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Winner of the 2014 Systematic Review Award

Posterior Instability of the Shoulder

A Systematic Review and Meta-analysis of Clinical Outcomes

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Background: To date, there are no reports in the literature of a systematic review and meta-analysis for posterior instability of the shoulder.

Purpose: The primary objective was to systematically capture, critically evaluate, and perform a meta-analysis of all available literature on arthroscopic clinical outcomes to provide insight and clinical recommendations for unilateral posterior shoulder instability. The secondary objective was to use the same means to assess clinical outcome literature for open treatment, of which a subset of highly reported outcome measures were used to determine superiority of arthroscopic versus open procedures for unilateral posterior shoulder.

Study Design: Systematic review, meta-analysis.

Methods: A systematic search to obtain every available, published, level of evidence study reporting patient data for unidirectional posterior shoulder instability was performed by use of the Cochrane Database of Systematic Reviews, PubMed/Medline database, manual searches of high impact factor journals and conference proceedings, and secondary references appraised for studies meeting inclusion criteria.

Results: The systematic search captured a total of 1035 publications. After initial exclusion criteria were applied, 607 abstracts were assessed for eligibility. Full-text articles were obtained for 324 articles, and a total of 53 unique publications (27 arthroscopic studies, 26 open studies) reporting clinical outcomes for unidirectional posterior shoulder instability met inclusion criteria and were included in the systematic review and meta-analysis.

Conclusion: Well-defined and uniform shoulder outcome measures to assess posterior shoulder instability are lacking throughout the literature. However, arthroscopic procedures are shown to be an effective and reliable treatment for unidirectional posterior glenohumeral instability with respect to outcome scores, patient satisfaction, and return to play. Despite similar results of outcome measures to the overall athletic population, throwing athletes are less likely to return to their preinjury levels of sport compared with contact athletes or the overall athletic population. Evidence also indicates that arthroscopic stabilization procedures using suture anchors result in fewer recurrences and revisions than anchorless repairs in young adults engaging in highly demanding physical activity. Furthermore, the literature suggests that patients treated arthroscopically have superior outcomes compared with patients who undergo open procedures with respect to stability, recurrence of instability, patient satisfaction, return to sport, and return to previous level of play.

Keywords: systematic review; meta-analysis; posterior shoulder instability; recurrent posterior shoulder instability; unidirectional posterior shoulder instability; posterior shoulder instability repair; posterior shoulder instability reconstruction; open arthroscopic procedure

It is well known that posterior shoulder instability is observed less frequently than anterior instability.[‖] However, the incidence of posterior instability occurring within the competitive athletic population is becoming increasingly recognized due to improved understanding of pathophysiology and the ability to treat patients with reliable arthroscopic procedures.[12,33,37,40,54,64] Patients may have undefined and vague symptoms, such as posterior shoulder

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The authors declared that they have no conflicts of interest in the authorship and publication of this contribution.

The American Journal of Sports Medicine, Vol. 43, No. 7
DOI: 10.1177/0363546515577622
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‖References 3, 5, 10-12, 14, 38, 39, 51-53, 55, 72.

discomfort, pain, inability to participate in their respective sport, and repeated subluxation events.[14,39,54,68] Further complexity exists because no single pathologic lesion occurs in all cases of posterior shoulder instability, and posterior shoulder subluxation is often accompanied by various lesions, which may result in instability in more than a single isolated direction.[33,48,65]

Posterior shoulder instability varies widely within the athletic population and may occur through various mechanisms: (1) Traumatic posterior shoulder instability injuries often occur in contact or collision sports through a single traumatic event with the shoulder in a flexed, adducted, and internally rotated position, such as a fall on an outstretched arm.[43] This type of acute, traumatic, posteriorly directed shearing force along the glenoid face between the posterior labrum and glenoid articular surface often results in capsulolabral detachment.[21,40,49] (2) Microtraumatic injuries often can be seen clinically in offensive football linemen due to repetitive, posteriorly directed axial loading of the shoulder.[66] Repetitive microtrauma to the posterior capsule may ultimately lead to capsular attenuation and labral tears.[23] (3) Insidious onset frequently occurs secondary to overhead or throwing sporting activities due to gradual capsular failure from repetitive overhead movements seen in baseball pitching, the backhand stroke in racket sports, the follow-through phase in golf and batting (ie, "batter's shoulder"), and the pull-through phase of swimming.[43,69] Insidious onset often results in laxity of the posterior capsule and associated passive stabilizers.[54,60,69] (4) Other mechanisms of occurrence are seen in rare instances such as seizure disorders and electrocution and in activities that entail distinct, posteriorly directed vector forces, such as archery, riflery, and wheel chair use.[19,25,67] This unique and underrecognized injury occurs through various mechanisms with complex pathogenesis, but many other factors, such as volition, degree of instability, direction of instability, and associated injury, ultimately influence the choice of operative intervention.

In recent years, there has been a shift from open procedures to more modern arthroscopic techniques.[12,14] Many arthroscopic techniques to address posterior shoulder instability have been described throughout the literature. The predominant posterior capsulolabral stabilization procedure uses anchor or anchorless suture fixation of the posterior labrum with or without capsular plication.[13] Other, less common arthroscopic procedures, such as posterior humeral avulsion of the glenohumeral ligament repair, arthroscopic bone block augmentation, and thermal capsulorrhaphy to address posterior capsular redundancy, have been performed, often resulting in less reliable outcomes.[17] The spectrum of procedures arises from continued uncertainty regarding pathobiomechanical lesions of the posterior labrum, posterior capsule, and posterior inferior glenohumeral ligament complex as well as osseous abnormalities of the posterior glenoid.[17] Patients with a posteriorly unstable shoulder remain a challenging group to accurately diagnose, classify, and effectively treat via surgical management. As a result, surgical intervention to address posterior instability of the shoulder has frequently been inconsistent, resulting in unreliable functional outcomes.[12]

We report the first systematic review and clinical outcome meta-analysis for posterior instability of the shoulder. The primary objective of this study was to systematically capture, critically evaluate, and perform a meta-analysis of all available literature on arthroscopic clinical outcomes to provide insight and clinical recommendations for the treatment of unilateral posterior instability of the shoulder. The secondary objective was to use the same means to assess the literature on clinical outcomes of open treatment, of which a subset of the most highly reported outcome measures were used to determine superiority of arthroscopic versus open procedures for unilateral posterior instability of the shoulder. We hypothesize that patients undergoing arthroscopic treatments for posterior instability have high rates of return to sport, improved clinical outcome scores, high satisfaction rates, and superior results compared with patients who undergo open treatments.

