

**Research Paper****Relationship between Critical Shoulder Angle and Rotator Cuff Tears in Patients with Non-Traumatic Shoulder Pain**

Authors

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Dr Sowmya Uppalapati**Introduction**

Rotator cuff tears are the most common cause of pain and restricted movements of the shoulder joint. They can be due to traumatic or degenerative causes. The prevalence of rotator cuff tears (full thickness) ranges from 5% to 40% and their incidence increases progressively with the advancing age. Based on history and physical examination, the interpretation of the integrity of rotator cuff muscles helps in diagnosis of tears. A shoulder radiograph is usually done to assess osseous anatomy, fractures, dislocations, and osteoarthritis changes. However, certain indirect signs related to acromial morphology such as type of acromion, its thickness, spurs, acromio-humeral distance, and lateral acromial angle have also been attributed to the rotator cuff disease. Critical shoulder angle was proposed by Moor et al, as a new radiologic parameter to measure the lateral acromial projection. In the present study, we aim to evaluate the influence of CSA as a predisposing factor for development of non-traumatic RCTs.

Aims and Objectives

To determine the relationship between critical shoulder angle and non-traumatic rotator cuff tears.

Materials and Methods

This is a retrospective, case-control study conducted on **70** subjects who presented to orthopedic OPD with pain and restricted movements of the shoulder and were referred to our Radiology department for imaging. The study is conducted at the Medicity Institute of Medical Sciences from January 2018 to May 2021. Based on the presence or absence of rotator cuff tears on MRI, subjects are divided into cases and controls respectively. The study group includes **40** cases and **30** controls.

Inclusion Criteria

Patients with shoulder pain and restricted movements undergoing radiographic and MRI evaluation of shoulder, without any history of trauma or previously confirmed rotator cuff tears.

Exclusion Criteria

Patients with a history of trauma, previous surgeries, glenohumeral or acromioclavicular osteoarthritis, and infections. Informed consent was obtained from all the patients.

Radiographic Evaluation of CSA

Along with demographic data, clinical history and radiological evaluation are done for each subject. A true AP radiograph of the shoulder (Grashey view) is to be taken, without any rotation and with overlapping of the glenoid cavity anterior and posterior edges. The CSA is measured as an angle that is formed by a line drawn from the inferior to the superior rim of the glenoid fossa and another line connecting the inferior rim of the glenoid with the most inferolateral point of the acromion. Each angle is measured three times and the mean is obtained for analysis.



Figure 1: Measurement of critical shoulder angle on a true AP radiograph of left shoulder

Results

The study included subjects with an age group of 42 - 68 years, the mean age of the case group is 56.5 years, while that of the control group is 51.5 years. The study group has predominantly males accounting for 70% and the majority showed involvement of the right shoulder.

Table 1: Age, sex and side distribution of the study group

Parameter	Cases (40)	Controls (30)
Age group (mean)	42-61 years (51.5)	45-68 years (56.5)
Females	9 (30%)	12 (30%)
Males	21 (70%)	28 (70%)
Right shoulder	18 (60%)	31 (77%)
Left shoulder	12(40%)	9 (23%)

Subjects are categorized based on CSA, in reference to the upper limit of normal range into those, less than or equal to 35° and more than 35°. The majority of the subjects in the case group showed CSA > 35°, whereas the control group showed CSA ≤ 35°.

Table 2: Categorisation of study group based on CSA values

Study group	CSA ≤ 35°	CSA > 35°	Total
Cases	3	37	40
Control	24	6	30
Total	27	43	70

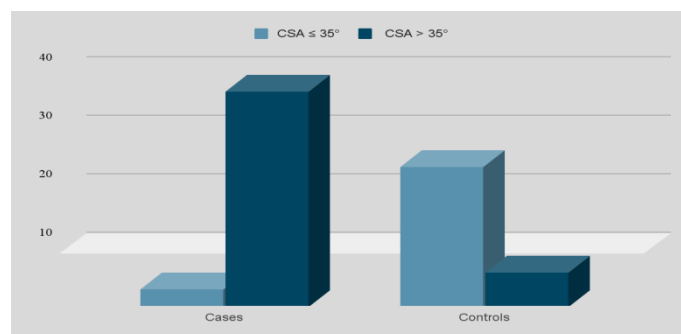


Figure 2: Distribution of the study group with relation to CSA



Figure 3a: True-AP radiograph of right shoulder of a patient, showing critical shoulder angle (CSA) of 38°.

