JSES Reviews, Reports, and Techniques 2 (2022) 135–139

Contents lists available at ScienceDirect

JSES Reviews, Reports, and Techniques

journal homepage: www.jsesreviewsreportstech.org

# Does shoulder stability differ with or without subscapularis repair after primary reverse total shoulder arthroplasty? A systematic review

David Ulery, DO, Anthony J. Mancuso II, DO, MPH, Tom Edgerton, DO, Justin Butler, DO, Amy Singleton, DO*, Richard M. Miller, DO

*Mercy Health St. Vincent Medical Center, Department of Orthopedics, Toledo, OH, USA*

ARTICLE INFO

*Keywords:*
Reverse
Shoulder arthroplasty
Subscapularis
Tenotomy
Glenohumeral joint
Instability

*Level of evidence:* Systematic Review

The use of reverse total shoulder arthroplasty (RTSA) has expanded from its original indication as a rotator cuff arthropathy treatment to include a large variety of pathologies. A frequently reported complication with this surgery is postoperative shoulder instability with reported incidence varying widely from 2.3 to 38%. The etiology for this instability is broad and includes prosthesis design, mechanical impingement, surgical technique, and axillary/deltoid function. A PROSPERO-registered systematic review was performed utilizing PRISMA guidelines using Cochrane, PUBMED, Embase, and Eline. Of the 1442 studies initially identified, 7 studies met all inclusion criteria, all of which were level III or IV evidence. All 7 studies evaluated postoperative instability, but no study reported a statistically significant difference in instability rates between the groups. Dislocations occurred in 5 patients (5/679, 0.7%) with subscapularis repair and 8 patients (8/527, 1.5%) without repair. A nonsignificant difference in the risk of instability for surgeries with repair compared to surgeries without repair was found (overall risk difference: 0.01, random effects 95% confidence interval: −0.00 to 0.02, $P = .11$). This review suggests no difference in postoperative shoulder instability rates between patients that underwent primary RTSA with or without subsequent repair of the subscapularis tendon. Interestingly, one study comparing implants with a medialized or nonlateralized implant showed a significantly increased rate of dislocation with the medialized group compared to the lateralized group. When these groups were then stratified based on subscapularis repair status, there was no increased risk with a nonrepaired tendon. This study suggests that implant design may have more influence on the stability of RTSA than subscapularis status. However, overall, there does appear to be a trend suggesting improved postoperative clinical outcomes and active range of motion for patients with a subscapularis repair vs. without a repair. Further research is needed to better elucidate the ideal combination of surgical technique and implant design to minimize postoperative glenohumeral joint instability while optimizing postoperative clinical outcomes and range of motion after primary RTSA.



Reverse total shoulder arthroplasty (RTSA) continues to be an effective treatment for patients presenting with rotator cuff arthropathy (RCA). Since gaining Food and Drug Administration approval in 2004, the implementation of RTSA by orthopedic surgeons has increasingly grown across the United States.[2] In 2014, Palsis used the National Inpatient Sample database to demonstrate there were 79,105 shoulder arthroplasties performed in the United States, 46% of which were RTSA.[16] Indications for RTSA have expanded from its original indication as treatment for RCA to include osteoarthrosis and allied disorders, unspecified arthropathies of the shoulder, complex fracture patterns of the proximal humerus, massive rotator cuff tears, pseudoparalysis, and failed anatomic total shoulder arthroplasty.[14,15,17] As indications expand, however, so do the potential complications. One of the most frequently reported complications postoperatively is instability of the shoulder, with or without associated trauma. The incidence of postoperative instability and dislocation reported in the literature varies widely from 2.3% to 38%.[1,4] The etiology for this instability is broad and includes soft-tissue tensioning, prosthesis design, mechanical impingement, surgical technique, and axillary/deltoid function.[5]

The standard surgical approach for shoulder arthroplasty is the deltopectoral approach, with exposure of the glenohumeral joint

Institutional review board approval was not required for this review article.

*Corresponding author: Amy Singleton, DO, Mercy Health St Vincent Medical Center, Department of Orthopedics, 2409 Cherry Street, Suite #10, Toledo, OH 43608, USA.

