T2　　　　　　　　　　　MR　　　　　　　　　１

.　　　　.　　　　.　　　　.　　　²　　　.

:　　　　　　　　　　　　　　　　　　　　　　T2

.

: 51　　　　　,　　　　28 ,　　　69　　　2

T2

.　　　T2

,　　　,　　　　　　　,　　　T2

.　　Az

T2　　　　　　　　　　T2

.

:　　　　　　　　　　　　　　T2

,　　　,　　3cm　　　800%,

975%, 939%, 3cm　　92.3%, 950%, 935%　　,　　　T2

3cm　　867%, 1000%,

97.3%, 3cm　　92.3%, 1000%, 95.7%　　T2

.　　　Az　　　　　　　　　　　　.

:　　　　　　　　　　　　　　T2

.

T2

.

zation transfer effect)

T2

.

(13).

T2　　(intermediate) T2　　　　T2

,　　　(heavi-　　　.

ly) T2　　　　　　　　T2　　　　T2

(1-6), Gd-DTPA　　　　　T2

(7-12).　　　T2　　　(14), Ito　(7)　　T2

(5),　　　T2

(7).　　　　　　　　　　　　　,

.　　T2　　　　　　　　.

(magneti-　　　　　　　T2

: T2 MR

(n= 3) . (n= 1),
(n= 1),
(n= 1)
(n= 1) .

1996 12 1998 7 MR
,
, , ,
53
51
. 33 18 , 33-78 (:
52) .

97
. 14 22 ,
32 62 . 5
,
6 7 . 19
28 , 37 69 .
0.5-15cm (: 2.4cm) , 3cm 74
(: 15 , : 59) 3cm
23 (: 13 , : 10) .
19 15 , 3
, 1 .
1 ,
1 . 69
32 37 .
(n= 4)
(100-200ng/ml; 3 , 400ng/ml ; 5)
, TACE (transcatheter arte-
rial chemoembolization) lipiodol-CT
(n= 8), 400ng/ml

(n= 14), CT MR 5
(n= 9), CT MR
MR (n= 14) .
5
(n= 4), MR
MR CT
(n= 28) .

MR 1.5T MR (Magnetom vision;
Siemens, Erlangen, Germany) ,
(phase-array surface coil) . MR
MR T2
fast low angle shot (FLASH)
.
T2 90 180
(refocusing)
RARE (e-
cho train) 9 . 83 165msec k-
, k-
(higher-order phase encoding step)
, 83,165msec
(83,165 effective TE)
effective .
effective TE
83 165 T2 .
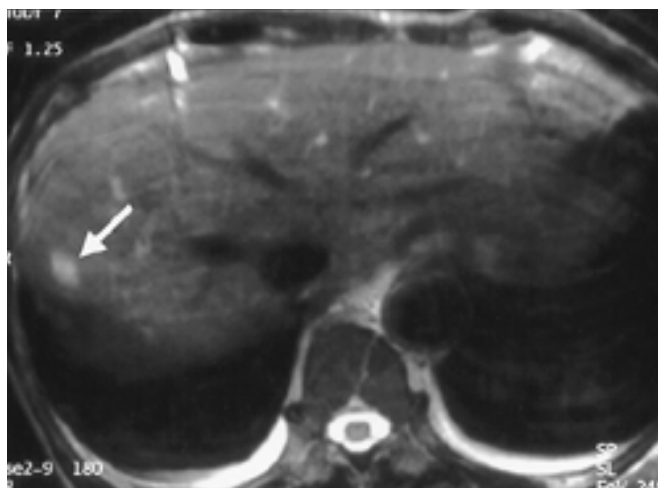(opposed-phase)
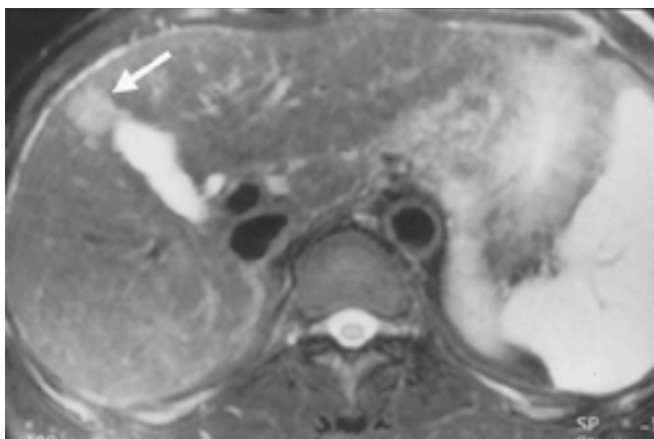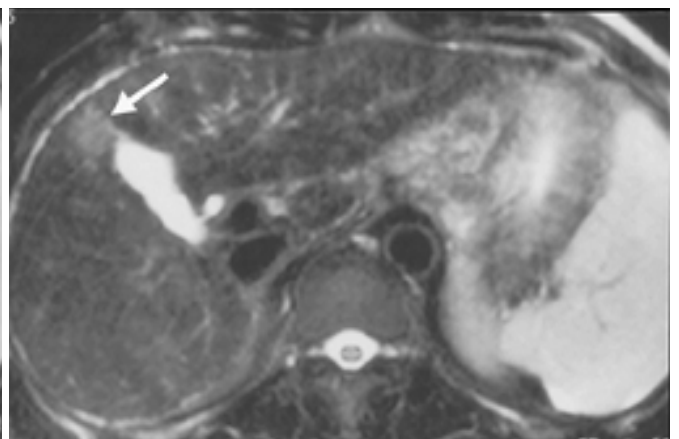
A   B

