



RESEARCH ARTICLE

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## Analysis of MR Arthrogram *Versus* Arthroscopy in Glenoid Labral Tear Diagnosis: Identifying Pitfalls to Improve Radiologic Accuracy

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### ABSTRACT

**Background:** Magnetic Resonance (MR) arthrogram is the preferred diagnostic imaging study for detecting glenoid labral tears. Despite this, there is still discrepancy between MR arthrogram and arthroscopy, the diagnostic gold standard. We aim to identify areas of discordance between imaging findings and surgical findings to aid radiologists in a more accurate diagnosis of glenoid labral tears.

**Methods:** A retrospective chart review was conducted at our institution on a population that underwent an MR arthrogram and then underwent shoulder arthroscopy within six months. Factors such as patient demographics, location of labral tear, and radiologist and surgeon experience were collected.

**Results:** Analysis revealed a labral tear discrepancy rate of 14% and a labral tear location discrepancy rate of 39%. Labral tear discrepancies occurred at a significantly higher rate in older patients ( $p=0.035$ ) and females ( $p=0.018$ ). Discrepancies were most common in the superior and anterosuperior zones of the labrum. Increased radiologist experience was associated with decreased discrepancies ( $p=0.01$ ). Increased surgeon experience was associated with increased discrepancies ( $p=0.03$ ).

**Conclusion:** Awareness of various factors associated with discrepancies, such as the patient demographic and labral tear location, should prompt radiologists and surgeons to pay particular attention to those cases and thus improve clinical decision-making.

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### Keywords

MR arthrogram; Arthroscopy; Shoulder; Glenoid; Labral tears; Radiology

## Introduction

Magnetic Resonance (MR) arthrogram is the preferred imaging modality for assessing shoulder injuries, particularly glenoid labral tears [1]. Studies have shown the superiority of MR arthrogram over standard 2D non-arthrographic MRI when assessing for glenoid labrum injuries [2]. However, while it is a valuable tool for diagnosis, MR arthrogram does not confer complete accuracy compared to arthroscopy, which is considered the gold standard for diagnosis [3]. MR arthrogram is a minimally invasive imaging technique used to diagnose a variety of soft tissue pathologies of the shoulder [4]. MR arthrogram is an MRI imaging technique preceded by the injection of contrast into the glenohumeral joint, typically under fluoroscopic or ultrasound guidance [3,5]. Intra-articular contrast material injection results in distension of the joint capsule and better delineation of intra-articular structures; contrast material may further infiltrate and highlight abnormalities [6]. Arthroscopy is still considered the gold standard for intra-articular shoulder pathologies and allows for direct visualiza-

tion of injury [7]. Therapeutic intervention during the procedure is a benefit of arthroscopy, though it is more invasive and requires general anesthesia, potentially leading to more complications [3].

Numerous studies have compared the accuracy of MR arthrogram *versus* arthroscopy in shoulder injuries [3,7-10]. Studies evaluating MR arthrogram in detecting glenoid labral tears, using arthroscopy as the gold standard, have found high sensitivity and specificity. For example, in 2011, Jonas et al. found MR arthrogram to have a sensitivity of 0.65 and a specificity of 1.00 [10]. In 2015, Saqib et al. showed a sensitivity of 0.87 and a specificity of 0.76 [8]. In 2021, Jensen et al. found a sensitivity of 0.955 and a specificity of 0.68 [3].

While studies have compared MR arthrogram and arthroscopy for labral tears, there is a lack of literature investigating the discrepancy between the two techniques based on the precise location of labral tears and other factors, such as patient age and sex, as well as radiologist and surgeon training. Due to the small size of the structures being investigated and the

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vast range of patient backgrounds and physician training, we aim to identify any discrepancies in diagnosis and determine areas of improvement for clinical decision-making. Our goal is to thus correlate MR arthrogram with arthroscopy findings, with analysis of multiple associated variables and parameters. Such analysis may reveal common imaging pitfalls that radiologists should be aware of when diagnosing labral tears on MR arthrogram.

