Original Research Article

Comparison of diffusion weighted magnetic resonance imaging and T2 weighted imaging in focal liver lesions

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Abstract

Background: Focal liver disease is a common diagnostic problem referred to radiologists for evaluation owing to its nonspecific clinical presentation and marked inter-observer variation on clinical examination. Diffusion weighted imaging (DWI) is another mechanism for developing image contrast and relies on changes in the diffusion properties of water molecules in tissues. Diffusion images should be interpreted in conjunction with conventional sequences. In patients who cannot receive gadolinium based contrast agents, DW MR imaging has the potential to be a reasonable alternative technique to contrast-enhanced imaging. Thus a study design for comparison of diffusion weighted magnetic resonance imaging and T2 weighted imaging in focal liver lesions is conducted. **Aims and Objectives:** Comparison of diffusion weighted magnetic resonance imaging and T2 weighted imaging in focal liver lesions. **Materials and Methods:** Total 60 Patients were studied during period of October 2010 to August 2012. Diagnosis on MRI was made with background of clinical context. Final diagnosis was reached in consensus with biopsy/FNAC, wherever applicable, or clinical, laboratory, other imaging modality findings and follow up. **Results:** DWI was associated with significantly higher detection rate of all FLLs when compared to T2WI ($p<0.001$). DWI significantly improved the detection of FLLs when compared to T2WI. DWI was significantly better than T2W imaging in terms of detection for both lobes RL-99.3% Vs 83.92%, LL-91.87% Vs 86.18% respectively. Significant difference between proportion of detection T2WI and DWI for all lesion and malignant lesions was observed. In present study DWI was associated with significantly higher detection rate of metastatic lesions ($P<0.001$) when compared to T2WI. **Conclusion:** DWI was significantly better than T2W imaging in terms of detection of focal liver lesions.

Key Word: Diffusion Weighted Magnetic Resonance Imaging, T2 Weighted Imaging, Focal Liver Lesions.

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INTRODUCTION

Focal liver disease is a common diagnostic problem referred to radiologists for evaluation owing to its nonspecific clinical presentation and marked inter-observer variation on clinical examination. Focal hepatic lesions include a large gamut of both benign and malignant lesions such as hepatic cysts, liver abscesses, haemangioma, adenoma, focal nodular hyperplasia, hepatocellular carcinoma, hepatoblastoma, metastases etc. Today, focal liver lesions are diagnosed using ultrasonography (USG) and/or computed tomography (CT). Additionally, magnetic resonance imaging (MRI) is preferred when further characterization of these masses is

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needed. MRI has many advantages (e.g., high contrast resolution, the ability to obtain images in any plane, lack of ionizing radiation and the safety of using particulate contrast media rather than those containing iodine) that make it a favoured modality. Lesion morphology, signal intensity, and contrast enhancement pattern are taken into consideration when characterizing focal liver lesions with MRI; however, even if the data are evaluated together, there can still be difficulties in the differentiation of benign and malignant lesions. Although dynamic contrast enhanced examinations have become a routine component of abdominal imaging, the high cost/benefit ratio and risk of contrast media side effects remain an issue. Moreover, sometimes it is not possible to distinguish between highly vascular metastases and haemangiomas, even using dynamic examinations.[1] Diffusion weighted imaging (DWI) is another mechanism for developing image contrast and relies on changes in the diffusion properties of water molecules in tissues.[2] Stejskal and Tanner[3] were the first to describe an MR experiment that could be used to observe and measure water diffusion. They modified a standard T2-weighted imaging sequence by applying a symmetric pair of diffusion-sensitizing gradients on either side of the 180° refocusing pulse. Diffusion coefficients in DWI are reflected in the *apparent diffusion coefficient* (ADC, expressed in mm^2/s).[2] Restricted or impeded diffusion is seen in tissues with high cellularity, e.g. tumors, abscesses, fibrosis and cytotoxic edema. Relative free or unimpeded diffusion is encountered in tissues with low cellularity or tissues with disrupted cell membranes, for example in cysts and necrotic tissues. DWI relies on measuring diffusion of water molecules in the tissue by MRI. It uses a pulse sequence (T2-weighted spin echo sequence) and 2 strong motion probing gradients on either side of the 180º refocusing pulse, known as the Stejskal-Tanner sequence[3]. Diffusion images should be interpreted in conjunction with conventional sequences. In patients who cannot receive gadolinium based contrast agents, DW MR imaging has the potential to be a reasonable alternative technique to contrast-enhanced imaging.[4] Thus a study design for comparison of diffusion weighted magnetic resonance imaging and T2 weighted imaging in focal liver lesions is conducted.

