

Comparison of MRI and MRA for the diagnosis of rotator cuff tears

A meta-analysis

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Abstract

Background: Numerous quantitatively based studies measuring the accuracy of MRI and MRA for the diagnosis of rotator cuff tears remain inconclusive. In order to compare the accuracy of MRI with MRA in detection of rotator cuff tears a meta-analysis was performed systematically.

Methods: PubMed/Medline and Embase were utilized to retrieve articles comparing the diagnostic performance of MRI and MRA for use in detecting rotator cuff tears. After screening and diluting out the articles that met inclusion criteria to be used for statistical analysis the pooled evaluation indexes including sensitivity and specificity as well as hierarchical summary receiver operating characteristic (HSROC) curves with 95% confidence interval (CI) were calculated.

Results: Screening determined that 12 studies involving a total of 1030 patients and 1032 shoulders were deemed viable for inclusion in the meta-analysis. The results of the analysis showed that MRA has a higher sensitivity and specificity than MRI for the detection of any tear; similar results were observed in the detection of full-thickness tears. However, for the detection of partial-thickness tear, MRI has similar performance with MRA.

Conclusion: MRI is recommended to be a first-choice imaging modality for the detection of rotator cuff tears. Although MRA have a higher sensitivity and specificity, it cannot replace MRI after the comprehensive consideration of accuracy and practicality.

Abbreviations: CI = confidence interval, CT = computer tomography, CTA = computer tomography angiography, DOR = diagnostic odd ratio, FN = false-negative, FP = false-positive, HSROC = hierarchical summary receiver operating characteristic, MRA = MR arthrography, MRI = magnetic resonance imaging, PRISMA-DTA = Preferred Reporting Items for a Systematic Review and Meta-analysis of Diagnostic Test Accuracy Studies, SROC = the summary receiver operating characteristic curve, TN = true negative, TP = true-positive.

Keywords: Diagnostic value, meta-analysis, MRA, MRI, rotator cuff tears

1. Introduction

The rotator cuff, composed of the supraspinatus, infraspinatus, subscapularis, and teres minor tendons, plays a crucial role in the movements and stabilization of the shoulder joint.^[1,2] The rotator cuff tear coupled with complications is one of the most common factors causing motor disability as well as serious shoulder pain, accounting for about 70% of all patients with

shoulder dysfunction.^[3,4] With an aging population, the prevalence and severity are expected to increase. Rotator cuff tears can be classified based on several different ways: aetiology (traumatic or degenerative), duration (acute or chronic), or size (partial- or full-thickness).^[2,5,6] Small, medium, large, or massive lesions are used to describe the size of tears.^[7] All characteristics above will affect treatment decisions. As such, early accurate

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diagnosis of rotator cuff tear and its extent are essential, which can help to determine appropriate treatment methods (conservative vs surgical strategy).^[18]

Rotator cuff tears must be discerned from shoulder impingement syndrome and glenohumeral joint instability.^[9,10] Shoulder x-ray film and physical examinations have been shown to be insufficient at effectively detecting rotator cuff tears.^[11,12] With the advance in imaging techniques, conventional magnetic resonance imaging (MRI) and MR arthrography (MRA) significantly increased the diagnostic accuracy of rotator cuff tears,^[13] which not only provide useful and rich information to support findings from the medical history and physical examination, but also demonstrate the pathoanatomy of the shoulder dysfunction.^[14]

Usually, MRA extends the capabilities of conventional MRI in the detection of any rotator cuff tear because contrast agents can outline abnormalities.^[13,15] Several researchers suggested that MRA should be used on all patients undergoing MRI of the shoulder to increase the accuracy of diagnosis.^[16] However, MRA is more invasive, costly, and time-consuming, and may expose patients to ionizing radiation. Indeed, with regard to detecting typical complete tears,^[17] MRI has fulfilled the need for diagnostic certainty, because the sensitivity and specificity of MRI is ~90%.^[18] Additionally, for the detection of partial-thickness, small full-thickness rotator cuff tears and degeneration, while MRA is more accurate, it is only marginally superior to MRI.^[15] Therefore, for the option of MRI versus MRA for detecting rotator cuff tears, there seems to be no general consensus, despite numerous studies were published.^[16,19,20] Hence, a synthesis of the literature is quite helpful to compare the accuracy of MRI with MRA.

To the best of our knowledge, several meta-analyses^[15,21] have been published on the diagnostic accuracy of medical imaging for the characterization of rotator cuff tears. McGarvey et al^[15] performed a meta-analysis to compare the diagnostic accuracy of rotator cuff tears using 3-T MRI versus 3-T MRA, which demonstrated that 3-T MRI appeared equivalent to 3-T MRA in the diagnosis of full- and partial-thickness tears. However, it only compared the effectiveness between 3.0-T MRA and 3.0-T MRI. Recently, by searching related databases, it could be noticed that some high quality studies were newly published, most of which used high magnetic field strength and multidimensional imaging for MRI and MRA. Therefore, an updated meta-analysis is warranted to determine if new data and improved technology over the years have an impact on the diagnostic accuracy of a given pool.

The primary objective of this study was to perform a meta-analysis on the diagnostic accuracy of MRI and MRA in the assessment of partial-, full-thickness or any tear.

2. Methods

This meta-analysis was conducted based on the checklists of the Preferred Reporting Items for a Systematic Review and Meta-analysis of Diagnostic Test Accuracy Studies (PRISMA-DTA) statement.^[22] Ethical approval and patient consent were not necessary, as the analysis was performed based on data available in published articles.

