

# Can Acromio-Humeral Distance difference predicts rotator cuff lesion? – A study among Unilateral Shoulder Pain in Makassar

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Received: November 30, 2017; Accepted: January 26, 2018

## ABSTRACT

**Background:** Magnetic resonance imaging (MRI) is the gold standard for detecting rotator cuff injury. Simple X-ray measurement such as acromiohumeral distance (AHD) could be helpful in places where MRI is not available, in determining the possibility of rotator cuff injury. AHD is mainly genetically determined, rather than adaptively. **Objective:** The objective of the study was to prove the correlation of AHD difference between symptomatic and asymptomatic shoulder with rotator cuff lesion in MRI among unilateral shoulder pain in Makassar and to measure sensitivity and specificity of AHD difference in diagnosing rotator cuff tear. **Materials and Methods:** This is a cross-sectional controlled study. 30 patients with unilateral shoulder pain, motion range deficit, age 45–65 year old, were included in this study. Chest anteroposterior (AP) X-ray was taken, AHD difference was measured. MRI of the symptomatic shoulder was taken to confirm rotator cuff lesion. Chest AP X-ray also was taken from healthy subject for significance comparison. Statistical analysis was conducted using Spearman's test, independent sample *t*-test and receiver operating characteristic curve. **Result:** AHD difference correlates positively with the presence of rotator cuff lesion in MRI among unilateral shoulder pain (coefficient 0.749 [ $P < 0.05$ ]). AHD difference 1.05 mm detects at least partial supraspinatus tear with sensitivity 85.7 % and specificity 88.9%. AHD difference 1.75 mm detects a total supraspinatus tear with sensitivity 80% and specificity 90%. **Conclusion:** AHD difference on X-ray correlates with rotator cuff tear seen in MRI, and be considered as a diagnostic aid in places where MRI is not available.

**KEY WORDS:** Acromiohumeral Distance; Rotator Cuff; Shoulder Pain


## INTRODUCTION

Self-reported prevalence of shoulder problem is estimated up to 66% lifetime; it is the third most common cause of musculoskeletal consultation in primary care.<sup>[1]</sup> Approximately 1% of adults consult a general practitioner with new shoulder pain annually.<sup>[2]</sup> Stiff and pain shoulder

complaints are closely related to frozen shoulder or rotator cuff lesion.<sup>[3]</sup>

Rotator cuff injury covers up to 70% of shoulder problems in orthopedic practices. Diagnosis of rotator cuff injury is established from history taking, physical examination and radiologic workup. Magnetic resonance imaging (MRI) is the gold standard for confirming the presence of rotator cuff injury. However, MRI machine availability is very limited in the east part of Indonesia due to its expensive cost.

Rotator cuff lesion can be predicted by X-ray measurements such as proximal humeral migration, acromion shape, and acromiohumeral distance (AHD).<sup>[4,5]</sup> Although MRI and

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| Website: <a href="http://www.ijmsph.com">http://www.ijmsph.com</a> | Quick Response code   |
| DOI: 10.5455/ijmsph.2018.1131926012018                             |  |

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Ultrasonogram is the best way to detect it.<sup>[6]</sup> Simple X-ray measurement could be helpful enough in places where MRI is not available, in determining the possibility of rotator cuff problems.

Saupe *et al.* and Mayerhoever *et al.* found that narrowing of AHD correlates significantly with rotator cuff tear and concomitant muscle degeneration.<sup>[5,7]</sup> Other study stated that AHD reflects clinical condition in patients with supraspinatus muscle disorder. However, Gumina *et al.* found that AHD is more influenced by genetic factor rather than adaptive/environmental factor.<sup>[8]</sup> Therefore, in patients with narrow AHD, does not mean suffer from rotator cuff tear, meanwhile, patients with wide AHD does not necessarily free from rotator cuff injury. We have a same consideration as the Gumina *et al.* stated before. We assumed that the physiologic AHD is individual fashioned.

