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The value of percutaneous ultrasound-guided subacromial bursography in the rotator cuff tears diagnosis

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Abstract

Aim: To determine the feasibility and diagnostic value of percutaneous ultrasound-guided subacromial bursography (PUSB) in the diagnosis of rotator cuff tears. **Material and methods:** Seventy-eight patients with shoulder arthroscopic surgery and images of conventional ultrasound (US), Magnetic Resonance Imaging (MRI) and PUSB were included in this retrospective study. The features of US, MRI and PUSB were evaluated. **Results:** The overall detection rate via PUSB was significantly higher than the rates via US and MRI (96.2%, 75.6% and 82.1%, respectively), as were the detection rates for partial-thickness tears (PTTs) (95.2%, 64.3% and 76.2%, respectively). The sensitivity and specificity of MRI, US and PUSB in diagnosing PTTs were 90.5%, 90.5%, 100% and 98.2%, 93.0%, 100%, respectively. There was no significant difference in the accuracy of diagnosing the full-thickness tears (FTTs) and no tears (NTs) among PUSB, US and MRI (100%, 90.5%, 90.5% and 87.5%, 86.7%, 86.7, respectively). **Conclusions:** It is feasible to diagnose rotator cuff tears by PUSB, which can be used as an important supplement imaging method to evaluate rotator cuff tears.

Keywords: rotator cuff tears; ultrasound; contrast enhanced ultrasound; bursography

Introduction

The painful shoulder or shoulder with limited movement are very common symptoms in the general population, with an incidence of 0.9-2.5% in different age groups and a 1-year prevalence of 4.7-46.7% [1]. In musculoskeletal pathology, the shoulder is in the third place as the frequency of pain localization [2]. The shoulder pain is generally caused by rotator cuff tears and/or shoulder impingement syndrome (SIS) [3]. Clinically, rotator cuff tears are usually divided in partial-thickness (PTTs) and full-thickness tears (FTTs) according to the thickness dimension. The prevalence of rotator cuff tears increases significantly after the age of forty, and it is around 20-30% after the age of sixty [4]. Clinical signs and symptoms that contribute to the diagnosis of rotator cuff tears include pain from overhead movement, weakness during the Jobe test or the External Rotation Resistance Strength test, and positive impingement sign [5,6].

Rotator cuff tears must be distinguished from impingement syndrome and shoulder instability [7,8]. Shoulder X-rays and physical examinations have been shown to be inadequate in the effective detection of rotator cuff tears [9-11]. With advances in imaging techniques, ultrasound (US) and Magnetic Resonance Imaging (MRI) have been routinely used to assess rotator cuff tears, which have significantly improved the accuracy in diagnosing rotator cuff tears and in identifying different causes of shoulder pain and disease staging [12]. Both US and MRI showed high soft tissue resolution, sensitivity, and specificity in rotator cuff pathology evaluation. The clinical application of MRI is limited due to its high cost, time-consuming and contraindications. US is increasingly widely used in the diagnosis and treatment of rotator cuff injury because of its good penetration of soft

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tissue, real-time, dynamic imaging ability, and repeated examination of the site of interest.

Contrast-enhanced ultrasound (CEUS) is a novel US technology based on the principle of US. Compared with US, CEUS has more advantages, including improved spatial resolution and real-time dynamic evaluation of normal and abnormal tissue perfusion, imaging of large vessels and microvessels, etc [13]. CEUS has also been used for intravascular injection for urinary US examination, detection of complications after paediatric transplantation, evaluation of inflammatory bowel disease activities, and evaluation of tumour response to angiogenesis therapy [14]. Cheng et al [12] was the first author that used percutaneous US-guided subacromial bursography (PUSB) to diagnose subacromial impingement syndrome by injecting a contrast agent mixture into the subacromial sac of SIS patients and observing its distribution [12].

In our clinical practice, we observed that the MRI results of some patients were inconsistent with the clinical signs and symptoms, which affected the judgment of whether to undergo shoulder arthroscopic surgery. Also, during PUSB we found that, due to the fact that the patients dynamically observe their own rotator cuff injury, they better understand their condition and accept easily the medical advice. So, we collected clinical data of these patients and carried out this retrospective study to explore the feasibility and diagnostic value of PUSB in evaluating rotator cuff tears.

