by Bassett and Cofield[24] if the first 2 sizes are combined in each system (Bateman class I and II and Post small and medium both represent tears <3 cm). Hantes et al.[25] classified 4 tears as medium, 16 as large, and 15 as massive tears. Braune et al.[19] classified 7 tears in the traumatic group as Bateman I or II and 3 tears as Bateman 3. Interestingly, this group reported 10 partial-thickness tears in their traumatic group and only 1 partial-thickness tear in their nontraumatic group. Lahteenmaki et al.[26] reported 6 medium, 10 large, and 10 massive tears using the Post classification. Bassett and Cofield[24] noted 7 small (<3 cm), 10 medium (3 to 5 cm), and 20 large (>5 cm) tears. When these studies are combined, 22% were <3 cm, 36% 3 to 5 cm, and 42% >5 cm. Petersen and Murphy[27] used a classification system reported by Galatz[29] that is based on area rather than longitudinal dimension and noted 5 small, 15 medium/large, and 15 massive tears (Table 3)

Concomitant Pathology

Namdari et al.[20] found that 77% of patients had biceps tendon pathology; however, 1 of their inclusion criteria was a >50% subscapularis tear. Gerber et al.[22] also had a subscapularis tear as an inclusion criterion, and reported 63% of their patients had biceps pathology, including 5 thickened biceps tendons, 4 dislocated tendons, and 1 with a prior tenodesis. The other study that had subscapularis tear as an inclusion criterion did not report concomitant pathology. Glenohumeral dislocations occurred in 7 of 20 (35%) traumatic tears in 1 study and 17 of 42 (40%) in another study. The latter study, by Bjornsson et al.,[21] also had 2 greater tuberosity fractures, 4 transient axillary nerve palsies, and 1 small glenoid fracture.

Table 3. Surgical Parameters

Author	Inclusion	Exclusion	Mechanism of Injury	Tendon	Repair
Bassett and Cofield (1983)[24]	Significant acute injury and FT RCR; repair within 3 months	Chronic tear, defined as repair >3 months	Fall on shoulder or outstretched hand (59%), stress lifting (16%), other (25%)	RC	Primary tendon suture, 9 patients: side-to-side tendon suture and suturing of healthy tendon to cancellous bone of humeral tuberosities
Gerber et al. (1996)[22]	Acute onset of pain, functional impairment of limb; severity resulting in temporary work disability; SS tear	Avulsion of lesser tuberosity; concomitant rupture of SSp or ISp; postop avulsion of SS tending during surgery	Forceful external rotation of abducted upper extremity (56%), 1 traumatic anterior dislocation, others could not be precisely defined	SS	Open TO tendon suture
Braune et al. (2003)[19]	No pre-existing shoulder pain or malfunction; complete, sudden loss of shoulder function; sharp trauma-related pain with correlated dead arm sign	Chronic shoulder pain; pre-existing shoulder malfunction; mechanical outlet impingement signs; ≥50 years excluded for traumatic origin but included for nontraumatic origin	Group 1: 7 traumatic shoulder dislocations (35%); complete RCTs in 10 patients (50%); 10 partial tears, either on acromial or articular surface Group 2: 25 patients (96.2%) sustained complete RCT	RC	Tendon-to-bone refixation with TO suture in McLaughlin's technique or tendon-to-tendon repair
Lahteenmaki et al. (2006)[26]	FT tear; acute symptoms, trauma; <90° of abduction and forward flexion	Massive tear <5 cm in diameter; concomitant shoulder dislocation; fracture; nerve injury; chronic symptoms	Acute traumatic	RC	NR
Namdari et al. (2008)[20]	Traumatic RCT that involved SS in addition to SSp, <12 months in duration, treatment with open repair	Partial-thickness tear; FT tear of SS that involved <50% insertion; prior failed RCR, symptoms <12 months; atraumatic mechanism; symptoms in contralateral shoulder	NR	RC	TO technique and suture anchors
Ide et al. (2007)[23]	Arthroscopic repair of FT tear of SS with SSp or ISp; MRI scans preop and postop, minimum 2-year follow-up	Irreparable RCT; partial RCR; stage 3/4 fatty infiltration of RC muscles; cuff tear arthropathy; failed prior cuff repair; Worker's Compensation claim	NR	RC	Arthroscopic repair, TO technique, and suture anchors
Hantes et al. (2011)[25]	No pre-existing shoulder pain or malfunction; complete, sudden loss of shoulder function; sharp trauma-related pain with correlated dead arm sign in combination with adequate trauma mechanism	Chronic shoulder pain with onset irrelevant to trauma; pre-existing shoulder malfunction; acromioclavicular joint arthritis; acromion osteophytes	Fall on shoulder/ hand; shoulder dislocation; motor vehicle accident	RC	Mini-open arthroscopic technique
Bjornsson et al. (2011)[21]	Trauma to shoulder; sudden onset; asymptomatic before trauma; pseudoparalysis; FT RCT of at least one tendon with acute appearance when sutured; no signs of previous cuff tearing	Previous or gradual onset of symptoms in injured shoulder, partial cuff tear, displaced fracture	NR	RC	Open technique, osteostructures and suture anchors in all patients, one arthroscopic procedure
Petersen and Murphy (2011)[27]	Acute, traumatic, FT RCT; inability >90° of active abduction	NR	Work related	RC	Open approach, suture and tendon to greater tuberosity by TO tunnels; all procedures included anterior acromioplasty

