Systematic Review

No Difference in Recurrent Instability Between Knotted and Knotless Repair Techniques in Arthroscopic Treatment of Isolated Posterior Labral Tears: A Systematic Review

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Purpose: To compare clinical failure, recurrent instability, patient-reported outcome measures (PROMs), and return to sport (RTS) between knotted and knotless fixation methods in arthroscopic posterior labral repair for isolated posterior shoulder instability (PSI). **Methods:** Multiple databases were queried according to Preferred Reported Items for Systematic Reviews and Meta-Analyses guidelines for clinical studies with Level I to IV evidence, including knotted and knotless suture anchors for arthroscopic posterior labral repair. Combined anterior and posterior instability, multidirectional instability, SLAP injuries, unspecified repair techniques, majority open procedures, and revision surgery were excluded. **Results:** Screening yielded 17 full-text articles reporting on 852 shoulders undergoing posterior labral repair. Recurrent instability ranged from 0% to 21%, and the rate of revision surgery ranged from 0% to 11% in knotted only, 0% in knotless only, and 2.0% to 8.1% in knotted and knotless studies. Six studies with both pre- and postoperative visual analog scale scores and 7 studies with both pre- and postoperative American Shoulder and Elbow Score scores all showed improvement in scores after intervention regardless of repair technique. Thirteen studies reported RTS or duty rates with a minimum of 79%. **Conclusions:** Overall recurrent instability after posterior labral repair for isolated PSI was low with improvement in PROMs and favorable RTS rates regardless of fixation method. There was no clear difference in recurrent instability or revision surgery between knotted and knotless fixation methods for isolated posterior labral repair. However, the current literature is predominantly limited by Level III and IV evidence. The quality of literature and lack of standardization on the definition of clinical failure and recurrent instability among surgeons preclude any definitive conclusion regarding one clinically superior fixation method. **Level of Evidence:** Level IV, systematic review of Level III and IV studies.

Isolated posterior shoulder instability (PSI) is relatively uncommon, accounting for around 5% to 10% of overall shoulder instability in its entirety.[1,2] This is in contrast to studies in the young, active military population that note an increased prevalence of up to 25% compared to the general US population.[1,3] PSI is commonly attributed to posterior labral pathology causing continued pain and limitation of shoulder mobility and is most frequently seen in the young, athletic male population.[4,5] Posterior labral tears often occur in the setting of repetitive microtrauma in overhead and contact athletes, the high-demand servicemember population, or an acute traumatic injury in the provocative position of flexion, adduction, and internal rotation.[2,6-8] After failure of conservative management with recurrent instability, the first surgical intervention recommended is arthroscopic repair of the posterior labral tear.[8-10] Arthroscopic procedures have been

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shown to be an effective and reliable treatment for unidirectional PSI with overall good patient satisfaction and clinical outcomes and return to sport (RTS) rates up to 90%.[5,11-13]

There are multiple described techniques for arthroscopic management of posterior labral tears to include the use of suture-based capsulolabral plication to an intact labrum vs glenoid-based anchor fixation.[14-16] Within suture anchor repair, there are both knotted and knotless techniques described, yet there is a paucity of high-level evidence supporting one preferred technique leading to superior clinical outcomes. An ideal arthroscopic implant must withstand the greatest amount of stress early during postoperative recovery while also maintaining a low profile, as well as provide optimal tension for healing and ease of knot tying.[15,17] Advantages of traditional knot-tying have been shown to be biomechanically superior ex vivo but are technically challenging and highly dependent on knot security with the risk of migration, loosening, or prominence over time and may also lead to prolonged operative time.[16,18,19] With the advancement of arthroscopic implants, knotless suture anchors have shown improved efficiency without risk of knot prominence, but at the risk of gap formation and need for retensioning of the repair.[14,16,20-22] Most of the current literature investigating in vivo arthroscopic repair techniques has been in the clinical context of anterior capsulolabral repair for recurrent anterior shoulder instability, which has supported similar rates of recurrent instability and revision surgery with overall good outcomes across both techniques.[16,23] The purpose of this systematic review is to compare clinical failure, recurrent instability, patient-reported outcome measures (PROMs), and RTS between knotted and knotless fixation methods in arthroscopic posterior labral repair for isolated posterior shoulder instability. We hypothesize that there is no difference in rates of clinical failure, recurrent instability, PROMs and RTS in patients treated with knotted or knotless suture repair in the setting of arthroscopic posterior labral repair for PSI.

Methods

Search Strategy

PubMed, MEDLINE, Science Direct, and SPORTDiscus databases were queried for full-text English language articles up to July 25, 2022. The search used the keywords "posterior shoulder instability," "knotted and knotless repair," and "labral tears" in human subjects. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was used for screening of articles for inclusion (Fig 1). The protocol was registered through the PROSPERO database (CRD42021244172).

Study Screening

Two authors (M.T.D. and E.R.M.) independently screened the titles, abstracts, and full-text articles. Any disagreements were reconciled by the senior author (T.J.D.) to determine inclusion of the study. Eighteen additional articles were identified by title and abstract review through a search of the references, which were not identified in the original search.

