How do MRI and radiograph findings correlate with clinical scores in patients with rotator cuff tears?

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Background:
Rotator cuff tendon tears are a common shoulder pathology, particularly among older adults, leading to significant pain, restricted movement, and shoulder muscle weakness. Despite the prevalence of asymptomatic cases, the correlation between clinical symptoms and radiological findings remains a subject of debate.
Objective:
This study aims to explore the relationship between clinical findings and radiological parameters in patients with full-thickness rotator cuff tears (RCTs).
Methods:
A cross-sectional study was conducted on 85 patients with symptomatic complete RCTs at Mansoura University, Mansoura, Egypt, from August 2018 to May 2020. Clinical assessments included the Shoulder Pain and Disability Index (SPADI) and Constant score. Radiological measurements involved acromio-humeral distance (AHD), critical shoulder angle (CSA), tear size, number of torn tendons, and fatty infiltration, evaluated using magnetic resonance imaging. Statistical analysis was performed to determine correlations between clinical and radiological findings.
Results:
Significant correlations were observed between clinical scores and radiological parameters. A smaller AHD (<6 mm) and larger tear size were associated with worse clinical scores. Better SPADI scores were significantly linked to a CSA of <35°. The number of torn tendons and fatty degeneration grades were also significantly correlated with clinical outcomes. Additionally, age and the duration of symptoms were associated with poorer clinical scores.
Conclusion:
The study highlights the strong correlation between radiological findings and clinical severity in patients with full-thickness RCTs. These findings underscore the importance of comprehensive radiological assessment in guiding the management of rotator cuff pathology. Furthermore, research studies with larger cohorts are needed to validate these results and explore the role of asymptomatic tears in clinical decision-making.

Keywords:
clinical, correlation, cuff tears, radiological

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Introduction

A rotator cuff tendon tear is a prevalent condition encountered by shoulder surgeons [1]. Approximately 20% of the adult population has experienced a complete rotator cuff tears (RCTs) [2], with the prevalence increasing to 25% among individuals aged 60 years and almost 50% among those aged 80 years [1]. Shoulder pain of varying intensity, restricted glenohumeral movement, and shoulder muscle weakness are the most common symptoms. Interestingly, some patients may be entirely asymptomatic, experiencing no pain and maintaining nearly full shoulder motion. Studies suggest that 34.7% of RCTs are symptomatic, while 65.3% are asymptomatic [3].

Besides clinical examination, the diagnosis of cuff tendon tears depends on radiological assessment [4]. Antero-posterior and axial radiographs assess the degree of arthritis, proximal migration [acromio-humeral distance (AHD)], and critical shoulder angle (CSA) [5]. Magnetic resonance imaging (MRI) accurately diagnoses the number of torn tendons, tear size, and shape. The degree of fatty infiltration of the cuff muscles could be assessed by computed tomography scan and MRI [6,7].

Complete tears of the rotator cuff tendons are categorized based on the location of the tear, the number of tendons involved, and the impact on shoulder function. They are also classified by the degree of tendon retraction into three grades: small, with partial exposure of the footprint; medium, with

full exposure of the footprint; and large, with tendon retraction potentially reaching the glenoid level. Additionally, tears are classified by shape into crescent, reverse L, L-shaped, and trapezoidal.

Various clinical scoring systems are used to assess shoulder pathology, with the Constant score being the most utilized by many authors. The Shoulder Pain and Disability Index (SPADI) score is a highly reliable questionnaire used to evaluate shoulder pain and function. A patient's medical history and clinical examination are crucial for raising suspicion of an RCT.

There is ongoing debate and discrepancy regarding the relationship between radiological findings and clinical shoulder function and scores. Numerous studies have demonstrated a strong correlation between symptoms and tear size. Additionally, the correlation between SPADI scores and changes in MRI findings over time has been documented. However, other studies have identified significant radiological changes in completely asymptomatic patients, with partial tears being more prevalent in asymptomatic than symptomatic populations.

This study aims to explore the relationship between clinical findings and radiological findings in patients with full-thickness RCTs.

Hypothesis: we propose that there is a positive correlation between clinical findings and clinical scoring on one side and radiological findings on the other.

