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MINIREVIEWS

Posterior shoulder instability in the athletic population: Variations in assessment, clinical outcomes, and return to sport

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Abstract

Posterior instability of the shoulder is becoming an increasingly recognized shoulder injury in the athletic population. Diagnostic elements, such as etiology, directionality, and degree of instability are essential factors to assess in the unstable athletic shoulder. Concomitant injuries and associated pathologic lesions continue to be a significant challenge in the surgical management of posterior shoulder instability. Return to sport and previous level of play is ultimately the goal for every committed athlete and surgeon, thus subpopulations of athletes should be recognized as distinct entities requiring unique diagnostic, functional outcome measures, and surgical approaches.

Key words: Posterior shoulder instability; Overhead throwing athletes; Contact athletes

Core tip: This article focuses on important posterior shoulder instability diagnostic criteria, effects of concomitant injuries, discussion of variations in athletic subpopulations and effects of return to sport, surgical management and advantages of arthroscopic *vs* open techniques.

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INTRODUCTION

Posterior instability of the shoulder represents a unique entity among athletic shoulder injuries. Accurately diagnosing and treating posterior instability of the shoulder is often challenging due to the numerous confounding variables existing on the shoulder instability injury spectrum. However, despite diagnostic and surgical challenges, posterior shoulder instability is becoming increasingly recognized as a treatable shoulder injury.

Posterior shoulder instability is multifactorial and the etiology varies widely within the athletic population. Primary mechanisms of injury may include: (1) an acute traumatic posteriorly directed shearing force along the glenoid face between the posterior labrum and glenoid articular surface, resulting in capsulolabral detachment[1-3]; (2) repetitive microtrauma to the posterior capsule, ultimately leading to capsular attenuation and labral tears[4]; or (3) insidious onset of laxity of the posterior capsule and associated passive stabilizers[5-7]. Other causes of posterior instability often result from (1) excessive glenoid or humeral retroversion; (2) an engaging reverse Hill-Sachs lesion; and (3) and glenoid hyperplasia[1,5].

DIAGNOSIS OF INSTABILITY

Essential elements, such as etiology, directionality, and degree of instability are critical to assess in order to adequately manage posterior instability and prevent recurrence. Thus, it has been shown that unrecognized instability in more than a single isolated direction may be a significant contributing factor leading to poor patient outcomes. A level 2 study performed by Bradley *et al*[8] evaluated 100 athletes undergoing posterior shoulder stabilization procedures reported 62.5% (5 of 8) of their recurrences may have been a direct result of failure in diagnosis of bi-directional or multi-directional instability at the time of the index procedure. Furthermore, an earlier retrospective investigation by Wolf *et al*[9] identified similar findings in their cohort of 14 patients, in which the 1 reported failure was noted to have pronounced inferior laxity accompanying posterior instability at the time of the revision procedure.

It is also well known that patients with recurrent subluxation and/or dislocation frequently have osseous defects of the posterior glenoid rim or humeral head, which may contribute to the degree of instability. Operative intervention to address such cases may involve more aggressive and invasive procedures, such as reverse Hill-Sachs, humeral head or posterior bone allografts[10,11]. Ultimately, the degree of instability is one of many variables that should be considered in order to determine the most appropriate operative management in order to ensure successful patient outcomes.

Patients with a voluntary component to their posterior shoulder instability should also be recognized as a unique entity with the potential for less predictable outcomes. In a case series of 33 patients, Provencher *et al*[12] demonstrated that patients with voluntary instability resulted in worse outcomes. Specifically, they identified recurrent instability to be specific to patients with a voluntary instability component, whereas, all patients with involuntary instability were stable at follow-up (P = 0.025). Similarly, a case series of 20 shoulders reported by McIntyre *et al*[13] observed that 4 of 5 of their patients with a recurrence had a voluntary component to their instability.

Ultimately, failure to accurately access posterior instability both preoperatively *via* clinical examination, magnetic resonance imaging, as well as, intraoperative arthroscopic assessment to identify potential excessive capsular laxity, concurrent soft-tissue or osseous lesions, and bi- or multi-directional instability may result in unfavorable patient outcomes[8].

