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Role of diffusion -weighted imaging (DWI) / apparent diffusion coefficient (ADC) MRI sequences in differentiation bengin from malignant focal liver lesions

A thesis submitted to the College of Medicine, Babylon University, according to the requirements for obtaining a high diploma in diagnostic radiology

By:
Dr.Huda Abdulyemah Ismael
M.B.Ch.B

Supervised by

Dr.Osamah Ayad Abdulsattar
Prof. of Radiology

Dr.Kadhim Ch. Hasan
Assistant prof. C.A.B.S

A thesis submitted to the University of Babylon/ College of Medicine as partial fulfillment of requirements for the degree of a high diploma in diagnostic radiology .

Dr . Huda Abdulyemah Ismael

M.B.CH.B

Supervisor Certification

We certify that this thesis entitled **"Role of diffusion weighted imaging (DWI) / apparent diffusion coefficient (ADC) MRI sequences in differentiation benign from malignant focal liver lesions "** was prepared under our supervision as a partial fulfillment of requirements for the degree of a high diploma in diagnostic radiology

Dr.Osama Ayad Abdulsattar

Prof . of Radiology

M.B.CH.B. , F.I.B.M.S (RAD)

D.M.R.D (RAD)

Dr.Kadhim Ch.Hasan

Assistant prof

M.B.CH.B , C.A.B.S.

Examination committee certification

We, the examining committee, after reading this thesis entitled "Role of diffusion weighted imaging (DWI) / apparent diffusion coefficient (ADC) MRI sequences in differentiation benign from malignant focal liver lesions " and examining the candidate Dr . Huda Abdulyemah Ismael in its contents , find that it meets the standard and requirements as a thesis in a partial fulfillment of requirements for the degree of a high diploma in diagnostic radiology.

Dr. Amjaad M. Hameed

Prof .of Radiology

D.M.R.D F.I.B.M.S. R.D

(Chairman)

Dr.Jabir Hassan Obaid Al sanafi

Consultant radiologist

F.I.B.M.S. (Rad.)

(member)

Dr.Hasanain Ahmed Al Bayati

Prof . of Radiology

M.B.CH.B. F.I.B.M.S (Rad.)

(member)

Dean's certification

I , the Dean of College of Medicine University of Babylon certify that , this thesis **"Role of diffusion weighted imaging (DWI) / apparent diffusion coefficient (ADC) MRI sequences in differentiation benign from malignant focal liver lesions "** was prepared by the candidate **Dr . Huda Abdulyemah Ismael** and submitted to our college committee on graduate studies

Prof.

Dr . Mohend A.N. Al- Shalah

The Dean of College of Medicine

University of babylon

بسم الله الرحمن الرحيم

(فتعالى الله الملك الحق ولا تعجل بالقرآن من قبل أن يقضى إليك

وحيه وقل ربي زدني علماً)

صدق الله العلي العظيم

سورة طه الآية 114

Dedication

I dedicate my humble effort to my husband : I am really grateful for your endless support , inspiration and devotion

To my kids : for whom I have worked hard to be a good mother .

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First and above all thanks to my god who helped me in completing this reserach.

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Huda Abdulyemah Ismael

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LIST OF ABBREVIATIONS

ADC	Apparent diffusion coefficient
CT scan	Computed tomography
DWI	diffusion-weighted imaging
ECA	Extracellular contrast agents
FNH	Focal nodular hyperplasia
HCA	Hepatocellular adenoma
HCC	Hepatocellular carcinoma
HNF	Hepatocyte nuclear factor
ICC	Intrahepatic cholangiocarcinoma
MRI	Magnetic resonance image
ROI	Region of interest
SD	Standard deviation
SPSS	Statistical package of social sciences

CHAPTER ONE

❖ ABSTRACT

- **BACKGROUND**

MRI is important radiological diagnostic step capable of providing comprehensive and highly accurate radiological diagnostic information with the additional advantage of lack of harmful ionizing radiation. These properties make MRI the mainstay of radiological noninvasive evaluation of focal liver lesions

- **AIM OF THE STUDY**

The objective of this study was to assess the utility of diffusion-weighted imaging (DWI) and apparent diffusion coefficient (ADC) value in evaluating focal liver lesions to differentiate benign from malignant lesions.

- **PATIENTS AND METHOD**

Cross sectional study for 59 patients started from 1st August 2021 to 1st September 2022 in Al Hilla General Teaching hospital recruited patients with focal liver lesions diagnosed by other image modalities, and most of them have histopathological result of biopsy. Each patient full history taken including personal questionnaire and complete clinical assessment were done for enrolled patients. The patients were examined in supine position and Magnetic resonance imaging of liver were performed on 1.5 T system(1.5 Tesla device).

DWIs were obtained in transverse plane using single-shot echo-planar spin echo sequences.

Data was collected and analyzed using SPSS 23.

- **RESULTS**

The study included 59 patients with age range from 20-70 years old, mean age 57.2±10.4. Patients below 50 years constituted 23.8% of sample and 76.2% of patients were 50 years or more. Male to female ratio was 1.7:1. pathological findings by MRI were; 38.7% haemangiomas , 6.4% focal nodular hyperplasia FNH,4.8% hepatic adenoma, hepatocellular carcinomas 13%, liver metastases 19.3%, cysts 9.7% and cholangeocarcinoma 8.1%.

The mean ADC value for benign lesions was 1.8±0.7(10^{-3} mm^2 /s) and for malignant lesions was 1.3±0.4(10^{-3} mm^2 /s) and these differences was statistically significant with p-value < 0.001.

- **CONCLUSION**

1- ADC value is a reliable index for differentiating benign from malignant liver lesions .

2- The ADC value of benign hepatic lesions was higher than the ADC value of malignant hepatic lesions.

❖ INTRODUCTION

The magnetic resonance imaging (MRI) is considered as the most specific and sensitive in evaluation of focal liver lesions , in comparison to other modalities such as computed tomography (CT scan) and ultrasound (US) [(1)]. Advanced technique in MRI was diffusion weighted image (DWI), is non-contrast magnetic resonance imaging sequence which is used to comprehens assessment of focal liver lesions[(2)].

