Radiology

ORIGINAL RESEARCH ■ MUSCULOSKELETAL IMAGING

Recurrent Superior Labral Anterior-to-Posterior Tears after Surgery: Detection and Grading with CT Arthrography[1]

Massimo De Filippo, MD
Philip A. Araoz, MD
Francesco Pogliacomi, MD
Alex Castagna, MD
Dario Petriccioli, MD
Nicola Sverzellati, MD
Maurizio Zompatori, MD

Purpose: To retrospectively evaluate the sensitivity and specificity of multidetector computed tomographic (CT) arthrography for the detection of recurrent superior labral anterior-to-posterior (SLAP) tears in the shoulder of patients who have previously undergone shoulder surgery and are clinically suspected of having a recurrent tear.

Materials and Methods: The hospital ethics board did not require patient approval or informed consent for this retrospective review of case records. Multidetector CT arthrograms of 45 shoulders of 45 patients (35 men, 10 women; mean age, 29 years; age range, 21–38 years) who had undergone conventional arthroscopy within 30 days after the CT arthrographic examination were reviewed. Owing to the referral patterns at the authors' institution, all patients were professional athletes. Volumetric multidetector CT arthrography was performed by using a 16-detector CT scanner after the intra-articular injection of iodinated contrast material. All images were independently reviewed by two experienced musculoskeletal radiologists, with disagreements resolved by a third experienced musculoskeletal radiologist. The sensitivity and specificity of multidetector CT arthrography in the detection of any Snyder type II–IV tear was evaluated by using arthroscopy as the reference standard. The numbers and percentages of tears that were assigned the correct Snyder classification with multidetector CT arthrography were reported. Interobserver agreement regarding the correct Snyder classification with multidetector CT arthrography was determined by using κ statistics.

Results: With multidetector CT arthrography, recurrent SLAP tears were correctly identified in 35 of 37 patients (95% sensitivity), and the absence of these tears was correctly noted in seven of eight patients (88% specificity). Multidetector CT arthrography– and arthroscopy-derived tear grades were in agreement in 30 (81%) of 37 patients with recurrent SLAP tears. Interobserver agreement at multidetector CT arthrography was substantial ($\kappa = 0.76$).

Conclusion: In the described highly selected patient population, multidetector CT arthrography was useful for evaluating recurrent SLAP tears.

[1] From the Department of Clinical Sciences, Section of Radiological Sciences (M.D.F., N.S., M.Z.), and Department of Surgery, Section of Orthopedic Sciences (F.P.), University of Parma, Parma Hospital, Via Gramsci 14, 43100 Parma, Italy; Department of Radiology, Mayo Clinic and Mayo Foundation, Rochester, Minn (P.A.A.); Section of Orthopedic Surgery, Istituto Clinico Humanitas, Milan, Italy (A.C.); and Section of Orthopedic Surgery, Istituto Clinico Città di Brescia, Brescia, Italy (D.P.). Received September 5, 2008; revision requested October 20; revision received March 9, 2009; accepted April 16; final version accepted May 4. **Address correspondence to** M.D.F. (e-mail: *massimo.defilippo@unipr.it*).

Magnetic resonance (MR) imaging and MR arthrography are frequently performed for evaluation of shoulder disorders such as recurrent labral tears after surgery. However, MR imaging has some disadvantages compared with computed tomography (CT). MR examinations take longer to perform; are performed with a smaller bore gantry, which might not accommodate some patients; and cannot be performed owing to claustrophobia in 1%–2% of patients (1,2). Also, MR imaging is more prone to yield metallic artifacts, which may be substantive postoperatively in patients with metallic clips and anchors (3,4). While investigators in one prior study reported 96% sensitivity and 82% specificity for MR arthrographic detection of recurrent labral tears after surgery, in that study, with 39 patients, two patients with extensive metallic artifacts were excluded from labral evaluation (5).

Recently introduced spiral multidetector CT technology offers high spatial resolution—with isotropic voxel volumes—that enables high-quality multiplanar reconstructions. The principal limitation of multidetector CT relative to MR imaging is inferior soft-tissue contrast resolution. For joints, one can overcome this limitation by imaging the joint(s) after the injection of contrast material into the joint cavity, a technique known as multidetector CT arthrography. The purpose of this study was to retrospectively evaluate the sensitivity and specificity of multidetector CT arthrography for the detection of recurrent superior labral anterior-to-posterior (SLAP) tears of the shoulder in patients who have previously undergone shoulder surgery and are clinically suspected of having recurrent tears.

Advances in Knowledge

- Multidetector CT arthrography is sensitive and specific for the detection of repeat superior labral anterior-to-posterior (SLAP) tears.
- Multidetector CT arthrography enables correct Snyder classification of repeat SLAP tears.

Materials and Methods

Patients

This study was performed outside the United States, and the institutional review board of our institution (University of Parma) did not require patient approval or informed consent for this retrospective review of case records. The study was a retrospective investigation of the findings in patients who underwent multidetector CT arthrography between April 2003 and December 2007 at a tertiary-care center and subsequently underwent conventional arthroscopy within 30 days. Inclusion criteria were prior surgical repair of SLAP lesions, placement of some type of metallic implant as part of the repair, and clinical findings suggestive of recurrent SLAP tear. Retrospective chart review revealed 45 shoulders of 45 consecutive patients (mean age, 29 years; age range, 21–38 years) who fulfilled these criteria: 35 men (mean age, 29.5 years; age range, 21–38 years) and 10 women (mean age, 28 years; age range, 21–38 years). Because our institution has a large referral base of professional athletes, all of the patients in the study were professional athletes (volleyball, basketball, baseball, rugby). There were no patients at our institution who met the inclusion criteria and were not professional athletes.

