



Invited review

Posterior shoulder instability: a systematic review

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Abstract

Introduction: This review aims to provide information on outcomes of surgical procedures for soft tissue or bony glenoid and/or humeral abnormalities in case of posterior shoulder instability.

Source of data: A systematic review of the literature according to the PRISMA guidelines was performed. A comprehensive search of PubMed, Medline, CINAHL, Cochrane, Embase, Ovid and Google Scholar databases using various combinations of the keywords 'shoulder', 'posterior instability', 'dislocation', 'reversed bony bankart', 'reversed Hill Sachs', and 'capsulolabral' was performed.

Areas of agreement: A total of 847 shoulders in 810 patients were included. A redislocation event occurred in 33 (8.7%) of 411 shoulders with soft tissue abnormalities and in 12 (9.1%) of 132 shoulders with bony abnormalities of the glenoid, humeral head or both.

Areas of controversy: The optimal treatment modalities for posterior shoulder dislocation remain to be defined.

Growing points: Operative stabilization for posterior shoulder instability should be lesion-specific and should correct all components of the posterior instability.

Areas timely for developing research: Future prospective studies should aim to establish the optimal treatment modalities for posterior shoulder instability.

Key words: shoulder, posterior, instability, soft-tissue and bony abnormalities, arthroscopy

Introduction

Posterior shoulder instability is considered rare as it comprises only a small subset of shoulder instabilities.¹⁻³ Young active men aged between 14 and 19 years are most commonly affected with an incidence of 32.8 per 100 000 person-years.⁴ The overall sex- and age-adjusted incidence is 4.6 per 100 000 person-years.⁴ A particular high incidence has also been reported among military personnel and overhead or contact-sports athletes.⁵⁻⁹ In approximately half of the affected patients, only a low-energy injury is reported and a documented previous episode of posterior shoulder dislocation that required relocation is relatively uncommon.^{7,10-17} Biomechanical investigations have reported that both soft tissue and bony lesions play an important role in posterior shoulder instability, and MR arthrography and CT scans been proven particularly helpful to correctly assess them.¹⁸ Different classification systems have been proposed, making it difficult to compare the different studies. It is necessary to consider the type of lesion (microtrauma or macrotrauma), the direction of instability (unidirectional, bi-directional, multidirectional), the presence of structural changes (bones and soft-tissues), and whether the posterior subluxation or dislocation is voluntary or involuntary.⁷ A first-line conservative management consisting of pain management, activity modification and strengthening of the scapulothoracic and rotator cuff muscles should always be provided. An improvement of symptoms has been reported in 70% to almost 90% of patients after a 6-month therapy of appropriately performed physical therapy.^{6,19,20} If pain or instability persist, a surgical intervention

addressing the soft tissue or bony lesions may be needed.²¹ The purpose of this systematic review is to analyze outcomes of surgical procedures for either soft tissue or bony glenoid and/or humeral lesions, performed singularly or in combination, in patients with posterior glenohumeral instability. A second aim is to analyze the frequency of diagnosis of soft tissue and bony abnormalities in the published scientific literature.

Materials and methods

A systematic review of the literature was performed according to the PRISMA guidelines with a PRISMA checklist and algorithm,^{22,23} shown in [Figure 1](#). A comprehensive search of PubMed, Medline, CINAHL, Cochrane, Embase, Ovid and Google Scholar databases using various combinations of the keywords 'shoulder', 'posterior instability', 'dislocation', 'bone loss', 'reversed bony bankart', 'osseous glenoid defects', 'glenoid bone grafting', 'glenoid', 'humeral head', 'surgery', 'glenohumeral', 'reversed Hill Sachs' and 'capsulolabral' was performed to include articles that were published between 1966 and 2019.

Three independent reviewers (U.G.L., J.L. and C.C.) separately conducted the search. All journals were considered, and all relevant studies were analyzed. To qualify for the study, an article had to be published in a peer-reviewed journal. All articles were initially screened for relevance by title and abstract, excluding articles without an abstract, and obtaining the full-text article if the abstract did not allow the investigators to assess the defined

