ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 17, Issue 6, 2024

Online - 2455-3891
Print - 0974-2441

Research Article

EVALUATION OF HEPATIC MASS LESIONS BY DIFFUSION WEIGHTED MAGNETIC RESONANCE IMAGING

CHANDRA SEKHAR PONNADA[1], HARPREET SINGH[2], RAJAT SHUKLA[3], ARVINDER KAUR HEER[4]*

[1]Department of Radiology, Divisional Railway Hospital, Kharagpur, West Bengal, India. [2]Department of Radiology, Military Hospital, Jalandhar, Punjab, India. [3]Department of Radiology, Military Hospital, Yol, Himachal Pradesh, India. [4]Department of Gynecology, Command Hospital, Chandimandir, Haryana, India.
***Corresponding author: Arvinder Kaur Heer; Email: dr.groundwork6@gmail.com**

Received: 03 February 2024, Revised and Accepted: 20 March 2024

ABSTRACT

Objectives: The purpose of this study was to compare apparent diffusion coefficient (ADC) values for benign and malignant neoplastic hepatic lesions and also for suspected infective hepatic masses in which histopathology may always not be indicated.

Methods: This is a cross-sectional study conducted in the department of radio diagnosis and imaging, army hospital research and referral, Delhi Cantt. All the patients coming for magnetic resonance imaging (MRI) scans for focal liver lesions detected on other imaging modalities were included. The imaging was done at the 1.5 Tesla MAGNETOM AVANTO A Tim system (Siemens Ltd.). Various parameters of the morphology of lesions in conventional MRI and parameters in diffusion-weighted MRI were evaluated.

Results: A total of 75 patients were included in the study. The mean age of the subjects was 52.57±15.28 years, with a male: female sex ratio of 0.5:1. Among the 75 subjects, 20 subjects with hepatic cysts had no restrictions, and 12 patients with hemangioma were hyperintense on both diffusion-weighted imaging (DWI) and ADC. The mean differences between benign and malignant lesion ADC values. The difference was statistically significant ($p<0.001$). In the present study, we get a cut-off for the ADC value of 1.581×10^{-3} mm^2/s, which proved to be an optimal parameter for differentiation between benign and malignant lesions.

Conclusion: DWI proved to be a very useful supplementary imaging technique in conjunction with conventional imaging sequences in the analysis of focal hepatic lesions and should be included in the imaging algorithm for such lesions.

Keywords: Hepatic mass lesions, Liver malignancy, Magnetic resonance imaging, Diffusion-weighted imaging, Apparent diffusion coefficient.

 DOI: http://dx.doi.org/10.22159/ajpcr.2024v17i6.50602. Journal homepage: https://innovareacademics.in/journals/index.php/ajpcr

INTRODUCTION

Focal liver disease usually presents non-specific symptoms and is associated with variations in clinical findings; hence, radiologists are preferred for evaluation and diagnosis [1]. Focal liver lesions include both benign and malignant lesions [1]. In today's era, focal liver lesions are diagnosed using ultrasonography (USG), computed tomography (CT), or magnetic resonance imaging (MRI) [2]. Even though USG and CT are the most commonly used methods of detection of liver lesions, MRI is preferred for investigation when further characterization of these masses is needed [3]. In MRI, using a contrast enhancement pattern, lesions can be characterized based on the morphology of the lesion and the signal intensity of the lesion in various sequences. However, sometimes, it is very difficult to differentiate benign lesions from malignant ones [4]. Diffusion-weighted imaging (DWI) is a rapidly acquired, non-invasive technique that does not require the administration of intravenous gadolinium [5]. Previous studies have proposed that diffusion MR can help in the characterization of the lesion, and it also helps in distinguishing benign lesions from malignant ones based on diffusion effects using apparent diffusion coefficient (ADC) measurements. The reason is that malignant lesions have restricted diffusion, while benign lesions do not [6]. In a review by Bruegel and Rummeny, it was concluded that DWI is more sensitive than T2-weighted MRI and at least as accurate as super-paramagnetic iron oxide or gadolinium-enhanced MRI for the detection of hepatic metastases [7]. It has also been claimed that ADC measurement has the potential to discriminate between benign and malignant focal hepatic lesions [8]. Hence, the purpose of this study is to compare ADC values for benign and malignant neoplastic hepatic lesions and also for suspected infective hepatic masses in which histopathology may not always be indicated.

