J Shoulder Elbow Surg (2021) 30, e178–e180

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Journal of Shoulder and Elbow Surgery

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Letter to the Editor regarding Young et al: "Reverse shoulder arthroplasty with and without latissimus and teres major transfer for patients with combined loss of elevation and external rotation: a prospective, randomized investigation"

To the Editor:

We read with great interest the article entitled "Reverse shoulder arthroplasty with and without latissimus and teres major transfer for patients with combined loss of elevation and external rotation: a prospective, randomized investigation" by Young et al.[22] We would like to commend the authors for their investigation of an important research question: Do "CLEER" patients (combined loss of elevation and external rotation) who undergo reverse shoulder arthroplasty (RSA) with latissimus dorsi and teres major transfer (+LD/TM) have better functional results than those treated with RSA alone? They performed a randomized controlled trial (RCT) and found no significant differences at 2 to 3.5 years of follow-up. At least 3 important methodological weaknesses limit the strength of this RCT and deserve discussion: patient selection, statistics, and interpretation of results.

Patient selection

CLEER is a well-defined clinical and anatomic entity.[3,4,6] Patients present with shoulder pseudoparalysis and complete loss of active external rotation. Imaging studies show massive irreparable posterosuperior cuff tears with severe fatty infiltration (Goutallier grades 3 and 4) of infraspinatus and atrophy/absent teres minor (Tm). Unfortunately, some of the recruited patients in the study of Young et al did not meet CLEER criteria. As shown in Table II, some patients had *no pseudoparalysis* (*active* forward elevation $\geq 100°$) and the authors included 5 patients who had an *intact Tm* (Table I) or grade 2 fatty infiltration of Tm. Furthermore, as shown in Figure 3, some patients had no active external rotation deficit with a *preoperative* Activities of Daily Living requiring active External Rotation (ADLER) score near 30 points (maximum) and thus should not have been labeled as CLEER patients nor included in the study. As acknowledged by the authors themselves and shown in Table III, the median *preoperative* ADLER score of their cohort is far higher (17/30 points in the RSA group and 16/30 points in the RSA+LD/TM group) than in the usual population affected by CLEER (4±3/30).[3,4,6,7,9,16,17,20]

Statistics

The authors calculated a minimum sample size of 20 total patients. The authors quote 2 publications[3,6] for their power calculation, but chose the least restrictive ($26° \pm 4°$)[3] and used a unilateral statistical test. The choice of the other referenced results ($25° \pm 5°$),[6] a bilateral test (as it is customary), and a classical hypothesis of 20% lost to follow-up would have led to a minimum of 40 patients required to reach statistical power (20 patients *per* group). Furthermore, the number of randomized patients ($n = 31$) dropped to only 22 reviewed at a minimum of 2 years for patient-reported outcomes, and only 12 assessed for active ROM. With the methodology employed, the final 2-year follow-up was underpowered to detect differences between groups, as acknowledged by the authors themselves: "The relatively small sample size of this study certainly leads to potential study frailty."[22]

Interpretation of the results

First, despite the fact that the purpose of this study was to analyze restoration of active ER after RSA±LD/TM, the authors could not compare pre- and postoperative range of motion as they failed to report *preoperative* values of active ER. Secondly, the authors suggest that the spontaneous resolution of the preoperative hornblower sign, observed in *58.3% of patients in the control group* (RSA alone), could be attributed to increased posterior deltoid recruitment coupled with the use of a constrained prosthesis and a slightly lateralized center of rotation (2-3 mm of

DOIs of original article: https://doi.org/10.1016/j.jse.2019.12.024, https://doi.org/10.1016/j.jse.2020.11.003

https://doi.org/10.1016/j.jse.2020.11.004

lateralization).[1] To prove this interpretation, the authors should have stratified results according to the *presence or absence of Tm on preoperative imaging studies*. Unfortunately, they fail to do it. Greiner et al[11] performed this type of stratification in their RCT study comparing the rotational outcomes of lateralized RSA vs. medialized (Grammont type) RSA. They observed that lateralized RSA (10 mm BIO-RSA) significantly improved active ER in patients with an intact Tm muscle, but not when this muscle was absent/atrophied. In other words, regardless of the type of reverse prosthesis used (lateralized or medialized), a functional Tm muscle is needed to improve postoperative *active* ER. As already shown in many studies,[3,4,9,17,21] a lateralized RSA is able to improve *passive ER* (by delaying posterior impingement), but a viable Tm muscle is needed to improve *active ER*.