DWI, at the beginning was used in neuroradiology investigation then included abdominal organs images. It was introduced in mid of 1990 and it acquired a greater role in clinical evaluation of human pathology[(3)].

The DWI works on principle of diffusion restriction within tissues of lesions, the variation in diffusion gives variable image permit to quantitatively assess pathological lesions by measurement of ADC map inside lesions of interest.it depends mainly on motion of water molecules between two spaces intra and extra cellular[(4)].

Many studies stated that the malignant tissues have variable features from normal tissues for example in cell structures consistency of cells and extracellular compartment structures[(5)]. These differences made water molecules diffusion variable from normal tissue and thus give different pictures in analysis and comparison by DWI. More over various stages of tumors also show inconstant images of diffusion[(6)].

Focal liver lesions has different presentations such as cysts, vascular lesions, infective lesions , primary solid tumor and metastatic lesions. The challenges in diagnosis and evaluation are great[(7)]. DWI has good modalities in diagnosis of focal liver lesions and differentiates between benign and malignant tissues, but has questionable reliability criteria of test, another

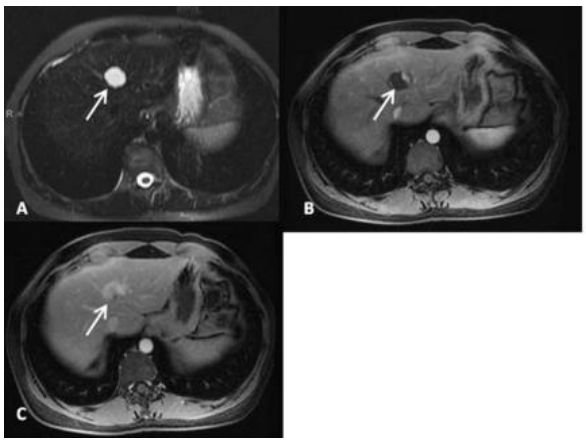
limitation in DWI are cutoff points that are used in distinction between various lesions types, cut off value is calculated from apparent diffusion coefficient (ADC) map for quantitative assessment of lesion[8,9].

- **HEMANGIOMA**

Hemangioma is considered as the commonest benign lesion in liver and incidence range from 2 -20% approximately. Hemangioma seen in traditional MRI as round or lobular margin, T2 show hyperintensities and enhances design. Enhancement pattern that design for hemangioma about three pattern, their specificity 100% and accuracy about 95%.

These pattern include

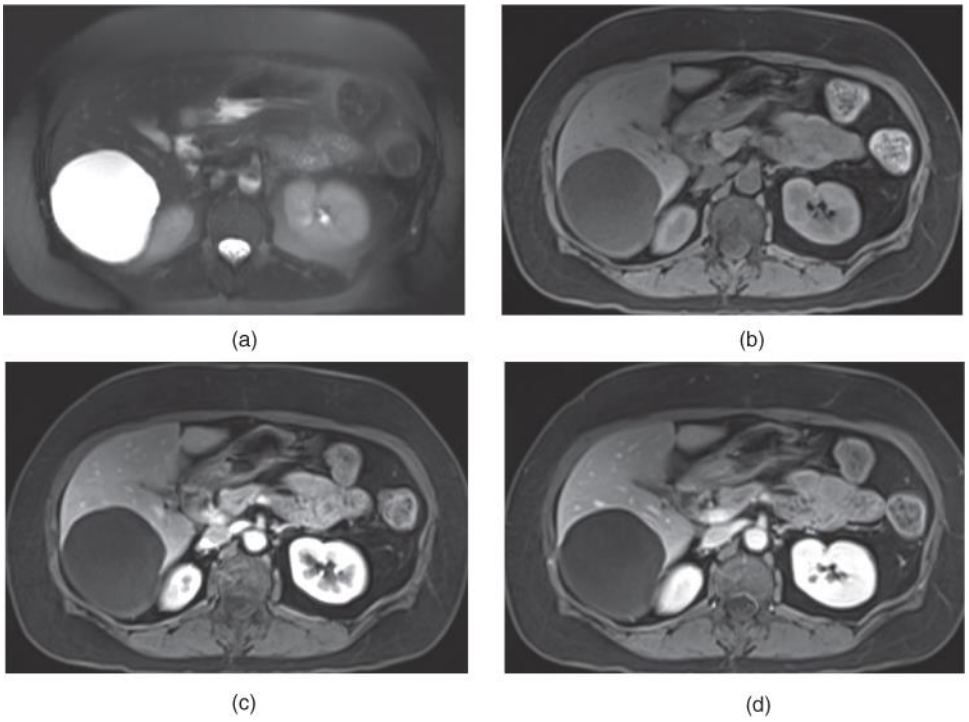
1- Lesions less than 2 cm are illustrated arterial enhancement in uniform appearance is called flash fillings (Figure (1-1) [10].
2- Large hamenagioma are appear nodular or intermittent enhancements combing centrally although hypointensity present in center .
3- Some of these giant lesions have areas of fibrosis or thrombosis producing center of scar with line hypointensity in T2[11].



