Magnetic resonance imaging arthrography following type II superior labrum from anterior to posterior repair: interobserver and intraobserver reliability

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Background: Arthroscopic repair of type II superior labrum from anterior to posterior (SLAP) lesions is a common surgical procedure. However, anatomic healing following repair has rarely been investigated. The intraobserver and interobserver reliability of magnetic resonance imaging arthrography (MRA) following type II SLAP repair has not previously been investigated. This is of particular interest due to recent reports of poor clinical results following type II SLAP lesion repair.

Purpose: To evaluate the MRA findings following arthroscopic type II SLAP lesion repair and determine its intraobserver and interobserver reliability.

Study design: Cohort study (diagnosis), Level of Evidence, 2.

Methods: Twenty-five patients with an isolated type II SLAP lesion (confirmed via diagnostic arthroscopy) underwent standard suture anchor-based repair. At a mean of 25.2 months postoperatively, patients underwent a standardized MRA protocol to investigate the integrity of the repair. MRAs were independently reviewed by two radiologists and a fellowship trained shoulder surgeon. The outcomes were classified as healed SLAP repair or re-torn SLAP repair.

Results: On average, 54% of MRAs were interpreted as healed SLAP repairs while 46% of MRAs were interpreted as having a re-torn SLAP repair. Overall, only 43% of the studies had 100% agreement across all interpretations. The intraobserver reliability ranged from 0.71 to 0.81 while the interobserver reliability between readers ranged from 0.13 to 0.44 (Table 1).

Conclusion: The intraobserver agreement of MRA in the evaluation of type II SLAP repair was substantial to excellent. However, the interobserver agreement of MRA was poor to fair. As a result, the routine use of MRA in the evaluation of type II SLAP lesion repair should be utilized with caution. A global evaluation of the patient, including detailed history and physical examination, is paramount in determining the cause of failure and one should not rely on MRA alone.

Keywords: SLAP, MRA, labrum, postoperative

Introduction
Tears of the superior labrum were first described by Andrews et al1 in 1985. Subsequent to this, Snyder et al2 coined the term superior labrum from anterior to posterior (SLAP) lesion and classified them into four types. SLAP lesions have reported incidences ranging from 4% to 26%3–7 with the type II SLAP lesion being the most common surgical lesion. However, controversy still exists in the treatment of this condition in part due to the difficulty in the clinical diagnosis of a symptomatic SLAP lesion.

In North America, magnetic resonance imaging (MRI) has become the imaging modality of choice when evaluating soft tissue lesions of the shoulder. With improved assessment of intra-articular pathology, magnetic resonance imaging arthrography
(MRA) is widely used when evaluating lesions of the labrum (eg, SLAP lesions, Bankart lesions).

While MRI or MRA have been routinely utilized preoperatively, their utility in the postoperative scenario has been less frequently reported. In particular, MRI has been more commonly applied in the assessment of rotator cuff integrity following repair. However, the use of MRA has only rarely been reported. In particular, its utility in the postoperative assessment of superior labrum tears is unclear.

Recently, the intraobserver and interobserver reliability of various diagnostic tests to detect type II SLAP lesions has been investigated. In particular, MRA has been extensively investigated and has shown to be a sensitive, minimally invasive procedure for detection and grading of SLAP lesions, with substantial to excellent intraobserver and interobserver reliability.

However, the intraobserver and interobserver reliability of MRA in the postoperative scenario following type II SLAP repair has not previously been investigated. In addition, the anatomic healing of a type II SLAP lesion following repair has rarely been investigated. This is particularly relevant in light of reports of poor results following type II SLAP lesion repairs.

Therefore, the purpose of this study is to evaluate the MRA findings following arthroscopic type II SLAP lesions repairs and determine its intraobserver and interobserver reliability. We hypothesized that the intraobserver and interobserver reliability would be highly variable in this patient population.

Methods

The study was a retrospective cohort study and patients were identified from a billing review of the senior author's practice. Patients were contacted by the research coordinator to determine their eligibility and interest in participating in the study. The University of Calgary Conjoint Health Research Ethics Board approved this research.

Between March 2003 and June 2006, the senior author performed isolated repairs of 25 type II SLAP lesions in 25 patients (18 male, 7 female) with a mean age of 40 ± 12 years. Exclusion criteria included: previous surgery, significant concomitant pathology requiring treatment (eg, subacromial decompression, distal clavicle excision, rotator cuff repair, biceps tenodesis, biceps tenotomy, Bankart repair, posterior labral repair, osteoarthritis), significant cervical spine pathology (and/or radiculopathy), significant medical issues precluding surgery, secondary gain issues (Workers’ Compensation Board claim, litigation), unwillingness to complete study outcomes, and unable to provide informed consent.