Contrast Material Injection

The shoulder was injected with iodinated contrast material (iodixanol, Visipaque 320; Amersham Health, Buckinghamshire, England) after it was locally prepared with topical iodine and a local anesthetic (2–3 mL of lidocaine) was applied to the skin. A 20-gauge spinal needle was introduced into the glenohumeral joint via an anterior approach with CT guidance, and 15–18 mL of contrast material was injected. The patient was then asked to abduct and internally or externally rotate the humerus to facilitate even distribution of the contrast material throughout the joint.

Implication for Patient Care

- Multidetector CT arthrography may be used to diagnose and grade repeat SLAP tears.

Image Acquisition

The patients were imaged with a 16-detector CT scanner (Sensation 16; Siemens Medical Systems, Forchheim, Germany). All subjects were imaged while in the supine position, with the examined shoulder in the center of the gantry and the examined arm along the side of the body in slight external rotation (6). The other arm was positioned over the head.

For data acquisition, a section collimation of 16×0.75 mm, a section width of 0.75 mm, and a reconstruction increment of 0.3 mm were used. The pitch was 1.2, the tube current was 120 mAs, and the tube voltage was 120 kV. The CT radiation dose was calculated on the basis of the Monte Carlo simulation by using a computer program (ImPACT CT Patient Dosimetry Calculator; ImPACT, London, England) (7).

Image Analysis

Review at workstation.—For multidetector CT arthrographic data review, the images were downloaded to a Volume Zoom Wizard workstation (Siemens Medical Solutions). The reviewers created multiplanar reformatted images, including coronal and transverse reformatted images of the joints, at the workstation. The window settings for all images were adjusted for each patient by the reviewers.

Image review.—Two musculoskeletal radiologists (M.D.F., N.S.) with 10 and 8

Published online before print
10.1148/radiol.2531081586

Radiology 2009; 252:781–788

Abbreviation:
SLAP = superior labral anterior to posterior

Author contributions:
Guarantors of integrity of entire study, M.D.F., D.P., M.Z.; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; manuscript final version approval, all authors; literature research, M.D.F., P.A.A., F.P., D.P., N.S., M.Z.; clinical studies, M.D.F., F.P., A.C., D.P., M.Z.; statistical analysis, M.D.F., P.A.A., F.P., D.P., M.Z.; and manuscript editing, M.D.F., P.A.A., F.P., D.P., N.S., M.Z.

Authors stated no financial relationship to disclose.

years of CT arthrography experience, respectively, reviewed all the imaging studies independently and categorized the depicted SLAP lesions, when present, according to the Snyder classification system. The CT images were reviewed before arthroscopy was performed. The reviewers had access to patient identification and clinical data but were blinded to the initial clinical interpretation of the multidetector CT arthrograms. In cases in which the reviewers disagreed on the Snyder grade, a third, tie-breaking, reviewer provided the final classification. The third reviewer (M.Z.) was a musculoskeletal radiologist with 12 years of experience. The third review was performed after arthroscopy. The third reviewer also had access to patient identification and clinical data but was blinded to the results of arthroscopy.

SLAP tear lesion classification.—The reviewers used the classification system proposed by Snyder et al in 1990 (8) to grade SLAP tear lesions. With this classification system, SLAP tear lesions are divided into four categories that differ in terms of the degree of tear of the bicipital complex from the glenoid labrum (8,9) (Fig 1). With this system, Snyder type I lesion is defined as degenerative fraying of the superior glenoid labrum. A Snyder type II lesion is an avulsion of the labral-bicipital complex from the superior glenoid labrum. Type II lesions are often confused with physiologic sulci, and in this study, the reviewers differentiated a type II lesion from a sublabral recess on the basis of the orientation of the defect, with laterally oriented defects interpreted as tears and medially oriented defects interpreted as physiologic sulci. Type III lesions are bucket-handle tears with a preserved biceps anchor. Type IV lesions are bucket-handle tears with extension into the biceps tendon.

Arthroscopy

Arthroscopic examinations of the shoulder were performed by two orthopedic surgeons (A.C., D.P.) with