Figure(1-1) : (A-C) Classic hemangioma T2 ‘ light bulb’ bright hepatic (A), which show classic interrupted peripheral enhancement (B,C) on ECA-enhanced MRI

- **CYSTIC LESION**

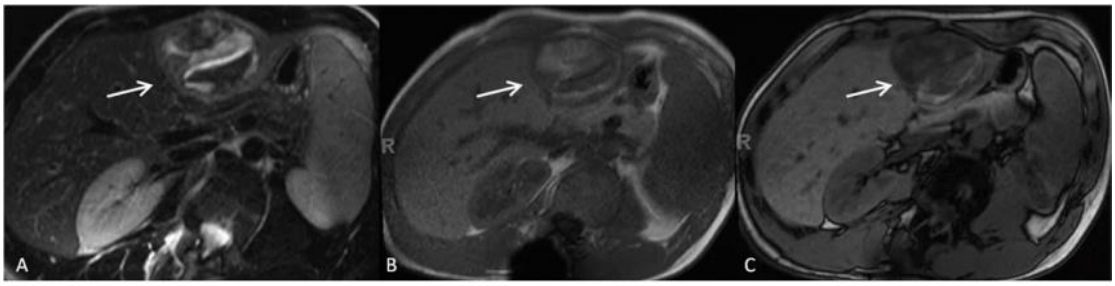
One of the common cystic lesions is congenital biliary cysts (simple cysts), prevalence about 15%, some times, cyst presents in atypical with unilocular and invisible outline and contents appear homogeneous with obvious low SI on T1 and on T2 tremendously higher SI, in addition, the cysts don't take enhancement on contrast study (Figure (1-1)[12].



Figure(1-2) : Solitary large simple cyst. T2- fat-suppressed (A), T1- fat-suppressed (B), T1-fat-suppressed post-gadolinium hepatic venous phase (C) and interstitial phase (D) show a large liver cyst. The cyst demonstrates markedly high signal on T2 (A) and low signal on pre-contrast T1 (B) shows no wall enhancement on post-gadolinium (c, d).

- **HEPATOCELLULAR ADENOMA (HCA)**

These lesions are rare hepatic lesions, they might be linked to hormonal exposure. HCA have three separated lesions with variable behavior and various feature in imaging study. The following sub type are: hepatocyte nuclear factor-1 alpha (HNF-1 alpha)-mutated, beta-catenin, and inflammatory HCA. The first sub type forms the majority of presentation of HCA[13]. Inflammatory subtype on T2 hyperintense and increase arterial enhancement that take long time through portal venous phases. While HNF-1 alpha shows no persistent arterial enhancement phase and lipid inside lesion. Thus because of lipid contents the HNF-1 alpha is called steatotic HCA. In some occasions the inflammatory sub type may contain lipid but in small amount and appear heterogeneous signal loss in comparison to diffusion signal loss in steatotic HCA (Figure (1-3)[14].

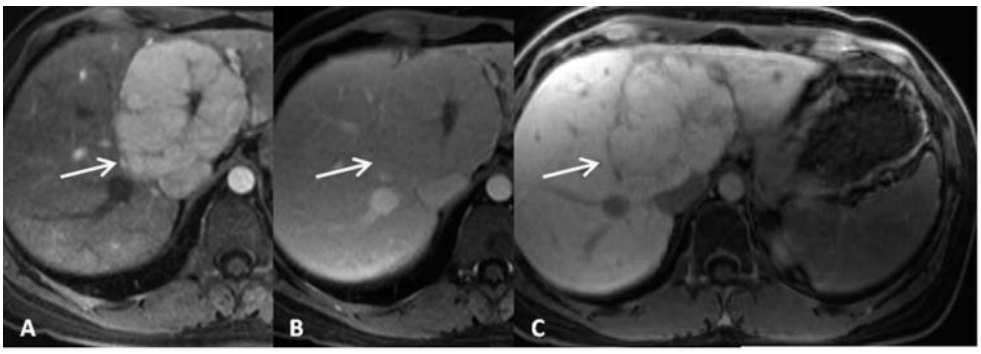


Figure(1-3) : Hepatic adenomas. (A-C) Hemorrhagic adenoma. The presence of hemorrhage is indicated by the area of T2 hypointensity (A) and T1 hyperintensity (B). The loss of signal on the opposed-phase image (C) mark presence of fat within the lesion.

- **FOCAL NODULAR HYPERPLASIA**

Asymptomatic lesion from accumulation of non neoplastic hepatocyte in non systemic organized collection with scar and abnormal vessel lying in center of them. The hepatocyte are quit and hardly visible from normal liver parenchyma in traditional images while it shows enhanced pattern in contrast[15].

The lesion shows typical enhancement design. it appear enhance nodular artery, that render isotense on portal venous phases image in comparison to liver structures. In some extent the lesion has scar in central compartment, with hyperintense T2 (Figure (1-4) [15].

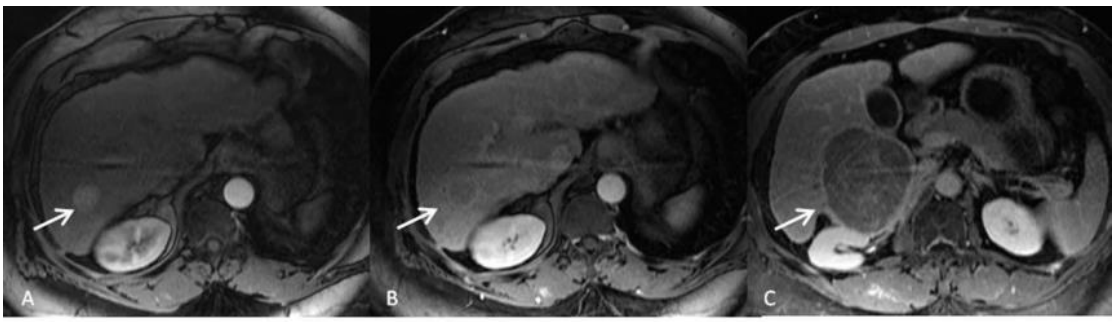


Figure(1-4) : Focal nodular hyperplasia , large arterial enhancing (A) , lobulated mass (arrows) , with central scar becomes isointense to liver during portal venous phase (B), and retains contrast on the hepatobiliary phase .

- **HEPATOCELLULAR CARCINOMA (HCC)**

These lesions follow the chronic liver diseases in every setting. Traditional appearance of Hepatocellular Carcinoma on enhanced MRI, in cirrhosis background as tumoral arterial enhanced, after this show washout in phase of portal venous and late enhanced pseudo- capsule. The washout appearance are due to the lesion loss of portal venous supply by many steps of carcinogenesis changes that happened during the disease[16].

