Fast imaging techniques are essential for acquiring T2WI with good quality for diagnosis of focal liver lesions. The purpose of our study was to compare the diagnostic performance of two fast T2-weighted imaging sequences, breath-holding turbo spin-echo (BH-TSE) and expiratory-triggered half-Fourier single-shot spin-echo (ET-HASTE), on liver MR imaging with a superparamagnetic iron oxide (SPIO) liver-specific contrast agent (Resovist). Qualitative and quantitative analyses of twenty-one focal liver lesions from thirteen patients were studied before and after Resovist administration. The preliminary results revealed that better image quality of BH-TSE sequence was obtained before Resovist administration. There was a higher percentage of signal-intensity loss (PSIL) of BH-TSE sequence, but no significant difference in image quality between BH-TSE and ET-HASTE sequences after Resovist administration. On the other hand, ET-HASTE sequence was superior to BH-TSE sequence in free of motion artifacts, and had a higher lesion signal-to-noise ratio (SNR) for all lesions, higher lesion-to-liver contrast-to-noise ratio (CNR) for malignant lesions, as well as a more reliable PSIL measurement. In conclusion, the ET-HASTE was comparable with or better than the BH-TSE sequence in Resovist-enhanced liver MRI.

Key words: Iron; Liver neoplasms, MR; Magnetic resonance (MR), comparative studies; Magnetic resonance (MR), contrast medium; Magnetic resonance (MR), half-Fourier imaging

Resovist (SHU-555-A; Schering, Berlin, Germany) is a liver-specific MR contrast medium which comprises a small SPIO particle (60nm) and shows relatively rare side effects following rapid intravenous injection.[1] This SPIO agent has a strong effect on the shortening of T1 and T2 relaxation times in blood and susceptibility effect when the Kupffer cells and RES have phagocytosed the particles. A dramatic signal intensity (SI) decrease can be seen in normal liver tissue on T2WI and T2*WI MR sequences. As most malignant tumors like metastasis or hepatocellular carcinoma do not contain Kupffer cells or have impaired cell activity, the SPIO affects their native signal intensity to a lesser extent. Therefore, this results in an improvement of the lesion to liver contrast and also offers additional information on differential diagnosis of benign and malignant liver tumors. Many studies have recently reported that this agent has improved the diagnostic capacity for focal hepatic tumors on T2-weighted images [1-5].

Currently, the conventional spin echo (CSE) and respiratory-triggered fast spin echo (RT-FSE) has been utilized as a standard pulse sequence for SPIO-enhanced MR imaging of liver lesions [2-5]. The conventional T2-weighted spin-echo (CSE) sequence has been a standard component of magnetic resonance imaging examination for liver lesions. However, respiratory motion artifacts tremendously degrade the imaging quality of the CSE T2WI. A respiratory-triggered fast spin echo technique, using the repetition times that equal the period of the respiratory cycle,
provides higher contrast T2WI and minimizes respiratory motion artifacts. This method would be an alternative for a T2-weighted imaging technique in routine liver examinations. However, ghosting artifacts were sometimes prominent in patients with irregular breathing and the acquisition time was relatively long [6].

One of the most effective ways to improve these drawbacks is the use of the rapid imaging technique in conjunction with breath-holding [7]. With recent improvement in gradient technology, breath-hold turbo spin-echo (BH-TSE) and half-Fourier single-shot turbo spin-echo (HASTE) have facilitated clinical application of breath-hold T2WI in the abdominal region because of the shorter scan time. Conventional HASTE sequence suffered from poor soft-tissue contrast due to T2 decay in later echoes during data acquisition [6] and magnetization transfer (MT) effect due to off-resonance RF irradiation during the previous image acquisition in a multislice technique. Expiratory-triggered HASTE technique has been introduced to produce a better image quality [8] and can even effectively reduce the MT effect from the off-resonance RF irradiation [9]. However, there are few data regarding the comparison of both T2WI sequences in Resovist contrast enhanced MRI. In this study, we obtained BH-TSE and expiratory-triggered HASTE (ET-HASTE) T2WI sequences before and after administration of Resovist in patients with focal liver lesions. The clinical feasibility of both sequences was evaluated quantitatively and qualitatively.

**MATERIALS AND METHODS**

**Patient selection**

Ten men and three women aged 34-77 years (mean 55.6 years) were recruited from patient groups who were referred for routine liver MR examination.