Materials and methods

Patients

Seventy-eight patients (32 males, 46 females, mean age 53.9±9.1 years; age range, 31-70 years) with shoulder arthroscopic surgery and images of conventional US, MRI and PUSB examined in our department between July 2019 to October 2021 were included in this retrospective study. Inclusion criteria were as follows: 1) having complete clinical, US, MRI and PUSB data; 2) underwent shoulder arthroscopy surgery. The exclusion criteria were: 1) having incomplete imaging data; 2) patients unsuitable for PUSB examination; 3) patients who have already undergone previous surgery on the shoulder area.

The study was approved by the Ethics Committee of the Second Affiliated Hospital of Xi'an Jiaotong University and, being a retrospective study, the written informed consent was waived.

MRI

MRI was performed with 1.5 T superconducting MRI equipment from the German Siemens Magnetom Avanto, equipped with a special coil for the shoulder joint. For coronal section scanning, the scanning plane was perpendicular to the glenoid cavity and ranged from the acromion to subscapular humerus with a fast-spin echo T2-weighted sequence (TR/TE=2200 ms/84 ms) and a spin echo T1 weighted sequence (TR/TE=450 ms/16 ms). For oblique coronal scanning, the scanning plane was parallel to the long axis of the supraspinatus muscle and ranged from the outer end of the clavicle to the acromion with rapid spin echo T2-weighted imaging (TR/TE= 2370 ms/39 ms). The scanning parameters were as follows: a FOV = 20 cm×20 cm; a matrix =257×192; a layer thickness =4 mm; and a layer spacing = 4.8 mm.

US

US and PUSB examinations were performed using SIEMENS ACUSON Sequoia (Siemens Medical Solutions, USA). US examination was performed with a 6-18 MHz linear array probe (18L6). The patient was seated and facing the operator, who performs the procedure according to the shoulder US technical guidelines recommended by the European Society of Musculoskeletal Radiology [15]. The biceps long-head tendon, subscapularis tendon, supraspinatus tendon, infraspinatus and teres minor tendons were examined successively. Transverse and longitudinal images were performed, and the dynamic and static images were retained.

PUSB

All 78 patients underwent PUSB examination after initial US. First, US examination was performed to routinely scan the rotator cuff and identify the acromial glide capsule clearly so that the skin puncture site could be marked. A 2.5 mL of the SonoVue (Bracco, Italy) solution was diluted with 7.5 mL of 0.9% sodium chloride. Then, a 4-10 MHz linear array probe (10L4) was used to perform PUSB. The tip of the needle was directed into the subacromial bursa and the contrast agent was slowly injected. At the same time, the probe was rotated to observe the distribution of contrast agent in the bursa and tendon. Typical images were captured and stored during the inspection for recording and analysis. After the examination, the puncture site was disinfected and covered with a sterile dressing.

Diagnostic criteria

MRI: (1) Full-thickness tear: the supraspinatus tendon was thickened and twisted, with a high signal involving the whole layer. (2) Partial-thickness tear: the supraspinatus tendon was irregular in shape, with a focal high signal, and the whole layer is not involved [16,17].

US: (1) Full-thickness tear: (i) a hypoechoic defect extends from the bursal to the articular sides; (ii) local defects involving both the bursal and articular sides in the short-axis and long-axis views; and (iii) the rotator cuff not visible due to extensive full-thickness tears and retraction below the acromion. (2) Partial-thickness tear: (i) an obvious hypoechoic defect area or a discontinuous area on the bursal or articular sides of the tendon is present; (ii) focal hypoechoic defects within the tendon are seen in the longitudinal and transverse planes [18]. (3) No tear (NTs): a normal subacromial-subdeltoid bursa (SASD) appeared as a hypoechoic line between two hyperechoic planes, with total thickness of less than 2 mm [12].

PUSB: (1) Full-thickness tear: the contrast agent leaks from the defect area of the bursal side through the supraspinatus into the articular side. (2) Partial-thickness tear: for the part of bursal-side tears, PUSB shows that the contrast agent filled the bursal-side tear part and the contrast agent flows from the subacromial bursa to the bursal-side tears area in the PUSB dynamic imaging. For the intratendinous or articular side partial-thickness tears, the contrast agent can be observed in tendons or from tendons to the articular side by injecting it into the area of the suspected tendon lesion directly. (3) No tear: the contrast agent is scattered only in the subacromial bursa, outlines the regular surface of the rotator cuff, and does not leak into the rotator cuff.