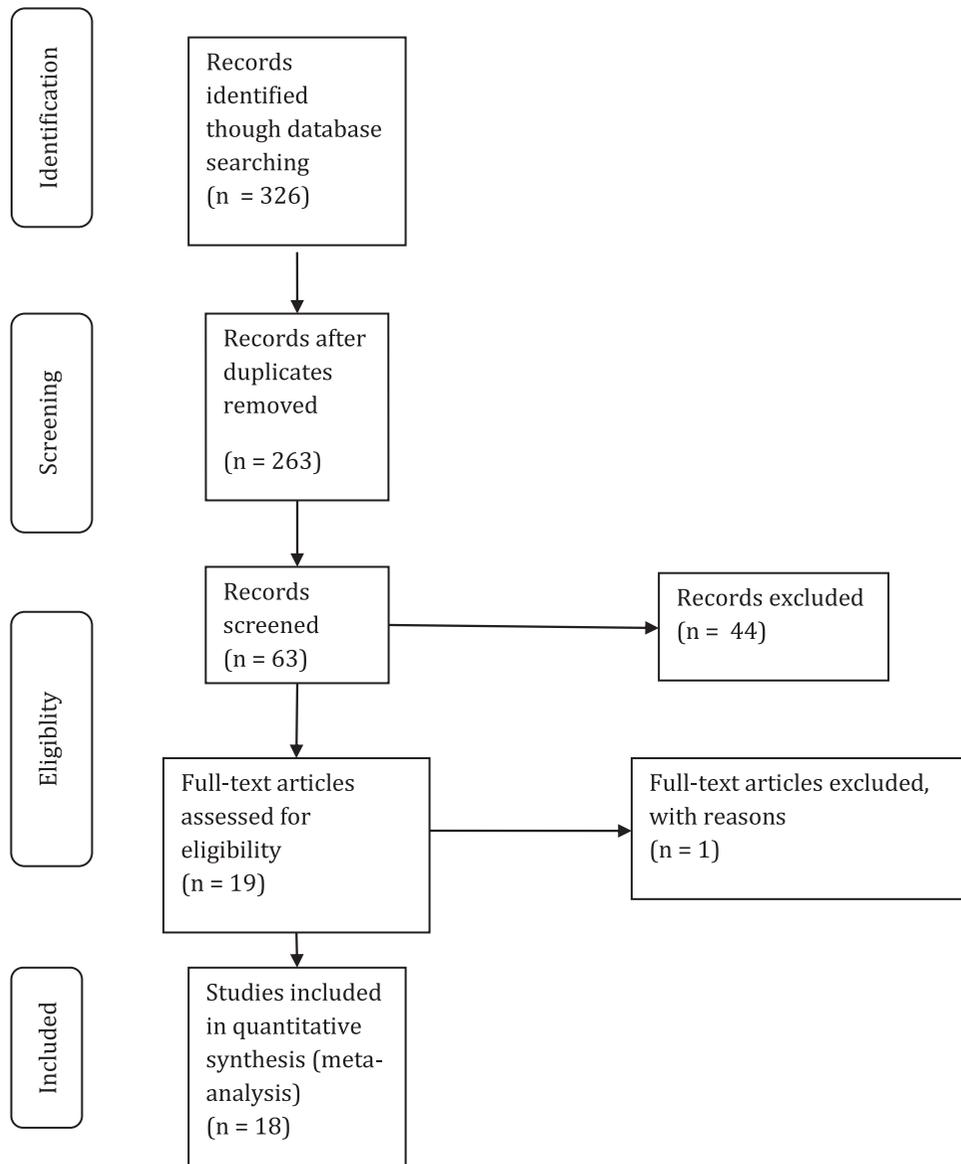


Fig. 1 PRISMA algorithm: PRISMA 2009 flow diagram.

inclusion and exclusion criteria. The three investigators (U.G.L., J.L. and C.C.) separately reviewed the abstract of each publication and then performed a close reading of all papers and extracted data, to minimize selection bias and errors. A cross-reference research of the selected articles was also performed

to obtain other relevant articles for the study. All articles reporting outcomes of surgical procedures for glenoid and/or humeral bony defects, performed singularly or in combination, in patients with posterior glenohumeral instability were taken into account. The last search was performed on July 20, 2019.

According to the Oxford centre of EBM, level I–IV articles were found in the literature and included in our study. Given the linguistic capabilities of the authors, articles in English, French, Spanish, German and Italian were considered for inclusion.

Articles published from inception of databases to July 20, 2019 that reported outcomes of surgical procedures for either soft tissue or bony glenoid and/or humeral abnormalities in patients with posterior glenohumeral instability were included. Articles were included if they presented a sufficient description of soft tissue and bony abnormalities with arthroscopy or imaging techniques, had an appropriate description of the surgical procedure and follow-up period, presented at least one of the following clinical outcome scores (ASES,²⁴ Rowe,²⁵ WOSI,²⁶ Constant²⁷), and included a description of the complication rate. The outcome parameters reviewed were recurrence of redislocation and clinical scores.

Missing data pertinent to these parameters warranted exclusion of the article from this systematic review. Literature reviews, case reports, studies on animals, cadavers or *in vitro*, biomechanical reports, tumour studies, technical notes, letters to editors and instructional courses were excluded. We also excluded articles if they did not report the diagnosis, clinical examination, imaging, arthroscopic or surgical assessment of the soft tissue or bony abnormalities, surgical intervention, clinical postoperative outcomes, follow-up, or statistical analysis.

Finally, to avoid bias, the selected articles, the relative list of references, and the articles excluded from the study were reviewed, assessed, and discussed by all the authors and, if there was disagreement among the investigators regarding the inclusion and exclusion criteria, the senior investigators (V.D. and N.M.) made the final decision.

The following data were independently extracted by all the investigators: demographics, previous surgery, imaging assessment, soft tissue and bony abnormalities assessment/measurement, diagnosis, surgical management, outcome measurements, return to sport, recurrence of the instability and complications.

To assess the quality of the studies, the Coleman Methodology Score (CMS) was applied, which assesses methodology using 10 criteria, giving a total score between 0 and 100. A score of 100 indicates that the study largely avoids chance, various biases and confounding factors. The final score can be defined as excellent (85 to 100 points), good (70 to 84 points), fair (50 to 69 points) and poor (<50 points). The subsections that make up the Coleman Methodology Score are based on the subsections of the CONSORT statement (for randomized controlled trials) and are modified to allow for other trial designs.

The Coleman criteria were modified to make them reproducible and relevant for the systematic review of soft tissue, glenoid and humeral bone abnormalities in patients with posterior glenohumeral instability. Each study was scored by two reviewers (U.G.L. and J.L.) independently and in duplicate for each of the criteria adopted (listed in Table 1) to give a total Coleman methodology score between 0 and 100. Disagreements were resolved by discussion.

Results

The literature search and cross-referencing resulted in a total of 332 references, of which 263 were rejected due to failure of the inclusion criteria (Fig. 1).

After reading the remaining full-text articles, another 45 articles were excluded because of insufficient details and uncertain diagnosis and outcome measures.

Finally, 24 articles were included, describing patients with soft tissue abnormalities,^{6,8,28–47} glenoid bony defect,^{29,30,38,43,44,46,48} humeral bony defect^{31,34,39,49} or both^{28,32,33,35,40–42} in the setting of posterior glenohumeral instability.

Demographics

A total of 847 shoulders in 810 patients were included, with a median age at surgery of 25.9 years, ranging from 14^{32,48} to 66³¹ years. The dominant

Table 1 Modified Coleman Methodology Score

Part A: Only one score to be given for each of the seven sections		
Study size—number of patients	<30	0
	30–50	4
	51–100	7
	>100	10
Mean follow-up	<12 months	0
	12–36 months	4
	37–60 months	7
	>61 months	10
Surgical approach	Different approach used and outcome not reported separately	0
	Different approaches used and outcome reported separately	7
	Single approach used	10
Type of study	Retrospective cohort study	0
	Prospective cohort study	10
	Randomized control trial	15
Description of diagnosis	Described without % specified	0
	Described with % specified	5
Descriptions of surgical technique	Inadequate (not stated, unclear)	0
	Fair (technique only stated)	5
	Adequate (technique stated, details of surgical procedure given)	10
Description of postoperative rehabilitation	Described	5
	Not described	0
Part B: Scores may be given for each option in each of the three sections if applicable		
Outcome criteria	Outcome measures clearly defined	2
	Timing of outcome assessment clearly stated	2
	Use of outcome criteria that has reported reliability	3
	General health measure included	3
Procedure of assessing outcomes	Subjects recruited	5
	Investigator independent of surgeon	4
	Written assessment	3
	Completion of assessment by patients themselves with minimal investigator assistance	3
Description of subject selection process	Selection criteria reported and unbiased	5
	Recruitment rate reported	5
	>90%	0
	<90%	0

side was involved in 299 (60.5%) of 494 shoulders, while the non-dominant side was involved in 195 (39.5%) shoulders. In the remaining 353 shoulders, these data were not reported^{29,32,34–36,38,39,46} (Table 2). Patients were assessed at a median follow-up period of 3.4 years (ranging from 10.8 months³³ to 21.5 years³²).