## Materials and Methods

### Patients

Institutional Review Board (IRB) approval was obtained. The records and imaging for all patients who underwent an MR arthrogram of the shoulder at our institution from 2014 to 2021 were retrieved. Patients were included if they had a shoulder arthrogram and then underwent a shoulder arthroscopy at our institution within six months after imaging. All other patients were excluded. Patients were also excluded if the arthrogram was technically unsuccessful (extra-articular injection of contrast) or if there had been prior labral surgery. All patient information was anonymized.

### Data collection

The specific data collected were the patient's age at the time of the MRI, MRI sequences obtained, MRI magnet strength, gender, BMI, date and the result of MR arthrogram of the shoulder, whether an ABER (abduction external rotation) view was used, radiologist's name, date of arthroscopy, diagnoses made during surgery, procedures done during surgery, surgeon's name, and laterality of the shoulder that was imaged and operated on. Radiologist experience (including MSK fellowship training and years in practice), surgeon experience (including shoulder sub-specialization and years in practice), and the time difference between MRI and arthroscopy were also recorded. Radiology reports, MRI images, and operative notes were reviewed to collect this data. After review, the following fields were filled: MRI presence of labral tear (yes/no), MRI location of labral tear (superior, anterosuperior, anteroinferior, inferior, posteroinferior, and/or posterosuperior), arthroscopy presence of labral tear (yes/no), arthroscopy location of labral tear, discrepancy for labral tear (yes/no), and discrepancy for labral tear location (yes/no). Each discrepant result was analyzed to determine any significant associations.

### Data analysis

We analyzed 285 consecutive patients over a seven-year period who underwent an MR arthrogram and subsequently had an arthroscopy within six months of the MRI. This required a retrospective review of the radiology reports and operative reports. The discrepancy rate between imaging and surgery was calculated, and

analysis of 35 data points was performed to find any associated factors.

Our null hypothesis was that MR arthrogram would be as accurate as arthroscopy when diagnosing labral tears regardless of the location of the tear, the patient's sex and age, and the radiologist's and surgeon's training.

Labral tears were considered discrepant if MRI reported a labral tear, but no labral tear was found at the time of surgery, or vice versa. Labral tear location was considered discrepant when there was a difference of more than one quadrant in the reporting of the tear. For instance, if the radiologist reported a labral tear anterosuperiorly and the surgeon reported a labral tear anteroinferiorly on the same patient, this was taken to be concordant, but not if the surgeon reported the labral tear to be inferior.

Some radiologists and surgeons reported labral tear location using a clock face—this was converted to six zones (Figure 1), i.e., superior, anterosuperior, anteroinferior, inferior, posteroinferior, and/or posterosuperior. A labral tear could involve multiple zones. While radiologists considered 3 o'clock to be anterior for both the right and left shoulder, some orthopedists considered 3 o'clock to be anterior for the right shoulder but posterior for the left shoulder. This was corrected when there was a clear indication that such a reversal had occurred due to laterality (Figure 1).

Vague or ambiguous language in both radiology and operative reports posed a problem. Such cases were taken to be concordant. For instance, if the radiologist reported a labral tear and the surgeon reported labral fraying, this was taken to be concordant. If the radiologist reported an equivocal tear and the surgeon reported a tear (or no tear), this was also taken to be concordant.