*E-mail address:* asingleton@mercy.com (A. Singleton).

https://doi.org/10.1016/j.xrrt.2022.01.003

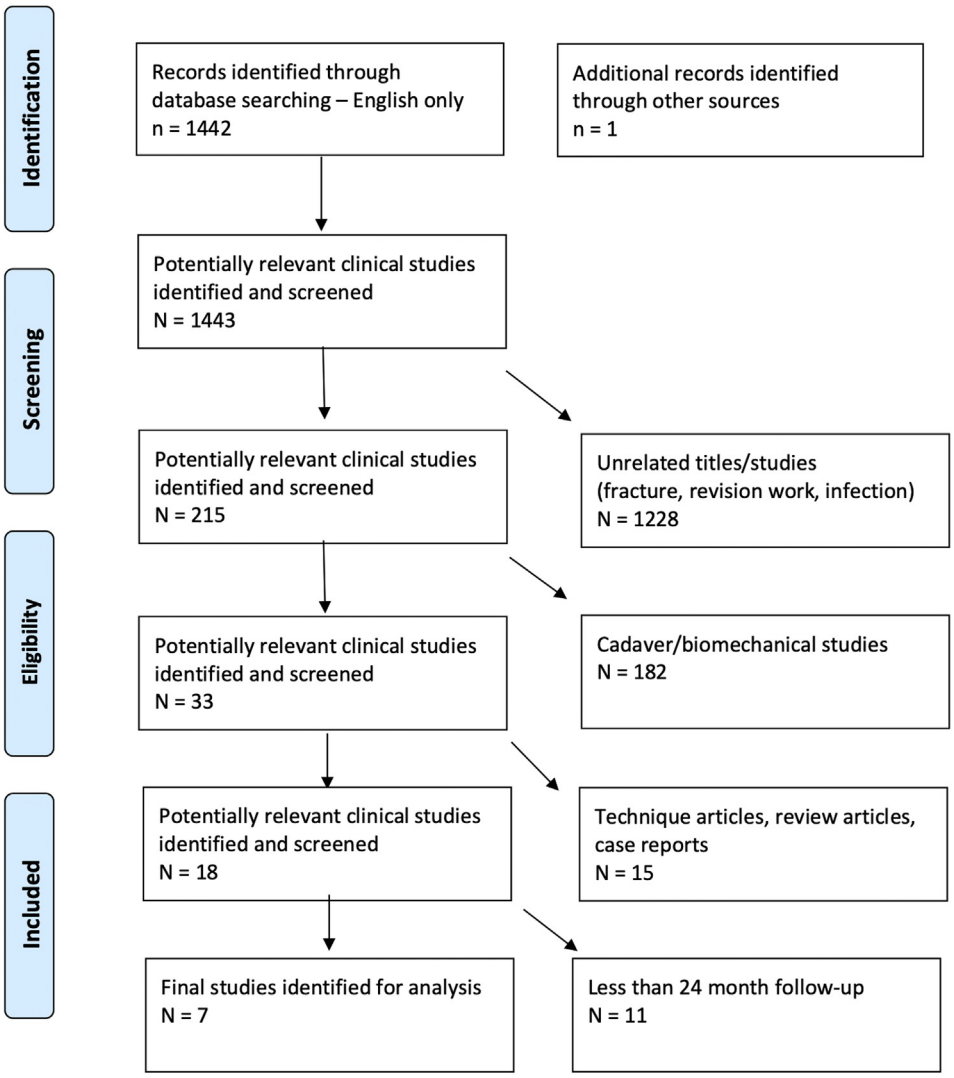


**Figure 1** A PRISMA diagram of study screening.

requiring incision and subsequent reflection of the subscapularis tendon and/or its insertion on the lesser tuberosity. Multiple techniques exist for achieving exposure of the glenohumeral joint, the merits of each having been well investigated. Three main techniques—a lesser tuberosity osteotomy, subscapularis tenotomy, or a subscapularis peel—have been shown to be equal in subscapularis strength, healing rates, and patient satisfaction scores postoperatively.[3,10,11] However, controversy remains regarding the handling of the subscapularis during primary RTSA after implant placement. There continues to be debate as to whether the subscapularis needs to be repaired to preserve stability, normalize biomechanics, and improve patient outcomes postoperatively. Quality studies evaluating this dilemma are lacking in the orthopedic literature. To compound the problem, the relative infancy of this surgery in the United States leads to the continued evolution of RTSA implants; thus, no standard protocols exist and the etiology of instability postoperatively is likely to be multifactorial. Prospective studies directly comparing and detailing the benefits and drawbacks of subscapularis repair in conjunction with different implant designs are needed. The purpose of this systematic review is to evaluate and compare stability and clinical outcomes of primary RTSA performed with and without subscapularis repair utilizing the currently available literature.

## Methods

A PROSPERO-registered systematic review (CRD42019112184) was performed utilizing PRISMA guidelines.[12,13] Two reviewers independently conducted an electronic search on March 15, 2018, using the following publicly available databases: Cochrane, PUBMED, Embase, and Eline. Search terms utilized included the following: arthroplasty, replacement, shoulder, total; either used alone or in combination. The search terms were deliberately left broad to encompass as many studies in the initial search as possible. Any studies that would have discussed “subscapularis” as a term would have to have used one of the included terms as well to be relevant to the study.

