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Comparison of ability of lesion detection of two MRI sequences of T2WI HASTE and T2WI BLADE for hepatocellular carcinoma

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Abstract

We investigated the diagnostic accuracy of 2 magnetic resonance imaging (MRI) sequences of T2 weighted image (T2WI) half-Fourier acquired single turbo spin-echo (HASTE) and BLADE, for hepatocellular carcinoma (HCC) detection. From November 2010 to August 2018, patients diagnosed with HCC and regularly followed up, and who underwent MRI with 2 kinds of T2WI, were included in this study. The diagnosis of HCC was established based on histopathological findings or LI-RADS 4 and 5 by image. The sensitivities and positive predictive value for the detection of HCC by T2WI HASTE and BLADE were compared for each sequence. Quantitative assessment with lesion contrast-to-noise ratio and visual rating scoring of image quality, based on factors such as artifact, margin of organs, and vessel sharpness of the 2 sequences, were compared. No significant differences in lesion detection were observed based on paired comparison of all lesions and lesions larger than 1 cm across both sequences. The sensitivity was higher in larger than 1cm group in all sequences. The HASTE sequence had less motion artifact, but the BLADE images had advantage in edge sharpness of organs and vessels. The HASTE without fat-saturation seems to have better overall image quality. The lesions contrast-to-noise ratio of the 2 image modalities were not significantly different. Compared with T2 BLADE, T2 HASTE may be a more effective protocol for detecting HCC larger than 1 cm without loss of sensitivity. The accuracy of data from 2 T2WI protocols could be applied to streamline MRI protocols of HCC screening and surveillance.

Abbreviations: 3D = 3-dimensional, CNR = contrast-to-noise ratio, FA = flip angle, FOV = field of view, FS = fat-saturation, HASTE = half-Fourier acquired single turbo spin-echo, HCC = hepatocellular carcinoma, Hz = hertz, MRI = magnetic resonance imaging, PPV = positive predictive value, ROI = regions-of-interest, SD = standard deviation, SI = signal intensity, T2WI = T2 weighted image, TE = echo time, TR = repetition time, TSE = turbo spin echo.

Keywords: BLADE, diagnostic accuracy, HASTE, hepatocellular carcinoma, imaging: oncology, MRI technique, T2WI

1. Introduction

Magnetic resonance imaging (MRI) is becoming increasingly valuable for abdominal imaging of hepatocellular carcinoma (HCC). This examination has the advantages of avoiding radiation, using a safe contrast agent, giving abundant information other than anatomy, and having a noninvasive high-precision diagnostic capability, and plays a crucial role in the diagnosis, management, and treatment effect tracking of HCC.[1–4] MRI with difference sequences and technique provide distinct information for morphology, material composition, vascularity, and even some chemical and physical properties.

A T2 weighted image (T2WI) is a standard MRI sequence for focal liver lesions, including HCC detection and characterization.

Fluid content, biliary tract, fibrosis, iron content and morphology are easily identified in the T2 WI. HCC also reveals a slightly high signal intensity on T2 weighted image in comparison with normal liver parenchyma.[2]

For MRI of the upper abdomen organs, T2-weighted spin-echo imaging has a long acquisition time and poor-image quality due to motion artifacts related to respiration and other physiological activity. A decreased signal-to-noise ratio also limits the accuracy for clinical applications. Therefore, some sequences less affected by respiratory motion are increasing in demand. Half-Fourier acquired single turbo spin-echo (HASTE) is a fast, breathing-independent, single-shot technique. All radiofrequency echoes necessary to fill half of k space are collected after a single excitation, with the use of short echo spacing. The

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HASTE sequence provides high quality images but the contrast between hepatic lesions and surrounding parenchyma may be reduced.[5–11]

BLADE, a Siemens software application or periodically rotated overlapping ParallEL lines with enhanced reconstruction, or MultiVane technique, was developed to reduce motion artifacts and provide a better signal-to-noise ratio and contrast-to-noise ratio (CNR) by oversampling data at the center of the k-space. Regardless of the long acquisition time, the BLADE sequence can improve image quality and lesion detection.[1,12–16]