Figure 1

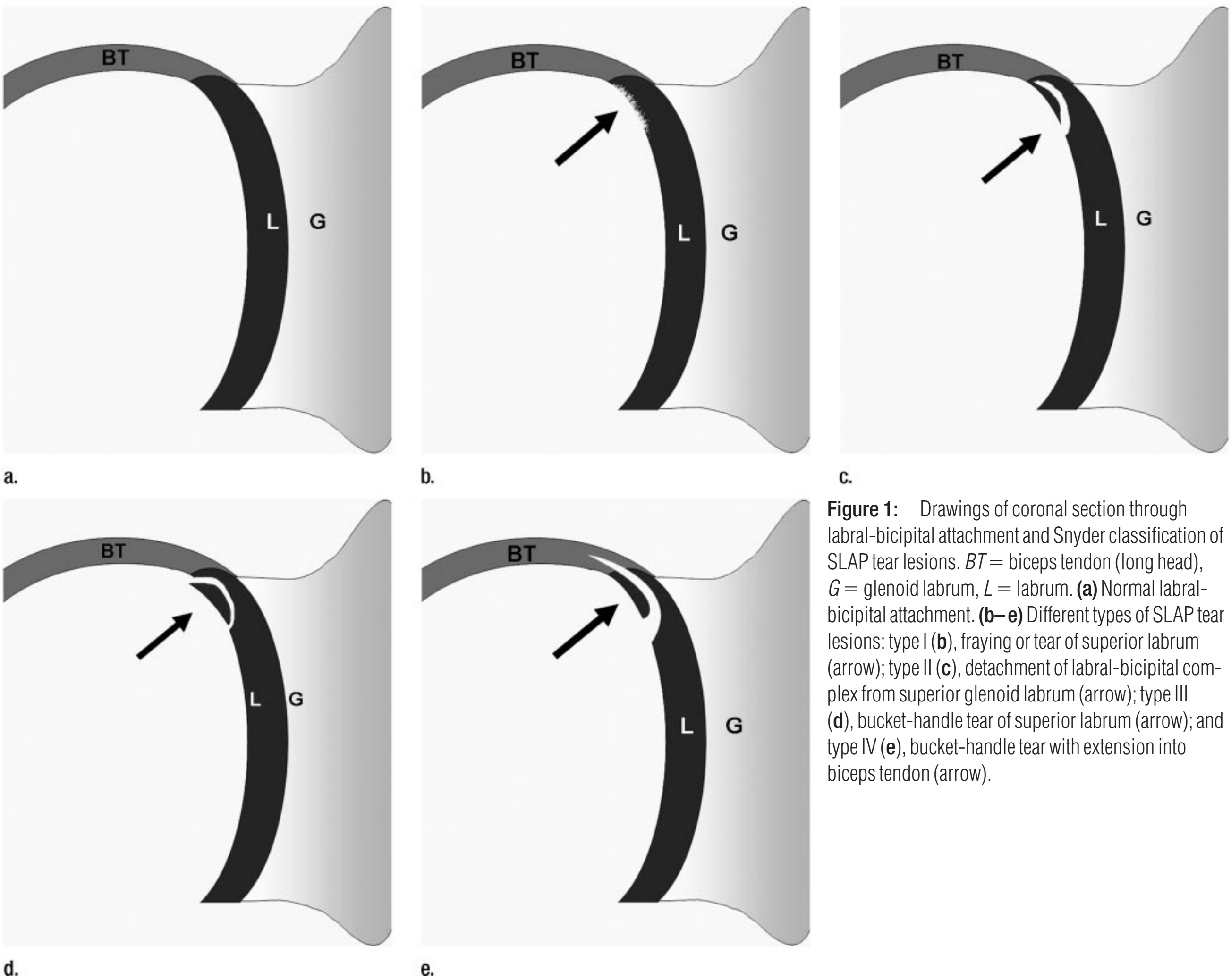


Figure 1: Drawings of coronal section through labral-bicipital attachment and Snyder classification of SLAP tear lesions. *BT* = biceps tendon (long head), *G* = glenoid labrum, *L* = labrum. **(a)** Normal labral-bicipital attachment. **(b– e)** Different types of SLAP tear lesions: type I (**b**), fraying or tear of superior labrum (arrow); type II (**c**), detachment of labral-bicipital complex from superior glenoid labrum (arrow); type III (**d**), bucket-handle tear of superior labrum (arrow); and type IV (**e**), bucket-handle tear with extension into biceps tendon (arrow).

25 and 18 years experience performing arthroscopy, respectively. Arthroscopy was performed less than 30 days after multidetector CT arthrography (average, 20 days after multidetector CT; range, 8–28 days). Patients were referred for arthroscopy on the basis of their clinical history, physical examination results, and multidetector CT arthrogram findings. Patients with a negative multidetector CT arthrogram could be referred for arthroscopy if they had symptoms and clinical signs of superior labral tears. Patients did not undergo MR imaging or any other imaging procedure (besides multidetector CT arthrography) whose results might have led a clinician to perform arthroscopy; nor did they undergo any other interval treatment or procedure. During arthroscopy, reformatted sagittal and coronal multidetector CT arthrographic images on film hard copy, as well as the original clinical reports that included complete descriptions of the lesions, were available to the surgeons.

Arthroscopy was performed with regional anesthesia (ie, brachial plexus nerve blockage). The patient was placed in the lateral position, with the affected arm placed in 30° abduction and 10° forward flexion. For surgery, the three-portal technique was applied with use of dorsal, ventral, and suprabicipital portals (outside-in technique). After diagnostic inspection by way of the dorsal portal, the ventral and dorsal portals were used for all surgical therapeutic interventions. Thus, visualization was performed through the suprabicipital portal, which allows one control of the surgical process by means of direct view of the ventral and inferior glenoid labra and the capsule-labrum complex.

Statistical Analyses

Arthroscopy was used as the reference standard for determining shoulder abnormalities. The sensitivity and specificity of multidetector CT arthrography for detecting any recurrent SLAP tear were calculated. The overall and per-grade percentages of cases correctly assigned to a Snyder grade were reported.