## Results

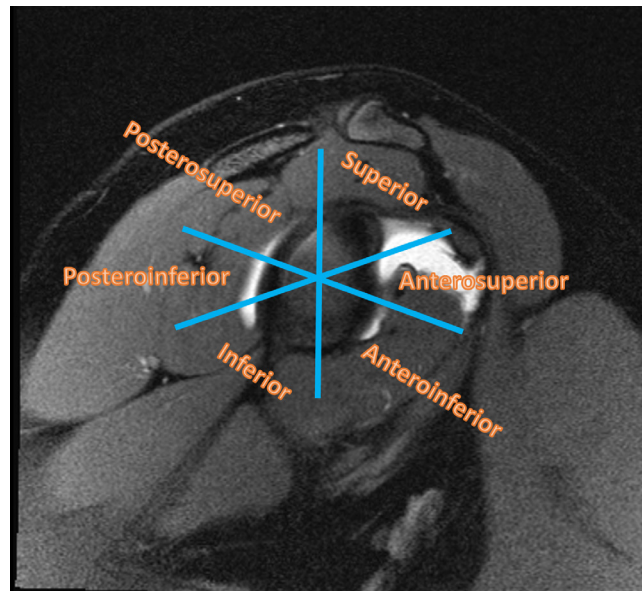
A total of 285 patients from a single academic institution were included. Analysis revealed a labral tear discrepancy rate of 14% and a labral tear location discrepancy rate of 39%, which is a notably high discrepancy rate. Among the patient factors that were analyzed, patient age and gender were associated with a statistically significant discrepancy rate. An age greater than 65 years was considered to be older for our patient population. Labral tear discrepancies occurred at a significantly higher rate in older patients ( $p=0.035$ ) and females ( $p=0.018$ ) (Figure 2). In our patient population, discrepancies in labral tear location occurred relatively more frequently in the left shoulder than the right (Figure 3). However, this was not significant after accounting for clock face convention discrepancies between radiologists and orthopedic surgeons ( $p=0.346$ ). Looking at the discordance based on the location of la-

brum injury within the respective shoulder; superior and anteroinferior were the most common locations of the labrum that were discrepant between MRI and surgery (Figure 4); these may be locations that require special attention. Of note, patient BMI did show significant discordance in labral tear or tear location.

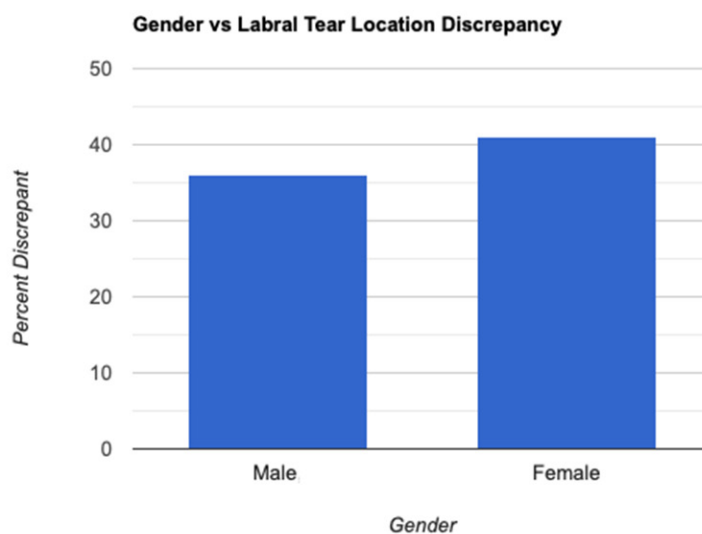
Moving to imaging factors that could play a role in discordance, the use of ABER (abduction external rotation) view decreased both labral tear and labral tear location discrepancies, although this was not statistically significant. MRI magnet strength also did not result in a statistically significant difference in labral tear or tear location.