METHODS

Search Strategy

A systematic review was conducted to identify all published literature reporting clinical outcomes using arthroscopic and open techniques for the treatment of unidirectional posterior instability of the shoulder. A comprehensive literature search was performed via a computer-based search within the Cochrane Database of Systematic Reviews and the online Medline/PubMed Database (US National Library of Medicine, National Institutes of Health) from 1946 to August 12, 2014. The electronic database algorithm search was not limited by study design or language of publication and intentionally used broad terms to maximize capture of literature. The following terms were used as keywords and Medical Subject Headings (MeSH) and appeared in the title, abstract, or keyword fields: (posterior) AND (shoulder OR glenoid OR glenohumeral OR unidirectional OR labrum) AND (instability OR laxity OR subluxation).

Study selection for inclusion in the systematic review was determined by examining the title and/or abstract of all articles obtained from the database search. Duplicates and nonrelevant articles were excluded; non–English language articles were assessed, and it was determined whether translation was possible. Full text was retrieved from all remaining potentially relevant abstracts.

Further studies were identified by examining reference lists and citation searches of all included investigations and review articles captured by the database search. To ensure complete coverage and identification of recent publications not yet included and indexed by the electronic database, hand-searches of high impact factor orthopaedic sports medicine journals (2000 to July 2014) and abstracts of highly attended conference proceedings (2009 to July 2014) were performed (Appendix A, available online at http://ajsm.sagepub.com/supplemental).

All investigators subsequently analyzed each included study. Clinical studies were descriptively analyzed and assessed for multiple parameters and outcomes of interest. Primary outcomes consisted of (1) recurrent instability, (2)

revision/reoperation, (3) persistent pain, (4) subjective instability, (5) return to any level of sport, and (6) return to previous level of sport. To further quantify the arthroscopic clinical outcomes of posterior instability of the shoulder, the following secondary outcomes were assessed: (7) objective stability (8) shoulder stiffness, (9) range of motion (ROM), (10) muscle strength, (11) patient satisfaction, and (12) complications.

Exclusion Criteria

Articles were excluded based on the following criteria: (1) multidirectional shoulder instability, (2) bidirectional shoulder instability, (3) habitual or psychogenic voluntary subluxations, (4) history of seizure or neuromuscular disorders, and (5) non–English language articles that could not be interpreted.

RESULTS

Literature Selection

The Cochrane Library database reported no systematic review on posterior instability of the shoulder, and the online PubMed/Medline database search produced an overall total of 1035 publications. After exclusion of duplicate and nonrelevant articles, 607 abstracts were assessed for eligibility. Eleven articles were published in German or French medical journals and could not be further translated beyond the abstract. Full-text articles were obtained for 324 articles. An initial 266 articles were evaluated for inclusion and exclusion criteria, and an additional 58 publications were identified through secondary screening measures (reference and citation searches and manual searches of high impact factor orthopaedic journal and conference proceedings). After exclusion criteria were applied, a total of 27 unique references reporting arthroscopic clinical outcomes and 26 reporting open clinical outcomes of posterior instability of the shoulder were included in the final systematic review (Figure 1). The arthroscopic literature consisted of 24 (n = 410 patients) level 4 retrospective studies and 3 (n = 407 patients) level 2 prospective studies; all 26 (n = 321 patients) open studies were level 4 retrospective investigations.

Data Extraction and Meta-analysis—Arthroscopic Procedures

Patient Demographics

The 27 arthroscopic studies meeting criteria for the systematic review contained 817 total shoulders from 773 patients: 748 shoulders were from overall athletes, with 227 from contact athletes and 155 from overhead/throwing athletes. Of the total 817 shoulders, it was possible to extract data on patient sex specific to our inclusion criteria for 718 shoulders, indicating that there were 134 female shoulders and 584 male shoulders.

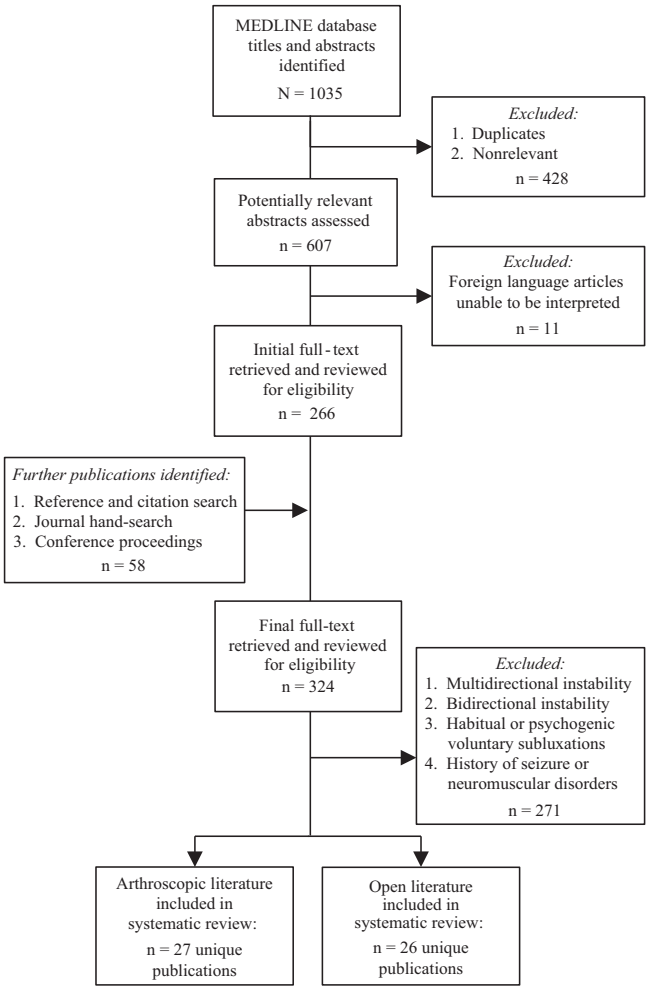

Figure 1. Literature selection algorithm.

Patient age data were available for 768 shoulders and indicated an average age of 24.5 years (range, 15-70 years). Follow-up data were available for 765 shoulders, with a reported mean follow-up of 28.7 months (range, 4-149 months). Patient demographics are summarized in Appendix B[i] (available online).

Primary Outcome Measures

Primary outcomes are summarized in Table 1 and in Appendix C[i] (available online).

Recurrent Instability

Total Population. For the 817 total shoulders, outcome data for recurrent instability were not reported on 2 shoulders. Of the remaining 815 shoulders (26 studies) with available reported outcomes, 66 shoulders were reported to have recurrent instability after the index procedure, resulting in a recurrent instability rate of 8.10% (SD, ±3.75%; range, 0%-25%).