Interobserver agreement between multidetector CT arthrogram reviewers 1 and 2 in assigning the Snyder grade was assessed with κ statistics by using commercially available software (JMP 7.0.1; SAS Institute, Cary, NC) (10). As suggested by Landis and Koch (11), κ values lower than 0 were considered to indicate poor agreement; κ values of between 0 and 0.20, slight agreement; κ values of between 0.21 and 0.40, fair agreement; κ values of between 0.41 and 0.60, moderate agreement; κ values of between 0.61 and 0.80, substantial agreement; and κ values of between 0.81 and 1.00, nearly perfect agreement.

Results

Thirty-seven of the 45 patients had recurrent SLAP tears at arthroscopy. Of the 37 recurrent SLAP tears diagnosed with arthroscopy, none were type I lesions, 16 were type II lesions, 11 were type III lesions, and 10 were type IV lesions. At multidetector CT arthrography, reviewers 1, 2, and 3 (the tie breaker) correctly detected recurrent SLAP tears in 35 of 37

Table 1

Sensitivity, Specificity, and Accuracy of Multidetector CT Arthrography

Reader	Sensitivity (%)	Specificity (%)	Accuracy (%)
1	95 (35/37), (82, 99)	63 (5/8), (24, 91)	89 (40/45), (76, 96)
2	95 (35/37), (82, 99)	88 (7/8), (47, 100)	93 (42/45), (82, 99)
3	95 (35/37), (82, 99)	88 (7/8), (47, 100)	93 (42/45), (82, 100)

Note.—Sensitivity = number of true-positive findings divided by (number of true-positive findings plus number of false-negative findings). Specificity = number of true-negative findings divided by (number of true-negative findings plus number of false-positive findings). Accuracy = (number of true-positive findings plus number of true-negative findings) divided by total number of findings. The first set of numbers in parentheses are the numbers used to calculate the percentage. The second set of numbers in parentheses are 95% confidence intervals.

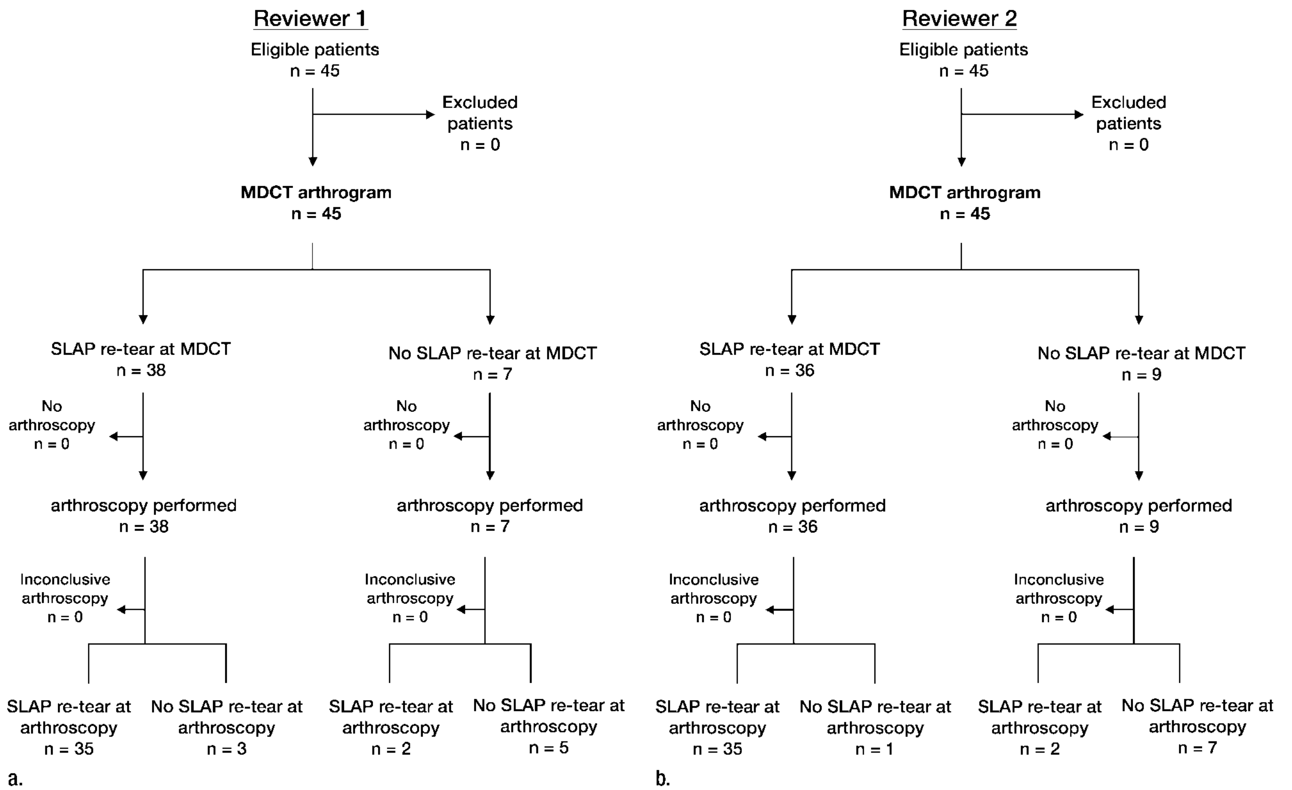
Table 2

Comparison of Multidetector CT Arthrography– and Arthroscopy-based Snyder Grades Assigned by Readers

