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The effect of shear wave elastography in the diagnosis of delaminated partial-thickness rotator cuff tears

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Abstract

Aim: To assess the effectiveness of shear wave elastography (SWE) in diagnosing delaminated partial-thickness rotator cuff tears (DPT-RCT). **Material and methods:** A retrospective study was carried out on 137 patients with DPT-RCT. The study included complete clinical data, including the images of conventional ultrasound (US), SWE, Magnetic Resonance Imaging (MRI) and shoulder arthroscopic surgery. The features of US, SWE, and MRI were evaluated. The study analysed the Shear-Wave Velocity (SWV) among three types of DPT-RCT, and between the regions of tears, normal contralateral, and affected unilateral supraspinatus tendon. Furthermore, receiver operating characteristic (ROC) curves were evaluated. **Results:** The SWE detection rate was significantly higher (91.2%) compared to US (73.7%) and MRI (87.6%) for the overall diagnosis of DPT-RCT. Similarly, SWE yielded higher rates of detection for types 1 (89.5%) and 2 (92.3%) of DPT-RCT as compared to US (71.7%, 69.2%) and MRI (81.6%, 94.9%), respectively. However, there was no significant difference in the accuracy of diagnosing type 3 among the three methods. The SWV of the 137 supraspinatus tendon tears was 3.64±0.60 m/s, which was higher than that of the normal supraspinatus tendon (2.43±0.47 m/s, $p<0.01$) as well as the region of tears (1.61±0.54 m/s, $p<0.01$). Nevertheless, there was no significant difference in SWV among the three types of DPT-RCT. The cutoff thresholds of SWV for identifying normal tendon from DPT-RCT and for identifying DPT-RCT from the region of tears were 2.96m/s and 2.39m/s, respectively. **Conclusions:** SWE with SWV can provide both quantitative and qualitative diagnostic information for DPT-RCT, which can be used as a crucial supplement imaging method.

Keywords: rotator cuff tears; ultrasound; shear-wave velocity; delaminated tear

Introduction

The rotator cuff refers to a group of muscles and their respective tendons including the subscapularis, supraspinatus, infraspinatus, and teres minor, that function collaboratively to regulate the movement of the shoulder. Rotator cuff tears (RCT) represent a widespread shoulder disorder and are typically classified into partial-thickness tears (PTTs) and full-thickness tears (FTTs) based on the degree and depth of tearing. The supraspinatus tendon is the most frequently affected site for rotator cuff injury since it encompasses an ischemic zone approximately 1 cm distal to its insertion, where stresses concentrate, and blood supply is limited [1,2]. The incidence of delaminated tear of the rotator cuff, which is frequently characterized by a horizontal tear of the supraspinatus tendon, is reported to range from 38-82% [3,4]. The occurrence of a delamination tear in the rotator cuff results in a compromised tendon quality and the formation of an intramuscular synovial space. These factors contribute to a diminished healing potential, ultimately impacting the diagnosis and prognosis of the injury [5].

The initial indications among many clinical patients afflicted with delaminated partial-thickness rotator cuff tears (DPT-RCT) are often atypical, presenting diagnos-

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tic challenges. Despite the availability of medical imaging technologies such as ultrasound (US) and magnetic resonance imaging (MRI), the accuracy of diagnoses for partial tears remains limited [6]. An earlier study conducted by our team revealed that the diagnostic accuracy of both US and MRI with regard to FTTs was 90.5%, with no consequential statistical variance. In contrast, both imaging modalities produced distinct differences in the diagnostic accuracy of PTTs, with US achieving 64.3% and MRI resulting in 76.2% accuracy, with a statistically significant variance recorded [6]. Moreover, advancing pathology in these cases typically results in a worsening of symptoms over time. Keener et al [7] conducted a follow-up study of 224 patients with asymptomatic PTTs and revealed that 44% of these cases developed into FTTs within a median time of 5.1 years and 46% developed new pain with a median time of 2.6 years. Thus, there exists a critical need for accurate and quantitative evaluation of DPT-RCT.