TABLE 1
Primary and Secondary Arthroscopic Outcomes—Posterior Shoulder Instability[a]

Outcome Measure	Total Population		Overall Athletes		Contact Athletes		Throwing/Overhead Athletes	
	% (SD)	n/N (Studies)[b]	% (SD)	n/N (Studies)[b]	% (SD)	n/N (Studies)[b]	% (SD)	n/N (Studies)[b]
Primary outcomes								
Recurrent instability	8.1 (±3.8)	66/815 (26)	8.6 (±4.8)	44/513 (15)	5.1 (±2.3)	9/178 (6)	12.1 (±1.5)	4/33 (3)
Revision/reoperation	7.6 (±3.5)	38/502 (19)	6.8 (±4.0)	26/381 (13)	6.2 (±2.9)	11/178 (6)	[c]	1/6 (2)
Persistent pain	12.3 (±2.2)	45/365 (18)	17.5 (±2.5)	18/103 (9)	[c]	1/1 (1)	[c]	4/4 (2)
Subjective stability	91.1 (±48.3)	637/699 (18)	91.9 (±58.2)	443/482 (11)	91.4 (±47.1)	160/175 (5)	89.3 (±16.3)	25/28 (2)
Return to sport (any level)	N/A	N/A	91.8 (±45.4)	561/611 (19)	89.3 (±42.4)	159/178 (6)	83.9 (±12.5)	26/31 (3)
Return to sport (previous level)	N/A	N/A	67.4 (±35.9)	368/546 (15)	71.9 (±32.6)	128/178 (6)	58.1 (±7.9)	18/31 (3)
Secondary outcomes								
Objective stability	95.1 (±10.5)	97/102 (7)	97.1 (±12.8)	68/70 (5)	92.9 (±4.2)	26/28 (4)	100[c] (±2.6)	13/13 (4)
Postoperative stiffness	[c]	2/8 (3)	[c]	2/8 (3)	[c]	1/1 (1)	[c]	1/1 (1)
Range of motion	90.4 (±52.7)	492/544 (15)	83.6 (±63.7)	285/341 (8)	97.1 (±49.1)	133/137 (5)	[c]	6/7 (3)
Muscle strength	64.4 (±36.6)	328/509 (9)	54.0 (±40.9)	174/322 (5)	53.6 (±31.9)	67/125 (3)	[c]	2/2 (2)
Patient satisfaction	93.8 (±51.8)	442/471 (13)	93.2 (±60.4)	341/366 (10)	92.4 (±52.5)	157/170 (4)	[c]	1/1 (1)

[a]N/A, not applicable.
[b]n/N, number of affected shoulders/total number reported (number of studies).
[c]Low-powered patient population.

Overall Athletes. For the 748 total overall athletic shoulders, 513 shoulders (15 studies) had recurrence outcomes reported for total overall athletic shoulder population; 8.58% (SD, ±4.82%; 44 of 513 shoulders) were reported to have recurrent instability after the index procedure.

Contact Athletes. For the total 227 contact sport athletic shoulders, 178 shoulders (6 studies) had recurrence outcomes reported specific to contact sport athletic shoulders; 5.06% (SD, ±2.35%; 9 of 178 shoulders) were reported to have recurrent instability after the index procedure.

Overhead/Throwing Athletes. For the total 155 overhead/throwing athletic shoulders, 33 shoulders (3 studies) had recurrence outcomes reported specific to overhead/throwing athletic shoulders; 12.12% (SD, ±1.53%; 4 of 33 shoulders) were reported to have recurrent instability after the index procedure.

Revision/Reoperation

Total Population. For the 817 total shoulders, outcome data for revision surgery were not reported in 315 shoulders. Of the remaining 502 shoulders (19 studies) with reported outcomes, 38 shoulders were reported to have undergone revision after the index procedure, resulting in a revision rate of 7.57% (SD, ±3.53%; range, 0%-33.33%).

Overall Athletes. For the 748 total overall athletic shoulders, 381 shoulders (13 studies) had revision rates reported that were specific to the total overall athletic shoulder population; 6.82% (SD, ±3.98%; 26 of 381 shoulders) were reported to have a revision after the index procedure.

Contact Athletes. For the total 227 contact sport athletic shoulders, 178 shoulders (6 studies) had revision rates reported that were specific to contact sport athletic shoulders; 6.18% (SD, ±2.86%; 11 of 178 shoulders) were reported to have a revision after the index procedure.

Overhead/Throwing Athletes. For the total 155 overhead/throwing athletic shoulders, only 6 shoulders (2 studies) had outcomes reported specific to revision. One shoulder out of 6 was reported to have revision surgery after the index procedure.

Persistent Pain

Total Population. For the 817 total shoulders, outcome data for persistent pain were not reported for 452 shoulders. Of the remaining 365 shoulders (18 studies) with available reported outcomes, 45 shoulders were reported to have persistent pain after the primary procedure, resulting in a persistent pain rate of 12.33% (SD, ±2.18%; range, 0%-42.86%).

Overall Athletes. For the 748 total overall athletic shoulders, 103 shoulders (9 studies) had data on persistent pain specific to the total overall athletic shoulder population; 17.48% (SD, ±2.50%; 18 of 103 shoulders) were reported to have persistent pain after the index procedure.

Contact Athletes. Only 1 case report was identified to report specific details on persistent pain for a contact sport athletic shoulder. This 1 patient was reported to have persistent pain after the index procedure.

Overhead/Throwing Athletes. Only 2 studies (4 shoulders; SD, ±1.41) were identified to report specific details on persistent pain for overhead/throwing athletic shoulders. All 4 shoulders were reported to have persistent pain after the index procedure.

Subjective Stability

Total Population. For the 817 total shoulders, outcome data for subjective stability were not reported for 118 shoulders. Of the remaining 699 shoulders (18 studies) with available reported outcomes, 637 shoulders were reported to be stable or to have an excellent to good stability rating at the latest follow-up, resulting in a stability rate of 91.13% (SD, ±48.29%; range, 74%-100%).

Overall Athletes. For the 748 total overall athletic shoulders, 482 shoulders (11 studies) had subjective stability outcomes available that were specific to the total overall

TABLE 2
Functional Outcome Measures—Posterior Shoulder Instability[a]

Outcome Measure	No. of Studies	No. of Shoulders	Mean Preoperative Score	Mean Postoperative Score	Maximum Score/Raw Points	Postoperative % of Ideal Maximum Score
ASES	9	524	53.63 (7 studies)	89.65	100	90
WD	2	21	37.4 (1 study)	80.45	100	80
Modified Conway	1	12	NR	NR	NR	NR
SST	3	70	9.3 (1 study)	11.57	12	96
VAS	2	49	3.5 (1 study)	0.9	10	91
Modified West Point Rowe	1	1	40	95	100	95
UCLA	2	30	16 (1 study)	31.8	35	91
Oxford	2	4	15 (1 study)	43	48	90
Bigliani	2	15	3 (1 study)	6.54	8	82
Rowe	2	46	35.6 (1 study)	94.8	100	95
SANE	3	54	NR	90.83	100	91
WOSI	3	81	NR	312.63	2100	85
PSS	1	5	NR	87	100	87
Neer-Foster	2	133	NR	97% Satisfactory	Satisfactory	97
Subjective Patient Shoulder Evaluation	1	33	NR	20.0	24	83
Wolf-Eakin	2	32	NR	22.3 (1 study)	24	93
L'Insalata	1	27	NR	90	100	90
SF-36	1	27	NR	50.4	50 (normal, healthy)	99
Constant-Murley	1	3	NR	NR	100	NR
Athletic Shoulder Outcome Rating	1	20	NR	83	100	83
Undefined scoring system	2	17	NR	NR	NR	NR