Fig. 1. Dual-echo T2-weighted TSE images of HCC.
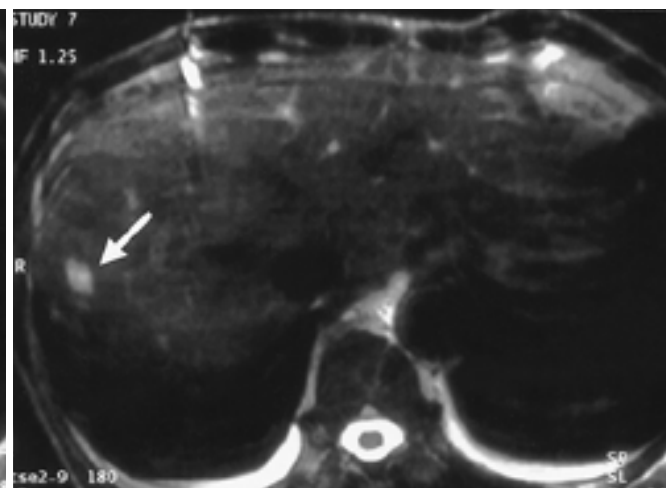A. Moderately T2-weighted TSE MR image shows a hyperintense lesion (arrow) in the liver.
B. On heavily T2-weighted TSE MR image, the signal intensity of the lesion (arrow) is decreased. So the relative signal intensity dif-
ference between the lesion and liver parenchyma is decreased compared with that shown in A.

FLASH   .   (op-
posed-phase) FLASH   , 0.1mmol Gd-DTPA   T2
(Magnevist, Shering Ag, Germany)   ,   T2
                    10cc   .   15   .
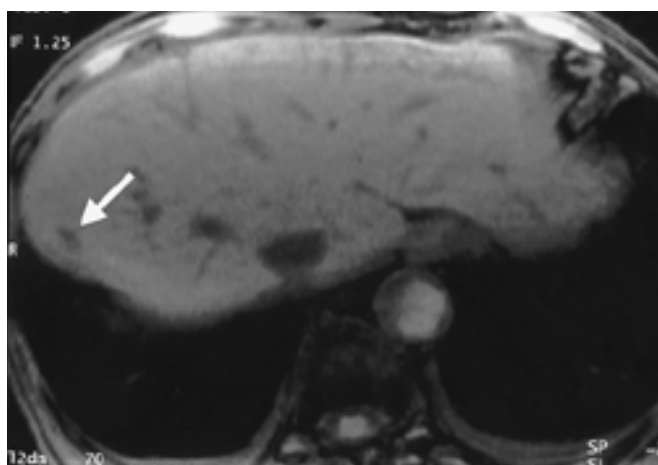   , 40   , 3   (imaging parameter)   .

