

Preoperative AHI and Goutallier Classification Using CT and MRI Reliably Predict Rotator Cuff Integrity as Confirmed Intraoperatively in Shoulder Arthroplasty Patients

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INTRODUCTION: The purpose of the present study was to determine the reliability of computed tomography (CT), magnetic resonance imaging (MRI), and x-ray (XR) in the evaluation of routine radiologic shoulder measurements of rotator cuff integrity in a population of patients undergoing total shoulder arthroplasty (TSA). In particular, measurement of the acromiohumeral interval (AHI) and Goutallier classification of supraspinatus muscle quality were determined using multiple imaging modalities and compared to intraoperative rotator cuff integrity and patient reported outcome measures (PROMs).

METHODS: Patients who underwent anatomic (aTSA) and reverse total shoulder arthroplasty (RSA) were identified from our institution’s shoulder arthroplasty registry. Patients were eligible for inclusion if they had XR, MRI, and CT scans performed within six months of surgery and rotator cuff integrity documented by intraoperative report. Two raters independently measured AHI using XR, MRI, and CT and assigned a Goutallier score using MRI and CT. Rotator cuff integrity was determined intraoperatively by the operating surgeon and reported as part of the institutional registry to be (1) intact or (2) torn/attenuated. Intraclass correlation coefficients (ICCs) were calculated for each measurement and imaging modality. Cut-point analysis predicting rotator cuff integrity was performed by maximizing the product of sensitivity and specificity for each threshold measurement.

RESULTS: There were 199 patients (132 aTSA, 67 RSA) who met inclusion criteria. ICC values for Goutallier and AHI measurements showed at least moderate agreement between reviewers for all modalities (Goutallier MRI: 0.73, Goutallier CT: 0.76, AHI MRI: 0.81, AHI CT: 0.72, AHI XR: 0.76). AHI and Goutallier were significantly negatively correlated on CT (R=-0.42, p=7.8e-10) and MRI (R=-0.49, p=2.6e-13). Goutallier measurements on MRI and CT were very highly positively correlated (R=0.93, p<2.2e-16). AHI measurements correlated most strongly between MRI and CT (R=0.79, p<2.2e-16) followed by MRI and XR (R=0.71, p<2.2e-16). AHI correlated moderately comparing CT and XR (R=0.64, p<2.2e-16). AHI most significantly predicted cuff integrity using MRI, where the optimal cut-point was 6.40mm (Accuracy 0.709, AUC of 0.867). The optimal cut-point was 5.75mm on CT (Accuracy 0.789, AUC of 0.709) and 7.90mm on XR (Accuracy 0.638, AUC of 0.664). Using Goutallier, the optimal cut-point for predicting cuff integrity was 1.50 for MRI (Accuracy 0.824, AUC of 0.867) and 1.00 for CT (Accuracy 0.714, AUC of 0.873).

DISCUSSION AND CONCLUSION: This study demonstrates that CT correlates very strongly with MRI in the evaluation of rotator cuff status using supraspinatus muscle bulk and AHI as surrogate measurements. Several studies have compared AHI using various imaging modalities, however, to our knowledge none have compared both AHI and supraspinatus muscle atrophy on CT with rotator cuff integrity confirmed intraoperatively. The findings of this study suggest that surgeons may be able to determine rotator cuff status in shoulder arthroplasty patients through physical exam and CT scan alone, without the use of MRI. Additionally, the present study identifies optimal cut-points using AHI for predicting rotator cuff status as determined by intraoperative assessment, with greater than 70% accuracy using MRI at 6.40mm and CT at 5.75mm. Upright XR demonstrated the least accurate measurement for predicting cuff status at 63% accuracy.

Figure 1. A) Scatter plot demonstrating positive correlation of AHI measurements between CT and x-ray (XR), MRI and CT, and MRI and XR. B) Scatter plot demonstrating positive correlation of Goutallier measurements between MRI and CT. C) Scatter plot demonstrating negative correlation between AHI and Goutallier measurements for both CT and MRI.

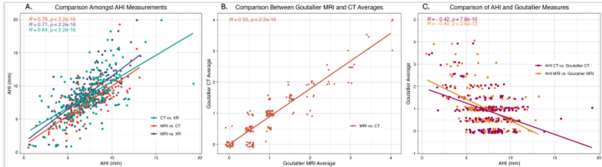


Table 1. Table of optimal cut-points for each imaging measurement and modality for predicting rotator cuff status, as determined intra-operatively. Goutallier measurements less than the listed cut-point predicted an intact rotator cuff, whereas Goutallier measurements greater than the cut-point predicted a deficient rotator cuff. In contrast, AHI measurements less than the listed cut-points predicted a deficient rotator cuff, whereas AHI measurements greater than the listed cut-points predicted an intact rotator cuff.

Predicting Cuff Status at Surgery Optimal Cutpoints								
Measure	Optimal Cutpoint <sup>1</sup>	Accuracy	Sensitivity	Specificity	AUC	log(OR) <sup>2</sup>	p-value	95% CI <sup>2</sup>
Goutallier MRI (0-4)	1.50	0.824	0.635	0.912	0.867	-2.24	3.02e-10	-3, -1.6
Goutallier CT (0-4)	1.00	0.714	0.937	0.610	0.873	-2.36	9.55e-11	-3.14, -1.7
AHI MRI (mm)	6.40	0.709	0.750	0.619	0.729	0.44	9.96e-07	0.27, 0.63
AHI CT (mm)	5.75	0.789	0.919	0.508	0.709	0.36	3.99e-06	0.22, 0.52
AHI XR (mm)	7.90	0.638	0.669	0.571	0.664	0.22	2.21e-04	0.11, 0.35

<sup>1</sup> Determined by maximal product of sensitivity and specificity

<sup>2</sup> OR = Odds Ratio, CI = Confidence Interval