The mechanism of AHD narrowing due to the ascension of humeral head is still not precisely known. Proposed probable mechanism is overpull of deltoid muscle due to loss of infraspinatus injury or loss of subacromial volume due to retracted supraspinatus muscle/tendon.<sup>[5]</sup>

Based on several considerations mentioned above, authors decided to study the difference of AHD between symptomatic and asymptomatic shoulders, whether it is correlated significantly with rotator cuff tear or not. We evaluated the AHD difference between the symptomatic and the asymptomatic shoulders, rather than solely evaluate single symptomatic shoulder without contralateral comparison. To the extent of our literature review, no previous research ever evaluating AHD difference between symptomatic and asymptomatic shoulder. Moreover, no study ever measuring the AHD of Indonesian population. We hope that this study could be a proper additional reference about AHD research in Indonesia or world-widely.

## Objectives

The objectives of this study are to prove the correlation of AHD difference between symptomatic and asymptomatic shoulders with rotator cuff tear presence seen in MRI among unilateral shoulder pain patients in Makassar; to measure the predictive performance of AHD difference in detecting rotator cuff tear in MRI, and to measure AHD value of Indonesian population.

## MATERIALS AND METHODS

### Study Design and Site

This is a cross-sectional study. The study conducted in Makassar, from September 2016 to July 2017. We collected data from patient age 45 to 65 years old, with a complaint of unilateral shoulder pain and stiffness.

## Inclusion and Exclusion Criteria

### Inclusion criteria

The following criteria were included in this study:

1. Male or female age 45–65 years old,
2. Unilateral shoulder pain and deficit in range of motion,
3. Complaint duration at least 3 months.

### Exclusion criteria

The following criteria were excluded from the study:

Exclusion criteria such as concomitant neurologic disorder on affected shoulder, bilateral shoulder pain, evidence of fracture around shoulder seen from X-ray, recent shoulder overactivity.

## Research Flow

Thorax anteroposterior (AP) upright X-ray (symmetric neutral or slight abduction of both arms) was taken from patients with matched inclusion criteria. AHD was measured from both shoulders, and the difference is calculated using radiological software assisted with manual mouse-pointer clicking at the radiology monitor. Next, MRI 1.5T was performed on symptomatic shoulders to confirm the rotator cuff tear. Thorax AP upright X-ray also taken from healthy subjects, and AHD was measured as a significance comparison (control group).

## Ethical Clearance

This research got ethical approval from Medical Research Ethical Committee of Hasanuddin University Hospital/Wahidin Sudirohusodo General Hospital, Makassar.

## Statistical Analysis

SPSS 22 was employed for this study. We performed the descriptive test and comparative test (independent sample *t*-test) between AHD of sample group and control group. Next, we assess the correlation between AHD difference and rotator cuff tear severity seen in MRI using Spearman rank test. The predictive performance of AHD difference was assessed using the area under curve of receiver operating characteristic (ROC) curves of sensitivity over 1-specificity.

## RESULT

This study collected sample from two hospitals in Makassar, September 2016 through July 2017. This study was included total 30 patients in sample group and 30 patients in control group.

### Sample and Control Characteristics

Characteristic of sample and control was arranged according to sex, age, symptomatic shoulder, and MRI finding.

14 (46.7%) of samples are male, meanwhile, 16 (53.3%) of samples are females. Mean age of this study is 54.63 ( $\pm 6$ ) years old for the sample group, with range 45–65 years old; and 55.23 ( $\pm 6$ ) years old for the control group, with range 46–65 years old. There are more samples with right shoulder pain than left shoulder pain (18 samples (60%) vs. 12 samples (40%)). Nine samples had no tear (30%), 11 samples had partial supraspinatus tear (36.7%), 3 samples had total supraspinatus tear (10%), and 7 samples had multiple rotator cuff tear (23.3%).

AHD was measured and collected from control group representing normal value of AHD. 15 (50%) of control are male, 15 (50%) of control are female. Mean AHD of male is  $10.17 \pm 1.32$  mm on the right shoulder,  $9.98 \pm 1.55$  mm on the left shoulder. Mean AHD of female is  $9.12 \pm 0.80$  mm on the right shoulder,  $8.94 \pm 0.62$  mm on the left shoulder. Mean AHD of male is significantly wider than female ( $P = 0.016$  for right shoulder and  $P = 0.027$  for left shoulder).

### Correlation between AHD Differences with Shoulder MRI Finding on Sample Group

Based on Spearman rank test, there is a positive correlation between AHD difference with shoulder MRI findings [Table 1]. It means that the wider the AHD difference, the worst the rotator cuff tear present in symptomatic shoulder MRI. Correlation coefficient is 0.749, signifies that this two variable are strongly correlated each other (strong correlation coefficient = 0.50–0.89) ( $P < 0.05$  [0.000]).