MATERIAL AND METHODS

Size: Total 60 Patients were studied during period of October 2010 to August 2012. Diagnosis on MRI was made with background of clinical context. Final diagnosis was reached in consensus with biopsy/FNAC, wherever applicable, or clinical, laboratory, other imaging modality findings and follow up.

Inclusion criteria: All patients referred to the department of Radio diagnosis. Patients of all age groups referred to MRI clinically suspected of focal liver lesions. Patients with indeterminate lesions detected on USG or CT.

Exclusion Criteria: All patients having cardiac pacemakers, prosthetic heart valves, cochlear implants or any metallic implants. Patient having history of claustrophobia. All patients who do not consent to be a part of the study.

Data Analysis: Patients with more than ten lesions, only larger ten lesions were considered in the study. Results expressed as mean, standard deviation, number and percentages. One-way ANOVA was used for multiple group comparison and student unpaired 't' test for 2 group comparison. Categorical data was analyzed by chi-square test. p-value of 0.05 or less was considered for statistically significant.

Machine: 1.5 Tesla GE – SignaHdxt MRI machine.

OBSERVATIONS AND RESULTS

A total of 60 patients with 267 focal liver lesions were studied. Age range was of 16-95 years. Mean age was 52.75 years. Out of 60 patients 31 patients had benign lesions and 29 patients had malignant lesions. 28.33% of patients were in age group of less than 40 years, followed by 26.67% in the age group of 61-70 years. Most malignant lesions were seen in the age group of 61-70 years. Most of the HCC were seen in the age group of 61-70 years. All lesions were common in males namely HCC (66.67%), metastasis (58.82%), simple cysts (71.42) except haemangiomas and hydatid cysts which were equally seen in males and females. Out of 267 focal liver lesions in 60 patients, 101(37.83%) were benign lesions and 166(62.17%) were malignant lesions. Most common lesion was metastasis (52.8%). Maximum numbers of lesions were between 2.1-5.0cm. Average size of lesion was 3.72 ± 2.39 cm. Most of the metastasis haemangiomas, and simple cysts were in the range of 2 to 5cm.

Table 1: Detection Rate Of Focal liver lesions in 60 Patients (267 lesions) with DWI and T2 weighted imaging.

Total no. of lesions	T2WI	DWI	p-value
267	227	256	0.0002
100%	85.39%	95.58%	

DWI was associated with significantly higher detection rate of all FLLs when compared to T2WI ($p<0.001$). DWI significantly improved the detection of FLLs when compared to T2WI.

Table 2: Determination of 267 Focal liver lesions in 60 Patients With DWI and T2WI Stratified By Location (RI/LI)

Parameter	RL (143)		LL(123)		Hilum(1)	
	No	%	No	%	1	%
DWI	142	99.30	113	91.87	1	100.0
T2WI	120	83.92	106	86.18	1	100.0

DWI was significantly better than T2W imaging in terms of detection for both lobes RL-99.3% Vs 83.92%, LL-91.87% Vs 86.18% respectively. There was significant difference for detection rate with DWI between right and left lobe (99.30% Vs 91.87%) There is significance by using Fisher's exact test i.e. there is association between location and detection by DWI. p-value was 0.0003.

Table 3: Detection Rate Of Benign And Malignant Focal liver lesions in 60 Patients (267 Lesions) With DWI And T2 Weighted Imaging

Parameter	All lesions	Malignant	Benign
Total	267	166	101
T2WI	227	128	99
DWI	256	162	94
p-value	0.0002*	< 0.001*	0.184

* Significant

By using 2 sample proportion test i.e. significant difference between proportion of detection T2WI and DWI for all lesion and malignant lesions

Table 4: Lesion Detection Rate Stratified by Size

1. T2WI

Size	T2WI Findings		Total	p-value
	Positive	Negative		
≤ 2.0	28	40	68	
2.1– 5.0	145	0	145	< 0.001
> 5.0	54	0	54	

Conclusion: By using Fisher's exact test p-value <0.05 therefore there is significant association between T2WI findings and size of lesion.