Patients and methods

Study design

Our study was approved by the institutional review board of the university with the code number (MS.18.10.39–2018/08/04). Informed consent with an explanation of the type of study and patient privacy was done for all patients. This observational cross-sectional study was carried out on patients with complete RCT at the Unit of Knee Surgery, Arthroscopy and Sports Injuries, Orthopedic Department, Mansoura University, during the period from August 2018 to May 2020.

Patients

All patients who presented to our outpatient clinic during the study period with a symptomatic complete RCT, confirmed by clinical examination and/or radiological assessment, were included in the study. Patients with Hamada classification grade II or higher osteoarthritis, a history of prior shoulder surgery, partial thickness tears (PTTs), or associated shoulder fractures were excluded from the study.

Clinical assessment

Clinical assessment was conducted through patient history, clinical examination, and clinical scoring. The SPADI was specifically developed to evaluate current shoulder pain and disability in an outpatient setting. The SPADI includes 13 items divided into two domains: a five-item subscale for pain assessment and an eight-item subscale for disability assessment. There are two versions of the SPADI: the original version, which uses a visual analog scale for scoring, and the second version, which utilizes a numerical rating scale. The history taken focused on the mechanism and timing of trauma, associated comorbidities, and the patient's level of activity. Clinical evaluation was performed using the Constant score and SPADI score [8,9].

Radiological measurements

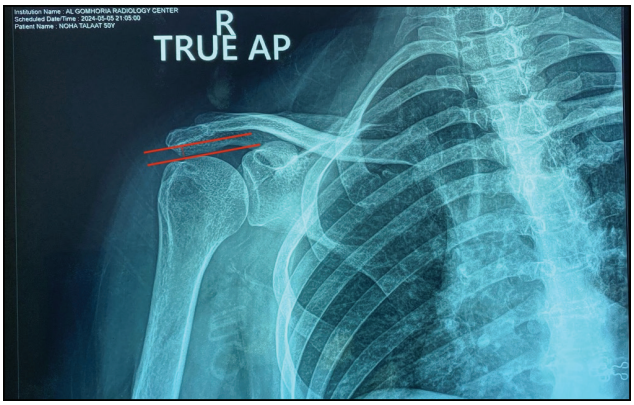
The AHD was defined as the distance between two lines: the first line touches the tip of the tuberosity and the highest point on the humeral head, while the second line is parallel to the first and situated beneath the acromion. For statistical analysis, patients were categorized based on whether their AHD was greater or less than 6 mm (Fig. 1). The CSA is defined as the angle between two lines, the first drawn from the superior to the inferior edge, of the glenoid, and the second from the inferior edge of the glenoid to the tip of the acromion was also assessed (Fig. 2). Patients were grouped into those with a CSA greater or less than 35° for the analysis. The degree of osteoarthritis was evaluated according to the Hamada classification.

The tear size on digital MRI was measured using the Cofield classification, with measurements obtained digitally through specialized software [10]. The patients were grouped according to tear size on MRI into a small tear group, a medium-size tear group, a large-size tear group, and a massive tear group. Additionally, the number of torn tendons and the degree of fatty infiltration were assessed according to the Goutillier classification [11].

Statistical analysis and interpretation

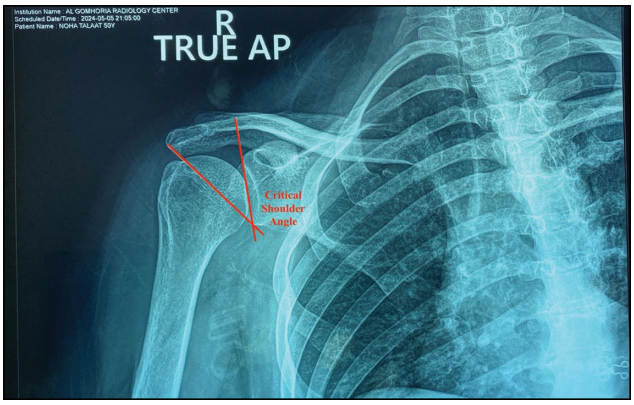
Data was analyzed using SPSS, Version 22.0 (IBM, Chicago, Illinois, USA). Quantitative data were described using median (minimum and maximum) for nonparametric data tested by the Mann–Whitney *U* test while mean and SD for parametric data. To compare two independent groups, a Student *t* test was used, while more than two independent groups were compared by the one-way analysis of variance test. The post-hoc Tukey test was used to detect

Figure 1



Acromio-humeral distance.