A

B

C
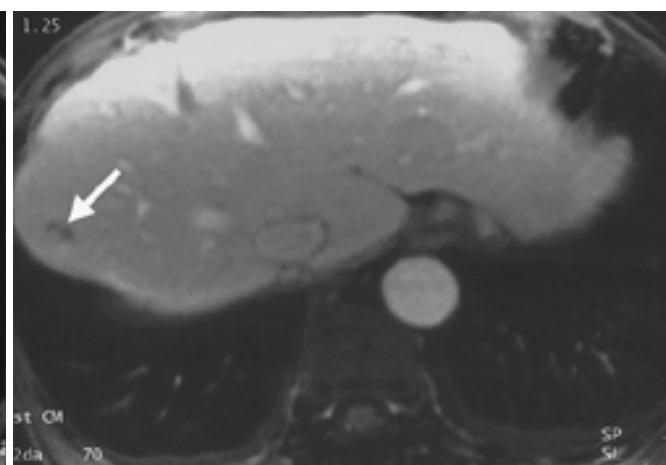
D
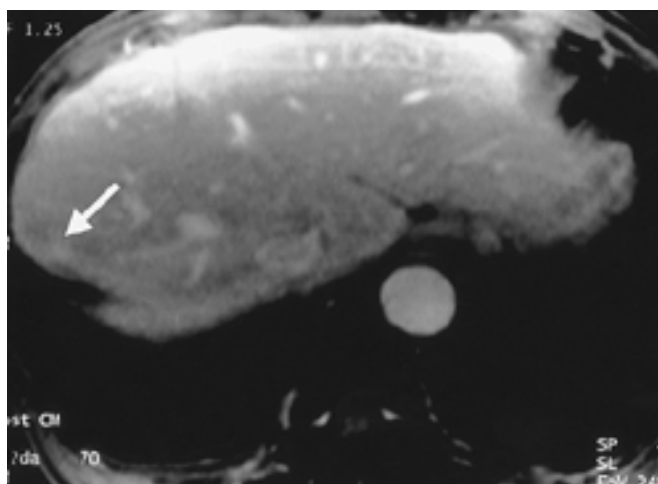
E

Fig. 2. MR images in a patient with hemangioma.
A. Moderately T2-weighted TSE MR image shows a small hy-
perintense lesion (arrow) in the right lobe of the liver.
B. On heavily T2-weighted TSE MR image, signal intensity of
the lesion is increased (arrow) compared with that shown in A.
C. Pre-enhanced FLASH MR image shows a small hypointense
lesion (arrow) in liver.
D. On portal-phased contrast-enhanced MR image, the lesion
(arrow) shows peripheral nodular enhancement.
E. On delay-phased dynamic contrast-enhanced MR image, the
lesion (arrow) shows homogeneous enhancement.

T2 TR 4500-5000
msec, TE 83,165msec; (bandwidth), 130Hz/
pixel; (field of view), 350mm; 3/4 (6/8)
matrix 108-198× 256 effective matrix
, 144-256× 256; , 7-11mm; , 0.7-3mm;
3-4 4 5 5 35
. FLASH
TR 105 213, TE 22 65; , 130
488Hz/pixel; (flip angle), 70 75 ; 3/4
(6/8) matrix 96-173× 256 effective
matrix , 128-231× 256; , 7-10mm; , 0.7-
3mm; 1 16-20
.

MR
. T2

T2
.

5 (five point scale)

T2 MR

, 1 , 2 , 3
, 4 , 5
. , , ,
.

MR
(sensitivity), (specifici-
ty), (accuracy) . 1,2
4,5 , 3
. , , .
= (/
) × 100, = (/
) × 100, = (
/
) × 100 .
T2

