Original Article

Relation between Hypertrophy of Teres Minor Muscle and External Rotation Lag Sign in Patients with Rotator Cuff Pathology

Sandeep Vella, A Srinivasa Rao

Department of Orthopaedics, Katuri Medical College and Hospital, Guntur, Andhra Pradesh, India

Abstract

Background: The purpose of this study was to determine the compensatory hypertrophy of the teres minor (TM) muscle in rotator cuff tears (RCTs) and also the relation between hypertrophy of TM muscle and external rotation lag sign (ERLS). **Methods:** In the period between June 2017 and April 2018, forty patients with RCTs of the shoulder joint came to our institution. We determined the ERLS of all the RCT patients along with the TM occupation ratio in the magnetic resonance imaging (MRI) scan and correlated them together. The normal mean of TM occupational ratio was calculated from ten patients who have undergone MRI scan for other causes but with normal rotator cuff muscles. **Results:** In our study, the mean TM occupational ratio of 10 normal rotator cuff patients was 0.277. Of 40 rotator cuff pathology patients, the mean occupational ratio of the TM in RCTs is 0.359. Sixteen of the 40 patients had ER lag positive and the remaining 24 patients had ER lag negative. Those who were ER lag negative have an TM occupational ratio >0.401. A positive correlation was found between hypertrophy of TM and ERLS. **Conclusion:** ERLS will be negative in patients with hypertrophy of TM in the setting of posterosuperior cuff tears. There is a strong correlation between cuff tears and hypertrophy of TM muscle, which helps in better prognosis and functional outcome of the patients treated with surgical intervention.

Keywords: *External rotation lag sign, occupational ratio, rotator cuff tears*

Introduction

Rotator cuff tear (RCT) is a common musculoskeletal disorder in the elderly. A large RCT is often irreparable due to retraction and degeneration of rotator cuff muscles. Hypertrophy of teres minor (TM) is present in a proportion of patients suffering from large RCT. The integrity of TM muscle is thought to affect postoperative functional recovery in patients who have undergone certain surgical treatment modalities.

Even in massive irreparable RCTs, tears involving the TM are rare. Clinically, it is difficult to assess the TM muscle, due to which there has been limited research and assessment of the true nature of TM compared with other rotator cuff muscles. However, during the past two decades, there has been increased number of reverse shoulder arthroplasty, which has greatly increased the importance of TM.[1-3] The condition of the TM is now considered to be a valuable postoperative prognostic factor for achieving good functional improvement after reverse shoulder arthroplasty. Many recent studies have also reported the importance of TM integrity in latissimus dorsi tendon transfer.[4-6]

External rotation lag sign (ERLS) is accepted as highly specific and sensitive test for posterosuperior RCTs. ERLS is said to be positive in a posterosuperior RCT unless if there is a compensated hypertrophy of TM muscle. Kikukawa *et al*.[7] reported that TM appeared hypertrophic on magnetic resonance imaging (MRI) in patients with posterosuperior RCTs with atrophic infraspinatus (ISP) muscles.

We used the MRI evaluation criteria from the study by Kikukawa *et al*.[7] to assess the status of the ISP and TM muscles. Anatomic ER (a-ER) muscle area is calculated as combined area of ISP and TM muscles. Briefly, the ISP muscle area, TM muscle area, and a-ER muscle area were measured on the most lateral oblique plane in which the scapular spine was in contact with the scapular body using

How to cite this article: Vella S, Rao AS. Relation between hypertrophy of teres minor muscle and external rotation lag sign in patients with rotator cuff pathology. Indian J Orthop 2019;53:392-5.

Address for correspondence:
Dr. Sandeep Vella, Assistant Professor, Department of Orthopedics, Katuri Medical College and Hospital, Guntur, Andhra Pradesh, India.
E-mail: sandeepvella@gmail.com

Access this article online

Website: www.ijoonline.com

DOI: 10.4103/ortho.IJOrtho_259_18

Quick Response Code:

ImageJ software (National Institutes of Health, Bethesda, MD, USA). The occupational ratios of the ISP and TM muscle areas were calculated. The occupational ratio of TM muscle = area of TM muscle/area of a-ER muscle [Figure 1].

The objective of this study was to determine: (a) if compensatory hypertrophy of the TM muscle occurs in a large RCTs and (b) relation between hypertrophy of TM and ERLS.

