**Original Article**

# A STUDY OF DIAGNOSTIC VALUE OF DIFFUSION WEIGHTED MAGNETIC RESONANCE IMAGING IN DIFFERENTIATION OF BENIGN AND MALIGNANT FOCAL LIVER LESIONS

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**ABSTRACT:**

**Background:**

Focal liver lesions are a group of heterogeneous pathologies ranging from solitary benign lesions to multiple metastases. The MRI imaging modality is most accurate in characterizing these lesions, especially Diffusion weighted imaging (DWI) sequence.

**Objectives:** To evaluate the role of DWI in detecting focal liver lesions and to assess its role in differentiating benign from malignant lesions.

**Materials and methods:**

Hospital based cross-sectional study conducted on 94 patients with focal liver lesions who underwent DWI MRI.

**Results:**

A total of 94 patients having focal liver lesions were identified, ADC values were calculated for the focal liver lesions which were as follows, HCC: 1.073+/-0.13 x $10^{-3}mm^2$/sec, hemangioma:1.842+/-0.18 x $10^{-3}mm^2$/sec, hepatic cyst:2.953+/-0.17 x $10^{-3}mm^2$/sec, metastasis:1.084+/-0.15x $10^{-3}mm^2$/sec, liver abscess:1.790+/-0.18x$10^{-3}mm^2$/sec and hydatid cyst:3.055+/-0.22x $10^{-3}mm^2$/sec.

**Conclusion:**

Apparent diffusion coefficient values of some of the benign lesions were seen to overlap with ADC values of malignant lesions, hence interpretation of focal liver lesion with Diffusion weighted images along with conventional MR sequences should be followed.

**Keywords:** Apparent diffusion coefficient, Diffusion weighted imaging

## INTRODUCTION

The liver is an organ in which various benign or malignant, primary or secondary focal liver lesions(FLL) can occur. FLLs are solid or cystic masses or areas of tissue that are identified as an abnormal part of the liver.

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The term "lesion" rather than "mass" was chosen because "lesion" is a term that has a wider application, including solid and cystic masses[1]. Focal liver lesions are group of heterogeneous pathologies ranging from solitary benign lesions to multiple metastases from a variety of primary tumours. With the advent of imaging modalities like USG, triple Phase CT-scan and MRI, the rate of detecting focal liver lesions has increased[2]. The MRI imaging modality

is most accurate in characterizing these lesions, especially DWI sequence. Molecular level of information of tissues which gives structural and functional information is obtained by DWI and also it helps in assessing the treatment response in tumor cells. In DWI measurement of diffusion properties of water molecules within tissues is done, thus giving contrast to the tissues. Diffusion is expressed in an Apparent Diffusion Coefficient (ADC), which reflects the diffusion properties unique to each type of tissue.

**Principle of DWI:**

**Diffusion:**

The liver lesion identification and characterization can be more specifically done by DWI imaging, this is due to the high contrast resolution of DWI MRI. The diffusion weighted imaging is based on the principle of free movement of water molecules in the body. The random movement of the water molecules in the unrestricted space is called as Brownian movement or free diffusion. The random movement of water molecules are driven by their thermal energy [2]. The Brownian movement of water molecules is not same in the biological tissues as in unrestricted environment, because of the restriction of movement due to tissue compartments, cell membranes and cell organelle. So these molecular movements within the tissue are categorized into intravascular, intracellular or extracellular movements. There may be restriction or impedance to the free movement of the water molecules in the tissues which depend on the intact cell membranes, tissue cellularity, and tissue viscosity. In tissues where there is high cellularity like in tumor, cytotoxic edema, abscess and fibrosis, the movement of the water molecules is restricted. In conditions like tissues with low cellularity, vasogenic edema and disrupted cell membranes there will be increased movement of the water molecules.

**DWI:**

Diffusion of water molecules in the tissues are measured in MRI which is known as DWI.DWI uses a basic T2 weighted spin echo sequence, which has a 90° RF pulse followed by 180° RF pulse, on either side of 180° refocusing pulse, two strong motion probing gradients are applied. Small amount of motion of water at microscopic level can be picked up by the DWI and the sensitivity of the DWI sequence is characterized by its b value. The b- value is a factor that reflects the strength and timing of the gradients used to generate diffusion weighted in $mm^2$/ sec. as the b value increases the sensitivity for the sensing diffusion of water molecules increases.

