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FULL PAPER

The usefulness of the three-dimensional enhanced T_1 high-resolution isotropic volume excitation MR in the evaluation of shoulder pathology: comparison with two-dimensional enhanced T_1 fat saturation MR

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Objective: To evaluate the diagnostic accuracy of three-dimensional (3D) enhanced T_1 high-resolution isotropic volume excitation (eTHRIVE) shoulder MR for variable shoulder pathology such as rotator cuff tear, labral injury and synovial pathology in comparison with two-dimensional enhanced fast spin echo T_1 fat saturation (2D T1 FS) sequences MR.

Methods: This retrospective study included 86 patients who underwent MRI of the shoulder using eTHRIVE technique. Two radiologists evaluated anatomic identification of the supraspinatus, glenoid labrum and acromioclavicular joint (AC joint) on routine MRI sequences (2D T1 FS) and compared them with the reformatted eTHRIVE images. Subjective scoring of the images was performed with a four-point scale that rated the degree of discrimination of the shape of the supraspinatus, glenoid labrum and AC joint. The diagnostic accuracy of eTHRIVE compared with

routine MR images was evaluated in terms of rotator cuff pathology, labral pathology and synovial pathology.

Results: Anatomic identification scores of the supraspinatus tendon and labrum were significantly lower for eTHRIVE than for 2D T1 FS. There were no significant differences between eTHRIVE and 2D T1 FS in anatomic identification of the AC joint. There were no significant differences between eTHRIVE and 2D T1 FS in diagnosing the three disease categories.

Conclusion: eTHRIVE had comparable diagnostic accuracy to 2D T1 FS imaging in the evaluation of rotator cuff tears, labral injury and synovial pathology, but anatomic identification was inferior to that of 2D T1 FS.

Advances in knowledge: The accuracy of 3D eTHRIVE imaging is comparable to that of 2D T1 FS for the diagnosis of rotator cuff tears, labral injury and synovial pathology.

INTRODUCTION

Isotropic three-dimensional (3D) MRI enables multiplanar reformatted images to be created in any desired orientation from the original acquisition plane.^{1–3} Advantage of 3D MRI is the superior ability to visualize small structures because 3D isotropic images can minimize partial volume artefact by their thin slice thickness and lack of an intersection gap.⁴ The acquisition of a single 3D isotropic volume can be faster than acquiring multiple two-dimensional (2D) blocks in different orientations. 3D enhanced T_1 high-resolution isotropic volume excitation MR [eTHRIVE, a vendor-specific term (Philips Medical Systems), similar sequence of Siemens Healthcare is VIBE and LAVA of GE Healthcare] is a new 3D imaging sequence that uses T_1 weighted gradient echo with a dual half scan and shows superior fat saturation.^{5,6} Lee et al⁵ reported that 3D eTHRIVE can provide proper spatial and contrast resolution

of the ligament and cartilage of the wrist. To date, no studies have compared 3D eTHRIVE and 2D enhanced fast spin echo T_1 fat saturation (2D T1 FS) sequences in the evaluation of shoulder joint pathology. The purpose of this study was to compare the diagnostic accuracy of 3D eTHRIVE shoulder MR and 2D T1 FS for shoulder pathology, such as rotator cuff tears, labral injury and synovial pathology.

METHODS AND MATERIALS

Case selection and clinical diagnoses

Kangbuk Samsung Hospital ethics review board approved this study and waived the requirement for informed consent owing to the retrospective study design. We retrospectively evaluated 94 patients who consecutively underwent enhanced shoulder MRI using 3D eTHRIVE technique. The study population comprised 36 males (42%) and 50 females (58%) (mean age: 55 ± 12 years, range: 22–89 years). Inclusion criteria for MRI

Table 1. Imaging parameters for routine MR sequences

Parameter	Coro T2 FS FSE	Coro T1 FSE	Sagittal T2 FSE	Axial proton density FSE	Axial T2 FS FSE	Axial T1 FS enhanced	Coro T1 FS enhanced	Enhanced T ₁ high-resolution isotropic volume excitation
Repetition time (ms)	3200–3500	600–1000	2800–3000	3000–3200	3200–3500	500–1000	500–1000	12
Echo time (ms)	60–80	10	60–90	30	60	10	10	7
Flip angle (°)	90	90	90	90	90	90	90	12
Matrix size (pixel)	356 × 262	340 × 250	356 × 250	340 × 250	356 × 260	430 × 320	340 × 250	270 × 270
Field of view (cm)	16	16	16	16	16	16	16	16
Slice thickness (mm)	3	3	4	4	4	4	3	0.6
Interslice gap (mm)	1	1	1	1	1	1	1	0
Bandwidth (kHz)	290	290	360	290	290	236	290	430
Echo train length	15	23	16	14	15	7	5	40
Number of signal average	2	2	2	2	2	2	2	1
Scan time (min:sec)	2:50	2:50	2:05	2:30	2:30	2:50	2:30	3:30