### Comparative Test between AHD Difference Symptomatic-asymptomatic Shoulders in Sample and Control Group

The mean of AHD difference in sample group is 1.42 mm ( $\pm 0.85$  mm), meanwhile, the mean of AHD difference in the control group is 0.25 mm ( $\pm 0.18$  mm). AHD difference between sample and control group is significantly different,  $P < 0.05$  (0.001) [Table 2].

### Sensitivity and Specificity (Predictive Performance) of AHD Difference to Determine Rotator Cuff Tear in Shoulder MRI

From the analysis of ROC curve, to predict at least partial tear of supraspinatus on MRI cut off point 1.05 mm of AHD was noted with sensitivity 85.7% and specificity 89.9%. To predict at least total tear supraspinatus (with/without other rotator cuff muscle) on MRI, cut off point 1.75 mm of AHD was noted with sensitivity 80.0% and specificity 90.0%. To predict multiple rotator cuff tear on MRI, cut off point 1.75 mm of AHD was noted with sensitivity 71.4% and specificity 78.3% [Table 3].

**Table 1:** Spearman's correlation test between AHD difference and shoulder MRI findings

| Variable              | AHD difference | Shoulder MRI findings |
|-----------------------|----------------|-----------------------|
| Spearman's rank test  |                |                       |
| AHD difference        |                |                       |
| Coefficient           | 1.000          | 0.749**               |
| <i>P</i> (1-tailed)   | 0.0            | 0.000                 |
| <i>n</i>              | 30             | 30                    |
| Shoulder MRI findings |                |                       |
| Coefficient           | 0.749**        | 1.000                 |
| <i>P</i> (1-tailed)   | 0.000          | 0.0                   |
| <i>n</i>              | 30             | 30                    |

\*\*Correlation is significant on  $P < 0.01$  (1-tailed). AHD: Acromiohumeral distance, MRI: Magnetic resonance imaging

**Table 2:** Comparison between sample and control group

| Variable       | Group   | <i>n</i> | Mean (mm) | SD (mm) | <i>P</i> |
|----------------|---------|----------|-----------|---------|----------|
| AHD difference | Sample  | 30       | 1.42      | 0.85    | 0.001    |
|                | Control | 30       | 0.82      | 0.38    |          |

SD: Standard deviation

## DISCUSSION

Our samples have the same mean age with the control (sample  $54 \pm 6$  years old vs. control  $55 \pm 6$  years old). This finding is similar with the descriptive study conducted by Petersson *et al.*, in which the mean age of a patient with supraspinatus tear is 55 years old.<sup>[9]</sup>

There is more right shoulder pain than the left shoulder pain, with ratio 3:2. This could be caused by the hand dominance (right hand dominant is more prevalent than the left hand dominant). Based on the shoulder MRI findings, partial supraspinatus tear is the most prevalent (11 subjects), followed by no rotator cuff tear (9 subjects), multiple rotator cuff tear (7 subjects), and total supraspinatus tear (3 subjects). If categorized by "tear" versus "no tear," then the samples divided into 9 subjects without rotator cuff tear versus 21 subjects with rotator cuff tear.

In Makassar population, mean AHD on normal male is  $10.17 \pm 1.32$  mm on the right shoulder and  $9.98 \pm 1.55$  mm on the left shoulder. Meanwhile, on a normal female is  $9.1 \pm 0.8$  mm on the right shoulder and  $8.9 \pm 0.62$  mm on the left shoulder. Statistically, the difference is significant ( $P = 0.016$  for the right shoulder, and  $P = 0.027$  for the left shoulder). Our findings are closely similar with the previous researcher. Petersson *et al.*, found that the mean AHD for a male is 10.2 mm (range 6.6–13.8 mm) and 9.5 mm (range 7.1–11.9 mm) for female.<sup>[9]</sup> Possible explanation for this difference is because the size of tendon and muscle in male is relatively larger than female, and the workload of the right

**Table 3:** Sensitivity and specificity of AHD difference to predict several types of rotator cuff tear

| Prediction                                     | AHD cut off (mm) | Sensitivity (%) | Specificity (%) |
|--|------------------|-----------------|-----------------|
| To predict at least partial tear supraspinatus | 1.05             | 85.7            | 89.9            |
| To predict at least total tear supraspinatus   | 1.75             | 80.0            | 90.0            |
| To predict multiple rotator cuff tear          | 1.75             | 71.4            | 78.3            |

AHD: Acromiohumeral distance

shoulder may be higher than the left shoulder. Hence, the tendon and rotator cuff muscle may be more hypertrophic, in turns, will produce wider AHD.

