

A New Radiographic Classification of Greater Tuberosity Irregularities in the Detection Of Rotator Cuff Tears

Anestis Iossifidis¹, E Ibrahim², P. Mitra¹, G. Toghias¹, C. Petrou¹

1 Department of Trauma and Orthopaedic Surgery, Shoulder Unit, Croydon University Hospital, London, UK;

2 Chelsea and Westminster Hospital, Chelsea, London, UK.

Conflict-of-interest statement: The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

Open-Access: This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

Correspondence to: Anestis Iossifidis, MD, FRCS Ed, FRCS Ed (orth.) Head of Orthopaedic Surgery, Croydon University Hospital, 530 London Road, Croydon, London, CR7 7YE, United Kingdom.

Email: anestis.iossifidis@gmail.com

Telephone: +0044 (0) 7802404708

Received: October 14, 2020

Revised: November 6, 2020

Accepted: November 10 2020

Published online: December 28, 2020

ABSTRACT

INTRODUCTION: We propose a new radiographic classification of greater tuberosity changes seen in patients with atraumatic rotator cuff dysfunction. The aim of this study is to determine the predictive values and accuracy of this classification for the detection of rotator cuff tears using arthroscopic findings as the gold standard.

STUDY DESIGN & METHODS: This was a retrospective study of 91 consecutive patients (47 male, 44 female; mean age 57 year old) who underwent shoulder arthroscopy for a clinical diagnosis of rotator cuff dysfunction. The presence and size of a rotator cuff tear for each patient had been documented at the time of surgery. The radiographs were anonymised and randomised for interpretation by 2 experienced shoulder surgeons and of 2 orthopaedic residents

newly-educated on the use of the classification. The predicative values of the new classification for the diagnosis of rotator cuff tear were calculated. Inter-rater agreement values were obtained using the Fleiss' kappa method. Statistical significance was set at $p < 0.05$.

RESULTS: Comparative statistics showed that Stage 0 or 1 were associated with the absence of a cuff tear. Stage 2 and 3 were strongly predictive of a rotator cuff tear. The mean predicative values of the new classification stage 2 and 3 for the detection of a rotator cuff tear were: sensitivity 93%, specificity 83%, positive predictive value 87%, and negative predictive value 92%. The accuracy of the experienced observer group was significantly higher than the inexperienced group (97% v 83%, p -value < 0.01) and therefore the overall group accuracy was 89%. Inter-rater agreement for stages 1, 2 and 3 changes was substantial overall (Kappa value of 0.63) and almost perfect between the experienced assessors (Kappa=0.95)

CONCLUSIONS: The new classification is a useful adjunct for the diagnosis of rotator cuff tears where adequate radiographs are available. It may be used as a screening test in a large number of patients with shoulder pain and select stage 2 and 3 patients for further rotator cuff imaging to assist preoperative planning.

Key words: Shoulder radiographs; Rotator cuff tear; Shoulder classification; Greater tuberosity; Shoulder joint

© 2020 The Author(s). Published by ACT Publishing Group Ltd. All rights reserved.

Iossifidis A, Ibrahim E, Mitra P, Toghias G, Petrou C. A New Radiographic Classification of Greater Tuberosity Irregularities in the Detection Of Rotator Cuff Tears. *International Journal of Orthopaedics* 2020; 7(6): 1379-1381 Available from: URL: <http://www.ghrnet.org/index.php/ijo/article/view/3011>

INTRODUCTION

Rotator cuff disease is very common and the presence of a rotator cuff tear often affects management. Plain radiographs are usually performed as an initial diagnostic evaluation of patients with shoulder pain. There has been therefore a resurgence of interest in the value of plain radiographs for the diagnosis of rotator cuff tears Multiple authors have noted the presence of abnormalities on plain radiographs

in patients with rotator cuff tears. None have been demonstrated to be consistently accurate enough to be used in preference to imaging such as ultrasound or Magnetic resonance. The exact morphology of tuberosity changes most associated with cuff tears has not been well defined. We propose a new radiographic classification of greater tuberosity changes seen in patients with rotator cuff dysfunction.

The aim of this study is to determine the accuracy of this new classification of greater tuberosity changes for the detection of rotator cuff tears using arthroscopic findings as the gold standard.