<table>
<thead>
<tr>
<th>Table 1. The imaging characteristics of hepatic lesions on CT and MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion No.</td>
</tr>
</tbody>
</table>
| 1, 2 | FNH | T1WI: hypointensity; T2WI: slightly hyperintensity  
Post Gd+: hypointensity on arterial phase and slightly hypointensity or isointensity on delayed phase |
| 3 | hemangioma | NECT: Slightly hypodense;  
CECT: spotty marginal enhancement on arterial phase and persistent enhancement on delayed phase  
T1WI: hypointense; T2WI: hyperintense  
Post Gd+: peripheral nodular enhancement on arterial phase and centripetally progressive enhancement on delayed phase |
| 4 | adenoma | NECT: Low attenuation;  
CECT: high attenuation on arterial phase and venous phase  
T1WI & T2WI: inhomogeneous hypo- and hyper-intense  
Post Gd+: inhomogeneous enhancement |
| 5, 7, 11, 12 | Dysplastic nodule | NECT: isodense;  
CECT: slightly enhancement on arterial phase and isodense on delayed phase  
T1WI: hyperintense; T2WI: slightly hyperintense  
Post Gd+: less enhancement on arterial and delayed phase |
| 6, 8, 9, 10 | Dysplastic nodule | NECT: isodense;  
CECT: less enhancement on arterial phase, slightly hypodense on delayed phase  
T1WI: hyperdense; T2WI: hypodense  
Post Gd+: less enhancement on dynamic study |
| 13 | Radiation fibrosis | T1WI: hypointensity; T2WI: hyperintensity;  
Post Gd+: no enhancement |
| 14, 15 | HCC | NECT: hypodense;  
CECT: early arterial enhancement and rapid washout on portal venous phase;  
T1WI: hypointensity; T2WI: hyperintensity  
Post Gd+: early arterial enhancement followed by washed out on portal venous phase. |
| 16, 17 | HCC | NECT: hypodense;  
CECT: early arterial enhancement and rapid washout on portal venous phase;  
T1WI: hyperintense; T2WI: hyperintensity  
Post Gd+: early arterial enhancement, less enhancement; |
| 18, 19, 20, 21 | metastasis | NECT: hypodense with calcification; CECT: marginal enhancement  
T1WI: hypointensity; T2WI: hyperintensity  
Post Gd+: marginal enhancement |

NECT: non-enhancement CT scan  
CECT: Contrast-enhancement CT scan  
Post Gd+: Post gadolinium-DPTA contrast agent administration
owing to the presence of abnormal lesions found by ultrasonographic (US) or computer tomographic (CT) examinations, or were receiving post-therapeutic follow-up for hepatic disorders or other clinical reasons. Patients found with abnormal focal hepatic lesions on routine liver MR examinations with gadolinium-chelated contrast agents immediately underwent liver MRI with Resovist contrast agents within 7 to 10 days and without undergoing any interventional procedure in this period. There were 21 lesions from 13 patients, which included 8 dysplastic nodules from 3 patients, 4 hepatocellular carcinomas in 4 patients, 4 metastases in 1 patient, 2 focal nodular hyperplasia (FNH) in 2 patients, 1 adenoma in 1 patient, 1 hemangioma in 1 patient and 1 radiation fibrosis in 1 patient. Only one FNH was histologically proved. Others were proved by unequivocal appearances in routine pre- and post-contrast CT and MR studies, characteristically clinical presentations and follow-up for at least 10 months. (Table 1.)

**Contrast agent**

Resovist (SHU555A; Schering, Berlin, Germany), a stable colloid of SPIO particles, consists of an aqueous suspension which is adjusted to a pH of 6.5 and contains SPIO microparticles with a mean diameter of approximately 60nm [maghemite (Fe$_2$O$_3$)/magnetite (Fe$_3$O$_4$)] coated with a carboxydextran shell. The suspension of Resovist is dark brown in color and has an osmolarity of 0.319 Osm/kg water. It’s T1 and T2 relaxation rates are about 25.4 mmol • 1$^{-1}$ • s$^{-1}$. Resovist was manually administered through a connecting tube to a 20 gauge intravenous catheter as a bolus injection over a period of 3-5s. Then, the connecting tube was flushed with 15ml of saline (0.9% NaCl). The dosage of Resovist was about 1.4mL for patients with ≥ 60kg body weight, and 0.9mL for patients with < 60kg body weight. The post-contrast imaging can be performed as early as 10min after bolus injection.