Previous surgery

Ten^{29,30,33,34,36–39,41,43} of the 24 studies, describing a population of 192 patients, reported that 68 patients had undergone previous shoulder surgery for the management of posterior glenohumeral instability, including posterior Bankart repair and posterior bone block. Previous arthroscopic procedures

Table 2 Details of the included studies

Authors	Study design (level of evidence)	No of patients (shoulders)	Mean age (range) (years)	Side (dominant/not dominant)	Bony abnormalities	Soft tissue abnormalities	Previous surgery	Coleman Methodology Score
Servien et al. ²⁸	Retrospective review (III)	21	24 (17–40)	12/9	Glenoid fracture (10); loss of normal contour of the posterior osseous glenoid (2); reverse Hill-Sachs lesion (10); both glenoid fracture and reverse Hill-Sachs lesion (5)	-	None	53
Millett et al. ²⁹	Case series (IV)	2	15.5 (15–16)	-	Large posterior glenoid bone defect (2)	-	Posterior capsulolabral repair (1)	57
Schwartz et al. ³⁰	Case series (IV)	18 (19)	29.85 (15–56)	8/11	Glenoid dysplasia (3); glenoid arthrosis with posterior bone loss (1)	-	Posterior Bankart repair (4); anterior arthroscopic stabilization (1)	62
Seung Ho-Kim ³²	Case series (IV)	27	21 (14–33)	-	Reverse Hill-Sachs lesion (3); glenoid superficial osseous defect (2)	Posterior inferior labrum lesion (27); type I: incomplete stripping (18); type II: marginal crack (4); type III: chondrolabral erosion (3); stretching of the posterior band of the inferior glenohumeral ligament (22); partial thickness rotator cuff tear (4) in the articular surface of the supraspinatus tendon	None	57
Goubier et al. ³³	Case series (IV)	11 (13)	33 (18–47)	9/4	Posterior margin fracture of the glenoid (1); anterior lesion of the humeral head (20% of the humeral cartilage surface) (1); posterior erosion of the glenoid (12)	Posterior Bankart lesion (13); humeral head chondral anterior lesion (2); glenoid cartilage lesions in the posterior third of the chondral surface (2).	Surgery for anterior instability on the affected shoulder (1)	57

(Continued)

Table 2 Continued

Authors	Study design (level of evidence)	No of patients (shoulders)	Mean age (range) (years)	Side (dominant/not dominant)	Bony abnormalities	Soft tissue abnormalities	Previous surgery	Coleman Methodology Score
McIntyre <i>et al.</i> ³⁴	Case series (IV)	19 (20)	22 (15–36)	-	Reverse Hill Sachs's lesions (10, of which 8 associated with posterior Bankart lesion)	Posterior Bankart lesions (12); posterior labral fraying (3); posterior capsular laxity (3)	Arthroscopy (4) open staple capsulorrhaphy (1); arthroscopic stapling (1)	62
Williams III <i>et al.</i> ³⁵	Retrospective review (III)	26 (27)	28.7 (15–55)	-	Reverse Hill-Sachs lesion (2); bony posterior Bankart (1); bony posterior Bankart and reverse Hill Sachs lesion (2)	Reverse Bankart lesion (27)	-	48
Antoniou <i>et al.</i> ³⁶	Case series (IV)	41	28	-	-	Labral detachment (5); chondral or labral erosion (7); capsular and synovial stripping (9); labral split or tear (13)	Repair of a Bankart lesion (3) capsular shift (5); posterior bone-block (1); others (11)	48
Bradley <i>et al.</i> ⁸	Cohort study (II)	183 (200)	24 (15–65)	124/76	-	Patulous posterior capsule (42); incomplete posterior labral tear (30); full-thickness detachment of the posterior labrum (128)	-	70
Wolf <i>et al.</i> ³⁷	Case series (IV)	14	26 (14–54)	8/6	-	Reverse Bankart lesion (8); flap or bucket tear of the posterior labrum without posterior labral avulsion (4)	Arthroscopic capsular plication (14)	42
Bradley <i>et al.</i> ⁶	Cohort study (II)	61 (100)	23.3 (15–61)	64/36	-	Patulous capsule (43); incomplete labral tear (27); posterior labrum complete detachment (30)	-	70

(Continued)

Table 2 Continued

Authors	Study design (level of evidence)	No of patients (shoulders)	Mean age (range) (years)	Side (dominant/not dominant)	Bony abnormalities	Soft tissue abnormalities	Previous surgery	Coleman Methodology Score
Bortoni et al. ³⁸	Case series (IV)	30 (31)	23 (15–39)	-	Glenoid posterior rim fractures or rim calcification (30); bony posterior Bankart lesion (1)	Reverse Bankart lesions (30)	Anterior stabilization operation (1); shoulder arthroscopy (2); anterior stabilization procedures (Magnuson-Stack and Bankart repairs) (2); arthroscopic anterior stabilization or superior labral anterior posterior lesion repair (2)	66
Matthew et al. ³⁹	Case series; (IV)	33	25 (19–34)	-	Small anterior humeral head compression defect (1)	Posterior labral tear (17); and rotator interval lesion (1); posterior labral tear and SLAP (1); posterior labral tear and articular sided, partial-thickness rotator cuff tear of the infraspinatus tendon (1); excessive posterior capsular patulence (14)	Thermal posterior capsular shrinkages (4); anterior open capsular shifts (2); superior labral type II repair (1); superior labral type I debridement (1); arthroscopic stabilization (1)	54
El Shewy et al. ³¹	Case series (IV)	17	48.5 (32.5–66)	14/3	Humeral head 25% impression fracture (17)	-	-	70
Struck et al. ⁴¹	Case series (IV)	13 (15)	20 (17–32)	7/6	Bony posterior glenoid defects (2); revers Hill-Sachs < II grade (15)	Kim's lesion (15)	Arthroscopic posterior capsulolabral repair (2)	60
Shams et al. ⁴⁹	Cohort study (II)	11	39 (31–49)	8/3	Humeral head defect, with a mean of 35% (30–40%)	-	-	67
Wooten et al. ⁴⁸	Case series (IV)	22 (25)	17.3 ± 1.2 (14–17.9)	17/8	Posterior glenoid dysplasia (3)	-	-	56
Lenart et al. ⁴⁰	Case series (IV)	32	21.4 (15–33)	19/13	Reverse Bony Bankart (5); reverse Hill-Sachs lesion (3)	Posterior–inferior labral detachment (18); SLAP (6); HAGL (2)	None	54