The primary purpose of our letter is to re-emphasize the indications for RSA+LD/TM. This combined procedure is indicated *only* in CLEER patients with a positive hornblower sign and atrophy/absence of the Tm muscle on imaging.[3,4,6] The absence/atrophy of Tm is a risk factor for poorer functional results, *whatever* the surgical procedure: biceps tenotomy/tenodesis,[2,19] cuff repair,[12,14] LD tendon transfer,[8,10,15] and of course, RSA.[4,7,9,17] The Tm contributes up to 45% of ER power, mainly in abduction, which is important to control hand positioning in space.[2,5,13,14,18,21] Even when not active, the tendon transfer provides a tenodesis effect and allows patients to control their hand position in space and perform ADLs. In patients with persistently deficient active ER and handicap for ADLs after isolated RSA, Puskas et al[16] have even shown that secondary LD transfer significantly improved active mobility and subjective results.

In summary, in light of the methodological weaknesses noted, we find it unsurprising that this study reported equivalent functional results in patients treated with RSA alone and with RSA+LD/TM. We encourage the authors to perform further studies, better controlling for these biases, and hopefully providing a ''CLEER answer'' to this difficult clinical problem. In the meantime, we will continue performing RSA+LD/TM in CLEER patients with no Tm, given the data from the aforementioned references.

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Pascal Boileau is a consultant for and receives royalties from Wright Medical.

Marc-Olivier Gauci is a consultant for Wright Medical.

The other 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.

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References

1. Berglund DD, Rosas S, Triplet JJ, Kurowicki J, Horn B, Levy JC. Restoration of external rotation following reverse shoulder arthroplasty without latissimus dorsi transfer. JB JS Open Access 2018;3:e0054. https://doi.org/10.2106/JBJS.OA.17.00054
2. Boileau P, Baqué 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
3. Boileau P, Chuinard C, Roussanne Y, Bicknell RT, Rochet N, Trojani C. Reverse shoulder arthroplasty combined with a modified latissimus dorsi and teres major tendon transfer for shoulder pseudoparalysis associated with dropping arm. Clin Orthop 2008;466:584-93. https://doi.org/10.1007/s11999-008-0114-x
4. Boileau P, Chuinard C, Roussanne Y, Neyton L, Trojani C. Modified latissimus dorsi and teres major transfer through a single deltopectoral approach for external rotation deficit of the shoulder: as an isolated procedure or with a reverse arthroplasty. J Shoulder Elbow Surg 2007;16:671-82. https://doi.org/10.1016/j.jse.2007.02.127
5. Boileau P, McClelland WB, Rumian AP. Massive irreparable rotator cuff tears: how to rebalance the cuff-deficient shoulder. Instr Course Lect 2014;63:71-83.
6. Boileau P, Rumian AP, Zumstein MA. Reversed shoulder arthroplasty with modified L'Episcopo for combined loss of active elevation and external rotation. J Shoulder Elbow Surg 2010;19(Suppl):20-30. https://doi.org/10.1016/j.jse.2009.12.011
7. Boughebri O, Kilinc A, Valenti P. Reverse shoulder arthroplasty combined with a latissimus dorsi and teres major transfer for a deficit of both active elevation and external rotation. Results of 15 cases with a minimum of 2-year follow-up. Orthop Traumatol Surg Res 2013;99:131-7. https://doi.org/10.1016/j.otsr.2012.11.014
8. Costouros JG, Espinosa N, Schmid MR, Gerber C. Teres minor integrity predicts outcome of latissimus dorsi tendon transfer for irreparable rotator cuff tears. J Shoulder Elbow Surg 2007;16:727-34. https://doi.org/10.1016/j.jse.2007.02.128
9. Favre P, Loeb MD, Helmy N, Gerber C. Latissimus dorsi transfer to restore external rotation with reverse shoulder arthroplasty: a biomechanical study. J Shoulder Elbow Surg 2008;17:650-8. https://doi.org/10.1016/j.jse.2007.12.010