Eligibility Criteria

Studies were deemed eligible for inclusion in this review if they were therapeutic, human studies in English reporting recurrent instability, failure rates, complications, clinical outcomes, and return to duty or sport rates on patients undergoing isolated arthroscopic posterior shoulder labral repair with a described knotless and/or knotted suture repair technique. All patients with posterior labral tears were included regardless of injury pattern (i.e., posterior dislocation or chronic overuses/attritional wear). Studies with combined anterior and posterior instability, multidirectional instability, SLAP injuries, unspecified repair techniques, majority open procedures, and revision surgery were excluded. Additionally, studies in which the repair technique was unclear were excluded. Review articles, technique articles, abstract-only papers, and articles that did not exclusively report on posterior instability were excluded. There was no exclusion of studies based on patient age or time of follow-up.

Data Extraction

Two independent reviewers (M.T.D. and E.R.M.) extracted study data into a spreadsheet (Excel version 2016; Microsoft). The following data were collected from each included study: authors, year of publication, level of evidence, study date, sample size, follow-up interval, age, sex, dominant shoulder or laterality, athletic status, history of recurrent dislocation, prior procedure, procedure performed, and knotless vs knotted repair technique, as well as various PROMs including recurrent instability, clinical failure, revision surgery, return to sport, and other functional outcome scores. Clinical failure and recurrent instability are reported as defined in each individual study, which differed between recurrent patient-reported symptoms of instability, dislocation, subluxation, persistent pain preventing return to prior level activity, and recurrent instability in addition to other reported complications (adhesive capsulitis, complex regional pain syndrome, postoperative deep vein thrombosis).

Quality Assessment

The Methodological Index for Non-Randomized Studies (MINORS) criteria were used to assess and grade study quality by 2 independent reviewers (M.T.D. and E.R.M.). Each MINORS criterion was graded by a

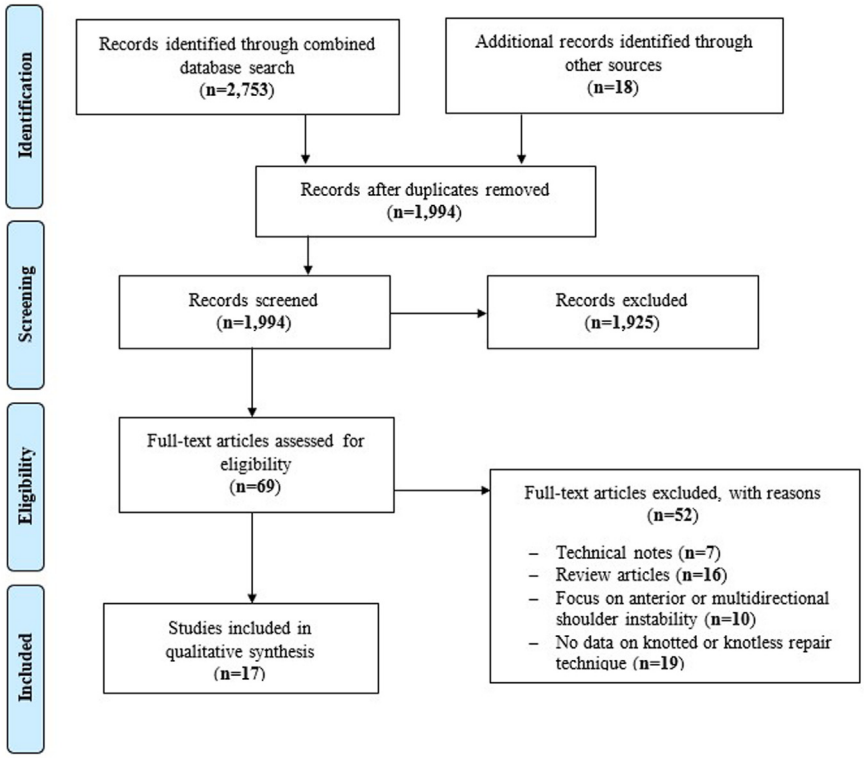

Fig 1. Preferred Reporting items for Systematic Review and Meta-Analyses flow diagram for search characteristics.

score of 0 (not reported), 1 (reported but inadequate), or 2 (reported and adequate), with a maximum score of 16 for noncomparative studies and 24 for comparative studies. The intraclass correlation coefficient (ICC) was calculated to evaluate agreement. Agreement was characterized according to the following thresholds: ICC >0.9, considered to be excellent agreement, 0.75 to 0.9, considered to be good agreement, 0.5 to 0.75, considered to be moderate agreement, and <0.5, considered to be poor agreement. Additionally, the κ value was calculated to determine the interrater agreement between the 2 independent reviewers for the title, abstract, and full-text screening stages. This was characterized according to the following thresholds $\kappa > 0.61$, considered to be substantial agreement; 0.21 to 0.6, considered to be moderate agreement; and <0.21, considered to be slight agreement. A formal risk of bias assessment was not performed as there were no available randomized controlled trials included in the systematic review with overall low-level evidence studies lacking appropriate controls and mostly retrospective designs.

Statistical Analysis

The data from each study were extracted as reported in the article as means and standard deviations or ranges, when available. All data are presented in a descriptive formation. Due to the heterogeneity of the presented data, studies were not pooled into mean calculations, as the included studies were nonrandomized with low-level evidence and mostly retrospective designs. Missing data are left out where applicable with N/A (not applicable) or blank designation as noted. All data are presented in a descriptive format.

