



# Systematic review of reversing pseudoparalysis of the shoulder due to massive, irreparable rotator cuff tears

Patrick Dickerson, MD, MS<sup>a</sup>, Stephan G. Pill, MD<sup>b</sup>, Robert Longstaffe, MD, FRCSC<sup>c</sup>, Ellen Shanley, PhD, PT, OCS<sup>d,e</sup>, Charles A. Thigpen, PhD, PT, ATC<sup>d,e</sup>, Michael J. Kissenberth, MD<sup>b,\*</sup>

<sup>a</sup>Mercy Clinic Orthopedics, Rogers, AR, USA

<sup>b</sup>Steadman Hawkins Clinic of the Carolinas, Prisma Health-Upstate, Greenville, SC, USA

<sup>c</sup>Pan Am Clinic, Winnipeg, MB, Canada

<sup>d</sup>ATI Physical Therapy, Greenville, SC, USA

<sup>e</sup>SC Center for Effectiveness Research in Orthopaedics, Greenville, SC, USA

**Background:** Correcting pseudoparalysis of the shoulder due to massive rotator cuff tear is challenging. The most reliable treatment for restoring active shoulder elevation is debatable. Therefore, the purpose of this systematic review was to evaluate the success of various treatment options for reversing pseudoparalysis due to massive rotator cuff tear.

**Methods:** A search was performed in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines of the MEDLINE database, Cochrane database, Sportdiscus, and Google Scholar database for articles evaluating shoulder pseudoparalysis due to massive rotator cuff tears.

**Results:** Nine articles evaluating reverse total shoulder arthroplasty (RTSA), superior capsular reconstruction (SCR), and rehabilitation programs were included in the study. Though there was variability, the definition of pseudoparalysis was active forward elevation (AFE) less than 90° with preserved passive range of motion (ROM). Reversal of pseudoparalysis was defined as restoration of AFE greater than 90°. The overall rate of reversal of pseudoparalysis across studies was similar for RTSA (96% ± 17%) and SCR (94% ± 3%). However, there was a difference in average improvement in AFE for RTSA (56° ± 11°) and SCR (106° ± 20°). A progressive rehabilitation program described improvements in a single study with 82% reversal of pseudoparalysis.

**Conclusion:** The available Level IV evidence suggests that RTSA and SCR reliably reverse pseudoparalysis in most patients with massive, irreparable rotator cuff tears. However, the dissimilar improvements in ROM suggest that a more consistent definition of pseudoparalysis is warranted. Future randomized controlled trials are needed to determine the best treatment approach for patients with massive irreparable rotator cuff tears.

**Level of evidence:** Level IV; Systematic Review

© 2020 Journal of Shoulder and Elbow Surgery Board of Trustees. All rights reserved.

**Keywords:** Pseudoparalysis; superior capsular reconstruction; reverse shoulder arthroplasty; systematic review; outcomes; rehabilitation

This systematic review did not require institutional review board approval.

\*Reprint requests: Michael J. Kissenberth, MD, Steadman Hawkins Clinic of the Carolinas, Prisma Health–Upstate, 200 Patewood Drive, Suite C100, Greenville, SC, USA.

E-mail address: [mike.kissenberth@hawkinsfoundation.com](mailto:mike.kissenberth@hawkinsfoundation.com) (M.J. Kissenberth).

Shoulder pseudoparalysis associated with a massive irreparable rotator cuff tear remains a challenge to define and treat. Consistency in defining pseudoparalysis has remained elusive in published literature, and this may ultimately be the most important factor in determining

success of treatment.<sup>28</sup> Many have proposed shoulder pseudoparalysis as active forward elevation (AFE) of less than 90° with preservation of passive range of motion.<sup>7,8,24,27</sup> Others consider “true pseudoparalysis” as no AFE with anterosuperior escape of the humeral head at any attempt in moving the shoulder.<sup>1,18,25,28</sup> The effect that this difference in definition has on the success of different treatment options is unknown and makes interpretation of the literature difficult.