FT, full-thickness; RCR, rotator cuff repair; RCT, rotator cuff tear; RC, rotator cuff; SS, subscapularis; TO, transosseous; SSp, supraspinatus; ISp, infraspinatus; preop, preoperation; postop, postoperation; NR, not reported.

Bassett and Cofield[24] reported 6 patients who required a distal clavicle excision and 2 with biceps pathology requiring tenodesis. Lahteenmaki et al.[26] also noted biceps pathology in 2 of 26 patients. The remaining 2 studies do not mention associated pathology.[19,27]

Pain Scores

Three studies did not report pain scores as a separate outcome measure.[19,21,25] Two studies used a standard VAS pain score, with Namdari et al.[20] revealing an improvement from 6.2 pre-operatively to 1.2 post-operatively, and Petersen and Murphy[27] reporting a similar improvement from 7 preoperatively to 1.4 postoperatively. Ide et al.[23] used the pain component of the JOA score, which ranged from 0 to 30, with 0 being severe pain. This group also reported a significant reduction in pain scores from pre- to postoperatively (11.2 to 24.8, respectively). Lahteenmaki et al.[26] used the pain component of the UCLA score and noted a significant improvement from 2.1 preoperatively to 9.3 postoperatively. Gerber et al.[22] used the pain component of the Constant score and reported post-operative pain scores of 10.4 to 15, with a score of 15 denoting no pain. Finally, Bassett and Cofield[24] used a scale that allowed patients to rate their pain as none, slight, moderate, or severe. All patients scored their pain as moderate or severe preoperatively, whereas postoperatively 13 reported no pain and the remaining 24 reported only slight pain (Table 3).

Strength/Motion

The preoperative forward elevation was reported in 4 studies with a weighted average of 80.9° (59° to 95°).[20,23,26,27] These improved to a weighted average of 149.9° (88° to 142°) postoperatively, as measured in 6 studies.[19,20,23,24,26,27] Preoperative and postoperative external rotation was reported in 4 studies,[23,26] and averaged 42.4° preoperatively to 49.1° at final follow-up. Internal rotation was reported by 3 groups[20,23,27] and found to improve from a weighted average of L-1 (T-10 to gluteal level) preoperatively to T-10 (T-9 to T-12) postoperatively. Postoperative abduction was measured in only 2 studies, and the weighted average was 165.7° (<90° to 173.1°).[19,26] Gerber et al.[22] did not report actual degrees of motion, but stated that flexion was reduced in 4 of 16, abduction was reduced in 5 of 16, and external rotation was reduced in 6 of 16.

Braune et al.[19] reported a significant difference in improvement in postoperative forward flexion and abduction between the traumatic rotator cuff group and the nontraumatic group, with mean differences of 10° in forward elevation and 26° in abduction. Bassett and Cofield[24] reported approximately 40° of improved forward elevation in their acute (<3 weeks) repair group compared with later repairs; this difference was significant. Petersen and Murphy[27] also found that their 2 acute repair groups had significantly better forward elevation (137° and 142°) than their delayed repair group (100°). This study also showed a more significant improvement in forward elevation in those with small and medium/large tears than with those with massive tears.