All studies comparing subscapularis repair vs. unrepaired in primary RTSA were eligible for inclusion. Inclusion criteria were as follows: 1) English language studies reporting instability episodes, 2) studies reporting clinical and functional outcome measures and

**Table 1**
Characteristics of the included studies (n = 7) for the final review.

| Study | Year published | Years of patient enrollment | Mean patient age (yr) | No. of subscapularis repairs | No. of subscapularis tenotomies | Mean follow-up (mo) | Clinical outcomes |
|---|---|---|---|---|---|---|---|
| De Boer[6] | 2016 | 2006-2014 | 74 | 25 | 40 | 36 | No dislocations for either group<br>No difference in postoperative ROM, strength, C-M, or Oxford scores<br>10 of 25 (40%) repaired subscapularis tendons remained sufficient on ultrasound examination postoperatively |
| Edwards[7] | 2009 | 2004-2006 | 68 | 51 | 24 | 36 | No dislocations in repair group, 1 dislocation in tenotomy group<br>Not significant |
| Friedman[8] | 2017 | | 72 | 340 | 251 | 37 | No dislocations in repair group, 3 dislocations in tenotomy group<br>Not significant<br>Repair group had significantly higher postoperative SST, ASES, Constant, and SPADI scores with less active abduction and ER, and a higher IR score<br>Repair group had significantly better improvements in SST and Constant scores, IR score, active ER, and strength |
| Huri[9] | 2016 | 2004-2011 | 75 | 48 | 17 | 35 | There was a non-significant difference in dislocation events between the two groups<br>Medialized implants had 3 dislocations, lateralized had none, which was a significant difference |
| Roberson[18] | 2017 | 2007-2012 | 68 | 58 | 41 | 49 | 3 dislocations in repair group, 1 dislocation in tenotomy group<br>Not significant<br>No differences in ASES, SANE, PSS, VR-12, FE, or ER |
| Vourazeris[19] | 2017 | 2007-2013 | 71 | 86 | 116 | 40 | No dislocations in repair group, 3 dislocations in tenotomy group<br>Not significant<br>No differences in ASES, SPADI, UCLA, SST-12, Constant, ROM, or strength |
| Werner[20] | 2018 | 2007-2014 | 71 | 71 | 38 | 24 | 2 dislocations in repair group, no dislocations in tenotomy group<br>Not significant<br>No difference ASES between groups<br>Patients undergoing subscapularis repair and glenosphere lateralization had less improvement in ASES scores |

