



# MR arthrogram for shoulder microinstability and hidden lesions



Mahmoud Agha <sup>a,b,\*</sup>, Nasser Gamal <sup>c</sup>

<sup>a</sup> Radiology Department, Medical Research Institute, Alexandria University, Egypt

<sup>b</sup> Almana General Hospital, Saudi Arabia

<sup>c</sup> Orthopedic Department, Almana General Hospital, Saudi Arabia

Received 21 January 2014; accepted 5 April 2014

Available online 1 May 2014

## KEYWORDS

Shoulder MR arthrogram;  
Microinstability;  
Perthes;  
ALAPSA;  
GLAD;  
Rotator interval

**Abstract** Shoulder joint pain due to anterior microinstability is not an unusual complaint of young active individuals. Different etiologies of such shoulder microinstability are encountered, mainly affecting the anterior–inferior labro-ligamentous capsular structures. These injuries include Perthes lesion, ALPSA, GLAD, RIT, SLAP and glenohumeral ligamentous injuries.

*The aim of this study:* The aim of this study is to enhance the role of MR arthrogram over routine MRI in the diagnosis of such subtle lesions.

*Patients and methods:* This is a prospective study, involving 30 consecutive patients of shoulder microinstability complaints, evaluated by MR arthrogram of the affected shoulder.

*Results:* Perthes lesions were diagnosed in 6 patients, ALPSA in 3 patients, GLAD in 2 patients, RIT in 2 patients and SLAP in 11 patients. Ligamentous injuries that include tear of MGHL, were found in 2 patients and IGHL in 4 patients.

*Conclusion:* MR arthrogram is highly recommended for the management of young patients with shoulder microinstability or unexplained painful movement complaints.

© 2014 Alexandria University Faculty of Medicine. Production and hosting by Elsevier B.V. All rights reserved.

## 1. Introduction

Shoulder joint instability has been classified, according to etiology and management response, into two major items:

the so-called TUBS (Traumatic, Unidirectional, Bankart lesion, responds to surgery) and on the other AMBRII (Atraumatic, Multidirectional, Bilateral, responds to rehabilitation, inferior capsular shift, interval closure). Between these

*Abbreviations:* ABER, abduction external rotation; AIOS, Acquired Instability in Overstressed shoulder, surgery; ALPSA, anterior labral ligamentous periosteal sleeve avulsion; AMSI, Atraumatic Minor Shoulder Instability; GLAD, glenolabral articular disruption; IGLI, avulsion of inferior glenohumeral ligament; MGL, middle glenohumeral ligament; RI, rotator interval; RIT, rotator interval tear; SLAP, superior labrum anterior to posterior tear; TUBS, Traumatic, Unidirectional, Bankart lesion, responds to surgery

\* Corresponding author. Address: P.O. Box 50367, Al Salhiyah, 12–14 Al Najah St., Al Ahsa, Hofuf 31982, Saudi Arabia. Tel./fax: +966 3 5887005.

E-mail address: [mahmoudagha23@hotmail.com](mailto:mahmoudagha23@hotmail.com) (M. Agha).

Peer review under responsibility of Alexandria University Faculty of Medicine.

2090-5068 © 2014 Alexandria University Faculty of Medicine. Production and hosting by Elsevier B.V. All rights reserved.

<http://dx.doi.org/10.1016/j.ajme.2014.04.002>

two extremes there is a wide group of conditions, defined as minor or microinstability, including AIOS (Acquired Instability in Overstressed shoulder, surgery) and AMSI (Atraumatic Minor Shoulder Instability), that are common complaints of young active individuals.<sup>1,2</sup>

The glenohumeral joint has a loose lax capsule; therefore it is solely at risk of dislocation and in need for additional supporting factors. The strongest stabilizing structures of the glenohumeral joint are the rotator cuff muscles. Additionally, the glenoid labrum is another important structure for maintaining shoulder stability, as it deepens the socket shaped bony glenoid, providing more coverage and stability of the articulating ball shaped humeral head. Also, it provides attachment of the glenohumeral ligaments, long head of biceps and joint capsule to the glenoid rim. The glenohumeral ligaments act to reinforce the joint capsule, and provide more joint support.<sup>3,4</sup>