Healing Rates

Rotator cuff healing was evaluated in only 3 of the 9 studies, 2 using MRI[23,25] and the other using ultrasound[21] to evaluate cuff integrity. Ide et al.[23] divided patients into 2 groups on the basis of MRI healing. The group with an intact repair (13 of 20 patients, 65%) was significantly younger (58 years) than the failed repair group (68 years) and had significantly better JOA scores (93 *v* 87). Of note, 6 of the 7 tears that failed involved the entire tendinous portion of the subscapularis and retraction was to the level of the glenoid. Hantes et al.[25] observed healing on MRI in 23 of 35 (66%) patients, but found no difference in healing based on time to surgery. In the early repair group, there was no difference in outcomes based on presence of healing; however, in the delayed repair groups, UCLA and Constant scores were significantly better for those that healed. Bjornsson et al.,[21] using ultrasound at follow-up, found that 29 of 42 (69%) had an intact cuff, and 9 of 42 (21%) had partial-thickness tears. This study reported a significantly lower age (60 years) in the intact group than in the defect group (68 years). The other studies did not report rotator cuff healing as an outcome variable.[19,20,22,24,26,27]

Outcome Scores

The UCLA[23,25-27] and Constant[19,21,22,25] scores were the most frequently used outcome scores, each being used in 4 of the 9 studies. One study did not report specific outcome scores and reported only functional results.[24] All showed a significant improvement from preoperative to postoperative values for the respective outcomes measures used. The weighted average post-operative UCLA score was 30.1 (9 to 31), and the weighted average Constant score was 76.6 (39 to 95) for all patients with traumatic tears. One study compared traumatic and atraumatic tears, and thus, the scores for the atraumatic group were not used in this calculation. Several studies compared outcomes with respect to tear size,[26] time to repair,[27] or healing,[21] and 1 study compared outcomes by both healing and time to repair.[25] However, these scores incorporate all patients with traumatic tears, regardless of time to surgery, healing, or tear size (Table 4).

Namdari et al.[20] reported postoperative SST and DASH scores of 82.8 and 12.2. Ide et al.,[23] using the JOA score, reported an improvement to 91.0 post-operatively. Hantes et al.[25] reported significantly better Constant and UCLA scores in the acute repair group than in the delayed repair group ($P < .05$). Petersen and

Table 4. Clinical Outcomes

Study	Constant Score	VAS Score	UCLA Score	Active Forward Flexion	Active External Rotation	Other
Gerber et al. (1996)[22]	59 (preop) to 95	NR	NR	NR	NR	NR
Braune et al. (2003)[19]	Group 1: 94.1 (acute repair) Group 2: 75.3 (delayed repair)	Group 1: 20 (7-10) Group 2: 13 (7-10), 7 (5-6), 6 (<5)	NR	Group I: 166 Group II: 156	Group 1: 56 Group 2: 38	NR
Lahteenmaki et al. (2006)[26]	NR	NR	Pain: 1.8 (preop) to 8.3 Function: 1.8-8.6 Strength: 2.7-4.4 Satisfied 239/unsatisfied 7 Overall score: 30.6	Small tear: 130-160 Medium tear: 112-153 Large tear: 115-151	Small tear: 62-61 Medium tear: 60-54 Large tear: 59-54	Overall satisfaction rating: 38% excellent, 38% good, 38% fair, 9% poor
Namdari et al. (2008)[20]	93.4	6.2-1.2	NR	81-97	93-109 (internal rotation: 3 to <1)	DASH: 41.7-12.2 SST: 36.4-82.8 SF-36: 54.99-84.26 (Pain); 88.55-99.24 (Physical functioning)
Ide et al. (2007)[23]	NR	NR	14.9-31.1	97-162	30-43 (internal rotation: L-2 to T-10)	JOA score: 55.7-91.0 Pain: 11.2-24.8 Function: 9.4-18.7 External rotation: 5.5-6.9 Internal rotation: 3.6-5.9
Hantes et al. (2011)[25]	Group 1: 39-82 Group 2: 40-70	NR	Group I: 10-31 Group 2: 12-27	NR	NR	NR
Bjornsson et al. (2011)[21]	73 (repaired) 83 (contralateral shoulder)	NR	NR	NR	NR	DASH: 17 (intact) to 31 (defect) WORC: 79 (intact) to 65 (defect)
Petersen and Murphy (2011)[27]	NR	7-1.4	Group 1: 6-30 Group 2: 9-30 Group 3: 9-25	Group 1: 54-137 Group 2: 52-142 Group 3: 66-100	39-49	Strength of SST: 2.7-4.1 Strength of infraspinatus: 3.7-4.2 ASES Group 1: 28-82 Group 2: 31-79 Group 3: 24-65

VAS, visual analog scale; UCLA, University of California, Los Angeles; DASH, Disabilities of the Arm, Shoulder, and Hand score; SST, supraspinatus; SF-36, Short Form-36; JOA, Japanese Orthopaedic Association; WORC, Western Ontario Rotator Cuff score; ASES, American Shoulder and Elbow Surgeons score.