Several prior studies mentioned above have shown that the application of the HASTE and BLADE technique to T2 weighted images resulted in improved lesion detection and decreased artifacts compared to conventional spin-echo, fast spin-echo, multishot turbo spin echo (TSE), breathhold TSE, and true fast imaging with steady state precession.[7–18] One prior study included patients who received 3-dimensional (3D)-T2WI, T2-HASTE images, and T2-TSE images. Comparing sensitivity and artifacts in different T2WI sequences, 3D-T2WI was found to improve sensitivity and reduce artifacts compared to other T2-TSE imaging sequences for the detection of malignant liver tumors. However, for HCC, the difference was not significant.[1] A recent study in 2022 compared the HASTE sequence with BLADE with fat-saturation (FS) sequence demonstrated HASTE not only reduced acquisition time but also improved image quality.[19]

The purpose of this study was to determine the diagnostic accuracy of 2 MRI sequences of T2WI (HASTE and BLADE) for the detection and diagnosis of HCC and image quality. Selecting proper MRI protocols will save examination and interpretation time without decreasing accuracy.

2. Materials and Methods

2.1. Patients

This study was a retrospective study conducted in a single center. We retrospectively analyzed the patients who received liver MRI for diagnosis of HCC or post treatment follow up from November 2010 to August 2018. These patients underwent MRI with 2 different techniques: T2WI sequence and T1WI multiphase contrast-enhanced sequence. The diagnosis of patients with HCC was established by histopathological findings or multiphasic contrast enhancement imaging modalities. For patients without a pathological diagnosis in this study, LI-RADS 4 and 5 were used as diagnostic criteria under dynamic sequence and threshold growth of MRI.

2.2. Image acquisition

All examinations were scanned with a standardized scan protocol on a 1.5-Tesla MRI scanner (MAGNETOM Aera, Siemens Healthcare, Erlangen, Germany). The sequences included:

A single breath-hold axial HASTE T2-weighted images (T2WI) with and without FS: repetition time (TR)/echo time (TE) = 1400/95 ms, flip angle (FA) = 160°, field of view (FOV) = 360 mm* 360 mm, matrix size = 320*208, slice

thickness = 6 mm. Thirty to forty sections with a 1.2 mm intersection gap were obtained to cover whole Liver. The bandwidth was 650 hertz (Hz) per pixel, and the interecho spacing was 4.3 ms. The acquisition time was about 240 to 300 seconds.

A multibreath-hold axial BLADE T2-weighted images (T2WI) with FS: TR/TE = 4320/86 ms, FA = 140°, FOV = 360 mm* 360 mm, matrix size = 320*320, slice thickness = 6 mm. Thirty to forty sections with a 1.2 mm intersection gap were obtained to cover whole Liver. The bandwidth was 650 Hz per pixel, and the interecho spacing was 4.3 ms. The acquisition time was about 300 to 360 seconds.

Dynamic contrast study of axial 3D T1-weighted images (T1WI) volume-interpolated breath-hold examination (vibe) with FS acquired on pre-contrast, artery, early portal venous phase, delayed 360 second phase (TR/TE = 4.15/2 ms, FA = 10°, FOV = 360 mm* 320 mm, matrix size = 320*186, slice thickness = 4 mm). Forty to 60 sections were obtained to cover whole Liver. The bandwidth was 650 Hz per pixel, and the interecho spacing was 4.3 ms. The acquisition time for each scan was about 11 to 15 seconds.

The sequence of T2WI BLADE was performed with FS in all patients included. Moreover, the T2WI HASTE sequence was performed with and without FS. In order to avoid the use of FS to influence lesion detection, we separated the patients into 2 groups. The patients received T2WI HASTE without FS were in group 1. The other patients received T2WI HASTE FS and were in group 2.

2.3. Image quality

We compared the image quality and artifacts of these 2 sequences of T2WI by visual rating score. Motion artifact included respiratory ghosting, vascular pulsation and peristalsis. The depiction of the intrahepatic vessels, the edge sharpness of the liver, pancreas, intrahepatic vessels, and the overall image quality were evaluated as the grades listed in (Table 1).