Currently, MRI and US are the most ubiquitous imaging methods used to diagnose rotator cuff injury. However, both MRI and US suffer from limitations in the accuracy of qualitative diagnoses and demonstrate high interobserver variability [8]. Elastography is an imaging modality that evaluates the mechanical properties of tissues through quantifying deformation and recovery, encompassing both Strain Elastography (SE) and Shear Wave Elastography (SWE) techniques. SE assesses the hardness and elastic properties of the tissue by applying pressure to the tissue in the target area and measuring the deformation of the tissue, while SWE assesses the hardness and elastic properties of the tissue by transmitting an elastic wave through the tissue and measuring the speed at which the wave travels [9]. SWE presents the capability to enable clinicians to make quantitative diagnoses utilizing the shear wave velocity (SWV) values as a supplementary tool to traditional two-dimensional US.

Recent studies have reported the clinical value of SWE for diagnosing a broad scope of systemic conditions, including tumors, liver disease, and tendinopathy. As such, SWE has garnered a reputation for attaining high clinical applicability. In diagnosing fatty liver disease, SWV values demonstrate statistical significance when comparing patients with healthy subjects, suggesting their potential utility as a diagnostic indicator with moderate to excellent repeatability and reproducibility [10]. Papillary thyroid carcinoma studies have demonstrated that SWV ratio > 1.3 can represent a risk factor for cervical lymph node metastasis (CLNM). US with SWV can possess significant value in assessing for CLNM during preoperative evaluations [11]. Currently, Deng et al [12] indicates that SWV can also be used in the diagnosis of supraspinatus tendinopathy. Notably, SWV demonstrated significant differences among the tendinopathy group, the PTTs group, and the FTTs group, with a gradually decreasing trend. However, no previous study has investigated the diagnostic value of SWE in delaminated rotator cuff tears. Therefore, we conducted a retrospective case study to explore the feasibility and diagnostic value of SWE in DPT-RCT via comparing the results of SWE with the results of US and MRI and evaluated the cut off values of SWV in different types of DPT-RCT as well as in the normal contralateral tendon, so as to provide reference for subsequent clinical diagnosis.

Materials and methods

Patients

In this retrospective study, consecutive patients with shoulder arthroscopic surgery and images of US, SWE, and MRI examined in our department between October 2020 to May 2023 were included from our electronic database. Inclusion criteria were as follows: 1) the patients with unilateral shoulder pain and diagnosed with DPT-RCT by shoulder arthroscopy; 2) the contralateral shoulder of patients was asymptomatic, and the US and SWE results were normal; 3) complete clinical, US, MRI and SWE data of shoulders were available. The exclusion criteria were: 1) having incomplete imaging data; 2) patients unsuitable for SWE examination; 3) patients who had already undergone previous surgery on the shoulder area; 4) patients with tendon calcification.

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

US

US and SWE examinations were conducted using SIEMENS ACUSON Sequoia (Siemens Medical Solutions, USA). The US examination was performed with a 6-18 MHz linear array probe (18L6). The patient was seated and facing the operator, who adhered to the shoulder US technical guidelines recommended by the European Society of Musculoskeletal Radiology during the procedure [13]. Successive examinations of the biceps long-head tendon, subscapularis tendon, supraspinatus tendon, infraspinatus tendon, and teres minor tendon were carried out. Both transverse and longitudinal images were recorded, and both dynamic and static images were retained.

SWE

Following 2D ultrasound, the examination protocol was transitioned to the SWE imaging mode. During the

SWE examination, the patient was facing the operator in a sitting position, with the upper arm inwardly rotated, the elbow curved, and the palm placed above the ilium wing, and the sonographer positioned the probe perpendicular to the long axis of the supraspinatus tendon and applied gentle pressure to achieve full dermal contact while instructing the patient to hold their breath. The box for colour map was placed in the region were US indicated the possible torn area and a 3 mm diameter circular region of interest (ROI) was used. The sonographer measured the SWV of the supraspinatus tendon tear site and the surrounding normal tissue. The dynamic range for SWV measurements was 0.5–6.5 m/s. The aforementioned procedures were performed thrice independently, and the mean SWV of the three measurements was regarded as the final result. As for the contralateral unaffected shoulder, the SWV were calculated in three corresponding equidistant ROIs within the insertional 1-2 cm of the supraspinatus tendon (medial, middle, lateral).