All patients underwent a diagnostic arthroscopy with confirmation of an isolated type II SLAP lesion. Standard suture anchor based repair was then performed. One anchor (3.0 mm Bio-FASTak or Bio-SutureTak double loaded with #2 Fiberwire; Arthrex, Inc., Naples, FL, USA) was placed underneath the biceps root and sutures were passed anterior and posterior to the biceps tendon. For larger tears extending posteriorly, subsequent anchors were placed through separate percutaneous transtendon portals (eg, Port of Wilmington) into the posterior superior aspect of the glenoid neck. Nine patients had one anchor inserted under the biceps, 13 patients had two anchors inserted, and three patients had three anchors inserted (Figure 1).

MRA imaging

At a mean of 25.2 months postoperatively (range: 13–44 months), 21 of 25 patients underwent a standardized MRA protocol to investigate the integrity of the type II SLAP repair. All sequences were obtained immediately post intra-articular injection of 10–15 mL dilute gadolinium into the glenohumeral joint, performed under fluoroscopic guidance prior to MRI.

A 1.5-T MRI scanner (Symphony; Siemens Healthcare Global) was utilized with the patient’s arm positioned in the neutral position. Standardized coronal oblique T1FS, T2FS, sagittal oblique T1, T2FS, Axial T1FS, and Axial GRE images were obtained. Parameters for all sequences were a section thickness of 3 mm with an intersecting gap of 1 mm.
0.3 mm, a field of view of 16 cm and an in-plane resolution of 0.4×0.3–0.5 mm.

**Image analysis**

All magnetic resonance images were reviewed on a commercial picture archiving and communication system (PACS) workstation (EasyVision; Philips, Best, the Netherlands). MRAs were independently reviewed by two radiologists with >10 years of experience in musculoskeletal imaging. In addition, the MRAs were evaluated by a fellowship-trained shoulder surgeon with >10 years experience in shoulder surgery. All readers were blinded to previous imaging reports, patient demographics, and all clinical findings and outcomes. MRAs were read twice in random order separated by a minimum of 6 months.

Outcomes were classified according to:

1. Healed SLAP repair: minimal to no dye leakage (and/or improvement when compared to the preoperative imaging) under the labrum (Figure 2).
2. Re-torn SLAP repair: detached superior labrum and dye present between the labrum and superior glenoid at the 12 o’clock position or posteriorly (Figure 3).

**Statistical analysis**

Statistical analysis was performed using SPSS (version 18; SPSS Inc., Chicago IL, USA). Cohen’s kappa coefficients (κ) were used to determine intraobserver agreement (<0 poor agreement; 0.00–0.20 slight; 0.21–0.40 fair; 0.41–0.60 moderate; 0.61–0.80 substantial; 0.81–1.00 excellent). Fleiss’ kappa coefficients used to determine interobserver agreement among the three readers (<0.4 poor; 0.4–0.75 fair to good; >0.75 excellent).

**Results**

Twenty-one patients were included in the analysis. The results of each reader’s interpretation are summarized in Table 1. On average, 11.4 (54.3%) (range: 9–14) of MRAs were interpreted as healed SLAP repairs (Figure 2) while 9.6 (45.7%) (range: 7–12) MRAs were interpreted as having re-torn SLAP repairs (Figure 3). Overall, only nine of 21 MRIs (42.9%) had 100% agreement across all interpretations.

The intraobserver reliability was 0.81 for radiologist one (excellent agreement), 0.71 for radiologist two (substantial agreement), and 0.71 for the surgeon (substantial agreement). The interobserver reliability between readers was ranged considerably but was considered poor to fair (range: 0.13–0.44).

Confirmatory arthroscopy was not performed routinely. However, in one patient with a poor clinical outcome, a second operative procedure was performed. This case was a 27-year-old male who developed acute onset, dominant-sided...
shoulder pain following an overhead pressing exercise in the 
gym. Arthroscopy demonstrated a type II SLAP lesion and a 
repair was performed with the use of two anchors. The patient 
initially did reasonably well, but continued to have difficulties 
with overhead activities and reaching activities, and became 
fatigued easily. A postoperative MRA performed 42 months 
after surgery was read as intact on five of six interpretations 
(Figure 4A). Fifty-eight months following surgery the patient 
underwent a second-look arthroscopy. Diagnostic arthroscopy 
demonstrated an intact superior labrum (Figure 4B) but there 
was evidence suggesting nonhealing of the transtendon pos-
terolateral portal (Port of Wilmington), which was felt to be 
responsible for the patient’s symptoms (Figure 4C).

Discussion

Despite its initial description almost 30 years ago and the 
subsequent multitude of articles pertaining to SLAP lesions, 
the clinical diagnosis of a type II SLAP lesion still remains 
controversial.17 For this reason, various imaging modalities 
used to evaluate superior labral tears have been investigated. 
In 2001, Jee et al18 retrospectively reviewed the results of 
80 patients who underwent MRA and arthroscopy during a 
54-month period. They concluded that the interobserver 
agreement was substantial to moderate with a reported 
accuracy between 74% and 85%. In 2010, Holzapfel et al13 
evaluated the intraobserver and interobserver reliability for 
the detection and classification of SLAP lesions; they dem-

Table I Results of each reader’s interpretation of postoperative MRA following type II SLAP lesion repair

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Abbreviations: MRA, magnetic resonance imaging arthrography; SLAP, superior labrum from anterior to posterior.
Figure 4 Patient with a failed SLAP repair following type II SLAP repair.