2.4. Lesion detection

The possible HCCs under T2WI were defined as intermediate high signal intensity (Fig. 1). The non-solid lesions with high signal intensity, identified as hepatic cysts or hemangioma, were excluded. Another sign of a hepatic cyst is a well-defined margin.[2,20,21]

Two board-certified radiologists with 9- and 4-year experience in abdominal radiology reviewed the images separately. The sequence of T2WI HASTE was read first. The detected lesions were labeled, and their size was measured. After 4 weeks, the sequences of T2WI BLADE (FS and non-FS) were read. The 4-week interval between the 2 readings was designed to avoid recall bias. All the labeled lesions received appropriate cross reference to dynamic studies to evaluate the lesion detection with the consensus of the 2 radiologists. The detected lesions on T2WI were labeled as true and false lesions. If they did not agree each other about the detection on sequences of T2WI, a consensus decision was made through discussion.

Table 1

Five-grade Likert scale for image quality.

| Grade	Motion artifact	Depiction of the intrahepatic vessels & Edge sharpness	Overall image quality
1	Diffuse with non-interpretable images	Unacceptable depiction	Unacceptable image quality
2	Severe artifact	Poor and severely blurred depiction	Poor image quality
3	Moderate artifact	Moderate depiction	Fair image quality
4	Mild artifact	Clear depiction with slight blurring	Good image quality
5	Absent artifact	Excellent depiction with no blurring	Excellent image quality
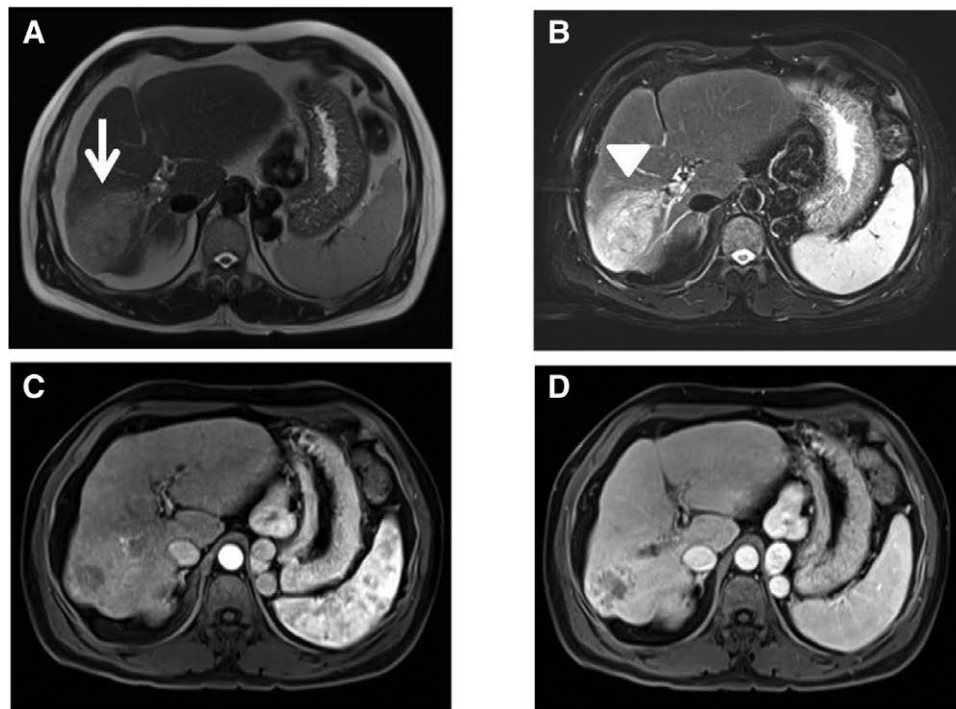
Figure 1. A 59-year-old patient suffers from alcoholic liver cirrhosis with unifocal hepatocellular carcinoma in segment 6 of the liver. A. T2-HASTE image in the axial plane shows a mass in segment 6 of liver (arrow) with intermediate high signal intensity and relative blurred border of lesion. B. T2-BLADE image with fat saturation in the axial plane display the same lesion in segment 6 of liver (arrowhead). The mass present more defined margin in BLADE series than in HASTE series. C. T1 weight image in the axial plane with fat-saturation and contrast enhancement of late arterial phase shows non-rim enhancement of the lesion. D. In portal venous phase, the lesion shows non peripheral "washout" in part relative to composite liver tissue. HASTE = half-Fourier acquired single turbo spin-echo.