METHODS

The present study is a cross-sectional study conducted in the department of radiodiagnosis and imaging, Army Hospital Research and Referral, Delhi Cantt. Ethical approval was obtained from the institutional ethics committee. All the patients coming for MRI scans for focal liver lesions detected on other imaging modalities were included after taking the informed consent form. Patients having contraindications to the MR examination *per se*, that is, metallic implants in the body, pacemakers, claustrophobia, and patients, who have undergone previous surgery, radiation therapy, or chemotherapy, were excluded. The imaging was done at a 1.5 Tesla MAGNETOM AVANTO A Tim system (Siemens Ltd.) present in the department of radiodiagnosis, Army Hospital (research and referral). The imaging sequence, diffusion-weighted images, and other routine sequences such as HASTE T2W imaging axial, sagittal, and coronal, T1 VIBE axial and post-contrast, T1 VIBE axial, sagittal, and coronal, and dynamic post-contrast, if required, were included. Various parameters of the morphology of lesions in conventional MRI and parameters in diffusion-weighted MRI were evaluated.

Statistical analysis

Categorical variables were presented in number and percentage (%), and continuous variables were presented as mean±SD and median. The Kolmogorov–Smirnov test was used to test the normality of the data. If normality was rejected, then a non-parametric test was used.

RESULTS

Out of 75 patients, 25 were above 60 years of age, followed by 22 patients between 51 and 60 years, 12 patients between 41–50 years, and 8 each between 31–40 and 21–30 years, respectively. The mean age of the subjects was 52.57±15.28 years (Fig. 1). In the present study, the majority of patients were females (49) rather than males (26), and the male: female sex ratio was 0.5:1.

Table 1 shows the findings of diffusion-weighed imaging against diagnosis among the 75 subjects: 20 subjects with hepatic cysts had no restrictions, and 12 patients with hemangioma were hyperintense on both DWI and ADC. Metastasis (23 cases), pyogenic abscess (02 cases), cholangitic abscess (02 cases), hepatocellular carcinoma (HCC) (09 cases), and cholangiocarcinoma (07) had restrictions on DWI.

Table 2 shows the ADC value range according to diagnosis. The mean ADC was 2.96±0.232 for the hepatic cyst, with a minimum of 2.60 and a maximum of 3.40. The mean ADC was 2.14±0.157 for hemangioma, with a minimum of 1.90 and a maximum of 2.50. The mean ADC was 1.04±0.115 for metastasis, with a minimum of 0.86 and a maximum of 1.30. The mean ADC was 1.16±0.145 for hepatic cell carcinoma, with a minimum of 0.97 and a maximum of 1.32. The mean ADC was 1.13±0.795 for hilar cholangiocarcinoma, with a minimum of 1.05 and a maximum of 1.24. The mean ADC was 1.68±0.121 for the abscess, with a minimum of 1.54 and a maximum of 1.83. The mean ADC in normal hepatic parenchyma is 1.5±1.

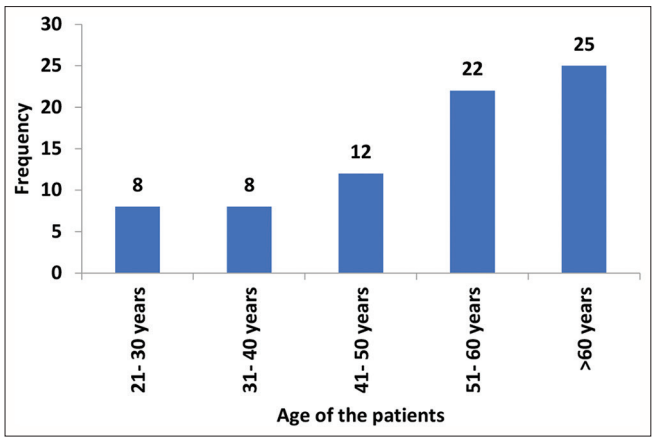

Fig. 1: Age distribution of patients

Table 1: Distribution of subjects according to findings on diffusion-weighed imaging against histopathology/diagnosis

Diffusion-weighted findings	Histopathology/ diagnosis	Frequency (%)
No restriction	Hepatic cyst	20 (26.7)
Hyperintense on both DWI and ADC (T2 shine through)	Hemangioma	12 (16)
Restriction on DWI	Metastasis	23 (30.7)
	Abscess	2 (2.7)
	Cholangitis abscess	2 (2.7)
	Hepatic cell carcinoma	9 (12)
	Cholangiocarcinoma	7 (9.3)