		Multidetector CT Arthrography		
Patient No.	Arthroscopy	Reader 1	Reader 2	Reader 3
1	0	0	0	NA
2	0	0	0	NA
3	0	0	0	NA
4	0	2	0	0
5	0	0	0	NA
6	0	2	2	NA
7	0	2	0	0
8	0	0	0	NA
9	2	2	2	NA
10	2	2	2	NA
11	2	2	2	NA
12	2	2	2	NA
13	2	2	2	NA
14	2	2	2	NA
15	2	2	2	NA
16	2	2	2	NA
17	2	3	2	3
18	2	3	2	3
19	2	2	2	NA
20	2	2	2	NA
21	2	2	2	NA
22	2	3	2	2
23	2	0	0	NA
24	2	0	0	NA
25	3	3	3	NA
26	3	3	3	NA
27	3	3	3	NA
28	3	3	3	NA
29	3	3	3	NA
30	3	3	3	NA
31	3	2	3	2
32	3	3	3	NA
33	3	2	3	2
34	3	2	3	3
35	3	2	2	NA
36	4	4	4	NA
37	4	4	4	NA
38	4	4	4	NA
39	4	4	4	NA
40	4	4	4	NA
41	4	4	4	NA
42	4	4	4	NA
43	4	4	4	NA
44	4	4	4	NA
45	4	4	4	NA

Note.—Reader 3 served as the tie breaker and did not assign a grade when readers 1 and 2 assigned the same grade at arthroscopy. NA = not applicable.

Figure 2



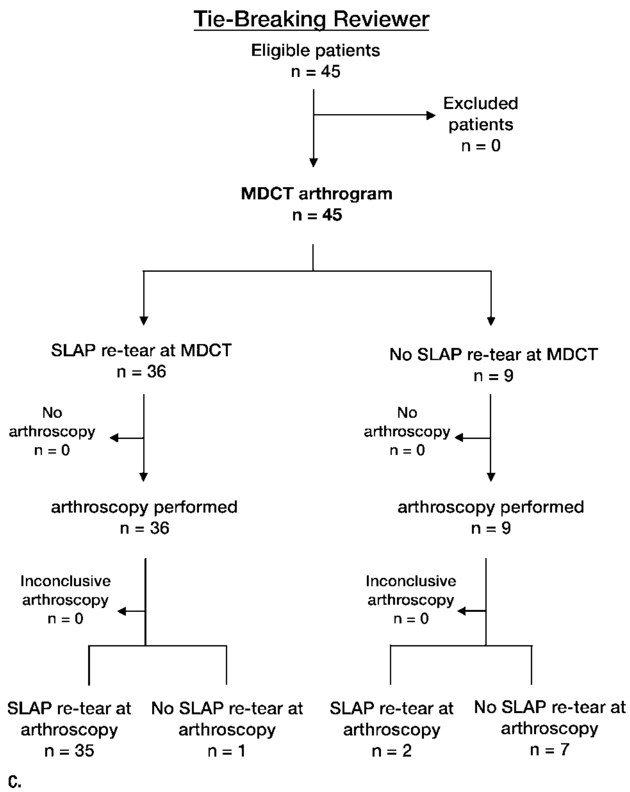


Figure 2: Flowchart of patient population whose data were studied for analysis of recurrent SLAP tears. Diagrams for **(a)** reviewer 1, **(b)** reviewer 2, and **(c)** reviewer 3, the tie breaker, are shown. *MDCT* = multidetector CT.

patients (95% sensitivity). In the two false-negative cases, multidetector CT arthrography depicted the lesion as a sublabral recess, while Snyder type II recurrent SLAP tears were noted at arthroscopy (Table 1).

Eight of the 45 patients had no recurrent SLAP type II–IV tear lesions at arthroscopy. At multidetector CT arthrography, reviewer 1 correctly identified five of eight recurrent SLAP tear–negative shoulders (62% specificity). Reviewers 2 and 3 (the tie-breaker), however, correctly identified seven of eight negative shoulders (88% specificity). Results are summarized in a flow diagram (Fig 2) and in Table 1.

The multidetector CT arthrography–derived tear grade determined by the third (tie-breaking) reviewer and the arthroscopy-derived grade were in agreement in 30 (81%; 95% confidence interval: 65%, 92%) of the 37 patients with recurrent SLAP tears and in 37 (82%; 95% confidence interval: 68%, 92%) of all 45 patients included in the study. In five of six cases (patients 6, 17, 18, 23, 24, and 35) in which the multidetector CT arthrography–derived and arthroscopy-derived grades were not in agreement, the multidetector CT arthrography–assigned Snyder grade was higher. These results are summarized in Table 2. Multidetector CT arthrography correctly depicted 12 of 16 type II tear lesions (75%; 95% confidence interval: 48%, 93%) (Fig 3), eight of 11 type III lesions (73%; 95% confidence interval: 39%, 94%) (Fig 4), and all 10 type IV lesions (100%; 95% confidence interval: 69%, 100%) (Fig 5). No type I lesions were identified at either arthroscopy or multidetector CT arthrography.