Results

Search and Study Characteristics

Initial review of the literature yielded 2,753 studies, with 17 full-text studies meeting inclusion criteria. There were 12 Level IV case series,[24-35] 3 Level III retrospective reviews,[36-38] and 2 Level II prospective cohort studies.[39,40] Twelve studies reported on knotted-only techniques,[24-33,39,40] 2 studies reported on knotless-only techniques,[34,35] and 3 studies reported on both knotted and knotless techniques.[36-38] Of the 3 studies that described both knotted and knotless suture techniques,[36-38] only 1 study[36] performed direct comparison of outcomes based on suture technique.

There was complete agreement between the 2 independent reviewers at all phases of the review process, including title ($\kappa = 1.0$), abstract ($\kappa = 1.0$), and full-text ($\kappa = 1.0$) review. The comparative studies[36-38,40] (n = 4) received a MINORS score ranging from 17.5 to 19.5, while the noncomparative studies[24-35,39] (n = 13) received a MINORS score ranging from 7.5 to 11. There was good agreement between the 2

independent reviewers with respect to MINORS score with an ICC of 0.95. Table 1 provides a descriptive review of the study design and MINORS score for each of the included studies.

Patient Demographics and Description of Surgical Techniques

A total of 852 shoulders in 846 patients were included across all 17 studies. The overall mean patient age ranged from 18.8 to 28.7 years with an 84.2% male population. Eight studies[24,30,32-35,39,40] specifically studied a population of athletes, 3[25,26,37] of military servicemembers, and 6[27-29,31,36,38] of civilian adults. The mean follow-up reported across all studies ranged from a minimum of 12 to 96 months. The difference in length of follow-up reported between the studies included a range 27 to 66 months in the knotted-only (68.7%-100% follow-up rate), 24 to 96 months in the knotless-only (100% follow-up rate), and 12 to 71.5 months in the knotted and knotless (51.7%-100% follow-up rate) anchor repair techniques.

All studies were performed using arthroscopic techniques, except Bottoni et al.,[25] which included both arthroscopic (19) and open (12) techniques. Of the 12 studies that detailed a knotted-only technique[24-33,39,40] a total of 620 shoulders were included, compared to a total of 35 shoulders among the 2 studies describing a knotless-only technique.[34,35] Of the 3 studies that included both suture techniques,[36-38] 2 studies[37,38] combined the results of 137 total shoulders based on surgeon preference while only 1 study[36] compared results between the 2 types of suture fixation. Bents et al.[36] compared the results of 56 shoulders with knotted vs 39 shoulders with knotless repair techniques. Five studies[24,29,31,34,38] noted additional procedures performed at the time of posterior labral fixation, with the most common including biceps tenodesis (28), SLAP repair (12), and subacromial decompression or debridement (5). Table 2 outlines a comprehensive description of the baseline patient demographics and description of surgical techniques performed.

Clinical Failure, Recurrent Instability, Complications, and Revision Surgery

All but 1 study[36] reported on overall clinical failure rates. The overall failure rate ranged from 3.4% to 26.3%. Recurrent instability was the most frequently reported complication regardless of suture anchor technique, with the overall rate of recurrent instability ranging from 0% to 21.0%. The overall rate of recurrent instability for the 2 studies that included both knotless and knotted techniques[37,38] ranged from 1% to 2.7% vs 0% to 21.0% in knotted-only studies[24-33,39,40] and 14.2% in knotless-only studies.[34,35] Table 3 highlights the reported failure rates and overall complications reported across the included studies. Eight studies reported clinical failure other than recurrent instability, including complications of American Shoulder and Elbow Score (ASES) score <60 postoperatively[39,40] (13), activity-limiting shoulder pain[26,32] (10), adhesive capsulitis[27,35,37,38] (5), mechanical clunk while throwing in an overhead athlete[31] (1), and postoperative deep vein thrombosis/complex regional pain syndrome[35] (1).

The definition of recurrent instability was also variable and included patient-reported subjective instability,[24-26,29,31,35,38] a subjective instability score of ≥ 5 on a 10-point scale,[39,40] described subluxation[27,33-35] and dislocation[27] events, and recurrent instability after a traumatic reinjury.[28,32,37] Episodes of recurrent instability were treated with both physical therapy and/or revision surgery across all studies. Rates of revision surgery were reported in all but 3 studies,[24,33,36] ranging overall from 0% to 11.1% in knotted-only studies,[25-32,39,40] 0% in knotless-only studies,[34,35] and 2.0% to 8.1% in knotted vs knotless studies.[37,38] Most revision procedures included revision capsulolabral plication (27),[31,32,37-40] followed by open posterior Bankart knotted repair[25,31] (2) and lysis of adhesions[37,38] (3). One patient underwent shoulder arthroplasty 1 year after primary posterior labral repair for PSI.[38]