2.1. Selection, inclusion, and exclusion criteria

PubMed/Medline and Embase were retrieved for published literatures measuring the sensitivity, specificity, and accuracy of

MRI and MRA for the diagnosis of rotator cuff tears with the keywords “MRI [All Fields],” “magnetic resonance imaging [All Fields],” AND “MRA [All Fields],” “magnetic resonance angiography [All Fields],” “MR angiography [All Fields]” AND “rotator cuff [All Fields],” “supraspinatus [All Fields],” “subscapular [All Fields],” or “subscapularis [All Fields].” The newest search, without language limitation, was performed on August 1, 2018. Subsequently, manual search was further conducted to retrieve additional studies omitted in the search of databases in the reference lists of included studies.

Inclusion criteria should follow all items:

1. clinical studies involved patients with rotator cuff tears;
2. one study used imaging modalities including MRI and MRA simultaneously for the detection of rotator cuff tears;
3. study compared the diagnostic value of MRA and MRI;
4. studies provided original diagnostic data (True positive [TP], False positive [FP], false negative [FN], and true negative [TN]) or can be calculated using enough evidence;
5. gold standard should be open surgery or shoulder arthroscopy for assessment accuracy of MRA and MRI;
6. studies presenting the most data values was included this statistical analysis if literatures contain overlapping data.

Exclusion criteria comprised:

1. letters, conference summary, meeting abstract, commentary and other no full-text studies;
2. animal and cadaver experiments;
3. and articles presenting non original diagnostic data (TP, FP, FN, and TN) directly or no enough evidence to calculate diagnostic data indirectly.

2.2. Data extraction and quality assessment

First, main characteristics of the included studies were extracted, including the first author’s surname, publication time, country of origin, inclusion interval, study design, gold standard, time from MRI/MRA to gold standard (mean days), whether blinding, number of readers, and readers’ experience. Second, main characteristics of the patients from included studies were extracted, including the number of patients and shoulders, mean age (range), gender, clinical indication of shoulders, methods, and final diagnoses of included patients. Third, information of MRI and MRA were extracted, including scanner vendor, model, magnetic strength, sequence of MRI and MRA, slice thickness and analyzed image plane. Finally, diagnostic data including TPs, FPs, TNs, and FNs were extracted. To reduce potential bias, all targeted data were extracted into a standardized form by two independent and blinded researchers (Researcher A & B).

We used a quality assessment tool (QUADAS-2)^[23,24] to evaluate the methodological quality of the included studies. This tool consists of 11 items, and if the included study meets one item, one score will be given. The quality of each included studies was assessed by two independent and blinded researchers. Inconsistencies between researchers were resolved by consensus.

2.3. Statistical analysis

The primary outcome of this meta-analysis was an assessment the value of MRI and MRA for the detection of rotator cuff tears. The secondary pooled outcomes comprised comparison between MRI and MRA with evaluation index. The third outcomes were

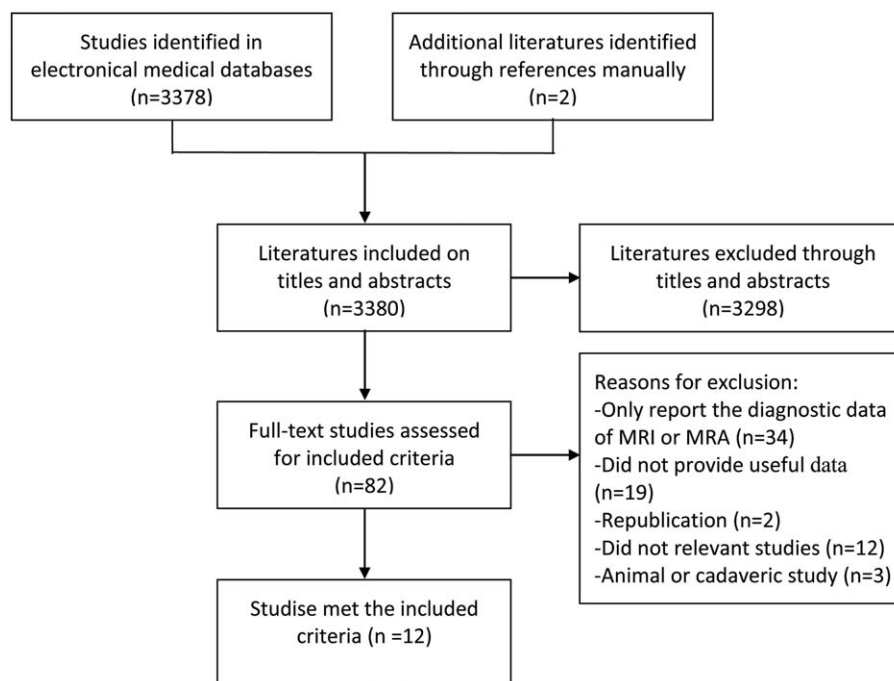


Figure 1. Selection flow chart for included studies in the meta-analysis.

the various subgroups (full-, partial-thickness, supraspinatus, any tear) to check the reliability in various subgroups.

A bivariate random-effects model was applied to derive summary estimates of the diagnostic value by merging the following pooled outcome estimates: sensitivity, specificity, and hierarchical summary receiver operating characteristic (HSROC) curves.^[25] Heterogeneity between studies was evaluated using Cochran's Q test ($P < .05$ indicating the presence of heterogeneity).^[26] Deeks' funnel plot asymmetry test^[27] was omitted to assess publication bias according to the PRISMA-DTA. All statistical analyses were calculated with

STATA, version 12.0 (StataCorp, College Station, TX). A 2-sided $P < .05$ were considered as significant.