**Magnetic resonance imaging**

BH-TSE and ET-HASTE sequences with fat-saturation were performed on a 1.5T whole body system (Sonata, Siemens, Erlangen, Germany) with a phase-array torso coil. Before the MR examination, every patient was taught how to hold their breath during expiration for BH-TSE imaging and to breathe regularly and smoothly for ET-HASTE. Two acquisitions of BH-TSE were applied to acquire 20 to 24 axial slices to cover the whole liver. Other imaging parameters were TR of 2400ms, effective TE of 94ms, echo-train-length of 22, matrix of 256 × 160, slice thickness/gap of 6.0-7.0/1.2-1.4mm, one single average, rectangular field-of-view (FOV) and scan time of 20 – 22seconds per acquisition. Multi-slice ET-HASTE with echo train of 144 refocused 150˚RF pulses, echo space of 4.2 ms, and a sampling rate of 476 Hz per pixel was triggered manually during end-expiration under respiratory monitoring. The interval between image acquisitions for each slice was one breathing cycle for respiratory rate (RR) less than 15 per minute and two cycles for RR more than 16 per minute. The imaging parameters were infinite TR, effective TE of 62ms, matrix of 256 × 256, slice thickness/gap of 6.0/0mm, one single average, rectangular field-of-view (FOV) and one image acquisition time of 1 second. The number of slices was unlimited, which was dependent on the size of liver.

**Statistical analysis**

Quantitative and qualitative analyses were used for comparing the performance of these two pulse sequences. For quantitative analysis, the signal intensities of the operator-defined regions-of-interest (ROI) were measured in liver, hepatic lesions and background noise from pre- and post-contrast BH-TSE and ET-HASTE images. The background noise is the standard deviation of the ROI signal intensity measured outside of the anterior abdominal wall. For liver lesions, a circular region of interest was drawn to encompass as much of the lesion as possible. Only focal hepatic lesions with a diameter less than 1cm were not analyzed to exclude inaccuracy in measurement of SI due to high partial volume effect. Then, the following data were calculated: Signal intensity of lesion to noise ratio (SNR = SI$_{lesion}$ / SD$_{noise}$); and lesion-to-liver contrast-to-noise ratio (CNR = [SI$_{lesion}$ - SI$_{liver}$] / SD$_{noise}$); where SI represents signal intensity. All quantitative values were reported as mean ± SD. The student’s t test was used for paired data for quantitative evaluation between BH-TSE and ET-HASTE. In addition, the percentage of signal intensity loss (PSIL) in focal lesions was calculated (as PSIL = [SI$_{precontrast}$ - SI$_{postcontrast}$] / SI$_{precontrast}$) for determination of the regional uptake or Kupffer cellular activity after administration of Resovist. The paired t-test was employed to evaluate the statistical significance.

For qualitative analysis, both BH-TSE and ET-HASTE T2-weighted images before and after Resovist administration were reviewed separately by two experienced radiologists. After they completed their individual reviews, the observers then reviewed the images together and reached a consensus for all qualitative parameters. With regard to lesion conspicuity, sharpness and clarity, the image quality was subjec-
tively graded on a five-point scale: 1, unacceptable; 2, poor; 3, fair; 4, good; 5, excellent. Additionally, image artifact from motion or blood flow was also observed and graded as unacceptable, severe, moderate, mild and absent (with numerical scores of 1, 2, 3, 4 or 5).

Image ranking data were compared with a nonparametric test, the Mann-Whitney test.

**RESULTS**

<table>
<thead>
<tr>
<th>characteristics</th>
<th>TSE (No. = 16)</th>
<th>HASTE (No. = 16)</th>
<th>$p_1*$</th>
<th>$p_2*$</th>
<th>$p_3*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artifact</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>4.00 ± 0.63</td>
<td>5.00 ± 0.00</td>
<td>0.001</td>
<td>0.059</td>
<td>1.000</td>
</tr>
<tr>
<td>After</td>
<td>4.31 ± 0.60</td>
<td>5.00 ± 0.00</td>
<td>0.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharpness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>3.94 ± 0.85</td>
<td>3.63 ± 0.62</td>
<td>0.059</td>
<td>0.008</td>
<td>0.0001</td>
</tr>
<tr>
<td>After</td>
<td>4.81 ± 0.40</td>
<td>4.56 ± 0.51</td>
<td>0.157</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Wilcoxon signed-rank test
Abbreviation: $p_1$: comparing BH-TSE and ET-HASTE
$p_2$: comparing precontrast and postcontrast in BH-TSE
$p_3$: comparing precontrast and postcontrast in ET-HASTE