Patient-Reported Outcome Measures

There was a wide variety of outcome scores reported across each study (Table 4). Three studies[26,30,31] did not report PROMs, and no single PROM was included across all of the remaining studies. The ASES,[24,28,29,33-37,39,40] visual analog scale (VAS) for pain,[28,29,33,35,36,38,39,40] and Western Ontario Shoulder Instability Index (WOSI)[24,25,37,38] scores were the most common PROMs reported across all studies (Table 5). Overall, 6 total studies found a significant improvement from preoperative scores in various outcome measures including in the VAS for pain,[28,29,35,39,40] ASES,[28,29,35,39,40] Rowe score,[27,28,35] and University of California, Los Angeles shoulder score,[28,35] and Simple Shoulder Test.[29]

Six studies (4 knotted-only techniques,[28,29,39,40] 1 knotless-only technique,[35] and 1 knotted and knotless technique[36]) compared both preoperative and postoperative VAS scores, and 7 studies (4 knotted-only techniques,[28,29,39,40] 2 knotless-only techniques,[34,35] and 1 knotted and knotless technique[36]) compared both preoperative and postoperative ASES scores. All studies showed a statistically significant improvement in VAS and ASES scores after surgical intervention for PSI regardless of repair technique. Four studies[24,25,37,38] reported postoperative WOSI scores ranging from 190 $\pm$ 392 to 822.6 $\pm$ 538 across included studies. Bents et al.[36] was the only study to report pre- and

Table 1. Study Characteristics

First Author	Publication Year	Journal	Country	LoE	Study Design	Study Period	No. of Surgeons	Study Site	MINORS Score
Knotted-only anchor repair technique									
Bahk[24]	2010	*Arthroscopy*	USA	IV	Case series	NR	1	Single center	10
Bottoni[25]	2005	*Am J Sports Med*	USA	IV	Case series	May 1996—Feb 2002	NR	Multicenter	10
Bradley[39]	2013	*Am J Sports Med*	USA	II	Prospective cohort study	Jan 1998—Dec 2009	1	Single center	11
Chan[26]	2020	*Arthrosc Sports Med Rehabil*	USA	IV	Case series	2009-2015	7	Single center	11
Engelsma[27]	2010	*Knee Surg Sprots Traumatol Arthrosc*	Netherlands	IV	Case series	1998-2005	1	Single center	9.5
Kim[28]	2003	*J Bone Joint Surg Am*	Korea	IV	Case series	1995-1999	1	Single center	11
Lenart[29]	2012	*Arthroscopy*	USA	IV	Case series	2004-2009	1	Single center	9.5
Mair[30]	1998	*Am J Sports Med*	USA	IV	Case series	NR	1	Single center	7.5
Radkowski[40]	2008	*Am J Sports Med*	USA	II	Prospective cohort study	1998-2005	1	Multicenter	19.5
Williams[31]	2003	*Am J Sports Med*	USA	IV	Case series	1989-1998	1	Single center	10.5
Wolf[32]	1998	*Arthroscopy*	USA	IV	Case series	1990-1992	1	Single center	10
Wooten[33]	2015	*J Pediatr Orthop*	USA	IV	Case series	Jan 2002—Dec 2009	1	Single center	10
Knotless-only anchor repair technique									
Lacheta[34]	2021	*Knee Surg Sprots Traumatol Arthrosc*	USA	IV	Case series	2009-2016	1	Single center	10
Pennington[35]	2010	*Arthroscopy*	USA	IV	Case series	Jan 2005—Dec 2006	1	Single center	10.5
Knotted and knotless anchor repair techniques									
Bents[36]	2017	*Am J Orthop*	USA	III	Retrospective cohort	2012-2019	115	Multicenter	17.5
Galvin[37]	2019	*J Shoulder Elbow Surg*	USA	III	Retrospective cohort	Jan 2010—Jan 2014	5	Single center	19
Young[38]	2021	*J Shoulder Elbow Surg*	USA	III	Retrospective cohort	Feb 2010—Dec 2015	NR	Single center	19

LoE, level of evidence; MINORS, Methodological Index for Non-Randomized Studies; NR, not reported.

Table 2. Patient Demographics and Surgical Data

First Author	No. of Shoulders	Population	Sex (M/F)	Age (y)	Follow-up (mo)	Follow-up Rate (%)	Prior Shoulder Procedures	Approach	Surgery Performed	Additional Procedures Performed
Knotted-only anchor repair technique										
Bahk[24]	29	Athlete, adult civilian	28/1	26.3 (18.3-43.4)	66	100	NR	Arthroscopic	Posterior labral repair ± capsulorrhaphy	SLAP repair (5), RHAGL repair (2), Mumford (1), microfracture (1), PASTA debridement/ repair (2)
Bottoni[25]	31	Active duty, adult civilian	29/1	23 (15-39)	40	100	0	Arthroscopic (19), open (12)	Posterior labral repair ± capsulorrhaphy (suture/anchor)	NR
Bradley[39]	200	Athlete	158/42	24.3 (15-65)	36.7	100	NR	Arthroscopic	Capsulolabral plication (suture), capsulolabral plication (anchor), capsulolabral plication (suture/ anchor)	NR
Chan[26]	65	Active duty	60/5	27.8 ± 6.6	36	100	NR	Arthroscopic	Posterior labral repair ± capsulorrhaphy	
Engelsma[27]	19	Adult civilian	8/10	26 ± 7.9	50	100	3	Arthroscopic	Posterior labral repair (7), capsulorrhapy (3), thermal capsular shrinkage (9)	
Lenart[29]	32	Adult civilian	26/6	21.4 (15-33)	35.5	68.7	0	Arthroscopic	Posterior labral repair and capsulorrhaphy (28), capsulorrhaphy (4)	SLAP repair (6), reverse Hill-Sachs repair (3), HAGL repair (2)
Kim[28]	27	Athlete, adult civilian	25/2	21 (14-33)	39	87	0	Arthroscopic	Posterior labral repair ± capsulorrhaphy	
Mair[30]	9	Athlete	9/0	18.8 (16-21)	30	100	0	Arthroscopic	Posterior labral repair ± capsulorrhaphy	