3. Results

3.1. Selection process

The primary search of the targeted two electronic databases and subsequently screening process of feasible articles is represented in Figure 1. Of 3380 records identified during database and

Table 1

Main characteristics of the subjects from included studies.

Study, year	No. of patients	Mean age (years, range)	Gender (M/F)	No. of shoulders	Clinical indication of shoulder	Methods	Final diagnosis of included patients
Lou et al 2016	127	38.3 (27–77)	73/54	127	Shoulder pain and motion limitation, previous trauma	MRI/MRA	Full/partial-thickness RCT
Zhang et al 2016	79	39.1 (25–71)	43/36	79	Shoulder pain and motion limitation, previous trauma	MRI/MRA	Partial-thickness RCT
Sun et al 2015	36	42.2 (18–77)	17/19	36	Suspicious of having RCT	MRI/MRA	Full/partial-thickness RCT
Li et al 2013	26	46.2 (19–72)	16/10	26	Suspicious of having RCT	MRI/MRA	Full/partial-thickness RCT
Magee et al 2013	150	55 (18–83)	116/34	150	Shoulder pain	MRI/MRA	Full-thickness RCT
Hitachi et al 2011	66	58 (13–79)	43/25	68	Shoulder pain, contracture, trauma, and/or dislocation	MRI/MRA	Full/partial-thickness RCT
Tian et al 2010	127	38.4 (14–90)	187/77	127	Suspicious of having RCT	MRI	RCT
	137			137		MRA	
Magee et al 2009	150	31 (14–50)	109/41	150	Shoulder pain	MRI/MRA	Full/partial-thickness RCT
Lu et al 2008	20	57.4 (34–87)	13/7	20	Shoulder pain and motion limitation, previous trauma	MRI	Full/partial-thickness RCT
Yagci et al 2001	20	48.2 (26–59)	9/11	20		MRA	
	24	52 (16–73)	7/17	24	Suspicious of having RCT	MRI/MRA	Full/partial-thickness RCT
Zheng et al 2001	32	43.6 (20–68)	14/18	32	Suspicious of having RCT	MRI/MRA	RCT
Hodler et al 1992	36	42.5 (17–69)	24/12	36	Scheduled for shoulder surgery	MRI/MRA	Full/partial-thickness RCT

NR=no reported, RCT=rotator cuff tear.

Table 2
Main characteristics of the included studies.

Author, year	Country	Inclusion interval	Study design	Gold standard	Time from MRI/MRA to gold standard, mean days (range)	Blinding	No. of readers	Reader experience
Lou et al 2016	China	2011.5–2015.4	P, C	Shoulder arthroscopy	NR	Yes	≥2	Yes
Zhang et al 2016	China	2011.5–2015.7	R, C	Shoulder arthroscopy	NR	Yes	≥2	Yes
Sun et al 2015	China	2009.4–2013.4	P, C	Shoulder arthroscopy or surgery	30	Yes	2	Yes
Li et al 2013	China	2011.10–2012.12	R, C	Shoulder arthroscopy	NR	Yes	2	10/10 years
Magee et al 2013	USA	2011.7–2012.1	R, C	Shoulder arthroscopy	19 (1–47)	Yes	2	Yes
Hitachi et al 2011	Japan	2003.11–2005.12	P, C	Shoulder arthroscopy or surgery	42 (1–264)	Yes	3	Yes
Tian et al 2010	China	2006.6–2009.7	R, C	Shoulder arthroscopy or surgery	29.1 (1–330)	Yes	2	5/10 years
Magee et al 2009	USA	2007.1–2007.7	P, C	Shoulder arthroscopy	11 (1–30)	Yes	2	10/10 years
Lu et al 2008	China	2002.11–2006.8	R, C	Shoulder arthroscopy	NR	Yes	2	Yes
Yagci et al 2001	Turkey	1997.8–1998.6	P, C	Shoulder surgery	11 (0–27)/7 (1–23)	Yes	2	Yes
Zheng et al 2001	China	1999.1–2000.11	P, C	Shoulder arthroscopy	2–360	NR	NR	NR
Hodler et al 1992	USA	NR	R	Shoulder arthroscopy	NR	Yes	3	Yes

C=consecutive, NR=no reported, P=prospective, R=retrospective, RCT=rotator cuff tear.

bibliography searches, 82 ineligible records were excluded by screening titles and abstracts. Subsequently, the remaining ones were downloaded and reviewed as full-text versions. After detailed search and selection, ultimately, 12 studies^[16,19,20,28–36] involving 1030 patients with rotator cuff tears were recruited into the meta-analysis.

3.2. Study characteristics and quality assessment

The main characteristics of the subjects, the included studies and imaging modalities (MRA and MRI) in this meta-analysis are shown in Tables 1–3, respectively. All included studies^[16,19,20,28–36] were published in the time span from 1992 to 2016 with the number of shoulders ranging from 20 to 150. For all included studies, eight studies^[16,20,28,30,31,34–36] used arthroscopy as the gold standard of diagnosing rotator cuff tears, three^[19,32,33] using

shoulder arthroscopy or surgery and only one study^[29] used shoulder surgery. Six studies^[16,19,29,30,33,34] were prospective, and the remaining^[20,28,31,32,35,36] were retrospective.