*ROM*, range of motion; *C-M*, Constant Murley; *SST-12*, Simple Shoulder Test; *ASES*, American Shoulder and Elbow Surgeons; *SPADI*, Shoulder Pain and Disability Index; *IR*, internal rotation; *ER*, external rotation; *SANE*, Single Assessment Numeric Evaluation; *PSS*, Penn Shoulder Score; *VR-12*, Veterans Rand-12; *FE*, forward elevation; *UCLA*, University of California, Los Angeles.

preoperative vs. postoperative range of motion values, and 3) studies reporting primary RTSA for the following indications: rotator cuff tear arthropathy, massive irreparable rotator cuff tear, glenohumeral osteoarthritis with irreparable rotator cuff tear, glenohumeral osteoarthritis with glenoid bone loss, inflammatory arthritis with rotator cuff tear, and avascular necrosis of the humeral head with rotator cuff tear. Studies were excluded based on the following criteria: 1) publication in a non-English language, 2) studies involving arthroplasty for fracture, malunion, nonunion, revision, 3) studies in which subscapularis status was not well defined, 4) cadaveric/biomechanical studies, 5) and any study with an average follow-up of less than 24 months. Levels I, II, III, and IV evidence were included. All references within the included studies were cross-referenced for inclusion of any studies potentially missed by the initial search. RevMan software (John Wiley & Sons, Indianapolis, IN, USA), for noncommercial use, was utilized to determine the 95% confidence intervals for the risk difference of instability events between the repair group and the nonrepair group.

## Results

Of the 1442 studies initially identified, 21 studies were then screened by full text or abstract. Seven final studies met all inclusion criteria, of which all were level III or IV evidence.[6-9,18-20] A PRISMA diagram is found in Figure 1. Four studies (4/7, 57%) were single-institution studies with single surgeon results. Two studies (2/7, 29%) obtained patient data from regional or national registries. A total of 1206 shoulders in 1192 patients, with a mean patient age of 71 years, underwent primary RTSA for one of the following diagnoses: rotator cuff arthropathy, massive irreparable rotator cuff tear, or inflammatory arthritis. Various implant brands were utilized based on surgeon preference and institution policy. The average follow-up was 37 months. A total of 679 shoulders underwent subscapularis repair, while 527 did not. Those who did not undergo repair underwent tenotomy or did not have enough tissue for repair.

All seven studies evaluated postoperative instability, but no study reported a statistically significant difference in instability

rates between the 2 groups. Overall, dislocations occurred in 5 of the patients (5/679, 0.7%) with a repaired subscapularis and 8 of the patients (8/527, 1.5%) with no repair. A nonsignificant difference in the risk of instability for surgeries with repair compared to surgeries without repair was found (overall risk difference: 0.01, random effects 95% confidence interval: −0.00 to 0.02, $P = .11$). A summary of the included studies is found in Table I.

## Discussion

RTSA has become a powerful treatment option for orthopedic surgeons. Nonetheless, the ideal approach for handling the subscapularis tendon after implant placement remains undetermined. The purpose of this study was to perform a systematic review of the current literature to determine the rates of instability associated with repair vs. without repair and to determine if clinical and functional outcomes differed between the two techniques.

Seven studies met inclusion criteria, all of which reported on the number of instability events between the groups. All included studies reported clinical outcome scores and postoperative measures of patient range of motion. The results suggest that either undergoing repair or not of the subscapularis tendon after primary RTSA does not alter the probability that a patient may experience a dislocation event.

Furthermore, only one of the seven studies reported a significant improvement in postoperative functional outcome scores and range of motion measures for the subscapularis repair group.[8]

This study demonstrated a significant difference in outcome scores in the repair group vs. the no-repair group using the Simple Shoulder Test ($P = .0001$), American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form ($P = .0008$), Constant score ($P < .0001$), and Shoulder Pain and Disability Index scores ($P = .0002$). The repair group showed improved scores regardless of the scoring system used. This same study found that the repair group vs. the nonrepair group had better improvements in active internal and external rotation ($P = .0030$ and $.0045$) and passive external rotation (mean 22° vs. 19°), while the nonrepair group demonstrated better improvement in active abduction (mean 41° repair vs. 45° nonrepair, $P = .3563$).