2. DWI

Size	Diffusion		Total	p-value
	Positive	Negative		
≤ 2.0	57	11	68	**<0.001**
2.1 – 5.0	145	0	145	
> 5.0	54	0	54	

Conclusion: By using Fisher's exact test p-value < 0.05 therefore there is significant association between DWI findings and size of lesion.

	Positive	Negative	Total	p-value
T2WI	227	40	267	0.001*
DWI	256	11	267	

*Significant (2 sample proportion test used)

The detection rate was stratified according to the lesion size. There was significant difference only for detection of FLLs with the diameter of less than 2 cm (p<0.001). No significant difference between DWI and T2WI for FLLs more than >2 cm.

Table 5: Individual Case Detection Rate Of Focal liver lesions in 60 Patients (267 Lesions) With Dw And T2 Weighted Imaging

	Number of lesion	T2WI detected	Diffusion detected	P value
HCC	23	19 (82.61%)	22 (92.65%)	0.613
Mets	140	106 (75.71%)	137 (97.68%)	< 0.001*
CholangioCa	3	3 (100.0%)	3 (100.0%)	-
Haemangioma	32	32 (100.0%)	32 (100.0%)	-
Simple cyst	51	49 (96.08%)	46 (90.20%)	0.464
Hydatid cyst	3	3 (100.0%)	3 (100.0%)	-
Abscess	13	13 (100.0%)	13 (100.0%)	-
Dysplastic nodule	2	2 (100.0%)	0	-

* Significant

2 sample proportion test used In present study DWI was associated with significantly higher detection rate of metastatic lesions (P<0.001) when compared to T2WI. HCCs did not show significant detection rate, because most of HCCs were in more than >2cm in size.

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Table 6: Number of Focal liver lesions missed on DWI And T2WI

	Number of lesion	T2WI	Diffusion
HCC	23	4 (17.39%)	1 (17.39%)
Mets	140	34 (24.29%)	3 (2.14%)
Cholangio Ca	3	0	0
Haemangioma	32	0	0
Simple cyst	51	2 (3.92%)	5 (9.80%)
Hydatid cyst	3	0	0
Abscess	13	0	0
Dysplastic nodule	2	0	2 (100.0%)

Total 11 lesions were missed on DWI including 1 HCC, 3 Mets, 5 Simple cysts, and 2Dysplastic nodules. Total 40 lesions were missed on T2W imaging including 2 HCC, 34 Mets, and 2 Simple cysts.

DISCUSSION

A total of 60 patients (267 focal liver lesions) were studied. Diagnosis on MRI was made with background of clinical context. Final diagnoses was reached in consensus with biopsy/ FNAC, wherever applicable, or clinical, laboratory, other imaging modality findings and follow-up. Patients with more than ten lesions, only larger ten lesions were considered in the study.

Comparison with T2-weighted imaging:

Out of 267 lesions in 60 patients 256(95.58%) lesions were detected on DWI and 227(85.39%) were detected on T2W. DWI was associated with significantly higher detection rate of all focal liver lesions when compared to T2W ($p<0.001$). DWI MRI significantly improved the detection of FLLs when compared T2WI. These findings are comparable to Parikh *et al*[5] The number of malignant FLLs detected with DWI (62 out of 63 – 98.4%) was highly significant than that detected with T2 WI ($P <0.001$). However, there was no significant difference between the T2 weighted imaging and DWI for the detection of HCCs alone. This result was different from a previous study Parikh *et al*[5]. In our study, 19 of 23 (82.61%) HCCs were detected on T2 weighted imaging and 22 of 23 (92.65%) on DWI. There was no significant difference with $p=0.061(p>0.05)$. These findings where similar to PalmucciS, *et al*.[6] This may be explained by the different signal intensity observed in these lesions: in fact, in a recent study by Kim *et al* they were isointense or hyperintense to the liver. In a cirrhotic liver, HCCs may show the same signal intensity as the surrounding parenchyma, involved in a chronic fibrotic process, and as a consequence the detection and characterization of HCCs may be difficult Kim *et al*[7]. This may also be due to their sizes; most of these lesions were in the group of more than 2cms. In our study DWI detection rate was significant in lesions less than 2cms. There was no difference determined between the use of T2 weighted imaging and DWI for the detection of benign hepatic lesions in our study. This result was different from a previous study Parikh *et al*[5]. In our study 99 of 101(98.01%) benign hepatic lesions were detected on T2 weighted images and 94 of 101(93.06%) on DWI. These findings were comparable to Yang DM *et al*[8] However, in a study by Parikh *et al*[5], 83.3% of benign hepatic lesions were detected on T2 weighted images and 90% of benign hepatic lesions were detected on DWI. We think that this difference is due to a different lesion distribution between the two studies. All of the benign lesions in our study were cystic lesions including haemangiomas and cysts. Conversely, benign hepatic lesions in the study by Parikh *et al*[5] were composed of both solid and cystic lesions including haemangiomas, cysts, adenomas, liver abscesses, focal nodular hyperplasia and intrahepatic haematomas. Haemangiomas and cysts are usually detected on T2 weighted images. However, a small benign solid tumour might not be detected on T2 weighted images because of less conspicuity of the solid lesions by the magnetisation transfer (MT) effect.[9]

Stratification By Lesion Location: DWI was significantly better than T2W imaging in terms of detection for both lobes RL-99.3% Vs 83.92%, LL-91.87% Vs 86.18% respectively. There was significant difference for detection rate with DWI between right and left lobe (99.30% Vs 91.87%). p-value 0.0003. There is significance by using Fisher's exact test i.e. there is association between location and detection by DWI. These findings are comparable to Parikh *et al*.5 Kim *et al*.10 Significant difference in detection rate between right and left lobe could be due to DWI is vulnerable to other kinds of motions producing artefacts. In this study 1 HCC, 5 simple cysts and 3 metastasis could not be detected using DWI, because of its extreme sensitivity to the physiological motion of cardiac pulsation and smaller

size. These findings are comparable to Ref Kim *et al*[11], D J Kim *et al*[12]

Missed Lesions: Total 11 lesions were missed on DWI including 1 HCC, 3 Mets, 5 Simple cysts, and 2 Dysplastic nodules. This could be due to their location in left lobe or subdiaphragmatic region because of distortion artifacts and most of them were smaller than 1cm. 2 dysplastic nodules were isointense and could not be visualized. These findings are comparable to Kim *et al*[11], D J Kim *et al*[12].

Lesions detection rate stratified by size: The detection rate was stratified according to the lesion size. In lesion less than 2 cm range, DWI detected 57 of 68 (83.82%) lesions whereas T2WI detected 28 of 68(41.17%) lesions. There was significant difference only for detection of FLLs with the diameter of less than 2 cm ($p<0.001$). No significant difference between DWI and T2WI for detection of FLLs more than >2 cm in size. Parikh *et al*[5] study showed that DW MR imaging significantly improved detection of small malignant lesions less than 2 cm when compared with breath hold T2-weighted imaging (78.5% vs.45.8%, P<.001). Several publications have reported the use of DW MR imaging for liver lesion detection.[5] Few of these studies have compared DW MR imaging and T2-weighted imaging in terms of lesion detection, generally showing improved detection with DW MR imaging, in terms of image quality, findings showed comparable image quality with that of DW MR imaging by using low b values.[13]

CONCLUSION

DWI was associated with significantly higher detection rate of all FLLs when compared to T2WI ($p<0.001$). DWI significantly improved the detection of FLLs when compared to T2WI. DWI was significantly better than T2W imaging in terms of detection for both lobes RL-99.3% Vs 83.92%, LL-91.87% Vs 86.18% respectively (p-value 0.0003). There is significance by using Fisher's exact test i.e. there is association between location and detection by DWI. By using 2 sample proportions test i.e. there is significant difference between T2WI and DWI for detection of malignant lesions. There was no difference determined between the use of T2 weighted imaging and DWI for the detection of benign hepatic lesions in our study. There was significant difference only for detection of FLLs with the diameter of less than 2 cm ($p<0.001$). No significant difference between DWI and T2WI for FLLs more than >2 cm.

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