Notes: (A) Post-operative T1-weighted fat-suppressed para-coronal MRA imaging demonstrating an intact superior labrum with no gadolinium contrast intervening between the superior labrum and superior glenoid; (B) Arthroscopic view of a right shoulder from the posterior portal demonstrating an intact superior labrum. The superior labrum was stable under direct palpation with a probe and with range of motion; (C) Arthroscopic view of a right shoulder from the posterior portal demonstrating a persistent partial thickness rotator cuff tear corresponding to the previous posterior lateral portal site (Port of Wilmington).

Abbreviations: SLAP, superior labrum from anterior to posterior; MRA, magnetic resonance imaging arthrography.

hardware problems, arthritis, rotator cuff tears) with various subsequent revision procedures (eg, revision SLAP repair, biceps tenodesis, removal of loose hardware, rotator cuff repair, total shoulder arthroplasty). These reports highlight the importance of careful diagnostic evaluation of failed type II SLAP repairs with multiple mechanisms of failure and treatment options. This is even more relevant since only 29% of their patients were satisfied with conservative management and eventually required surgery.14

In the current study, while substantial to excellent intraobserver agreement was demonstrated, there was only poor to fair interobserver agreement. There are multiple reasons for this outcome. First, while the overall interobserver agreement may be good in the primary setting, it may in fact be poor in the postoperative setting due to interference by postoperative artifact. This may include anchors or implants, suture material, and debris (metallic or other). This artifact may affect postoperative imaging, obscure detail, and consequently cloud interpretation. Second, the actual normal healing mechanism of a type II SLAP repair is unknown; that is, how a type II SLAP lesion heals over time is unknown. Even though all MRAs were obtained at a minimum of 1 year postoperatively, it is possible that further remodeling of granulation material may occur and affect interpretation. Third, while we attempted to utilize strict criteria when interpreting MRAs, a formal training program with confirmatory arthroscopy was not employed, nor did the observers meet to discuss classifications prior to the study. This may have improved the results but could have affected reader interpretation by subjecting them to previous biases, education, thus limiting the study’s generalizability. A formal training period with interpretation consensus could have improved interobserver reliability. Fourth, interpreter experience may be a factor.20 In our study, all interpreters were musculoskeletal trained radiologists or shoulder surgeons with >10 years of experience in musculoskeletal medicine. However, while all had vast experience in evaluating the primary cases of type II SLAP lesions, the assessment of type II SLAP lesions postoperatively is not routinely performed. Therefore, because of the infrequency of postoperative imaging of type II SLAP lesions, the actual experience in interpreting this scenario would be significantly less. Furthermore, continued self-assessment with arthroscopic confirmation would be even rarer.

In fact, it is important to consider that there was no routine arthroscopic correlation to confirm the radiologist’s or surgeon’s MRA interpretation. Therefore, the accuracy of each reader’s interpretation of MRAs is unknown. Nevertheless, one patient with ongoing symptoms did have revision surgery. In this patient, the majority of readers interpreted the postoperative MRA as demonstrating a healed superior labrum with subsequent arthroscopic confirmation.

While routine arthroscopic correlation would have significantly strengthened our study, even arthroscopic evaluation of the superior labrum can be difficult.12,21,22 In 2008, Gobezie
et al\textsuperscript{12} used recorded video “vignettes” of diagnostic arthroscopies to evaluate the reliability of arthroscopy in the diagnosis and treatment of type II SLAP lesions. In what was considered a “normal” shoulder, only 68\% of surgeons made the same “normal” diagnosis and 10\% of surgeons felt the labrum was torn and repair was indicated. Furthermore, in “type II SLAP” lesion shoulders, only 54\% of surgeons made the same diagnosis of a type II SLAP lesion and 22\% felt the labrum was normal. These results and others\textsuperscript{21,22} have lead some to question the use of diagnostic arthroscopy as the gold standard for the diagnosis of superior labrum tears.\textsuperscript{13} We would expect that with the further influence of surgical artifact, the postoperative healing interpretation of diagnostic arthroscopy following type II SLAP repairs would be even more variable.

Overall, following a type II SLAP repair, approximately 46\% were interpreted to be re-torn and 54\% of patients were interpreted as demonstrating healed superior labrums by MRA. However, the MRA results did not correlate with patient outcomes. Patients with intact or re-torn type II SLAP repairs by MRA demonstrated similar outcomes.\textsuperscript{22} This suggests that patients with good outcomes may have persistent dye insinuation between the glenoid and labrum similar to persistent defects following rotator cuff repair.\textsuperscript{23–25} Furthermore, in the evaluation of the failed type II SLAP repair, the presence of a recurrent tear should not routinely be interpreted as the cause of failure and careful clinical evaluation should ensue to rule out the multiple different causes of a failed SLAP repair.\textsuperscript{14,16}

**Conclusion**


MRA findings in arthroscopic type II SLAP lesion repairs