**Figure 1.** A 73 year old patient with HCC at right lobe liver. BH-TSE with TR/TE:2400/94ms (a, before Resovist administration, b, after Resovist administration) ET-HASTE with TR/TE 62ms (c, before Resovist administration, d: after Resovist administration) Before the Resovist administration, the overall image quality of lesion conspicuity and clarity with BH-TSE sequence was better than that with ET-HASTE sequence. After the Resovist administration, the lower signal intensity of liver parenchyma than focal lesion show better lesion conspicuity and clarity on BT-TSE, as well as ET-HASTE.
Qualitative evaluation – The summary of qualitative analysis is listed in Table 2. The overall image quality of lesion conspicuity, sharpness and clarity with BH-TSE sequence was significantly better than that with ET-HASTE sequence before Resovist administration, but there was no significant difference after Resovist administration, as shown in Fig. 1. However, there were significantly fewer artifacts from motion and blood flow on ET-HASTE images than on BH-TSE, either before or after Resovist administration. For 3 cases on BH-TSE, the motion artifact even hindered the detection and quantification of the focal lesions, as shown in Fig. 2.

Quantitative evaluation – Table 3 reveals the mean SNR and CNR of all focal liver lesions on both two T2-weighted sequences before and after Resovist administration. For all lesions, the SNR on ET-HASTE sequence was significantly higher than that on BH-TSE sequence before and after Resovist administration. For malignant lesions, the mean lesion-to-liver CNR on both BH-TSE and ET-HASTE sequences significantly increased after Resovist administration. The mean CNR of ET-HASTE sequence was significantly higher than that of ET-TSE after Resovist administration. For benign lesions, the mean lesion-to-liver CNR on ET-HASTE sequence was not significantly different between before and after Resovist administration. The mean CNR on BH-TSE sequence decreased after Resovist administration. The mean CNR was higher in ET-HASTE sequence than in ET-TSE sequence after Resovist administration, but there was no statistical significant.

Table 4 shows the mean PSIL of benign and malignant lesions after Resovist administration. The mean PSIL of malignant lesions were significantly lower than that of benign lesions on both BH-TSE and ET-HASTE sequence before and after Resovist administration. For malignant lesions, the mean lesion-to-liver CNR on both BH-TSE and ET-HASTE sequences significantly increased after Resovist administration. The mean CNR of ET-HASTE sequence was significantly higher than that of ET-TSE after Resovist administration. For benign lesions, the mean lesion-to-liver CNR on ET-HASTE sequence was not significantly different between before and after Resovist administration. The mean CNR on BH-TSE sequence decreased after Resovist administration. The mean CNR was higher in ET-HASTE sequence than in ET-TSE sequence after Resovist administration, but there was no statistical significant.

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Figure 2. A 77-year-old patient with hepatic hemangioma. Comparison of BH-TSE with TR/TE: 2400/94ms (a. before Resovist administration, b. after Resovist administration), and ET-HASTE with infinite TR/TE 62ms (c. before Resovist administration, d. after Resovist administration). Although the overall image quality of lesion conspicuity and clarity with BH-TSE sequence and ET-HASTE sequence was better, artifacts are present on BH-TSE. This artifact could influence quantitative measurement.
ET-HASTE. Furthermore, the mean PSIL values of BH-TSE sequence were significantly higher than that of ET-HASTE sequence in both benign and malignant lesions.

**DISCUSSION**

Conventional non-breath-holding or respiratory-triggered fast spin echo sequences have been widely used as a T2-weighted imaging technique for the detection and characterization of focal liver lesion. However, they are limited by image degradation due to motion artifacts and lengthy acquisition time. To overcome the limitation, various fast techniques have been developed which were proved to have a better diagnostic performance in lesion-to-liver contrast and detectability and to be free from motion artifacts [6-7]. BH-TSE and HASTE are two of the most popular fast imaging techniques allowing for acquisition of abdominal T2WI in a short time with better image quality, and are thus less vulnerable to motion artifacts.

**BH-TSE**

The fast imaging techniques of BH-TSE and HASTE based on the fast spin echo sequences allow for acquisition of abdominal T2WI in a short time and effectively reduce motion artifacts. The edge-blurring effect is one of the major drawbacks with fast spin echo sequences because relatively shorter TE produces a loss of signal for the larger k-space values which usually acquire later echoes [10]. The blurring edge effect of solid lesions is not obvious in the TSE sequence with the relatively long effective TEs in order of 90-100ms and the relatively short ETL in order of 20-25. The echo-train-length of HASTE was much longer (in order of 100 or more). Therefore, the blurring edge effect of solid lesions is often present on the HASTE images. The sequence properties would explain the better overall image quality of BH-TSE sequences in lesion conspicuity, sharpness and clarity in our study.