[a]ASES, American Shoulder and Elbow Score; NR, not reported; PSS, Penn Shoulder Score; SANE, Single Assessment Numeric Evaluation; SF-36; Short Form Health Survey; SST, Simple Shoulder Test; UCLA, University of California, Los Angeles Shoulder Rating Scale; VAS, Visual Analog Scale; WD, Walch-Duplay; WOSI, Western Ontario Shoulder Instability.

athletic shoulder population; 91.91% (SD, ±58.23%; 443 of 482) were reported to have a stable shoulder or an excellent to good stability rating at the latest follow-up.

Contact Athletes. For the total 227 contact sport athletic shoulders, 175 shoulders (5 studies) had subjective stability outcomes specific to contact sport athletic shoulders; 91.43% (SD, ±47.05%; 160 of 175) were reported to have a stable shoulder or an excellent to good stability rating at the latest follow-up.

Overhead/Throwing Athletes. For the total 155 overhead/throwing athletic shoulders, 28 shoulders (2 studies) had subjective stability outcomes specific to overhead/throwing athletic shoulders; 89.29% (SD, ±16.26%; 25 of 28) were reported to have a stable shoulder or an excellent to good stability rating at the latest follow-up.

Functional Outcome Measures

No standardized method of evaluation was consistently performed throughout the 29 arthroscopic studies included in the systematic review. The various functional outcome measures used by different investigators are represented in Table 2.

The primary functional outcome measure used throughout the literature is the American Shoulder and Elbow Score (ASES), assessing function, activities of daily living (ADLs), and pain. The ASES was used by 9 of the 29 studies and was available for 524 shoulders. The mean ASES score improved from 53.63 preoperatively (n = 7 studies) to 89.65 postoperatively, resulting in an overall mean postoperative score of 90% of the maximum score.

Taking into account the overlap of multiple functional outcome measures used for each individual study, all shoulders received at least an 80% rating of the ideal maximum score of any respective functional outcome measure. Specifically, 14% (175 of the total 1253 shoulders) received a score between 80% and <90% of the ideal maximum score for any outcome measure. The majority of shoulders, 86% (1078 of 1253 shoulders), received 90% or greater rating of any outcome measure (Table 2).

Return to Sport

Overall Athletes. For the 748 total overall athletic shoulders, outcome data for return to sport at any level were not reported for 137 shoulders. Of the remaining 611 athletic shoulders (19 studies) with available reported outcomes, 561 were reported to have returned to sport at any level, resulting in 91.81% (SD, ±45.43%; range, 0%-100%) returning return to sport at any level of play.

For the 748 athletic shoulders, outcome data for return to sport at preinjury level were not reported for 202 shoulders. Of the remaining 546 shoulders (15 studies) with available reported outcomes, 368 were reported to have returned to sport at the preinjury level, resulting in an overall 67.40% (SD, ±35.85%; range, 0%-100%) return to sport at the preinjury level.

Contact Athletes. For the total 227 contact sport athletic shoulders, 178 shoulders (6 studies) had outcomes reported for return to sport at any level and return to previous level of play specific to contact sport athletic shoulders; 89.33% (SD, ±42.39%; 159 of 178 shoulders) were reported to have returned to any level of sport after the index procedure, and 71.91% (SD, ±32.56%; 128 of 178 shoulders) were reported to have returned to previous level of play after the index procedures.

Overhead/Throwing Athletes. For the total 155 overhead/throwing athletic shoulders, 31 shoulders (3 studies) had outcomes reported for return to sport at any level and return to previous level of play specific to overhead/throwing athletic shoulders; 83.87% (SD, ±12.50%; 26 of 31 shoulders) were reported to have returned to any level of sport after the index procedure, and 58.06% (SD, ±7.94%; 18 of 31 shoulders) were reported to have returned to previous level of play after the index procedures.

1-Year Versus 2-Year Follow-up. For the 15 studies reporting outcomes for athletic shoulders with at least a 1-year follow-up (range, 12-149 months), 90.68% (SD, ±48.99%; 535 of 590 shoulders) and 67.73% (SD, ±38.41%; 361 of 533 shoulders) of athletic shoulders were reported to have returned to sport at any level and to have returned to the previous level of play, respectively.

For the 8 studies reporting outcomes for athletic shoulders with at least a 2-year follow-up (range, 24-149 months), 92.19% (SD, ±8.78%; 118 of 128) and 71.42% (SD, ±4.85%; 50 of 71) of athletic shoulders were reported to have returned to sport at any level and to have returned to the previous level of play, respectively.

Secondary Outcome Measures

Secondary outcomes are summarized in Table 1 and Appendix D[i] (available online).

Objective Stability

Total Population. For the 817 total shoulders, outcome data for objective instability were not reported for 715 shoulders. Of the remaining 102 shoulders (7 studies) with available reported outcomes, 97 were reported to be stable at final follow-up as determined via objectives measures, resulting in an overall objective stability rate of 95.10% (SD, ±10.53%; range, 85%-100%).

Overall Athletes. For the 748 total overall athletic shoulders, only 70 shoulders (5 studies) had objective stability outcomes reported that were specific to the total overall athletic shoulder population; 97.14% (SD, ±12.76%; 68 of 70) of shoulders were reported to be stable as determined via objectives measures.

Contact Athletes. For the total 227 contact athletic shoulders, only 28 shoulders (4 studies) had objective stability outcomes specific to contact athletes; 92.86% (SD, ±4.20; 26 of 28 shoulders) were reported to be stable as determined via objective measures.

Overhead/Throwing Athletes. For the 155 total overhead/throwing shoulders, only 13 shoulders (4 studies) had objective stability outcomes specific to overhead/throwing shoulders; 100% (SD, ±2.63%; 13 of 13) were reported to be stable as determined via objective measures.

Postoperative Stiffness

Outcomes regarding shoulder stiffness were reported for only 8 shoulders (3 studies). Two of the 8 shoulders were reported to have stiffness after the index procedure. One of these shoulders was reported for a contact athlete and the other for an overhead/throwing athlete.

Range of Motion

Total Population. For the 817 total shoulders, individual ROM outcome data were not reported for 273 shoulders. Of the remaining 544 shoulders (15 studies) with available reported outcomes, 492 were reported to have satisfactory or full ROM at the latest follow-up, resulting in an overall satisfactory or full ROM of 90.44% (SD, ±52.73%; range, 52%-100%).