Next, we aimed to determine causes of discordance with relation to the surgeon and radiologist. Upon comparing those surgeons with additional specializa-

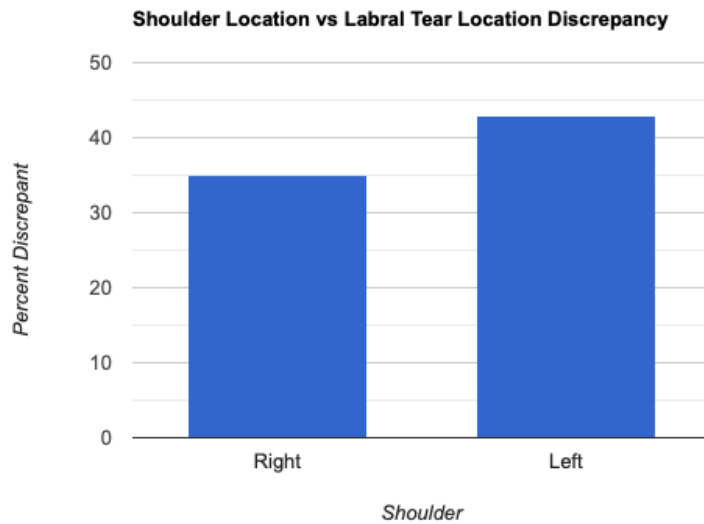
tion in the shoulder to those without, discrepancies in labral tear and labral tear location were more common among surgeons who were not shoulder specialists. However, statistical significance was limited due to the low number of cases performed by non-shoulder specialists. Radiologist fellowship training did not significantly affect labral tear or tear location discrepancies. We also calculated how the discordance rate changes with increased years of surgeon or radiologist experience. Comparing the discordance rate with total years of experience of surgeon and radiologist, we found that increased radiologist experience was associated with decreased discrepancies, with an abrupt decrease after 3 years of experience ( $p=0.01$ ) (Figure 5), while increased surgeon experience was associated with increased discrepancies with a relatively abrupt increase at 27 years of experience ( $p=0.03$ ) (Figure 6).



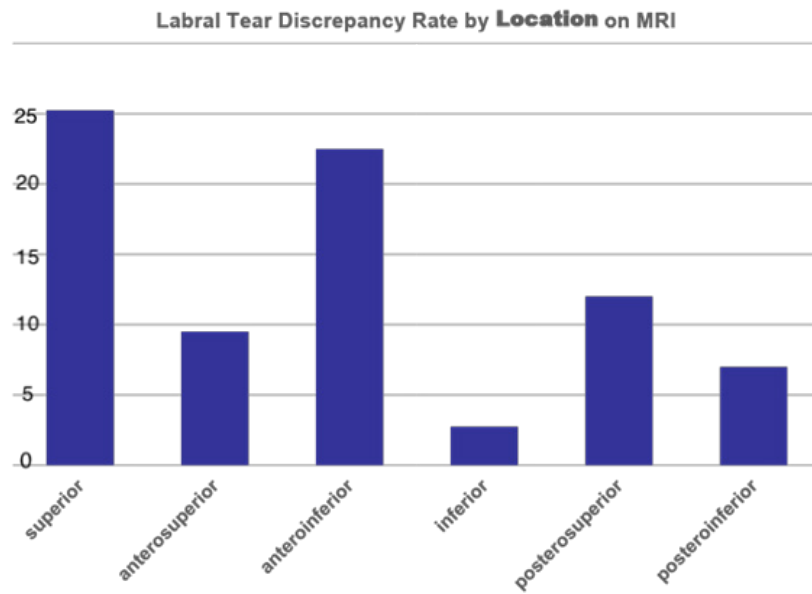
**Figure 1.** MR arthrogram demonstrating the six zones of the glenoid labrum.