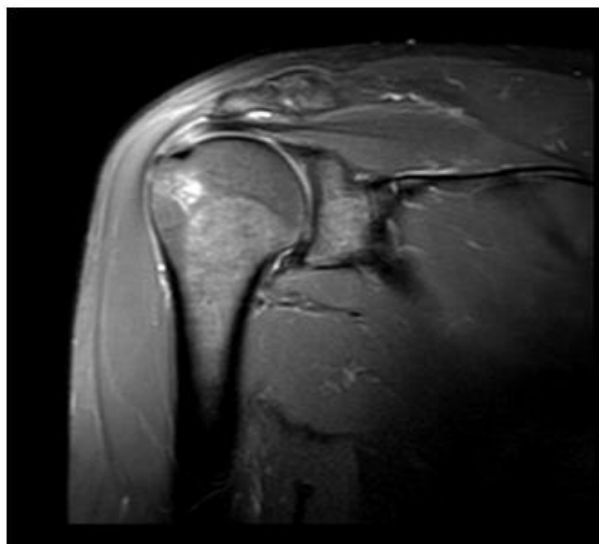


Figure 3b: PD-fat saturated coronal image showing partial tear of the supraspinatus tendon in the same patient with wider critical shoulder angle.

Table 3: CSA values in the study group as shown:

Subjects	CSA Range	Mean	Standard deviation
Cases	33.2° - 46.4°	38.5°	3.3
Control	28.6° - 38.9°	31.2°	3.1

The study showed that the most commonly involved rotator cuff is supraspinatus alone in about 47.5% of the cases followed by combined involvement of supraspinatus and subscapularis (37.5%). Combined involvement of supraspinatus and infraspinatus is seen in 7.5% of cases.

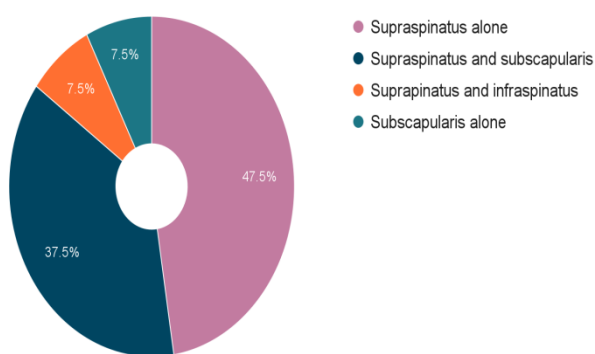


Figure 4: Percentage distribution of rotator cuff tears in the case group

Applying the Chi-square test to the above data, showed a *p-value* of < 0.00001. Thus concluding the strong association between CSA and rotator cuff tears in patients with non-traumatic shoulder pain.

Discussion

The present study showed an association between larger CSAs and non-traumatic RCTs. Moor et al. introduced critical shoulder angle (CSA), a new radiological index that combines the acromion index and the inclination of the glenoid fossa.¹ More recently it was reported by Suter et al. that views exceeding 5° of anteversion, 8° of retroversion, 15° of flexion, and 26° of extension resulted in >2° deviation of the CSA compared with the true AP view.² CSA measurement on MRI showed a higher variability and lower correlation, in contrast to the measurements taken by radiograph.

The CSA quantifies the extent of acromial coverage and the inclination of the glenoid. Neer et al. recognized the mechanical conflict between the rotator cuff muscles and the acromion and termed it impingement syndrome.³ Greater obliquity of the glenoid cavity is associated with an increase in the shear component of the forces generated by the deltoid muscle and, therefore, with greater humeral head elevation. Marked lateral acromion extension increases the vertical component of the deltoid forces. These vertical forces may increase humeral head elevation, thereby promoting the development of both damage to the deep rotator cuff surface and of subacromial impingement. This was recognised by Watson-Jones R and Armstrong JR that lateral acromion extension is the risk factor in development of rotator cuff disease.^{4,5}

Nyffeler et al. suggested an association between the lateral projection of acromion and risk for rotator cuff injury.⁶ Gerber et al. found that insufficient CSA reduction in arthroscopic lateral acromioplasty was associated either with a higher rate of non-healing or with a lower abduction strength when the tears heal.⁷ Li et al. used postoperative MRI to study the retear rate of the repaired rotator cuff and found that there is an increased risk of retear in patients with larger CSA.⁸ Cherchia et al. not only found an association of RTC pathology with CSA but were also able to correlate increased CSA with labral

tears requiring repair.⁹ The critical shoulder angle is thus useful in helping surgeons determine when it is necessary to order a preoperative MRI in the evaluation of the rotator cuff.