Quantitative reflection of diffusion is termed as diffusion coefficient. The molecular mobility of water molecules which intern depends on extracellular space, viscosity and cellularity is depicted in quantitative form as apparent diffusion coefficient (ADC). Apparent because it is a mean value of diffusion contributed by movement of intracellular, extracellular and vascular water molecules within an image voxel (volumetric pixel) at different b-values[9]. The ADC values calculated for each voxel will be automatically displaced in the mapping format called ADC map (available in most of the scanners). The values of ADC will be low if the diffusion of water molecules are restricted like in tumor cases and ADC will be high in the conditions where water molecules are freely moving like cysts.

**Diffusion in pathological (Liver) conditions.**

In pathological conditions like in focal liver lesions, the DWI with ADC mapping plays a very important role in characterizing the lesion into benign and malignant variety due to its qualitative and quantitative assessment [3]. In conditions like tumor, fibrosis, the number of cells will be more

leading to less extracellular space to movement of water molecules thus leading to diffusion restriction and low values of ADC. In conditions of low cellularity there will be fewer structural barriers, leading to diffusion path longer. This results in low diffusion restriction and high ADC values.

## OBJECTIVES

To evaluate the role of DWI in detecting focal liver lesions and to assess its role in differentiating benign from malignant lesions.

## MATERIAL AND METHODS

### Study population:

The study was conducted under an approval by the institutional review board. Data for the study was collected from the patients referred to the department of radio-diagnosis at S. S institute of medical sciences and research Centre with focal liver lesions, over a period of one year

### Inclusion Criteria:

•Patients undergoing evaluation in our department found to have focal liver lesion/ lesions.
•Patients with diagnosed focal liver lesion/ lesions through various methods (histopathology/ LIRADS / Biochemical)

### Exclusion Criteria:

•Patients with metallic implants, cardiac pacemakers, cochlear implants.
•Patients who were claustrophobic, unwilling for imaging.

## RESULTS:

In our study total 65(69%) patients were males and 29(31%) were females.
Among our 94 cases males predominated (69%). Higher number of patients were in the age group of 51-60 years (29 patients). The oldest patient was of age70 year and the youngest was of age 21year.

Different focal liver lesions were studied like HCC, metastasis, hemangioma, abscess, simple hepatic cysts and hydatid cysts. Out of these focal liver lesions most common lesion were hepatocellular carcinoma and hemangioma. Table-1 shows the number of patients with different focal liver lesions.

**Table 1. Distribution of cases among focal liver lesions**

| Diagnosis | Number of patients | Percentage (%) |
|---|---|---|
| Hepatocellular carcinoma | 26 | 27.6 |
| Hemangioma | 21 | 22.3 |
| Hepatic cysts | 15 | 15.9 |
| Metastasis | 13 | 13.8 |
| Abscess | 10 | 10.6 |
| Hydatid cysts | 9 | 9.5 |

Out of 94 patients studied 55 patients (58.5%) were benign and 39 (41.4%) were malignant.
90% of the abscesses and 88% of the hydatid cysts were in males and hemangiomas were almost equal in males and females.

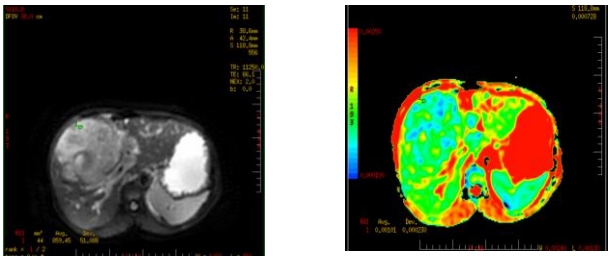
**Table 2. ADC value of different FLL**.

| Liver lesions | ADC value ($mm^2$/ sec) |
|---|---|
| Hemangioma(Fig 3 a and b) | $1.842+/-0.18 \times 10^{-3}$ |
| Abscess | $1.790+/-0.18 \times 10^{-3}$ |
| HCC(Fig 2 a and b) | $1.073+/-0.13 \times 10^{-3}$ |
| Hepatic cyst(Fig 4 a and b) | $2.953+/-0.17 \times 10^{-3}$ |
| Metastasis(Figure 1a and b) | $1.084+/-0.15 \times 10^{-3}$ |
| Hydatid cyst | $3.055+/-0.22 \times 10^{-3}$ |

