



# Inter Observer Variability in the Specificity of Magnetic Resonance Imaging for External Impingement of the Shoulder—Is There Agreement among Radiologists?

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## Abstract

**Purpose:** External impingement in the shoulder is a condition characterised by tenderness in the antero-lateral aspect of the shoulder on arm elevation due to an absolute or relative decrease in the subacromial space. Magnetic resonance imaging (MRI) is frequently utilised to confirm the condition and rule out other differential diagnoses. We conducted a study to look at the inter observer variability in specificity of MRI scanning in impingement of the shoulder. **Methods:** Twenty-six shoulders aged between 20 and 34 who all presented with shoulder instability only were included in the study. Three experienced consultant musculoskeletal radiologists were then asked to comment on the presence or absence of impingement on reviewing their MRI scans. **Results:** Radiologist 1 (R1) diagnosed 7 shoulders with impingement and 19 shoulders without. Radiologist 2 (R2) observed that 13 shoulders had radiological signs of impingement and 13 did not, and radiologist 3 (R3) suspected impingement in 20 shoulders with 6 shoulders normal. For R1 and R2, the agreement was 0.58 with a kappa value of 0.16. Between R2 and R3, the agreement was also 0.58 with a kappa value of 0.16. Comparing R1 and R3, the agreement was 0.46 and the kappa value was 0.14. Across all three radiologists, there was agreement in 8 out of the 26 MRI scans (31%) but only in 4 out of the 26 (15.4%) did they all agree that impingement was not present. **Conclusion:** MRI should be used judiciously in the work up of patients with external impingement of the shoulder.

## Subject Areas

Radiology & Medical Imaging

## Keywords

Shoulder Pain, Impingement, External Impingement, MRI Scanning in

## Shoulders, Shoulder Imaging, Specificity of MRI in External Impingement

## 1. Introduction

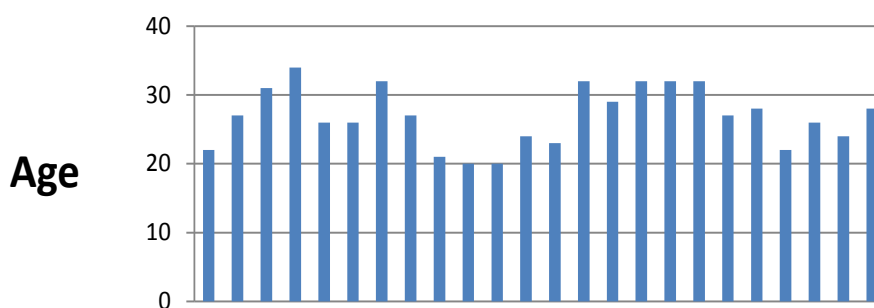
External impingement of the shoulder is a condition characterised by tenderness in the antero-lateral aspect of the shoulder on arm elevation due to an absolute or relative decrease in the space between the humeral head and the coraco-acromial arch. This space contains, from inferior to superior, the tendon of the long head of the biceps, the rotator cuff, the subacromial bursa, and the coraco-acromial ligament. Pathology of any one of these structures or their bony boundaries, the head of the humerus or the acromion process can lead to impingement, a common cause of shoulder morbidity in the middle aged. The diagnosis is mainly clinically made after a history and examination, though increasingly MRI scanning is utilised to confirm the condition and rule out other differential diagnoses such as rotator cuff tears that may affect the treatment plan. We conducted a study to look at the specificity of MRI scanning in impingement of the shoulder and discuss the relevance of this imaging modality in aiding the clinician.

## 2. Methods

Twenty four patients, 21 males and 3 females, (26 shoulders) who all presented with shoulder instability only and no clinical signs of impingement were included in the study (**Figure 1**). They had all been assessed either directly by or under the supervision of a consultant shoulder orthopaedic surgeon. They had their MRI scans reviewed by 3 independent experienced consultant musculoskeletal radiologists who were blinded to the indications of the scans, patient age and the previous reports. We asked the radiologists to comment on whether or not impingement was present on the MRI images. The agreement between the three radiologists was then statistically determined.