As the body of literature surrounding RTSA continues to grow, trends in implant design have shifted. A large portion of the currently available implants on the market today boast some form of lateralization of the center of rotation. Of the seven studies included in our review, there was only 1 that utilized an implant with a medialized or nonlateralized implant.[9] This group showed an increased rate of dislocation (n = 3) compared to their lateralized group (n = 0). Despite this, when these groups were then stratified based on subscapularis repair status, there was no increased risk with a nonrepaired tendon. This may suggest that implant design has more influence on the stability of RTSA than subscapularis status, but one study does not reflect the aggregate of studies containing medialized implants, which did not meet the inclusion criteria for this review.

Interestingly, de Boer demonstrated that only 40% of their initially repaired subscapularis tendons appeared still sufficient on follow-up ultrasound examination.[6] There was no increased rate of instability in this group that had postoperative insufficiency. Despite having an adequate amount of tissue for repair intraoperatively, a failed repair postoperatively does not seem to have an overall effect on stability of the glenohumeral joint, again suggesting that the subscapularis status may have a lesser role in overall stability than implant design.

This study's main limitation was the small number of studies captured by our inclusion criteria. This limited our ability to perform a meta-analysis despite the large number of patients included in the studies (n = 1192) and limited our ability to draw concrete conclusions about our topic of interest. Dislocations were only recorded in 1.1% (13/1206) of patients, much smaller than previously reported rates of 2.3% to 38%.[1,4] A larger cohort is needed to discover a practical effect size. There was also a great deal of heterogeneity in reporting systems for outcome measures. There were seven different measures used to measure clinical range of motion and strength and 13 different measures used to measure functional outcomes. This limited our ability to generalize clinical outcomes between studies and between groups. Even so, the trends of the different studies were in agreement, and we are confident in our conclusions regarding subscapularis repair in primary RTSA.

## Conclusion

There are many factors that contribute to postoperative stability of a shoulder after RTSA procedures including a patient's native shoulder anatomy, postoperative physical therapy, implant design, technical aspects of implant positioning, and subscapularis repair. This review suggests no difference in postoperative shoulder instability rates between patients that underwent primary RTSA with or without subsequent repair of the subscapularis tendon. There appears to be a trend suggesting improved clinical outcomes and active range of motion for patients with a subscapularis repair. Prospective, randomized controlled trials comparing the two methods utilizing different implant designs are needed to better elucidate the optimal surgical technique to minimize postoperative glenohumeral joint instability and improve postoperative clinical outcomes, satisfaction, and range of motion after primary RTSA.

## Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

## Acknowledgments

The authors acknowledge Anil Gupta, MD for assistance in supervision of this project. The authors would like to acknowledge Superior Medical Experts for assistance with manuscript drafting and image creation.

## References

1. Boileau P. Complications and revision of reverse total shoulder arthroplasty. Orthop Trama Surg Res 2016;102:S33-43. https://doi.org/10.1016/j.ostr.2015.06.031.
2. Boileau P, Watkinson DJ, Hatzidakis AM, Balg F. Grammont reverse prosthesis: design, rationale, and biomechanics. J Shoulder Elbow Surg 2005;14:147S-61S. https://doi.org/10.1016/j.jse.2004.10.006.
3. Buckley T, Miller R, Nicandri G, Lewis R, Voloshin I, Armstrong A. Analysis of subscapularis tenotomy in total shoulder arthroplasty using ultrasound and validated clinical outcome measures. J Should Elbow Surg 2014;23:1309-17. https://doi.org/10.1016/j.jse.2013.12.009.
4. Bufguin T, Hersan A, Hubert L, Massin P. Reverse shoulder arthroplasty for the treatment of three- and four-part fractures of the proximal humerus in the elderly: a prospective review of 43 cases with a short-term follow-up. J Bone Joint Surg Br 2007;89:516-20. https://doi.org/10.1302/0301-620X.89B4.18435.
5. Cheung E, Willis M, Walker M, Clark R, Frankle M. Complications in reverse total shoulder arthroplasty. J Amer Acad Orthop 2011;19:439-49.
6. de Boer FA, van Kampen PM, Huijsmans PE. The influence of subscapularis tendon reattachment on range of motion in reversed shoulder arthroplasty: a clinical study. Musculoskelet Surg 2016;100:121-6. https://doi.org/10.1007/s12306-016-0401-8.