(continued)

Table 2. Continued

First Author	No. of Shoulders	Population	Sex (M/F)	Age (y)	Follow-up (mo)	Follow-up Rate (%)	Prior Shoulder Procedures	Approach	Surgery Performed	Additional Procedures Performed
Radkowski[40]	107 (27 thrower, 80 nonthrower)	Athlete	84/23	21 ± 5.5 (thrower), 23.6 ± 9.1 (nonthrower)	27	100	NR	Arthroscopic	Capsular plication (suture), capsulolabral repair (suture), capsulolabral repair (anchor), capsulolabral repair (anchor), and additional capsular plication (suture)	
Williams[31]	27	Adult civilian	26/0	28.7 (15-55)	61.2	100	NR	Arthroscopic	Posterior labral repair ± capsulorrhaphy	Subacromial decompression (3)
Wolf[32]	14	Athlete	11/3	26 (14-54)	33	82.3	NR	Arthroscopic	Posterior labral repair ± capsulorrhaphy	
Wooten[33]	25	Athlete	19/3	17.3 ± 1.2	63	100	3	Arthroscopic	Posterior labral repair ± capsulorrhaphy	
Knotless-only anchor repair technique										
Lacheta[34]	7	Athlete	7/0	23.5 (17-43)*	96	100	0	Arthroscopic	Posterior labral repair ± capsulorrhaphy	SLAP repair (1), biceps tenodesis (1)
Pennington[35]	28	Athlete	24/4	21 (15-43)	24	100	0	Arthroscopic	Posterior labral repair ± capsulorrhaphy	
Knotted and knotless anchor repair techniques										
Bents[36]	95 (56 knotted, 39 knotless)	Adult civilian	NR	29.1 ± 12.0 (knotted), 27.5 ± 11.9 (knotless)	Minimum 12	51.7 (knotted), 61.5 (knotless)	0	Arthroscopic	Posterior labral repair ± capsulorrhaphy	
Galvin[37]	37	Active duty	37/0	28 ± 5 (20-44)	37.2	80.4	0	Arthroscopic	Posterior labral repair ± capsulorrhaphy	
Young[38]	100 (99 knotted, 1 knotless)	Adult civilian	82/18	39.5*	71.5*	100	0	Arthroscopic	Posterior labral repair ± capsulorrhaphy	Biceps tenodesis (27)

NOTE. Data are n or n (%) or mean ± standard deviation or mean (range), unless otherwise noted.
HAGL, humeral avulsion of the glenohumeral ligament; NR, not reported; RHAGL, reverse humeral avulsion of the glenohumeral ligament.
*Median.

Table 3. Clinical Failure Rate, Recurrent Instability, and Revision Surgery

First Author	Clinical Failure*	Complication Type	Recurrent Instability	Revision Surgery	Revision Procedure
Knotted-only anchor repair technique					
Bahk[24]	1 (3.4)	Recurrent instability (1)	1 (3.4)	NR	NR
Bottoni[25]	2 (6.4)	Recurrent instability (2)	2 (6.4)	1 (3.2)	Open posterior Bankart repair (1)
Bradley[39]	19 (9.6)	Recurrent instability† (7), ASES score‡ (5), both recurrent instability/ASES score (7)	14 (7.0)	13 (6.5)	Capsulolabral plication (anchor, 7), capsulolabral plication (suture, 6)
Chan[26]	11 (16.9)	Activity-limiting shoulder pain (10), recurrent instability (1)	1 (1.5)	1 (1.5)	NR
Engelsma[27§]	5 (26.3)	Recurrent subluxation (2), recurrent dislocation (2), adhesive capsulitis (1)	4 (21.0)	0 (0)	N/A
Kim[28]	1 (3.7)	Recurrent instability after reinjury (1)	1 (3.7)	0 (0)	N/A
Lenart[29]	2 (8.0)	Recurrent instability (2)	2 (8.0)	0 (0)	N/A
Mair[30]	0 (0)	N/A	0 (0)	0 (0)	N/A
Radkowski[40]	3 (11.1, thrower), 9 (11.2, nonthrower)	Recurrent instability† (11), ASES score‡ (1)	3 (11.1, thrower), 8 (10.0, nonthrower)	3 (11.1, thrower), 8 (10.0, nonthrower)	Capsulolabral plication (suture, 8), capsulolabral plication (anchor, 3)
Williams[31]	2 (7.6)	Recurrent instability (1), mechanical clunk (1)	2 (7.6)	2 (7.6)	Open posterior Bankart repair (1), arthroscopic labral debridement (1)
Wolf[32]	2 (14.2)	Recurrent instability after reinjury (1), activity-limiting shoulder pain (1)	1 (7.1)	1 (7.1)	Capsulolabral plication (1)
Wooten[33]	2 (8.0)	Recurrent subluxation (2)	2 (8.0)	NR	NR
Knotless-only anchor repair technique					
Lacheta[34]	1 (14.2)	Recurrent subluxation (1)	1 (14.2)	0 (0)	N/A
Pennington[35]	6 (21.4)	Recurrent instability (2), recurrent subluxation (2), adhesive capsulitis (1), DVT/CRPS (1)	4 (14.2)	0 (0)	N/A
Knotted and knotless anchor repair techniques					
Galvin[37]	3 (8.1)	Adhesive capsulitis (2), recurrent instability after re-injury (1)	1 (2.7)	3 (8.1)	Lysis of adhesions (2), capsulolabral plication (1)
Young[38]	1 (1.0)	Recurrent instability/ adhesive capsulitis (1)	1 (1.0)	2 (2.0)	Capsulolabral plication/ lysis of adhesions (1), shoulder arthroplasty (1)

