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Multidetector CT arthrography in shoulder instability and its comparison with MR arthrography and arthroscopy

Vinod Kumar, Jeetendra S. Lodhi*, Dhananjay Sabat, Rakesh Sehrawat, Deepak Gupta

Maulana Azad Medical College and Lok Nayak Hospital, New Delhi, India

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***Correspondence:**
Dr. Jeetendra S. Lodhi,
E-mail: drjeet.ucms@gmail.com

ABSTRACT

Background: Purpose of this study was to compare diagnostic effectiveness of MDCT arthrography (MDCTA) in shoulder instability and pain in throwing and its comparison to MR arthrography (MRA) and arthroscopy taking arthroscopy as gold standard.
Methods: 20 patients with history of recurrent shoulder dislocation in activity were included in this study. After detailed clinical examination, each patient underwent MDCT-MR arthrography in one sitting followed by diagnostic arthroscopy within 6 weeks. Results were compared with the help of statistician.
Results: At arthroscopy, 10 Bankart's lesions, 7 Hill Sachs lesion, 6 SLAP lesion, 1 ALPSA, 1 capsular laxity, 1 partial subscapularis tear and 1 supraspinatus fraying were visualized in 20 shoulders. For Bankart's lesion MDCT has sensitivity 80%, specificity 100%, positive predictive value (PPV) 100% and negative predictive value (NPV) 83.3%. MRA has sensitivity of 90%, specificity 100%, PPV 100% and NPV 90.9%. For SLAP lesions sensitivity, specificity, PPV and NPV for MDCTA and MRA are 88.3%, 100%, 100%, 93.3%. For Hill-Sachs lesion; sensitivity, specificity, PPV and NPV for MDCTA are all 100% and for MRA they are 85.7%, 100%, 100%, 92.8% respectively. For ALPSA; sensitivity is 100%, specificity is 95%, PPV is 50% and NPV is 100% both for MDCTA and MRA.
Κ value for MRA is 0.60 and for CTA is 0.55 suggesting moderate agreement.
Conclusions: Considering availability, cost, time consumption, superior detection of bony lesions and comparable detection of soft tissue lesions; MDCTA can be used as single investigation of choice in shoulder instability pain.

Keywords: Arthroscopy, Arthrography, Bankart's lesion, Hill sachs lesion

INTRODUCTION

Shoulder instability is a common problem with annual incidence between 0.084%-1.7%.[1] There are 46%-100% incidence of recurrent dislocation for patients aged less than 40 years without surgical intervention, which decreases to 7%-15% after surgical stablization.[1] To improve the pre-operative planning and post-operative result of surgery, exact diagnosis of pathology and anatomy of labroligamentous structure is essential.

Conventional computerized tomographic arthrography (CTA) has limited soft tissue contrast and spatial resolution which has led to it being replaced by conventional and contrast enhanced magnetic resonance imaging (MRI) of shoulder.[2-6] At present, magnetic resonance arthrography (MRA) of shoulder is well proven and useful technique for diagnosis of intra-articular lesions.[5,11] However it is still expensive and metal in the vicinity interferes with the true signal.

Since multidetector CT (MDCT) was introduced in 1988, cross-sectional imaging has been revolutionized by the

capacity for routine acquisition of substantial anatomic volumes with an isotropic sub-millimeter spatial resolution and scan times of less than 10 seconds for 300 mm of coverage.[5,7-9] The use of MDCTA as a diagnostic method in various joints, including the shoulder, has been reported.[2,10-14]

The purpose of this study was to determine the utility of MDCTA in evaluation of lesions associated with shoulder instability and its comparison with MRA and arthroscopy, taking arthroscopy as gold standard. We hypothesized that MDCTA would be cost effective and comparable with MRA for assessing lesions in shoulder instability.

METHODS

It was a cross sectional study. The study was approved by the institutional ethical committee and conducted in the period from August 2012 to April 2014. Written informed consent was obtained from all patients. 20 consecutive patients with symptomatic shoulder instability were included in the study group. Patients with history of previous shoulder surgery, shoulder sepsis, any fracture and time delay between imaging and arthroscopy longer than 6 weeks were excluded. All patients underwent MDCTA and MRA after a single injection of contrast media under fluoroscopic control. Contrast media mixture used was 25% iodinated contrast media (Iomeron 250) and 1.25 mmol/L gadolinium contrast media (Dotarem 0.5 mmol/ml diluted to 1/400 dilution).[12] 12-20 ml of this combined contrast media was injected followed by MDCTA and MRA.