As the size of the lesions plays an important role in lesion detection and diagnosis, we set the cut point to 1 cm for the nodules, according to LI-RAD criteria. All lesions were divided into groups of larger than 1 cm or < or equal to 1 cm.[20,22,23]

2.5. Quantitative analysis

Quantitative image analysis of the lesion signal intensity (SI) was performed using the criteria of the lesion/liver CNR. The CNR was defined as (SI of lesion–SI of liver)/ standard deviation (SD). The SD is the of the background noise. We measured the SI of the target lesion and the background liver parenchyma and background value using operator-defined oval regions-of-interest (ROI) for each image. To measure the SI of focal liver lesions, ROIs were placed on lesions over 5 mm in diameter to avoid central necrosis or cystic change. The SI of the normal hepatic parenchyma beside the lesions was measured, avoiding the large vessels, bile duct, and peripheral parenchyma near the margin of the liver and artifacts. Standard deviation of the noise was measured in the image outside the body along the phase-encoding direction. The size of the ROI was normalized in both sequences, but it varied in each patient and lesion. The mean and SD were calculated for each sequence. The quantitative analysis was performed on the appropriate cross references by the 2 radiologists.

2.6. Statistical analysis

The overall sensitivity and positive predictive value (PPV) were evaluated. The sensitivity was defined as the number of detected lesions divide by the total number of HCCs. The PPV was calculated by the numbers of true HCCs detected on T2WI images divided by the number of all suspect HCCs detected on T2WI.

The McNemar test was used to calculate the significance of lesion detection between each sequence. The Wilcoxon signed rank test was performed to compare the visual image quality between 2 sequences of T2WI and for the quantitative study in SIR and CNR in 2 paired T2WI sequences for the same HCC. $P < .05$ were considered statistically significant. The statistical analysis was performed using IBM SPSS statistics 25 (IBM Corp., Armonk, NY).

3. Results

3.1. Participant characteristics

From November 2010 to August 2018, total 103 patients who performed dynamic contrast enhancement MRI examination for HCC diagnosis and follow-up with 2 kinds of T2WI sequence were identified after searching the MRI database in our radiologic department. Data on the patient population includes liver parenchymal disease associated with viral hepatitis, alcohol related, and non-B non-C liver cirrhosis. After reviewing the biopsy results, image reports and the follow-up series of imaging, some of patients who proved to be ineligible for LI-RAD 4 and 5 criteria of HCC diagnosis or conformed to be other diagnoses such as hepatic metastatic tumors, focal nodular hyperplasia, and hemangioma were excluded. Eight patients were proved to have other kind of malignancy, 17 patients were benign tumors, and eight patients only met the criteria of LI-RAD 3. Finally, total 65 patients with 132 HCCs were included in the study. There were 52 men and 13 women with a mean age of 64.15 years ± 9.70 (SD) (range: 30–91 years). The mean number of HCC per patient was 2.03 tumors per patient. The average diameter of HCCs was 1.819 ± 1.214 cm. The patients' profile of the 2 groups that performed MRI with differences on fat suppression techniques on T2WI HASTE series were listed on (Table 2).

3.2. Lesion detection

In group 1, a total 41 patients with 85 HCCs are included. There were 63 suspect lesions detect on T2WI HASTE image. 50 lesions were compatible with HCCs according to dynamic studies. The other 13 lesions were false positive. 65 lesions were detected on T2WI BLADE image. Within these detected lesions, 54 lesions were considered as HCCs. The other 10 lesions were false positive. The HASTE images and BLADE FS images have overall sensitivity of 58.8% and 63.5%. The PPV of the HASTE are 79.4% and the BLADE FS is 83.6%. After stratified sampling, 50 HCCs larger than 1 cm and 35 HCCs < or equal to 1 cm are identified. The T2WI HASTE detected 42 (Sensitivity = 85.7%) larger than 1 cm HCCs and 8 (Sensitivity = 22.9%) < or equal to 1 cm HCCs. The T2WI BLADE FS detected 43 (Sensitivity = 86%) larger than 1 cm HCCs and 12 (Sensitivity = 34.3%) < or equal to HCCs. No significant differences were observed by paired comparison of all lesions, larger than 1 cm and smaller than or equal to 1 cm lesions for both sequences.