Image analysis

The imaging results of US and PUSB were independently interpreted by 2 sonographers with 10 and 8 years of experience in musculoskeletal US. Similarly, 2 radiologists with 9 and 8 years of experience in musculoskeletal MRI, evaluated all images independently. When the results were inconsistent, multidisciplinary consultation was conducted, and a consensus was reached. Finally, the results of MRI, US and PUSB were compared with those of arthroscopy.

Shoulder arthroscopy

All the patients underwent shoulder arthroscopy performed by an associate chief physician with more than 10 years of shoulder arthroscopy experience. Under arthroscopy, the types of rotator cuff tears were classified as full-thickness tears, partial-thickness tears and no tears according to whether there were any rotator cuff defects and the location and size of defects. The diagnostic results of shoulder arthroscopy were considered the standard.

Statistical analysis

SPSS 18.0 (SPSS, Inc., Chicago, IL, USA) software was used for statistical data processing. The MRI, US and PUSB results were correlated with the shoulder arthroscopy results. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI, US and PUSB in the diagnosis of rotator cuff tears of different types were calculated, with the results of shoulder arthroscopy serving as the standard. Enumeration data are presented as examples, and the X^2-test (α=0.05, two-sided) was used to compare the difference in diagnostic accuracy between different methods.

Results

Arthroscopic diagnosis of the shoulder

The results of shoulder arthroscopy showed that there were 21 cases of FTTs, 42 cases of PTTs and 15 cases of NTs (Table I). Among the 42 patients with partial tears, 2 cases were intratendinous or articular tears, and the rest were bursal tears. Of the 15 patients without tears, 1 had biceps head-long tendinitis with a small amount of fluid, 1 had low elastic tendons (accompanied by hypertension and diabetes), 5 had calcified supraspinatus tendons, and 8 had acromial bursitis.

Results of MRI, US and PUSB in the diagnosis of rotator cuff tears

For the 78 patients with suspected rotator cuff tears, the diagnostic results of MRI, US, and PUSB for FTTs, PTTs, and NTs are shown in Table I. The diagnostic and predictive indexes (sensitivity, specificity, positive predictive value and negative predictive value) of these three methods for different rotator cuff tear types are shown in Table II, Table III and Table IV.

Results of full-thickness tears

Among the 21 patients with full-thickness tears, the numbers of cases correctly diagnosed by MRI, US and PUSB were 19, 19 and 21, respectively (Table I). Both MRI and US misdiagnosed 2 patients with cases of full-

Table I. Comparison of MRI, US and PUSB in detecting rotator cuff tears with arthroscopy as standard

Arthroscopy	MRI			US			PUSB			Total
	FTT	PTT	NT	FTT	PTT	NT	FTT	PTT	NT	
FTT	19	2	0	19	2	0	21	0	0	21
PTT	1	32	9	4	27	11	0	40	2	42
NT	0	2	13	0	2	13	0	1	14	15
Total	20	36	22	23	31	24	21	41	16	78

US - ultrasound; MRI - magnetic resonance imaging; PUSB - percutaneous ultrasound-guided subacromial bursography; FTT - full-thickness tear; PTT - partial-thickness tear; NT = no tear.

Table II. Performance of MRI, US and PUSB in the diagnosis of full-thickness rotator cuff tears

	Se% (95%CI)	Sp% (95%CI)	PPV% (95%CI)	NPV% (95%CI)
MRI	90.5 (76.68,104.17)	98.2 (94.73,101.76)	95.0 (84.53,105.47)	96.6 (91.71,101.39)
US	90.5 (76.68,104.17)	93.0 (86.14,99.82)	82.6 (65.85,99.37)	96.4 (91.26,101.47)
PUSB	100 (-)	100 (-)	100 (-)	100 (-)

MRI - magnetic resonance imaging; US - ultrasound; PUSB - percutaneous ultrasound-guided subacromial bursography; CI - confidence interval; Se - Sensitivity; Sp - Specificity; PPV - positive predictive value; NPV - negative predictive value.