NOTE. Data are n or n (%) or mean ± standard deviation or mean (range), unless otherwise noted.

ASES, American Shoulder and Elbow Score; CRPS, complex regional pain syndrome; DVT, deep vein thrombosis; N/A, not applicable; NR, not reported.

*Clinical failure is reported as defined in each individual study, which differed between recurrent instability alone, recurrent instability in addition to other reported complications, and recurrent instability with persistent pain preventing return to prior level of activity.

†Procedures were considered failures if patients rated postoperative subjective instability as ≥5 of 10 on the recurrent instability scale.

‡ASES score <60 postoperatively labeled as a clinical failure.

§Study reported that 1 of 4 patients with recurrent instability ultimately underwent arthrodesis in the setting of generalized ligamentous laxity and Ehler Danhlos syndrome outside of the study period.

Table 4. Reported Patient-Reported Outcome Measures (PROMs)

	VAS		ASES		Rowe		UCLA		WOSI		SANE		QuickDASH		SST	
First Author	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Knotted-only anchor repair technique																
Bahk[24]	-	-	-	+	-	-	-	+	-	+	-	-	-	-	-	-
Bottoni[25]	-	-	-	-	-	+	-	-	-	+	-	+	-	-	-	+
Bradley[39]	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
Engelsma[27]	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-
Kim[28]	+	+	+	+	-	-	+	+	-	-	-	-	-	-	-	-
Lenart[29]	+	+	+	+	-	-	-	-	-	-	-	-	-	-	+	+
Radkowski[40]	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
Wolf[32]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wooten[33]	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Knotless-only anchor repair technique																
Lacheta[34]	-	-	+	+	-	-	-	-	-	-	+	+	+	+	-	-
Pennington[35]	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-
Knotted and knotless anchor repair techniques																
Bents[36]	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
Galvin[37]	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-
Young[38]	-	+	-	-	-	-	-	-	-	+	-	-	-	+	-	+
Total	**6**	**8**	**7**	**10**	**2**	**3**	**2**	**3**	**0**	**4**	**1**	**2**	**1**	**2**	**1**	**3**

NOTE. +, PROM reported. -, PROM not reported.

ASES, American Shoulder and Elbow Score; QuickDASH, Quick Disabilities of Arm, Shoulder and Hand; SANE, Single Assessment Numeric Evaluation; SST, Simple Shoulder Test; UCLA, University of California, Los Angeles shoulder score; VAS, visual analog scale for pain; WOSI, Western Ontario Shoulder Instability Index.

postoperative VAS and ASES scores for studies including both knotted and knotless techniques. The authors found no significant difference between the 2 methods of posterior labral fixation in VAS ($P = .730$) or ASES ($P = .451$) scores at 1 year after surgery. In the knotted technique, VAS for pain score was 3.5 and 1.1, pre- and postoperatively, respectively, while VAS for pain score was 3.4 and 0.9, pre- and postoperatively, respectively, in the knotless technique. ASES scores were 63.2 and 88.6 pre- and postoperatively, respectively, in the knotted technique and 62.5 and 89.8 pre- and postoperatively, respectively, in the knotless technique.

Return to Sport or Duty

Thirteen studies reported on rates of RTS[24,28-35,39,40] or military duty.[26,37] Across all reporting studies, RTS rates ranged from 78.5% to 100% (Table 6). RTS rates in the 2 studies describing a knotless-only technique[34,35] ranged from 92.8% to 100%, while the 10 studies describing a knotted-only technique[24,26,28-33,39,40] reported an RTS rate ranging from 78.5% to 100%. Galvin et al.[37] was the only combined knotted and knotless technique study that reported on return to duty with an overall return to duty rate of 84% with 6 military members undergoing medical separation at a mean of 1.1 years postoperatively due to persistent shoulder dysfunction. Chan et al.[26] also reported on return to duty in an active-duty population with a similar rate of 83% return to prior duty level. The authors noted that 10 servicemembers reported persistent pain preventing full return to prior level of duty, but only 1 underwent medical separation with no improvement in pain after revision surgery.