Coro, coronal; FS, fat saturation; FSE, fast spin echo; T1 FS enhanced, enhanced T₁ weighted spin echo fat saturation.

Data in bold indicate the three sequences which have been investigated.

were unbearable shoulder pain and impaired mobility. Exclusion criteria were previous surgical history (five cases), pyogenic arthritis (two cases) and lipoma of the shoulder (one case). An orthopaedic surgeon and two radiologists made a reference diagnosis for each patient based on the patient's symptoms, physical examination and plain radiography (for calcific tendinitis). 19 patients underwent arthroscopic surgery (22%). Other patients were diagnosed based on clinical findings and physical examinations. Symptoms suggesting rotator cuff injury included pain that was worsened by overhead shoulder movement and weakness and motion limitation in the affected shoulder. Findings of the physical examination that indicated a rotator cuff injury included Hawkin's sign and Neer's sign, both of which give rise to pain when a physician elevates the patient's arm.⁷ Positive clinical findings for

glenoid labra were positive results of the Jobe relocation test (with the arm in abduction and external rotation, pain when the examiner applies pressure to the posterior arm) and O'Brien test (pain when the patient adducts with thumbs pointing down).⁸ Clinical diagnostic criteria of synovial pathology were as follows. Adhesive capsulitis could be diagnosed if the patient had shoulder pain and motion limitation. The physical examination showed loss of both passive and active range of motion; however, the plain radiograph did not demonstrate osteoarthritis of the shoulder joint or dislocation of the joint.⁹

MR parameters

MR examinations were performed by using a 3.0-T MR scanner (Achieva; Philips Medical Systems, Best, Netherlands) with an

Table 2. Median scores for anatomic identification and image quality

Image	Supraspinatus tendon ^a		Labrum ^b		Acromioclavicular joint ^c		Total	
	Reader 1	Reader 2	Reader 1	Reader 2	Reader 1	Reader 2	Reader 1	Reader 2
Enhanced T ₁ high-resolution isotropic volume excitation	2 (2.0–3.0)	2 (2.0–3.0)	3 (2.0–3.0)	3 (2.0–3.0)	3 (2.0–3.0)	3 (2.0–3.0)	8 (7.0–8.0)	8 (7.0–8.0)
Two-dimensional fast spin echo enhanced T ₁ fat saturation	3 (3.0–3.0)	3 (2.0–3.0)	3 (3.0–3.0)	3 (3.0–3.0)	3 (2.0–3.0)	3 (3.0–3.0)	8 (8.0–9.0)	8 (8.0–9.0)
p-value	<0.001	<0.001	0.002	0.002	0.282	0.157	<0.001	<0.001

^aDiscrimination of the supraspinatus tendon.

^bDiscrimination of the glenoid labrum.

^cDiscrimination of the acromioclavicular joint.

Data in parentheses are interquartile range.

Figure 1. The anatomic identification score of the supraspinatus tendon in a 56-year-old male with shoulder pain. (a) An oblique coronal image reformatted from three-dimensional enhanced T_1 high-resolution isotropic volume excitation MRI demonstrating good delineation of the tendon of $>50\%$ but $<100\%$ (arrow). The score was two. (b) Oblique coronal two-dimensional enhanced T_1 fat saturation image (repetition time/echo time, 760/10 ms) demonstrating good delineation of the entire tendon (arrow). The score was three.

eight-channel shoulder coil. Parameters of the conventional fast spin echo MR sequences and eTHRIVE sequences are summarized in Table 1. Comparison with eTHRIVE images was made through sagittal and coronal 2D T_1 FS. The eTHRIVE images were obtained with the following parameters: repetition time (TR)/echo time = 12/7 ms; field of view = 16×16 cm; number of acquisitions = one; flip angle = 12° ; slice thickness = 1.2 mm (slice interpolation = 0.6 mm); matrix = 270×270 pixels; and average scan time = 3 min 30 s. The multiplanar and isovolumetric images were generated along axial, oblique sagittal and oblique coronal planes with 3-mm thickness immediately at the operating console and then transferred to the picture archiving and communication system. A 3-mm reconstruction thickness was chosen in order to match the 2D T_1 FS images. In the reformatted images, we set interslice gap as 1 mm to be

equivalent to the 2D T_1 FS images. The average time for image reformation was about 2 min.