Recent advances in arthroscopic shoulder surgery necessitate accurate imaging diagnosis of such stability insults, facilitating successful repair. The most common causes of microinstability are injuries within the anterior and superior additional supporting structures i.e. injuries around rotator interval (RI). Spectrum of these insults includes superior labrum anterior to posterior tear (SLAP), rotator interval (RI) tears, and partial anterior labral tears like Perthes and anterior labral ligamentous periosteal sleeve avulsion (ALPSA) lesions. Also, avulsion of the inferior glenohumeral ligament (IGL) or middle glenohumeral ligament (MGL) is an additional non-stabilizing insult.<sup>5,6</sup>

## 2. Patients and methods

This is a prospective study of 30 MR arthrography examinations performed between January 2011 and December 2013, for patients with anterior shoulder pain or impingement like symptoms, with negative X ray findings. Also, the selection did not include patients with positive routine MRI findings of bony or rotator cuff injuries, as they were excluded from the study. Candidate patients were referred for shoulder MR arthrogram after failure of non-steroidal analgesic therapy and rehabilitation programs. The study protocol was approved by the scientific and ethics committee in the Al-Mana General Hospital, Eastern Province, Saudi Arabia. Signed consents were obtained from all study candidates, for acceptance of both arthrographic MRI examination and study participation.

## 3. Aim of the study

The study aims to enhance the role of MR arthrogram examinations in the diagnosis of some stabilizing factors and defects that may be missed in routine MRI examinations in young active patients with shoulder microinstability.

## 4. Technique

After conventional MR sequences were performed, patients were shifted to a fluoroscopic X-ray room. Patients were positioned supinely on a fluoroscopy table (Diagnost 96, Philips Medical Systems, St-Laurent, QC, Canada) with the arm in external rotation to avoid the long head of the biceps

tendon. If this position is too painful for the patient, neutral position -with palm against the thigh- was used instead. At AP shoulder joint position, the skin was marked over the upper medial quadrant of the humeral head, in close approximation with the articular joint line. Under strict sterile aseptic technique, the skin was anesthetized with Xylocain 1% using a 20 or 22-gauge spinal needle.

With intermittent fluoroscopy, the needle was introduced parallel to the X-ray beam or with a slight medial angulation until it came in contact with the humeral head, then slightly pulled up for 1 or 2 mm. 1 ml of contrast was then injected to ascertain the intraarticular position of the needle. Finally, injection of 20 ml of a contrast mixture, made of 10 ml normal saline, 5 ml Omnipaque 300, 4 ml 1% lidocaine and 0.1 ml gadolinium through a 20 cm syringe was made. Then the patient was shifted to MRI again, for postcontrast imaging. Post contrast axial, sagittal and coronal T1w fat sat sequences, as well as ABER sequences were obtained. All examinations were done through MRI Philips Intera 1.5 T, Closed Magnet, Philips Medical Systems, 5656 AE Eindhoven, Netherlands.

## 5. Review of MR arthrogram findings

The images were checked by the radiology author who is experienced in MRI shoulder studies, first separately, then in group discussion with the orthopedic author, who got ten years experience in shoulder arthroscopic and surgical procedure. Lastly, reports were made after reaching a conclusion in consensus.

## 6. Results

The study involved 30 consecutive patients of shoulder microinstability complaints. Age of 11 patients was less than 30 years, 15 patients ages were from 30–40 years, and 4 patients were 40–50 years. (Table 1)

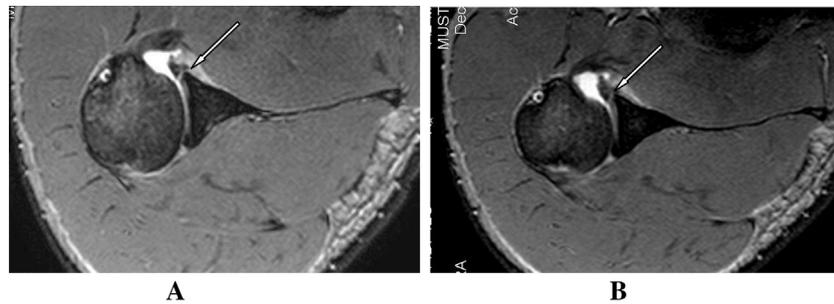
Labro-capsular injuries including Perthes lesions were diagnosed in six patients (Figs. 1 and 2), ALPSA in three patients (Fig. 3), GLAD in two patients (Fig. 4), RIT in two patients (Fig. 5) and SLAP in eleven patients (Fig. 6), in comparison to ligamentous injuries that include tear of MGHL which were found in two patients and IGHL in four patients. (Fig. 7) (Table 2).