(Continued)

Table 2 Continued

Authors	Study design (level of evidence)	No of patients (shoulders)	Mean age (range) (years)	Side (dominant/not dominant)	Bony abnormalities	Soft tissue abnormalities	Previous surgery	Coleman Methodology Score
Bakk <i>et al.</i> ⁴⁴	Therapeutic case series (IV)	29	26.3 (18.3–42.4)	9/20	Reverse Hill-Sachs lesion (5); posterior bony Bankart lesion (9)	Posterior Bankart lesion (29)	None	66
Arner <i>et al.</i> ⁴⁶	Case series (IV)	56	17.9 (14.8–25.5)	-	-	Posterior Bankart lesion (56)	-	65
Khira <i>et al.</i> ⁴⁷	Case series (IV)	12	2.6 (22–36)	9/3	Reverse Hill-Sachs lesion	-	-	70
Garret <i>et al.</i> ⁴⁵	Case series (IV)	25	30 (16–45)	17/8	Reverse Hill-Sachs lesion	-	-	40
Badge <i>et al.</i> ⁴³	Case series (IV)	11	24.8 (15–36)	6/5	Posterior bony Bankart lesion (1)	Posterior Bankart lesion (10); SLAP lesion (5)	1 for SLAP lesion; 1 for anterior stabilization	60
Clavert <i>et al.</i> ⁴²	Case series (IV)	66	27.8 (15–58)	51/15	Reverse Hill-Sachs lesion (20), fracture of glenoid (10)	Posterior Bankart lesion (39), Kim lesion (7)	-	65

were performed in 29 (42.6%) of them^{29,30,34,38,41,43} (Table 2).

Imaging assessment

Twenty^{6,8,28–33,35,38–43,45–49} studies, describing 707 of 810 (87.3%) patients, provided a detailed description of imaging exams performed for preoperative assessment. Most common imaging assessments were radiographic, magnetic resonance (MR) and computer-tomography (CT). On the other hand, the remaining four^{34,36,37,44} studies, describing 103 of 810 (12.7%) patients, used radiological exams but no further specifications were given (Table 3).

Soft-tissue and bony abnormalities assessment

In the included studies, both radiological and intra-operative methods to assess bony defects were used (Table 3).

Diagnosis

A total of 650 soft tissue lesions in the included 847 shoulder were reported.^{6,8,28–49} The most common injury was a posterior labrum lesion, reported in 512 shoulders (50%). A bony lesion was reported in 210 (25%) shoulders, including 80 (9.4%) humeral head impression fractures and 17 (2%) glenoid fractures.

Five of 24 included studies,^{6,8,36,37,46} describing 411 shoulders, reported only soft-tissue abnormalities (Table 2). The most common soft-tissue abnormalities reported were a posterior labrum lesion, observed in 308 (75.0%) shoulders,^{6,8,36,37} a patulous posterior capsule in 94 (22.9%) shoulders.^{6,8,36}

Another eight studies,^{28–31,45,47–49} describing 132 shoulders, reported only the number of bony defects (Table 2). The most common bony abnormalities were a humeral head impression fracture in 75 shoulders (56.8%),^{28,31,45,47,49} a glenoid fracture in 12 shoulders (9.1%),^{28,29} glenoid dysplasia in 6 (4.5%) shoulders,^{30,48} and both glenoid fracture and reverse Hill-Sachs lesion in 5 (3.8%) shoulders.²⁸

Table 3 Soft tissue and/or bony abnormalities surgical management

Authors	Imaging assessment	Surgical procedure	Complications	Revision surgery
Servien et al. ²⁸	X-Rays (21); CT (16); MRI (1)	Iliac crest posterior glenoid bone block	Sensory neurological complication associated with injury to the lateral femoral cutaneous nerve during harvest of iliac crest bone graft (1)	-
Millett et al. ²⁹	CT (2)	Distal tibia osteoarticular allograft	-	-
Schwartz et al. ³⁰	X-Rays; CT (19); MRI (19)	Arthroscopic posterior bone block augmentation using bone graft harvested from the ipsilateral iliac crest	K-wire broke during advancement through the glenoid (1)	Screw removal because of pain and discomfort in the region of the infraspinatus tendon (5) because of malpositioning (2); trimming of the graft borders because of a proud glenoid rim (4); partial osteolysis of the iliac crest bone graft (1); loose fragment removal (1); additional posterior capsulorrhaphy because of large capsulolabral lesion (2); revision iliac crest bone graft (1)
Seung Ho-Kim ³²	X-Rays (27); MRI (27)	Arthroscopic posterior labral repair and capsular shift	-	-
Goubier et al. ³³	X-Rays (13); CT (13)	Arthroscopic labral suture with anchors and capsular plication with 4 portals	-	-
McIntyre et al. ³⁴	-	Arthroscopic posterior capsular shift	-	-
Williams III et al. ³⁵	X-Rays (27)	Arthroscopic repair of posterior Bankart lesion	-	-
Antoniou et al. ³⁶	-	Arthroscopic posteroinferior capsulolabral augmentation	-	Arthroscopic posterior Bankart repair fail (2)
Bradley et al. ⁸	X-Rays (200); MRI (200)	Arthroscopic capsulolabral plication without suture-anchors (44); arthroscopic capsulolabral plication with suture-anchors (119); arthroscopic capsulolabral plication with suture-anchors and additional plication sutures (37)	-	Capsulolabral plication without suture-anchors (6); capsulolabral plication with suture-anchors (7)
Wolf et al. ³⁷	-	Arthroscopic posterior capsular plication with suture-anchors(8); arthroscopic posterior capsular plication without suture-anchors (6)	-	Second arthroscopic stabilization because of new injury (1)
Bradley et al. ⁶	X-Rays (100); MRI (100)	Arthroscopic capsulolabral plication without suture anchors (44); arthroscopic capsulolabral plication with suture anchors (39); arthroscopic capsulolabral plication with suture anchors and additional plication sutures (17)	Superficial infection of an arthroscopic portal (1); subacromial impingement (2); full-thickness traumatic rotator cuff tear (1)	-
Bottoni et al. ³⁸	X-Rays (31); MRI (31)	Open repair (12); Arthroscopic stabilization with suture anchors, permanent sutures and capsular plication (12); arthroscopic bioabsorbable tacks (5); arthroscopic bioabsorbable tacks with thermal capsulorrhaphy augmentation (2)	-	Arthroscopic group: revision open posterior Bankart repair with tack fixation of the labrum with electrothermal capsulorrhaphy augmentation (1)
Matthew et al. ³⁹	X-Rays (33); MRI (33)	Arthroscopic posteroinferior capsulolabral repair: plication alone (16); anchor repair (17)	-	Biceps tenodesis for unstable biceps tendon secondary to thermal necrosis of the rotator interval (1)
El Shevy et al. ³¹	X-Rays (17)	Posterior capsular repair	Superficial wound infection that completely resolved with appropriate antibiotics (1)	-