MDCTA was performed using 128 slice CT scan (Seimens, Forchheim, Germany) in axial, oblique coronal, sagittal coronal plane with 3mm section thickness. Oblique coronal images were reconstructed parallel to supraspinatus muscle and oblique sagittal images parallel to joint surface of glenoid with an identical section thickness and reconstruction interval.

MRA was performed on 1.5 T System (Seimens, Forchheim, Germany). Fat suppressed T1-wiegted spin echo images were obtained in transverse plane, in oblique coronal and oblique sagittal plane.

MDCTA and MRA were blinded and randomly evaluated in consensus by two musculoskeletal radiologists with more than 5 years of experience. The different lesions found in shoulder instability were assessed independently on each imaging modality.

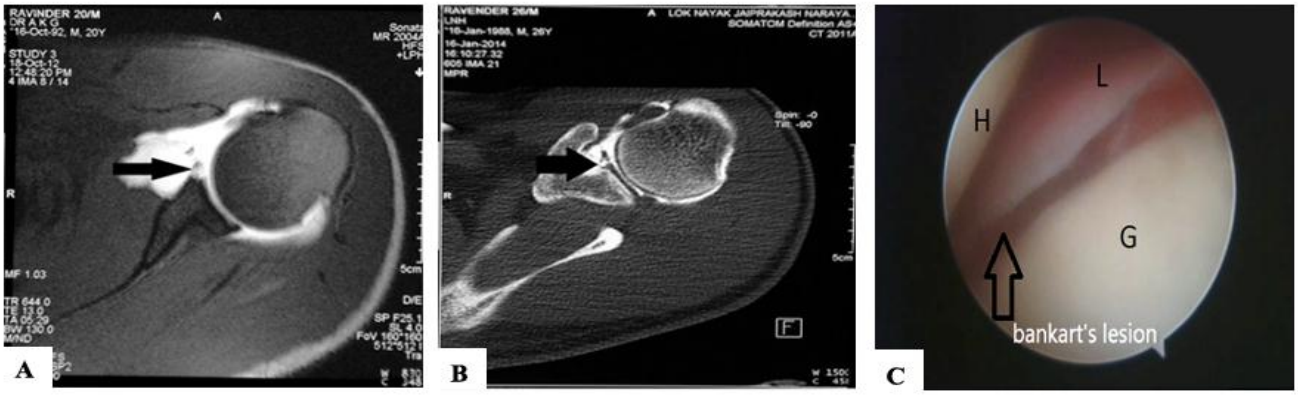

Figure 1: Classical Bankart's lesion (A) MRA axial section; (B) MDCTA axial section; (C) on arthroscopy.

Figure 2: Hill Sach's lesion (A) MRA axial section; (B) MDCTA axial section; (C) on arthroscopy.

Figure 3: SLAP lesion (A) MRA axial section; (B) MDCTA axial section; (C) on arthroscopy.

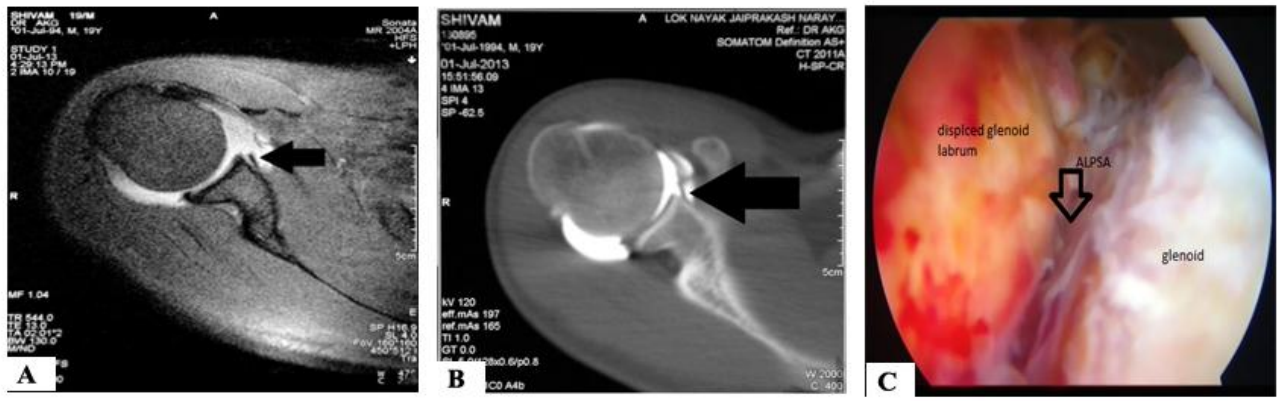

Figure 4: ALPSA lesion (A) MRA axial section; (B) MDCTA axial section; (C) on arthroscopy.
H- Humeral head, G- Glenoid, L- Labrum.

