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RESEARCH

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A new section of shoulder magnetic resonance imaging (MRI) used to assess the fat infiltration of the rotator cuff muscles

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Abstract

Background Accurately assessing the degree of fat infiltration in the rotator cuff muscles is essential. However, in patients with massive rotator cuff tears and significant retractions, assessing fat infiltration of the rotator cuff in the traditional scapular Y-view of Shoulder MRI is not very accurate.

Purpose This study aimed to evaluate the reliability and reproducibility of the suprascapular notch sagittal section (r-view) for assessing fatty infiltration in the supraspinatus and infraspinatus muscles, with comparative analysis against the Y-view assessment results.

Methods Magnetic resonance imaging data from 91 patients with rotator cuff tears (RTCs) were retrospectively analyzed. The patients were divided into three groups on the basis of the extent of retraction of rotator cuff tears. Fat infiltration of rotator cuff muscles was independently graded by three orthopedic surgeons via the Goutallier classification. The interclass and intraclass correlation coefficients (ICCs) were calculated to assess the consistency and repeatability of grading fat infiltration in the supraspinatus and infraspinatus using Y view and r view. The Wilcoxon rank-sum test was used to compare categorical variables of 3 groups (fat infiltration of the supraspinatus and infraspinatus graded in Y view and r view).

Results In the 3 groups of patients, regardless of the supraspinatus or the infraspinatus, the interclass coefficients of fat infiltration grade in the r view were ≥ 0.80, with excellent interobserver agreement and reliability of evaluation. The intraclass coefficients of each reader for grading fat infiltration of the supraspinatus and infraspinatus in the r view were ≥ 0.80, indicating excellent intraobserver agreement and reproducibility. In the group with the most severe rotator cuff tear retraction, there was a significant difference in the degree of fat infiltration between Y view and r view ($P < 0.01$).

Conclusion The r view utilized in this study is a new section for assessing the fat infiltration of the supraspinatus and infraspinatus. In contrast to the conventional Y view, assessing fatty infiltration of the supraspinatus and infraspinatus muscles in the r view demonstrates better reliability and reproducibility, with less influence from tendon retraction.

Levels of evidence Level III.

Keywords Fat infiltration, Goutallier classification, Y view, r view, Supraspinatus, Infraspinatus, Rotator cuff tears (RCTs)

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Introduction

Rotator cuff tears (RCTs) are a prevalent global condition affecting numerous individuals worldwide [1] and represent a common cause of shoulder pain and dysfunction [2]. Numerous studies have demonstrated that rotator cuff tendon tears and retraction lead to muscle atrophy and increased fatty infiltration, resulting in diminished muscle strength and impaired function [2–4]. The severity of preoperative fatty infiltration of the rotator cuff muscle is associated with the rate of postoperative rotator cuff retearing and worse functional outcomes. Accurate assessment of fatty infiltration of rotator cuff muscles can predict the rate of retearing after surgery [5–7]. Fat infiltration of the rotator cuff muscle is a predictor of outcomes and graft integrity after rotator cuff repair and is the factor associated with graft failure [8]. Therefore, the degree of fat infiltration in the rotator cuff is a crucial factor for assessing surgical indications and postoperative prognosis, playing a pivotal role in clinical decision-making regarding the treatment of patients with RCTs [6, 9].

The Goutallier classification, originally based on axial CT imaging, is the primary method for grading rotator cuff fatty infiltration, defined as follows: grade 0, normal; grade 1, some fatty streaks; grade 2, less than 50% fatty muscle; grade 3, as much fat as muscle; and grade 4, more fat than muscle [7]. However, MRI has now become the modality of choice for shoulder joint evaluation, providing comprehensive assessment of rotator cuff pathology including tear characteristics (size and location), degree of fat infiltration, severity of muscle atrophy, and extent of tendon retraction [10–12]. Thomazeau et al. [13, 14] used oblique sagittal MRI to quantify supraspinatus muscle cross-sectional area, standardizing the Y-shape view, which is in the most lateral sagittal section on which the scapular spine was in contact with the scapular body. Fuchs et al. [15] assessed fatty infiltration of the rotator cuff using the Goutallier classification combined with Y-shaped view magnetic resonance imaging (MRI) of the shoulder joint. At present, this is the most commonly used method for assessing fatty infiltration of the rotator cuff.