In the present study, all the HCC lesions were showing hyperintense signal on DWI at 500 b

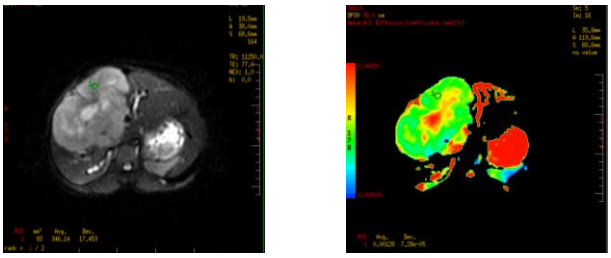
value and hypointense on ADC map suggesting restricted diffusion. All the metastasis showed similar findings as HCC. In some cases where predominantly necrotic tissue was seen, DWI and ADC map showed heterogenous hyper/ hypointensity. Other focal liver lesions like abscess, hepatic cysts and hydatid cysts and hemangiomas showed diffusion restriction of DWI and hypointense on ADC map, and a few (4 out of 21patients) of the hemangiomas were of heterogenously hyperintense on DWI with heterogenously hypointense on ADC map.

In the current study out of 94 patients, it was observed that most of the focal liver lesions were showing diffusion restriction with highest mean ADC values in the benign lesions. The mean ADC values are mentioned in the table 2.



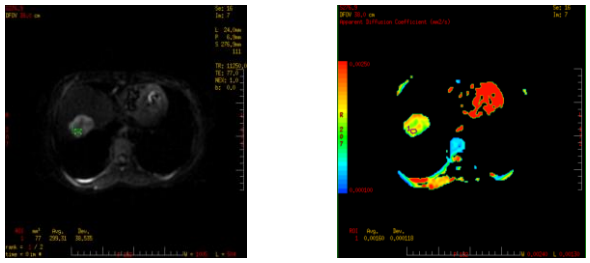
a b

Fig1 a) The axial DWI image showing metastatic lesion with diffusion restriction, b) ADC of the same with ADC value as : 1.0x $10^{-3}$ $mm^2$/sec.



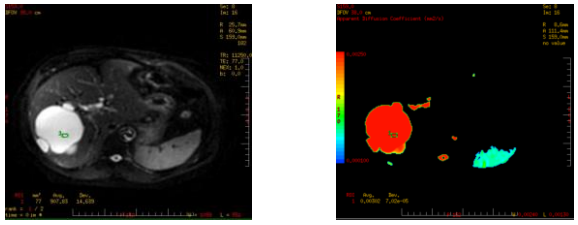
a b

Fig2 a) The axial DWI image showing HCC lesion with diffusion restriction, b) ADC of the same with ADC value as : 1.2 x $10^{-3}$ $mm^2$/sec.



a b

Fig3 a) The axial DWI image showing hemangioma lesion with diffusion restriction, b) ADC of the same with ADC value as : 1.6 x $10^{-3}$ $mm^2$/sec.



a b

Fig 4 a) The axial DWI image showing hepatic cyst lesion with diffusion restriction, b) ADC of the same with ADC value as : 3.0 x $10^{-3}$ $mm^2$/sec.

## DISCUSSION:

ADC cut of range for benign and malignant FLL were 1.1 to 3.56 x $10^{-3}$$mm^2$/sec and 0.79 to 1.36 x $10^{-3}$ $mm^2$/sec respectively. Comparative mean ADC values of individual FHL subtypes by our study is compared with various published literatures.