(Continued)

Table 3 Continued

Authors	Imaging assessment	Surgical procedure	Complications	Revision surgery
Struck <i>et al.</i> ⁴¹	X-Rays; CT (11)	Open repair: tricortical bone graft was harvested from the scapular spine (11) or the anterior iliac crest (4)	Osteoarthritis (1) (at CT)	Removed screw arthroscopically (4) for crepitation and mild pain
Shams <i>et al.</i> ⁴⁹	X-Rays (11); CT (11)	Open repair with the transfer of subscapularis tendon and the attached lesser tuberosity to reconstruct the reverse Hill-Sachs defect; transferred tuberosity was fixed with size 5 Ethibond sutures	-	-
Wooten <i>et al.</i> ⁴⁸	MRI (19); CT (6)	Arthroscopic posterior labral repair with Bio-Suture tack suture anchors (25) and capsular shift repair with OrthoCord (19)	None	-
Lenart <i>et al.</i> ⁴⁰	X-Rays (32); MRI (32);	Arthroscopic posterior stabilization: plication alone (4); anchor repair (28)	-	-
Balk <i>et al.</i> ⁴⁴	-	Arthroscopic labral suture with anchors (29)	-	-
Amer <i>et al.</i> ⁴⁶	X-Ray	Arthroscopic labral suture without anchors (12), Arthroscopic labral suture with anchors (31), additional plication suture (13)	None	None
Khira <i>et al.</i> ⁴⁷	X-Ray; TC (12)	Modified McLaughlin technique with iliac crest bone graft	Axillary nerve injury (2)	-
Garret <i>et al.</i> ⁴⁵	X-Ray (25), MRI (25), TC (25)	Arthroscopic capsulo-labral reconstruction (22), iliac bone block (2), acromial bone block (1)	(1) osteoarthritis; (1) anchor migration); (1) acromial block nonunion; (2) shoulder stiffness; (1) osteolysis of an iliac bone block.	-
Badge <i>et al.</i> ⁴³	MR (11)	Arthroscopic capsulo-labral reconstruction with anchors	None	None
Clavert <i>et al.</i> ⁴²	X-Ray; TC (66)	Iliac bone block (57), acromial bone block (9)	Partial lysis of bone blocks (33)	-

MRI, magnetic resonance imaging; CT, computed tomography.

The remaining eleven studies,^{32–35,38–44} describing 304 shoulders, reported shoulders with both soft tissue and/or bony abnormalities. In this case, the most commonly described abnormalities were a posterior labrum lesion in 204 shoulders,^{32–35,38,42–44} a reverse Hill-Sachs lesion in 43 shoulders,^{32,34,35,40,42,44} a glenoid posterior rim fracture or rim calcification in 30 shoulders,³⁸ a stretching of the posterior band of the inferior glenohumeral ligament in 22 shoulders,³² a posterior erosion of the glenoid in 22 shoulders,^{33,42} a Kim's lesion in 22 shoulders^{41,42} and a bony posterior Bankart in 17 shoulders.^{35,38,40,43,44}

A rotator cuff tear was found in five shoulders^{32,39}; a rotator interval lesion was also described.³⁹

Surgery

The surgical management of posterior instability varied among the included studies (Table 3).

In five studies,^{6,8,36,37,46} evaluating 411 shoulders with soft-tissue abnormalities, the management was always arthroscopic and it only addressed soft tissues. An arthroscopic capsulolabral plication with (264 shoulders) or without (106 shoulders) suture anchors was performed in 370 (90%) shoulders^{6,8,37,46} and an arthroscopic posteroinferior capsulolabral augmentation was performed in 41 (10%) shoulders.³⁶

In seven studies,^{28–31,45,47,49} evaluating 107 shoulders with bony defect of the glenoid or humeral head or both, surgical management was open in 63 (58.9%) shoulders^{28,29,31,47,49} and arthroscopic in 44 (41.1%). An arthroscopic posterior bone block augmentation, using bone graft harvested from the ipsilateral iliac crest, was performed in 21 (19.6%) shoulders,^{30,45} using acromial bone block in 1 (0.9%). The remaining 22 (20.6%) shoulders underwent an arthroscopic capsule-labral reconstruction without addressing the bony defect. In the open group, the bony defect was always addressed: an iliac crest posterior glenoid bone block was performed in 33 (52.4%) shoulders,^{28,47} a posterior capsular repair was performed in 17 (27%) shoulders³¹ and a distal tibia osteoarticular allograft was performed in 2 (3.2%) shoulders.²⁹ A transfer

of the subscapularis tendon and the attached lesser tuberosity was done in 11 (17.5%)⁴⁹ shoulders to reconstruct the reverse Hill-Sachs defect.