Table III. Performance of MRI, US and PUSB in the diagnosis of partial-thickness rotator cuff tears

	Se% (95%CI)	Sp% (95%CI)	PPV% (95%CI)	NPV% (95%CI)
MRI	76.2 (62.76,89.62)	88.9 (78.10,99.67)	88.9 (78.10,99.67)	76.2 (62.76,89.62)
US	64.3 (49.17,79.40)	88.9 (78.10,99.67)	87.1 (74.60,99.60)	68.1 (54.25,81.92)
PUSB	95.2 (88.52,101.95)	97.2 (91.58,102.86)	97.6 (92.63,102.49)	94.6 (86,95,102.24)

MRI - magnetic resonance imaging; US - ultrasound; PUSB - percutaneous ultrasound-guided subacromial bursography; CI - confidence interval; Se - Sensitivity; Sp - Specificity; PPV - positive predictive value; NPV - negative predictive value.

Table IV. Performance of MRI, US and PUSB in the diagnosis of no tears of rotator cuff

	Se% (95%CI)	Sp% (95%CI)	PPV% (95%CI)	NPV% (95%CI)
MRI	86.7 (67.18,106.15)	85.7 (76.83,94.60)	59.1 (36.78,81.40)	96.4 (91.41,101.44)
US	86.7 (67.18,106.15)	82.5 (72.90,92.18)	54.2 (32.67,75.66)	96.3 (91.09,101.50)
PUSB	93.3 (79.03,107.63)	96.8 (92.37,101.28)	87.5 (69.30,105.70)	98.4 (95.16,101.61)

MRI - magnetic resonance imaging; US - ultrasound; PUSB - percutaneous ultrasound-guided subacromial bursography; CI - confidence interval; Se - Sensitivity; Sp - Specificity; PPV - positive predictive value; NPV - negative predictive value.

thickness tears as partial-thickness tears, while PUSB could correctly diagnose all patients with full-thickness tears (fig 1). The sensitivity of MRI, US and PUSB was 90.5%, 90.5%, 100%, respectively, and the specificity was 98.2%, 93.0%, 100%, respectively; moreover, the positive predictive value and negative predictive value were 95.0%, 82.6%, 100% and 96.6%, 96.4%, 100%, respectively (the 95% CI is shown in Table II).

Results of partial-thickness tears

Among 42 patients with partial-thickness tears, the numbers of patients whose cases were correctly diagnosed on MRI, US and PUSB were 32, 27 and 40, respectively (Table I). For the diagnosis of partial-thickness tears, the sensitivity was 76.2%, 64.3%, and 95.2%, respectively, the specificity was 88.9%, 88.9%, and 97.2%, respectively, the positive predictive values were 88.9%, 87.1%, and 97.6%, respectively and negative predictive values were 76.2%, 68.1%, and 94.6%, respectively (95% CI is shown in Table III). Among them, MRI diagnosed 1 partial-thickness tear as a full-thickness tear and 9 as no tear, US diagnosed 4 partial-thickness tears as full-thickness tears and 11 as no tears, and PUSB diagnosed only 2 partial-thickness tears as no tears. Because these 2 partial-thickness tears were articular partial-thickness tears, the contrast agent couldn't reach the area of defections due to the needle limitations and patient complaints of pain, (fig 2). For the typical bursal side partial-thickness tears (fig 3) and intratendinous partial-thickness tears (fig 4), PUSB could show clear imaging and provide accurate diagnosis results.

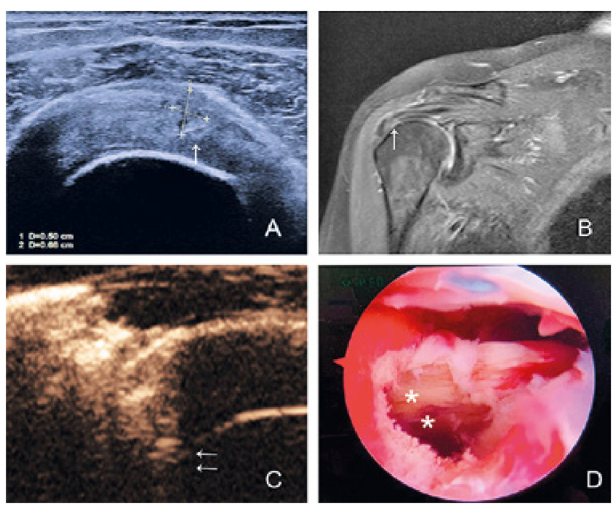

Fig 1. US, MRI, PUSB, and shoulder arthroscopic images of a 65-year-old woman with full-thickness tear: (A) US revealed a partial-thickness tear of the supraspinatus tendon on the bursal side that did not reach the articular surface (↑); (B) The T2 image of MRI indicated the presence of high signal in the supraspinatus tendon (↑), which did not penetrate the whole layer; (C) PUSB showed that contrast agent flowed from the defect of the supraspinatus tendon bursal to the articular side (↑) and reached the articular cavity, suggesting a full-thickness supraspinatus tear. (D) Arthroscopy showed a full-thickness tear of the supraspinatus tendon.