Similarly, irreparable is defined differently by authors.<sup>5</sup> Tears can be considered irreparable when the tendon cannot be reattached without undo tension or if the quality of the muscle-tendon unit is compromised (muscle atrophy, tendon degeneration, etc.).<sup>6,19,20</sup> Others use surrogate markers to define irreparability, such as acromiohumeral distance less than 6-7 mm, tendon retraction medial to the glenoid, or advanced fatty degeneration of the muscle (Goutallier grade III or IV).<sup>9,13,26</sup> These findings suggest that the tear will unlikely be reparable at the time of surgery.

Commonly used treatments for pseudoparalysis include rehabilitation alone, reverse total shoulder arthroplasty (RTSA), and partial rotator cuff repair with superior capsular reconstruction (SCR). Rotator cuff débridement with biceps tenotomy has been described but less effective at restoring AFE in a small series of patients.<sup>1</sup> RTSA is perhaps the best studied treatment for pseudoparalysis. Initially developed for rotator cuff arthropathy, indications have now been expanded to include massive irreparable rotator cuff tears even without the presence of arthritis.<sup>2,10,11,30</sup>

More recently, SCR using either fascia lata autograft or dermal allograft has shown good early results for improving function in cuff deficient shoulders.<sup>3,4,22,23</sup> Although SCR may minimize risks compared to prosthetic options, it is unclear whether it can correct true pseudoparalysis.<sup>28</sup>

A comprehensive rehabilitation program remains an appealing option especially in the elderly patient when surgical risks are unacceptable.<sup>7,21</sup> The success of different treatment options in reversing pseudoparalysis has been discussed and studied individually. However, most of these studies are relatively small case series without randomized controlled trials to compare different treatments. Although each treatment option has shown improvement in the patient clinical presentation, it is unknown which treatment options offer the most reliable way to reverse shoulder pseudoparalysis. Thus, the goal of this review is to systematically review the existing literature on which treatment best reverses shoulder pseudoparalysis caused by irreparable rotator cuff tear.

## Methods

A systematic review was performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)

guidelines. Our search was performed by using the MEDLINE, Cochrane, SportDiscus, and Google Scholar databases; it included all years through January 2019. Search terms / key words for the literature review included pseudoparalysis, pseudoparesis, irreparable rotator cuff tear, reverse total shoulder arthroplasty, and superior capsular reconstruction. The initial search was performed on November 1, 2018, with a follow-up search performed on January 4, 2019.

Inclusion criteria included patients diagnosed with pseudoparalysis or pseudoparesis as defined by AFE less than 90° with preserved passive range of motion (ROM), concomitant irreparable rotator cuff tear, and articles in the English language. Review articles, case reports, and technique papers were excluded. Studies were also excluded if the definition of pseudoparalysis was not provided by the authors. Patients treated with RTSA for arthritis (ie, cuff tear arthropathy) were excluded from statistical analysis in an attempt to match patient characteristics between studies.

## Results

The initial key term search identified 1901 potential articles. A key term and title review of each article was performed reducing the initial search to 69 articles. After abstract review of these 69 articles for inclusion and exclusion criteria, 20 articles met the criteria. These articles were analyzed and cross-referenced to ensure no additional articles should be included. After full-text review, 9 articles were included in the final analysis. The key term literature search, abstract review, and full-text reading were conducted independently by 2 of the authors (PD, RL). Any discrepancies among the articles selected were reviewed and settled after mutual agreement.

Data extraction from the 9 articles meeting inclusion criteria was performed. Definition of pseudoparalysis was variable among articles. The majority of the articles defined pseudoparalysis as AFE of the shoulder less than 90° with preservation of passive range of motion. Other articles were stricter with their definition of pseudoparalysis as “no active range of motion” or ROM less than 90°. Outcomes of interest included rate of reversal of pseudoparalysis, which was defined as “restoration of AFE greater than 90°” and improvement in AFE. The 9 studies were divided into 3 treatment categories: (1) SCR, (2) RTSA, and (3) rehabilitation alone. Two studies were included in the SCR group, 6 studies were included in the RTSA group, and 1 study was included in the rehabilitation group (Table I).