According to the methodological quality of QUADAS-2 tool, only one study^[28] received a score of 8, four studies^[31,34–36] received a score of 9, and the remaining^[16,19,20,29,30,32,33] achieved an overall score of 10.

3.3. Diagnostic value of MRI and MRA for detecting any tear

Results estimating the value of MRI vs MRA in the diagnosis of patients with any tear, as generated from the 9 studies^[16,19,28–30,32–34,36] involving 763 shoulders, demonstrated pooled sensitivity of 0.84 (95% CI 0.73–0.91) vs 0.97 (95% CI 0.63–1.00), specificity of 0.92 (95% CI 0.78–0.97) vs 0.97 (95% CI

Table 3
Main characteristics of MRI and MRA.

Author, year	Scanner (MRI/MRA)			Method (MRA)	Sequence (MRI)	Technical parameters (MRI/MRA)			Analyzed image plane
	Vendor	Model	Magnetic strength			Sequence (MRA)	Slice thickness	NO. of analyzed image plane	
Lou et al 2016	GE	Signa	1.5 T	Direct	T1WI (FSE), PDWI, T2WI (GRE)	T1WI	4 mm	3/3	Axial, obl cor, obl sag
Zhang et al 2016	GE	Signa	1.5 T	Direct	T1WI (FSE), PDWI, T2WI (GRE)	T1WI	4 mm	3/3	Axial, obl cor, obl sag
Sun et al 2015	Siemens	Symphony and Avanto	1.5 T	Direct	T1WI (SE), T2WI (TSE)	T1WI (SE), T1FS, T2WI (TSE)	3.5 mm	3/3	Axial, obl cor, obl sag
Li et al 2013	Philips	Acheiva	1.5 T	Direct	T1WI+FS (TSE), T2WI+FS (TSE), T2WI (SPAIR)	T1WI (TSE)	3 mm	3/3	Axial, obl cor, obl sag
Magee et al 2013	GE	Signa	3.0 T	Direct	T1WI (FSE), T2WI, PDFS	T1FS, T1WI	3 or 4 mm	3/3	Axial, obl cor, obl sag
Hitachi et al 2011	Philips	Intera Nova	1.5 T	Direct	T1WI (TSE), T2WI (TSE), PDFS	T1WI (TSE), T1FS	3.5 mm	3/3	Axial, obl cor, obl sag
Tian et al 2010	Siemens	Sonata or Magnetom Trio Tim	1.5 T or 3.0 T	Direct	T1WI (SE), T1WI (FSE), PD	T1WI (SE), T1WI (FSE), PD	4 mm	3/3	Axial, obl cor, obl sag
Magee et al 2009	GE	Signa	3.0 T	Direct	T1WI (FSE), T2WI (FSE)	T1WI, T1FS	3 or 4 mm	3/3	Axial, obl cor, obl sag
Lu et al 2008	GE	Signa	1.5 T	Indirect	T1WI, T2WI (TSE) PD, STIR	T1WI, T2WI (TSE) PD, STIR, T1FS, T2FS	4 mm	3/3	Axial, obl cor, obl sag
Yagci et al 2001	Siemens	Superconductive magnet	1.0 T	Direct	T1WI, T2WI, T2WI (GRE)	T1WI, T1FS	4 mm	3/3	Axial, obl cor, obl sag
Zheng et al 2001	Siemens	Magnetom Vision	1.5 T	Direct	T1WI (SE) T2WI, T2FS (TSE)	T1WI (SE) T2WI, T2FS	4 mm	3/3	Axial, obl cor, obl sag
Hodler et al 1992	GE	Signa	1.5 T	Direct	T1WI, PD, T2WI, PD	T2WI, PD	4 mm	3/3	Axial, obl cor, obl sag

Axi=axial, FS=fat suppressed, FSE=fast spin-echo, GRE=gradient echo, NR=not reported, obl cor=oblique coronal, obl sag=oblique sagittal, PD=proton density, SE=spin echo, SPAIR=spectral attenuated inversion recovery, STIR=short-TI inversion recovery, TSE=turbo spin echo, WI=weighted image.