MRI

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

Diagnostic criteria

The delamination patterns of partial-thickness rotator cuff tear (PT-RCT) were divided into three types following previous published studies [14-16]: Type 1, delaminated tear with the articular layer retracted (articular type); Type 2, delaminated tear with the bursal layer retracted (bursal-surface type); and Type 3, isolated intratendinous horizontal splitting tear.

The criteria for SWE to diagnose DPT-RCT were the detection of a blue area (soft, reduced elastic properties) corresponding to the articular surface (type 1), bursal surface (type 2) and isolated intratendinous area (type 3).

Typically, MRI diagnosis of DPT-RCT reveals an irregularly shaped supraspinatus tendon with focal hypersignal, but without whole-layer involvement. Tendon delamination was identified by oblique coronal MRI as either Type 1 or Type 2, involving the retraction of articular or bursal layers with the presence of an intervening plane of fluid, respectively, or as Type 3, involving horizontal intrasubstance splitting of bursal and articular layers by an intervening plane of fluid [14].

Image analysis

The imaging results of US and SWE were interpreted independently by two sonographers with 11 and 9 years of experience in musculoskeletal US, respectively. Similarly, two radiologists with 10 and 9 years of experience in musculoskeletal MRI independently evaluated all images, respectively. In cases of inconsistent results, a multidisciplinary consultation was conducted to reach a consensus. Finally, the results of US, SWE and MRI were compared with arthroscopic findings.

Shoulder arthroscopy

All affected shoulders underwent arthroscopy, which was performed by an associate chief physician with over 10 years of experience in the procedure. During arthroscopy, rotator cuff tears were categorized. The diagnostic findings derived from shoulder arthroscopy served as the standard for comparisons.

Statistical analysis

SPSS 18.0 (SPSS, Inc., Chicago, IL, USA) software was used for statistical data processing. The normal distribution of data was tested by the Shapiro–Wilk test. The measurement data were expressed as the mean ± standard deviation. The detection rates of US, SWE, and MRI in the diagnosis of DPT-RCT 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 detection rates between different methods. The difference of SWV values of different PDT-RCT types and the SWV values of normal contralateral, affected unilateral supraspinatus tendon and the region of tears was compared by one-way ANOVA. The ROC curve was drawn by MedCal, and the diagnostic value of SWV to DPT-RCT was determined according to the area under the curve, to obtain cut-off value, sensitivity and specificity among normal contralateral vs. affected unilateral and affected unilateral vs. region of tears. $p<0.05$ was considered statistically significant.

Results

Population characteristics and arthroscopic diagnosis of the shoulder

A total of 137 patients with unilateral DPT-RCT (43 in the left shoulder and 94 in the right shoulder), aged 32-

Table I. Comparison of US, SWE and MRI in detecting DPT-RCT with arthroscopy as a standard

Arthroscopy	US					SWE					MRI					Total
	1	2	3	NT	FTT	1	2	3	NT	FTT	1	2	3	NT	FTT	
Type 1	54	0	3	5	14	68	0	2	2	4	62	0	3	2	9	76
Type 2	0	27	1	7	4	0	36	2	1	0	0	37	1	1	0	39
Type 3	0	0	20	2	0	0	0	21	1	0	0	0	21	1	0	22
Total	54	27	24	14	18	68	36	25	4	4	62	37	25	4	9	137

US = ultrasound; SWE = shear wave elastography; MRI = magnetic resonance imaging; DPT-RCT = delaminated partial-thickness rotator cuff tears; 1 = type 1; 2 = type 2; 3 = type 3; NT = no tear; FTT = full-thickness tear.

Table II. Comparison of US, SWE, and MRI in overall correct diagnosis of DPT-RCT with arthroscopy as a standard

Types	US	SWE	MRI	p (X^2-test)
DPT-RCT	73.7(101/137)	91.2(125/137)	87.6(120/137)	<0.001
1	71.1(54/76)	89.5(68/76)	81.6(62/76)	0.015
2	69.2(27/39)	92.3(36/39)	94.9(37/39)	0.002
3	90.9(20/22)	95.5(21/22)	95.5(21/22)	0.766

The results are expressed as percent(number of patients detected by imaging methods/number of patients detected by arthroscopy). US = ultrasound; SWE = shear wave elastography; MRI = magnetic resonance imaging; DPT-RCT = delaminated partial-thickness rotator cuff tears; 1 = type 1; 2 = type 2; 3 = type 3.