The study by Liem et al. [16] revealed differential progression of fat infiltration in rotator cuff muscles following surgery: the supraspinatus and infraspinatus muscles showed significant increases in fat infiltration postoperatively regardless of tendon integrity, whereas no significant progression was observed in the subscapularis muscle. Therefore, evaluating the degree of fat infiltration of the supraspinatus and infraspinatus before surgery is highly important.

In clinical practice, we have observed that in patients with massive rotator cuff tears, the retraction of the supraspinatus and infraspinatus muscles leads to the appearance of retracted, thickened tendinous tissue and atrophied muscle with reduced cross-sectional area on the MR image of the scapula Y views. Consequently, accurate assessment of fat infiltration in the supraspinatus and infraspinatus muscles becomes challenging. In contrast, in the suprascapular notch section, which is more medial relative to the Y view, the supraspinatus and infraspinatus muscles have a greater muscle cross-sectional area and are less affected by the retracted tendon. Therefore, sagittal MR imaging of the suprascapular notch section is very meaningful for assessing the degree of fat infiltration in the supraspinatus and infraspinatus muscles. To distinguish it from the Y view, the suprascapular notch is named the r view according to its bony structure, which resembles the letter r (Fig. 1).

The aim of this study was to investigate the differences in the assessment of fat infiltration in the supraspinatus and infraspinatus between the y-view and the r-view, as well as the advantages and disadvantages of the two views in assessing the degree of fat infiltration in the supraspinatus and infraspinatus.

Methods

Patients

The study was approved by our institutional review board, and the requirement for informed consent was waived because of its retrospective nature. Ethical certification number: KL20240849.

Patients who underwent 1.5-T MRI of the shoulder between April 2023 and January 2024 were enrolled. The inclusion criteria for the study were: (1) MRI-confirmed rotator cuff tears, and (2) shoulder MRI scans encompassing oblique sagittal sections extending to the medial border of the scapula. We excluded patients with a history of shoulder surgery at the time of imaging, patients with a history of shoulder dislocation, and patients with abnormal shoulder bone structure. A total of 91 patients who met the criteria were ultimately included (mean age: 63.6 ± 9.4 years, range: 32–82 years; 31 men and 60 women).

Retraction of the rotator cuff is due to asynchronous shortening of the tendon and muscle after tendon tears [17]. Rotator cuff tear retraction was classified into three stages using the Patte classification on coronal T2 images: Stage 1: Proximal stump near bony insertion. Stage 2: Proximal stump at humeral head level. Stage 3: Proximal stump at glenoid level or beyond [18, 19]. Patients were grouped accordingly: Group 1: Partial tears/full-thickness tears with Stage 1 retraction. Group 2: Stage 2 retraction (humeral head level). Group 3: Stage 3 retraction (glenoid level).