Interobserver agreement for multidetector CT arthrography–based assignment of the correct Snyder tear grade was substantial (κ = 0.76). In terms of overall CT radiation doses administered in all of the patients, the average total effective dose was 2.8 mSv (range, 2.1–3.1 mSv) and the average equivalent dose to the thyroid was less than 0.3 mSv (range, <0.3 to 0.3 mSv).

Discussion

Multidetector CT arthrography had very good sensitivity (95%) and specificity (88%) for the detection of recurrent SLAP tears in professional athletes who had previously undergone surgical repair of SLAP tears. It also enabled accurate Snyder categorization of recurrent SLAP tears in 30 (81%) of 37 patients and facilitated substantial interobserver agreement (κ = 0.76) in the assignment of Snyder SLAP lesion grade.

The high sensitivity that we observed is comparable to the reported sensitivity of MR arthrography in patients postoperatively, although, to our knowledge, there have been no studies of MR arthrography exclusively in patients with prior SLAP tear repair. Probyn et al (5) examined 39 patients with prior shoulder instability repair and found MR arthrography to have 96% sensitivity (25 of 26 tears) for detecting any labral tear and 94% sensitivity (15 of 16 tears) for detecting superior labral tears. Although Probyn et al excluded two patients with metallic artifacts from their analysis, they achieved the high sensitivity in patients with a lower prevalence of disease than that in our study group; this makes their sensitivity results even more impressive. In a study by Wagner et al (12), the sensitivity of MR arthrography performed in a subset of six patients was 100% (three of three), although the patients had previously undergone anterior, posterior, or multidirectional instability repair but not SLAP tear repair. The prior studies of neither Probyn et al (5) nor Wagner et al (12) involved assessment of recurrent SLAP tear grading.

Although we found multidetector CT arthrography to have high sensitivity, our study had several biases inherent of retrospective analyses that could have contributed to the increased sensitivity. First, the decision to perform arthroscopy was based in part on the multidetector CT arthrographic findings. This variable in-

Figure 3

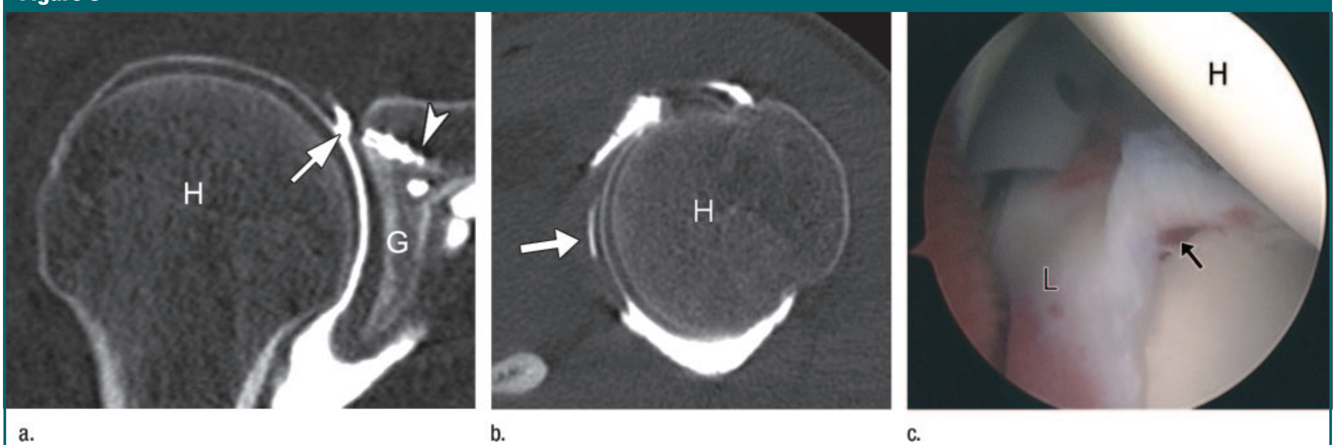
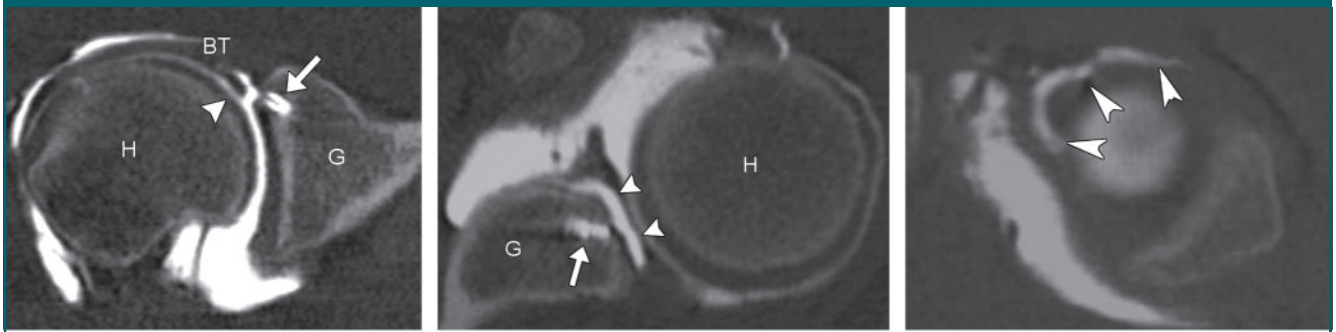
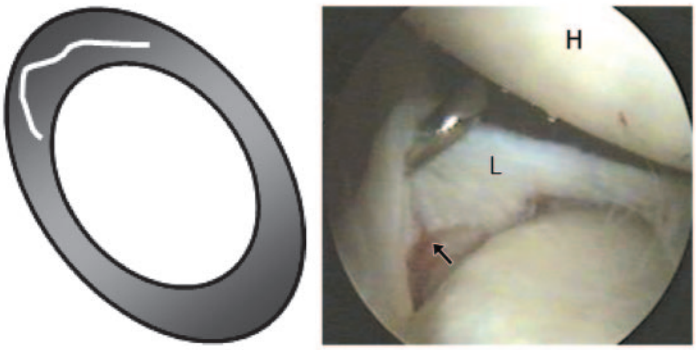