70 years (mean age 53.8±7.6 years) were included in this study (Table I). There were no significant differences in age and gender among the three types of groups.

The detection rates of US, SWE, and MRI in the diagnosis of DPT-RCT

The diagnostic efficacy and comparative analysis of US, SWE, and MRI for the detection of delaminated PT-RCT are summarized in Table II. There were significant statistical differences in the overall percent of correct diagnosis among US, SWE, and MRI, and SWE was the highest among the three methods (p<0.001). The detection rates with SWE were significantly higher compared with US and MRI for type 1 (fig 1), respectively (p=0.015). For the type 2 (fig 2), the detection rates of variables US, SWE, and MRI were significantly different (p=0.02). Notably, both SWE and MRI demonstrated detection rates exceeding 90%. As for type 3 (fig 3), there was no statistically significant difference observed in the detection rates among the three methods (p=0.766).

SWV differences among three tear types of DPT-RCT

The mean SWE of 137 cases of supraspinatus tendon around the tear area was 3.64±0.60 m/s. Further analyses were conducted, classifying participants according to the DPT-RCT, which revealed that of the 76 patients diagnosed with DPT-RCT type 1, the mean SWV was 3.60±0.60 m/s, while type 2 demonstrated SWV of 3.81±0.55 m/s in 39 patients. Type 3 exhibited the SWV of 3.47±0.66 m/s in the remaining 22 cases. Notably, one-way ANOVA tests indicated no significant variance in SWV values across the affected supraspinatus tendon among the different types of DPT-RCT (F=2.605, p=0.078). Similarly, the mean SWV of the tear zone is 1.61±0.54 m/s. The SWV of the tear zone of DPT-RCT type 1, 2 and 3 were 1.58±0.47 m/s, 1.64±0.56 m/s and 1.68±0.72m/s, respectively, with no significant difference (F=0.386, p=0.680).

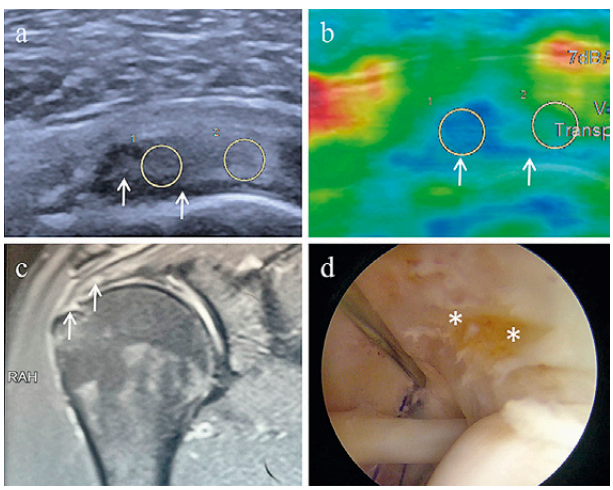

Fig 1. US, SWE, MRI, and shoulder arthroscopic images of a 34-year-old man with type 1 of DPT-RCT: a) US revealed a hypoechoic zone of the supraspinatus muscle on the articular side that did not reach the bursal surface (↑); b) SWE showed that the presence of an area of retraction on the articular surface, along with a blue-coloured region representing low elasticity within the tendon (↑); c) The T2 image of MRI indicated the presence of high signal on articular side and within the supraspinatus tendon (↑); d) Arthroscopy demonstrated an articular delaminated partial-thickness tear of the supraspinatus muscle (**) (type 1).

