

The Influence of the Relative Deltoid Moment Arm on Active Motion in Patients in Massive Cuff Tears

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Introduction:

Underlying mechanisms for why certain patients with massive cuff tears develop pseudoparesis are unclear. The variability in clinical presentation in this population is likely multifactorial but may be partially related to individual variation in deltoid and cuff mechanics [1]. A recent biomechanical study described the shoulder abduction moment (SAM) index, which considers the deltoid and rotator cuff moment arms based on a patient's specific anatomy as measured on a plain XR Grashey view [2]. The clinical validity of this index remains unclear. Therefore, the purpose of this study was to clinically evaluate the correlation of pseudoparesis with the SAM index in patients with massive cuff tears.

Methods:

This was a single surgeon retrospective study of 107 patients presenting with MRI-diagnosed massive cuff tears from 2018-2019. A massive cuff tear was defined as a full thickness tear of the rotator cuff involving two or more tendons. Pseudoparesis was defined as inability to achieve active forward elevation of 90° with retained passive motion beyond 90° of forward elevation. Range of motion was documented in clinic by a single surgeon. Patients with a decentered head (Hamada grade >1) or arthritis were excluded from this study as they would have an artificially elevated SAM index. There were 70 patients (65%) who presented with preserved forward elevation > 90°. Thirty-seven patients (35%) presented with pseudoparesis.

Patient demographics and initial decision for surgical or nonsurgical treatment were collected. Six radiographic measurements including the SAM index were evaluated as risk factors for pseudoparesis (**Figure 1**). The SAM index was calculated by taking dividing the radius of the humeral head by the moment arm of the deltoid. The moment arm of the deltoid was approximated by the radius of a circle centered on the humeral head with its perimeter running along the undersurface of the acromion (**Figure 1**). Univariate analyses were performed to compare demographics and radiographic measurements between patients with and without pseudoparesis. Receiver operating characteristic curves (ROC curves) were generated to evaluate the effectiveness of each of the six radiographic measurements in prediction of pseudoparesis.

Results

Univariate analysis showed no significant differences in demographics between those with and without pseudoparesis (**Table 1**). Patients with pseudoparesis more commonly opted for surgery instead of physical therapy as their initial treatment (43% vs 20%; $p=0.02$; **Table 1**). When comparing radiographic measurements, only the SAM index was significantly different between patients with and without pseudoparesis (**Table 2**). For those with pseudoparesis, the mean SAM index was significantly lower (0.72 ± 0.04 vs 0.76 ± 0.03 ; $p<0.001$; **Table 2**). The ROC curves comparing radiographic measurements' ability to predict pseudoparesis demonstrated that the measurement with the highest area under the curve (AUC) was the SAM index (**Figure 2**). The AUC of the SAM index was 0.77 (95% CI 0.67 – 0.87).

Conclusions

The SAM index was found to correlate with the clinical presence of pseudoparesis in patients with massive cuff tears. This index is an indication of the relative moment arms of the deltoid and rotator cuff

and may provide insight into the variable presentation of massive cuff tear patients. Further study is needed to determine whether this index holds prognostic value for success of nonoperative treatment.

Table 1.

Patient demographics in patients with massive cuff tears stratified by pseudoparesis.

Demographic Variable[†]	All Patients (N=107)	Active Elevation > 90° (N=70)	Pseudoparesis (N=37)	<i>p</i>
Female Sex	41 (38%)	24 (34%)	17 (46%)	0.332
Age (years)	64.0 ± 9.1	63.0 ± 9.2	66.0 ± 8.5	0.096
Race:				0.635
White	66 (62%)	43 (61%)	23 (62%)	
Black	13 (12%)	10 (14%)	3 (8%)	
Other	28 (26%)	17 (24%)	11 (30%)	
Smoking	12 (11%)	8 (11%)	4 (11%)	1.000
Diabetics	23 (22%)	13 (19%)	10 (27%)	0.444
BMI (kg/m ²)	29.4 ± 5.4	28.7 ± 4.5	30.8 ± 6.6	0.142
Elixhauser Comorbidity Index	0.89 ± 3.11	0.8 ± 2.5	1.0 ± 4.0	0.648
Active Forward Elevation	102° ± 45°	123° ± 33°	59° ± 33°	<0.001
Initial Trial of Physical Therapy	57 (53%)	43 (61%)	14 (38%)	0.034

[†]Continuous variables are displayed as means ± standard deviations. Categorical variables are displayed as absolute numbers of patients with proportions.