CONCOMITANT INJURIES

Posterior shoulder instability rarely occurs in isolation, often accompanied by microtrauma resulting from repetitive shearing forces, macrotraumatic events, prior dislocations, scapulothoracic dysfunction, and various osseous and soft-tissue abnormalities[4]. Concomitant injuries and procedures pose additional challenges in the management of posterior shoulder instability, which may lead to varied and less favorable outcomes[14]. In a retrospective case series of 14 patients, Bahk *et al*[15] reported that patients with concurrent injuries had less reliable outcomes, *e.g.,* higher pain scores (P = 0.001), lower American Shoulder and Elbow Scores (ASES) scores (P < 0.001), lower University of California, Los Angeles Shoulder Rating Scale (UCLA) scores (P < 0.001), higher subjective instability scores (P < 0.001), higher Western Ontario Shoulder Instability (WOSI) scores (P = 0.0002), or lower score for WOSI percentage of normal (P = 0.0002) at an average follow-up of 66 mo (range, 24-149 mo). Additionally, the senior author (JPB) has determined approximately 40% of his cohort of 389 patients that underwent surgical management of posterior shoulder instability had concomitant pathology at the time of the index stabilization procedure (James P. Bradley, personal communication, June 1, 2015). Furthermore, an advanced understanding of biomechanics and pathoanatomy of the posterior capsulolabral complex and 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 are also critical for precise patient evaluation and surgical management.

Higher rates of failures and less favorable patient outcomes may result from poor quality posterior capsular tissue as a consequence of prior surgical intervention. In particular, thermal capsulorrhaphy has been shown to result in failures and revisions. For instance, the level 4 retrospective case series of 33 patients by Provencher *et al*[12] determined that 71% (5 of 7) of their failures had undergone prior surgical procedures, such as thermal capsulorrhaphy (n = 3) and anterior stabilization (n = 2) and resulted in a higher chance of failure. Additionally, the level 4 retrospective investigation of 20 shoulders performed by McIntyre *et al*[13] utilized a multiple suture technique and reported 60% (3 of 5) of their

Table 1 Arthroscopic clinical outcomes of athletes - Posterior shoulder instability *n* (%)

Ref.	Evidence level	Primary procedure	No. total shoulders	No. athletic shoulders	Mean age, yr (range) Female/Male	Mean follow-up, mo (range)	Recurrence rate	Subjective stability (Stable or E/G)	Patient satisfaction	Return to sport (any level)	Return to sport (pre-injury level)
Bradley *et al*[18]	II	CLR	200	Overall: 200 Contact sport: 117 Overhead/ Throwers: 60	Overall: 24 (15-65) 42 F/158 M Contact sports: 21 (16-28) NR, F/NR, M	Overall: 37 (12-115) Contact sports: 35 (12-77)	Overall: 12 (6) failures *via* ASES 14 (7) failures *via* stability scale 7 (4) failures *via* both ASES and stability scale Contact athlete: 7 (6) *via* ASES 4 (4) *via* stability scale 3 (3) *via* ASES and stability scale	Overall: 182 (91) Contact athlete: 110 (94)	Overall: 187 (94) Contact athlete: 111 (95)	Overall: 180 (90) Contact athlete: 106 (91)	Overall: 127 (64) Contact athlete: 81 (69)
Schwartz *et al*[29]	IV	BB	19 (1 patient Ehlers Danlos)	Overall: 18 Contact sport: 13	30 (15-56) 5 F/13 M	21 (13-32)	3 (6) (1 bilateral patient with persistent instability of unknown etiology, contralateral shoulder was revised; 1 patient persistent pain due to prominent graft)	16 (84)	16 (84)	16 (89)	9 (50)
Wanich *et al*[30]	IV	10 CLR 2 DB only	12	12 Baseball "batter's shoulder"	21 (16-33) 0 F/12 M	34 (18-64)	1 (8)	NR	NR	11 (92)	11 (92)
Lenart *et al*[31]	IV	CLR	22	19	NR	NR	2 (9)	NR	NR	19 (100)	19 (100)
Bahk *et al*[15]	IV	CLR	29	28	26 (18.3-43.4) 1 F/28 M	66 (24-149)	1 (3.4)	28 (97) ≥ 30 yr old, lower instability scores (P = 0.041)	28 (97)	22 (85)	17 (68)
Savoie *et al*[14]	IV	CLR	92	Overall: 81 Throwing sports: 32	26 (15-59) 21 F/69 M	28 (12-132)	2 (2)	90 (98)	NR	NR	NR
Radkowski *et al*[19]	II	CLR	107	Overall: 107 Throwing sports: 27 Nonthrowing sports: 80	Overall: 23 F/84 M Throwing athletes: 21 (range, NR; SD ± 5.5) 7 F/20 M Nonthrowing athletes: 24 (range, NR; SD ± 9.1) 16 F/64 M	Throwing athletes: 28 (range, NR; SD ± 11.6) Nonthrowing: 28 (range, NR, SD ± 12.5)	11/107 (10)	No difference between 2 groups for postoperative stability Overall: 96/107 (90) Throwers: 24/27 (89) Nonthrowers: 72/80 (90)		Overall: 96/107 (90) Throwers: 23/27 (85) Nonthrowers: 73/80 (91)	Overall: 72/107 (67) Throwers: 15/27 (55) Nonthrowers: 57/80 (71)