## 3. Results

Radiologist 1 (R1) diagnosed 7 shoulders with impingement and 19 shoulders without. Radiologist 2 (R2) observed that 13 shoulders had radiological signs of



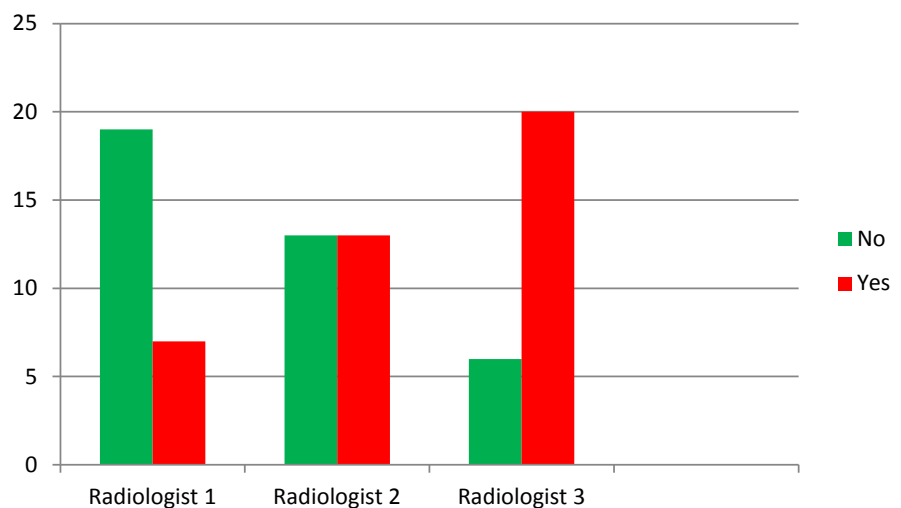
**Figure 1.** Age spread.

impingement and 13 did not, and radiologist 3 (R3) suspected impingement in 20 shoulders with 6 shoulders normal (**Figure 2**).

#### Statistical analysis

In order to compare inter-rater variability, the kappa value is utilised. This figure is calculated by first finding out the agreement between the observers then factoring in the individual cases they agreed on and the possibility of this agreement being down the chance. This gives a kappa value between 0 and 1, where 1 denotes perfect agreement and 0 demonstrates that the agreement was no better than chance. Landis and Koch [1] published guidelines on the adequacy of inter observer reliability and interpretation of the kappa value and is summarised in **Table 1**.

The agreement and kappa values of the study are summarised in **Table 2**. Across all three radiologists, there was agreement in 8 out of the 26 MRI scans (31%) but only in 4 out of the 26 (15.4%) did they all agree that impingement was not present.



**Figure 2.** Bar chart of shoulders diagnosed with impingement by each radiologist.

**Table 1.** Landis and Koch table on interpretation of kappa values.

Kappa value	Classification
<0.20	Poor
0.21 - 0.40	Weak
0.41 - 0.60	Moderate
0.61 - 0.80	Good
0.81 - 1.00	Very good

**Table 2.** Agreement and kappa values across all 3 radiologists.

	R1 vs. R2	R2 vs. R3	R1 vs. R3
Agreement	0.58	0.58	0.46
Kappa value	0.16	0.16	0.14

## 4. Discussion

External impingement occurs due to compression of the structures between the humeral head and the coraco-acromial arch on arm elevation. Clinically, provocative tests such as Neer's and Hawkin's are invaluable in making the diagnosis but recent studies have shown that Hawkins test may actually create internal impingement [2]—abutment of the articular surface of the rotator cuff between humeral head on the edge of the glenoid—and subacromial decompressions performed on patients with internal impingement will be of limited benefit. Furthermore, in the Neer's provocative position (full flexion in internal rotation) the space between the rotator cuff and the acromion was found to be increased [3]. This makes accurate clinical diagnosis challenging and often to aid the clinician imaging is utilised.

The use of MRI scans in picking up shoulder pathology is controversial. An early study by Ianotti *et al.* [4] showed a sensitivity of 100% and specificity of 95% for complete tears of the rotator cuff, and sensitivity of 87% and specificity of 93% for differentiation between normal and inflamed tendon. Nelson *et al.* [5] demonstrated the superiority of MRI in establishing the aetiology of a painful shoulder and with its superior soft tissue detail, Uri [6] reported that MRI was the favoured imaging tool in rotator cuff pathologies, a claim supported by Bachman *et al.* [7] who, in a cadaveric study, found MRI had a sensitivity of 96% and a specificity of 100% in differentiating between normal and abnormal cuff tendons. This was challenged by Torstensen *et al.* [8] who compared MRI to arthroscopic findings and reported a sensitivity of 96% but a lower specificity of 49% in picking rotator cuff tears.