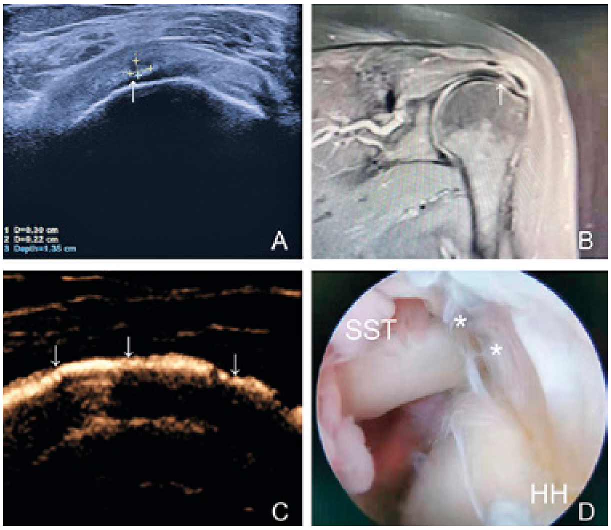

Fig 2. A 50-year-old female with partial-thickness tear of supraspinatus on articular side: (A) US showed that the supraspinatus tendon bursal plane was intact (↑), and the hypoechoic zone could be detected near the articular side of the supraspinatus tendon (*); (B) MRI showed high signal shadow at the articular surface of the supraspinatus tendon (↑), indicating a partial-thickness tear of the supraspinatus tendon on the articular side; (C) PUSB results suggested that the contrast agent was evenly distributed along the supraspinatus tendon on the bursal side after entering the subacromial bursa, and no contrast agent was found in the supraspinatus tendon; (D) Shoulder arthroscopy revealed a partial-thickness tear of the supraspinatus tendon on articular side (**). SST = supraspinatus tendon; HH = humeral head.

Results of no tears

Among the 15 patients without tears, the numbers of misdiagnosed cases by MRI, US and PUSB were 2, 2, and 1, respectively, and they were all misdiagnosed as partial-thickness tears (Table I). The reason PUSB misdiagnosed 1 NT as PTT may be that a large number of synovial tissue hyperplasia, resulting in the pseudo-image formation of the contrast agent during the infiltration process. For the diagnosis of no tear, the sensitivity of MRI, US and PUSB was 86.7%, 86.7%, and 93.3%, respectively, and the specificity was 85.7%, 82.5% and 96.8%, respectively; moreover, the positive predictive value and negative predictive value were 59.1%, 54.2%, 87.5% and 96.4%, 96.3% and 98.4%, respectively.

The accuracy of MRI, US and PUSB in the diagnosis of rotator cuff tears

Among all 78 patients, the accuracy and differences in MRI, US and PUSB for different types of rotator cuff tears are shown in Table V. The overall accuracy of MRI, US and PUSB in the diagnosis of rotator cuff tears was 82.1% (64/78), 75.6% (59/78) and 96.2% (75/78), respectively. The overall accuracy of PUSB in the diagnosis of rotator cuff tears was higher than that of MRI