Discussion

The most important findings from this systematic review suggest no clear clinically superior method of arthroscopic fixation for posterior labral tears with regard to knotted vs knotless fixation methods in terms of clinical failure, recurrent instability, or revision surgery rates, which supports our overall hypothesis. The rate of clinical failure was 0% to 26.3% in knotted-only techniques, 14.2% to 21.4% in knotless-only techniques, and 1% to 8.1% failure rate in studies reporting on both knotted and knotless techniques. Similarly, rates of revision surgery were comparable, ranging from 0% to 11.1% in knotted-only studies, 0% in knotless-only studies, and 2.0% to 8.1% in knotted vs knotless studies. Another important finding of this review is that posterior labral repair for isolated PSI showed good overall clinical outcomes regardless of fixation method used, with an overall RTS or duty rate at a minimum of 78.5%. Revision surgery was most commonly performed to address recurrent instability with revision capsulolabral plication or open posterior Bankart repair.

This finding of no superior method adds to clinical practice as it suggests that newer methods of knotless suture anchors may be considered an acceptable alternative to traditional knotted techniques. Bents et al.[36]

Table 5. Most Frequently Reported Patient Outcomes Measures

	VAS		ASES		WOSI	
First Author	Pre	Post	Pre	Post	Pre	Post
Knotted-only anchor repair technique						
Bahk[24]	NR	NR	NR	90.7 (53.3-100)	NR	359 (0-1,033)
Bottoni[25]	NR	NR	NR	NR	NR	190 ± 392 (arthroscopic), 594 ± 677 (open)
Bradley[39]	6.5 ± 2.6 (0-10)	1.9 ± 1.9 (0-9)	45.9 ± 18.2 (1.6-94.8)	85.1 ± 14.9 (25-100)	NR	NR
Kim[28]	4.5 ± 1.8 (3.8-5.2)	0.2 ± 0.4 (0-0.4)	51.2 ± 10.9 (47-56)	96.5 ± 4.7 (95-98)	NR	NR
Lenart[29]	3.5 ± 2.1	0.8 ± 1.3	67.9 ± 15.2	93.2 ± 8.9	NR	NR
Radkowski[40]	6.1 ± 2.9 (thrower), 5.6 ± 2.7 (nonthrower)	2.4 ± 2.3 (thrower), 1.5 ± 1.8 (nonthrower)	51.5 ± 16.5 (thrower), 49.6 ± 19.3 (nonthrower)	82.9 ± 17.2 (thrower), 86.8 ± 15.4 (nonthrower)	NR	NR
Wooten[33]	NR	3 (0-9)	NR	74.3 ± 20 (20-100)	NR	NR
Knotless-only anchor repair technique						
Lacheta[34]	NR	NR	74.3 ± 20 (20-100)	100 (92-100)	NR	NR
Pennington[35]	5.92 ± 2.14	0.38 ± 0.51	44.77 ± 13.50	92.54 ± 11.41	NR	NR
Knotted and knotless anchor repair techniques						
Bents[36]	3.5 (knotted), 3.4 (knotless)	1.1 (knotted), 0.9 (knotless)	63.2 (knotted), 62.5 (knotless)	88.6 (knotted), 89.8 (knotless)	NR	NR
Galvin[37]	NR	NR	NR	65.6 ± 22 (15-100)	NR	822.6 ± 538 (5-1,854)
Young[38]	NR	10*	NR	NR	NR	545.5*

NOTE. Data are n or n (%) or mean ± standard deviation or mean (range), unless otherwise noted.
ASES, American Shoulder and Elbow Score; NR, not reported; VAS, visual analog scale for pain; WOSI, Western Ontario Shoulder Instability Index.
*Median.

Table 6. Return to Sport and Duty Characterization

First Author	Total No. of Athletes	Return to Sport/Duty	Preinjury Level of Sport	Limited Level of Sport
Knotted-only anchor repair technique				
Bahk[24]	26	22 (84.6)	17 (77.2)	5 (22.7)
Bradley[39]	200	180 (90)	127 (70.5)	53 (29.4)
Chan[26]*	65	54 (83)[†]	N/A	N/A
Kim[28]	27	26 (96.2)	24 (92.3)	2 (7.6)
Lenart[29]	22	22 (100)	22 (100)	0 (0)
Mair[30]	9	9 (100)	9 (100)	0 (0)
Radkowski[40]	27 (thrower), 80 (nonthrower)	23 (85.1, thrower), 73 (91.2, nonthrower)	15 (65.2, thrower), 57 (78.0, nonthrower)	8 (34.7, thrower), 16 (21.9, nonthrower)
Williams[31]	26	25 (96.1)	24 (96)	1 (4)
Wolf[32]	14	11 (78.5)	10 (90.9)	1 (9.0)
Wooten[33]	25	22 (88)	17 (77.2)	5 (22.7)
Knotless-only anchor repair technique				
Lacheta[34]	7	7 (100)	7 (100)	0 (0)
Pennington[35]	28	26 (92.8)	23 (88.4)	3 (11.5)
Knotted and knotless anchor repair techniques				
Galvin[37]*	37	31 (83.7)[‡]	N/A	N/A