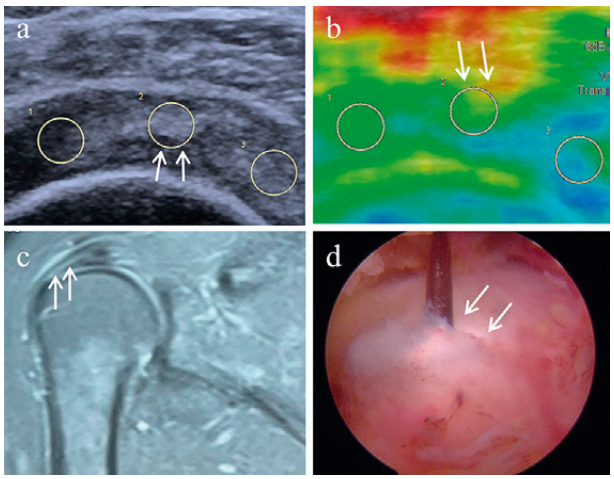

Fig 2. US, SWE, MRI, and shoulder arthroscopic images of a 58-year-old woman with type 2 of DPT-RCT: a) US showed that the hypoechoic zone could be detected near the bursal side and within the supraspinatus tendon (↑); b) SWE results suggested that the presence of a retraction area on the bursae surface, accompanied by a surrounding region of high elasticity within the tendon (↑); c) MRI only showed a high signal shadow within the supraspinatus tendon (↑), indicating the type 3 of DPY-RCT. D) Shoulder arthroscopy revealed a bursal delaminated partial-thickness tear of the supraspinatus muscle (↑) (type 2).

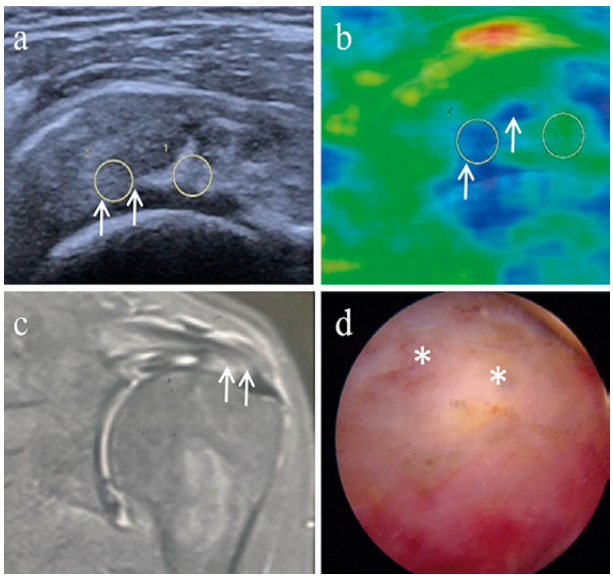

Fig 3. US, SWE, MRI, and shoulder arthroscopic images of a 67-year-old woman with type 3 of DPT-RCT: a) US revealed an intratendinous hypoechoic area of supraspinatus tendon in the long-axis view (↑); b) SWE revealed blue-coloured low-elasticity regions within the tendon and the surrounding high-elasticity tendon areas (↑); c) An oblique coronal MRI image revealed a brighter signal within the supraspinatus tendon (↑); d) Arthroscopy confirmed that there was a large amount of synovial tissue hyperplasia on the bursal surface of the supraspinatus tendon (**), and the elastic of the supraspinatus tendon was compromised during the probe examination. However, there was no apparent tear on the bursae surface (type 3).

SWV differences among normal contralateral, affected unilateral supraspinatus tendon and region of tears

For the control group, SWV measurements for 137 normal tendons averaged 2.43±0.47 m/s, establishing these as statistically lower than SWV recordings noted at the affected tendon regions (2.43±0.47 vs 3.64±0.60, p<0.001), while measurements taken from the tear area were shown to be significantly lower than the control group (1.61±0.54 vs 2.43±0.47, p<0.001) (Table III). Within the cohort investigated, results from one-way ANOVA statistical analyses highlighted significant differences in SWV values among these groups under scrutiny (p<0.001). Furthermore, a notable difference of SWV was observed between the affected unilateral supraspinatus tendon and tear region (3.64±0.60 vs 1.61±0.54, p<0.001).

The ROC curves of SWV

To differentiate between supraspinatus tendon regions determined as normal, affected, and torn, ROC curves were established, allowing for optimal cut-off values to be identified in discerning between different types (fig 4). Based on the SWV values determined through the ROC curves, sensitivity and specificity values were able to be obtained. Upon examination of the ROC curve obtained from the experiment, analysis revealed the optimal single cut-off point to differentiate between normal and affected tendons was 2.96 m/s, with an AUC of 0.940 (95%CI, 0.904 to 0.965; p<0.001), generating a sensitivity of 86.13%, and specificity of 88.32%. Meanwhile, the optimal single cut-off point for differentiation between the affected tendon and the region of tears was 2.39 m/s, with an AUC of 0.991 (95%CI, 0.972, 0.999; p<0.001), demonstrating a high sensitivity of 93.43% and a specificity of 100% (Table IV).