10. Gerber C, Rahm SA, Catanzaro S, Farshad M, Moor BK. Latissimus dorsi tendon transfer for treatment of irreparable posterosuperior rotator cuff tears: long-term results at a minimum follow-up of ten years. J Bone Joint Surg Am 2013;95:1920-6. https://doi.org/10.2106/JBJS.M.00122
11. Greiner S, Schmidt C, Herrmann S, Pauly S, Perka C. Clinical performance of lateralized versus non-lateralized reverse shoulder arthroplasty: a prospective randomized study. J Shoulder Elbow Surg 2015;24:1397-404. https://doi.org/10.1016/j.jse.2015.05.041
12. Kim JK, Yoo HJ, Jeong JH, Kim SH. Effect of teres minor fatty infiltration on rotator cuff repair outcomes. Arthrosc J Arthrosc Relat Surg 2016;32:552-8. https://doi.org/10.1016/j.arthro.2015.10.021
13. Kurokawa D, Sano H, Nagamoto H, Omi R, Shinozaki N, Watanuki S, et al. Muscle activity pattern of the shoulder external rotators differs in adduction and abduction: an analysis using positron emission tomography. J Shoulder Elbow Surg 2014;23:658-64. https://doi.org/10.1016/j.jse.2013.12.021
14. Melis B, DeFranco MJ, Lädermann A, Barthelemy R, Walch G. The teres minor muscle in rotator cuff tendon tears. Skeletal Radiol 2011;40:1335-44. https://doi.org/10.1007/s00256-011-1178-3
15. Moursy M, Forstner R, Koller H, Resch H, Tauber M. Latissimus dorsi tendon transfer for irreparable rotator cuff tears: a modified technique to improve tendon transfer integrity. J Bone Joint Surg Am 2009;91:1924-31. https://doi.org/10.2106/JBJS.H.00515
16. Puskas GJ, Germann M, Catanzaro S, Gerber C. Secondary latissimus dorsi transfer after failed reverse total shoulder arthroplasty. J Shoulder Elbow Surg 2015;24:e337-44. https://doi.org/10.1016/j.jse.2015.05.033
17. Simovitch RW, Helmy N, Zumstein MA, Gerber C. Impact of fatty infiltration of the teres minor muscle on the outcome of reverse total shoulder arthroplasty. J Bone Joint Surg Am 2007;89:934-9. https://doi.org/10.2106/JBJS.F.01075
18. Walch G, Boulahia A, Calderone S, Robinson AH. The 'dropping' and 'hornblower's' signs in evaluation of rotator-cuff tears. J Bone Joint Surg Br 1998;80:624-8.
19. Walch G, Edwards TB, Boulahia A, Nové-Josserand L, Neyton L, Szabo I. Arthroscopic tenotomy of the long head of the biceps in the treatment of rotator cuff tears: clinical and radiographic results of 307 cases. J Shoulder Elbow Surg 2005;14:238-46. https://doi.org/10.1016/j.jse.2004.07.008
20. Wieser K. CORR Insights®: latissimus dorsi and teres major transfer with reverse shoulder arthroplasty restores active motion and reduces pain for posterosuperior cuff dysfunction. Clin Orthop 2015;473:3218-20. https://doi.org/10.1007/s11999-015-4473-9
21. Williams MD, Edwards TB, Walch G. Understanding the importance of the teres minor for shoulder function: functional anatomy and pathology. J Am Acad Orthop Surg 2018;26:150-61. https://doi.org/10.5435/JAAOS-D-15-00258
22. Young BL, Connor PM, Schiffern SC, Roberts KM, Hamid N. Reverse shoulder arthroplasty with and without latissimus and teres major transfer for patients with combined loss of elevation and external rotation: a prospective, randomized investigation. J Shoulder Elbow Surg 2020;29:874-81. https://doi.org/10.1016/j.jse.2019.12.024