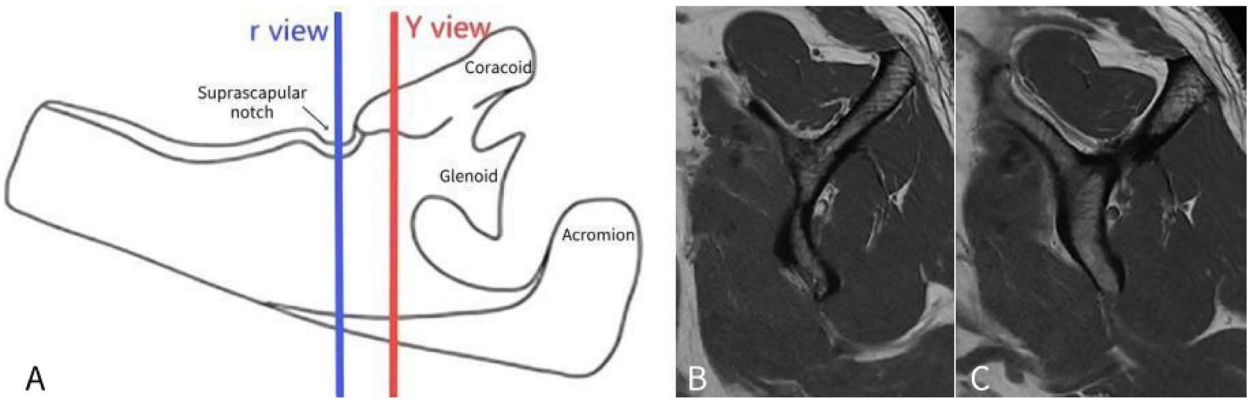

Fig. 1 **A** Overhead view of the two different sections (r view and Y view in this study) at the scapular position, with the r view at the suprascapular notch position and the Y view at the most lateral aspect where the scapular spine was in contact with the scapular body. **B** MRI of the shoulder joint T1-weighted sagittal section of the suprascapular notch (r view). **C** MRI of the shoulder joint T1-weighted sagittal section of the scapular Y view

MRI evaluation

Fatty infiltration was assessed according to the Goutallier classification applicable to magnetic resonance imaging. This classification was applied to sagittal T1-weighted MR images of the shoulder [15]. The assessment of fatty infiltration in the rotator cuff muscles is typically conducted in the Y view of the scapula. In this study, a sagittal section at the level of the suprascapular notch (r view) was added for comparison. The degree of fatty infiltration in these sections was graded according to the Goutallier classification described by Goutallier et al. [20] and Fuchs et al. [15]

The MRI evaluation of the rotator cuff was performed by three orthopedic surgeons (reader A, an orthopedic surgeon with more than 10 years of experience; reader B, an orthopedic surgeon subspecialized in sports medicine with 8 years of experience; reader C, an orthopedic surgeon subspecialized in sports medicine for 5 years) in consensus. The images were retrospectively assessed by three readers in a randomized sequence. Three readers jointly confirmed the sections from the Y view and the r view and then interpreted the images independently. The readers were blinded to the clinical information. One month after the initial image evaluation, the three readers conducted a second retrospective assessment of the images in a random order. All three readers were proficient in reading shoulder MR images, Goutallier classification, and Patte classification.

Statistical analysis

Assessment of agreement in grading fatty infiltration of the supraspinatus and infraspinatus in the Y view and R view: We used interclass and intraclass correlation coefficients (ICCs) to assess the interobserver and intraobserver agreement of the fatty infiltration assessment values obtained by three readers in three groups of patients. The Wilcoxon rank-sum test was used to compare categorical variables among the 3 groups (fat infiltration of the supraspinatus and infraspinatus was graded in the Y-view and R-view).

The results were analyzed via SPSS statistical software (IBM SPSS Statistics for Windows, Version 27.0.1. Armonk, NY: IBM Corp). The level of significance for all calculations was defined as $P < 0.05$.

Result

The patients in this study were divided into 3 groups based on the degree of retraction of the rotator cuff tendon and the Patte classification. Figure 2 is a schematic diagram showing the degree of tendon retraction in each group of patients, cited from the Patte classification [19]. The basic information of the patients in each group is shown in Table 1.

The interobserver agreements among the three readers in assessing the grade of supraspinatus and infraspinatus fat infiltration via the Goutallier classification in the Y-view and r-view are presented in Table 2. The interclass correlation coefficients (ICCs) of the r view are greater than those of the Y view, indicating better agreement and providing better reliability. In addition, in patients in groups 1 to 3, the interclass correlation coefficient of the degree of fat infiltration in the r view was ≥ 0.80, regardless of the supraspinatus or infraspinatus muscle, and the interobserver agreement was excellent.

The intraclass correlation coefficients were used to assess the intraobserver agreement of each reader in evaluating the degree of fat infiltration in the supraspinatus and infraspinatus. The results are shown in Table 3.