## 7. Discussion

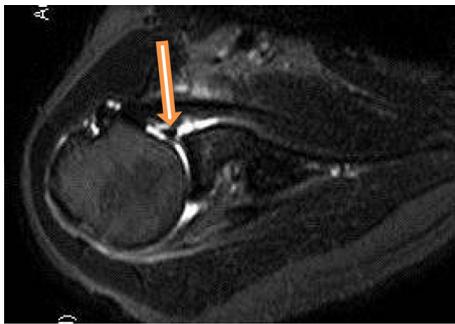
The cumulative microtraumatic stresses on the shoulder joint represent challenges for the physiologic limits of the stabilizing structures and often compromise the static status of the joint. This finally makes shoulder micro-instability not an uncommon occurrence in young active individuals. Many of the causative factors can be surgically corrected, regaining the painless

**Table 1** Different age groups of the study candidates.

Age of patients	Number of patients
20 to <30 years	11
30 to <40 years	15
40 to <50 years	4
Total	30



**Figure 1** MR arthrogram axial T1w fat sat images of Perthes lesion show non displaced torn segment of the anterior labrum (arrow in A) with still intact glenoid periosteal link (arrow in B).



**Figure 2** Perthe's lesion in a 35 year old patient, with minimally displaced inverted torn labral segment(arrow), with still intact periosteum.

stable status, if early managed. This is because it helps to avoid the uncorrected muscular atrophy which is the end-stage of long standing missed insults. These subtle lesions can be easily missed on routine plain MRI examinations, especially if MRI power is less than 3 tesla, hence the importance of MR arthrogram examinations.<sup>7,8</sup>

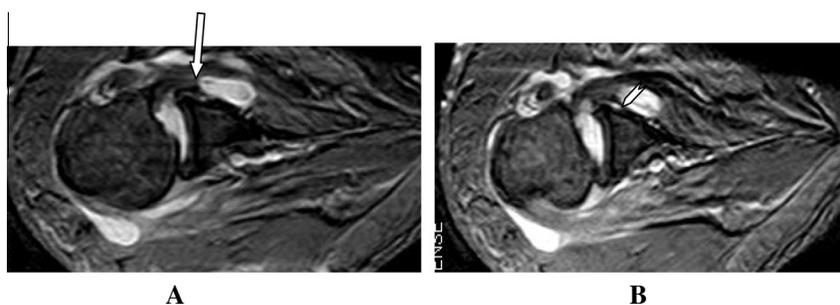
The glenoid labrum is a wedge-shaped fibrous ring, which is attached to the glenoid articular surface through a fibrocartilaginous transition zone. The inferior labrum is firmly continuous with the articular cartilage; while its upper half is more mobile i.e. meniscus like configuration. Anterior labral insults include three types. Type I, in which the labrum is completely separated from the glenoid bone, is termed the Bankart lesion. In type II, which is termed Perthes lesion, the labrum is incompletely separated from the glenoid bone, due to the periosteum which is still intact, while in type III, the torn labral segment is retracted medially with the intact periosteum (ALPSA).<sup>9,10</sup>

Bankart lesion has been reported to result in a 50% decrease in the glenoid depth. Lippit et al.<sup>11</sup> demonstrated that the translational force required to dislocate the humeral head was 20% smaller after removal of the glenoid labrum. Bankart lesions are usually easily demonstrated by routine MRI workup, however, the other clinically significant labral injury types are less clear and may be missed, namely Perthes and ALPSA lesions.<sup>11,12</sup>