Overall Athletes. For the 748 total overall athletic shoulders, individual ROM outcome data were not reported for 407 shoulders. Of the remaining 341 shoulders (8 studies) with available reported outcomes, 285 were reported to have satisfactory or full ROM at the latest follow-up, resulting in an overall rate of satisfactory or full ROM of 83.58% (SD, ±63.72%).

Contact Athletes. For the total 227 contact athletic shoulders, 137 shoulders (5 studies) had individual outcome data reported for ROM specific to contact athletes; 97.08% (SD, ±49.06%; 133 of 137) of shoulders were reported have satisfactory or full ROM at the latest follow-up.

Overhead/Throwing Athletes. For the total 155 overhead/throwing shoulders, only 7 shoulders (3 studies) had individual outcome data for ROM specific to overhead/throwing athletes; 85.71% (SD, ±2.65%; 6 of 7) of shoulders were reported have satisfactory or full ROM at the latest follow-up.

Muscle Strength

Total Population. For the 817 total shoulders, outcome data for normal muscle strength at the latest follow-up were not reported for 308 shoulders. Of the remaining 509 shoulders (9 studies) with available reported outcomes, 328 were reported to have normal strength at the latest follow-up, resulting in an overall rate of normal muscular strength of 64.44% (SD, ±36.60%; range, 48%-100%).

Overall Athletes. For the 748 total overall athletic shoulders, outcome data for normal muscle strength at the latest follow-up were not reported for 426 shoulders. Of the remaining 322 shoulders (5 studies) with available reported outcomes, 174 were reported to have normal strength at the latest follow-up, resulting in an overall rate of normal muscular strength of 54.04% (SD, ±40.86%).

Contact Athletes. For the 227 total contact athletic shoulders, outcome data for normal muscle strength at the latest follow-up were reported for 125 shoulders; 53.60% (SD, ±31.90%; 67 of 125) of shoulders were reported to have normal strength at the latest follow-up.

Overhead/Throwing Athletes. For the 155 total overhead/throwing shoulders, outcome data for normal muscle strength at the latest follow-up were reported for only 2 shoulders (2 studies). Both shoulders were reported to have normal muscular strength at the latest follow-up.

Patient Satisfaction

Total Population. For the 817 total shoulders, outcome data for patient satisfaction were not reported for 346 shoulders. Of the remaining 471 shoulders (13 studies) with available reported outcomes, 442 patients were reported to be very satisfied to satisfied or considered the surgery to be worthwhile and would have the surgery again, resulting in an overall satisfaction rate of 93.84% (SD, ±51.82%; range, 84%-100%).

Overall Athletes. For the 748 total overall athletic shoulders, outcome data for patient satisfaction were not reported for 382 shoulders. Of the remaining 366 shoulders (10 studies) with available reported outcomes, 341 patients were reported to be very satisfied to satisfied or considered the surgery to be worthwhile and would have the surgery again, resulting in an overall satisfaction rate of 93.17% (SD, ±60.38%).

Contact Athletes. For the total 227 contact sport athletic shoulders, 170 shoulders (4 studies) had patient satisfaction outcomes reported that were specific to contact sport athletic shoulders; 92.35% (SD, ±52.52%; 157 of 170) were reported to be satisfied with the procedure or considered it worthwhile and would have the surgery again.

Overhead/Throwing Athletes. For the total 155 overhead/throwing athletic shoulders, only 1 case report provided patient satisfaction outcomes specific to overhead/throwing athletic shoulders. This 1 patient was satisfied with the procedure.

Complications

For the 817 total shoulders, outcome data for complications were not reported for 334 shoulders. Of the remaining 483 shoulders with available reported outcomes, there were 16 reports of complications occurring with 12 shoulders after the primary procedure, resulting in an overall complication rate of 2.48% (SD, ±1.73%; range, 0%-100%).

Reported complications included hardware removal (1 broken K-wire, 5 screw removals), 1 trimming of bone graft due to proud glenoid rim, 1 partial osteolysis of graft, 1 loose body/fragment removal, 1 completely resorbed bone graft requiring revision in a bilaterally affected patient, 1 adhesive capsulitis, 1 superficial infection treated successfully, 2 subacromial impingements, 1 full-thickness traumatic rotator cuff tear, and 1 subsequent subacromial decompression performed for shoulder stiffness.

Study Characteristics

Study characteristics are described in Appendix B (available online).

Prior Surgery

For the 817 total shoulders, outcome data for prior surgery were not reported for 513 shoulders. Of the remaining 304 shoulders (14 studies) with available reported outcomes, 30 shoulders from 7 studies were reported to have undergone surgery before the posterior instability index procedure, resulting in a prior surgery rate of 9.87% (SD, ±2.74%; range, 0%-30%).

Prior surgeries reported were as follows: 6 thermal capsulorrhaphy, 9 anterior stabilization procedures, 5 posterior Bankart repair, 1 posterior reconstruction, 1 open staple capsulorrhaphy, 1 arthroscopic stapling, 4 arthroscopies (details not reported), 2 superior labrum anterior and posterior (SLAP) procedures, and 1 anterior stabilization or SLAP (details not reported).

Three studies reported correlations of failures with prior surgeries. From these studies, 50% (10 of 20) of failed cases of recurrent instability were reported to have had prior surgery.

Injury Onset

For the 817 total shoulders, outcome data for traumatic injury were not reported for 206 shoulders. Of the remaining 611 shoulders (22 studies) with available reported outcomes, 377 shoulders (18 studies) were reported to have a distinct traumatic event leading to posterior shoulder instability, resulting in a traumatic onset rate of 61.70% (SD, ±16.85%).

Primary Procedures Performed

The majority of procedures performed for the 27 arthroscopic studies for posterior instability of the shoulder were for capsulolabral repair (CLR) (n = 22 studies; n = 773 shoulders) or thermal capsulorrhaphy (n = 5 studies; n = 45 shoulders). The specific breakdown of the primary procedures used was as follows: 15 studies involving CLR (693 shoulders); 1 study involving CLR + debridement only of labral tears (12 shoulders); 3 studies involving CLR + thermal capsulorrhaphy (25 shoulders); 1 study involving CLR + posterior humeral avulsion of the glenohumeral ligament repair (1 shoulders); 2 studies involving CLR + glenohumeral ligament repair (42 shoulders); 2 bone block studies (21 shoulders); 1 study of debridement of labral tears only (3 shoulders); and 2 thermal capsulorrhaphy studies (20 shoulders).