Murphy[27] also reported more improved results in early repair groups than with delayed repair groups, but found no difference in tear size. Bjornsson et al.,[21] however, found no difference in Constant, DASH, or WORC scores with respect to time from injury, but did report a significant difference in these scores with respect to healing of the rotator cuff tear. The mean DASH score was 17 in intact cuffs and 31 in those with a defect. The mean WORC score was 79 in the intact group and 65 in the defect group. The mean Constant score was 73 with an intact repair and 55 with a failed repair (Table 4).

Bias

All studies were retrospective in nature, which inherently introduces selection bias. Ide et al.[23] described enrolling consecutive patients who met inclusion criteria, which may minimize this bias. Independent examiners were not used or not mentioned in 5 studies,[20,24-27] which introduces detection bias in these studies. All studies had relatively small numbers of patients, and no study mentioned an a priori power analysis. Hantes et al.[25] used 2 different surgeons, 1 of whom used an open technique, and the other an arthroscopic technique. Also, in this study the delayed repair group had a large time range from 45 to 303 days postinjury. The level of evidence of the included studies was Level III or IV, which introduces additional selection and detection bias compared with Level I and II studies.

Bjornsson et al.[21] used 3 different surgeons and divided patients by age above or below 65, which likely introduces some bias as those over the age of 65 likely have poorer tissue. Bassett and Cofield[24] used multiple examiners, which introduces inconsistency with results, which is compounded by not using standardized outcomes scores. Petersen and Murphy[27] only had a 9-month minimum follow-up, and different rehabilitation was prescribed based on tear size and integrity of repair. Concomitant pathology was not discussed in several studies, which can be a factor in postoperative outcome scores and can introduce performance bias.

Discussion

Traumatic rotator cuff tears are often discussed as a separate entity compared with nontraumatic, attritional rotator cuff tears. Prior studies of rotator cuff tears have found that age and tear size are significant factors in outcome and healing. However, there has been relatively little literature examining the difference between traumatic and nontraumatic tears. The goal of this systematic review was to better delineate the epidemiology, anatomy, and outcome of traumatic rotator cuff tears and determine if there is evidence to support the acute repair of these injuries.

Patients who incur a traumatic rotator cuff tear are thought to be categorically different from those who experience a nontraumatic attritional type of tear, which can also produce acute symptoms. The average age in this study (54.7 years) is nearly 10 years younger than the average age in a recent publication of the Multicenter Orthopaedic Outcomes Network (MOON) Shoulder Group's demographics for atraumatic rotator cuff tears (62.6 years).[30] Braune et al.[19] used an exclusion criterion of age 50 to differentiate between true traumatic tears and acutely symptomatic attritional tears. However, this same study found more partial-thickness tears in the traumatic group.[19] Traumatic tears are thought to stem from more violent mechanisms and cause full-thickness tears, whereas the natural history of attritional tears is that they originate as partial-thickness tears and perhaps progress to full-thickness tears.[3] Also, traumatic tears may be larger and more likely to involve the subscapularis muscle. Three of the studies required subscapularis involvement as an inclusion criterion in their study.[22] In this review, only 22% of the patients had small tears <3 cm in size and more than 50% of patients had 2 or more tendons involved. These tears are much larger than atraumatic tears, with more than 71% of the single-tendon supraspinatus tears in the MOON Shoulder Group being classified as atraumatic[30] (Table 5). However, it is difficult to ensure that all patients in the included studies did not have acute on chronic tears as several studies included older patient populations with acute symptoms.

Healing continues to be a major focus in rotator cuff surgery, with surgeons and researchers attempting to determine the best milieu to allow tendon to bone healing. Healing has been consistently shown to dramatically affect outcomes.[31-39] Patient age[36,37,40] and tear size[18,38,41] are routinely quoted as the 2 biggest factors in rotator cuff healing. Recently, studies have evaluated type of repair and healing rates, showing that transosseous equivalent techniques have improved healing in tears larger than 1 cm.[42] The video shows an example of the authors' approach in repairing an acute traumatic tear (Video 1, available at www.arthroscopyjournal.org). Healing rates for traumatic tears should theoretically be improved when repaired early because they occur in younger patients, may have less retraction or muscle atrophy, and may present a favorable biological environment for tendon healing with ongoing inflammatory response. The 3 studies reporting healing in traumatic tears were consistent with 65% to 69% healing. A systematic review of rotator cuff healing showed failure rates as low as 7% in small tears <1 cm and upward of 69% retears in larger tears. These authors also found that the method of repair may play a role in healing, with double-row repairs performing better than single-row or transosseous repairs for all tears greater than 1 cm. In this systematic review, Bjornosson et al.[5] and Ide et al.[23]