METHODS

A classification of greater tuberosity (GT) changes was devised by the senior author, based on his observations of tuberosity changes on the AP radiographs of patients under his care. The classification system is intended to be applied to patients presenting with symptoms suggestive of chronic rotator cuff disease in the absence of glenohumeral arthritis. Stage 0 is a normal tuberosity, stage 1 is a tuberosity with cortical sclerosis, stage 2 displays cortical abnormality in the form of GT surface irregularity and/or intra-cortical cysts and stage 3 is tuberosity eburnation (Figure 1).

The pre-operative radiographs of 91 consecutive patients (47 male, 44 female; mean age 57 years) who had undergone an elective shoulder arthroscopic surgery over a 12 month period were assessed. The radiographs were anonymised and placed into a digital file. All the radiographs were reviewed and assessed for adequacy by the principal investigator, discarding those in which the greater tuberosity was not properly visible. The remainder 80 radiographs were included in this study and presented for interpretation in a blinded fashion to 4 independent assessors divided into two groups. The experienced group consisted of two shoulder surgeons with excess of two years' experience with the tuberosity classification in daily clinical practice. The inexperienced group consisted of two orthopaedic residents who were newly educated on the use of the classification. Each radiograph was staged from 0-3 and the results were compared to arthroscopic findings (no cuff tear, tear < 3 cm or tear > 3 cm) retrospectively. Comparative statistics and predicative values of the new classification for the diagnosis of rotator cuff tear were calculated and analysed. The inter-rater agreement values were calculated using the Fleiss' kappa method and statistical significance was set at $p < 0.05$.

RESULTS

Eighty radiographs were deemed adequate for tuberosity assessment and were included in this study. Arthroscopic findings revealed no tear in 31 patients and a full thickness cuff tear in 49 patients (61%). The size of the tear was less than 3cm in 34 patients.

Comparative statistics showed that Stage 0 or 1 features were associated with the absence of a cuff tear. Stage 2 and 3 features were strongly predictive of a rotator cuff tear.

The mean predicative values of the new classification stage 2 and 3 for the detection of a rotator cuff tear were: sensitivity 93%, speci-

ficity 83%, Positive predictive value 87%, Negative predictive value 92%, and accuracy 89%. Stage 3 features were highly specific and positively predictive for large cuff tears but not sensitive (Table 1).

The accuracy of the experienced observer group was significantly higher than the inexperienced group (p -value <0.01) and therefore the overall group accuracy was 89% (Table 2). Inter-rater agreement for stage 1, 2 and 3 changes was substantial overall with a Fleiss' Kappa value of 0.63 and almost perfect between the experienced assessors (0.95), but only moderate between inexperienced assessors (0.54) (Table 3).

DISCUSSION

Multiple authors have noted the presence of abnormalities on plain radiographs in patients with rotator cuff tears. However a study of 84 asymptomatic individuals found degenerative changes such as acromial osteophytes, acromioclavicular degeneration, and lateral clavicular and acromial sclerosis were age-related and not gender specific^[1]. Greater tuberosity (GT) changes appear to be the exception. Various tuberosity features including sclerosis, osteophytes and



Figure 1 a: Stage 0: normal GT. b: Stage 1: GT cortical sclerosis. c: Stage 2: GT intra-cortical cysts and/or cortical surface irregularity. d: Stage 3: GT eburnation.

Table 2 Comparison accuracy values between each observer group and overall for stage 2 or 3 changes in the presence of a cuff tear of any size.

Stage 2 or 3 (any size cuff)				
Experienced	Inexperienced	Overall		
accuracy	accuracy	p-value	accuracy	p-value
0.97	0.83	< 0.01	0.89	< 0.89

Table 3 Fleiss' Kappa values of inter-rater agreement between groups and overall. (0.41-0.60: moderate agreement, 0.61-0.80: substantial agreement, 0.81-1.00: almost perfect agreement.)

Stage 1 changes			Stage 2 or 3 changes		
Experienced	Inexperienced	Overall	Experienced	Inexperienced	Overall
0.95	0.55	0.63	0.95	0.54	0.63

Table 1 Predictive values for the detection of any size tear (stage 2 or 3), and large tears (stage 3) for each observer group and overall. PPV : Positive Predictive Value, NPV: Negative Predictive Value.

	Stage 2 or 3 (any size tear)			Stage 3 (large tear)		
	Experienced	Inexperienced	Overall	Experienced	Inexperienced	Overall
Sensitivity	0.98	0.9	0.93	0.4	0.33	0.36
Specificity	0.95	0.75	0.83	1	1	1
PPV	0.99	0.81	0.87	1	1	1
NPV	0.99	0.87	0.92	0.88	0.87	0.87

subchondral cysts are seen more with rotator cuff tear (RCT) than in patients without shoulder symptoms, but the evidence is conflicting^[2]. It has previously been reported that GT cortical thickening and subcortical sclerosis are not correlated to RCT^[3].