Figure 2



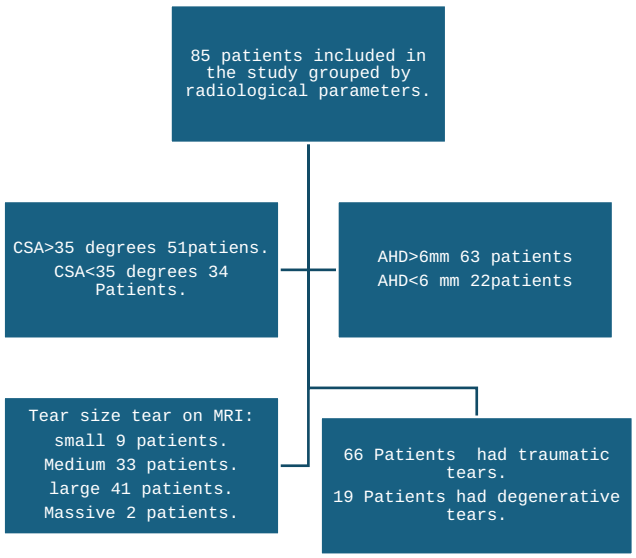
Critical shoulder angle.

pair-wise comparison after testing normality using the Kolmogorov–Smirnov test. Qualitative data were described using numbers and percentages. The Spearman's Ankh order correlation determines the strength and direction of a linear relationship between two nonnormally distributed continuous variables and ordinal variables. The significance of the obtained results was judged at the 0.05 level.

Results

The study included 85 patients with complete symptomatic RCT. The flow chart of patients seen during the study period is shown in Fig. 3. The age of the study population had a mean value of 52.92±10.24 years, ranging from 29 to 70 years. Duration of complaint was less than 12 months in 61.2% of patients. The mean duration of complaint was 17.8 ±15.33, ranging from 1.0 to 72 months. Most of the patients were traumatic 78.8 and 21.2% were degenerative. The median value of the AHD was 8.3 mm, ranging from 0.0 to 13.3 mm, and 74.1% of the studied cases had an AHD of more than 6 mm. Sixty percent of the studied patients had CSA more

Figure 3



Flow chart of patients. AHD, acromial-humeral distance; CSA, critical shoulder angle.

than 35° with mean CSA 36.18° ranging from 25 to 50°. The degree of osteoarthritis is distributed as follows: 12.9% is grade I, and 7.1% is grade II. On MRI, the mean size of the tear was 3.3 cm, with 48.2% of the studied patients having large tears, 38.8% having medium tears, and only 2.4% having massive tears. 52.9% of cases have only one torn tendon, 30.6% have two, and 16.5% have three torn tendons. Grade III fatty degeneration was detected among 37.6% of the studied patients, and 32.9% were grade IV fatty degeneration. The mean SPADI score among studied patients was 65±16.3, ranging from 32 to 93, and the mean constant score was 33.2±16.19, ranging from 17 to 80.

The data collected was analyzed to identify significant correlations between clinical scores, range of motion (ROM), and radiological findings, including radiograph and MRI, with the following results:

(1) There was a statistically significant correlation between AHD and clinical scores. An AHD of less than 6 mm was associated with worse Constant and SPADI scores. Conversely, a CSA of less than 35° was significantly associated with better SPADI scores, though no significant association was found with the Constant score.
(2) A statistically significant correlation was observed between clinical scores and the size of the tear. Larger tear sizes were associated with worse Constant and SPADI scores, while smaller tear sizes were significantly associated with better scores. Additionally, better Constant and SPADI scores were significantly linked to a smaller number

of torn tendons, and a better Constant score was associated with a lower grade of fatty degeneration.