On MRI, possible features of external impingement are a large amount of fluid within the subacromial bursa and medial to the acromioclavicular joint [9], a reduction in the acromiohumeral distance [10], the presence of downward facing acromioclavicular joint osteophytes [11], the shape of the acromion [12] [13] [14], an os acromiale [15] and rotator cuff lesions [16] [17]. However, many of the above lesions have been found in asymptomatic shoulders making radiological diagnosis unreliable.

In our study, the patients had MRI taken using a Toshiba™ 1.5 Tesla scanner with 4mm slices. On the axial T2 weighted views a field echo was applied with a repetition time (TR) of 551 milliseconds and an echo time (TE) of 15 milliseconds. The coronal T1 weighted images had a spin echo and a TR of 416 ms and a TE of 12 ms. The T2 weighted coronal images had a TR of 3136 ms and a TE of 96 ms. The coronal STIR images had a TR of 4483 ms and TE of 48 ms. In the sagittal view, the TR was 3136 ms and the TE 96 ms. All were sent to radiology because of instability and had a plain MRI as a first line of investigation prior to later having an MRI arthrogram if any doubts persisted as to the cause of their symptoms after a normal initial MRI. In this study, the radiologists were asked to comment on the MRI arthrogram. Though none had clinical signs of impingement, in several of the cases there were signals picked up by the radiologists that led them to believe that in the majority of patient's external impinge-

ment was present.

There was very little agreement however amongst the three radiologists, as shown by the low kappa values ( $<0.2$ ). One possible explanation for this is the lack of standardised protocol for assessing impingement. The radiologists used the above parameters of external impingement in different measure to determine whether they thought impingement was present. Also, the limits of acceptable radiological signs will vary depending on training, previous experience and differing patient anatomy.

Another possible reason for variation in reporting of the MRI scans is that they were contrast pictures, as the initial clinical pathology in question was instability rather than impingement, and this may have interfered with the usual signal given off in the presence of cuff tendinopathy leading to a false positive. Only one radiologist of the three thought that this interfered with their ability to make a confident diagnosis. In addition to this, signal intensity is influenced by the orientation of tendon fibres relative to the magnetic field, which may lead to misdiagnosis of normal rotator cuffs [18].

There were a few limitations to our study which we fully acknowledge. Firstly, the acromio-humeral distance is dependent on gender and arm position, this distance in men being 1.2 mm more on average with the arm in  $30^\circ$  abduction; and at  $90^\circ$  this distance is reduced further in both sexes. In our study, there was no standardisation of arm position whilst patients were in the MRI scanner and slight variations in positions may have led to an increased chance of an erroneous report by the radiologists. Ideally, we would have also had in this study a cohort of patients who clinically had impingement and MRI scans to compare with the patients who were included in this study to establish the sensitivity of MRI in this series as well. In our unit though, patients who are clinically thought to have impingement do not routinely have MRI scans so it was not possible to make this comparison [19]. The radiologists taking part in the study were prone to reporting bias when asked to comment on whether impingement was present on the MRI scan. With this condition being one of the most common shoulder pathologies, they may have had a lower threshold of “diagnosing” it on the scan. Lastly, in this paper, the kappa values were used to determine inter-rater reliability. However, it has been shown that with small sample sizes the kappa values tend to be lower [20] so with a larger sample size the values may have differed.

## 5. Conclusion

External impingement is a largely clinical diagnosis, and this study has shown that MRI can be misleading. Moreover, there is little agreement even among experienced musculoskeletal radiologists regarding the possible appearance of lesions in the shoulder. For these reasons, clinicians should be judicious in the use of this imaging modality, and closer communication between surgeon and radiologist should be developed prior to and, if the MRI scan is performed, after imaging so that the most effective treatment plan can be instituted. In our experience, this imaging modality has the limited value in assisting the clinician

when deciding whether or not patients require the operative treatment of this common condition.

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