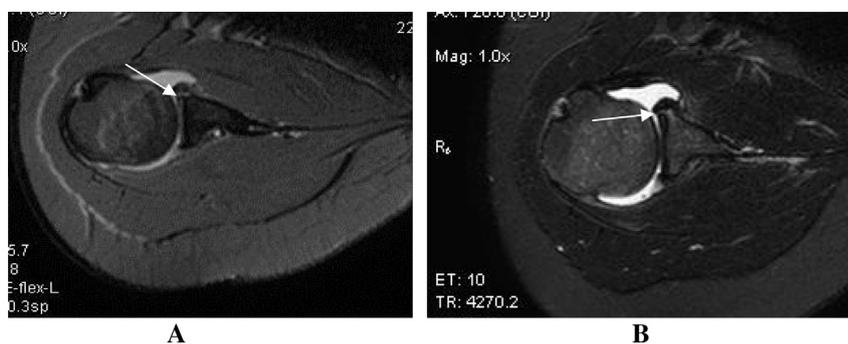
In Perthes lesion – which was diagnosed in 6 patients – there is only minimal displacement of the torn anterior labrum due to still intact periosteal glenoid connection, hence the lesions may be missed on routine MRI examination. MR arthrogram is more accurate and clearly delineates the torn segment. However, it sometimes had some limitation in demonstrating the non-displaced tears, hence the requirement of additional abduction external rotation (ABER) technique in arthrographic MRI study. ABER stretches the antero-inferior joint capsule and IGHL and helps in better delineation of the lesion. So, it is widely agreed that the ABER MR arthrogram is the most diagnostic sequence for these insults.<sup>13</sup>

ALPSA lesion – which was diagnosed in 3 patients – was first defined by Neviaser et al.<sup>14</sup>, as avulsion and gross medial displacement of the inferior labroligamentous complex, with a still intact periosteum. MR arthrogram is sensitive for diagnosis and clear demonstration of this insult. This is one of the most beneficial tools of MR arthrogram, as this lesion can be easily missed on arthroscopy, if there is no previous notification about such insult.<sup>14,15</sup>

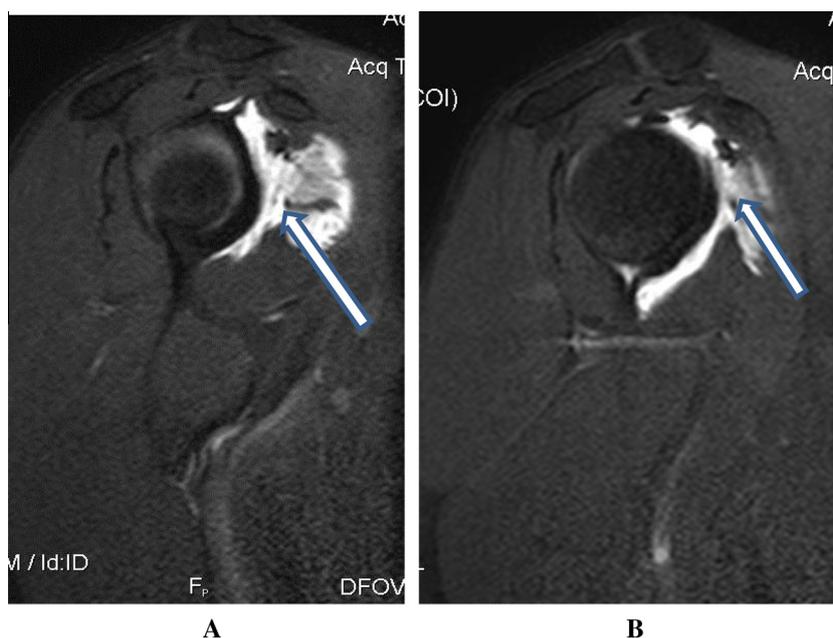
Glenolabral articular disruption (GLAD) -which was diagnosed in 2 patients – consists of an anterior labral tear associated with an anterior articular cartilage injury. The use of intra-articular contrast in the MR arthrogram helps to visualize small tears at the level of the anterior-inferior glenoid rim.



**Figure 3** (A, B) Axial T1 fat sat MR arthrogram shows torn and medially displaced anterior glenoid labrum (Arrow in A), with still intact periosteum (Chevron in B), consistent with ALPSA lesion.



**Figure 4** (A, B) Axial MR arthrogram T1 Fat Sat. Images show anterior scapular articular cartilage thin disruption consistent with GLAD injury (arrows).



**Figure 5** (A, B) Sagittal T1w Fat Sat. MR arthrogram images showing rotator interval tear, seen as extrasynovial leakage of contrast through the defect (arrows) into anterior extra-articular tissues.