(3) Regarding ROM and radiological findings, the abduction angle showed a statistically significant correlation with the number of torn tendons. The flexion angle demonstrated a statistically significant correlation with both fatty degeneration and the number of torn tendons (Table 1).
(4) Clinical scores had a statistically significant correlation with the chronicity of complaints. Better Constant and SPADI scores were associated with a shorter disease duration (<12 months), whereas worse scores were linked to a longer disease duration (>12 months). Additionally, there was a statistically significant correlation between the duration of complaints and AHD, the number of torn tendons, and the degree of fatty degeneration (Table 2).
(5) Both SPADI and Constant scores were statistically significantly correlated with age, duration of complaints, tear size, the number of torn tendons, fatty degeneration, ROM, and AHD (Table 3).

Discussion

The result of our study indicates a strong correlation between clinical findings and radiological parameters in patients with complete RCT. There was a notable correlation between clinical scores and tear size, as well as between clinical scores and the number of torn tendons. Patients with large tear sizes had inferior constant and SPADI scores; however, superior constant and SPADI scores were significantly associated with small tear sizes and a smaller number of torn tendons. A better Constant score is significantly associated with a lower grade of fatty degeneration.

Moosmayer and colleagues conducted a study comparing 50 individuals with asymptomatic complete RCTs and 50 individuals with symptomatic complete RCTs, all diagnosed by MRI. They analyzed various tear characteristics, including tear size, location, the condition of the long head of the biceps, and fatty degeneration of the muscles. Their findings indicated significant associations between clinical examination outcomes, specifically the American Shoulder and Elbow Score, and factors such as tear retraction greater than 3 cm and higher-grade fatty degeneration of the cuff muscles. These results align closely with our study's findings, which also highlight the critical role of tear size and fatty degeneration in influencing clinical severity and functional outcomes. This congruence underscores the importance of these factors in evaluating and managing rotator cuff pathology [12].

In contrast, Miniaci and colleagues found a weak association between the prevalence of RCT and symptomatic presentation. Their study involved 28 asymptomatic shoulders from 14 professional baseball players, averaging 20 years of age. They compared the throwing shoulder to the nonthrowing shoulder and discovered that 11 (79%) out of 14 throwing shoulders had lesions in the posterosuperior cuff tendons, while 12 (86%) out of 14 nonthrowing shoulders exhibited 1A or 1B changes in the same tendons. This finding underscores the complexity of correlating rotator cuff pathology with clinical symptoms, as significant lesions can be present even in asymptomatic individuals. The main distinction from our study lies in the younger age of the participants and their professional athlete status, which may contribute to the observed differences in symptom presentation and lesion prevalence [13].

Reilly and colleagues [14] conducted a comprehensive systematic review to investigate the prevalence of RCTs in both cadaveric and radiological studies, encompassing a total of 2553 shoulders. In cadaveric studies, the prevalence of full-thickness tears (FTTs) was found to be 11.75%, and PTTs were observed in 18.49%, with a total prevalence of 30.24%. The mean age of the cadaveric patients was 70.1 years.

The review also examined MRI studies, categorizing them into asymptomatic and symptomatic groups.

Table 1 Correlation between range of motion and radiological findings among studied cases

		Abduction	Flexion	External rotation	Internal rotation
Size of tear/cm	r_s	–0.275*	–0.162	–0.153	–0.038
	P	0.011	0.138	0.162	0.731
AHD/ mm	r_s	–0.127	–0.136	–0.052	–0.069
	P	0.248	0.215	0.639	0.529
Fatty degeneration	r_s	–0.201	–0.246*	–0.210	–0.111
	P	0.065	0.024	0.054	0.313
Number of torn tendons	r_s	–0.255*	–0.256*	–0.186	–0.095
	P	0.019	0.018	0.088	0.385

AHD, acromial-humeral distance; r_s, Spearman correlation coefficient.
*Statistically significant.

Among the four asymptomatic studies involving 271 patients with no history of shoulder symptoms, the prevalence of FTTs was 10.33%, and PTTs was 15.87%, resulting in a total prevalence of 26.2%. The mean age in this group was 44.3 years. In contrast, the 12 symptomatic studies, which included 490 patients presenting with a variety of shoulder complaints, such as pain or clinical suspicion of an RCT, revealed a much higher prevalence of tears. Specifically, FTTs were present in 40.81% of cases and PTTs in 8.57%, with a total prevalence of 49.38%. The mean age in the symptomatic group was 43.6 years.