Management for posterior shoulder instability with both soft-tissue and/or bony abnormalities was described in 11 studies,^{32–35,38–44} including 304 shoulders. The management was arthroscopic in 211 (69.4%) shoulders,^{32–35,38–40,43,44} and an open repair was performed in 27 (8.9%) shoulders.^{38,41} In a study,⁴² including 66 shoulders was used iliac bone block in 57 (86.4%) shoulders, and acromial bone block in 9 (13.6%) shoulders, but it has not been specified if it is an arthroscopic or open treatment. An arthroscopic labral suture with anchors and capsular plication was performed in 135 shoulders^{33,38–40,43,44}; an arthroscopic posterior labral repair and capsular shift in 27 shoulders³²; an arthroscopic repair of posterior Bankart lesion in 27 shoulders³⁵; and an arthroscopic posterior capsular shift in 20 shoulders.³⁴ A study,⁴⁸ describing 25 shoulders, reported an arthroscopic labral suture with anchors with capsular shift repair in 19 (76%) shoulders, and posterior labral repair without capsular shift repair in 6 (24%).

Outcome measurements

Several outcome measures were reported in the included studies (Table 4). The most frequently reported score was the American Shoulder and Elbow Surgeons (ASES) score used in 10 (41.6%) of 24 studies^{6,8,29,31,32,39,40,44,46,48} with a mean score of 87.38 from 74.3⁴⁸ to 96.5³²; the Rowe score used in 7 (29.2%)^{30–32,38,41,42,45} with a mean score of 85.23 from 78.4³¹ to 94.6³²; the University of California Los Angeles (UCLA) score used in 5 (20.8%)^{31,32,44,47,49} with a mean score of 31.80 from 30⁴⁷ to 33.4³²; and the Constant score used in 5 (20.8%)^{28,41–43,45} with a mean score of 88.23 from 81⁴⁵ to 99.⁴³ Other scoring systems included the Western Ontario Shoulder Instability Index (WOSI), the visual analogue scale (VAS) and the Walch-Duplay score, the Oxford Shoulder Score, the subjective shoulder value (SSV), the Single Assessment Numeric Evaluation (SANE) score,

Table 4 Results of surgical management

Authors	Outcome scores				Recurrence	Mean follow-up (range) (years)
	Rowe score	Constant score	UCLA score	ASES		
Servien <i>et al.</i> ²⁸	-	Post-operative: 93.3 points	-	Duplay Post-operative: 85.6 points	3 (1 dislocation, 2 subluxation)	6 (2–19)
Miller <i>et al.</i> ²⁹	-	-	-	DASH score Post-operative: 86 points VAS Post-operative: 9 points	None	2 (2)
Schwartz <i>et al.</i> ³⁰	Pre-operative: 18.4; Post-operative: 82.1 ($P < 0.01$)	-	-	Duplay Post-operative: 37.4 Post-operative: 82.9 ($P < 0.01$)	None	1.7 (1.08–2.67)
Seung Ho-Kim ³²	Pre-operative: 35.6; post-operative: 94.6 ($P < 0.0001$)	-	Pre-operative: 21.9; post-operative: 33.4 ($P < 0.0001$) excellent (21) good (5) fair (1)	Pre-operative: 51.2; Post-operative: 96.5 ($P < 0.0001$)	1 (traumatic dislocation)	2 (2–21.5)
Gauthier <i>et al.</i> ³³	-	-	-	Wilcoxon signed rank test: Function scores Post-operative > 90% of preinjury shoulder function (grade 0 or I) (24), 80–89% (grade II) (2), 70% (grade III) (1); Pain score: pre-operative: 4.5 Post-operative: 0.2 ($P < 0.0001$). VAS Post-operative: 0.03 Wolf and Eakin outcome scale: excellent or good, mean post-operative score: 22.3 (18–24)	None	2.8 (0.9–6.7)
McIntyre <i>et al.</i> ³⁴	-	-	-	Scale described by Tibone and Bradley: post-operative: 83/100 L'Insalata shoulder rating score 90/100 (50–100); SF-36 physical component summary score 50.4 (37–61); SF-36 mental component score: 53.9 (31–63)	5 (2 dislocation, 3 subluxation)	2.6 (2–3.7)
Williams III <i>et al.</i> ³⁵	-	-	-	-	None	5.1 (2.0–11.7)

(Continued)

Table 4 Continued

Authors	Outcome scores		Recurrence	Mean follow-up (range) (years)
	Rowe score	Constant score		
Antoniou et al. ³⁶	-	-	9 subluxations	2.3 (1-5.75)
Bradley et al. ⁸	-	-	13	3.1 (1-9.6)
Wolf et al. ³⁷	-	-	1 (traumatic dislocation)	2.75 (2.16-3.75)
Bradley et al. ⁶	-	-	8	2.31 (1-6.42)
Bottoni et al. ³⁸	-	-	Arthroscopic group: 1; open repair: 1	3.3 (2-5.25)
Matthew et al. ³⁹	-	-	4	3.26 (1.8-5)
El Shevly et al. ³¹	-	-	3	5 (5-10);
Struck et al. ⁴¹	-	-	1 (traumatic dislocation)	7.5 ± 2.4
Shams et al. ⁴⁹	-	-	None	2.42 (2-3.25)