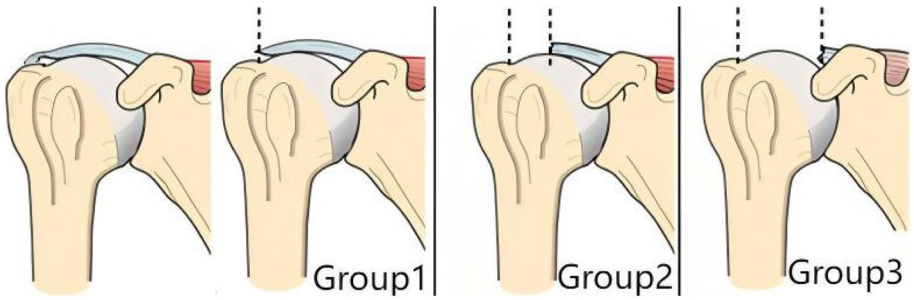

Fig. 2 Group 1: Partial tears/full-thickness tears with little tendon retraction. Group 2: retraction of tendon to level of humeral head. Group 3: retraction of tendon to level of glenoid

Table 1 Patient's demographic data

	Group 1	Group 2	Group 3	Combined
No.of patients	29	32	30	91
Percentage of patients	31.9%	35.1%	33.0%	100%
Age, y, mean ± standard deviation	60.2 ± 11.7	63.6 ± 7.6	66.9 ± 7.8	63.6 ± 9.4
Sex, Female ratio, n(%)	16(55.2)	24(75)	20(66.7)	60(65.9)

Table 2 Inter-observer reliability of fat infiltration graded in two sections of three groups

Muscle	Section	Group 1		Group 2		Group 3		*p*-value
		ICC	95% CI	ICC	95% CI	ICC	95% CI	
SSP	Y view	0.75	0.34,0.90	0.72	0.43,0.87	0.67	0.39,0.84	$p < 0.001$
	r view	0.80	0.54,0.91	0.82	0.66,0.91	0.89	0.81,0.95	$p < 0.001$
ISP	Y view	0.88	0.77,0.94	0.86	0.72,0.93	0,74	0.51,0.87	$p < 0.001$
	r view	0.89	0.79,0.94	0.88	0.75,0.94	0.85	0.73,0.93	$p < 0.001$

ICC Interclass correlation coefficient, *CI* Confidence interval, *SSP* Supraspinatus, *ISP* Infraspinatus

In each reader, for both the supraspinatus and infraspinatus, all of the intraclass correlation coefficients (ICCs) for assessing fat infiltration in the r view were ≥ 0.8, indicating excellent agreement. Notably, the ICCs of the r view surpassed those of the Y view, indicating high repeatability.

There were differences in the assessment of fat infiltration in the supraspinatus and infraspinatus muscles between the R-view and Y-view. For both the supraspinatus and infraspinatus muscles, a higher proportion of individuals were classified as Goutallier grade 3–4 when evaluated using the Y-view, as shown in Fig. 3.

The Wilcoxon rank-sum test was used to evaluate the difference between the Y view and the r view in grading fat infiltration of the supraspinatus and infraspinatus in each group. For both patients in Group 1 and Group 2, the assessment of fat infiltration in the supraspinatus and infraspinatus using either the Y-view or r-view showed no significant differences among the evaluations conducted

Table 3 Intra-observer agreement of fatty infiltration graded in two sections by three readers

Reader	Muscle	Section	ICC	95% CI	*p*-value
A	SSP	Y view	0.89	0.84,0.93	$p < 0.001$
		r view	0.94	0.91,0.96	$p < 0.001$
	ISP	Y view	0.91	0.86,0.94	$p < 0.001$
		r view	0.93	0.90,0.96	$p < 0.001$
B	SSP	Y view	0.84	0.70,0.91	$p < 0.001$
		r view	0.90	0.85,0.93	$p < 0.001$
	ISP	Y view	0.79	0.70,0.86	$p < 0.001$
		r view	0.92	0.88,0.95	$p < 0.001$
C	SSP	Y view	0.78	0.68,0.85	$p < 0.001$
		r view	0.80	0.72,0.87	$p < 0.001$
	ISP	Y view	0.80	0.70,0.87	$p < 0.001$
		r view	0.81	0.73,0.87	$p < 0.001$