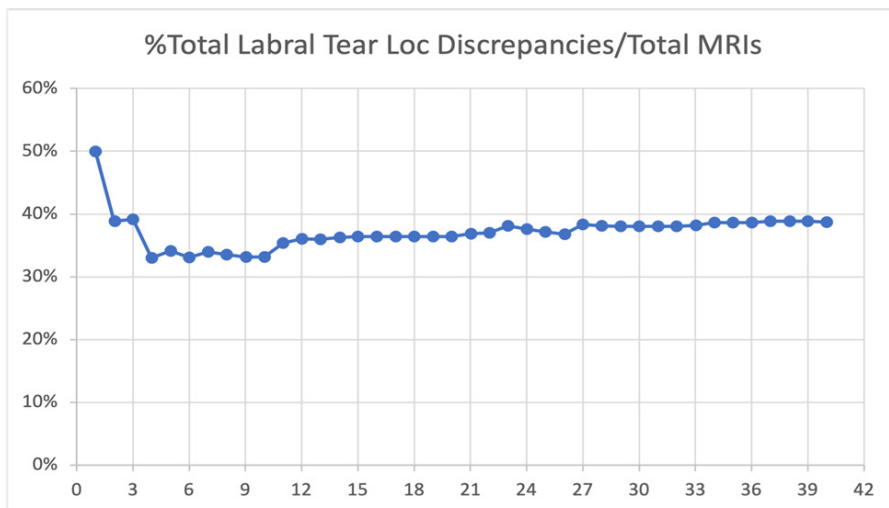
**Figure 2.** Analysis revealed a labral tear location discrepancy rate of 35% for males and 41% for females, which is a statistically significant difference.



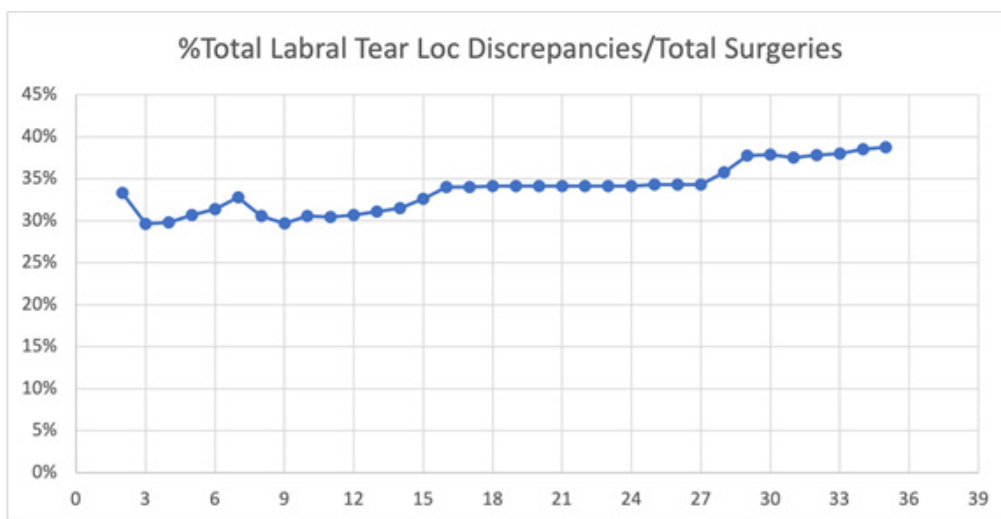
**Figure 3.** No statistically significant difference in labral tear location discrepancy was found when comparing right *versus* left shoulder (please see Results).



**Figure 4.** The two most common locations of the labrum for discrepant tears were found to be the superior and antero-inferior regions. These were both statistically significant from the radiologist’s point of view.



**Figure 5.** With increasing radiologist experience, there was a statistically significant association showing a decrease in discrepancies, with an abrupt change after 3 years of experience.



**Figure 6.** With increasing surgeon experience, there was a statistically significant association showing an increase in discrepancies, with a relatively abrupt change after 27 years of experience.

## Discussion

MR arthrograms of the shoulder are frequently performed for detection of glenoid labral tears. While there have been studies comparing the accuracy of diagnosing labral tears on MR arthrogram *versus* arthroscopy, there is a lack of literature comparing the exact location of labral tears as seen on MRI *versus* arthroscopy. Our study shows a nearly 40% discordance rate between radiology and surgery regarding labral tear location.