In group 2, a total 24 patients with 47 HCCs were included. There were 42 suspect lesions detect on T2WI HASTE image. 30 lesions were considered as HCCs. The other 12 lesions were false positive. 38 lesions were detected on T2WI BLADE image and 30 lesions were considered as HCCs after comparing with gold standard. The other 8 lesions were false positive. HASTE FS images and BLADE FS images had overall sensitivity of 70.8% and 62.5%. The PPV of the HASTE are 76.9% and the BLADE is 81.6%. There are 27 HCCs larger than 1 cm and 20 HCCs smaller than or equal to 1 cm are identified. The T2WI HASTE FS detected 24 (Sensitivity = 88.9%) larger than 1 cm HCCs and 6 (Sensitivity = 30.0%) smaller than or equal to 1 cm HCCs. The T2WI BLADE FS detected 23 (Sensitivity = 35.2%) larger than 1 cm HCCs and 7 (Sensitivity = 35.0%) smaller than or equal to 1 cm HCCs. No significant differences were observed by paired comparison of all lesions, larger than 1 cm and smaller than or equal to 1 cm lesions for both sequences. The details of stratified sampling of the 2 groups about the numbers of lesions detection, sensitivity, and PPV were summarized in (Table 3).

3.3. Image quality and quantitative results

Qualitative results of image quality are summarized in (Table 4). The T2WI HASTE sequence has significantly less motion artifacts than the T2WI BLADE sequence ($P < .001$). The T2WI BLADE sequence has significantly better recognition of intrahepatic vessels and sharpness of liver edge than the T2WI HASTE sequence ($P < .001$). These results had been observed on both group 1 and group. For group 1 the T2WI HASTE sequence has better overall image quality than T2WI BLADE FS sequence ($P < .001$). For group 2, the overall image quality was not significantly different. ($P = .132$)

In group 1, the qualitative results of lesion CNR showed significantly different results in T2WI HASTE series (73.97 ± 54.87 [SD]) and T2WI BLADE FS. (95.67 ± 70.37 [SD]) ($P = .015$) In group 2, the qualitative results of lesion CNR was not reach significantly different in T2WI HASTE FS series (77.63 ± 50.80 [SD]) and T2WI BLADE FS. (80.14 ± 55.76 [SD]) ($P = .350$).

4. Discussion

In the present study, the techniques of HASTE and BLADE performed on T2WI had equally high PPV and sensitivity for

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Table 2

Characteristics of patients who received liver MRI examination for hepatic cellular carcinoma.

	Group 1	Group 2	Total
	T2WI HASTE & T2WI BLADE FS	T2WI HASTE FS & T2WI BLADE FS	
Patient numbers	41	24	65
Age (yr)	63.30 ± 12.50	66.79 ± 12.97	64.15 ± 9.70
Gender (M/F)	31/10	21/3	52/13
Number of HCCs	85	47	132
Lesions per patient	2.07	1.96	2.03
Lesion size (cm)	1.907 ± 2.228	1.562 ± 1.409	1.819 ± 1.214

Results are expressed as means ± standard deviation (SD).

HASTE = half-Fourier acquired single turbo spin-echo, HCC = hepatocellular carcinoma, FS = fat saturation, MRI = magnetic resonance imaging, T2WI = T2 weighted image, WI = weighted image.

Table 3

Number of HCCs detected with different sequences of T2WI with analysis of 2 groups and stratified analysis according to lesion size.