Table 5. Differences Between Traumatic and Nontraumatic Rotator Cuff Tears

	Traumatic Tears	Attritional Tears
Epidemiology	Younger (mean, 54.7 years)	Older: prevalence increases with age
Mechanism of injury	Fall onto outstretched arm	Attritional, nontraumatic
	Forceful extended rotation on abducted arm	Slow progression of symptoms
Tear characteristics	Supraspinatus (84%)	Likely start as small supraspinatus tear and progress in size
	Infraspinatus (39%)	Fewer subscapularis tears
	Subscapularis (78%)	
	Size: 42% large/massive	
Outcomes	Forward elevation: 81 preop to 150 postop	Forward elevation improved
	UCLA: 30.1	UCLA: 28.6-33.3
	Constant: 76.6	Constant: 74.4-82.7
	Significant pain improvement	Significant pain improvement
Healing	Age and size related	Age and size related

UCLA, University of California, Los Angeles score.

found no difference in healing with respect to tear size or number of tendons involved, but the numbers were too small to prevent beta error. Two of the three studies that reported healing used single-row repairs,[16,20] and the other performed all-open repairs.[5] Two[21,23] of these studies reported better healing in the younger population. The third study evaluated healing as it related to time to surgery and found no difference in acute versus delayed repair[25] (Table 5). Again, no power analysis was performed to ensure this result was not caused by beta error. Because of the heterogeneity of these studies in terms of inclusion criteria, length of time to repair, repair type, age, and size of tears, as well as the fact that only 3 studies totaling less than 100 patients reported healing rates, it is inappropriate to comment on time to surgery or healing rates in traumatic rotator cuff tears based on the available literature.

The UCLA scores after repair of nontraumatic rotator cuff tears ranged from 28.6 to 33.3 in a recent systematic review; Constant scores in this same study ranged from 74.4 to 82.7.[43] The weighted average of the UCLA scores (30.7) and Constant scores (76.6) from this traumatic group fall within these ranges despite likely representing larger tears (Table 5). Lahteenmaki et al. also published their results of the opposite population of chronic tears repaired after 3 weeks from the onset of symptoms.[28] UCLA scores averaged 30.6, although this study excluded massive tears (>5 cm). Mean strength was 4.4 of 5, forward elevation was 154°, abduction was 148°, and age did not influence results. The only factor that consistently affected results was the size of the tear, with much better results in small tears than medium or large tears.[44] Other studies have also reported that the size of the tear (or number of tendons involved) has been shown to affect clinical outcome after repair.[45-48]

Limitations

There are several limitations to this study, which were determined by the studies included. The definition of acute tears was similar among the groups: each required the arm to be pain free prior to a specific, identifiable injury. Some studies had age restrictions. However, the ability to distinguish between an acute tear and a degenerative tear with an acute worsening is admittedly difficult[24,27,44,49] if not impossible without some screening examination of all patients prior to the injury to ensure no cuff tear was present. Some authors believe that traumatic tears occur mostly in diseased or aged tendons.[42,49-51] Another limitation of this study is the heterogeneity in the studies with several requiring subscapularis tears, which are more likely to involve biceps pathology, and this concomitant pathology can affect pain and outcome scores. All of these studies were Level III or lower, and many did not use independent examiners. Also, at most, 4 studies used the same outcome tools, which prevented meaningful pooling of results and meta-analysis. The studies included in this review do not fully evaluate the role tear size and tear chronicity have in rotator cuff healing nor overall results. With the current available literature, there is no indication that acute repair in traumatic injuries produces better outcomes; however, this may be related to the difficulty in differentiating an acute on chronic tear from a definitively acute, traumatic tear.

Further research is needed to directly compare the results of acute intervention for patients who present with traumatic rotator cuff tears.

Conclusions

Traumatic rotator cuff tears are more likely to occur in relatively young (age 54.7), largely male patients who suffer a fall or trauma to an abducted, externally rotated arm. These tears are typically large and involve the subscapularis, and repair results in acceptable results. However, insufficient data prevent a firm recommendation for early surgical repair.

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