Bradley *et al*[8]	II	CLR	100	Overall: 100 Contact sports: 51 Overhead/ Throwers: 28	23 (15-61) 23 F/77 M	(12-77)	Overall: 9 (9) failures according to ASES 11 (11) failures according to the standardized stability scale Contact athlete: 3 (6) failures according to ASES 5 (10) according to standardized stability scale	Overall: 89 (89) Contact athlete: 43 (84)	Overall: 92 (92) Contact athlete: 46 (90)	Overall: 89 (89) Contact athlete: 44 (86)	Overall: 67 (67) Contact athlete: 38 (74)
Bottoni *et al*[32]	IV	CLR TC	19	17	NR	40 (24-63)	1 (5)	NR	NR	NR	NR
Bisson[33]	IV	TC	14	Overall: 14 Contact sports: 7 Overhead sport: 1 swimmer Sport NR: 6	19 (15-32) Shoulders: 4 F/10 M Patients: 4 F/8 M	36 (26-53)	(3/14) (1 bilateral)	11 (79)	14 (100)	14 (100)	6 (43)
Goubier *et al*[34]	IV	CLR	13	Overall: 11 Contact sports: 1 Overhead/ Throwers: 3	33 (18-47) 5 F/8M	34 (11-80)	0 (0)	NR	13 (100)	NR	8 (89)
Kim *et al*[35]	IV	CLR	27	Overall: 27 Contact sports: 9 Overhead / Throwing: 6/6	21 (14-33) 2 F/25 M	39 (24-85)	1 (4)	26 (96)	NR	26 (96)	NR
Williams *et al*[36]	IV	CLR	27	Overall: 27 Contact sports: 11 Overhead/ Throwers: 5	29 (15-55) 0 F/27 M	61 (24-140)	2 (7)	25 (93)	25 (96)	25 (93)	NR

Wolf *et al*[9]	IV	CLR	14	Overall: 10 Contact sports: 3 Overhead/ Throwers: 2 (1 baseball pitcher, 1 tennis)	26 (14-54) 3 F/11 M	33 (24-45)	1 (7) traumatic reinjury	13 (93)	14 (100)	10 (100)	9 (90)
McIntyre *et al*[13]	IV	CLR	20	Overall: 14 Contact sports: 5 football (2 resulted in dislocations) Overhead/ Throwers: 2 baseball pitchers	22 (15-36) 4 F/15 M	31 (24-44)	5 (25) (2 recurrent dislocations, 3 subluxations)	17 (85)	NR	NR	12 (86)
Papendick *et al*[37]	IV	CLR PIGHLR	41	Overall: 36 Overhead/ Throwers: 21	23 (15-42) NR, F/NR, M	10 (4-41)	2 (4.8) recurrence (both recurrent dislocation)	NR	39 (95)	36 (100)	NR

AC: Acromioclavicular; ADL: Activities of daily living; ASES: American shoulder and elbow score; BB: Bone block; CI: Capsular imbrication; CLR: Capsulolabral repair; CP: Capsular plication; CR: Capsular repair; CS: Capsular shift; DB: Debridement; E/G: Excellent to good; GHLR: Glenohumeral ligament repair; IGHLR: Inferior glenohumeral ligament repair; LR: Labral repair; MDI: Multidirectional instability; NR: Not reported; PB: Posterior bankart; PHAGLR: Posterior humeral avulsion of the glenohumeral ligament repair; PIGHLR: Posterior inferior glenohumeral ligament repair; PSS: Penn shoulder score; ROM: Range of motion; SAD: Subacromial decompression; SANE: Single assessment numeric evaluation; SF-36: Short form health survey; SST: Simple shoulder test; TC: Thermal capsulorrhaphy; UCLA: University of California Los Angeles shoulder score; VAS: Visual analog scale; WD: Walch-Duplay; WOSI: Western ontario shoulder instability.

recurrences had also undergone prior surgery. Additional evidence of the effect of prior surgery having an effect on revision rates is supported by the level 2 cohort study of 100 athletic shoulders by Bradley *et al*[8] in which they reported 25% (2 of 8) of their revisions had undergone a prior thermal capsulorrhaphy procedure. Thus, prior surgery resulting in poor quality capsular, especially as a result of thermal shrinkage of capsular tissue may weaken the capsulolabral complex, resulting in unsatisfactory patient outcomes leading to further revision and failure[16].