Figure 3: Type II SLAP lesion correctly diagnosed with multidetector CT arthrography in 28-year-old man. *H* = humeral head. **(a)** Coronal oblique multidetector CT arthrogram shows lateral extension of contrast medium (arrow) into superior labrum. Arrowhead = metal anchorets, *G* = glenoid labrum. **(b)** Axial multidetector CT arthrogram shows anterior-to-posterior extension of contrast medium (arrow) into superior labrum. **(c)** Arthroscopic view from posterior portal confirms presence of type II SLAP tear (arrow). *L* = labrum.

Figure 4



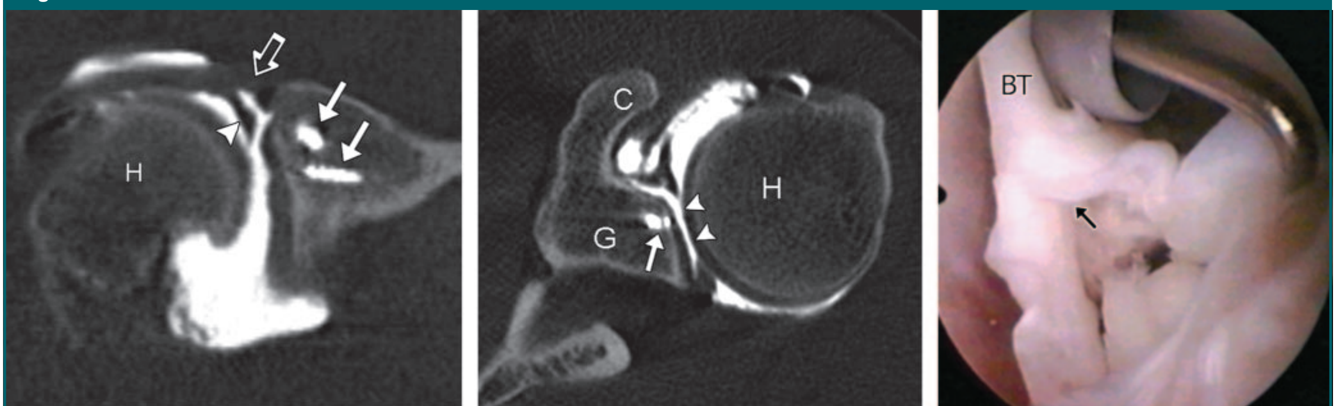
a. b. c.



d. e.

Figure 4: Type III SLAP tear lesion correctly diagnosed with multidetector CT arthrography in 31-year-old man. *G* = glenoid labrum, *H* = humeral head. **(a)** Coronal oblique multidetector CT arthrogram findings confirm preserved biceps tendon *(BT)* insertion above a bucket-handle fragment (arrowhead). A metallic screw (arrow) is visible in the glenoid labrum. **(c)** Axial and **(b)** oblique sagittal multidetector CT arthrograms show anterior-to-posterior extension of contrast medium (arrowheads) into superior labrum, indicating a bucket-handle tear. Arrow in **b** = metal anchoret. **(d)** Drawing of three-dimensional sagittal section through labral-bicipital attachment shows fibrocartilaginous SLAP tear. **(e)** Arthroscopic view from posterior portal shows type III (bucket-handle) SLAP tear (arrow). *L* = labrum.

Figure 5



a. b. c.

Figure 5: Type IV SLAP lesion correctly diagnosed in 23-year-old woman. *H* = humeral head. **(a)** Coronal oblique multidetector CT arthrogram shows detachment of fragment from superior labrum (arrowhead) with extension of tear (open arrow) into biceps tendon. Solid arrows point to metal anchorets. **(b)** Axial multidetector CT arthrogram shows anterior-to-posterior extension of contrast medium (arrowheads) into superior labrum. Arrow = metal anchoret, *C* = coracoid process, *G* = glenoid labrum. **(c)** Arthroscopic view from posterior portal confirms the presence of bucket-handle tear with extension into the long head of the biceps tendon *(BT)* (arrow).

troduced verification bias—also known as work-up bias—which occurs when the test being evaluated is used to select patients who will undergo the reference-standard test. This could have increased the sensitivity because those patients with negative multidetector CT arthrograms would have been less likely to undergo arthroscopy, and, thus, false-positive cases could have been excluded.

Second, the surgeons had access to the multidetector CT arthrograms and used them to guide the arthroscopic procedures. This created index test review bias, which occurs when the inves-

tigator knows the results of the "new" diagnostic test being evaluated when he or she interprets the reference-standard test results. Knowledge of the multidetector CT arthrographic results could have made the orthopedic surgeons in our study more prone to interpret the arthroscopic results in line with the multidetector CT arthrogram findings and thus led to improved sensitivity. Finally, our patient population was rather limited (in number) and had a high prevalence of disease.