Image analysis

Two radiologists specializing in musculoskeletal radiology with 7 and 14 years' clinical experience interpreted the shoulder MR images. They were blinded to the radiological diagnoses and clinical history of the subjects. Anatomical identification of the supraspinatus, glenoid labrum and acromioclavicular joint (AC joint) on the 2D T_1 FS and reformatted eTHRIVE images were evaluated respectively and independently at different times. Image evaluation was based on the oblique coronal, oblique sagittal and axial images of both sequences. Subjective scoring of the images used a four-point scale to determine the degree of discrimination of the shape of the supraspinatus, glenoid labrum

Figure 2. The anatomic identification score of the glenoid labrum in a 49-year-old female with shoulder pain. (a) Anterior and posterior labra do not appear prominent on axial images reformatted from three-dimensional enhanced T_1 high-resolution isotropic volume excitation MRI (arrows). The score was one. (b) An axial two-dimensional enhanced T_1 fat saturation image (repetition time/echo time, 630/13 ms) demonstrating prominent glenoid labra (arrows). The score was three.

Table 3. Interobserver agreement for anatomic identification and image quality (intraclass correlation)

Image	Supraspinatus tendon ^a	Labrum ^b	Acromioclavicular joint ^c
Enhanced T ₁ high-resolution isotropic volume excitation	0.672 (0.538–0.773)	0.709 (0.586–0.800)	0.899 (0.848–0.993)
Two-dimensional fast spin echo enhanced T ₁ fat saturation	0.676 (0.543–0.776)	0.773 (0.671–0.846)	0.741 (0.628–0.823)

^aDiscrimination of the supraspinatus tendon.^bDiscrimination of the glenoid labrum.^cDiscrimination of the acromioclavicular joint.

Numbers in parentheses are 95% confidence intervals.

and AC joint: zero, poor; one, questionable; two, adequate; and three, excellent.^{9,10} Scoring of the supraspinatus tendon was performed on the oblique coronal image as follows: (a) if all tendon fibres were prominent, then the score was three; (b) if >50% of fibres but <100% were prominent, then the score was two; (c) if <50% of the fibres were prominent, then the score was one; and (d) if little or no fibre was present, then the score was zero. Scoring of the glenoid labrum was performed on the axial image as follows: (a) if delineation of both the anterior and posterior labra was prominent, then the score was three; (b) if delineation of one of the labra was not as prominent as the other, then the score was two; (c) if delineation of both labra was not prominent but was still visible, then the score was one; and (d) if little or no labrum was seen, then the score was zero. Scoring of the AC joint was performed on the oblique coronal and oblique sagittal images as follows: (a) if delineation of both the bony structure and lining synovium of the distal end were prominent, then the score was three; (b) if delineation of the synovium was not prominent but delineation of the bony structure was prominent, then the score was two; (c) if delineation of both the synovium and bony structure was not prominent but was still visible, then the score was one; and (d) if little or no synovium or bony structure was identifiable, then the score was zero. First, the reader subjectively scored the 2D T1 FS images only. Then, to prevent recall bias, they subjectively scored the eTHRIVE images 1 week later at the next session. Diagnostic accuracy of 2D T1 FS and eTHRIVE was evaluated based on whether a rotator cuff tear, glenoid labral injury or synovial pathology such as adhesive capsulitis was identified. Each evaluation was performed on a different day with at least 1 week between evaluations. Diagnostic evaluation of a rotator cuff injury was based on the following findings. Full-thickness tear of the rotator cuffs, such as the supraspinatus and subscapularis, was diagnosed if a complete defect of the tendon was seen

visualized.¹⁰ If a partial defect or focal bright signal was seen in the tendon of the rotator cuff, then the diagnosis was a partial tear of the discrimination of the supraspinatus tendon (SST).¹¹ If a swollen tendon or a partial tear with a signal void was seen, then calcific tendinitis was diagnosed. A glenoid labral tear was diagnosed if a full-thickness tear, avulsion from the glenoid or crushed labra was seen on MRI.¹²