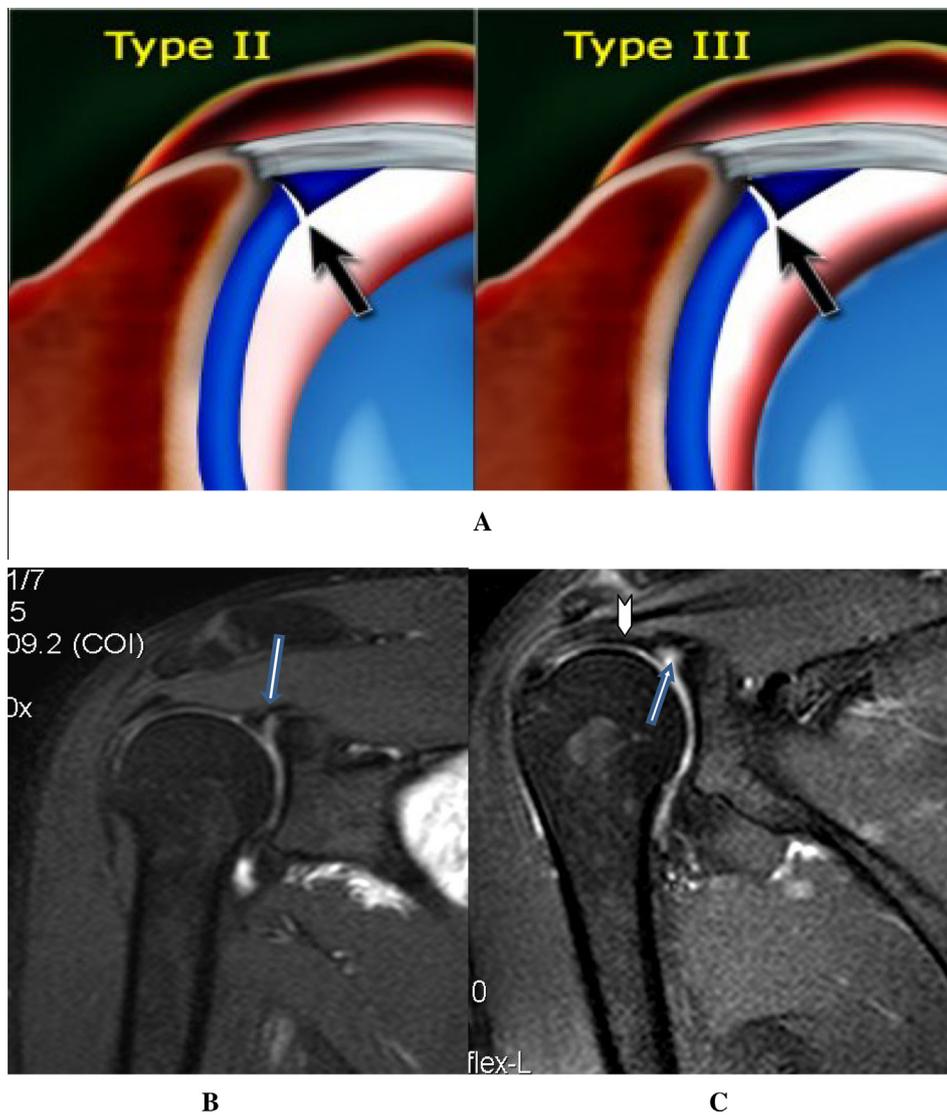
GLAD lesions are usually presented clinically with clicking during shoulder joint movement. It is one of the important causes of anterior shoulder pain, regardless it alone is not responsible for shoulder instability as described by Neviaser<sup>16</sup>

Rotator interval tear – diagnosed in 2 patients – is a subtype of rotator cuff tear which represents torn joint capsule between the supraspinatus and subscapularis tendons. This injury limits flexion and external rotation. MR arthrogram is essential for diagnosis of such injury, through demonstrating the extracapsular subscapularis contrast leak through the rotator interval defect. Routine MRI could not clearly diagnose this capsular defect.<sup>16,17</sup>