Review of the 9 articles evaluating RTSA, SCR, and rehabilitation alone was performed looking at the rate of reversal of pseudoparalysis. Both SCR articles and 4 of the RTSA commented on reversal of pseudoparalysis. The rate of reversal was similar for RTSA (96% ± 17%) and SCR (94% ± 3%). A single study looking at the success of a rehabilitation program alone in treating pseudoparalysis described a success rate of 82% in reversing pseudoparalysis (Table II). The average improvement in AFE was also compared in each study. SCR achieved

**Table I** List of studies by group

Article	Procedure	LOE	Pseudoparalysis definition	No. of shoulders	Mean active elevation (SD)		Mean active elevation improvement	Pseudoparalysis reversal, %	Average follow-up, mo
					Preoperation	Postoperation			
Burkhart (2019) <sup>4</sup>	SCR	IV	AFE <45° with full PROM; no change in ROM after injection	10	27 (2)	159 (15)	132	90	12.9
Mihata (2018) <sup>23</sup>	SCR	IV	M: <90° AFE but no drop arm; S: <90° AFE and drop arm	43 T: 28 M, 15 S	M: 54.3 (24.4) S: 36.7 (19.1)	M: 146.8 (33.0) S: 150 (36.8)	M: 92.5, S: 113.3	M: 96, S: 93, T: 95	60
Werner (2005) <sup>30</sup>	RTSA	IV	AFE <90° with intact PROM	58	42	100	58	N/A	38
Boileau (2009) <sup>2</sup>	RTSA	IV	AFE <90°	30	56	123	67	N/A	50
Ek (2013) <sup>10</sup>	RTSA	IV	AFE <90° with intact PROM	40	72	119	47	N/A	93
Ernstbrunner (2017) <sup>11</sup>	RTSA	IV	AFE <90° with intact PROM	21	64	117	53	N/A	140
Gerber (2018) <sup>12</sup>	RTSA	IV	AFE <90° with intact PROM	16	53	101	48	N/A	193
Valenti (2011) <sup>29</sup>	RTSA	IV	AFE <90°	76	65	126	61	100	44
Levy (2008) <sup>21</sup>	Rehab	IV	Mentioned but not defined	17	40	160	120	82	N/A (min 9)

SCR, superior capsular reconstruction; RTSA, reverse total shoulder arthroplasty; Rehab, rehabilitation program; LOE, level of evidence; AFE, active forward elevation; PROM, passive range of motion; ROM, range of motion; M, moderate; S, severe; T, total; ER, external rotation; N/A, not applicable; min, minimum.

greater improvement in AFE ( $106^\circ \pm 20^\circ$ ) compared with RTSA ( $56^\circ \pm 11^\circ$ ) (Table II).

### Discussion

Although many treatment strategies exist when caring for patients with pseudoparalysis, operative treatment strategies appear to have a superior reversal rate when compared to nonoperative management. Comparing surgical options is more difficult. Both SCR and RTSA appear reliable in re-establishing ROM and reversing pseudoparalysis. The results from this review suggest that SCR may achieve better overall improvement in AFE than RTSA. However, this requires further study and longer-term follow-up. Preoperative factors may present confounding variables, such as average patient age, starting range of motion, length of follow-up, and changes in rehabilitation protocols. The difference in preoperative and postoperative ROM may be a better marker of treatment success than overall postoperative AFE.

RTSA demonstrated an average improvement of  $56^\circ$  with AFE. However, it is important to note that the review includes a long time span. More modern implants and techniques may prove to achieve better improvements in ROM. For example, inferior placement of the glenoid baseplate with slight inferior tilt has been shown to improve the total arc of motion.<sup>17</sup> Moreover, the majority of articles in this study used the Grammont-style RTSA rather than a more lateralized center of rotation design. Gutierrez et al<sup>14-16</sup> showed that decreasing the head-neck angle and lateralization of the center of rotation can lead to significant increases in impingement-free arc of motion. Similarly, the indications and techniques of SCR are evolving, so ongoing studies will be needed to further evaluate the effectiveness of these interventions. The benefits and amount of motion gained might be significantly greater than previously published.