ICC Intraclass correlation coefficient, *CI* Confidence interval, *SSP* Supraspinatus, *ISP* Infraspinatus

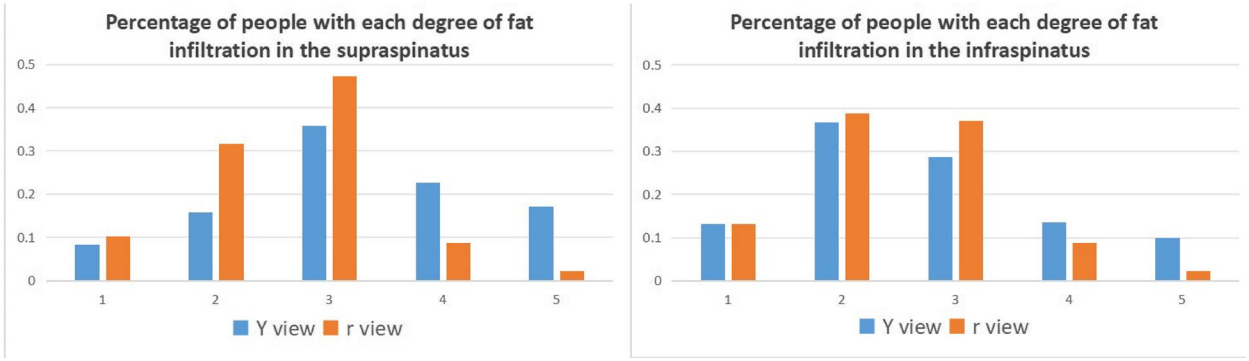

Fig. 3 The chart shows the proportion of individuals with varying degrees of fat infiltration in the supraspinatus and infraspinatus muscles. The left side represents the supraspinatus, while the right side represents the infraspinatus. The horizontal axis indicates the degree of fat infiltration, with grades 1–5 corresponding to fat infiltration levels 0–4. The vertical axis represents the percentage of individuals with each degree of fat infiltration relative to the total study population

by the three readers ($P > 0.05$). However, in group 3, there was a significant difference ($P < 0.01$) in the assessment of fat infiltration in the r view compared with the data in the Y view (shown in Table 4).

Discussion

Goutallier et al. [20] proposed the concept of fat infiltration of the rotator cuff in 1989. Several years later, they proposed the Goutallier classification (stage 0–4), which provides a five-stage qualitative assessment of fatty infiltration based on axial CT scans [7]. Numerous studies published since then have demonstrated that fat infiltration and atrophy of the rotator cuff before surgery are related to the rates of retearing and inferior functional outcomes [3, 5, 8, 21]. Fatty infiltration decreases the elasticity and viability of the rotator cuff and impairs healing [22]. Owing to the high sensitivity and specificity of MRI for the diagnosis of rotator cuff tears [23]. Fuchs et al. [15] assessed fat infiltration via MRI in a sagittal section named the scapular Y view. Ruderman et al. [24] verified that cellular lipid accumulation is positively associated with the MRI Goutallier classification of fatty infiltration by rotator cuff muscle biopsy, thus validating the Goutallier classification at the cellular level and supporting its utility in predicting rotator cuff muscle quality. Accurate preoperative assessment of the degree of fat infiltration is crucial for determining surgery plans and predicting postoperative outcomes. Goutallier et al. [7] reported that fatty infiltration of Goutallier grades 3 and 4 (as much fat as muscle or more fat than muscle) should be a contraindication to arthroscopic rotator cuff repair. In contrast, Burkhart et al. [25] reported that arthroscopic rotator cuff repair can provide significant functional improvement in patients with fatty infiltration of Goutallier grades 3 and 4. The reasons for such opposite results may be related to advances in surgical technique, surgical equipment, and other advances, or there may be a correlation with the reliability of the assessment of fat infiltration. The degree of rotator cuff fat infiltration closely correlates with the size of the rotator cuff tear [26]. Patients with rotator cuff fat infiltration up to Grade 3–4 according to the Goutallier classification are usually accompanied by a massive tear and significant retraction of the rotator cuff. The data in Table 2 showed that in the assessment of fat infiltration in the Y view, the ICCs gradually decreased from Group 1 to Group 3, indicating that as the degree of rotator cuff retraction increases, the agreement and reliability of fat infiltration evaluation in