Surgical Repair Using Anchors, Anchorless, or Other Means of Repair

For the 817 shoulders, an arthroscopic bone block procedure was performed on 21 shoulders, and a capsulolabral repair and/or capsular plication was performed on the remaining 796 shoulders. From these 796 shoulders, it was possible to identify 703 shoulders that used suture anchors, anchorless suture repair, and/or other means of repair. Suture anchors were used in 59.89% (SD,

±38.31%; 421 of 703) of cases and anchorless suture repairs were used in 30.58% (SD, ±17.47%; 215 of 703).

Other methods of repair were performed individually or in conjunction with other procedures. These repairs used suture tacks in 4.98% (SD, ±17.47%; 35 of 703), thermal capsulorrhaphy in 3.98% (SD, ±3.28%; 28 of 703), and isolated debridement in 0.71% (SD, ±0.74%; 5 of 703) of cases. Surgical repairs are summarized in Appendix B.

Data Extraction and Meta-analysis—Open Procedures

Data extraction and meta-analysis for open procedures are summarized in Appendix E[i] (available online).

Patient Demographics

The 26 studies meeting criteria for the systematic review of open procedures for unidirectional posterior instability of the shoulder contained 321 total shoulders with an average age of 24.2 years (SD, ±7.81 years; range, 10.5-70 years) and a mean follow-up of 69.8 months (SD, ±43.68 months; range, 12-396 months).

Outcome Measures Subset

Of the open shoulders with available reported outcomes, the respective rates were as follows: recurrence, 19.43% (SD, ±4.11%; 61 of 314 reported shoulders); subjective stability, 79.9% (SD, ±6.82%; 135 of 169 reported shoulders); patient satisfaction, 86.07% (SD, ±8.52%; 173 of 201 reported shoulders); return to any level of sport, 66.42% (SD, ±5.49%; 91 of 137 reported athletic shoulders); and return to previous level of play, 36.90% (SD, ±5.78%; 31 of 84 reported athletic shoulders).

DISCUSSION

This systematic review and meta-analysis identified several trends and variances throughout the literature. Strong factors, such as prior surgery, choice of repair technique, diagnostic elements, identification of pathologic subsets, and key postoperative mobilization factors, appeared to correlate with increased recurrent instability and revision rates. We also identified potential problems with current functional outcome shoulder scales, deficiencies in reporting of certain primary and secondary outcome measures, ambiguity in athletic categorization and return to sport, and lack of adequate measures to assess unique athletic populations. Furthermore, trends in primary outcomes were discovered to exist between arthroscopic versus open procedures for posterior instability of the shoulder.

Analysis of Arthroscopic Failures

Does Prior Surgery Affect Recurrence and Revision Rates?

Prior surgery, resulting in poor-quality capsular tissue and failure to recognize associated pathologic lesions, may compromise the outcome of the posterior instability procedure. Overall, the meta-analysis of arthroscopic studies identified 30 shoulders from 7 studies that had undergone prior surgery. Of this total, 10 of 20 (ie, 50%) patients from 3 studies who had undergone prior surgery of the affected shoulder reported failures. The first of these studies was a level 2 cohort study of 100 shoulders performed by Bradley et al,[12] who reported that 25% (2 of 8) of their revisions had undergone a prior thermal capsulorrhaphy procedure before the investigators performed their capsulolabral procedure. A level 4 case series of 33 consecutive patients conducted by Provencher et al[53] reported 71% (5 of 7) of failures to have also undergone a prior surgical procedure (n = 3 thermal capsulorrhaphy, n = 2 anterior stabilization). The investigators determined that patients with poor capsular tissue as a result of prior surgical intervention (particularly thermal capsulorrhaphy) had a higher chance of failure ($P = .02$). McIntyre et al[41] performed a capsular shift procedure using a multiple suture technique for 20 shoulders and indicated that 60% (3 of 5) of their recurrent instability cases had undergone prior surgery (specific procedures not reported). Ultimately, poor quality of the posterior capsule, especially as a result of prior unsuccessful thermal capsulorrhaphy,[20] makes it difficult to reestablish the capsular mechanism and achieve adequate repair with suture plication alone[48,69] and may require different methods of repair to obtain a successful outcome.

Do Method of Repair and Use of Anchors Affect Stability?

The method and choice of arthroscopic technique are critical to the success of treatment.[53] Our systematic review and meta-analysis of arthroscopic studies identified the use of suture anchors versus anchorless suture methods for capsulolabral repair and/or capsular plication in 60% versus 31% of cases, respectively. Of the 27 arthroscopic studies analyzed, only 2 reported specific outcomes on anchors or anchorless repair. The first of these studies, by Bradley et al,[14] reported anchorless repairs showing a trend toward a higher failure rate by 3-fold in all athletes and by 2-fold in the contact athlete group. Their analysis of the effect of suture anchors on patient outcomes showed a significantly higher return to play in athletes with suture anchors. The investigators noted that intraoperative placement of suture anchors may provide increased stability and function to the posterior capsulolabral complex and ultimately provided successful clinical results with rapid return to sport. The other study, performed by McIntyre et al,[41] used an arthroscopic anchorless multiple-suture technique that resulted in a high failure rate of 25%, which is consistent with recurrence rates for open procedures (5 of 20 shoulders).

Underestimation of capsular laxity, resulting in a less aggressive and inadequate capsular shift without the use of anchors in cases of an intact labrum and without significant detachment, may potentially lead to less favorable outcomes. For instance, Wolf and Eakin[72] reported that the only failure in their case series of 14 patients had pronounced posterior and inferior laxity, which required a more aggressive capsulorrhaphy revision. A report by Provencher et al[53] concluded that capsular plication rather

than labral suture anchor repair had a higher chance of failure among their 7 reported failed cases (P = .10). In 2008, Radkowski et al[55] reported that 8 of 11 failures had undergone a capsulolabral repair without suture anchor. Similarly, a 2006 investigation by Bradley et al[12] reported that 7 of the 8 failures that underwent revision surgery had undergone capsulolabral plication without the use of suture anchors and were noted to have no discrete labral tears (n = 6) or an incomplete labral tear (n = 1) at the time of the index procedure. Thus, identifying and quantifying the amount of capsular redundancy to determine the degree of capsular advancement are critical to obtain adequate postoperative stability. Furthermore, the subsequent use of modern arthroscopic suture anchor repair may provide the most reliable outcomes with rapid return to sport.[1,4,5,14]

Is Diagnosis of the Directionality of Instability Critical?