DWI: Diffusion-weighted imaging, ADC: Apparent diffusion coefficient

Table 2: ADC value according to diagnosis

Diagnosis	Number	Mean ADC	Minimum	Maximum
Hepatic cyst	20	2.96±0.232	2.60	3.40
Hemangioma	12	2.14±0.157	1.90	2.50
Metastasis	23	1.04±0.115	0.86	1.30
Hepatic cell carcinoma	09	1.16±0.145	0.97	1.32
Cholangiocarcinoma	07	1.13±0.795	1.05	1.24
Abscess	04	1.68±0.121	1.54	1.83

ADC: Apparent diffusion coefficient

Table 3 shows the association between ADC value and diagnosis, meaning ADC value plays an important role in diagnosis, which was statistically significant (p<0.001).

Table 4 shows the association between restriction and diagnosis, which was significant (p<0.001) with increases, decreases, and no restrictions for respective diagnoses.

Table 5 shows the mean differences between benign and malignant lesion ADC values. The difference was statistically significant (p<0.001). In the present study, we get a cut-off for the ADC value of 1.581×10^{-3} mm^2/s, which proved to be an optimal parameter for differentiation between benign and malignant lesions.

DISCUSSION

In the present study, the mean age was 52.57±15.28 years, consisting of 26 males and 49 females. Naoto *et al*. studied 70 patients, consisted of 52 men and 18 women with a mean age of 65.3 years [9]. In the study by Nijalingappa *et al*., the mean age was 55.6 years and consisted of 19 males and 11 females [10].

In the present study, no restriction was reported for hepatic cysts, whereas restriction was seen in most cases of metastases, abscesses, HCC, and cholangiocarcinoma. The Aly *et al*. reported the same findings [11]. Aly *et al*. study suggested that HCC and secondary show low signal intensity in T1 and high signal intensity in T2WI, while

Table 3: Association between ADC value and diagnosis

Parameter	Mean	SD	95% Confidence interval		p-value
			Lower	Upper	
ADC value and diagnosis	0.991	2.174	1.491	0.491	<0.001*

SD: Standard deviation, ADC: Apparent diffusion coefficient. *Level of significance: 0.05

Table 4: Association between restriction and diagnosis

Parameter	Mean	SD	95% Confidence interval		p-value
			Lower	Upper	
Restriction and diagnosis	0.173	0.381	0.856	0.261	<0.001*

SD: Standard deviation, ADC: Apparent diffusion coefficient. *Level of significance: 0.05

Table 5: Mean differences between benign and malignant lesions

ADC	Mean	SD	Cut off	95% Confidence interval		p-value
				Lower	Upper	
Benign lesions ADC	2.65	0.45	--	--	--	
Malignant lesion ADC	1.07	0.13	1.581	1.394	1.769	<0.001*

SD: Standard deviation, ADC: Apparent diffusion coefficient, *Level of significance: <0.05

cholangiocarcinoma shows low signal intensity in T1 and variable signal intensity in T2WI, and all of them show restricted diffusion. Hemangioma shows low signal intensity in T1, a very bright signal in T2WI, on heavy-weighted T2, a still bright signal, and diffusion shows a high signal in both diffusion and ADC map due to T2 shining through, which can be compared with the present study [11].

In the present study, the ADC value for hepatic cyst was 2.96±0.232, hemangioma was 2.14±0.157, metastasis was 1.04±0.115, hepatic cell carcinoma was 1.16±0.145, and abscess was 1.56±0.200. The study by Miller *et al*. reported the mean ADC value for hepatic cyst was 3.40±0.48, hemangioma was 2.26±0.70, metastasis was 1.50±0.65, hepatic cell carcinoma was 1.54±0.44, and abscess was 1.97±1.08. These findings were close to the present study [12].

A couple of studies by Taouli *et al*., Yamada *et al*. and Parikh *et al*. found quantitative ADC values also enable DW-MRI to distinguish benign and malignant focal hepatic lesions [13-15]. The ADC values of malignant hepatic lesions were significantly lower than those of benign hepatic lesions, with variable degrees of overlap representing 75% of cases, followed by hemangioma and cholangiocarcinoma [11].