Table 4 The difference of the grade of fat infiltration between Y view and r view in each group

Reader	Group	Group 1($N=29$)		Group 2($N=32$)		Group 3($N=30$)	
A	Muscle	SSP	ISP	SSP	ISP	SSP	ISP
	p-value	0.973	0.993	0.433	0.804	< 0.01	< 0.01
B	Muscle	SSP	ISP	SSP	ISP	SSP	ISP
	p-value	0.429	0.993	0.198	0.873	< 0.01	< 0.01
C	Muscle	SSP	ISP	SSP	ISP	SSP	ISP
	p-value	0.065	0.827	0.094	0.796	< 0.01	< 0.01

SSP Supraspinatus, *ISP* Infraspinatus

the Y view. This may make it difficult to accurately assess the degree of fatty infiltration in patients with massive rotator cuff tears. However, when assessing fat infiltration of rotator cuff in the r view, the degree of retraction did not significantly affect the assessment.

A recent MRI-based imaging study revealed that in patients with massive rotator cuff tears, the degree of fat infiltration in the supraspinatus and infraspinatus of the medial scapular body was less severe than that in the Y view [27]. Similarly, in this study, we observed a significant difference (shown in Table 4) in the degree of fat infiltration in the supraspinatus and infraspinatus between the Y view and the r view among patients with tendon retraction to the level of the glenoid (stage 3 of the Patte classification). The Goutallier grade of fat infiltration was lower in the r view. In these patients, owing to the significant retraction of the supraspinatus and infraspinatus muscles, the images viewed in the Y view (e.g., Fig. 4A) revealed retracted hypertrophied tendinous tissue and a limited amount of muscular tissue around the tendons, which did not allow for a complete representation of the muscular areas of the supraspinatus and infraspinatus. Fat infiltration could not be evaluated effectively. In contrast, on the image in the r view (e.g., Fig. 4B), both the supraspinatus and infraspinatus exhibited a more complete muscle cross-section, enabling a better assessment of the degree of fat infiltration. In the coronal images (Fig. 4C), the Y view presented the muscles close to the tendon stump and the myotendinous junction.

In patients with retraction of the tendon to the level of the humeral head, a similar situation was observed in the section more laterally than in the Y view and close to the tendon stump (Fig. 5A). On the MR image of this section, only conspicuous tendinous tissue and an alimited amount of muscular tissue could be observed in the supraspinatus and infraspinatus, making it difficult to assess the degree of fat infiltration. Moreover, on the MR image of the Y view (Fig. 5B) and the r view (Fig. 5C), the muscular tissues of the supraspinatus and infraspinatus were clearly presented, enabling an accurate assessment of the degree of fat infiltration in the rotator cuff. The coronal image (Fig. 5D) shows that the section in Fig. 3a represents the region close to the tendon stump and the myotendinous junction. The degree of fat infiltration in