Accurate diagnosis is imperative and should be based on mechanism, clinical examination, magnetic resonance imaging findings, and intraoperative diagnostic arthroscopy. Intraoperative assessment is critical in determining the degree of capsular laxity, the presence of labral lesions, and the directionality of the instability as determined via examination under anesthesia.[12] Bradley et al[12] reported that the majority of recurrences in their cohort of 100 athletes may have been attributed to failure in diagnosis of multidirectional instability and bidirectional instability at the time of the index procedure. At the time of revision surgery, the investigators observed that 62.5% (5 of 8) of their failed cases demonstrated signs of inferior or multidirectional instability. Similarly, Wolf and Eakin[72] identified the only failure from their retrospective analysis of 14 patients to have pronounced posterior and inferior capsular laxity at revision. It is well known that posterior shoulder subluxation is often accompanied by various lesions, such as SLAP lesions, partial rotator cuff tears, and midsubstance capsular rents, which can result in instability in more than a single isolated direction.[33,48,65] Consequently, it is possible that the aforementioned patients may have had unrecognized multidirectional instability rather than true isolated unidirectional posterior instability at the time of the index procedure and were not subsequently treated appropriately.[12]

Does Concomitant Injury and Procedures Affect Overall Outcomes?

Concomitant and varied lesions are often present in athletes with posterior instability and may require additional procedures and more complex intervention, ultimately leading to unpredictable outcomes.[57] In a retrospective case series of 14 patients, Bahk et al[5] identified patients with additional pathologic lesions that required concurrent procedures, such as supplemental anterior plication, to have less reliable outcomes at follow-up. Specifically, these patients had higher pain scores (P = .001), lower ASES scores (P < .001), lower University of California, Los Angeles Shoulder Rating Scale (UCLA) scores (P < .001), higher subjective instability scores (P < .001), higher Western Ontario Shoulder Instability (WOSI) scores (P = .0002), or lower score for WOSI percentage of normal (P = .0002). In addition to the posterior labrum and capsule, all static and dynamic structures, such as the rotator interval, the anterior-superior labrum and its attached superior glenohumeral ligament, the coracohumeral ligament, the inferior glenohumeral ligament complex, and infraspinatus, should be carefully assessed and identified as potential contributors to less predictable outcomes.

Does Excessive Capsular Laxity Represent a Unique Subset of Pathologic Disorders?

Patients with excessive capsular laxity may also represent a specific subset of patients with the potential for worse outcomes if not identified and treated appropriately. Of the 2 clinical failures reported by Williams et al[70] in their level 4 retrospective case series, 1 patient was noted to have a posterior instability grade of 3+ during examination under anesthesia for the posterior instability index procedure. Additionally, Wolf and Eakin[72] reported that the only failed case of recurrent instability from their retrospective case series of 14 patients had pronounced posterior and inferior capsular laxity identified at the revision procedure. Due to the unique pathologic changes of capsular hyperlaxity, these patients should be recognized as a distinct population requiring a well-defined surgical intervention to attain appropriate capsular advancement.

What Is the Effect of Early Return to Unrestricted Activity?

Early mobilization with unrestricted rehabilitation has the potential for less favorable outcomes. In a case series of 14 shoulders, Bisson[10] identified early mobilization as a contributing factor in 2 of the 3 failed cases (1 bilateral patient) that experienced recurrent instability 2 months after surgery. The patient's shoulders were treated with thermal capsulorrhaphy and were not immobilized postoperatively. Bradley et al[14] further emphasized the potentially negative effects of early unrestricted activity, as evidenced by all 13 failures from their level 2 cohort study of 200 shoulders occurring within 7 months of surgery. Hence, aggressive, early mobilization and its potentially deleterious effects should be carefully evaluated and considered as a potential contributor of failure.

Return to Sport

What Ambiguity Exists Throughout the Literature in Reporting Return to Sport?

Numerous variables were used to determine athletic performance, and oftentimes specific criteria for return to sport and return to previous level of play were not described in the literature. A patient was often considered an athlete based simply on the authors' definition of an athlete or whether the patient participated in any type of sporting activity (ie, elite or professional, collegiate, high school, recreational, or other). Furthermore, descriptions were frequently vague, such as athletes returning to "unlimited activity,"

TABLE 3
Arthroscopic Versus Open Procedures for Posterior Shoulder Instability[a]

	Arthroscopic			Open		
Outcome Measure	No. of Reported Studies	No. of Shoulders/ Total Reported	%	No. of Reported Studies	No. of Shoulders/ Total Reported	%
Recurrent instability	26	66/815	8	24	61/314	19
Subjective stability	18	637/699	91	17	135/169	80
Patient satisfaction	13	442/471	94	14	173/201	86
Return to sport (any level)	19	561/611	92	12	91/137	66
Return to sport (previous level)	15	368/546	67	6	31/84	37

[a]Mean age and mean follow-up for the 27 arthroscopic studies evaluated were 24.5 years (range, 15-70 years) and 28.7 months (range, 4-149 months), respectively. Mean age and mean follow-up for the 26 open studies evaluated were 24.2 years (range, 10.5-70 years) and 69.8 months (range, 12-396 months), respectively.

returning to "full activity," or returning with "little or no limitation," and consequently the level of return to play and respective data could not accurately be determined for these athletes.[38,48,70,72] Additional ambiguity exists in failure to return to sport due to circumstances unrelated to the shoulder injury or resulting from an unrelated injury: Athletes may have been injured during their final year of competition (ie, high school or college senior) and did not return due to graduation, or they may have recovered fully but decided to change sports.[14] These situations may have been reported by investigators as a failure to return to sport or previous level of play, ultimately altering true outcome data.

Unique Athletic Populations

Are There Unique Subsets of Athletes Requiring Distinct Outcome Methods?

Similarities are observed in overall athletes compared with contact or overhead/throwing athletes with respect to postoperative stability, ROM, strength, pain, and function according to the 21 different functional outcome measures used throughout the 29 arthroscopic studies that were systematically investigated. However, when the subset of overhead/throwing athletes are individually examined, the success rate is substantially lower.[55,69] The meta-analysis of arthroscopic studies identified a lower percentage of overhead/throwing athletes returning to sport at any level and previous level of play compared with contact athletes or the overall athletic population. Specifically, return to sport at any level after an arthroscopic stabilization procedure for the overall athletic population was 92% compared with 89% for contact athletes and 84% for overhead/throwing athletes; return to previous level of play for the overall athletic population was 67% compared with 71% for contact athletes and 58% for overhead/throwing athletes. This finding is supported by previous reports from a prospective level 2 investigation performed by Radkowski et al[55] in which they observed similar ASES postoperative scores for throwing versus nonthrowing athletes but distinctly different outcomes regarding return to sport and level of play. For nonthrowing versus throwing athletes, the investigators observed respective rates for return to sport at any level of 91% and 85% and respective rates for return to previous level of play of 71% and 55%.[55] This observation is of critical importance given that current functional outcome measures prevalent throughout the literature have the potential to inadequately assess the overhead/throwing athlete's true postoperative functioning. Thus, it should be recognized that subsets of athletes (eg, overhead/throwing athletes) may need to be evaluated by a more precise and distinct functional outcome method.

Arthroscopic Versus Open Procedures

Which Is Superior, Arthroscopic or Open Technique?