TSE sequences with a long echo-train-length produce much less sensitive to magnetic effect susceptibility than the usual gradient echo (GRE) T2* weighted sequences. However, as compared with HASTE sequences, BH-TSE sequences with a relatively shorter echo-train-length are more sensitive to susceptibility effect and can provide a higher signal intensity attenuation of liver and focal lesions. This may explain the results of the higher PSIL of liver and focal lesions on BH-TSE images than on ET-HASTE images after administration of Resovist, as shown in most of focal lesions in our study.

Though superior to ET-HASTE sequence in

---

**Table 3. Quantitative analysis for liver lesions before and after Resovist administration**

<table>
<thead>
<tr>
<th></th>
<th>BH-TSE</th>
<th>ET-HASTE</th>
<th>(p_1^*)</th>
<th>(p_2^*)</th>
<th>(p_3^*)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SNR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precontrast</td>
<td>28.3 ± 10.3</td>
<td>38.1 ± 15.5</td>
<td>0.00006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postcontrast</td>
<td>20.3 ± 10.2</td>
<td>28.7 ± 13.6</td>
<td>0.00003</td>
<td>0.00001</td>
<td>0.00009</td>
</tr>
<tr>
<td><strong>CNR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benign (n = 13)</td>
<td>8.8 ± 11.2</td>
<td>8.6 ± 13.5</td>
<td>0.483</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precontrast</td>
<td>6.9 ± 9.6</td>
<td>8.7 ± 14.0</td>
<td>0.174</td>
<td></td>
<td>0.464</td>
</tr>
<tr>
<td>Postcontrast</td>
<td>12.7 ± 9.6</td>
<td>12.0 ± 11.8</td>
<td>0.346</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malignant (n = 8)</td>
<td>16.0 ± 11.7</td>
<td>17.7 ± 14.6</td>
<td>0.094</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Paired-sample t-test
Abbreviation:  
\(p_1^*\): comparing BH-TSE and ET-HASTE  
\(p_2^*\): comparing precontrast and postcontrast in BH-TSE  
\(p_3^*\): comparing precontrast and postcontrast in ET-HASTE

**Table 4 PSIL for liver lesions after Resovist administration**

<table>
<thead>
<tr>
<th></th>
<th>BH-TSE</th>
<th>ET-HASTE</th>
<th>(p_1^*)</th>
<th>(p_2^*)</th>
<th>(p_3^*)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PSIL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benign</td>
<td>42.0 ± 17.2</td>
<td>37.2 ± 12.5</td>
<td>0.035</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malignant</td>
<td>16.0 ± 3.0</td>
<td>13.4 ± 3.3</td>
<td>0.027</td>
<td>0.00019</td>
<td>0.00026</td>
</tr>
</tbody>
</table>

* Paired-sample t-test
Abbreviation:  
\(p_1^*\): comparing BH-TSE and ET-HASTE  
\(p_2^*\): comparing benign lesions in BH-TSE  
\(p_3^*\): comparing malignant lesions in ET-HASTE
image quality and PSIL, BH-TSE sequence has some drawbacks. This fast imaging sequence effectively reduces the respiratory motion artifacts only in patients who can correctly hold their breath. In general, it is not easy to acquire motion-free images using BH-TSE sequence, especially in patients who are unable to hold their breath during the MR scan, as shown in Figure 2. In addition, shorter acquisition time restricts the spatial resolution of BH-TSE sequence. Quantitative measurement of the ROI signal intensity in MR images may be impaired by the lower spatial resolution, as well as other factors, such as the partial volume effect, spatial misregistration between the images acquired at different times, and motion or systematic-related artifacts in the images. For example, one FNH lesion appeared to require surgical resection because the calculated PSIL was 25.7% in BH-TSE T2WI, which was below the 30% threshold of the benign hepatic lesion [11].

**ET-HASTE**

HASTE sequence is an ultrafast imaging technique, allowing data acquisition in less than 1 second using a very long echo train followed a single 90° radiofrequency excitation. ET-HASTE sequence is made less sensitive to respiratory motion by manually external triggering at the end of expiration. This method is effective in achieving motion-free MR images. Therefore, no respiratory motion artifact was visualized on ET-HASTE images. In addition, there were four patients with better image quality by ET-HASTE sequence than by BH-TSE because motion artifacts degraded the image quality of the latter sequence, as shown in Figure 2. Meanwhile, though ET-HASTE might be substantially affected by edge-blurring effect, our results revealed that the image quality of ET-HASTE T2WI was better after Resovist administration than before, and was comparable to that of BH-TSE images after Resovist administration. Both the signal attenuation of liver parenchyma and the increase in lesion-to-liver CNR may lead to improvement of lesion conspicuity, sharpness and clarity after Resovist administration.