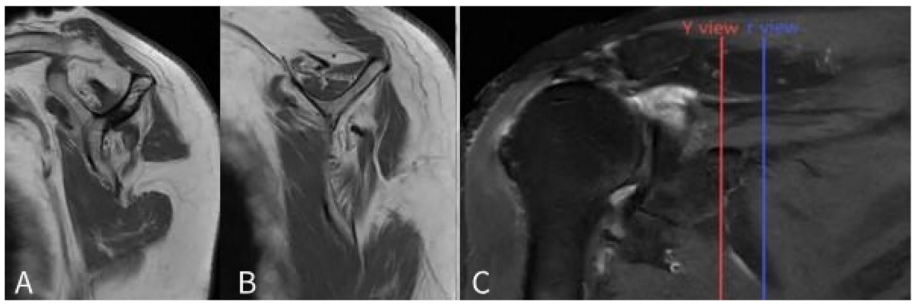

Fig. 4 MR images of patients with stage 3 tendon retraction according to the Patte classification. **A** T1-weighted MR image of the Y view; (**B**) T1-weighted MR image of the r view; (**C**) T2-weighted coronal view of the shoulder MRI with the left vertical line showing the position of the Y view in the scapula and the right vertical line showing the position of the r view

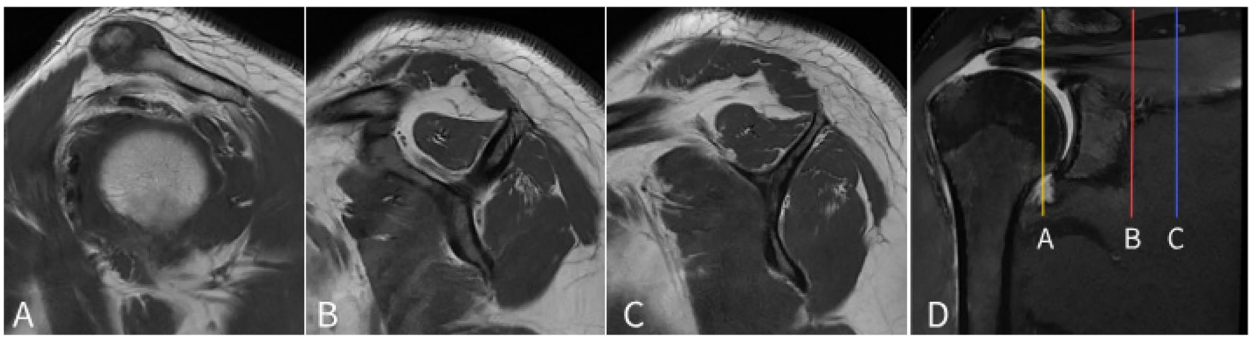

Fig. 5 MR images of patients with stage 2 tendon retraction according to the Patte classification. **A** A sagittal section more lateral than the Y view and close to the tendon stump; (**B**) T1-weighted MR image of the Y view; (**C**) T1-weighted MR image of the r view; (**D**) T2-weighted coronal view of the shoulder MRI showing the anatomical localization of three sections in the scapula

the supraspinatus and infraspinatus in this section was more severe than that in the Y view and r view.

Massive RTCs are correlated with tendon retraction and medial retraction of the rotator cuff musculature, leading to medialization of the muscle bulk [27]. Therefore, for patients with massive rotator cuff tears and severe tendon retraction in stage 3 of the Patte classification, the muscular portion of the supraspinatus and infraspinatus retracted to the more medial aspect of the scapula. The MR image in the Y view was equivalent to that in the section more laterally than the original Y view. This did not allow a good assessment of the degree of muscle fat infiltration. The r view was more medial to the Y view and showed the retracted rotator cuff muscle tissue well. The chart in Fig. 3 also shows that the grade of fat infiltration performed in the r-view was lower. Moreover, the data in Table 4 show that this difference originated in patients with severe tendon retraction (stage 3 of the Patte classification), where the degree of fat infiltration in the supraspinatus and infraspinatus was significantly different between the Y view and the r view. This suggests that in patients with severe tendon retraction, assessing the degree of fat infiltration in the Y view may lead to results that are more severe than they actually are. Thus, for patients with massive RTCs and severe tendon retraction, the assessment of fat infiltration of the supraspinatus and infraspinatus in the r view may yield more reliable results.