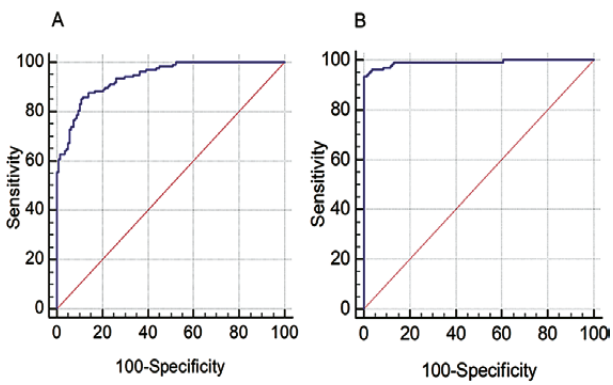

Fig 4. The ROC cures: A) Normal contralateral vs. Affected unilateral; B) Affected unilateral vs. Region of tears.

Table III. Comparison of SWV values of undamaged tendon, supraspinatus tendon tears and region of tears in different groups

	Group	n	Mean±SD (m/s)	F	P	LSD
SWV	Normal contralateral(A)	137	2.43±0.47	493.535	＜0.001	A>B*
	Affected unilateral(B)	137	3.64±0.60			A>C*
	Region of tears(C)	137	1.61±0.54			B>C*

SWV = Shear-Wave Velocity; n = the number of patients.

Table IV. Diagnostic performance of SWV for predicting various types of supraspinatus tendon tears by ROC cures

Group	AUC(95%CI)	p	Cutoff value (m/s)	Sensitivity (95%CI)	Specificity (95%CI)
A vs. B	0.940(0.904, 0.965)	<0.001	2.96	86.13(79.2, 91.4)	88.32(81.7, 93.2)
B vs. C	0.991(0.972, 0.999)	<0.001	2.39	93.43(87.9, 97.0)	100.00(97.3, 100.0)

SWV, Shear-Wave Velocity; A, Normal contralateral; B, Affected unilateral; C, Region of tears.

Discussion

Accurate imaging diagnosis is crucial in the successful diagnosis and treatment of rotator cuff injuries. Existing imaging diagnostic methods include X-ray, CT, MRI, and US. While X-ray and CT both demonstrate benefits regarding shoulder bone structure injuries, these methods lack sensitivity in detecting rotator cuff tendon injuries. Conversely, MRI offers high sensitivity and specificity in diagnosing rotator cuff tears, but various drawbacks include contraindications, time limitations, costs, and inapplicability for patients with implanted heart stents [17,18]. US is an alternative, with distinct benefits as a noninvasive, cost-effective, and widely applicable imaging modality for diagnosing rotator cuff injuries [19].

Rutten et al [20] found that US provided highly accurate diagnostic results regarding FTTs, with a recorded diagnostic accuracy of 95%. Similarly, the accuracy of diagnosing PTTs was demonstrated to be 89%, with no significant difference when compared to MRI diagnostic accuracy results. Tang et al [21] reported that US diagnostics achieved 74.2% accuracy in diagnosing various rotator cuff tear types, along with accuracy of 56.1% for PTTs and 100% for large FTTs. Comparatively, the current study achieved a 73.7% accuracy rate in diagnosing PTTs via US, positioning it between the aforementioned findings, which could be attributed to differences in patient characteristics or variability in the ultrasound equipment utilized for diagnostic imaging. Meanwhile, compared with FTTs, patients with early-stage PTTs, as their symptoms, signs, and imaging examinations may not present definitively [18]. As such, accurately diagnosing PTTs becomes a key diagnostic goal with significant implications for appropriate follow-up clinical interventions.

According to Jeong et al [22], preoperative SWE examination can serve as a valuable prognostic marker for patients with rotator cuff tears undergoing surgical intervention. Specifically, values for SWE elasticity were found to be higher among patients with incomplete rotator cuff repairs, with the elasticity ratio successfully predicting postoperative under-repair outcomes independent of rotator cuff tear size and muscle characteristics. Deng et al [12] reported significant disparities in SWE values across distinct rotator cuff tear types, with an identified SWE cut-off of 4.83 m/s successfully distinguishing between tendinopathy and PTTs, and SWE of 4.08 m/s in distinguishing between PTTS and FTTs.