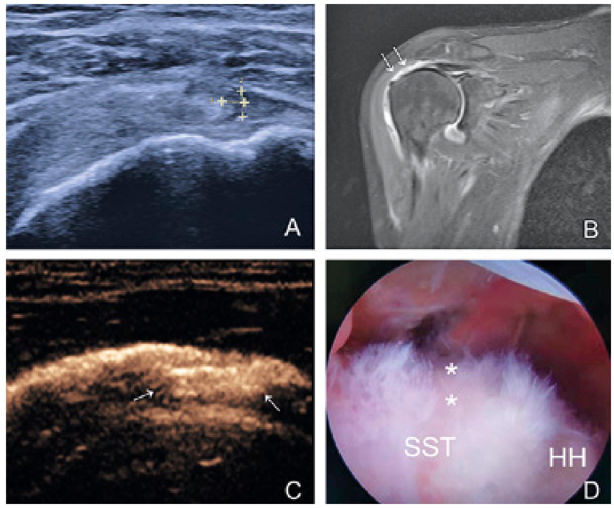

Fig 3. A 63-year-old female with partial-thickness tear of supraspinatus on bursal side: (A) US showed that the echo of supraspinatus tendon was not uniform, and the anechoic zone of 2.5×2.1 mm could be detected near synovial surface (+); (B) MRI showed high signal shadow on the supraspinatus tendon bursa (↑↑); (C) PUSB results showed that contrast agent could enter the anechoic area near the synovial surface of supraspinatus tendon (↑): (D) Arthroscopic results of the shoulder revealed a partial-thickness tear of the supraspinatus tendon on bursal side with abundant surrounding synovial tissue hyperplasia (**). SST = supraspinatus tendon; HH = humeral head.

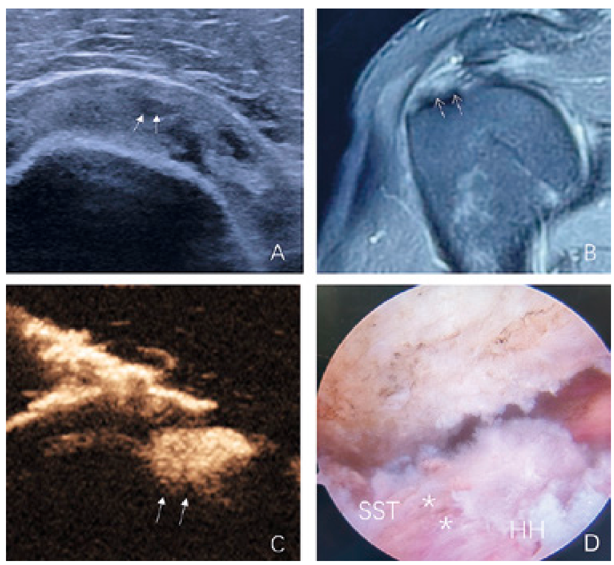

Fig 4. A 31-year-old male with intratendinous partial-thickness tear of supraspinatus: (A) US revealed an intratendinous hypoechoic area of supraspinatus tendon in the long-axis view (↑↑); (B) An oblique coronal MRI image revealed a brighter signal within the supraspinatus tendon (↑↑); (C) PUSB image revealed contrast agent filling in the tear area within the supraspinatus tendon (↑↑), which indicated an intratendinous partial-thickness tear in the long-axis view; (D) Arthroscopy confirmed that an intratendinous partial-thickness tear (↑↑) changed to a bursal-side partial-thickness tear during surgical exploration.

Table V. Comparison of MRI, US and PUSB in overall correct diagnosis of rotator cuff tears with arthroscopy as a standard

Method	Rotator cuff, *n* (%)	FTTs, *n* (%)	PTTs, *n* (%)	NTs, *n* (%)
MRI	64/78(82.1%)	19/21(90.5%)	32/42(76.2%)	13/15(86.7%)
US	59/78(75.6%)	19/21(90.5%)	27/42(64.3%)	13/15(86.7%)
PUSB	75/78(96.2%)	21/21(100%)	40/42(95.2%)	14/15(87.5%)
p-value	<0.001	0.344	<0.05	0.997

MRI - magnetic resonance imaging; US - ultrasound; PUSB - percutaneous ultrasound-guided subacromial bursography; FTTs - full-thickness tears; PTTs - partial-thickness tears; NTs - no tears; n - number of patients.

and US ($p<0.001$). In general, PUSB was more accurate than MRI and US in the overall diagnostic rate of rotator cuff tears, and PUSB had higher diagnostic efficiency for patients with partial-thickness rotator cuff tears.

Discussion

A common cause of shoulder pain or limited movement is the rotator cuff injury, including rotator cuff tendinosis and, most common, rotator cuff tears. Patients with calcified tendonitis are also more likely to have rotator cuff tears [19]. At present, US and MRI have been frequently applied in the diagnosis of rotator cuff tears. Different studies have reported the accuracy of US and MRI in different levels of FTTs and PTTs [20-22]. However, with the progress of US technology and the widespread application of contrast agents, CEUS has become an important diagnostic method [23]. SonoVue, the contrast agent used in shoulder arthrography, has been proven to be safe in relevant studies [24,25].