T2
Receiver op-
erating characteristic (ROC) curves .
,
.
area under each reader-specific binomial ROC (Az)
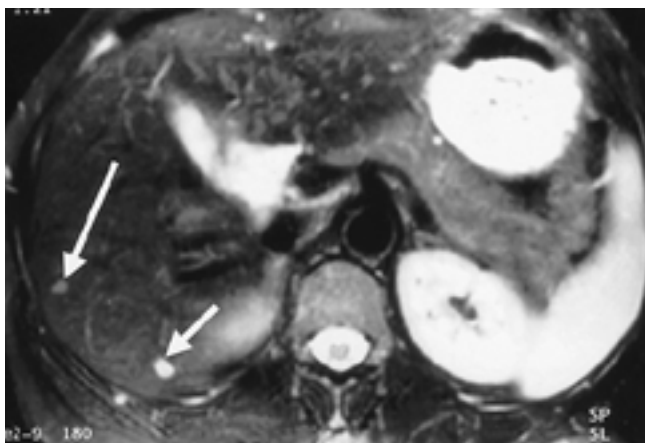
A
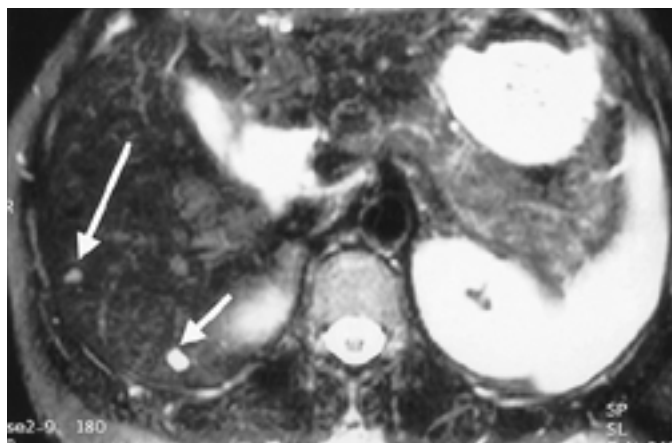
B
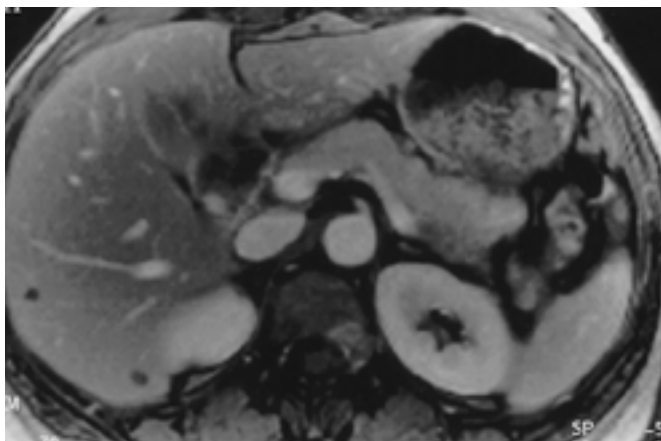
C

Fig. 3. MR images in a patient with simple hepatic cysts.
A. Moderately T2-weighted TSE MR image shows two small le-
sions in the right hepatic lobe. The larger lesion (short arrow)
shows high signal intensity, similar to that of CSF. But the signal
intensity of the smaller lesion (long arrow) is less than that of
the larger lesion.
B. On heavily T2-weighted TSE MR image, the both lesions (ar-
rows) show high signal intensity, similar to CSF.
C. On delay-phased contrast-enhanced MR image, the lesions
are not enhanced.

.   T2   ,   ,
T2   3cm   86.7%, 100%, 97.3%   3cm
                    Az   two-tailed Student t test   92.3%, 100%, 95.7%   T2
            . P- value   .05   .
                    .   Table 2   , 3cm   ,   3cm
                                                                              T2
        kappa (k) - statistics   T2
            . k   0   Az   .
        . k   0.00- 0.40   , 0.41- 0.75
        , 0.76- 1.00   .   T2   T2

                                                                        Az
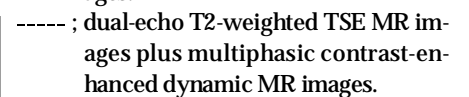   (p>0.05) (Fig. 4).
    Table 1   3cm   3cm   k   T2
                                  T2   0.889   ,   T2
                            T2
                                                                        0.897   .
                                            ,   ,
            .   T2
                                            ,   ,
    3cm   80.0%, 97.5%, 93.9%   (Fig. 1-
3), 3cm   92.3%, 95%, 93.5%   ,   .
    T2

Table 1. Differentiation of Solid Malignant Lesions from Nonsolid Benign Lesions on Dual-echo T2-weighted TSE MR Images and Dual-echo T2-weighted TSE MR Images Plus Multiphasic Contrast-enhanced Dynamic MR Images

	< 3cm (n=74)			3cm (n=23)		
	Reader 1	Reader 2	Mean	Reader 1	Reader 2	Mean
Dual-echo T2-weighted TSE						
sensitivity	73.3	86.7	80.0	84.6	100.0	92.3
specificity	96.6	98.3	97.5	90.0	100.0	95.0
accuracy	91.9	95.9	93.9	87.0	100.0	93.5
Dual-echo T2-weighted TSE plus Multiphasic Dynamic contrast-enhanced						
sensitivity	80.0	93.3	86.7	84.6	100.0	92.3
specificity	100.0	100.0	100.0	100.0	100.0	100.0
accuracy	95.9	98.6	97.3	91.3	100.0	95.7