Previous studies did not measure the SWV value of the torn area or reject it [8,23]. However, during US examination, we found that for DPT-RCT patients, the exact SWV value can be measured in the supraspinatus tendon tear area, which may be related to the incomplete tendon tear and the possibility that the torn area was not completely filled with fluid. It was also associated with synovial hyperplasia. Meanwhile, the SWV values of the torn area were significantly different from those of the surrounding tendon tissue, suggesting the presence of tendon tear. Although this is not a core indicator of clinical diagnosis, it can provide reference value for clinical diagnosis.

In this study, the SWV value of DPT-RCT was 3.64±0.60 m/s, a rate notably higher than the 2.43±0.47 m/s calculated for normal tendon SWV values. The resulting cut-off value was identified as 2.96 m/s, potentially linked to tendon hardness increases following tendon tears as a result of processes such as local inflammation, fat infiltration, tendon fibrosis, and calcification. These sequelae may account for the higher SWV values observed in partially torn tendons, as compared to normal tendons [24]. Evaluation of the SWV values corresponding to the tear area yielded an average of 1.61±0.54 m/s, a figure significantly lower than the corresponding SWV values determined for the partially torn tendon at

3.64±0.60 m/s. The calculated cutoff threshold for the tear area was identified as 2.39 m/s with a near-perfect AUC value of 1. The observed phenomenon can be attributed to differences in tissue stiffness resulting from different evaluation targets, as these measurements pertain to different tissue types and accordingly manifest in varying SWV values [25]. In this study, the partially torn tendon zone evaluated corresponded to the supraspinatus muscle tendon, whereas the region of tears referred to a "fluid area" generated from bursae effusion or exudated in the aftermath of a tendon rupture Is SWV value was significantly lower than that of the normal or partially torn tendons [26]. Promoting increased accuracy in both qualitative and quantitative diagnoses of rotator cuff tears, clinical investigations may leverage SWV values for detecting and comparing values between the torn area and the surrounding tendon.

Delamination reflects chronic degenerative changes in the tendon, which may be related to DPT-RCT [27,28]. Fukuda et al [27] proposed that intratendinous delaminated tears are induced by shear forces within degraded tendons. The laceration site exhibits inadequate blood supply due to hypertrophic alterations in tendon arterioles, and histological evidence suggests that chronic degeneration may contribute to the development of delaminated tears [29,30]. The tears of supraspinatus tendons are often accompanied by tendon inflammation, fatty infiltration, and eventual fibrosis [24]. Gigliotti et al [31] conducted a pathologic study and found that affected supraspinatus showed fiber atrophy, fibrosis, reduced vascular density, and a lower proportion of slow fibers compared with the ipsilateral control normal muscle, which was consistent with the trend reported in the literature. Differences in fibrosis of the supraspinatus are the microstructural bases for differential diagnosis between different RCT types on SWE.

The differences among the three types of DPT-RCT in terms of SWV were not statistically significant. This lack of significance can be attributed to the fact that the observed differences were mainly limited to the degree of articular surface, bursal surface, or intratendinous retraction, while the overall structure of the tendon remained relatively unchanged. Nevertheless, the notable distinction in SWV values between the region of tears and the affected tendon, along with the distinctive image characteristics of SWE, enables the precise qualitative and quantitative diagnosis of different types of DPT-RCTs.

Several limitations should be noted in the current investigation. Firstly, the study exclusively analysed DPT-RCT, thus omitting delaminated FTTs. Additionally, the trial solely appraised the status of a single supraspinatus tendon, failing to offer a comprehensive assessment with regard to other rotator cuff tendons. In addition，this study is retrospective and the small sample size resulted in even smaller group samples after dividing according to tear type. This could impact the results and statistical analysis of the study. On the other hand, only US and SWE examinations were performed on the patient's healthy shoulder, without gold-standard shoulder arthroscopy, and the possibility of injury could not be completely ruled out, which may have affected the US and SWE data on the unaffected contralateral shoulder.

Conclusion

SWE with SWV can provide both quantitative and qualitative diagnostic information for DPT-RCT, which can be used as a crucial supplement imaging method.

Conflict of interest: none

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