Methods

A total of 50 patients were enrolled in the study, of which 40 patients had rotator cuff pathology and another 10 patients with normal rotator cuff who had undergone MRI scans for other purposes. This is a prospective study carried out between June 2017 and April 2018. All the patients were examined clinically, particularly with a thorough shoulder examination and noted their ERLS. We determined the occupational ratio for TM muscle from the MRI and also evaluated for RCT tendon involvement. All the patients with ERLS positive with RCTs were grouped into Group A. Remaining patients with ER lag negative patients with RCTs were grouped into Group B.

The physical examination was performed by a single skilled examiner blinded to any imaging analysis until he had finished the physical examination and formulated his diagnosis. The ERLS was performed with the patient seated on an examination couch with his or her back to the examiner. The elbow was passively flexed to 90°, and the shoulder was held at 20° elevation in the scapular plane. The examining clinician passively rotated the patient's arm to the maximum external rotated position (minus a few degrees to avoid elastic recoil of the joint capsule and the scapulothoracic joint). The patient was then asked to actively maintain the position. If the patient could not maintain the position and the arm rotated internally upon release of the hand, the test was considered positive.

Occupational ratio of TM muscle of Group A and Group B was calculated, along with normal rotator cuff patients treating them as controls.

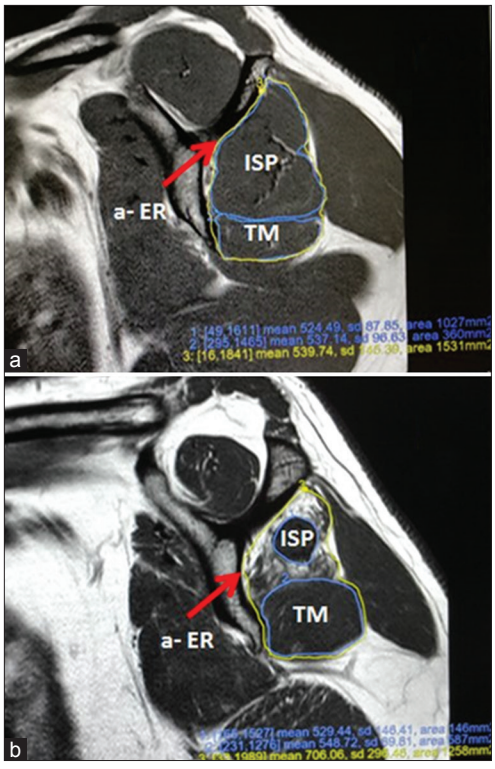

Figure 1: (a) Occupancy ratio of teres minor in normal rotator cuff person is 0.23, (b) occupancy ratio of teres minor in rotator cuff tear patient is 0.46

Results

In our study, the TM occupational ratio of 10 normal rotator cuff patients range is 0.16–0.42 ± 0.074, and mean value is 0.277. In Kikukawa *et al*.'s study, the normal occupational ratio of TM muscle was 0.112–0.288. According to their study, there were no significant differences in terms of the occupational ratios of the TM muscle according to age distribution or gender.

Of all 40 rotator cuff pathology patients, 16 patients have ERLS positive and 24 patients have ERLS negative. Occupational ratio of 40 rotator cuff patients' range is 0.11–0.588 ± 0.098 (mean: 0.359). ER lag positive group (16 patients) occupational ratio range is 0.11–0.4 ± 0.071 (mean: 0.296) [Figure 2]. ER lag negative group (24 patients) occupational ratio range is 0.27–0.588 ± 0.092 (mean: 0.401) [Figure 3]. ER lag negative group has higher occupational ratio of TM muscle and therefore has hypertrophy of the muscle [Table 1]. Hence, ERLS was negative in patients with hypertrophy of TM in the setting of posterosuperior cuff tear, which supports our hypothesis ($P < 0.001$) [Figure 4].

Discussion

Gerber *et al*. reported that the TM does not contribute >20% of ER strength after suprascapular nerve block was performed

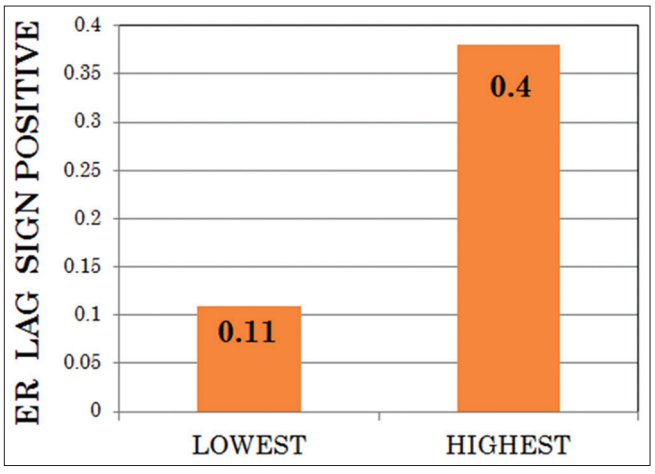

Figure 2: Among external rotation lag sign positive patients, lowest occupancy ratio is 0.11 and highest occupancy ratio is 0.4