7. Edwards TB, Williams MD, Labriola JE, Elkousy HA, Gartsman GM, O'Connor DP. Subscapularis insufficiency and the risk of shoulder dislocation after reverse shoulder arthroplasty. J Should Elbow Surg 2009;18:892-6. https://doi.org/10.1016/j.jse.2008.12.013.
8. Friedman RJ, Flurin PH, Wright TW, Zuckerman JD, Roche CP. Comparison of reverse total shoulder arthroplasty outcomes with and without subscapularis repair. J Shoulder Elbow Surg 2017;26:662-8. https://doi.org/10.1016/j.jse.2016.09.027.
9. Huri G, Familiari F, Salari N, Petersen SA, Doral MN, McFarland EG. Prosthetic design of reverse shoulder arthroplasty contributes to scapular notching and instability. World J Orthop 2016;7:738-45. https://doi.org/10.5312/wjo.v7.i11.738.
10. Lapner PLC, Sabri E, Rakhra K, Bell K, Athwal GS. Comparison of lesser tuberosity osteotomy to subscapularis peel in shoulder arthroplasty: a randomized controlled trial. J Bone Joint Surg Am 2012;94:2239-46. https://doi.org/10.2106/JBJS.K.01365.
11. Lapner PLC, Sabri E, Rakhra K, Bell K, Athwal GS. Healing rates and subscapularis fatty infiltration after lesser tuberosity osteotomy versus subscapularis peel for exposure during shoulder arthroplasty. J Should Elbow Surg 2013;22:396-402. https://doi.org/10.1016/j.jse.2012.05.031.
12. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, Ioannidis JPA, et al. "The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration". J Clin Epidemiol 2009;62:e1-34. https://doi.org/10.1016/j.jclinepi.2009.06.006.
13. National Institute for Health Research. The University of York. 2021. Available at: https://www.crd.york.ac.uk/prospero/. Accessed August 26, 2021.
14. Neer CS 2nd, Craig EV, Fukuda H. Cuff-tear arthropathy. J Bone Joint Surg Am 1983;65:1232-44.
15. Neer CS 2nd, Watson KC, Stanton FJ. Recent experience in total shoulder replacement. J Bone Joint Surg Am 1982;64:319-37.
16. Palsis JA, Simpson KN, Matthews JH, Traven S, Eichinger JK, Friedman RJ. Current trends in the use of shoulder arthroplasty in the United States. Orthopedics 2018;41:e416-23. https://doi.org/10.3928/01477447-20180409-05.
17. Westerman RW, Pugely AJ, Martin CT, Gao Y, Wolf BR, Hettrich CM. Reverse shoulder arthroplasty in the United States: a comparison of national volume, patient demographics, complications, and surgical indications. Iowa Orthop J 2015;35:1-7.
18. Roberson TA, Granade CM, Hunt Q, Griscom JT, Adams KJ, Momaya AM, et al. Nonoperative management versus reverse shoulder arthroplasty for treatment of 3- and 4-part proximal humeral fractures in older adults. J Shoulder Elbow Surg 2017;26:1017-22. https://doi.org/10.1016/j.jse.2016.10.013.
19. Vourazeris JD, Wright TW, Struk AM, King JJ, Farmer KW. Primary reverse total shoulder arthroplasty outcomes in patients with subscapularis repair versus tenotomy. J Shoulder Elbow Surg 2017;26:450-7. https://doi.org/10.1016/j.jse.2016.09.017.
20. Werner BC, Wong AC, Mahony GT, Craig EV, Dines DM, Warren RF, et al. Clinical Outcomes After Reverse Shoulder Arthroplasty With and Without Subscapularis Repair: The Importance of Considering Glenosphere Lateralization. J Am Acad Orthop Surg 2018;26:e114-9. https://doi.org/10.5435/JAAOS-D-16-00781.