Although we observed good specificity (88%) for excluding recurrent SLAP tears, there were few negative arthrograms—only eight. This was probably due to the fact that the multidetector CT arthrogram findings were used to select patients who would subsequently undergo arthroscopy. Because there were so few negative cases, confidence intervals for specificity were wide: 24%, 91% for reader 1 and 47%, 100% for both reader 2 and reader 3. Thus, our study was limited in the assessment of specificity for multidetector CT arthrographic detection of recurrent SLAP tears.

However, results were good at assessment of multidetector CT arthrography for assigning the correct Snyder grade for recurrent SLAP tears. This is encouraging because different types of tears require different therapies. Snyder types II and IV lesions require reattachment of the biceps tendon to reestablish the stabilizing effect of the biceps tendon on the shoulder, while type III lesions involve extensive damage to the superior labrum and require surgical debridement (13,14). Our results are even more encouraging when one considers the results of a study (15) in which 22 arthroscopies reportedly yielded greater interobserver variability in Snyder classifications ($\kappa = 0.54$) than did multidetector CT arthrography in our current study. Overall, the results in our study suggest that multidetector CT arthrography is robust for the detection and classification of recurrent SLAP tears.

Our study had several other limitations. First, there were numerous biases associated with the retrospective design, which were described earlier. Second, although arthroscopy was the reference standard in this study, it is an operator-dependent procedure, and, in our opinion, misinterpretation of sublabral recesses and SLAP type II lesions at arthroscopy was a possible source of error. Third, our patient population of professional athletes was very specific, so it is unclear whether our results would apply to other patient populations, such as the elderly. Fourth, none of the patients in our study had Snyder type I lesions (degenerative fraying of the superior glenoid labrum), so we cannot comment about the sensitivity or specificity of multidetector CT arthrography in detecting recurrent Snyder type I tears. However, type I lesions do not require surgery (13,14) and are therefore less clinically important compared with Snyder type II–IV tears. In conclusion, our results suggest that multidetector CT arthrography is useful for detecting and grading recurrent SLAP tears in athletes who previously have undergone shoulder surgery.

References

1. Dewey M, Schink T, Dewey CF. Claustrophobia during magnetic resonance imaging: cohort study in over 55,000 patients. J Magn Reson Imaging 2007;26:1322–1327.
2. Eshed I, Althoff CE, Hamm B, Hermann KG. Claustrophobia and premature termination of magnetic resonance imaging examinations. J Magn Reson Imaging 2007;26:401–404.
3. Lee MJ, Kim S, Lee SA, et al. Overcoming artifacts from metallic orthopedic implants at high-field-strength MR imaging and multi-detector CT. RadioGraphics 2007;27:791–803.
4. White LM, Buckwalter KA. Technical considerations: CT and MR imaging in the postoperative orthopedic patient. Semin Musculoskelet Radiol 2002;6:5–17.
5. Probyn LJ, White LM, Salonen DC, Tomlinson G, Boynton EL. Recurrent symptoms after shoulder instability repair: direct MR arthrographic assessment—correlation with second-look surgical evaluation. Radiology 2007;245:814–823.
6. Pennes DR, Jonsson K, Buckwalter K, Braunstein E, Blasier R, Wojtys E. Computed arthrotomography of the shoulder: comparison of examinations made with internal and external rotation of the humerus. AJR Am J Roentgenol 1989;153:1017–1019.
7. Perisinakis K, Damilakis J, Tzedakis A, Papadakis A, Theocharopoulos N, Gourtsoyiannis N. Determination of the weighted CT dose index in modern multidetector CT scanners. Phys Med Biol 2007;52:6485–6495.
8. Snyder SJ, Karzel RP, Del Pizzo W, Ferkel RD, Friedman MJ. SLAP lesions of the shoulder. Arthroscopy 1990;6:274–279.
9. Jee WH, McCauley TR, Katz LD, Matheny JM, Ruwe PA, Daigneault JP. Superior labral anterior posterior (SLAP) lesions of the glenoid labrum: reliability and accuracy of MR arthrography for diagnosis. Radiology 2001;218:127–132.
10. Cohen A. Comparison of correlated correlations. Stat Med 1989;8:1485–1495.
11. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159–174.
12. Wagner SC, Schweitzer ME, Morrison WB, Fenlin JM Jr, Bartolozzi AR. Shoulder instability: accuracy of MR imaging performed after surgery in depicting recurrent injury—initial findings. Radiology 2002;222:196–203.
13. Imhoff AB, Agneskirchner JD, Konig U, Temme C, Ottl G, McFarland EG. Superior labrum pathology in the athlete [in German]. Orthopade 2000;29:917–927.
14. Mileski RA, Snyder SJ. Superior labral lesions in the shoulder: pathoanatomy and surgical management. J Am Acad Orthop Surg 1998;6:121–131.
15. Gobezie R, Zurakowski D, Lavery K, Millett PJ, Cole BJ, Warner JJ. Analysis of interobserver and intraobserver variability in the diagnosis and treatment of SLAP tears by using the Snyder classification. Am J Sports Med 2008;36:1373–1379.