Table 2.

Radiographic measurements in patients with massive cuff tears stratified by pseudoparesis.

Radiographic Measurement[†]	All Patients (N=107)	Active Elevation > 90° (N=70)	Pseudoparesis (N=37)	<i>p</i>
Shoulder Abduction Moment Index	0.74 ± 0.04	0.76 ± 0.03	0.72 ± 0.04	<0.001
Lateral Shoulder Abduction Moment Index	0.58 ± 0.06	0.58 ± 0.05	0.59 ± 0.07	0.497
Acromial Humeral Interval	9.37 ± 1.76	9.09 ± 1.29	9.91 ± 2.35	0.140
Acromial Index/Lateral Offset	0.72 ± 0.08	0.72 ± 0.08	0.72 ± 0.08	0.830
Lateral Acromial Angle (degrees)	79° ± 7°	79° ± 7°	78° ± 6°	0.425
Glenoid Inclination	77° ± 7°	78° ± 7°	76° ± 7°	0.111

[†]Measurements are displayed as means ± standard deviations.

Figure 1.

Representative Measurements. (A) Shoulder abduction moment index = A/B ; (B) Lateral shoulder abduction moment index = A/B ; (C) Acromial humeral interval = AHI; (D) Acromial index/Lateral offset = A/B ; (E) Glenoid inclination = A ; (F) Lateral acromial angle = LAA.