The most prominent feature of HCC are appearance of washout and delay enhance with pesudocapsule. In addition, to vascular invasion, limited diffusion and T2 hyperintesity all these supportive features in diagnosis. Whereas other features which are controversial in evaluation of HCC are dysplastic nodules and problems of small lesion being only shows in hepatobilliary phases image (Figure (1-5) [17



Figure(1-5) : Typical features HCC of 2 patients (A-C) .Images (A,B) (arterial and equllibrium phase ECA-enhanced MRI) show arterial enhancement and washout with pseudocapsule. Image (C) (portal venous phase) from a 2nd patient shows a large lesion that manifest washout and pseudocapsule on ECA-enhanced MRI.

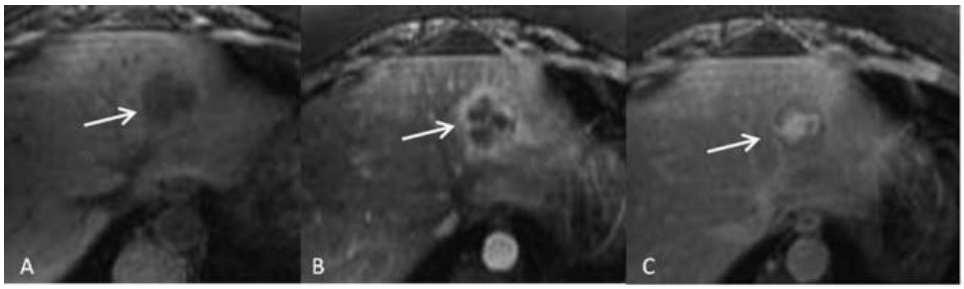
- **CHOLANGIOCARCINOMA (ICC)**

This lesion represent the 10% of primary liver malignant tumor and it arise in superimposed chronic hepatic diseases for example cholangitis, hepatitis, non –alcoholic chronic hepatic cirrhosis and to some extend in obesity(18).

Appearance in MRI of Cholangiocarcinoma is hypointense in T1 and hyperintense in T2, with irregular heterogeneous masses, edge early enhanced then progressing center enhancement of rest of lesion(19).

The preliminary marginal rim enhancement of Cholangiocarcinoma frequently continuous and differ from hemangioma which is has intermittent outline enhancement. These arterial enhance rim may show marginal wash out , which are not appear by hemangioma (Figure (1-6) (11).

Further more, there were high specific features for Cholangiocarcinoma which contain T2 hypointense scars due to central fibrosis, capsular retractions and dilatation peripheral biliary[13].

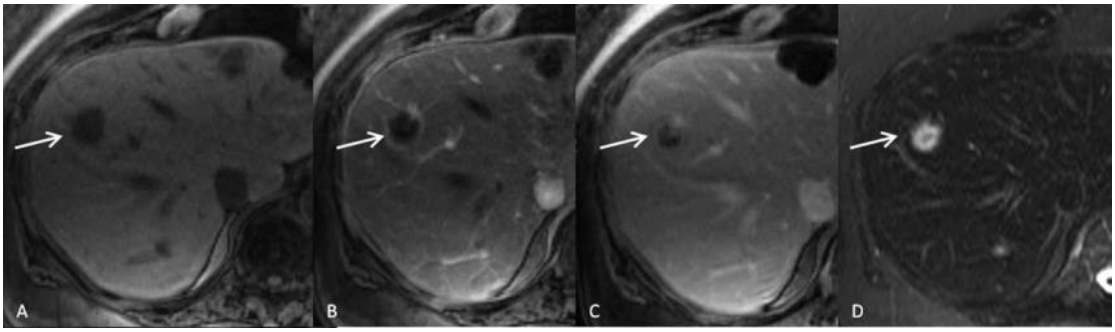


Figure(1-6) : Intrahepatic cholangiocarcinoma. (A-C) show Classic enhancement on ECAenhanced MRI. Precontrast (A) arterial (B), and 5-minute delayed (C) show the typical arterial enhancing rim and delayed central enhancement with washout of the rim manifesting the typical enhancement pattern of cholangiocarcinoma

- **METASTASES**

Liver are one of most site of secondary metastasis in the body, which are have variables appearance also it depend on original tumors. These metastasis characterized by hypervascular or hypovascular, with enhancement that differ from surrounding tissues[14].

The hypervascualr mostly seen with neuroendocrine tumor, renal cell carcinomas, thyroid carcinomas, melanomas, and sarcomas. Other metastasis give pictures of hypovascular. Renal cell carcinomas melanomas and lung cancer frequently illustrating T1hyperintesity[17].



Figure(1-7) : Hepatic metastasis (breast cancer). T1- precontrast, arterial and equilibrium phase postcontrast, and T2- images (A-D) show continuous rim of enhancement and progressive filling in a T2-hyperintense lesion. The continuous rim of enhancement is most compatible with metastases,

❖ AIM OF STUDY

The objective of this study was to assess the utility of diffusion-weighted imaging (DWI) and (ADC) value in evaluating focal liver lesions to differentiate benign from malignant lesions.

CHAPTER TWO

❖ PATIENTS AND METHODS

- **STUDY DESIGN**

Cross sectional study started from 1st August 2021 to 1st September 2022 in Al Hilla General Teaching hospital. recruited patients with focal liver lesion was diagnosed by other imaging modalities.

Inclusion criteria

1- US examination done for every patients

2-Patients had lesion size more than 10mm.

3- with good quality of images

4- age > 18 years

The exclusion criteria were:

1-patients with hepatic lesion less than 10mm in diameter.

2-clinically unstable patient

3- Contraindications to MRI such as claustrophobia or patients with pace maker or metal implants

4-patients who had prior chemotherapy or radiotherapy for hepatic neoplasm.

5- patients with hepatic coma.