CONTACT ATHLETES *VS* THROWING ATHLETES

Athletic clinical outcomes for posterior shoulder instability are summarized in Tables 1 and 2.

Posterior shoulder instability injuries can occur in contact or collision athletes *via* a single macrotraumatic episode with the shoulder in an internally rotated, flexed and adducted position (*e.g.*, wrestler takedown with outstretched arm) causing in-direct shearing forces that result in capsulolabral injury[1-3]. Additionally, repetitive microtrauma can also result in posterocapsular injuries in the contact athletes with continuous posteriorly directed axial loading of the glenohumeral joint (*e.g.*, football lineman)[10,17].

Table 2 Open clinical outcomes of athletes - Posterior shoulder instability *n* (%)

Ref.	Evidence level	Primary procedure	No. total shoulders	No. athletic shoulders	Mean age, yr (range)	Mean follow-up, mo (range)	Recurrence rate	Stability subjective (e/G)	Patient satisfaction (S or E/G)	Return to sport (any level)	Return to sport (preinjury level)
Servien *et al*[6]	Ⅳ	BB	21	19	24.8 (17-40)	72 (24-228)	3 (14)	21 (100)	21 (100)	17 (89)	13 (68)
Misamore *et al*[38]	Ⅳ	Capsulorrhaphy	14	14	19.6 (15-26)	45 (26-90)	1 (7)	13 (93)	NR	13 (93)	12 (86)
Hawkins[39]	Ⅳ	BB	10	8	26.4 (20-39)	61 (32-100)	1 (10)	9 (90)	NR	NR	NR
Hurley *et al*[40]	Ⅳ	Reverse Putti-Platt w/o bony procedure	22	22	18.3 (13-30)	60 (24-132)	16 (73)	NR	NR	15 (68)	1 (45)
Surin *et al*[41]	Ⅳ	Rotational Osteotomy of Humerus	11	6	23 (16-30)	80.73 (24-144)	0 (0)	11 (100)	10 (91)	4 (100)	3 (75)
Hawkins *et al*[42]	Ⅳ	Posterior Glenoid Osteotomy/ Capsulotendinous Plication/Reverse Putti-Platt	26	26	21 (NR)	86 (24-180)	13 (50)	NR	NR	10 (38)	NR

BB: Bone block; CLR: Capsulolabral repair; NR: Not reported.

Return to sport and return to previous level of play have been shown to be higher for contact athletes *vs* throwing athletes. A level 2 prospective cohort of 200 athletes by Bradley *et al*[18] underwent arthroscopic posterior shoulder stabilization procedures and outcomes were based on ASES scores, stability, pain, function, strength, return to sport and return previous level of play. The investigators reported no difference in the Contact Athlete subgroup compared to entire cohort for any outcome measure. An additional study conducted by the same group performed a level 2 study of 107 patients and also determined that was no difference in the Contact Athlete subgroup compared to entire cohort as well as no difference in functional outcome between traumatic *vs* atraumatic injuries[19]. However, throwing athletes should be recognized as a unique subset of athletes requiring unique diagnostic, operative intervention and shoulder outcome measures due to increased demands on the glenohumeral joint[20]. Repetitive microtrauma occurring with throwing athletes may put them at increased risk for developing posterior labral injuries *vs* other athletes[19,21]. For instance, in elite baseball pitchers, it has been reported that internal rotation of the humerus can approach velocities as high as 7000 deg/s[22]. Large compressive and distractive forces generated at the extreme ranges of motion in the late cocking phase and the high distraction forces occurring during the follow-through phase have been reported to cause weakening and contractures in the posterior inferior capsule, placing the glenoid capsulolabral complex and associated stabilizers at great risk for injury[23]. The largest study to date comparing surgical management of posterior instability in throwing athletes (n = 27) *vs* non-throwing athletes (n = 80) was a prospective level 2 study performed by Radkowski *et al*[19]. The investigators reported throwing athletes had nearly equal postoperative pain, stability, function, range of motion, strength and ASES post-operatively as non-throwing athletes. However, a lower percentage of throwers were able to return to their previous level of play (55%) compared to non-throwing athletes (71%). Ultimately, less dynamic glenohumeral demands of contact athletes compared to the throwing athlete may allow them to have higher rate of return to sport and previous level of play.