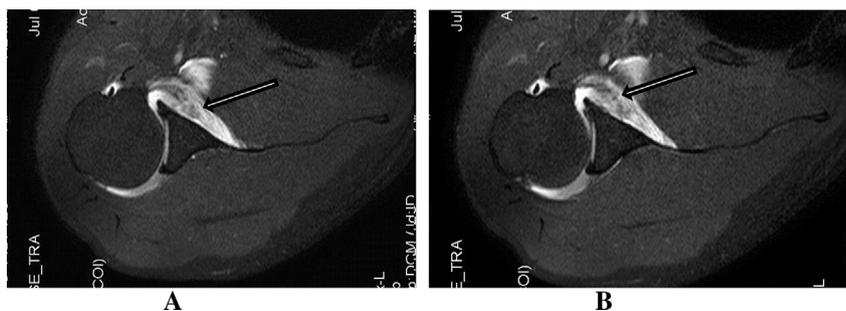
The superior labrum is originally more loosely attached and more mobile than the inferior labrum. This normal laxity leads to some diagnostic difficulty in identifying SLAP lesions. There are some variants of the superior labrum that may simulate SLAP tears for unspecialized radiologists. For example, in of Buford complex variant, there is absence of anterosuperior portion of the labrum, associated with a cordlike middle

glenohumeral ligament. Also, anatomic variations commonly occur in the superior labrum glenoid attachments that include sublabral recess (sulcus) and sublabral foramen (hole).<sup>18,19</sup> There are 3 types of attachment of the superior labrum at the 12 O'clock position where the biceps tendon is inserted. In type I there is no recess between the glenoid cartilage and the labrum. In type II there is a small recess. In type III there is a large sublabral recess (Fig. 5A). This sublabral recess can be difficult to distinguish from a SLAP tear. It is widely agreed that a defect more than 3 mm should be considered SLAP tear.<sup>20</sup>

Snyder et al.<sup>21</sup> classified SLAP lesions – that were diagnosed in 11 patients – into four types on the basis of arthroscopic evaluation. Type I lesion represents fraying, without frank tear. Type II lesion consists in stripping of the superior labrum and biceps tendon from the underlying glenoid cartilage. Type III lesion is a bucket-handle displaced tear, if it involves the biceps tendon, it will be classified as type IV. Additional classes were added by Maffet et al.<sup>22</sup> in 1995, reporting ten classes of



**Figure 6** (A) Diagram of type II and III normal variants of labral attachment, as shown in coronal MRI sequence (arrows).<sup>20</sup> (B, C) Coronal MR arthrogram T1 fat sat. Images showing SLAP II injury of superior labrum with non-detached labrum (notice the wide gap > 3 mm.) (arrows) and intact biceps tendon (Chevron in B).



**Figure 7** (A, B) Axial MR arthrogram T1 fat sat. Images showing interrupted glenoid attachment of the middle glenohumeral ligament with frayed distorted fibers (arrows).

SLAP injuries according to associated other joint part injuries to the initial four classes of the SLAP lesion. MR arthrogram can confidently demonstrate the complete extent of the labral

tear, which can be easily missed on routine MRI. So, MR arthrogram clearly determines the different classes of injury, which is essential for management decisions.<sup>18</sup>

**Table 2** Different types of lesions diagnosed by the MR arthrogram.

Type of lesions	Number of patients	
Labro-capsular injuries	Perthes	6
	ALPSA	3
	GLAD	2
	RIT	2
	SLAP	11
Ligamentous injury	MGHL	2
	IGHL	4
Total	30	

Tear or avulsions of the middle or inferior glenohumeral ligaments – that were diagnosed in 6 patients – from either humeral or glenoid sides (HAGL or GAGLE) are also considered important factors for anterior glenohumeral instability. Unless there is considerable effusion, diagnosis of these lesions will be difficult in plain MRI, however in the MR arthrogram there will be clear demonstration of the torn fibers and the gap formed by their retraction. This is also considered a crucial informative guide for the plan of management.<sup>22</sup>

## 8. Conclusion

- Shoulder microinstability is not an uncommon complaint of young active people.
- Superior and anterior labroligamentous-capsular lesions are responsible for the etiology of such instability.
- Routine shoulder MRI and even sometimes arthroscopy may not confidently diagnose such injuries.
- MR arthrogram is the most accurate helpful tool of imaging in diagnosis, classification and treatment planning of these injuries.

## Conflict of interest

The authors declare that they have no conflict of interest.