		HASTE			BLADE FS		
		Total	>1 cm lesion	≤1 cm lesion	Total	>1 cm lesion	≤1 cm lesion
Group 1	HCC number	85	50	35	85	50	35
	Detected HCCs	50	42	8	54	43	12
	Sensitivity	58.8%	85.7%	22.9%	63.5%	86%	34.3%
	PPV	79.4%	80.7%	72.7%	84.3%	82.7%	92.3$
	P value	-	-	-	.1814	1	.2888
		HASTE FS			BLADE FS		
		Total	>1 cm lesion	≤1 cm lesion	Total	>1 cm lesion	≤1 cm lesion
Group 2	HCC number	47	27	20	47	27	20
	Detected HCCs	30	24	6	30	23	7
	Sensitivity	63.8%	88.9%	30.0%	63.8%	85.2%	35.0%
	PPV	71..4%	70.6%	75.0%	78.9%	76.7%	87.5%
	P value	-	-	-	.6171	1	1

Results are expressed as numbers and percentages. *P* value: McNemar test.

HASTE = half-Fourier acquired single turbo spin-echo, HCC means hepatocellular carcinoma, PPV positive predict value, T2WI = T2 weighted image, FS = fat saturation.

Table 4

Comparison of qualitative evaluation parameters of image quality between groups and sequences.

		Respiratory Motion artifact		Bowel Motion artifact		Heart Motion artifact		Intrahepatic vessels		The edge sharpness		Overall image quality	
		Mean ± SD	P	Mean ± SD	P	Mean ± SD	P	Mean ± SD	P	Mean ± SD	P	Mean ± SD	P
Group 1	HASTE	4.88 ± 0.33*		4.95 ± 0.21*		4.93 ± 0.26*		3.95 ± 0.74.		3.83 ± 0.68		4.60 ± 0.54*	
	BLADE FS	3.80 ± 0.71	<0.001	4.29 ± 0.71	<0.001	4.27 ± 0.74	<0.001	4.63 ± 0.62*	<0.001	4.59 ± 0.67*	<0.001	3.83 ± 0.80	<0.001
Group 2	HASTE FS	4.54 ± 0.53*		4.62 ± 0.5		4.62 ± 0.5		3.62 ± 0.77		3.46 ± 0.67		3.83 ± 0.49	
	BLADE FS	3.88 ± 0.51	<0.001	4.46 ± 0.72	0.234	4.38 ± 0.68	0.130	4.88 ± 0.22*	<0.001	4.63 ± 0.5*	<0.001	3.63 ± 0.52	0.132

Wilcoxon non-parametric paired signed rank test.

HASTE = half-Fourier acquired single turbo spin-echo, FS = fat saturation, SD = standard deviation.

* Represent significant better quality.

HCC detection. The results were better when stratified analysis was performed according to lesion size. In HCCs larger than 1 cm, the sensitivity and PPV of the 2 T2WI sequences were improved in comparison to the smaller than or equal to 1 cm lesions. There was no significant difference in the lesion detection ability between the HASTE and BLADE in all groups, even after stratified sampling. The 2 protocols of T2WI had a similar ability to detect HCCs. The sensitivity for lesions < 1 cm in size showed a lack of acceptable lesion detection. Neither HASTE nor BLADE alone was enough for the detection and characterization of focal liver lesions. Therefore, the dynamic image and other sequences are essential for early and small lesion detection. Furthermore, a dynamic study confirmed that a characteristic pattern of contrast enhancement on the arterial and venous phase is still the gold standard for the diagnosis of HCC without invasive intervention.[2,3]

We found that there were some false positive findings detected by the T2WI, but not by the dynamic study. Some of the findings were related to motion artifact, and other kinds of solid lesions that have similar characteristics as HCCs. It is important that T2WI could differentiate focal lesions from hemangiomas and cysts. Some focal lesion-like metastasis, such as focal nodular hyperplasia, may mimic HCCs on T2 weighted images.[2,17,20]

To evaluate and compare image quality, most studies analyzed images based on 3 aspects: the presence of artifact, anatomy sharpness, and overall image quality.[6,7,12,14–16,18] Some of the studies discussed artifact separately and in detail, including cardiac, respiratory, and vessel pulsation artifacts,[1] and anatomy sharpness factors such as edge sharpness and depiction of vessels.[1,12,14,16] The use of a visual rating score with a Likert scale to classify the grade, artifacts, or image quality from absent to diffuse is the usual method.