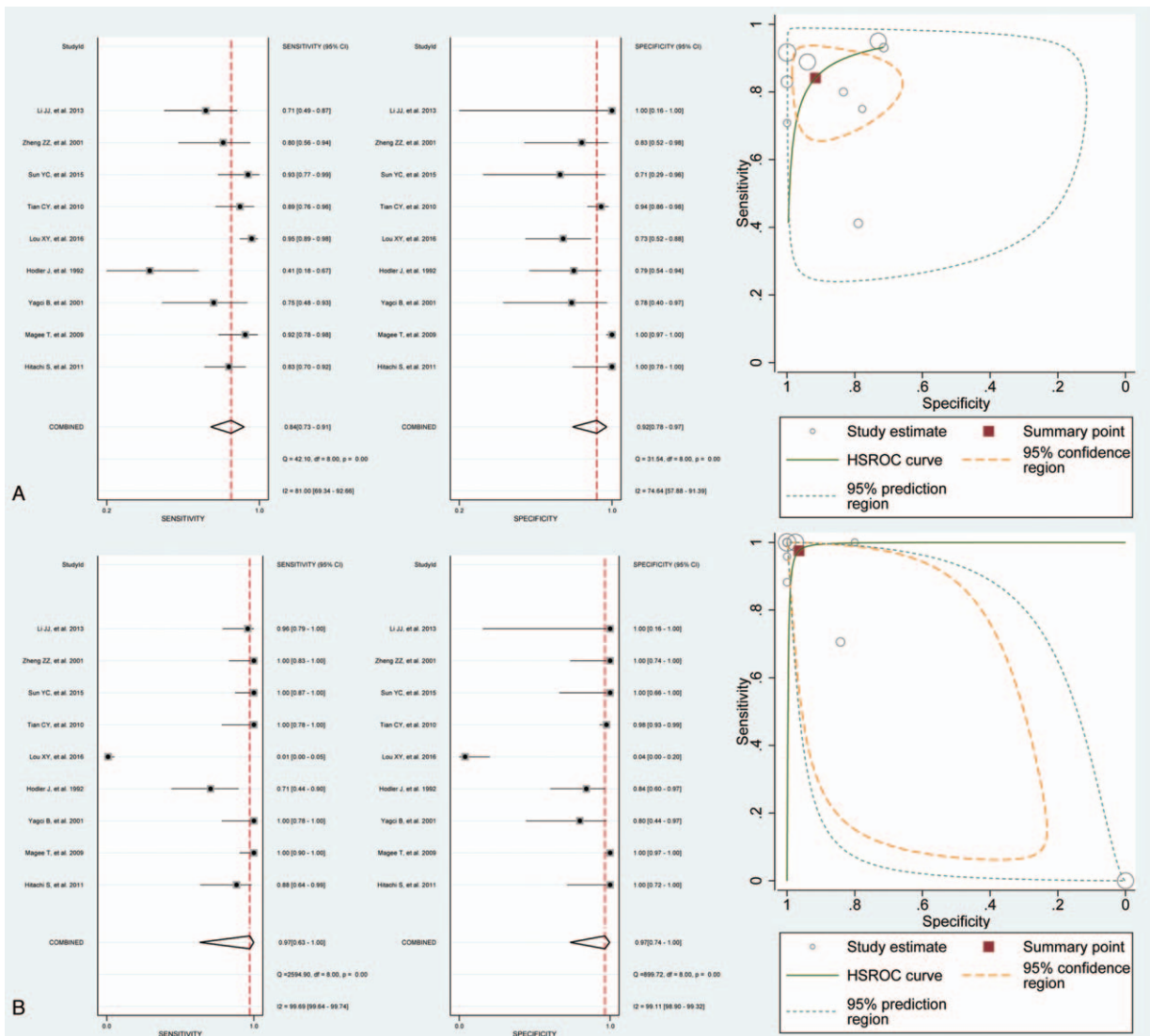


Figure 2. Pooled sensitivity, specificity and HSROC of MRI (A) and MRA (B) for detecting the rotator cuff tears.

0.74–1.00), and the area under the HSROC curve of 4.00 (95% CI 2.72–5.27) vs 7.00 (95% CI 0.43–13.59), respectively (Fig. 2).

3.4. Diagnostic value of MRI and MRA for detecting full-thickness tears

Results estimating the value of MRI vs MRA in the diagnosis of patients with full-thickness tears, as generated from the 8 studies^[19,20,28–31,33,34] involving 513 shoulders, demonstrated a pooled sensitivity of 0.81 (95% CI 0.69–0.89) vs 0.98 (95% CI 0.93–1.00), specificity of 0.95 (95% CI 0.81–0.99) vs 0.98 (95% CI 0.92–0.99), and the area under the HSROC curve of 4.15 (95% CI 2.36–5.93) vs 8.20 (95% CI 5.41–10.99), respectively (Fig. 3).

3.5. Diagnostic value of MRI and MRA for detecting partial-thickness tears

Results estimating the value of MRI vs MRA in the diagnosis of patients with partial-thickness tears, as generated from the 9

studies^[16,19,28–31,33–35] involving 592 shoulders, demonstrated a pooled sensitivity of 0.70 (95% CI 0.50–0.85) vs 0.45 (95% CI 0.07–0.89), specificity of 0.95 (95% CI 0.90–0.98) vs 0.76 (95% CI 0.05–1.00), and the area under the HSROC curve of 4.02 (95% CI 2.55–5.49) vs 0.51 (95% CI –5.56 to 6.57), respectively (Fig. 4).

3.6. Publication bias

Deeks’ funnel plots of individual studies was omitted to check for publication bias according to the PRISMA-DTA. For the detection of any tear, the *P* values of MRA and MRI were .86 and .06, respectively (Fig. 5).

4. Discussion

Rotator cuff tear is one of the most common shoulder musculoskeletal disorders that can result in disability, serious pain, and substantial health care costs.^[37] As numerous studies reported, the prevalence of rotator cuff tear is about 20.7% in the