Statistical analysis

We used Wilcoxon signed-rank tests to compare the scores for anatomic identification between the 2D T1 FS and eTHRIVE images. Interobserver agreement for the anatomic identification scores was analysed with an intraclass correlation coefficient (ICC). ICC interpretation was as follows: ICCs <0.40, poor agreement; ICCs of 0.40–0.75, fair-to-good agreement; and ICCs >0.75, excellent agreement.¹³ We applied kappa statistics in the analyses of interobserver agreement of the diagnosis. The values were interpreted as follows: $0.8 < k \leq 1$, near complete agreement; $0.6 < k \leq 0.8$, substantial; $0.4 < k \leq 0.6$, moderate; $0.2 < k \leq 0.4$, fair; $0 < k \leq 0.2$, slight; and $k \leq 0$, poor.¹⁴ The values for diagnostic accuracy of the eTHRIVE and 2D T1 FS images were assessed in terms of sensitivity, specificity and accuracy for diagnosing rotator cuff pathology, labral pathology or synovial pathology. These values were evaluated with the McNemar test, and surgically or clinically confirmed diagnoses were used as a reference standard. *p*-values ≤ 0.05 were considered to be statistically significant, and statistical analyses were performed with PASW software v. 18.0 (IBM Corporation, Armonk, NY).

RESULTS

The median scores for anatomic identification of the SST, labrum and AC joint with corresponding *p*-values are summarized

Table 4. Interobserver agreement and diagnosis (κ value)

Image	Rotator cuff pathology	Labral pathology	Synovial pathology
Enhanced T ₁ high-resolution isotropic volume excitation	0.783 (<0.001)	0.828 (<0.001)	0.945 (<0.001)
Two-dimensional fast spin echo enhanced T ₁ fat saturation	0.812 (<0.001)	0.830 (<0.001)	0.917 (<0.001)

Numbers in parentheses are *p*-values.

Table 5. Sensitivity, specificity and accuracy of enhanced T_1 high-resolution isotropic volume excitation (eTHRIVE) and two-dimensional fast spin echo enhanced T_1 fat saturation (2D T1 FS) in diagnosing rotator cuff pathology

Image	Sensitivity (%)		Specificity (%)		Accuracy (%)	
	Reader 1	Reader 2	Reader 1	Reader 2	Reader 1	Reader 2
eTHRIVE	73.2 (30/41)	80.5 (33/41)	95.6 (43/45)	91.1 (41/45)	84.9 (73/86)	86.0 (74/86)
2D T1 FS	75.6 (31/41)	87.8 (36/41)	95.6 (43/45)	88.9 (40/45)	86.0 (74/86)	88.4 (76/86)
<i>p</i> -value	1.000	0.250	1.000	1.000	1.000	0.625

Numbers in parentheses are the numbers of patients used to calculate the percentages.

in Table 2. For both readers, the anatomical identification scores of the SST and labrum were significantly lower for eTHRIVE than for 2D T1 FS (Figures 1 and 2). There were no significant differences between eTHRIVE and 2D T1 FS in the anatomical identification of the AC joint. The ICCs of the anatomical identification scores for both the eTHRIVE and 2D T1 FS images showed good reproducibility (more than fair-to-good agreement, 0.67–0.90, Table 3). Interobserver agreement between the two radiologists for the diagnosis was near complete for both eTHRIVE and 2D T1 FS (kappa values, 0.78–0.95, Table 4). The sensitivities, specificities and accuracies of both imaging systems in diagnosing rotator cuff pathology, labral pathology and synovial pathology are summarized in Tables 5–7. There were no significant differences between eTHRIVE and 2D T1 FS in the diagnosis of the three disease categories ($p > 0.05$, Figures 3 and 4); most values for sensitivity, specificity and accuracy were $>80\%$, with the exception of sensitivity for Reader 1 in the diagnosis of rotator cuff pathology (eTHRIVE, 73%; 2D T1 FS, 76%; Table 5). The diagnostic accuracy of the 2D T1 FS was minimally superior to eTHRIVE. By contrast, the entire diagnostic value of eTHRIVE in the diagnosis of synovial pathology and the sensitivities of eTHRIVE in the diagnosis of labral pathology tended to be greater than those of the 2D T1 FS, but this difference was not statistically significant (Tables 6 and 7). In a case of Bankart lesion, the 2D T1 FS images appeared normal, whereas the eTHRIVE images identified the correct diagnosis (Figure 5). However, in a normal case, the eTHRIVE images suggested anterior labral tear, whereas the 2D T1 FS images appeared normal (Figure 6).