HASTE series is a turbo spin echo single shot sequence which is no need for breath-hold. The physiological motion during a non-breath-hold signal acquisition loses the signal from the targets. Most of the k space is filled for the short acquisition time, and the remaining k space is reconstructed by half-Fourier algorithm to produce relatively high-resolution images. Due to the short acquisition time, the image quality is less influence by motion resulted from physiological activity included respiration, cardiac and vascular pulsation, and bowel motion occurring during data acquisition. The limitation of irregular respiratory cycle, inter-breath-hold irreproducibility in the breath hold fast sequences can be resolved.

The BLADE protocol is a breath hold series using rotating blades containing phase-encoding lines for central K space oversampling. The technique provide correction for motion and averages motion by oversampling. Using the BLADE sequence, motion artifacts were significantly reduced. However, the benefits only offer for in-plane motion artifact but not for through plane artifact. Although several studies have reported improved visual image quality, reduced motion artifacts, and increased detectability of lesions in the brain and upper abdomen with BLADE sequences.[13,14,16,24] The ability to reducing motion artifact was lost to HASTE. From our results, the HASTE image was better at presenting fewer image artifacts than BLADE images in both groups, especially in the respiratory artifacts which is most presenting as through-plane motion in upper abdomen.

T2 HASTE image may have image margin blurred in lesion, vessels and organ due to loss of signal for part of k-space values and T2 decay during data collection. These disadvantages limited the HASTE in detection of small hyperintense and hypointense lesions.[12,13,25] From our results, the HASTE image was better at presenting fewer image artifacts than BLADE images in both groups, especially in the respiratory artifacts which is most presenting as through-plane motion in upper abdomen.

Our results revealed that the 2 sequences have their own benefits that the overall quality reveal viable resultes. In group 1, the HASTE sequence had better overall quality compared with the BLADE sequence with fat saturation. The results was also in consonance with Mulé, Sébastien, et al,[19] who compared the image quality of 2 sequences. However, the results were not reproduced in group 2 when fat saturation was also applied to the HASTE images. The other explanation for the results of the overall image quality being different in the 2 groups could be due to the use of fat saturation. The same results were seen in the qualitative results of lesion CNR. The results of significant differences only occurred in group 1 and not in group 2, which may have been related to the use of fat saturation.

The BLADE technique is relative time-consuming and has limited real benefits. The BLADE technique needs several cycles of breath. It also needs 300 to 360 seconds for application of T2WI in the liver. HASTE image is a time saving choice (240–300 seconds) without sacrificing the diagnostic ability for HCC and overall image quality, as compared with the BLADE sequence. The results were more prominence while the HASTE image performed without FS that preserve better the overall image quality.

Our study had several limitations. First, the relatively small size of the sample may have limited the validity of the study. Second, some of the patients who underwent T2WI HASTE were obtained without fat saturation and for T2WI BLADE were obtained with fat saturation. Fat saturation imaging may increase the image contrast resolution and highlight lesions.[26,27] The difference in the application of fat saturation may be a confounding factor in the analysis. To resolve this bias, we separated the patients into 2 groups; 1 that underwent MRI with a fat suppression technique on T2WI BLADE. In this study, no statistical significance in the differences in lesion-to-lesion analysis were found between sequences with or without fat saturation. Third, although the interpretation of the image was performed separately by 2 readers, the final interpretation was established after consensus by the 2 radiologists. Inter-observer variability was not evaluated. It is possible that the interpretation may have been influenced by one

of the 2 radiologists. Fourth, due to the study design, only patients with a diagnosis of HCC were included. Therefore, no assessment of the specificity was conducted without normal population data.

5. Conclusion

In conclusion, T2 HASTE may be a time-saving protocol that can detect HCC lesions that are larger than 1 cm efficiently, without decreasing sensitivity, compared with T2 BLADE. The accuracy of our data for the 2 protocols of T2WI could serve as the foundation for simplified MRI protocols for HCC screening and surveillance.

Author contributions

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Writing – review & editing: Te-Cheng Su, Song-Ru Jhan.

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