Table 2. Reader's Az Values for Differentiation of Solid Malignant Lesions from Nonsolid Benign Lesions on Dual-echo T2-weighted TSE MR Images and Dual-echo T2-weighted TSE MR Images Plus Multiphasic Contrast-enhanced Dynamic MR Images

	overall (n=97)		< 3cm (n=74)		3cm (n=23)	
	Reader 1	Reader 2	Reader 1	Reader 2	Reader 1	Reader 2
Dual-echo T2-weighted TSE	0.898± 0.041	0.961± 0.026	0.895± 0.056	0.926± 0.048	0.862± 0.078	1.000± .000
Dual-echo T2-weighted TSE plus multiphasic dynamic Contrast-enhanced	0.911± 0.039	0.982± 0.018	0.900± 0.055	0.967± 0.033	0.923± 0.058	1.000± .000
P-value	0.593	0.177	0.872	0.156	0.176	1.000

Fig. 4. ROC curves display the observer's confidence in differentiating malignant hepatic lesions from benign hepatic lesions on the basis of dual-echo T2-weighted TSE MR images and on the basis of dual-echo T2-weighted TSE MR images plus multiphasic contrast-enhanced dynamic MR images.
A. Reader 1, overall size.
B. Reader 2, overall size.
C. Reader 1, less than 3cm in diameter.
D. Reader 2, less than 3cm in diameter.
——— ; dual-echo T2-weighted TSE MR images.
----- ; dual-echo T2-weighted TSE MR images plus multiphasic contrast-enhanced dynamic MR images.

      T2   (15).   T2   T2

    T2

         (1-6),   (13),

T2   - -   (signal to   T2

noise ratio)   2-4   , TE   .

            .   140msec   T2

     T2   T2

          (magnetiza-   ,   T2

tion-transfer effect)   T2

           (13), Shima   T2

     T2   (11),

    T2   60-120msec   T2

    (16). T2-   Ito   (17).   MR

   T2   T2

T2   T2   .

                      T2

    (13).   T2   ,

    T2   .

        Ito   (13)   T2

,   ,   T2   T2

       (7, 13)   ,

     ,   T2   , Ito   (13)   T2   T2

   Ito   (13)   .   T2

           ,

         .   ,

. Ito (13) T2 .

. (partial
volume averaging effect)

.

T2

T2

.

T2 k-

83mesc, 165msec ,

TE

T2 T2

. T2

T2 T2

.

Gd-DTPA

(7-12).

T2 T2

, T2

. T2 Ito

(13)

T2

.

, T2

3cm , 3cm

.

, T2

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T2

(islet cell tumor),

T2 T2

. T2

.

.

T2

T2

MR

.

T2

1. Li KC, Glazer GM, Quint LE, et al. Distinction of hepatic cavernous hemangioma from hepatic metastases with MR imaging. *Radiology* 1988;169:409-415

2. Lombardo DM, Baker ME, Spritzer CE, Blinder R, Meyers W, Herfkens RJ. Hepatic hemangiomas vs metastases: MR differentiation at 1.5T. *AJR* 1990;155:55-59

3. Wittenberg J, Stark DD, Forman BH, et al. Differentiation of hepatic metastases from hepatic hemangiomas and cysts by using MR imaging. *AJR* 1988;151:79-84

4. Choi BI, Han MC, Kim CW. Small hepatocellular carcinoma versus small cavernous hemangioma: differentiation with MR imaging at 2.0 T. *Radiology* 1990;176:103-106

5. McFarland EG, Mayo-Smith WW, Saini S, Hahn PF, Goldberg MA, Lee MJ. Hepatic hemangiomas and malignant tumors: improved differentiation with heavily T2-weighted conventional spin-echo MR imaging. *Radiology* 1994;193:43-47

6. Itoh K, Saini S, Hahn PF, Imam N, Ferrucci JT. Differentiation between small hepatic hemangiomas and metastases on MR images: importance of size-specific quantitative criteria. *AJR* 1990;155:61-66

7. Hamm B, Thoeni RF, Gould RG, et al. Focal liver lesions: characterization with nonenhanced and dynamic contrast material-enhanced MR imaging. *Radiology* 1994;190:417-423

8. Hamm B, Fischer E, Taupitz M. Differentiation of hepatic hemangiomas from metastases by dynamic contrast-enhanced MR imaging. *J Comput Assist Tomogr* 1990;14:205-216

9. Semelka RC, Shoenut JP, Kroeker MA, et al. Focal liver disease: comparison of dynamic contrast-enhanced CT and T2-weighted fat-suppressed, FLASH, and dynamic gadolinium-enhanced MR imaging at 1.5 T. *Radiology* 1992;184:687-694