When stratifying for location, we see a significant discrepancy in the superior and anteroinferior zones (Figure 4). The superior zone is commonly associated with Superior Labrum Anterior-Posterior (SLAP) tears, a common type of labral tear [11]. Anteroinferior labral tears are often Bankart-type lesions and are commonly associated with shoulder instability [12]. Because of their common involvement with glenoid labrum pathology, it is understandable that the superior and anteroinferior zones are the most frequent locations of inconsistency between radiologists and surgeons. With this knowledge, we recommend that radiologists pay close attention to tears in these areas when reviewing an MR arthrogram.

A significant discrepancy between imaging and surgery was found in females (Figure 2). Several factors may contribute to this finding. Glenoid labral tears, mainly SLAP tears, are commonly found in athletes, with overhead sporting activities being the most significant risk factor [13]. An implicit association between males and sports may influence radiologists to diagnose labral tears more frequently in males than females. Additionally, higher estrogen levels in women decrease connective tissue stiffness, which may lead to higher rates of injury that are not considered when making diagnoses on MR arthrogram [14]. An understanding of potential bias and biological differences can lead to improved

MR arthrogram diagnostic accuracy in females.

We also identified discordant MR arthrogram *versus* arthroscopic findings at a greater percentage as patients got older. This may be due to labral fraying, which is common in older patients [11]. Fraying can be challenging to identify and define. The MR arthrogram is often overcalled or undercalled when fraying is found on arthroscopy [15]. This leads to possible inter-reader variability between radiologists as well as variability between radiologists' and surgeons' reports. Our study considered vague or ambiguous language in radiology and operative reports concordant. However, radiologists need to understand age-related labral changes and the difficulty of correctly identifying these changes on imaging.

We also discovered a discordance in labral tear location when comparing the left shoulder to the right (Figure 3), although not significant after accounting for potential clock face discrepancies between radiologists and orthopedic surgeons. We recommend both radiologists and surgeons use descriptive language when reporting labral tear location, e.g., anteroinferior rather than 3 to 5 o'clock.

Additionally, we found that MR arthrogram concordance improved with increasing radiologist experience (Figure 5). Our data show a marked improvement after three years of attending practice. This finding suggests that increased MR arthrogram training in residency and fellowship can help improve diagnostic accuracy.

Lastly, we found that concordance worsened with increasing surgeon experience, with a relatively abrupt change at 27 years (Figure 6). While evidence suggests that postoperative outcomes can improve linearly according to surgeon experience, there is also evidence that, particularly with newer surgery techniques, older surgeons have greater resistance to learning and im-

plementing them effectively [16,17]. On a similar note, with MRI being a relatively newer technology, more senior surgeons might have a different pattern of utilization of MRI than younger surgeons who had more exposure to it during their training. In particular, older surgeons may not directly review the MRI images before arthroscopy, thus increasing their discrepancy rate relative to the radiologist.

Limitations of our study include the possibility of confirmation bias due to the surgeons' access to MR arthrogram reports before arthroscopies. While arthroscopy is considered the gold standard, it is still imperfect and dependent on the operator. Additionally, using arthroscopy as a reference standard restricted our sample to only surgery-eligible patients. Our study was a retrospective analysis of radiologic and surgical reports; thus, we could not clarify ambiguity in these reports during data collection. To address this, we conservatively classified ambiguity as concordance between the reports. Lastly, we attempted to limit the time between MR arthrogram and surgery to less than six months. Still, we acknowledge that the possibility of injury progression during this time could produce inaccuracies.

## Conclusion

The glenoid labrum is a difficult structure to evaluate on imaging and on arthroscopy due to its small size and normal variants that can mimic tears. There is significant disagreement between MRI and arthroscopy regarding the presence/absence of a labral tear and more so, the location of the labral tear. Interobserver variability in terminology, such as fraying and orientation of clock faces, can lead to ambiguity and should be clarified. Awareness of the factors associated with these discrepancies, such as the patient demographic and labral tear location, should prompt the radiologist and surgeon to pay particular attention in those cases, thus improving clinical decision-making.

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