Our study shows that GT irregularities such as spurs and cortical cysts (stage 2) and tuberosity eburnation (stage 3) are associated with rotator cuff tears (RCT) unlike GT cortical sclerosis (stage1). These findings are supported by other authors. Ultrasonographic studies have reported that GT cortical surface irregularities showed the highest sensitivity and negative predictive value in the diagnosis of RCT and they are not simply age related^[4,5].

Magnetic resonance studies of the cysts showed that they were located at or near footprint of cuff tendon and that anterior GT cysts were strongly associated with cuff tear but not with age. The cysts could be solitary or multiple in number and were defined as discrete, subcortical, or cortically based lesions measuring at least 2 mm in dimension^[6]. This study corroborates with others that greater tuberosity changes associated with rotator cuff tears are not age related^[2]. We believe that the tuberosity goes through a sequence of changes once it makes direct contact with the acromion undersurface. The results of this study indicate that the GT classification can be used as an effective screening tool for rotator cuff tears in a group of patients with rotator cuff pain. With experience predictive values are comparable with those reported for magnetic resonance and ultrasound^[7]. Therefore these tests can be reserved for patients with stage 2 or 3 changes for whom the surgeon wishes to have more information about tear size and tendon quality.

CONCLUSION

The GT classification is a useful adjunct for the diagnosis of rotator cuff tears when adequate radiographs are available with high predictive value of stage 2 and 3. If used as a screening test in a large number of patients with shoulder pain the need for further imaging may be reduced. This study has demonstrated that a normal greater tuber-

osity is a strong indicator of an intact rotator cuff and that tuberosity abnormalities should alert the clinician to the likelihood of a tear.

REFERENCES

1. Bonsell S, Pearsall A, Heitman R, Helms C, Major N, Speer K. The relationship of age, gender, and degenerative changes observed on radiographs of the shoulder in asymptomatic individuals. *J Bone & Joint Surg Br.* 2000; **82(8)**: 1135-9. [PMID: 11132273]; [DOI: 10.1302/0301-620x.82b8.10631]
2. Pearsall AW, Bonsell S, Heitman R, Helms CA, Osbahr D, Speer KP. Radiographic findings associated with symptomatic rotator cuff tears. *J of shoulder and elbow surgery.* 2003; **12(2)**: 122-7. [PMID: 12700562]; [DOI: 10.1067/mse.2003.19]
3. Huang LF, Rubin DA, Britton CA. Greater tuberosity changes as revealed by radiography: lack of clinical usefulness in patients with rotator cuff disease. *AJR Am J Roentgenol* 1999 May; **172(5)**: 1381-8. [PMID: 10227521]; [DOI: 10.2214/ajr.172.5.10227521]
4. Jacobson JA, Lancaster S, Prasad A, van Holsbeeck MT, Craig JG, Kolowich P. Full thickness and partial-thickness supraspinatus tendon tears: value of US signs in diagnosis. *Radiology* 2004; **230**: 234-242. [PMID: 14695399]; [DOI: 10.1148/radiol.2301020418]
5. Wohlwend JR, van Holsbeeck M, Craig J, Shirazi K, Habra G, Jacobsen G, Bouffard JA association between irregular greater tuberosities and rotator cuff tears: a sonographic study. *Am J Roentgenol.* 1998 Jul; **171(1)**: 229-33 [PMID: 9648794]; [DOI: 10.2214/ajr.171.1.9648794]
6. Fritz L B ,Ouellette HA, O'Hanley TA , Kassirjian A ,Palmer WE. Cystic changes at supraspinatus and infraspinatus tendon insertion sites: association with age and rotator cuff disorders in 238 patients. *Radiology* 2007 July; **244(1)**: 239-48 [PMID: 17581904]; [DOI: 10.1148/radiol.2441050029]
7. Roy J-S, Braën C, Leblond J, Desmeules F, Dionne CE, MacDermid JC, et al. Diagnostic accuracy of ultrasonography, MRI and MR arthrography in the characterisation of rotator cuff disorders: a meta-analysis. *British journal of sports medicine* 2015 Oct; **49(20)**: 1316-28. [PMID: 25677796]; [PMCID: PMC4621376]; [DOI: 10.1136/bjsports-2014-094148]