We found an overall accuracy of PUSB of 96.2% for rotator cuff tears, which was higher than that of both MRI and US (82.1% and 75.6%, respectively) ($p<0.001$). Roy et al [26] showed that the overall sensitivity and specificity of US, MRI and MRA in the diagnosis of full-thickness rotator cuff tears were all higher than 90%, indicating the positive role of US, MRI and shoulder arthrography in the diagnosis of full-thickness rotator cuff tears. In our study, MRI and US misdiagnosed 2 FTTs as PTTs probably because the defect of the supraspinatus muscle laceration on the bursa side was large and easy to observe, but the defect on the articular side was difficult to observe due to the small tear range, the influence of local new granulation tissue and the limitation of MRI stratification scanning. These findings also indicate that PUSB is advantageous in terms of timeliness and dynamic observations in the diagnosis of rotator cuff tears.

For the diagnosis of partial-thickness tears, the accuracy of PUSB was 95.2%, which was significantly higher than that of US and MRI, these findings being consistent with the results of Tang et al [25]. PUSB can assist in having a clearer and faster diagnosis of typical supraspinatus partial-thickness tears. However, there are also limitations of PUSB; that is, only when there is a tear on the bursal side can the contrast agent flow from the defect to the deep surface of the tear. When the tear is small or the disease course is long, there will be a scar or granulation tissue hyperplasia area in the defect, leading to the failure of the contrast agent to enter and resulting in false negatives [27]. Therefore, it needs to be combined with conventional US to directly inject the contrast agent into the suspected tear area. If there is a tear in the area, the contrast agent will easily fill it and the average total volume of contrast agent used was 4-6 mL. On the contrary, the contrast agent cannot be injected into the normal tendon due to the resistance.

For patients with shoulder pain or limited motion but with no rotator cuff tears, US, MRI, and PUSB can be used to accurately diagnose such patients. Many patients, whose imaging findings suggest no tears or small partial tears, suffer from severe shoulder pain symptoms and limited mobility, accompanied by severe subacromial bursitis. These patients have a strong desire for surgery, and their main purpose for surgery is to clear the hyperplastic synovial tissue and relieve pain without tendon suture.

Currently, MRI is the preferred method for the diagnosis of rotator cuff injury, followed by US, MR arthrography (MRA), and PUSB. Although MRA has a high diagnostic accuracy, it is not preferred due to its complex operation and high cost [26]. Compared with invasive PUSB, patients are more willing to choose non-invasive MRI examination. Therefore, MRI examination should be preferred for patients suspected of rotator cuff tears. However, PUSB can be used for auxiliary diagnosis when MRI examination is contraindicated, or the type of tear cannot be clearly diagnosed by MRI. For surgeons, PUSB can be used as a fast and convenient preoperative supplementary examination in addition to MRI. As the most routine imaging medical diagnosis technology in clinic, US has the advantages of simple, cheap, and easy to apply, especially for children, pregnant women, and patients with internal implants. The average cost of US and PUSB is about one-third lower than that of MRI. Moreover, PUSB examination can dynamically understand the pathological conditions of patients in real time, and patients are willing to accept it during follow-up [28].

There are still some limitations in the current research. First, PUSB is an invasive examination, which may be associated with negative experiences in some patients, such as pain, fear, and infection. Second, in this study, elderly patients accounted for a large proportion of all patients. Due to the low activity and high pain threshold of elderly individuals, tears are often serious during examination, while young patients usually experience acute trauma. At the same time, the US diagnosis of rotator cuff injury is highly dependent on doctors' experience. Taken together, these factors may affect the reference importance of this study.

Conclusions

In conclusion, PUSB is highly accurate, sensitive, and specific for the diagnosis of rotator cuff tears. At the same time, PUSB can be used to dynamically observe the rotator cuff tears in a timely manner. When patients have MRI contraindications or MRI cannot accurately determine the types of rotator cuff tears, PUSB can be used for auxiliary diagnosis with decreased cost and increased efficiency, making this method a good choice for patients in urgent need of surgery.

Conflict of interest: none

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