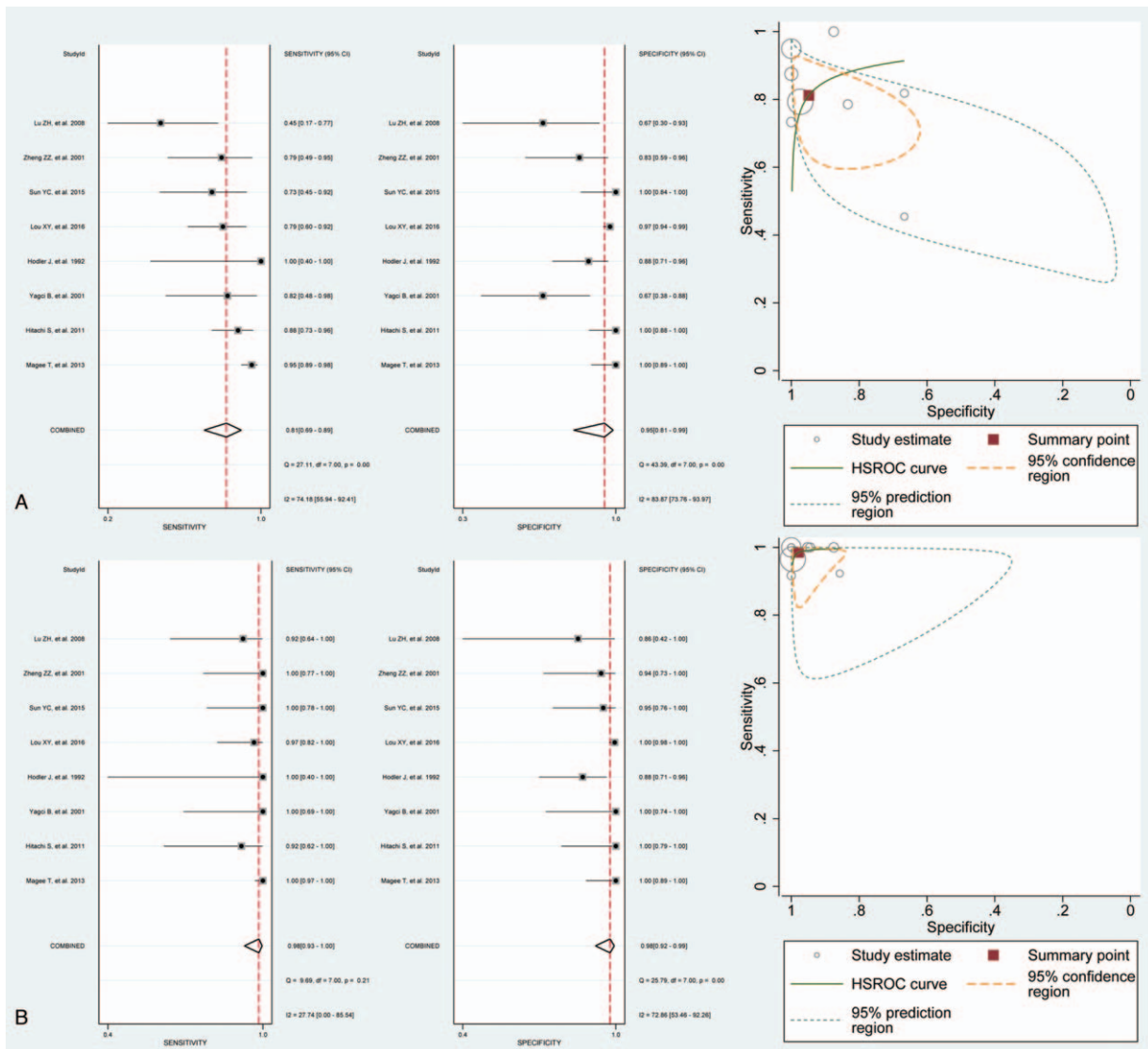


Figure 3. Pooled sensitivity, specificity and HSROC of MRI (A) and MRA (B) for detecting full-thickness rotator cuff tears.

general population.^[38] For patients with rotator cuff tears, a quite number of therapeutic options, ranging from rest or activity modification to medications to open surgery or arthroscopy, are available.^[16,39] However, the decision of treatment methods depends not only on the patients' presentation but also on imaging results.^[28,40,41] Unlike the clinical examinations that are difficult to find the location of rotator cuff tears, medical imaging has been considered as a quite good indicator of detecting rotator cuff tears and also played an important role in the management of rotator cuff tears.^[42-47] The diagnostic accuracy and effective use of different imaging technologies are the main concerns of patients. Therefore, the need to evaluate accuracy and efficiency of imaging diagnostic tests for rotator cuff tears is increasingly important. In this study, we sought to determine whether MRA provided enough additional benefit as compared to conventional MRI and analysis their advantages and disadvantages under various specific conditions.

It has long been a hot topic whether or not to inject contrast agents when using MRI for the detection of rotator cuff tears.

Although MRA has been considered to be more accurate than conventional MRI when detecting any rotator cuff tears, it also provokes a number of inevitable problems, such as invasion,^[48] ionizing radiation,^[49] adverse reactions and additional radiologist time.^[50] Hence, any such potential benefit from MRA must be weighed against the additional discomfort and invasiveness caused by the injection of the contrast material. For the option of MRI versus MRA, it is not appropriate to perform an invasive examination directly, especially when patients have no serious symptoms. Moreover, medical history and clinical examinations are also important considerations.^[51,52] In the actual clinical work, the radiologists and doctors make the diagnosis combined with all examinations, without following the blind methods of clinical research, prompting that MRA is not a general suggestion in the diagnosis of rotator cuff tears. Usually, patients with acute symptoms or severe, pathologic tears are more probably to have intrinsic image contrast in the form of effusion or soft-tissue changes that allow diagnosis and characterization without contrast agents.^[53,54] On the contrary, those with chronic