- **DATA COLLECTION**

For each patient complete history is_taken_and clinical assessment is done with guidance of questionnaire prepared for this aim including sociodemogrphic characters such as age, sex, residence, and occupation. Then complete history of present illness is taken and laboratory investigations(renal functions tests and liver biochemical profile) have been done and all relevant findings reported by physician.

Lastly, MRI study is done and result is reported.

Before MRI session done every patients given a brief explanation about this radiological examination, revealing the contraindication, how long extended it take and in what way to dresses for it, notify around the gradient sound would be received whereas being immobilize in a slender space and around the communicated through the intercoms, or video cameras.

- **MRI EXAMINATION TECHNIQUE**

MRI test was achieved by 1.5 tesla systems Philips medical systems. The following criteria: weighted image T2 in axial fast spine echo image, TR 3501m/sec TE 100m/sec. 90 angle flips. 3.5 slice thickness, gap thickness 0.4 matrixes 322×225, view field 16×15cm, train echo length 13, band width 31kHz. Weighted image of T2 achieved in axial and coronal planes. T1 weighted image performed before DWI.

All patients were examined in the supine position throughout this radiological examination.

Entirely DWI procedures performed in transverse planes by single shot echo plane sequence. Diffusion weighted images need a sum of 95s to scan by MRI. The array spatial sensitivities encoding techniques were used by way of parallels image techniques.

The assessment of findings were done clearly and cautiously. For various mass discover the ADC value was measured and detected on MRI and DW images stated by gray scales ADC map for every lesions at 1500 s/mm^2 gradients unite by measure region of interest. Then mean of ADC value was reported, in multiple lesion the largest one was measured.

After this the mean ADC value of benign lesion such as focal nodular hyperplasia and lesion of malignant features for example cholangiocarcinoma

were evaluated and compared. ADC value for each lesion was assessed to study the characters of each lesions and whether it can define its types.

The morphological features of each lesion were recorded included size of lesion ,its shape, margin and signal characteristics, as well as number and site of the detected focal lesions.

Apparent diffusion coefficient map was calculated by the implement of equation in soft ware which as follow: ADC (mm^2s-1) = [l n (S0/ S1000)] / 1000. where S0 and S1000 represented the signal intensity of image.

The part of tumor of large diameter were assigned for calculate of ADC. In these figure. a polygonal area of interest which is the biggest one manually draw on ADC map along boundary of masses.

Every image taken we measure the ADC map, ADC value range and mean.

- **ADC CALCULATION**

Calculation of ADC of every identified focal lesions by means of region of interest. The measurement was done twice time for every lesion then the two measurement were averaged. The region of interest was copied and saved for insurance we calculated the same area.

- **ETHICAL APPROVAL**

This study was approved by ethical committee of scientific research college of medicine / University of Babylon.

verbal consent was taken from each participants in this study.

- **STATISTICAL ANALYSIS**

Data was collected and included in a data based system and analyzed by statistical package of social sciences ((SPSS, Inc., Chicago, IL, USA)) version 23.

Parametric data were expressed as mean ± standard deviation (SD) ,it was analyzed statistically using student t-test such as difference in mean ADC between benign and malignant.

While non-parametric data were expressed as percentages and were analyze using chi square, such as comparison of gender in according to type of lesion. P-value < 0.05 was considered statistically significant.

CHAPTER THREE

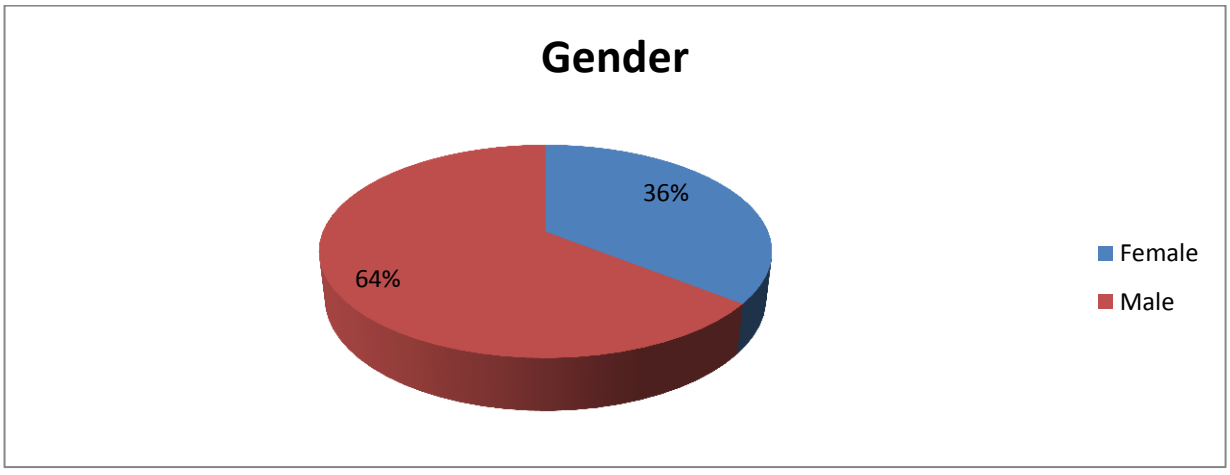
❖ RESULTS

Our study included 59 patients with age range from 20-70 years old, mean age 57.2±10.4. Patients below 50 years age constituted 23.8% of sample and 76.2% of patients have age 50 years or more. Male to female ratio was 1.6:1, female 37.5% and male 62.5% form the sample under study, as show in table 1.

Table 1: Age and gender distribution.