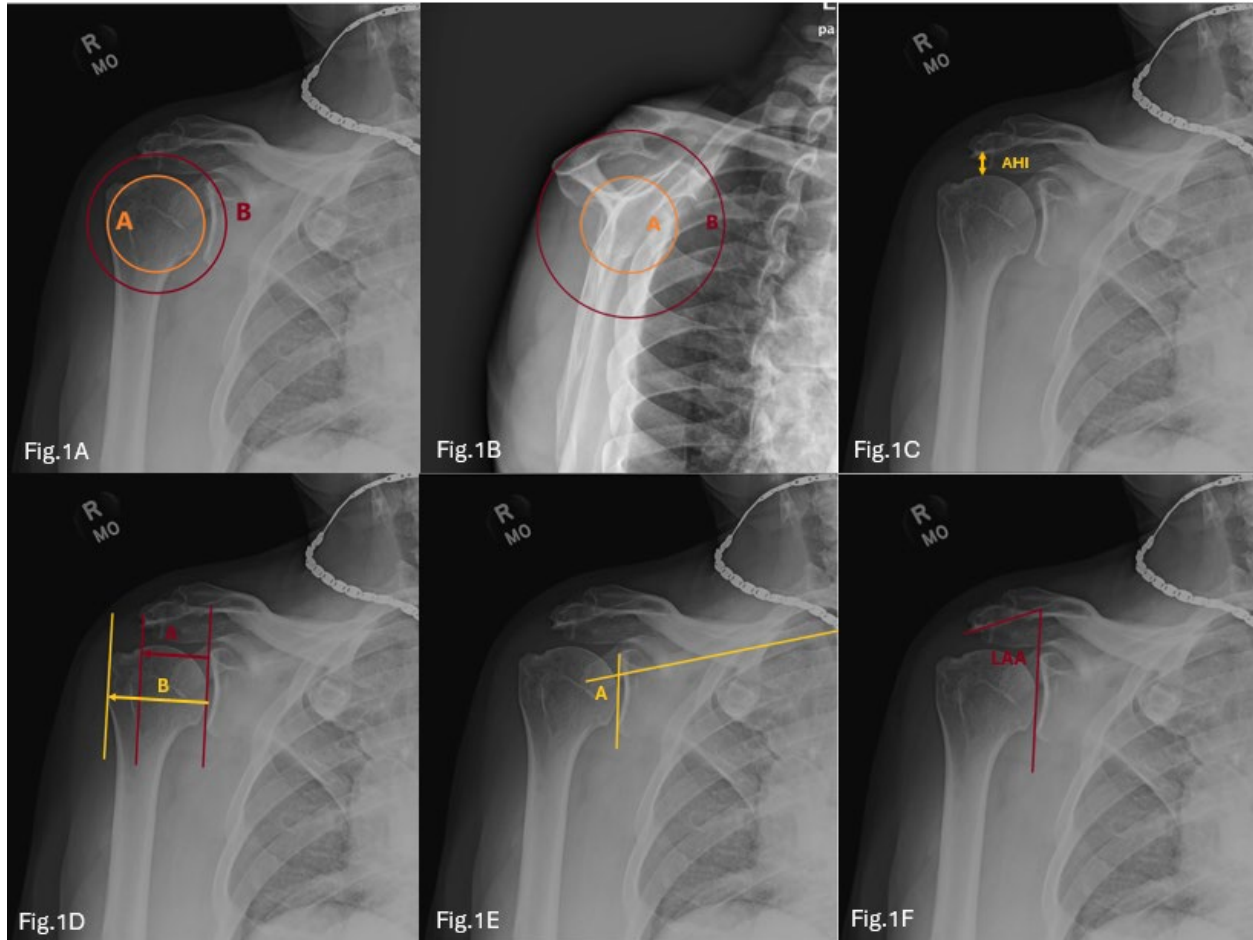
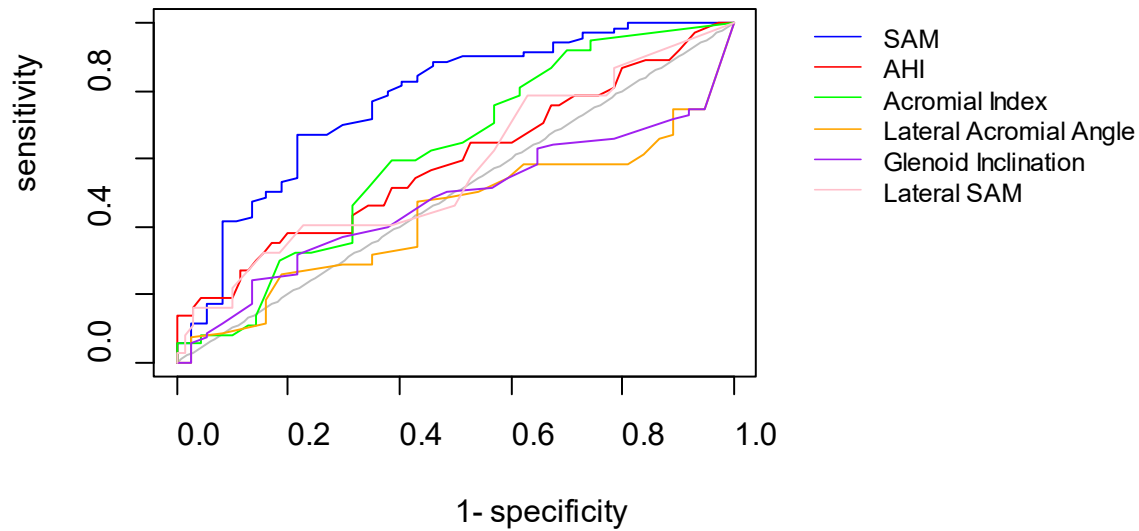


Figure 2.

Receiver operating characteristic curves for various radiographic measurements and pseudoparesis. SAM = Shoulder Abduction Moment Index, AHI = Acromial Humeral Index.



References

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