The pathogenesis of glenohumeral osteoarthritis was explained by similar biomechanical models wherein, smaller lateral acromion extension leads to a lower CSA, resulting in a higher compressive force component of the deltoid muscle. This compressive force may lead to excess loading on the glenohumeral joint and subsequent OA. Moreover, the presence of an inferiorly inclined glenoid can lead to higher deltoid compressive forces on the glenohumeral joint that contribute to the development of OA.

Surgical procedures that decrease the CSA, such as inferolateral acromial resection, lateral acromioplasty, or glenoid osteotomies, could also be developed theoretically to prevent progression of RCTs or OA.

The major drawback of our study is that all the subjects did not undergo surgery for arthroscopic confirmation of rotator cuff tears. Another limitation is that few technical errors may have occurred in measurement of CSA. Although literature suggests CSA to have a high interobserver and intraobserver reliability, there are still studies supporting the occurrence of clinically significant errors during measurement.

Conclusion

There is a strong association between wider critical shoulder angle and non-traumatic rotator cuff tears and therefore can be considered as an important assessment tool in predicting rotator cuff tears in patients with non-traumatic shoulder pain.

References

1. Moor BK, Bouaicha S, Rothenfluh DA, Sukthankar A, Gerber C. Is there an association between the individual anatomy of the scapula and the development of rotator cuff tears or osteoarthritis of the glenohumeral joint?: A radiological study of the critical shoulder angle. *Bone Joint J.* 2013 Jul;95-B(7):935-41. doi: 10.1302/0301-620X.95B7.31028. PMID: 23814246.
2. Suter T, Gerber Popp A, Zhang Y, Zhang C, Tashjian RZ, Henninger HB. The influence of radiographic viewing perspective and demographics on the critical shoulder angle. *J Shoulder Elbow Surg.* 2015 Jun;24(6):e149-58. doi: 10.1016/j.jse.2014.10.021.
3. Neer, Charles S. II, M.D.* Impingement Lesions, *Clinical Orthopaedics and Related Research: March 1983 - Volume 173 - Issue - p 70-77.*
4. Watson-Jones R. *Fractures and Joint Injuries.* Vol. 2. Baltimore: Williams & Wilkins; 1940. Fractures and joint injuries. [Google Scholar].
5. Armstrong JR. Excision of the acromion in treatment of the supraspinatus syndrome; report of 95 excisions. *J Bone Joint Surg Br.* 1949;31B:436-42. [CrossRef] [Google Scholar]
6. Nyffeler RW, Werner CM, Sukthankar A, Schmid MR, Gerber C. Association of a large lateral extension of the acromion with rotator cuff tears. *J Bone Joint Surg Am.* 2006 Apr;88(4):800-5. doi: 10.2106/JBJS.D.03042. PMID: 16595470.
7. Gerber C, Catanzaro S, Betz M, Ernstbrunner L. Arthroscopic Correction of the Critical Shoulder Angle Through Lateral Acromioplasty: A Safe Adjunct to Rotator Cuff Repair. *Arthroscopy.* 2018 Mar;34(3):771-780. Doi: 10.1016/j.arthro.2017.08.255. PMID: 29100767.
8. Li H, Chen Y, Chen J, Hua Y, Chen S. Large critical shoulder angle has higher risk of tendon retear after arthroscopic rotator cuff repair. *Am J Sports Med.* 2018;46(8):1892–900.
9. Cherchia L, Ciornohaca JF, Godetb J, Claverta P, Kempfa JF (2016) Critical

shoulder angle: Measurement reproducibility and correlation with rotator cuff tendon tears. *Orthopaedics & Traumatology. Surgery & Research* 102: 559-562.

10. Moor BK, Röthlisberger M, Müller DA, et al. Age, trauma and the critical shoulder angle accurately predict supraspinatus tendon tears. *Orthop Traumatol Surg Res* 2014;100:489–94. [PubMed] [Google Scholar].
11. Macaulay AA, Greiwe RM, Bigliani LU. Rotator Cuff Deficient Arthritis of the Glenohumeral Joint. *Clin Orthop Surg* 2010;2:196. [PMC free article] [PubMed] [Google Scholar].