It would be exceptionally helpful to characterize solid lesions as benign or malignant using DWI, as it is often difficult to make this distinction on an MRI, especially without the use of contrast material. Studies by Kim *et al*., Taouli *et al*., and Sun *et al*., have suggested that benign lesions have statistically higher ADC values than malignant lesions [13,16,17].

This study consisted of 32 benign tumors and 43 malignant tumors, whereas a study by Nijalingappa *et al*. among 30 patients consisted of 11 benign and 19 malignant tumors [6].

The present study showed a significant association between ADC values and liver lesions, whereas on the contrary, the study by Miller *et al*. found no significant differences in ADC values for liver lesions [18]. A study by Ichikawa *et al*. reported a significant difference in ADC values for hepatic cell carcinoma and metastasis [2]. Chandarana and Taouli reported that the advantage of DW-MRI is that it can easily demonstrate focal hepatic lesions localized near the liver capsula that mimic the intrahepatic vasculature [1].

In the present study, we get a cutoff for the ADC value of 1.581×10^{-3} mm^2/s, which proved to be an optimal parameter for differentiation between benign and malignant lesions. In a study by Jahic *et al*. they obtained a cut-off ADC value between benign and malignant lesions is of 1.341×10^{-3} mm^2/s [4]. Taouli and Koh, in their work of review, report the results of various studies in which the ADC cut-off ranged from 1:47×10 to 1.63×10^{-3} mm^2/s, which can be used for optimal differentiation of benign from malignant lesions [19].

One of the limitations of the present study was the relatively small sample size. Another limitation was that among benign lesions, only hemangiomas and cysts were seen; solid benign lesions such as adenomas and focal nodular hyperplasia were not encountered in our patient population.

CONCLUSION

In our study, it proved to be a useful scanning technique to help differentiate between various types of hepatic focal lesions. On visual appearance, in general, benign lesions showed no restriction, whereas malignant lesions showed some or significant restriction. This can also be further analyzed objectively based on ADC values (we found a cut-off ADC value between benign and malignant lesions is of 1.581×10^{-3} mm^2/s useful), as brought above, and this can provide an objective tool for characterizing a focal hepatic lesion in conjunction with other imaging features. Although the abscesses also showed significant restriction, they tend to have central restriction as against neoplasms, which have irregular or peripheral restriction.

Overall, DWI proved to be a very useful supplementary imaging technique in conjunction with conventional imaging sequences in the analysis of focal hepatic lesions and should be included in the imaging algorithm for such lesions.

ACKNOWLEDGMENT

Nil.

AUTHOR'S CONTRIBUTION

Dr. Rajat Shukla and Dr. Chandra Sekhar Ponnada designed the entire work. Dr. Harpreet Singh and Dr. Arvinder Kaur Heer contribute to making the necessary corrections and revisions of the manuscript. The final draft was checked by all the authors.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

FUNDING

Nil.