The mean ADC and cut off ADC values were compared with different studies like as follows, Taouli et al.,[5] investigated 66 patients by DWI and derived ADC value of malignant lesions like HCC and Metastasis were 1.33x 10-3 $mm^2$/sec and 0.94 x 10-3 $mm^2$ /sec. Benign lesions like hemangioma, hepatic cyst were evaluated with ADC values of 2.95x 10-3 $mm^2$ /sec and 3.63 x 10-3 $mm^2$ / sec.
Our study was comparable to other study done by Kim et al.,[6] in which 126 patients were investigated by DWI imaging with b value of 0, 846. Mean ADC value of HCC and metastasis

were like 0.09 - 1.28 x$10^{-3}$ $mm^2$ /sec and 1.06-1.11 x $10^{-3}$ $mm^2$/sec. ADC values of benign lesions like Hemangioma and hepatic cysts were like 2.04 - 2.1x $10^{-3}$ $mm^2$ /sec and 2.91 - 3.03x$10^{-3}$ $mm^2$/sec.

One more study done at kidwai hospital Bangalore by Madhu SD et al.,[2] was comparable to our study, which showed mean ADC values of malignant (HCC and metastasis) and benign (Hemangioma,hepatic cysts, abscess) as follows, CC- 0.975 x $10^{-3}$ $mm^2$ /sec, metastasis- 1.13x$10^{-3}$ $mm^2$ /sec, hemangioma – 1.68 x10-3 $mm^2$/sec, hepatic cyst-2.34 x$10^{-3}$ $mm^2$ /sec, abscess – 0.879x$10^{-3}$ $mm^2$ /sec.

Potential limitations that we encountered included some cases of hepatic abscess and hemangioma which were showing restricted diffusion, where ADC was found to be lower. The diagnosis in these cases then relied upon clinical and contrast enhanced CT findings.

Despite there being significant differences in mean ADC values of benign and malignant FHLs on a group basis, characterization of FHLs by using ADCs showed overlap even in our study. Again, these results are similar to the published results and ADC values cannot be used individually for characterization of FHLs. Thus DWI with other sequences will be helpful for characterization of FHL.

## CONCLUSION:

In our study based on qualitative and quantitative assessment of focal liver lesions on DWI and ADC mapping, characterization of liver lesions were done and differentiation between malignant and benign lesions were also done by using ADC values. The cut of range of ADC value for benign lesions were1.1 to 3.56 x $10^{-3}$ $mm^2$/s and cut of range of ADC value for malignant lesions were 0.79 to 1.36 x $10^{-3}$ $mm^{2/}$s.

As ADC values of some of the benign lesions were seen to overlap with ADC values of malignant lesions, hence interpretation of focal liver lesion with Diffusion weighted images along with conventional MR sequences should be followed

## References:

1.Marrero JA, Ahn J, Reddy KR. ACG clinical guideline: the diagnosis and management of focal liver lesions. The American journal of gastroenterology 2014;109:1328.

2.Madhu SD, Jaipal R, Pooja, Raghuram P. Role of DWI in detection and characterization of Focal liver lesions. International Journal of Anatomy, Radiology and Surgery. 2016; 5: 59-66.

3.Ichikawa T, Haradome H, Hachiya J, Nitatori T, Araki T. Diffusion-weighted MR imaging with a single-shot echoplanar sequence: detection and characterization of focal hepatic lesions. American journal of Roentgenology. 1998;170:397-402.

4.Taouli B, Koh DM. Diffusion-weighted MR imaging of the liver. Radiology. 2009;254:47-66.

5.Kim T, Murakami T, Takahashi S, Hori M, Tsuda K, Nakamura H. Diffusion-weighted single-shot echoplanar MR imaging for liver disease. American journal of Roentgenology. 1999;173:393-8.

6.Bruegel M, Holzapfel K, Gaa J, Woertler K, Waldt S, Kiefer B, et al., Characterization of focal liver lesions by ADC measurements using a respiratory triggered diffusion-weighted single-shot echo-planar MR imaging technique. European radiology. 2008;18:477-85.

7.Parikh T, Drew SJ, Lee VS, Wong S, Hecht EM, Babb JS, et al., Focal liver lesion detection and characterization with diffusion-weighted MR imaging: comparison with standard breath-hold T2-weighted imaging. Radiology. 2008;246:812-22.

8.Demir Öİ, Obuz F, Sagol Ö, Dicle O. Contribution of diffusion-weighted MRI to the

differential diagnosis of hepatic masses. Diagnostic and Interventional Radiology. 2007 ;13:81.

9.Petra G Kele, Eric J van der Jagt. Diffusion weighted imaging in the.liver. World journal of gastroenterology. 2010; 16 : 1567-1576.

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