Our hypothesis is the AHD difference on X-ray examination between the symptomatic and asymptomatic shoulder correlates positively with the degree of rotator cuff tear detected on the MRI. To the extent of our literature review, no previous research ever evaluating AHD difference between symptomatic and asymptomatic shoulder. Spearman rank test proves there is a positive correlation between the AHD difference and the MRI findings, means that the wider the AHD difference, the worst the degree of rotator cuff tear found at symptomatic shoulder MRI. The correlation coefficient is 0.79 signifies that these two variables are correlated each other strongly (range for the strong correlation is 0.70–0.89) and statistically significant,  $P < 0.05$  (0.000). Our hypothesis is proven in this study.

Keener *et al.* studied that the proximal migration of humeral head correlated significantly with the number of rotator cuff tear ( $1.01 \pm 1.5$  mm on supraspinatus and infraspinatus tear v.  $-0.09 \pm 1.5$  mm on isolated supraspinatus tear) among the shoulder pain with visual analog scale more than 5/10.<sup>[4]</sup> In our opinion, proximal migration of humeral head is analog with the AHD difference in patients with unilateral shoulder pain.

Saupe *et al.* describe that narrowing of AHD is reliable for predicting rotator cuff tear.<sup>[5]</sup> Research on 1970 by Weiner and Macnab found that mean for normal AHD is 10.5 mm, meanwhile, at the rotator cuff tear condition is only 8.2 mm.<sup>[10]</sup> Other study said AHD <7 mm as a sign of total rotator cuff tear.<sup>[5]</sup> However, Petersson *et al.* using a cut off <6 mm to determine a supraspinatus tear.<sup>[9]</sup> Gouttalier *et al.* stated that AHD <6 mm is definitive for infraspinatus tear.<sup>[11]</sup>

Based on ROC curve analysis (ROC), we found that AHD difference 1.05 mm, this variable has sensitivity 85.7% and specificity 89.9% to predict any type of rotator cuff tear on symptomatic shoulder MRI. Statistically, this finding is useful, but, in our opinion, this finding is less applicable since comparing a 1 mm distance accurately using bare eyes and simple ruler is very difficult.

AHD difference has sensitivity 80.0% and specificity 90.0% to predict a total tear of supraspinatus or multiple rotator cuff tear on symptomatic shoulder MRI at cut off point 1.75 mm.

AHD difference also has sensitivity 71.4% and specificity 78.3% to predict multiple rotator cuff tear on symptomatic shoulder MRI at cut off point 1.75 mm.

### Limitation and Auto critics

We noticed several flaws in our research. First, the measurement of AHD is using the software at the radiology monitor which is operator dependent, in which the point of measurement is manually clicked using mouse pointer. Second, we have only 30 samples; it is needed a larger study with more samples to get a more accurate result and conclusion. Third, we did not have any samples with an isolated tear on teres minor, infraspinatus, or subscapularis. Fourth, we did not exclude the osteoarthritic shoulder joint which may cause bias in evaluating rotator cuff tear.

### CONCLUSION

AHD difference has a positive correlation with the severity of rotator cuff tear found at shoulder MRI. AHD difference can be considered as a diagnostic aid for rotator cuff tear in 45–65 years old patient with non-traumatic unilateral shoulder pain and stiffness, in places which MRI is not available, especially if the AHD difference is more than 1.75 mm. AHD in males is relatively wider than the females on Makassar population. Larger samples are needed to evaluate the usefulness of AHD difference further. Another study can assess and compare AHD difference with other proven parameters of shoulder such as single symptomatic AHD, or proximal humeral head migration.

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**How to cite this article:** Then Z, Sakti M, Saleh MR. Can Acromio-Humeral Distance difference predicts rotator cuff lesion? – A study among Unilateral Shoulder Pain in Makassar. *Int J Med Sci Public Health* 2018;7(4):264-268.

**Source of Support:** Nil, **Conflict of Interest:** None declared.