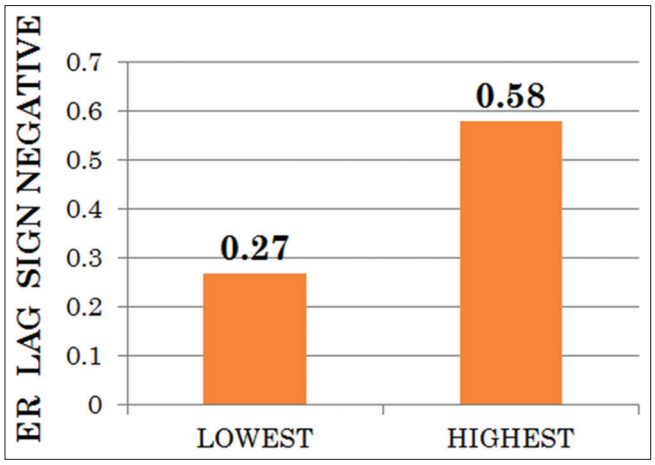

Figure 3: Among external rotation lag sign negative patients, lowest occupancy ratio is 0.27 and highest occupancy ratio is 0.58

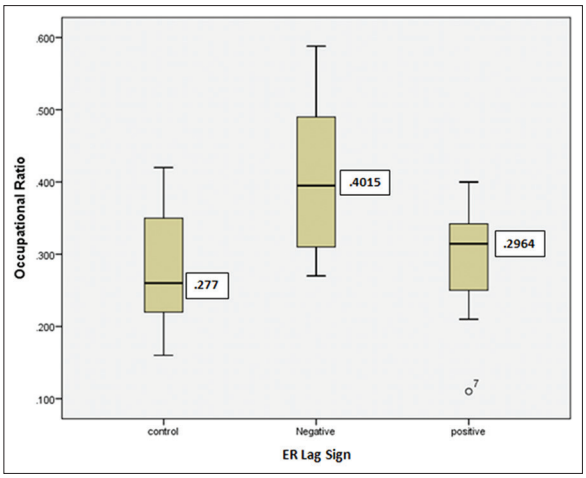

Figure 4: Mean occupational ratio in controls (10) is 0.277, mean occupational ratio in external rotation lag sign negative group patients (24) is 0.4015, and mean occupational ratio in external rotation lag sign positive group patients (16) is 0.2964. Overall occupational ratio of external rotation lag negative group patients is higher than controls. This resembles that there is a hypertrophy in teres minor muscle in this group which leads to maintaining the external rotation even in rotator cuff tear patients

Table 1: Total number of rotator cuff pathology patients are 40

ER lag sign	Number of patients	TM Occupational ratio		
		Lowest	Highest	Mean
ER lag positive	16	0.11	0.4	0.296
ER lag positive	24	0.27	0.588	0.401
Controls	10	0.16	0.42	0.277

Total number of rotator cuff pathology patients are 40. Out of them, 24 have TM occupational ratio 0.588 more than controls with ER lag sign positive. Remaining 16 patients have occupational ratio 0.296 less or near normal with ER lag sign negative. Total number of normal rotator cuff patients are 10. ER=External rotation, TM=Teres minor

in volunteers to achieve supraspinatus and ISP palsy. The authors also stated that in cases of chronic weakness of the ISP, the TM may develop compensatory hypertrophy, which is supported by the results of our quantitative MRI study. It can be supposed that hypertrophic changes of the TM muscle occur in proportion to the progress of ISP muscle atrophy in posterior-superior RCTs to restore ER strength.[7]

The ERLS as described by Hertel *et al*.[8] in 1996 was designed to test the integrity of the supraspinatus and ISP tendons. Dropping sign and the hornblower's sign were positive and highly accurate for the detection of large ruptures but not really useful for small ruptures.

Few reports have been published on the diagnostic value of the rotator cuff tears, particularly the ERLS in the Hertel study. Park *et al*.[9] reported similar result in sensitivity and specificity between the supraspinatus muscle test and the ISP muscle test, but they did not routinely evaluate the ERLS in each patient and did not distinguish among different extensions of thickness tears. They found that a combination of a painful arc sign, drop arm sign, and positive ISP muscle test produced the best posttest probability (91%) for full-thickness RCTs.