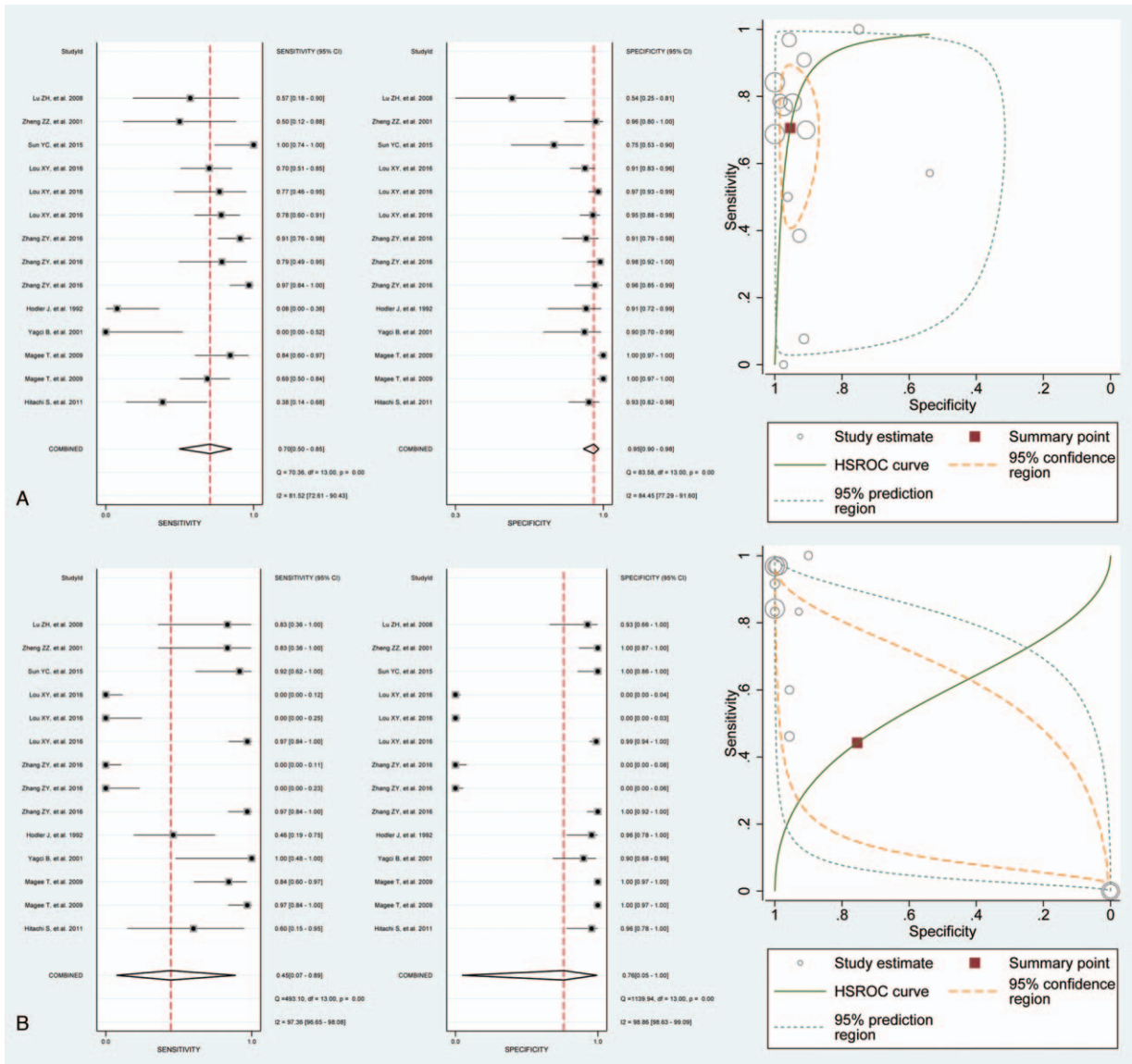


Figure 4. Pooled sensitivity, specificity and HSROC of MRI (A) and MRA (B) for detecting partial-thickness rotator cuff tears.

symptoms or a pathologic abnormality that is suspected to be more subtle on the basis of clinical assessment more often require MRA.^[55]

Rotator cuff tears can be categorized as either partial or full-thickness tears, and it is critical to differentiate full-thickness from partial-thickness tears when detecting tears, because its treatment methods are different.^[56] Especially athletes and younger patients suffering from full-thickness tears, who have the requirements to participate in high-level activities, would be treated by surgery or arthroscopy.^[19] In our pooled detecting results of full-thickness tears, MRA, have a higher sensitivity and specificity than MRI. However, should MRA be performed on all patients to increase the accuracy of detecting full-thickness tears? As mentioned above, because of its invasiveness and complicated procedures, the decision to perform MRA should depend on the clinical need.^[57,58] For example, post-operative re-tear of the rotator cuff should be investigated by MRA, because the fluid distension due to contrast agents can enable a better visualization that effectively

avoids the interference of the fibrosis and scarring. Additionally, to identify and distinguish very small complete tears from partial-thickness rotator cuff tears, MRA should be used when facing the specific clinical situation.^[59] In fact, with advances in technology, the improved spatial resolution and obvious tissue contrast have made MRI bring the similar accuracy in detecting moderate to large full-thickness rotator cuff tears.^[60]

Partial-thickness tears that extend to the articular or bursal surfaces, can be named as articular and bursal partial-thickness tears, respectively.^[61] The identification of partial-thickness tears is also very important because even small tears can be a source of persistent shoulder pain and disability, which also have a high possibility to progress into full-thickness tears.^[20] For overall analysis of partial-thickness tears, MRA have an obviously higher sensitivity and specificity compared with conventional MRI. For the conventional MRI, due to lack of contrast agents and joint distension, small partial tears may be mis-detected as tendinitis, and large ones as full-thickness rotator cuff tears.^[62]