	ASES	UCLA score	Constant score	UCLA score	ASES	Others
Antoniou et al. ³⁶	-	-	-	-	-	Simple Shoulder Test from 5.5 points preoperatively to 8.1 postoperatively (Wilcoxon signed-rank test, $P = 0.0023$).
Bradley et al. ⁸	Pre-operative: 45.9 Post-operative: 85.1 ($P = 0.0001$)	-	-	-	-	Patient-described subjective stability scale (0-10; 0 = stable, 10 = completely unstable) mean pre-operative stability score: 7.4; post-operative: 2.1 ($P = 0.001$); standardized subjective pain scale (0-10; 0 = no pain, 10 = severe pain) mean pre-operative pain score: 6.5; post-operative: 1.9 ($P = 0.0001$); mean preoperative functional score (0-30; 0 being worst); pre-operative 7.0; post-operative 26.3 ($P = 0.0001$)
Wolf et al. ³⁷	-	-	-	-	-	-
Bradley et al. ⁶	Pre-operative: 50.4; post-operative: 85.7; ($P = 0.0001$)	-	-	-	-	-
Bottoni et al. ³⁸	-	-	-	-	-	WOSI score (lower scores represent less disability) arthroscopic group: 190; open repair: 594 ($P = 0.03$) WOSI score: 389.4 (81.5% of normal; range, 0-1610); mean Subjective Patient Shoulder Evaluation score: 20.0 (6-24); SANE score: 87.5 (55-100)
Matthew et al. ³⁹	94.6	-	-	-	-	-
El Shevly et al. ³¹	Pre-operative: 40.3; post-operative: 79.8	UCLA score: Pre-operative: 18; post-operatively: 33	-	-	-	-
Struck et al. ⁴¹	Post-operative: 82 (64-98)	-	Post-operative: 82 (64-98)	-	-	Duplay score: 81 (0-100); WOSI: 77% (33-99%); ROM (12 of 13): forward flexion 176° (±8.2), external rotation 74° (±19.4); ROM (1 of 13): abduction 140°, forward flexion 180°, external rotation 100°
Shams et al. ⁴⁹	Pre-operative: 24 ± 1.8 (20-25); post-operative 30 ± 3.9 (20-34) ($P = 0.002$)	-	-	-	-	ROM: forward flexion 162° (140-170°), None external rotation 70° (55-80°), internal rotation 45° (35-55°), abduction 130° (110-155°)

(Continued)

Table 4 Continued

Authors	Outcome scores			Recurrence	Mean follow-up (range) (years)
	Rowe score	Constant score	UCLA score		
Wooten et al. ⁴⁸	-	-	-	2 (traumatic subluxation)	5.25 (2-9.58)
				ASES	
				Post-operative: 74.3 ± 20.0 (20-100)	
				Others	
				Subjective stability scale of 0-10: 3.0 (0-6); subjective pain scale of 0 to 10: 3.0 (0-9); subjective function scale of 0 to 30: 2.5 (9-30); Marx activity score: 14.8 ± 3.2 (7-20); ROM: active elevation 165.6°; external rotation 65.8°; internal rotation 15.7°	
Lenart et al. ⁴⁰	-	-	-	2 subluxation	2.9 (1-5.6)
				Pre-operative: 67.9; post-operative: 93.2 (P=0.0001)	
				VAS	
				Pre-operative: 3.5; post-operative: 0.8; (P=0.0001)	
				SST scores pre-operative: 9.3; post-operative: 11.6; (P=0.0001)	
Bahk et al. ⁴⁴	-	-	32.6	1/29 subluxation (3.4%)	5.5 (2-12.4)
				WOSI 359 (0-1033) or 82.9% (38.9%—100%) of normal; Return to sport: 84.6% (22/26); Return to previous athletic level: 68% (17/25)	
				Return to sport 92% (52/56); Mean stability score	
				Pre-operative: 47.4 ± 21 (2-92); Post-operative: 87.9 ± 13 (36-100) [P < 0.001]	
Arner et al. ⁴⁶	-	-	-	2 subluxations (3.5%)	3.6 (2-8.2)
				Return to previous jobs: 10/12 (2-10); post-operative: 1.6 ± 1.7 (0-6) [P < 0.001]; pain pre-operative: 6.2 ± 2.7 (0-10), post-operative: 1.4 ± 1.8 (0-7) [P < 0.001]	
Khira et al. ⁴⁷	-	-	30 (30-35)	None	2.5 (2-4)
Garrret et al. ⁴⁵	81	81	-	3	2
Badge et al. ⁴³	-	99	-	None	2.66 (1.42-4.5)
				Oxford score: 18; Oxford instability score: 12.3; All return to previous level of play	
Clavert et al. ⁴²	86.5 (20-100)	Pre-operative: 76.11; post-operative: 86.04 [P < 0.0001]	-	8 (1 dislocation, 7 subluxation)	3.7 (1-13)
				Walch-Duplay: 81.5 (25-100); VAS: 1.6; return to same activity: 94%	

UCLA, The University of California at Los Angeles Shoulder Score; DASH, The Disabilities of the Arm, Shoulder and Hand score; VAS, visual analogue scale; WOSI, The Western Ontario Shoulder Instability Index; SANE, Single Assessment Numeric Evaluation; SST, The Simple Shoulder Test; ROM, range of motion; SSV, Subjective Shoulder Value.

the Disabilities of Arm Shoulder and Hand score (DASH), the Wilcoxon signed-rank test, the Wolf and Eakin outcome scale, the Neer criteria, the Tibone and Bradley scale, the Marx activity score, L'insalata shoulder rating, and the SF physical and mental component score.

Return to sport

Eleven studies,^{29,30,33–35,40,41,43,44,46,48} including recreational, amateur and/or professional athletes in the study population, reported data about return to sport. In these studies, 213 patients were athletes. In this population, 173 (81.2%) patients returned to the choice sport, 25 (11.7%) had to modify level of sport, and 15 (7.1%) did not return to any sport.

Recurrent instability

Recurrence of instability occurred in 67 (7.9%) of 847 shoulders^{6,8,28,31,32,34,36–49} (Table 4).

Recurrent instability occurred in 31 (7.5%) of 411 shoulders^{6,8,36,37,46} with soft tissue abnormalities alone. In particular, 12 of 111 shoulders suffered subluxations, and a traumatic dislocation was reported in 1 of 111; these data were reported in only three studies.^{36,37,46} Recurrence of posterior instability occurred in 11 (7.5%) of 132 shoulders^{28–31,45,47–49} with bony abnormalities of the glenoid or humeral head or both. In particular, 4 of 46 shoulders suffered traumatic subluxations, and a traumatic dislocation was reported in 1 of 46 shoulders; these data were reported in only two studies.^{28,48} In the remaining 304 shoulders with both soft tissue and bony abnormalities, a recurrence of posterior instability occurred in 26 (8.5%) shoulders^{32–35,38–42,44}; in particular 13 of 189 shoulders suffered subluxations, 4 of 189 a traumatic dislocation, and 1 of 94 shoulders an atraumatic dislocation; these data were reported in only six studies.^{32,34,40–42,44} In six studies,^{6,8,31,38,39,45} the type of recurrent instability was not been specified.