In Melis *et al*.[10] study, TM muscle hypertrophy is the thickness of the TM muscle that is required to be larger than the anterior-posterior width of the glenoid, and moreover, TM muscle atrophy was defined as the thinning of the muscle in the anterior-posterior width, with tracks of fatty infiltration.

Pape *et al*.[11] found that the TM is important for patients who underwent resurfacing arthroplasty for cuff tear arthropathy to maintain ER strength. Moreover, atrophic or absent TM resulted in a significantly inferior shoulder function in patients with massive irreparable RCTs according to Boileau *et al*.

Walch *et al*.[12] previously reported that severe fatty infiltration of the ISP and TM muscles weakens the ER strength and suggested that the function of the TM may prove useful in the daily activities of patients after large tears of the rotator cuff.

Other authors have noted preservation of TM muscle mass in the setting of supraspinatus and ISP atrophy and fatty degeneration. Itoi *et al*. found that no atrophy was seen in either the TM or subscapularis after combined supraspinatus/ISP tears. The same group also reported that TM volume is preserved in the presence of RCTs, and others have reported TM hypertrophy in the setting of combined supraspinatus/ISP tears, also noting preserved function compared to those patients without TM hypertrophy.

In our study, occupancy ratio of 10 rotator cuff normal patients' range is of 0.16–0.42 ± 0.074 (mean: 0.277). In Kikukawa *et al*.'s study, the normal occupancy ratio of TM muscle ranges from 0.112 to 0.288.

Of all 40 rotator cuff pathology patients, 16 patients have ERLS positive and 24 patients have ERLS negative. Occupational ratio of 40 rotator cuff patients'

range is of 0.11–0.588 ± 0.098 (mean: 0.359). ER lag positive patients' group (16) occupational ratio range is 0.11–0.4 ± 0.071 (mean: 0.296). ER lag negative patients' group (24) occupational ratio range is 0.27–0.588 ± 0.092 (mean: 0.401). ER lag negative group has higher occupational ratio of TM muscle. Higher occupational ratio is the reason for hypertrophy of the muscle. Hence, ERLS was negative in patients with hypertrophy of TM in the setting of posterosuperior cuff tear, which supports our hypothesis.

Conclusion

ERLS will be negative in patients with hypertrophy of TM in the setting of posterosuperior cuff tear. Hence, there is a strong correlation between cuff tears and hypertrophy of TM muscle, which helps in better prognosis and functional outcome of the patients treated with surgical intervention.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Boileau P, Chuinard C, Roussanne Y, Bicknell RT, Rochet N, Trojani C, *et al.* Reverse shoulder arthroplasty combined with a modified latissimus dorsi and teres major tendon transfer for shoulder pseudoparalysis associated with dropping arm. Clin Orthop Relat Res 2008;466:584-93.
2. 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.
3. Sirveaux F, Favard L, Oudet D, Huquet D, Walch G, Molé D, *et al.* Grammont inverted total shoulder arthroplasty in the treatment of glenohumeral osteoarthritis with massive rupture of the cuff. Results of a multicentre study of 80 shoulders. J Bone Joint Surg Br 2004;86:388-95.
4. 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.
5. Namdari S, Voleti P, Baldwin K, Glaser D, Huffman GR. Latissimus dorsi tendon transfer for irreparable rotator cuff tears: A systematic review. J Bone Joint Surg Am 2012;94:891-8.
6. Nové-Josserand L, Costa P, Liotard JP, Safar JF, Walch G, Zilber S, *et al.* Results of latissimus dorsi tendon transfer for irreparable cuff tears. Orthop Traumatol Surg Res 2009;95:108-13.
7. Kikukawa K, Ide J, Kikuchi K, Morita M, Mizuta H, Ogata H, *et al.* Hypertrophic changes of the teres minor muscle in rotator cuff tears: Quantitative evaluation by magnetic resonance imaging. J Shoulder Elbow Surg 2014;23:1800-5.
8. Hertel R, Ballmer FT, Lombert SM, Gerber C. Lag signs in the diagnosis of rotator cuff rupture. J Shoulder Elbow Surg 1996;5:307-13.
9. Park HB, Yokota A, Gill HS, El Rassi G, McFarland EG. Diagnostic accuracy of clinical tests for the different degrees of subacromial impingement syndrome. J Bone Joint Surg Am 2005;87:1446-55.
10. 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.
11. Pape G, Bruckner T, Loew M, Zeifang F. Treatment of severe cuff tear arthropathy with the humeral head resurfacing arthroplasty: Two-year minimum followup. J Shoulder Elbow Surg 2013;22:e1-7.
12. 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.