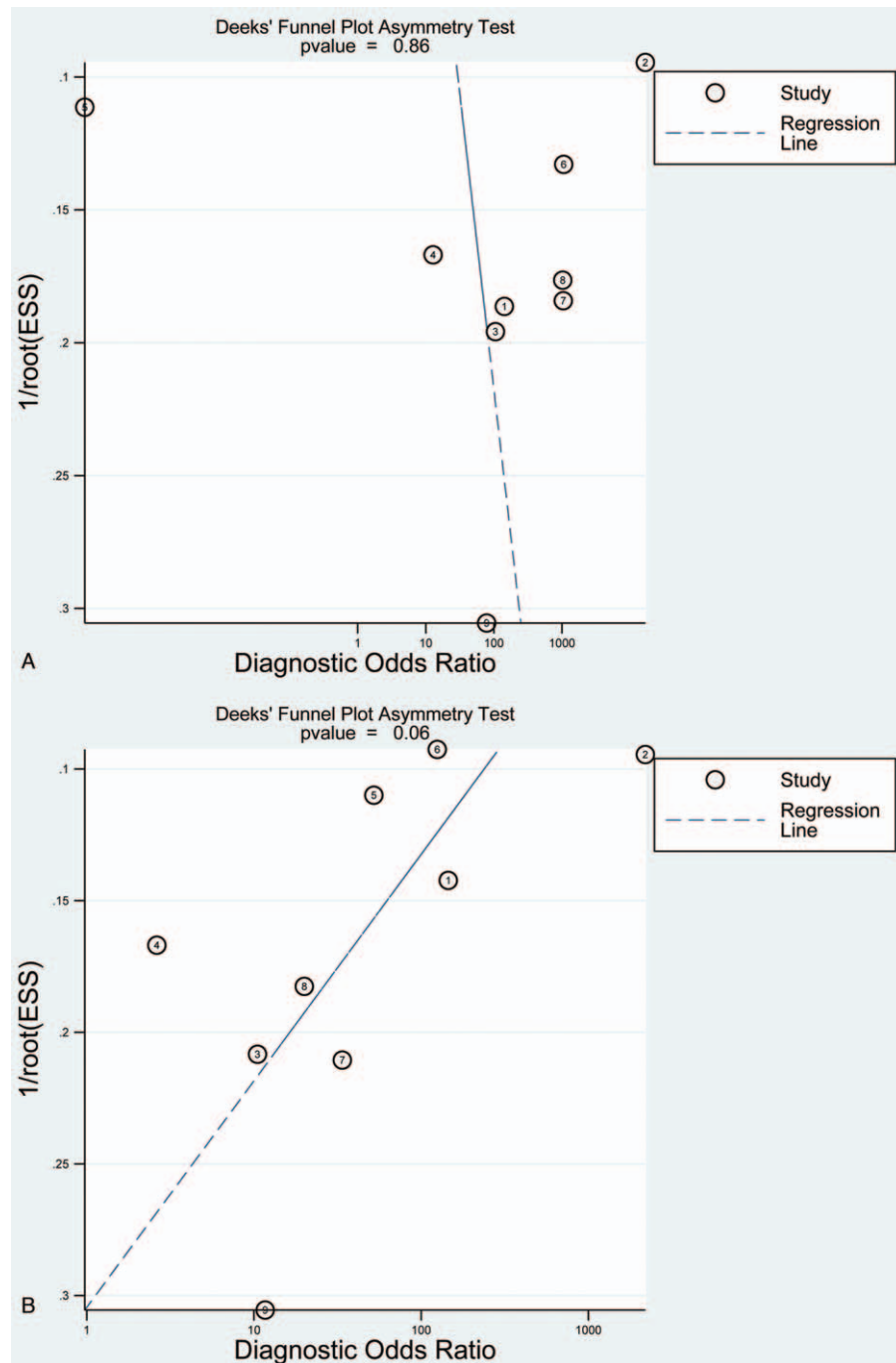


Figure 5. Deeks's funnel plot asymmetry test for assessment of publication bias. P values < 0.05 were considered as significant. MRA (A), MRI (B), ESS, effective sample sizes.

However, in terms of the bursal side partial-thickness tears, MRI has a similar sensitivity to MRA, mainly because direct magnetic resonance arthrography may not achieve the development in the delineation of the bursal side partial tears.^[21,63,64] Additionally, with the fast development of imaging techniques, some researchers have indicated that high-resolution MRI had values equivalent to those of MRA for diagnosing partial-thickness tears.^[19] Considering above, MRA is not required as the initial examination because of its invasiveness and inconvenient.

Several limitations exist in this meta-analysis. We assessed only the diagnostic value of imaging modality alone. The diagnostic performance of physical tests was not evaluated. Two or three methods, such as MRI+physical tests and MRA+physical tests were also not analyzed side-by-side. Several subgroup analyses were implemented based on the insufficient data, which make the certain results unstable. In addition, the safety, cost-effectiveness, and application of these imaging techniques in clinical practice should be assessed systematically.

5. Conclusion

MRI is recommended to be a first-choice imaging modality for the detection of rotator cuff tears. Although MRA have a higher sensitivity and specificity, it cannot replace MRI after the comprehensive consideration of accuracy and practicality.

Author contributions

Conceptualization: Fanxiao Liu.

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