Variables		Number	Percent
Age	<50 years	14	23.8%
	50 years ≥	45	76.2%
		59	
Gender	Male	37	62.5%
	Female	22	37.5%

Figure(3-1): Gender distribution

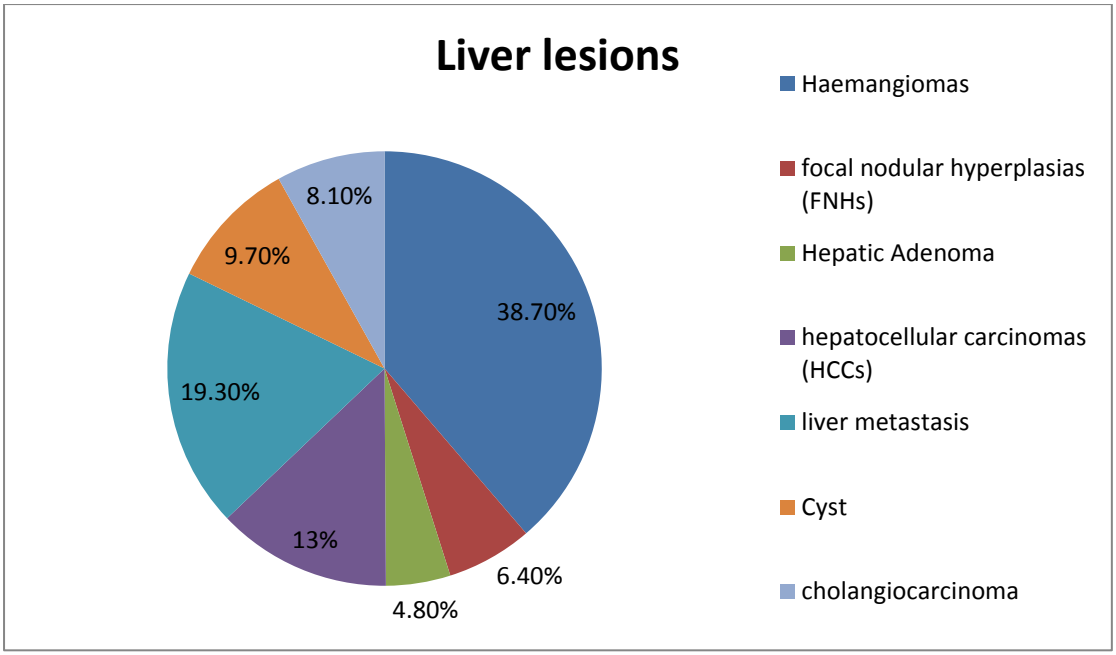


Pathological findings by MRI were as following: 38.7% haemangiomas, 6.4% focal nodular hyperplasia FNH, 4.8% hepatic adenoma, hepatocellular carcinomas 13%, liver metastases were 19.3%, cysts 9.7%, and cholingiocarcinoma 8.1% as shown in table 2.

Table 2: The pathological types by MRI.

Liver lesion	No.	Percent
Haemangioma	24	38.7%
focal nodular hyperplasia (FNHs)	4	6.4%
Hepatic Adenoma	3	4.8%
hepatocellular carcinomas (HCCs)	8	13%
liver metastasis	12	19.3%
Cyst	6	9.7%
cholangiocarcinoma	5	8.1%
Total	62	100%

Figure(3-2): Pathological types of liver lesion.



Male show predominance in presentation of benign and malignant lesion, of benign lesion 54% was male and 46% was female. For malignant lesions, there were 68% male and 32% in female patients as shown in table 3.

Table 3: Liver lesion according to gender.

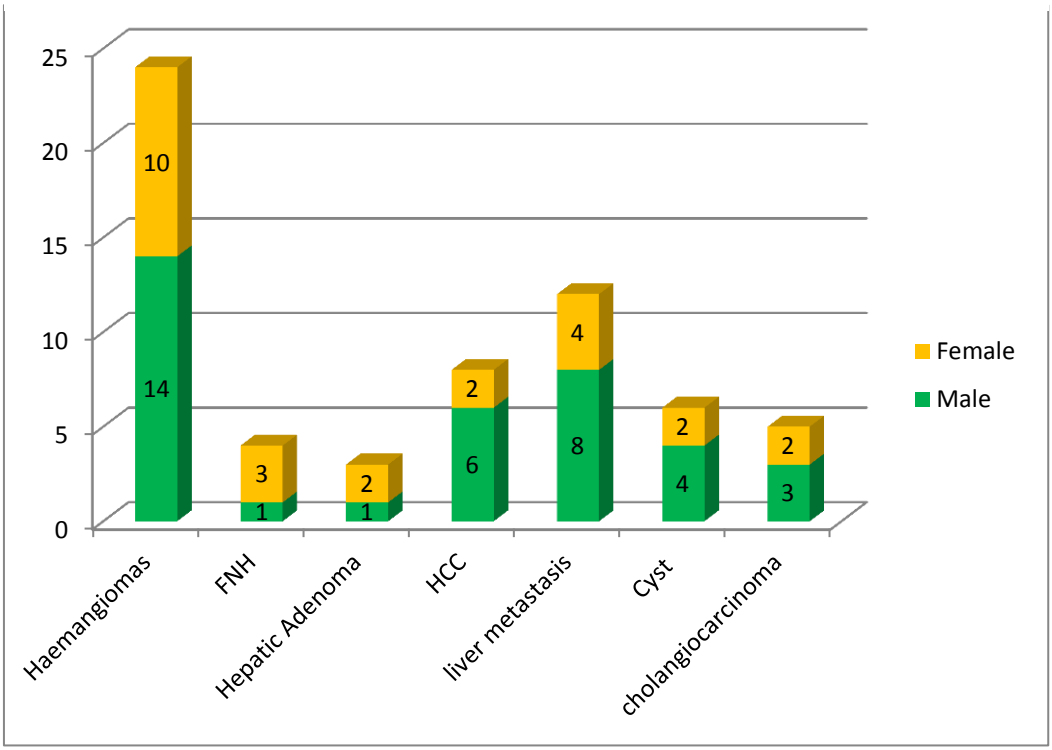
Liver lesion	Male	Female	Total	p-value
Benign	20(54%)	17(46%)	37	0.4
Malignant	17(68%)	8(32%)	25	
Total	37	25	62	

On the other hand heamangioma presented in male patients more than female patients and similar results shown by hepatocellular carcinoma, liver metastasis, hepatic cyst and cholangeocarcinoma. On the other hand, focal nodular hyperplasia and hepatic adenoma were seen in the female patients more than male as presented in table 4.