SCR was associated with a reliable reversal of shoulder pseudoparalysis and a greater increase in AFE ( $109^\circ$ ). In 2018, Mihata et al<sup>23</sup> found that patients with more profound pseudoparalysis had greater postoperative improvements than those with “moderate” pseudoparalysis. Others have challenged the ability of SCR to reverse profound pseudoparalysis. It could be that some of the differences seen are technique related, as the Mihata technique uses thick autologous fascia lata whereas most other studies use thinner human dermis allograft. It will also be important to study the long-term results of SCR, as the current literature is limited to short- and midterm results.

There are several limitations to the study. First, it is difficult to make definitive conclusions given the paucity of studies available consisting mostly of small case series. The number of studies for rehabilitation alone or arthroscopic débridement with biceps tenotomy was particularly small. Only 2 studies were identified that evaluated a

**Table II** Improvement in AFE and reversal of pseudoparalysis based on treatment

	SCR	RTSA	Rehab
Improvement in active elevation			
Number of studies	2	6	1
Number of patients	53	226	17
Mean	106	56	120
SD	20	11	N/A
Reversal of pseudoparalysis			
Number of studies	2	4	1
Number of patients	53	117	62
Mean	94	96	82
SD	3	17	N/A

AFE, active forward elevation; SD, standard deviation; SCR, superior capsular reconstruction; RTSA, reverse total shoulder arthroplasty; Rehab, rehabilitation program; N/A, not applicable.

deltoid re-education rehabilitation program for patients with pseudoparalysis.<sup>7,21</sup> However, the study by Collin et al<sup>7</sup> was excluded, as it did not include data on improvements in AFE and reversal of pseudoparalysis. Boileau et al<sup>1</sup> evaluated isolated débridement and biceps tenotomy or tenodesis for treating massive rotator cuff tears. Among the 3 patients with preoperative pseudoparalysis, all 3 had persistent pseudoparalysis at final follow-up. Second, there remains an inconsistency in the definition of pseudoparalysis in the orthopedic literature, making study comparisons difficult. The ideal treatment for “true” or “profound” pseudoparalysis with anterosuperior escape may differ from more liberal definitions, such as an inability to raise the arm beyond 90°. Many of the studies do not mention whether pain limited the ability of patients to raise the arm beyond 90° preoperatively. If the preoperative definition of pseudoparalysis included pain-free loss of motion, such as testing after a lidocaine injection, different results may have been found.<sup>28</sup>

## Conclusion

The available Level IV evidence suggests that both RTSA and SCR can reliably reverse pseudoparalysis in patients with irreparable rotator cuff tears. A more consistent definition of pseudoparalysis would help clarify the success of treatments. Future randomized controlled trials with modern techniques and indications are needed to determine the best treatment approach for patients who present with pseudoparalysis due to massive irreparable rotator cuff tearing in the absence of advanced arthritis.

## Disclaimer

The authors, their immediate families, and any research foundations 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.