While this systematic review provides valuable insights into the prevalence of RCTs across different populations, it is important to note that the study did not include clinical data or assess the degree of shoulder disability concerning pain or ROM. The focus was primarily on categorizing tears into symptomatic and asymptomatic groups, which limits the ability to fully understand the functional implications of these tears and their correlation with clinical symptoms.

Our study found a statistically significant association between AHD and clinical scores among the studied cases. Specifically, an AHD of less than 6 mm was correlated with worse Constant and SPADI scores, indicating that a reduced AHD may be predictive of greater functional impairment in patients with RCTs. Interestingly, 74.1% of the studied cases had an AHD greater than 6 mm, with a mean of 7.54 mm, suggesting that while AHD is a useful metric, it may not always be reduced in cases of complete cuff tears.

The findings align with those of Miswan *et al.* [15], who explored the relationship between shoulder joint anatomy, RCT, and glenohumeral osteoarthritis (GHOA). Their study revealed that an AHD of less than 6.6 mm and a CSA greater than 39° were more commonly associated with RCT. Miswan and colleagues suggested that a torn rotator cuff tendon is typically accompanied by a decreased AHD and proximal migration of the humeral head, corroborating the idea that anatomical changes reflected in AHD can be indicative of RCT severity. However, our study noted that not all cases with

Table 2 Correlation between chronicity and radiological findings among studied cases

	Duration of complaint/months	
	r_s	*P*
AHD/mm	–0.656	<0.001*
CSA	–0.07	0.53
Degree of OA	–0.191	0.43
Size of the tear	0.164	0.133
Number of torn tendons	0.241	0.026*
Fatty degeneration	0.340	0.001*

AHD, acromial-humeral distance; CSA, critical shoulder angle; OA, osteoarthritis; r_s, Spearman correlation coefficient.
*Statistically significant.

Table 3 Summary of significant correlations

		SPADI	Constant
Age/years	r_s	0.295*	–0.412*
	P	0.006	<0.001
Duration of complaint/months	r_s	0.289*	–0.396*
	P	0.007	<0.001
AHD/mm	r_s	–0.333*	0.214*
	P	0.002	0.050
CSA	r_s	0.078	0.011
	P	0.477	0.922
Size of the tear	r_s	0.252*	–0.237*
	P	0.020	0.029
Number of torn tendons	r_s	0.439*	–0.443*
	P	<0.001	<0.001
Fatty degeneration	r_s	0.292*	–0.385*
	P	0.007	<0.001
Abduction	r_s	–0.222*	0.414**
	P	0.041	<0.001
Flexion	r_s	–0.263*	0.502**
	P	0.015	0.001
External rotation	r_s	–0.313**	0.522**
	P	0.004	0.001
Internal rotation	r_s	–0.224*	0.369**
	P	0.039	0.001

AHD, acromial-humeral distance; CSA, critical shoulder angle; r_s, Spearman correlation coefficient; SPADI, Shoulder Pain and Disability Index.
*Statistically significant.

complete cuff tears exhibited a decreased AHD, implying that other factors may also contribute to maintaining or altering this distance in certain individuals.

Further supporting the utility of AHD as a diagnostic measure, Xu *et al.* [16] examined the reliability of AHD assessment via ultrasound in 59 patients with complete RCT. They found a strong correlation between AHD and the severity of the tear, reinforcing the value of AHD measurement in clinical practice. However, the variability observed in our study suggests that while AHD is a significant indicator, it should be considered alongside other clinical and radiological findings to provide a more comprehensive evaluation of RCTs.

In our study, we observed a significant association between a CSA of less than 35° and better SPADI scores, although no significant correlation was found with Constant scores. This finding suggests that a lower CSA may be indicative of less functional impairment as measured by SPADI, highlighting its potential relevance in the assessment of rotator cuff pathology.