## References

1. Castagna A, Nordenson U, Garofalo R, Karlsson J. Minor shoulder instability. *J Arthroscop Relat Surg* 2007;**23**(2):211–5.
2. Lippitt SB, Harryman II DT, Sidles JS, Matsen III FA. Diagnosis and management of AMBRI syndrome techniques. *Tech Orthop* 1991;**6**:61–73.
3. Hafizuddin A. Dislocation of shoulder joint. Review Article. *KYAMC* 2011;**2**:140–5.
4. Tate A, Turner GN, Knab SE, Jorgensen C, Strittmatter A, Michener LA. Risk factors associated with shoulder pain and

- disability across the lifespan of competitive swimmers. *Athl Train* 2012;**47**(2):149–58.
5. Saleem I Asgar M, Lee Joong K, Novak Leon M. Usefulness of the abduction and external rotation views in shoulder MR arthrography. *AJR* 2008;**191**:1024–30.
6. Halbrecht JL, Tirman P, Atkin D. Internal impingement of the shoulder: comparison of findings between the throwing and nonthrowing shoulders of college baseball players. *Arthroscopy* 1999;**15**:253–8.
7. Liu SH, Henry MH. Anterior shoulder instability: current review. *Clin Orthop Relat Res* 1996;**323**:327–37.
8. Matsen FA, Thomas SC, Rockwood CA, Wirth MA. Glenohumeral instability, in the Shoulder. 2nd ed. Philadelphia (PA), USA: W.B. Saunders; 1998, vol. 2: p. 611–89.
9. Mutlu S, Mahir M, Lullari J, Güler O, Uçar BY, et al. Clinical study: anterior glenohumeral instability: classification of pathologies of anteroinferior labroligamentous structures using MR arthrography. *Adv Orthoped* 20113: <http://dx.doi.org/10.1155/2013/473194>.
10. Bigliani LU, Newton PM, Scott P, Patrick M, et al. Lesions associated with recurrent anterior dislocation of the shoulder. *Am J Sports Med* 1998;**26**:41–5.
11. Lippitt SB, Vanderhoof JE, Harris SL, et al. Glenohumeral stability from concavity compression: a quantitative analysis. *J Shoulder Elbow Surg* 1993;**2**:27–35.
12. Erkoçak ÖF, Yel M. The functional results of arthroscopic bankart repair with knotless anchors for anterior glenohumeral instability. *Eur J General Med* 2010; **7**(No. 2):179–86.
13. Saleem AM, Lee JK, Novak LM. Usefulness of the abduction and external rotation views in shoulder MR arthrography. *AJR* 2008;**191**:1024–30.
14. Neviaser TJ. The anterior labroligamentous periosteal sleeve avulsion lesion: a cause of anterior instability of the shoulder. *Arthroscopy* 1993;**9**(Issue 1):17–21.
15. Acid S, Corroller TL, Aswad R, Pauly V, Champsaur P. Preoperative imaging of anterior shoulder instability: diagnostic effectiveness of MDCT arthrography and comparison with MR arthrography and arthroscopy. *AJR* 2012;**198**:661–7.
16. Neviaser TJ. The GLAD lesion: another cause of anterior shoulder pain. *Arthroscopy* 1993;**9**:22–3.
17. Krie OP. MRI of the rotator interval capsule. *AJR* 2005;**184**:1490–4.
18. Mohana-Borges AV, Chung CB, Resnick D. Superior labral anteroposterior tear: classification and diagnosis on MRI and MR arthrography. *AJR* 2003;**181**:1449–62.
19. Maeseneer MD, Van Roy F, Lenchik L, Shahabpour M, et al. CT and MR arthrography of the normal and pathologic anterosuperior labrum and labral-bicipital complex. *Radiographics* 2000;**20**:S67–81.
20. Smithuis R, van der Woude HJ. Shoulder MR – anatomy: normal anatomy, variants and checklist. <http://www.radiologyassistant.nl/en/p4f49ef79818c2/shoulder-mr-anatomy.html>.
21. Snyder SJ, Karzel RP, Del Pizzo W, et al. SLAP lesions of the shoulder. *Arthroscopy* 1990;**6**:274–9.
22. Wolf EM, Cheng JC, Dickson K. Humeral avulsion of glenohumeral ligaments as a cause of anterior shoulder instability. *Arthroscopy* 1995;**11**:600–7.