HASTE sequence encounters more MT and cross-talk effects than TSE sequence, because of the longer echo-train-length. However, the expiratory triggering technique provides a much longer interval between the image acquisitions for each imaging slice, usually longer than 3 seconds, than that of the time lag (TR/number of slices) in BH-TSE sequence. This longer time interval can effectively attenuate the MT effect induced by the off-resonance RF irradiation during the last slice acquisition. Our previous study demonstrated that ET-HASTE sequence is better than breath-hold HASTE in attenuating the MT effect with the same echo times [9]. In this study with shorter TE of ET-HASTE (62 ms), our results revealed that the mean SNR of focal liver lesions was higher in ET-HASTE than in BH-TSE. Although the mean CNR of ET-HASTE sequence was not significantly different from that of BH-TSE sequence before Resovist administration, it was significantly higher after Resovist administration.

ET-HASTE sequence is not only an ultrafast imaging technique, but also a free-breathing imaging technique. There is no tradeoff between the spatial resolution and the imaging time. Therefore, ET-HASTE can achieve smaller pixel size, thinner slice thickness and no gap between slices. By combining this advantage with the expiratory-triggered motion-free technique, we believe that quantitative measurements would be more reliable using ET-HASTE sequence than BH-TSE sequence. The PSIL of the FNH lesion surgically resected was about 38.9% measured in ET-HASTE, which was higher than the 25.7% measured in BH-TSE sequence and also the 30% threshold of the benign hepatic lesion. The reason for the false positive diagnosis in BH-TSE sequence might be explained by uncertainties in quantitative measurement of the ROI signal intensity in BH-TSE Resovist-enhanced liver MR images.

There were certain limitations in our study. First, the small sample size may have resulted in bias in statistical calculations. Second, most of our patients with focal liver abnormalities were unknown because pathologic results were not available. However, this bias probably did not significantly influence lesion evaluation, since this parameter was judged on the basis of multiplanar imaging modality and sequences. Furthermore, the aim of this study did not include characterization of lesions that would have lessened the need for pathologic proof. Another potential bias was related to the subjectivity of qualitative evaluation. The reviewers were not truly blinded to the sources of the pulse sequences evaluated because obvious differences existed between these two techniques.

In conclusion, Resovist-enhanced liver MRI with fast spin-echo T2-weighted images showed a slightly higher lesion-to-liver CNR than no contrast-enhanced MRI for detection of malignant lesions. It was also shown to be a useful diagnostic technique for lesion characterization of benign or malignant lesions. ET-HASTE technique provided good image quality without motion artifacts, and yielded high SNR and CNR, as well as accurate PSIL values for lesion char-
acterization. ET-HASTE generated images comparable with or better than those of BH-TSE technique in Resovist-enhanced liver MRI.

REFERENCES

注射Resovist之肝臟腫瘤磁振影像在閉氣性TSE與呼吸驅動HASTE臨床診斷效果之比較

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快速T2WI磁振造影技術是偵測肝臟局部腫瘤必備的重要技術。在本文中，主要是比較2種快速T2WI磁振造影技術（閉氣性TSE及呼吸驅動HASTE）在注射Resovist顯影劑後之肝臟腫瘤的偵測能力。共收集13個病人之21個腫瘤，進行顯影劑前後定性及定量的分析。在初步結果中，注射顯影劑前，閉氣性TSE有較高影像品質；但在注射顯影劑後，閉氣性TSE有比較高的PSIL，閉氣性TSE和呼吸驅動HASTE在影像品質方面並沒有太大的差別。在另一方面，呼吸驅動HASTE比較沒有移動性假影，而且在測量PSIL時比較可信賴；而且呼吸驅動HASTE有比較高的SNR；針對惡性腫瘤中，呼吸驅動HASTE也有比較高的CNR。本研究結果發現，在注射Resovist顯影劑後，呼吸驅動HASTE比閉氣性TSE有相同或更好的臨床診斷效果。

關鍵詞：鐵劑；肝臟腫瘤；磁振造影；磁振造影，比較研究；磁振造影，對比劑；磁振造影，半傳立葉影像