All patients were subsequently underwent arthroscopic examination of shoulder within 6 weeks of the radiographic study. The lesions identified during arthroscopy were noted for the comparison with the findings in MDCTA and MRA (Figure 1 to 3).

Considering the arthroscopic findings as gold standard; sensitivity, specificity, positive predictive value (PPV) and negative productive value (NPV) were calculated. Agreement was calculated between each imaging modality and arthroscopy using kappa coefficient (κ) as follows: 0-poor agreement**,** 0.01-0.20- slight agreement**,** 0.21-0.40- fair agreement**,** 0.41-0.60- moderate agreement**,** 0.61-0.80- substantial agreement**,** 0.81-1.00- almost perfect agreement.

Cohen's Kappa coefficient is a statistic tool which measures inter-rater agreement for qualitative (categorical) items.

RESULTS

Out of 20 patients in the study group, 16 were males and the rest 4 were females. Four patients were professional sports persons, 6 were body building professionals, and the rest 10 were not involved in any heavy physical or sports activity (Table 1). All patients had history of trauma either during sports, weight lifting or fall as a cause of shoulder dislocation. Three patients had more than 10 dislocations, 4 patients had 5-10 episodes, 7 patients had 4 episodes of dislocation and six patients had 3 episodes of dislocation. Two patients (one had more than 10 times dislocation and other had 5 times dislocation) gave history of dislocation during sleep. 16 patients were presented after 6 months but within a year. There was a patient who presented with 11 year of shoulder pain and history of dislocation.

At arthroscopy, 10 Bankart's lesions, 7 Hill Sach's lesion, 6 SLAP lesions, 1 ALPSA, 1 capsular laxity, 1 partial subscapularis tear and 1 supraspinatus fraying was seen. Lesions detected by MRA and MDCTA were noted in Table 2. Diagnostic efficacy of both imaging modality were excellent in detecting labral lesions. Sensitivity, specificity, positive predictive value and negative predictive value were same for SLAP lesions and ALPSA lesions and comparable for Bankart's and Hill Sachs lesions. The agreement of MDCTA and MRA with arthroscopic correlation was 0.60 and 0.55 respectively which was moderate agreement (Table 3 and 4).

Table 1: Demographic profile of the patients.

20 patients aged 15-50 years mean age 26 year	**Demographic profile**		
	Gender	Males	16
		Females	4
	Profession	Sports personnel	4
		Body building professional	6
		No specific activity	10

Table 2: Comparison of MDCT and MRA for detecting various shoulder lesions based on arthroscopic findings.

Pathology	Operative findings (n=20)	Modality	True positive	True negative	False positive	False negative
Bankart's lesion	10	MDCTA	8	10	0	2
		MRA	9	10	0	1
SLAP lesion	6	MDCT	5	14	0	1
		MRA	5	14	0	1
Hill-Sachs lesion	7	MDCTA	7	13	0	0
		MRA	6	13	0	1
ALPSA	1	MDCTA	1	19	1	0
		MRA	1	19	1	0

Table 3: Calculated sensitivity, specificity, positive and negative predictive values, and accuracy of MDCTA and MRA for each lesion.

Imaging test	SLAP	Bankart's lesion	Hill-Sachs lesion	ALPSA
MDCTA,%				
Sensitivity	83.3	80	100	100
Specificity	100	100	100	95
PPV	100	100	100	50
NPV	93.3	83.3	100	100
MRA,%				
Sensitivity	83.3	90	85.7 11 100	100
Specificity	100	100	100	95
PPV	100	90	100	50
NPV	93.3	90.9	92.8	100

Table 4: Calculated Kappa coefficient.

Imaging modality	Κ value
MRA	0.60
MDCTA	0.55

Table 5: For MDCTA.

Lesions	Present study				Oh et al[16]				Acid et al[1]				Mahmoud et al[17]			
	Sn	Sp	PPV	NPV	Sn	Sp	PPV	NPV	Sn	Sp	PPV	NPV	Sn	Sp	PPV	NPV
Bankart	80	100	100	83.3	86	95	86	95	*	*	*	*	91.6	100	100	95
Hill-Sachs	100	100	100	100	93	90	67	98	100	100	100	100	100	100	100	100
SLAP	83.3	100	100	93.3	86	90	90	86	*	*	*	*	87.5	95.8	87.5	95.8
ALPSA	100	95	50	100	*	*	*	*	93	100	100	86	*	*	*	*
GLAD																
HAGL																

Table 6: For MRA.