Advanced understanding of biomechanics and pathoanatomy, as well as awareness of throwing athletes requiring a more distinct functional shoulder outcome measure to assess the athletes true postoperative functioning is critical elements to consider during evaluation and treatment. Thus, although throwing athletes achieve similar improvements in pain, stability, and function compared to non-throwing athletes, experts have advised counseling the throwing athlete pre-operatively of the high probability that they are less likely to return to their previous level of play[19].

SURGICAL MANAGEMENT

Arthroscopy has evolved from being utilized strictly as a diagnostic tool to replacing many open techniques. Minimally invasive arthroscopic techniques have potential benefits and advantages compared to open procedures for posterior instability of the shoulder[18,24]. Intraoperative assessment allows for visualization of subacromial and intraarticular space and identification of abnormalities, such as rotator cuff pathology and intraarticular capsulolabral lesions. Anatomy can be restored more precisely to resemble native anatomy[14]. Concomitant injuries, such as SLAP and glenohumeral ligament complex lesions often missed during pre-operative evaluation may be identified during intraoperative arthroscopic assessment and can be addressed in the same operative setting[18,20]. Additionally, shoulder arthroscopy has been recognized as both a diagnostic and therapeutic technique with a low incidence of complications[25]. Post-operatively, increased range of motion, shorter rehabilitation, and less pain and morbidity have been reported in arthroscopic procedures compared to more invasive techniques[24]. A recent metaanalysis for the treatment of unidirectional posterior shoulder instability conducted by DeLong *et al*[26] evaluated 27 arthroscopic studies and 26 open studies and identified a trend in the current literature of arthroscopic techniques having superior outcomes compared to open techniques for stability, recurrence, patient satisfactions, return to sport and previous level of play. Ultimately, less comorbidity associated with arthroscopic surgical procedures may allow athletes to return sport faster and with less complications[24].

Recognition of pathoanatomy and choice of technique and repair to restore posterior shoulder stability is also important to consider. Appropriate evaluation of capsular laxity with or without an intact labrum and adequate capsular shift with the use of anchors has been shown to result in more favorable outcomes. The level 2 study of 200 athletes by Bradley *et al*[18] reported a significantly higher return to play in athletic shoulders that received suture anchors. The investigators concluded that techniques that utilized suture anchors increased stability and function of the posteriolabral complex and contributed to their favorable clinical outcomes and high rate of return to sport. The same group also reported an earlier study of 100 athletic shoulders in which 88% (7 of 8) of failures that had undergone capsulolabral plication without the use of suture anchors[6] and a study of 107 athletic shoulders in which 73% (8 of 11) of failures had undergone a capsulolabral repair without suture anchor[19]. Similarly, the retrospective level 4 investigation of 20 athletic shoulders by McIntyre *et al*[13] utilized an anchorless suture technique reported a high failure rate of 25% (5 of 20 shoulders). An additional level 4 report of 33 patients by Provencher *et al*[12] concluded that capsular plication rather than labral suture anchor repair had a higher chance of failure among their 7 reported failed cases (P = 0.10). Thus, arthroscopic posterior stabilization procedures utilizing suture anchors to address capsular pathology may provide the most consistent and favorable outcomes and return to sport[13,18,27,28].

CONCLUSION

Efforts should be made to identify the precise etiology, directionality, and degree of instability in the athlete with posterior shoulder instability. Isolated posterior instability is uncommon and rarely occurs in isolation and numerous and varied concomitant osseous and soft-tissue injuries create challenges in diagnosis and surgical management. However, awareness of these pathologic variables and knowledge of variances in athletic populations (*i.e.,* contact athletes compared to throwing athletes) may allow for a more precise approach to management. Finally, surgical intervention utilizing minimally invasive arthroscopy and suture anchors for capsulolabral repair may provide a significant advantage in assessment and post-operative recovery, ultimately, providing the best possible outcomes and return to sport.

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