10. Whitney WS, Herfkens RJ, Jeffrey RB, et al. Dynamic breath-hold multiplanar spoiled gradient-recalled MR imaging with gadolinium enhancement for differentiating hepatic hemangiomas from malignancies at 1.5 T. *Radiology* 1993;189:863-870

11. Low RN, Francis IR, Sigeti JS, Foo TKF. Abdominal MR imaging: comparison of T2-weighted fast and conventional spin-echo, and contrast-enhanced fast multiplanar spoiled gradient-recalled imaging. *Radiology* 1993;186:803-811

12. Berger JF, Laissy JP, Limot O, et al. Differentiation between multiple liver hemangiomas and live mtastases of gastrinomas: value of enhanced MRI. *J Comput Assist Tomogr* 1996;20:349-355

13. Ito K, Mitchell DG, Outwater EK, Szklaruk J, Sadek AG. Hepatic lesions: discrimination of nonsolid, benign lesions from solid, malignant lesions with heavily T2-weighted fast spin-echo MR imaging. *Radiology* 1997;204:729-737

14 Johnson BA, Fram EK, Drayer BP, Dean BL, Keller PJ, Jacobowitz R. Evaluation of shared-view acquisition using repeated echoes (SHARE): a dual-echo fast spin-echo MR technique. *AJNR* 1994;15:667-673

15. Goldberg MA, Hahn PF, Saini S et al. Value of T1 and T2 relaxation times from echoplanar MR imaging in the characterization of focal hepatic lesions. *AJR* 1993;160:1011-1017

16. Schima W, Saini S, Echeverri JA, Hahn PF, Harisinghani M, Mueller PR. Focal liver lesions: characterization with conventional spin-echo versus fast spin-echo T2-weighted MR imaging. *Radiology* 1997;202:389-393

17. Saini S, Nelson RC. Technique for MR imaging of the liver. *Radiology* 1995;197:575-577

Utility of Dual Echo T2-Weighted Turbo Spin Echo MR Imaging for Differentiation of Solid, Malignant Hepatic Lesions from Nonsolid, Benign Hepatic Lesions[1]

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Purpose : To evaluate the additive value of multiphasic contrast-enhanced dynamic MR imaging as a supplement to dual-echo T2-weighted TSE MR imaging for the differentiation of solid, malignant hepatic lesions from nonsolid, benign hepatic lesions .

Materials and Methods : Two radiologists retrospectively reviewed dual-echo T2-weighted TSE MR images and gadolinium-enhanced MR images in 51 patients with hepatic lesions (28 malignant, 69 benign). For the differentiation of malignant from benign lesions, as seen on dual-echo T2-weighted TSE MR images, we evaluated sensitivity, specificity, and accuracy, and compared with the results with those for dual echo T2-weighted MR images plus multiphasic contrast-enhanced dynamic MR images. In addition, Az values for dual echo T2-weighted MR images were compared with those for dual echo T2-weighted MR images plus multiphasic contrast-enhanced dynamic MR images.

Results : For the differentiation of malignant from benign hepatic lesions, as seen on dual-echo T2-weighted TSE images, sensitivity, specificity, and accuracy were 80.0 %, 97.5 %, and 93.9 %, respectively, for lesions less than 3 cm in diameter, and 92.3 %, 95.0 %, and 93.5 %, respectively, for those that were 3 cm or larger. The results for dual-echo T2-weighted MR imaging plus multiphasic contrast-enhanced dynamic MR imaging were 86.7 %, 100.0 %, and 97.3 %, respectively, for lesions less than 3 cm, and 92.3 %, 100.0 %, and 95.7 %, respectively for those that were 3 cm or larger. There were no significant differences in sensitivity, specificity, or accuracy between the results obtained using dual-echo T2-weighted MR imaging and those obtained with dual-echo T2-weighted MR imaging plus multiphasic contrast-enhanced dynamic MR imaging. Nor were there statistically significant differences in Az values between the two groups.

Conclusions : For the differentiation of solid, malignant hepatic lesions from nonsolid, benign hepatic lesions, there is no difference in accuracy between dual-echo T2-weighted TSE MR imaging and the additional use of multiphasic contrast-enhanced MR imaging. Dual-echo T2-weighted TSE MR imaging may, therefore, be useful for the differentiation of solid, malignant hepatic lesions from nonsolid, benign hepatic lesions without the use of multiphasic contrast-enhanced MR imaging.

Index words : Liver, MR
Liver, neoplasms
Magnetic resonance (MR), pulse sequences
Magnetic resonance (MR), contrast enhancement

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