Fifty-two (7.4%) of the 691 shoulders that underwent arthroscopic management had recurrence of posterior instability.^{6,8,30,32–40,43–46,48} Recurrence

of posterior instability occurred in 8 (8.9%) of 90 shoulders with an open surgical procedure.^{28,29,31,38,41,47,49} In the study with not specified technique,⁴² recurrent instability occurred in 8 (12%) of 66 shoulder.

Quality assessment

The mean value of the CMS score was 59 points, with a range from 40⁴⁵ to 70,^{6,8,31,47} showing that the mean quality of the included studies was fair. No statistically significant difference was found between mean values of CMS scores calculated by the two examiners (Table 2).

Discussion

The present systematic review identified a total of 24 studies,^{6,8,28–49} including 847 shoulders in 810 patients with both soft tissue and/or bony glenoid and/or humeral abnormalities in a posterior shoulder instability setting. The most common soft tissue injury was a posterior labrum detachment, reported in 50% of all shoulders. This increased to 75% if shoulders with both bony and soft tissue lesions were excluded. The second most common soft tissue abnormality was a patulous posterior capsule, found in 22.9% of all shoulders with soft tissue abnormalities only. Similar results have been reported.^{18,50} The glenoid labrum is a soft tissue extension of the circular glenoid rim. It is important for the concavity compression mechanism of the glenohumeral joint, as it centralizes the humeral head in the glenoid.⁵¹ The posterior capsule has also been proven to be important for glenohumeral stability, especially in the setting of glenohumeral laxity.⁵² A humeral head bony lesion, also called reverse Hill Sachs lesion, was seen in 9.4% of all patients and a bony abnormality of the glenoid in 2%. Most glenoid abnormalities were posterior glenoid fractures, but those of glenoid dysplasia were also reported. Considering the mechanism of injury, it is understandable that bony defects are less reported since they require larger traumatic forces, compared to soft

tissue injury.^{53–55} Surgical management and recurrence of instability varied among the included studies (Table 3). The Norwegian Register for Shoulder Instability Surgery reported that management of patients with posterior shoulder instability was an arthroscopic repair in 97%, and open repair in 3%.⁵⁶ The chief outcome measure that has been consistently recorded is the rate of recurrent instability. The results of open operative treatment of posterior shoulder instability have been variable, reporting overall prevalence of recurrent instability of 24–25%.⁷ The prevalence of recurrent instability reported by the same study following arthroscopic stabilization for the treatment of unidirectional posterior instability was, on the other hand, 5%.⁷ Leivadiotou and Ahrens⁵⁷ systematically reviewed six articles from 2003 to 2013 describing patients with arthroscopic treatment of posterior shoulder unidirectional traumatic posterior instability. They found that the outcome (return to previous sport status) can be expected to be good for these patients, if appropriate preoperative assessment and current arthroscopic techniques are employed.⁵⁷ In our systematic review, the recurrence of posterior dislocation was 7.4% of shoulders managed with an arthroscopic procedure,^{6,8,30,32–40,43–46,48} and 8.9% for open surgical procedures.^{28,29,31,38,41,47,49} An arthroscopic approach offers a number of benefits, over an open approach; this includes quicker recovery time, an optimal cosmetic result, and less short- and long-term complications associated with surgery. However, type of surgery alone is not the only determining factor for the rate of recurrence; lesions treated using arthroscopy, for example, may have a lesser recurrence rate given a lower preoperative severity of instability.⁵⁸ We also observed that shoulders managed arthroscopically had only soft-tissue abnormalities, whilst most of the shoulders treated with an open surgical technique reported both bony and soft tissue abnormalities. Interestingly, 20.6% of all shoulders with an open procedure for bony abnormalities underwent an arthroscopic capsulolabral reconstruction without addressing the bony defect. A further consideration is that the use of recurrence of instability as a benchmark of success

is not optimal: whilst some patients with postoperative recurrence rate their operation as a failure, others may have a subjectively better outcome, with less perceived instability and functional incapacity, despite the continuation of subluxations.⁷ Furthermore, failure of posterior repairs can result from inappropriate patient selection, surgical errors or re-injury of the shoulder.⁵⁹ The surgical approach must address all factors contributing to the instability. Failure to treat a rotator interval lesion, a concomitant inferior or anterior component of the instability, excessive glenoid retroversion or posterior erosion of the glenoid rim increases the likelihood of postoperative recurrence.⁷ Such lesions were uncommon but also reported in the included study (Table 2). An inappropriate preoperative diagnosis, such as a soft tissue lesion that might be missed on plane radiographs, will lead to poor postoperative outcomes.^{60,61}

A special group of patients are athletes. In such patients, a return to sport should be obtained within 6–9 months after surgery.⁶² Determining if patients are ready to return to full contact sports is challenging and surgeons should decide for each patient depending on pain or tenderness during examination and strength. At least 80% of strength compared with the contralateral, non-injured shoulder should be obtained.⁶² In our systematic review, eleven studies,^{29,30,33–35,40,41,43,44,46,48} included recreational, amateur and/or professional athletes. In this population, 173 (81.2%) patients returned to the choice sport, 25 (11.7%) had to modify their level of sport and 15 (7.1%) did not return to any sport.

The limitations of the present systematic review are related to the poor quality of the studies available in the literature. Because only case series were retrieved, no pooling of data could be performed. The outcomes were difficult to further analyze as a number of different scoring systems were used. It should be suggested that future studies utilize the most commonly reported outcome measures with larger sample sizes to provide reproducible evidence on the topic. Another limitation is that, unfortunately, none of the articles analyzed clearly reported the amount of bone defect, so it is unclear whether the type of management in posterior instability can

be planned according to the amount of bone defect, either in percentage or in absolute terms. It is, therefore, recommended that future investigations should report these data.

Conclusion

Our systematic review has established that the soft-tissue abnormalities are the most widely diagnosed in patients with posterior glenohumeral instability. We also found that the arthroscopic approach is the most widely used surgical technique, with less recurrence of postoperative instability compared to open surgical techniques. Nevertheless, operative stabilization for posterior shoulder instability should be lesion-specific and should correct all components of the posterior instability. We found that the best outcomes appear to follow arthroscopic procedures to repair soft-tissue abnormalities. Bony procedures show a higher rate of recurrence of redislocation and should be reserved for patients with definite evidence of marked bony abnormalities that are thought to contribute to the instability.

Conflict of interest statement

No conflict of interest is associated to the authors of this paper.

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