REFERENCES

1. Chandarana H, Taouli B. Diffusion and perfusion imaging of the liver. Eur J Radiol 2010 Dec 1;76(3):348-58. doi: 10.1016/j.ejrad.2010.03.016, PMID 20399054.
2. Kandpal H, Sharma R, Madhusudhan KS, Kapoor KS. Respiratory-triggered versus breath-hold diffusion-weighted MRI of liver lesions: Comparison of image quality and apparent diffusion coefficient values. AJR Am J Roentgenol. 2009 Apr;192(4):915-22. doi: 10.2214/AJR.08.1260, PMID 19304695.
3. Javadrashid R, Bavil Olyaei AS, Tarzamni MK, Razzaghi R, Jalili J, Hashemzadeh S, *et al*. The diagnostic value of diffusion-weighted imaging in differentiating benign from malignant hepatic lesions. Egypt Liver J. 2020 Dec;10:13.
4. Jahic E, Sofic A, Selimovic AH. DWI/ADC in the differentiation of benign from malignant focal liver lesion. Acta Inform Med. 2016 Jul 7;24(4):244-7. doi: 10.5455/aim.2016.24.244-247, PMID 27708485.
5. Filipe JP, Semedo LC, Lopes JC, Marcques MC, Alves FC. Diffusion-weighted imaging of the liver: Usefulness of ADC values in the differential diagnosis of focal lesions and effect of ROI methods in ADC measurements. MAGMA. 2013;26:303-12.
6. Gass A, Niendorf T, Hirsch JG. Acute and chronic changes of the apparent diffusion coefficient in neurological disorders-biophysical mechanisms and possible underlying histopathology. J Neurol Sci. 2001 May 1;186(Suppl 1):S15-23. doi: 10.1016/s0022-510x(01)00487-7, PMID 11334986.
7. Nishie A, Tajima T, Ishigami K, Ushijima Y, Okamoto D, Hirakawa M, *et al*. Detection of hepatocellular carcinoma (HCC)using super paramagnetic iron oxide (SPIO)-enhanced MRI: Added value of diffusion-weighted imaging (DWI). J Magn Reson Imaging. 2010;31(2):373-82. doi: 10.1002/jmri.22059, PMID 20099351.
8. Hussain SM, De Becker J, Hop WC, Dwarkasing S, Wielopolski PA. Can a single-shot black-blood T2-weighted spin-echo echo-planar imaging sequence with sensitivity encoding replace the respiratory-triggered turbo spin-echo sequence for the liver? An optimization and feasibility study. J Magn Reson Imaging. 2005;21(3):219-29. doi: 10.1002/jmri.20269, PMID 15723376.
9. Bruegel M, Rummeny EJ. Hepatic metastases: Use of diffusion-weighted echo-planar imaging. Abdom Imaging. 2010;35(4):454-61. doi: 10.1007/s00261-009-9541-8, PMID 19471997.
9. Naoto K, Akihiro C, Nasu K, Seto K, Nagaya S, Ohshima Y, *et al*. Role of diffusion-weighted magnetic resonance imaging in the differential diagnosis of focal hepatic lesions. World J Gastroenterol. 2009;14(46):5805-12.
10. Nijalingappa MB, Naveen S. Role of diffusion-weighted magnetic resonance imaging in focal liver lesions. J Dent Med Sci. 2015;14(7):10-22.
11. Elbarbary AA, Elahwal HM, Elashwah ME. Role of diffusion-weighted magnetic resonance imaging in the evaluation of hepatic focal lesions. Egypt J Radiol Nucl Med. 2015;46(2):325-34.
12. Miller FH, Hammond N, Siddiqi AJ, Shroff S, Khatri G, Wang Y, *et al*. Utility of diffusion-weighted MRI in distinguishing

benign and malignant hepatic lesions. J Magn Reson Imaging. 2010 Jul;32(1):138-47. doi: 10.1002/jmri.22235, PMID 20578020.

13. Taouli B, Vilgrain V, Dumont E, Daire JL, Fan B, Menu Y. Evaluation of liver diffusion isotropy and characterization of focal hepatic lesions with two single-shot echo-planar MR imaging sequences: A prospective study in 66 patients. Radiology. 2003 Jan;226(1):71-8. doi: 10.1148/radiol.2261011904, PMID 12511671.
14. Yamada I, Aung W, Himeno Y, Nakagawa T, Shibuya H. Diffusion coefficients in abdominal organs and hepatic lesions: Evaluation with intravoxel incoherent motion echo-planar MR imaging. Radiology. 1999 Mar;210(3):617-23. doi: 10.1148/radiology.210.3.r99fe17617, PMID 10207458.
15. 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 Mar;246(3):812-22. doi: 10.1148/radiol.2463070432, PMID 18223123.
16. Kim T, Murakami T, Takahashi S, Hori M, Tsuda K, Nakamura H. Diffusion-weighted single-shot echoplanar MR imaging for liver disease. AJR Am J Roentgenol. 1999 Aug;173(2):393-8. doi: 10.2214/ajr.173.2.10430143, PMID 10430143.
17. Sun XJ, Quan XY, Huang FH, Xu YK. Quantitative evaluation of diffusion-weighted magnetic resonance imaging of focal hepatic lesions. World J Gastroenterol. 2005 Nov 11;11(41):6535-7. doi: 10.3748/wjg.v11.i41.6535, PMID 16425430.
18. Taouli B, Koh DM. Diffusion-weighted imaging of the liver. Radiology. 2010;254(1):47-66. doi: 10.1148/radiol.09090021, PMID 20032142.
19. Elma J, Amela S and Azra H. DWI/ADC in differentiation of Benign from malignant focal liver lesion. Acta Inform Med. 2016;24(4):244-7. doi: 10.5455/aim.2016.24.244-247, PMID 27708485