## References

- Boileau P, Baque F, Valerio L, Ahrens P, Chuinard C, Trojani C. Isolated arthroscopic biceps tenotomy or tenodesis improves symptoms in patients with massive irreparable rotator cuff tears. *J Bone Joint Surg Am* 2007;89:747-57. <https://doi.org/10.2106/JBJS.E.01097>
- Boileau P, Gonzalez JF, Chuinard C, Bicknell R, Walch G. Reverse total shoulder arthroplasty after failed rotator cuff surgery. *J Shoulder Elbow Surg* 2009;18:600-6. <https://doi.org/10.1016/j.jse.2009.03.011>
- Burkhart SS, Denard PJ, Adams CR, Brady PC, Hartzler RU. Arthroscopic superior capsular reconstruction for massive irreparable rotator cuff repair. *Arthrosc Tech* 2016;5:e1407-18. <https://doi.org/10.1016/j.eats.2016.08.024>
- Burkhart SS, Hartzler RU. Superior capsular reconstruction reverses profound pseudoparalysis in patients with irreparable rotator cuff tears and minimal or no glenohumeral arthritis. *Arthroscopy* 2019;35:22-8. <https://doi.org/10.1016/j.arthro.2018.07.023>
- Castricini R, De Benedetto M, Orlando N, Gervasi E, Castagna A. Irreparable rotator cuff tears: a novel classification system. *Musculoskelet Surg* 2014;98(Suppl 1):49-53. <https://doi.org/10.1007/s12306-014-0320-5>
- Cho NS, Lee BG, Rhee YG. Arthroscopic rotator cuff repair using a suture bridge technique: is the repair integrity actually maintained? *Am J Sports Med* 2011;39:2108-16. <https://doi.org/10.1177/0363546510397171>
- Collin PG, Gain S, Nguyen Huu F, Ladermann A. Is rehabilitation effective in massive rotator cuff tears? *Orthop Traumatol Surg Res* 2015;101(Suppl):S203-5. <https://doi.org/10.1016/j.otsr.2015.03.001>
- Denard PJ, Ladermann A, Jiwani AZ, Burkhart SS. Functional outcome after arthroscopic repair of massive rotator cuff tears in individuals with pseudoparalysis. *Arthroscopy* 2012;28:1214-9. <https://doi.org/10.1016/j.arthro.2012.02.026>
- Di Benedetto ED, Di Benedetto P, Fiocchi A, Beltrame A, Causero A. Partial repair in irreparable rotator cuff tear: our experience in long-term follow-up. *Acta Biomed* 2017;88(4 Suppl):69-74. <https://doi.org/10.23750/abm.v88i4-S.6796>
- Ek ET, Neukom L, Catanzaro S, Gerber C. Reverse total shoulder arthroplasty for massive irreparable rotator cuff tears in patients younger than 65 years old: results after five to fifteen years. *J Shoulder Elbow Surg* 2013;22:1199-208. <https://doi.org/10.1016/j.jse.2012.11.016>
- Ernstbrunner L, Suter A, Catanzaro S, Rahm S, Gerber C. Reverse total shoulder arthroplasty for massive, irreparable rotator cuff tears before the age of 60 years: long-term results. *J Bone Joint Surg Am* 2017;99:1721-9. <https://doi.org/10.2106/JBJS.17.00095>
- Gerber C, Canonica S, Catanzaro S, Ernstbrunner L. Longitudinal observational study of reverse total shoulder arthroplasty for irreparable rotator cuff dysfunction: results after 15 years. *J Shoulder Elbow Surg* 2018;27:831-8. <https://doi.org/10.1016/j.jse.2017.10.037>
- Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. *Clin Orthop Relat Res* 1994;304:78-83.