DISCUSSION

The eTHRIVE imaging system has advantages over the 2D fast spin echo imaging system: total scan time for isovolumetric

imaging is reduced, and there is variable reformation of the MR images.⁵ In the present study, image acquisition took 3 min 30 s with eTHRIVE. By contrast, it took more than 5 min to acquire the 2D axial enhanced T1 fat saturation (FS) images and 20 min to acquire the 2D coronal enhanced T1 FS images. We could not acquire the 2D sagittal enhanced T1 FS images owing to time restrictions. If we acquired three orthogonal sequences of 2D T1 FS images, the total scan time might be 7 min 40 s. Therefore, if we replace 2D T1 FS images with eTHRIVE, we can save $>50\%$ of the total scan time. We acquired multiplanar reformatted images with $0.6 \times 0.6 \times 0.6$ -mm-sized isovolumetric voxels. The eTHRIVE uses a small flip angle (12° in this study) to perform an ultrafast data acquisition and short TR, which might result in poor T_1 weighted contrast. To overcome this poor contrast, eTHRIVE uses a 180° inversion pulse for the magnetization preparation delay between acquisition of the inversion pulse and the k -space lines.⁵ eTHRIVE technique is commonly used to image liver, breast and MR cholangiography.¹⁵ Furthermore, eTHRIVE provides multiplanar imaging, high resolution with gadolinium-enhanced images and good fat suppression. In this study of anatomical identification and image quality, eTHRIVE was inferior to 2D T1 FS in the evaluation of the supraspinatus and labrum but equivalent to 2D T1 FS in the evaluation of the AC joint. These weaknesses of eTHRIVE might result from poor contrast between the joint fluid and labrum and between the supraspinatus tendon and subdeltoid bursa. In addition, the fibre bundles of the supraspinatus tendon were less prominent with eTHRIVE than with 2D T1 FS. The margin of the labra was slightly less sharp in eTHRIVE than in 2D T1 FS. We also assessed whether eTHRIVE was comparable to 2D T1 FS in sensitivity, specificity and accuracy for diagnosing rotator cuff pathology,

Table 6. Sensitivity, specificity and accuracy of enhanced T_1 high-resolution isotropic volume excitation (eTHRIVE) and two-dimensional fast spin echo enhanced T_1 fat saturation (2D T1 FS) in diagnosing labral pathology

Image	Sensitivity (%)		Specificity (%)		Accuracy (%)	
	Reader 1	Reader 2	Reader 1	Reader 2	Reader 1	Reader 2
eTHRIVE	93.3 (14/15)	100 (15/15)	94.4 (67/71)	94.4 (67/71)	94.2 (81/86)	95.3 (82/86)
2D T1 FS	80.0 (12/15)	93.3 (14/15)	98.6 (70/71)	98.6 (70/71)	95.3 (82/86)	97.7 (84/86)
<i>p</i> -value	0.500	1.000	0.250	0.250	1.000	0.625

Numbers in parentheses are the numbers of patients used to calculate the percentages.

Table 7. Sensitivity, specificity and accuracy of enhanced T_1 high-resolution isotropic volume excitation (eTHRIVE) and two-dimensional fast spin echo enhanced T_1 fat saturation (2D T1 FS) in diagnosing synovial pathology

Image	Sensitivity (%)		Specificity (%)		Accuracy (%)	
	Reader 1	Reader 2	Reader 1	Reader 2	Reader 1	Reader 2
eTHRIVE	100 (25/25)	100 (25/25)	100 (61/61)	96.7 (59/61)	100 (86/86)	97.7 (84/86)
2D T1 FS	96.0 (24/25)	96.0 (24/25)	100 (61/61)	95.1 (58/61)	98.8 (85/86)	95.3 (82/86)
<i>p</i> -value	1.000	1.000	1.000	1.000	1.000	0.500

Numbers in parentheses are the numbers of patients used to calculate the percentages.