Table 4: Distribution of liver lesion in regarding to gender.

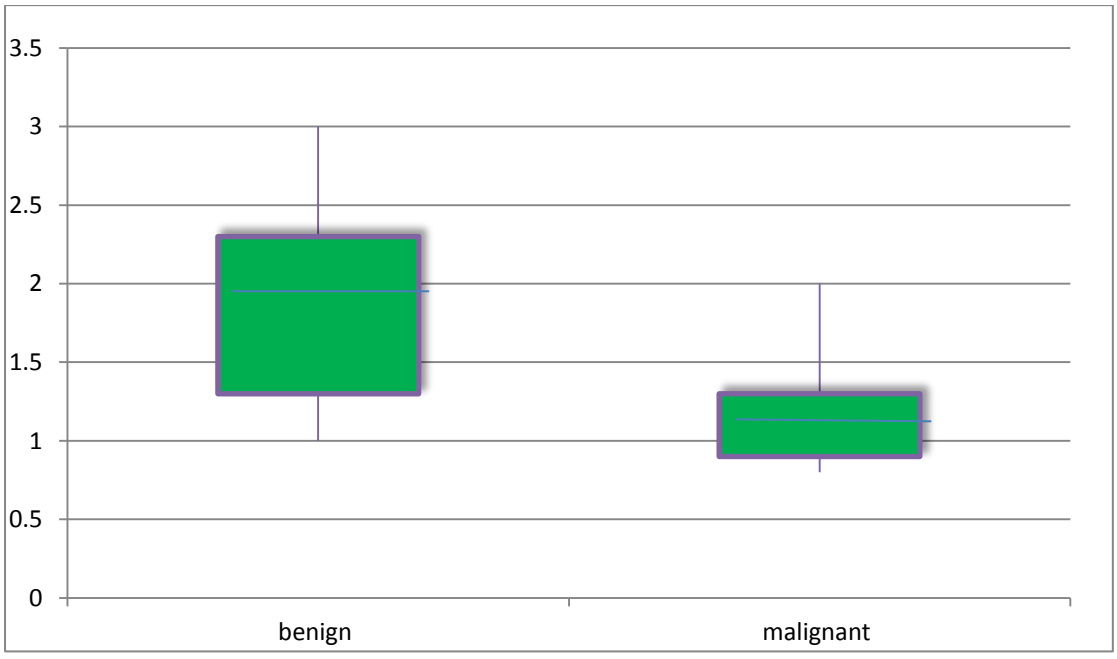
Liver lesion	Male	Female	Total
Haemangiomas	14	10	24
focal nodular hyperplasia (FNHs)	1	3	4
Hepatic Adenoma	1	2	3
hepatocellular carcinomas (HCCs)	6	2	8
liver metastasis	8	4	12
Cyst	4	2	6
cholangiocarcinoma	3	2	5

Figure(3-3): Liver lesion according to sex.



The mean ADC value for benign lesions was 1.8±0.7(10^{-3} mm^2 /s) and for malignant lesions was 1.3±0.4(10^{-3} mm^2 /s). these difference was statistically significant with p-value < 0.001 as shown in figure 4.

Figure(3-4): box plot show the difference between benign and malignant mean ADC value



Mean while the mean ADC value for variable lesion was recorded in (10^{-3} mm^2 /s), high value presented by cyst lesion 2.95±0.98, in haemangioma was 2.2±1.4, focal nodular hyperplasias (FNHs) 1.8±0.7, hepatic adenoma was 1.73±0.8, hepatocellular carcinoma1.3±0.5 and liver metastasis have 1.03±0.4. the difference was also statistical significant as presented in table 5.

Table 5: The mean of ADC value of various liver lesion.

Liver lesion	ADC mean (10^{-3} mm^2 /s)±SD	p-value
Haemangioma	2.2±1.4	0.001
Cyst	2.95±0.98	
focal nodular hyperplasias (FNHs)	1.8±0.7	
Hepatic Adenoma	1.73±0.8	
hepatocellular carcinomas (HCCs)	1.3±0.5	
liver metastasis	1.03±0.4	
cholangiocarcinoma	1.02±0.3	

Table 6 show the appearance of various liver lesion in different stages of examinations , cyst and hemangioma in usual MRI T1 appear hypo intense and in T2 show hyper intensity . in contrast, cyst lesions have not enhanced while hemangioma have nodular enhancement. Hepatocellular carcinoma and liver metastasis appear in T1and T2 hyper intense and early enhanced with contrast.

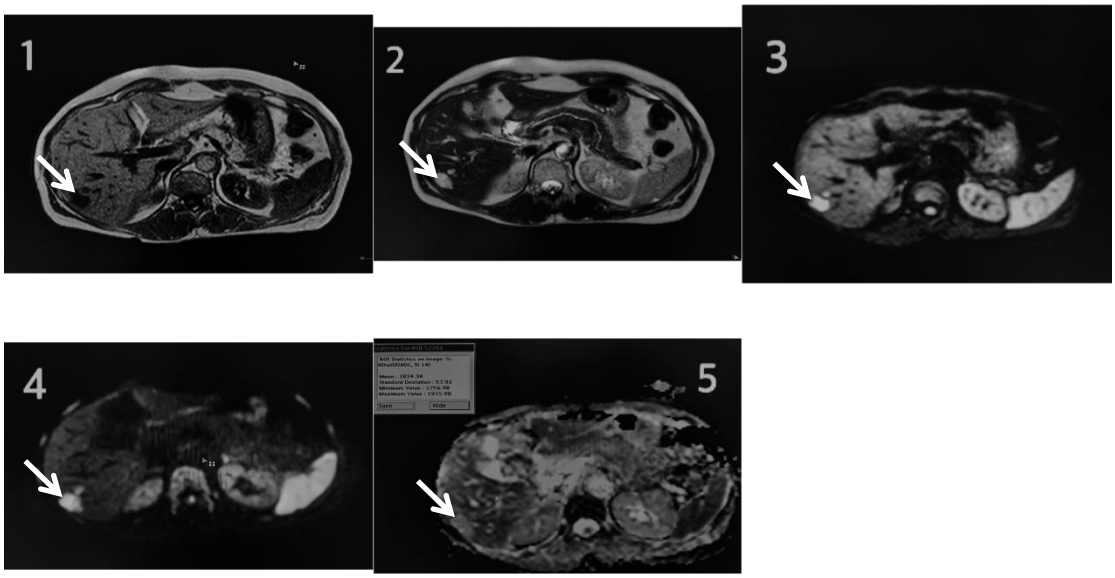
table 6: T1, T2 and ADC value of specific lesion.