14. Gutierrez S, Levy JC, Lee WE 3rd, Keller TS, Maitland ME. Center of rotation affects abduction range of motion of reverse shoulder arthroplasty. *Clin Orthop Relat Res* 2007;458:78-82. <https://doi.org/10.1097/BLO.0b013e31803d0f57>
15. Gutierrez S, Comiskey CAT, Luo ZP, Pupello DR, Frankle MA. Range of impingement-free abduction and adduction deficit after reverse shoulder arthroplasty. Hierarchy of surgical and implant-design-related factors. *J Bone Joint Surg Am* 2008;90:2606-15. <https://doi.org/10.2106/JBJS.H.00012>
16. Gutierrez S, Levy JC, Frankle MA, Cuff D, Keller TS, Pupello DR, et al. Evaluation of abduction range of motion and avoidance of inferior scapular impingement in a reverse shoulder model. *J Shoulder Elbow Surg* 2008;17:608-15. <https://doi.org/10.1016/j.jse.2007.11.010>
17. Gutierrez S, Luo ZP, Levy J, Frankle MA. Arc of motion and socket depth in reverse shoulder implants. *Clin Biomech (Bristol, Avon)* 2009;24:473-9. <https://doi.org/10.1016/j.clinbiomech.2009.02.008>
18. Harreld KL, Puskas BL, Frankle MA. Massive rotator cuff tears without arthropathy: when to consider reverse shoulder arthroplasty. *Instr Course Lect* 2012;61:143-56.
19. Khair MM, Gulotta LV. Treatment of irreparable rotator cuff tears. *Curr Rev Musculoskelet Med* 2011;4:208-13. <https://doi.org/10.1007/s12178-011-9098-3>
20. Kissenberth MJ, Rulewicz GJ, Hamilton SC, Bruch HE, Hawkins RJ. A positive tangent sign predicts the reparability of rotator cuff tears. *J Shoulder Elbow Surg* 2014;23:1023-7. <https://doi.org/10.1016/j.jse.2014.02.014>
21. Levy O, Mullett H, Roberts S, Copeland S. The role of anterior deltoid reeducation in patients with massive irreparable degenerative rotator cuff tears. *J Shoulder Elbow Surg* 2008;17:863-70. <https://doi.org/10.1016/j.jse.2008.04.005>
22. Mihata T, Lee TQ, Watanabe C, Fukunishi K, Ohue M, Tsujimura T, et al. Clinical results of arthroscopic superior capsule reconstruction for irreparable rotator cuff tears. *Arthroscopy* 2013;29:459-70. <https://doi.org/10.1016/j.arthro.2012.10.022>
23. Mihata T, Lee TQ, Hasegawa A, Kawakami T, Fukunishi K, Fujisawa Y, et al. Arthroscopic superior capsule reconstruction can eliminate pseudoparalysis in patients with irreparable rotator cuff tears. *Am J Sports Med* 2018;46:2707-16. <https://doi.org/10.1177/0363546518786489>
24. Mulieri P, Dunning P, Klein S, Pupello D, Frankle M. Reverse shoulder arthroplasty for the treatment of irreparable rotator cuff tear without glenohumeral arthritis. *J Bone Joint Surg Am* 2010;92:2544-56. <https://doi.org/10.2106/JBJS.I.00912>
25. Naveed MA, Kitson J, Bunker TD. The Delta III reverse shoulder replacement for cuff tear arthropathy: a single-centre study of 50 consecutive procedures. *J Bone Joint Surg Br* 2011;93:57-61. <https://doi.org/10.1302/0301-620X.93B1.24218>
26. Nove-Josserand L, Edwards TB, O'Connor DP, Walch G. The acromiohumeral and coracohumeral intervals are abnormal in rotator cuff tears with muscular fatty degeneration. *Clin Orthop Relat Res* 2005;433:90-6.
27. Oh JH, Kim SH, Shin SH, Chung SW, Kim JY, Kim SH, et al. Outcome of rotator cuff repair in large-to-massive tear with pseudoparalysis: a comparative study with propensity score matching. *Am J Sports Med* 2011;39:1413-20. <https://doi.org/10.1177/0363546511399865>
28. Tokish JM, Alexander TC, Kissenberth MJ, Hawkins RJ. Pseudoparalysis: a systematic review of term definitions, treatment approaches, and outcomes of management techniques. *J Shoulder Elbow Surg* 2017;26:e177-87. <https://doi.org/10.1016/j.jse.2017.02.024>
29. Valenti P, Sauzieres P, Katz D, Kalouche I, Kilinc AS. Do less medialized reverse shoulder prostheses increase motion and reduce notching? *Clin Orthop Relat Res* 2011;469:2550-7. <https://doi.org/10.1007/s11999-011-1844-8>
30. Werner CM, Steinmann PA, Gilbert M, Gerber C. Treatment of painful pseudoparesis due to irreparable rotator cuff dysfunction with the Delta III reverse-ball-and-socket total shoulder prosthesis. *J Bone Joint Surg Am* 2005;87:1476-86. <https://doi.org/10.2106/JBJS.D.02342>