For simplicity and conciseness, we chose to analyze only a specific subset of highly reported primary outcomes for open procedures to treat posterior instability of the shoulder as a means of comparison with arthroscopic procedures. Taking into account confounding variables, currently available literature data show a trend for arthroscopic techniques to have superior outcomes compared with open techniques for unidirectional posterior instability of the shoulder in regard to recurrence rate (8% vs 19%), subjective stability (91% vs 80%), patient satisfaction (94% vs 86%), return to sport at any level (92% vs 66%), and return to previous level of play (67% vs 37%) (Table 3). These findings are in contrast to the only report we identified in the literature that compared arthroscopic and open procedures for posterior shoulder instability. This study, conducted by Kakar et al[36] in 2007, reviewed 7 arthroscopic studies (186 patients) and 9 open studies (173 patients) and determined no difference in clinical outcomes for patients treated with either open or arthroscopic surgery for posterior shoulder instability. However, the investigators compared limited outcome measures that included only pain and recurrent instability. A patient was considered satisfactory if he or she had no pain or experienced pain with sports or strenuous work activity and had no recurrent subluxations; an unsatisfactory result was recorded if a patient had pain and/or recurrent instability.

With the advent of minimally invasive techniques, arthroscopy has several advantages over open techniques

and may allow for improved restoration of function.[14] For athletes with recurrent posterior instability, arthroscopy provides (1) a less invasive approach resulting in less disruption of shoulder anatomy; (2) improved visualization of intra-articular capsulolabral lesions; (3) complete visualization of the intra-articular and subacromial spaces; (4) more precise, anatomic-specific repairs[57]; (5) and the ability to treat multiple articular lesions and efficiently perform concomitant procedures, such as repair of SLAP lesions, repair of posterior humeral avulsion of the glenohumeral ligament, or restoration of the inferior glenohumeral ligament complex.[13,14]

Functional Outcome Scales

Are Adequate Functional Outcome Shoulder Scales Used Throughout the Literature?

This systematic review identified 21 different functional outcome measures used throughout the literature to assess posterior instability of shoulder (Table 2). Overall, despite the lack of standardized methodology, the majority (86%) of shoulders evaluated in the meta-analysis received a mean value equal to or greater than 90%, and all shoulders were at least 80% of the ideal maximum rating of any outcome measure used throughout all 27 arthroscopic studies included in the meta-analysis (Table 2). The most prevalent functional outcome measure used by investigators is the ASES, which assesses function, ADLs, and pain. The ASES was used by 9 of the 27 included studies and was used to evaluate 524 shoulders, resulting in a mean value that was 90% of the maximum ideal score.

One of the primary challenges in evaluating and comparing the outcomes of posterior instability is the numerous and diverse functional outcomes prevalent throughout the literature. Savoie et al[57] recognized the potential weakness of functional outcomes used in their cohort of 92 shoulders. These investigators identified a significant weakness in their study of not using more current rating scales to collect data and compare symptoms. Wolf and Eakin[72] also reported dissatisfaction with rating scales, such as the UCLA and Rowe scoring systems, due to limitations in assessing the active patient. Consequently, the investigators chose to develop and use their own unvalidated subjective scoring system in an attempt to provide a more sensitive outcome measurement of the various athletic activity levels of their patients (casual sport vs recreational vs competitive). This immense variation in functional outcome scales and the lack of uniformity from study to study make it problematic and difficult to accurately compare studies via meta-analysis.

What Outcome Measures Are Reported Less Frequently in the Literature?

Several outcome measures were reported less frequently throughout the literature. Objective stability (7 studies), stiffness (3 studies), range of motion (12 studies), and muscle strength (6 studies) were among the most deficient of the assessed outcome measures. Subjective patient stability (18 studies) rather than objective stability testing appeared to be primary means of determining postoperative stability of the shoulder. Subjective scoring systems used throughout the literature were often nondescriptive, entailing vague reports of patient subjectivity, and the objective scoring measures used were frequently inconsistent from study to study and used a variety of techniques, such as the posterior load-shift maneuver, the posterior drawer, and jerk test. These deficiencies prevalent among the literature lead to difficulties in comparing results between studies.

Limitations

This systematic review and meta-analysis provided an extensive, highly comprehensive, and detailed analysis of all available outcome literature on unidirectional posterior instability of the shoulder; however, there are limitations inherent to this study. Despite our attempts to provide uniform cohorts, lack of standardized outcome measures used throughout the literature created many challenges in comparing studies via meta-analysis. We attempted to extract as much data as possible specific to unidirectional instability of the shoulder, which often resulted in not obtaining the full spectrum of data for the primary and secondary outcome measures in numerous studies. Also, despite our attempts to provide uniform cohorts, it was frequently not possible to extract specific outcome criteria for the subsets of contact athletes and overhead/throwing athletes.

A major limitation of the literature for posterior shoulder instability is the lack of prospective studies. To date, only 3 prospective studies (level 2) have been reported on posterior instability of the shoulder.[12,14,55] Additionally, many of the studies addressing management of posterior shoulder instability involved retrospective analysis of relatively small patient populations.

Future studies reporting surgical outcomes on posterior shoulder instability should be mindful of the shoulder scoring systems used to ensure more precise functional assessment of specific subgroups, such as overhead/throwing athletes. Furthermore, there is a need for sufficiently powered, well-conducted, and high evidence level prospective investigations to decrease bias in patient cohorts, subsequently allowing for more accurate comparisons of clinical studies.

CONCLUSION

Clinical recommendations and insight can be provided by this systematic review and meta-analysis. Efforts should be made to use well-defined, standardized, and uniform shoulder outcome measures to assess patients with posterior shoulder instability in order to allow more accurate future comparisons and meta-analysis. Moreover, specific subsets of athletes require unique and distinct outcome measures to assess their true postoperative functioning. Despite similar results of outcome measures for the overall athletic population, throwing athletes are less likely to return to their preinjury levels of sport compared with contact athletes or the overall athletic population.

The current literature shows that arthroscopic procedures are an effective and reliable treatment for unidirectional posterior glenohumeral instability with respect to outcome scores, patient satisfaction, and return to play. Taking into account confounding variables, the available evidence for unidirectional posterior instability of the shoulder also indicates that arthroscopic stabilization procedures using anchors result in fewer recurrences and revisions than anchorless repairs in young adults engaging in highly demanding physical activity. Furthermore, the literature suggests that patients treated arthroscopically have superior and more reliable outcomes than those treated with open procedures with respect to stability, recurrence of instability, patient satisfaction, return to sport, and return to previous level of play.

ACKNOWLEDGMENT

The authors acknowledge Emily A. Brennan, MLIS (master of library and information science), assistant professor, informationist/research librarian, for her expertise and significant contribution in the development of precise and comprehensive literature search criteria.

NOTE

i. References cited in Appendices B-E are included in the article reference list.

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