NOTE. Data are n or n (%) or mean ± standard deviation or mean (range), unless otherwise noted.
N/A, not applicable; NR, not reported.
*Study reported on return to duty in active-duty servicemembers.
[†]One military member underwent medical separation with no improvement after revision surgery; 10 military members showed persistent, activity-limiting shoulder pain preventing return to previous level of military activities.
[‡]Six military members underwent medical separation due to persistent shoulder dysfunction after a mean of 1.1 years postoperatively.

was the only study to directly compare pre- and postoperative VAS and ASES scores between knotted and knotless repair techniques, showing no significant difference in postoperative VAS or ASES scores at 1 year after surgery. This has previously been supported in the setting of rotator cuff repair and anterior shoulder arthroscopic stabilization.[16,23] However, this study is a comprehensive comparative review in the literature evaluating knotted vs knotless techniques in the setting of posterior labral repair, which is far less common with significantly worse return to play outcomes reported compared to anterior shoulder stabilization.[41,42] Additionally, multiple studies have shown a decreased intraoperative time with knotless suture anchor techniques,[16,18,19,36] which is likely to become more attractive as knotless techniques become more widely used with improved surgeon familiarity.

The high RTS and duty rates, along with the improvement in PROMs shown in this systematic review across studies of all fixation methods, with comparable length of follow-up between studies, suggest that either repair technique may provide satisfactory outcomes. However, the lack of recent prospective direct comparison studies precludes a definitive determination of a superior method of fixation. Few studies reported on both knotless and knotted methods of posterior labral repair, with only 1 being a direct comparison. Bents et al.[36] provided the only direct comparison and showed overall improved PROMs across both groups after surgery with no difference based on knotted or knotless techniques at 1 year after surgery. This study was limited by a low follow-up rate (51% and 61% in the knotted and knotless groups, respectively) and did not provide any information on recurrent instability, revision rates, or return to activity.

The findings of the current study parallel those revealed by Matache et al.[16] in a systematic review of knotless vs knotted anchors in anterior labral repair. While the majority of the review focused on anterior labral pathology and SLAP tears, there was no difference in recurrence and revision rates with similar PROMs at final follow-up across the 17 included studies, suggesting either technique may be considered in clinical practice for anterior labral pathology. The authors supported the claim that the use of knotless anchors may reduce operative time. Of the 4 studies that compared operative time between fixation methods, all showed a decreased operative time with knotless fixation, similar to that revealed in the comparative review by Bents et al.[36]—67.0 minutes for knotted repairs vs 43.1 minutes for knotless repairs. Decreased intraoperative time has direct impacts on the global cost of care while also limiting unnecessary extended time under anesthesia to the patient and secondary complications.

The lack of agreement in surgeon terminology in defining outcomes for the "success" vs "failure" of a described technique risks misinterpretation of clinical results and further limits direct comparison of outcomes. There was large variability across studies in

reporting failure rates with overlap of clinical failure, recurrent instability, and complications, making it difficult to assess true rates of recurrent instability. Furthermore, recurrent instability was variably categorized by self-reported subjective instability, subluxation and dislocation events, persistent pain preventing return to prior level of activity, and clinical examination findings supporting posterior instability (posterior apprehension or posterior load shift), which again can make interpretation of results and direct comparison difficult. Bradley et al.[39] and Radkowski et al.[40] used objective data to define clinical failure, either by ASES score <60 postoperatively or a score of ≥ 5 of 10 on the recurrent instability scale. Further consensus should be directed to standardize definitions of recurrent instability and clinical failure across the literature. This lack of consensus shows the continued need for high-level prospective clinical studies investigating failure rates and recurrent instability, as well as patient outcome measures in knotless and knotted fixation anchors in PSI, particularly as the knotless technique continues to be more and more integrated into clinical practice over the past 20 years.

Limitations

This study is not without limitations. The large heterogeneity of not only the clinical outcomes reported across the included studies but, more important, the variability in surgeon definition of clinical failure and recurrent instability makes direct comparison of knotted and knotless techniques difficult across the current available literature. This systematic review was also limited by the heterogeneity of the data presented and lack of overall high-level evidence, which ultimately precluded the ability to perform pooled quantitative analysis. A compilation of studies with overall low-level evidence with mostly retrospective designs and lack of appropriate controls and blinding has a high propensity for introducing bias while limiting the overall applicability and clinical relevance of the results.[43] The large retrospective nature of the included studies and the unequal distribution of knotted vs knotless repair techniques is also a limitation, which prevented direct comparison of results. Of the 3 studies that included both knotted and knotless fixation methods, Young et al.[38] only had 1 patient in the knotless group (vs 99 patients in the knotted group); Galvin et al.[37] included both knotted and knotless fixation techniques depending on surgeon preference but did not note the distribution.

Conclusions

Overall recurrent instability after posterior labral repair for isolated PSI was low with improvement in PROMs and favorable RTS rates regardless of fixation method. There was no clear difference in recurrent instability or revision surgery between knotted and knotless fixation methods for isolated posterior labral repair. However, the current literature is predominantly limited by Level III and IV evidence. The quality of literature and lack of standardization on the definition of clinical failure and recurrent instability among surgeons preclude any definitive conclusion regarding one clinically superior fixation method.

Disclosures

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