These results are consistent with the study conducted by Spiegl *et al.*, which explored the relationship between CSA and various shoulder pathologies, including RCT and osteoarthritis [17]. Horan *et al.* investigated CSA across three groups: patients with complete RCT, patients with shoulder osteoarthritis, and a control group without any shoulder pathology. All groups were age-matched and had no significant differences in demographic characteristics. Their findings indicated that a higher CSA was strongly associated with RCT, while a lower CSA was more commonly observed in patients with shoulder osteoarthritis. This relationship underscores the importance of CSA as a key anatomical feature in differentiating between different types of shoulder pathology.

Given these findings, the measurement of CSA should be considered an important component in the evaluation of patients with shoulder conditions, whether they present with RCT or osteoarthritis. The variation in CSA among different pathologies supports its utility as a diagnostic tool, helping clinicians tailor their approach to each specific case based on a more nuanced understanding of the underlying anatomical changes [17].

On the other hand, Chalmers and colleagues studied a large cohort of 326 shoulders and compared CSA to MRI findings. They found a low correlation between CSA and tear size and also tear progression. They found that CSA does not change with time. They concluded that the CSA is not correlated with tear size or tear progression and does not seem to change with time [18]. So, CSA could be helpful in diagnosis but should be used in association with other clinical and radiological parameters to reach a better diagnosis.

In our study, the clinical assessment of patients with RCT revealed a mean SPADI score of 65±16.3, with a range from 32 to 93, and a mean Constant score of 33.2±16.19, ranging from 3 to 80. These findings indicate a considerable degree of functional impairment and pain among our patient population, as reflected by the relatively high SPADI scores and low Constant scores.

For comparison, Cadogan *et al.* [19] conducted a study involving 203 participants and reported a mean SPADI score of 38, with a broader range from 0 to 98. The lower mean SPADI score observed in Cadogan and colleagues study suggests a less severe degree of shoulder dysfunction in their cohort compared to ours. This discrepancy might be attributed to differences in the severity of rotator cuff pathology, the patient population, or variations in the duration and nature of symptoms between the two studies.

The higher SPADI scores in our study highlight the significant impact of RCT on the patient's quality of life, indicating more pronounced pain and disability. These variations underscore the importance of considering patient demographics and clinical context when interpreting clinical scores, as they can provide insight into the overall burden of disease and the effectiveness of interventions.

In our study, we found a statistically significant association between age and both SPADI and Constant scores, indicating that older patients tend to have worse clinical outcomes. This relationship suggests that as age increases, so does the severity of rotator cuff pathology, reflected in poorer functional scores.

Supporting our findings, Moosmayer and colleagues conducted a study using MRI and ultrasonographic screening on 32 asymptomatic individuals and observed that the prevalence of complete RCTs increases with age [12]. They reported that degenerative RCTs have become more common in older age groups, with ~15–30% of individuals over 70 years of age having complete RCTs. Notably, many of these individuals do not exhibit symptoms, which may be attributable to the lower physical demands typically placed on the shoulders in this age group.

This correlation between age and rotator cuff pathology underscores the degenerative nature of these tears, with older individuals being more susceptible to both the occurrence and severity of such injuries. It also highlights the complexity of managing RCTs in older populations, where the presence of asymptomatic tears can complicate clinical decision-making and treatment planning.

One of the key limitations of this study is the relatively small sample size, which may affect the generalizability of our findings. Additionally, this study did not include asymptomatic patients with positive MRI findings, which could have provided a more comprehensive understanding of the relationship between radiological abnormalities and clinical symptoms. The inclusion of both traumatic and degenerative cases within the patient cohort introduces variability that might have influenced the outcomes, potentially obscuring differences between these distinct etiologies. Future research with larger, more diverse populations and a focus on asymptomatic cases is needed to validate and expand upon our findings.

Conclusion

There is a strong correlation between the patient clinical and radiological findings. MRI findings, huge tear size, more than one tendon involvement, and a higher degree of fatty infiltration were associated with significant changes in the patient's clinical findings, such as ROM and clinical scores. Similarly, the radiograph findings as AHD and CSA strongly affect the patient's clinical scores and ROM. Age above 50 and medical comorbidities such as diabetes were associated with worse clinical score findings.

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Conflicts of interest

There are no conflicts of interest.

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