In the study by Osamu et al. [28], the scapula was divided into 10 equal sections, with the medialmost area defined as 0 and the lateralmost area defined as 1. The maximum cross-sectional area (CSA) of the supraspinatus was slightly located laterally to the center of the scapula, at the 0.6–0.7 position of the scapula. The maximum CSA of the infraspinatus was at the 0.5–0.6 position of the scapula. Both of them were located in the section more medially to the Y view. Samy et al. [29] also demonstrated that the maximum CSA of the supraspinatus and infraspinatus muscles was more medial to the Y view. The suprascapular notch, which is the location of the r view in this study, is situated in the 0.6–0.7 region of the scapula. In this section, the cross-sectional area (CSA) of the supraspinatus is the largest, while the CSA of the infraspinatus also approaches its maximum. Simultaneously, there is a reduced presence of tendinous tissue, minimizing its impact on muscle condition evaluation. This enhances the reliability of our assessment in evaluating fat infiltration in both the supraspinatus and infraspinatus compared with the Y-view.

Most studies selected the sagittal image acquired in the Y-shaped view for assessing the degree of fatty degeneration in the rotator cuff muscles owing to its distinct bony structural features, high reproducibility, and visualization of the muscular regions of all the RC muscles. Similar to the Y view, the r view reveals distinct bony landmarks and can effectively depict the muscle areas of all rotator cuff muscles. The Y view is vaguely defined, and surgeons may choose different slices on the basis of their understanding of anatomy, whereas the r view is very clearly defined. Moreover, the Y-view had notoriginally been described for fatty infiltration assessment but rather for atrophy evaluation. There is no subsequent research demonstrating that this is the optimal section for assessing fatty infiltration in the supraspinatus and infraspinatus muscles.

In this study, the interobserver and intraobserver agreement of the r view was excellent, which was better than that of the Y view. The reliability and reproducibility of the assessment of fat infiltration in the right view were better.

As rotator cuff tears and tendon retraction worsened, the assessment of fatty infiltration in the Y-view demonstrated increasing inconsistency among readers and declining reliability. Due to the medialization of muscle tissue, the evaluation results of fatty infiltration in the Y-view should be questioned, as partially reparable rotator cuff tears(RTCs) may be misclassified as irreparable, thereby skewing clinical surgical planning. However, assessing the degree of fatty infiltration in the r view offers better reliability and reproducibility, maintaining high consistency regardless of the extent of rotator cuff tendon retraction. These findings provide reliable support for the formulation of clinical surgical protocols.

Limitations of this study

1. There was a significant sex difference in the patients in this study, with nearly twice as many females as males.
2. The sample size is inadequate, averaging approximately 30 patients per group.
3. Our study is limited to MRI research exclusively, and whether it can accurately assess the actual muscle condition of clinical patients necessitates complementary assessment through surgery or muscle biopsy.
4. Whether r view is actually better predicting the clinical situation than Y view in massiverotator cuff tears requires further validation in future studies.

Conclusion

The assessment of the degree of rotator cuff fat infiltration in patients with RCTs is usually performed in the Y view of the scapula via the Goutallier Classification. However, in MR images of patients with massive rotator cuff tears, the evaluation of fat infiltration of the

supraspinatus and infraspinatus in the Y view may lead to an inaccurate assessment, usually overestimation of fat infiltration, due to severe retraction of the muscles. In contrast to the Y view, the R view employed in this study demonstrated superior inter-observer and intra-observer agreement in fat infiltration assessment, exhibiting excellent reliability and reproducibility. Furthermore, it reduced the interference from severe tendon retraction when assessing fat infiltration in both the supraspinatus and infraspinatus muscles. In contrast to the Y view, the new section of shoulder MRI named r view is more reliable and effective to evaluate fat infiltration of the rotator cuff muscles and may be a better choice for patients with severe tendon retraction.

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Authors' contributions
GZ: wrote the main manuscript text QH: read MRI images and provided data JZ: analyzed data and prepared tables LY: read MRI images and provided data DH: read MRI images and provided data XZ: formulation or evolution of overarching research goals and aims QZ: managed data and prepared figures All authors reviewed the manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The study was approved by institutional review board of Taizhou Hospital of Zhejiang Province. Approval number: KL20240849.

Consent for publication
All authors have approved the manuscript and agree with its submission.

Competing interests
The authors declare no competing interests.

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