Lesions	Present study				Oh et al[16]				Acid et al[1]				Mahmoud et al[17]			
	Sn	Sp	PPV	NPV	Sn	Sp	PPV	NPV	Sn	Sp	PPV	NPV	Sn	Sp	PPV	NPV
Bankart	90	100	90	90.9	90	100	100	98	*	*	*	*	91.6	100	100	95
Hill-Sachs	85.7	100	100	92.8	75	98	86	97	100	100	100	100	81.8	95.2	90	91
SLAP	83.3	100	100	93.3	72	95	92	80	*	*	*	*	100	100	100	100
ALPSA	100	95	50	100	*	*	*	*	100	67	87	100	*	*	*	*
GLAD																
HAGL																

*Lesions were not included in these studies.
Kappa coefficient (κ) 0-Poor agreement, 0.01-0.20- Slight agreement, 0.21-0.40- Fair agreement, 0.41-0.60- Moderate agreement, 0.61-0.80- Substantial agreement, 0.81-1.00- almost perfect agreement.

DISCUSSION

In shoulder instability and pain during throwing, diagnosis of pathology and knowledge of its exact anatomy is crucial for proper preoperative planning and treatment. History taking, physical examination and plain radiograph are usually sufficient for the diagnosis of instability, but to know exact causative lesion higher imaging modalities are often necessary.

MRI has been widely used for definitive diagnosis and preoperative assessment because of its inherent soft tissue contrast, oblique plane imaging capability and excellent resolution using surface coil. If contrast media is used along with MRI then diagnostic efficacy is increased due to filling of contrast media in the defects. So, the MRA is being used as imaging modality of choice in intra-articular derangement of shoulder joint. However MRI has following limitations; cost factor, time consuming, claustrophobic in some patients, and altered signals in presence of metal in vicinity.

CT shows high accuracy for detecting bony lesions. MDCTA has the advantages of isotropic sub millimeter spatial resolution, reduced examination time with decreased motion artifacts, imaging in abduction external rotation (ABER) position even when apprehension test is positive, possibility of reconstruction images with 1mm or thinner section in any direction, cost effectiveness, and can be useful even if metal is in vicinity.

In previously published studies by Oh et al, Acid et al and Mahmoud et al also have shown efficacy of MDCTA in diagnosing pathologies in shoulder instability.[1,15,16] The outcomes of these studies in comparison to ours in Table 5 and 6.

The study has following strength. It demonstrates the possibility of performing a one shot MDCTA-MRA of shoulder using mixture of iodinated and paramagnetic contrast agent. The MDCTA-MRA examination did not create any particular problem in performing or reading of images. By performing one shot MDCTA-MRA, we were able to compare the effectiveness of two imaging modalities simultaneously in the same patient. These were compared with arthroscopic findings and diagnostic efficacy of each imaging modality was demonstrated.

This study has the following limitations. First, although arthroscopy is supposed to be the best reference standard used in this study, it remains an operator dependent method. Second, because the decision to perform arthroscopy was based not only on clinical symptoms but also on preoperative imaging findings, a verification bias might have been introduced. Third, because all MDCTA and MRA examinations were analyzed by two radiologists in consensus, inter-observer variation was not studied. Fourth, although sample size was based on the sensitivity and specificity shown in previous studies, the number of each elemental lesion was too small to allow further statistical analysis. Fifth, mixed contrast material was used in this study. The stability of the mixture of gadolinium chelates and iodinated contrast agents has already been reported on, and its clinical safety was certain for performing CTA and MRA of the ankle and wrist as a one-shot CTA- MRA examination. Nevertheless, a decrease in the signal intensity on MRA was seen due to the dilution of the gadolinium chelate mixed with the iodinated contrast agent. This might have reduced the sensitivity of MRA for Bankart's variants in this study, as compared to previous studies.

CONCLUSION

In shoulder instability and pain in activity, both MRA and MDCTA demonstrate the labroligamentous lesions effectively. Although soft tissue lesions were better picked by MRA and bony lesions by CTA, both modality show moderate agreement (κ for MDCTA is 0.55 and for MRA it is 0.60) when compared with arthroscopy.

Considering availability, cost, time consumption, superiority in detecting bony lesions and comparable in soft tissue lesions detection MDCTA can be used as single investigation of choice in shoulder instability.

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Lodhi Jeetendra selected the patients, examined them, injected contrast agents for MDCTA and MRA, worked

them up for arthroscopy and prepared the manuscript. Sabat Dhananjay helped in editing the manuscript. Kumar Vinod gave concepts of study, designed the study and performed diagnostic arthroscopy in all patients. Sehrawat Rakesh and Gupta Deepak helped in statistical analysis of data.

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