labral pathology and synovial pathology. Interobserver agreement between the two radiologists for diagnostic accuracy was near complete for both eTHRIVE and 2D T1 FS, which indicates that our study was based on objective evaluation (Table 4). Tables 5–7 reveal similar sensitivity, specificity and accuracy of eTHRIVE in the evaluation of rotator cuff pathology, labral pathology and synovial pathology, although some mismatching cases exist. In two cases of full-thickness tear of the supraspinatus tendon, eTHRIVE could not detect the lesion owing to poor contrast (Figure 3). However, for one case of a Bankart lesion, the lesion was not seen on 2D T1 FS but was diagnosed on eTHRIVE. We could not find any significant differences between 2D T1 FS and eTHRIVE in the evaluation of rotator cuff pathology, labral pathology and synovial pathology. Thus, eTHRIVE and 2D T1 FS appear to have comparable diagnostic accuracy for these pathologies.

Our study had some limitations. First, there was a paucity of surgical diagnoses, as only 22% of patients underwent surgical intervention. Nevertheless, great care was taken to overcome

this problem and to make the best possible diagnosis of reference in non-surgical cases by using clinical manifestations and other radiological modalities, including plain radiography, other available MR sequences and consensus reading. Second, we used a subjective scoring method with a four-point scale. This method did not permit objective quantitative analysis in the evaluation of anatomical identification. Third, the total score had limited value because the three categories of anatomical identification had different weights. Fourth, eTHRIVE and 2D T1 FS sequences were not very well matched in terms of the in-plane pixel resolution. No attempt was made to match the two sequences in terms of in-plane pixel resolutions or signal-to-noise ratio (SNR) output. Fundamentally if the two sequences had completely different spatial resolutions and SNR properties, then the diagnostic and anatomical ability of the sequence is bound to be affected.

In conclusion, eTHRIVE had comparable diagnostic accuracy to 2D T1 FS imaging in the evaluation of rotator cuff tear, labral injury and synovial pathology, although anatomical identification was inferior to 2D T1 FS.

Figure 3. An example of a false-negative near-full-thickness tear of the supraspinatus tendon on three-dimensional enhanced T_1 high-resolution isotropic volume excitation (eTHRIVE) in a 71-year-old female. (a) An oblique coronal MR image reformatted from eTHRIVE demonstrating an intact supraspinatus tendon because of poor contrast between the joint fluid and tendon (arrow). (b) Oblique coronal two-dimensional enhanced T_1 fat saturation image (repetition time/echo time, 690/10 ms) demonstrating a near-full-thickness tear of the supraspinatus tendon (arrow).

Figure 4. An example of the same diagnoses of a partial tear of the supraspinatus tendon in a 58-year-old female. (a) An oblique coronal MR image reformatted from three-dimensional enhanced T_1 high-resolution isotropic volume excitation demonstrating a partial tear of the supraspinatus tendon at the bursal side (arrow). (b) Oblique coronal two-dimensional enhanced T_1 fat saturation image (repetition time/echo time, 560/10 ms) demonstrating a partial tear of the supraspinatus tendon at the bursal side (arrow).

Figure 5. A case of labral Bankart lesion in a 58-year-old female. (a) An axial MR image reformatted from three-dimensional enhanced T_1 high-resolution isotropic volume excitation (eTHRIVE) demonstrating a tear of the anterior glenoid labrum (arrow). (b) Axial two-dimensional (2D) enhanced T_1 fat saturation image (repetition time/echo time, 750/10 ms) demonstrating a suspicious labral tear that was not prominent (arrow). The diagnosis of the lesion on eTHRIVE was a Bankart lesion, and the diagnosis on 2D image was normal. The lesion was confirmed as a Bankart lesion arthroscopically.

Figure 6. A false-positive case of a Bankart lesion on three-dimensional enhanced T_1 high-resolution isotropic volume excitation (eTHRIVE) in a 67-year-old male with shoulder pain. (a) Axial MR image reformatted from eTHRIVE showing a suspicious tear of the anterior glenoid labrum (arrow). (b) Axial two-dimensional (2D) enhanced T_1 fat saturation image (repetition time/echo time, 630/10 ms) demonstrating an intact labrum (arrow). The diagnosis of the lesion on eTHRIVE was a Bankart lesion, and the diagnosis on the 2D image was normal. The lesion was confirmed as intact labrum arthroscopically.

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