Lesion	T1	T2	Contrast	ADC
Cyst	Hypo intense	Hyper intense	Not enhanced	2.95
Hemangioma	Hypo intense	Hyper intense	Nodular enhanced	2.2
HCC	Hyper intense	Hyper intense	Early enhanced	1.3
Metastasis	Hyper intense	Hyper intense	Early enhanced	1.03

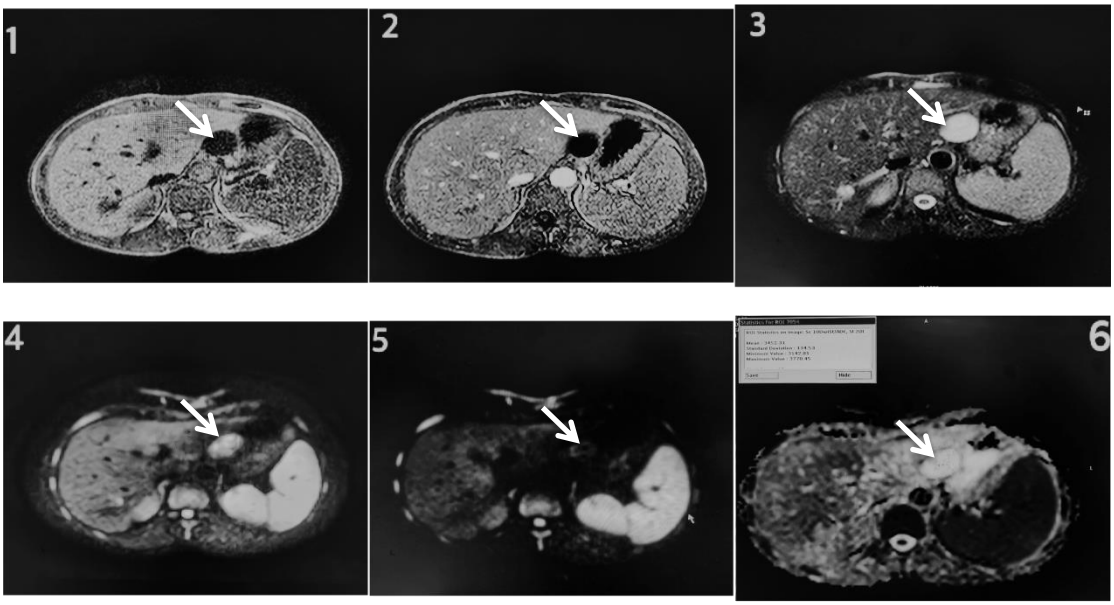
The mean ADC cut of value to differentiate between benign and malignant lesions was 1.2. these give high sensitivity (91%),but specificity was (72%) (depending on histopathological result when it is indicated) , the area under curve 0.88 (0.79-0.91) and with significant p-value 0.001.As shown in table 7.

Table 7: Cut value of ADC.

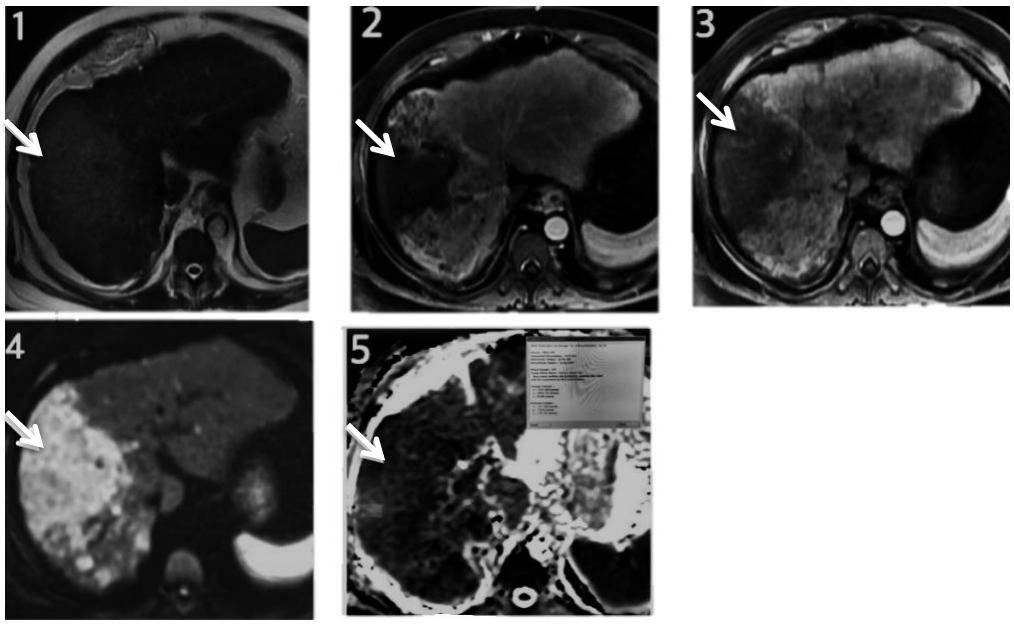
Variables case	Cutoff	Sensitivity	Specificity	AUC(95%CI)	p-value
Mean ADC	1.2	91%	72%	0.88(0.79-0.91)	0.001



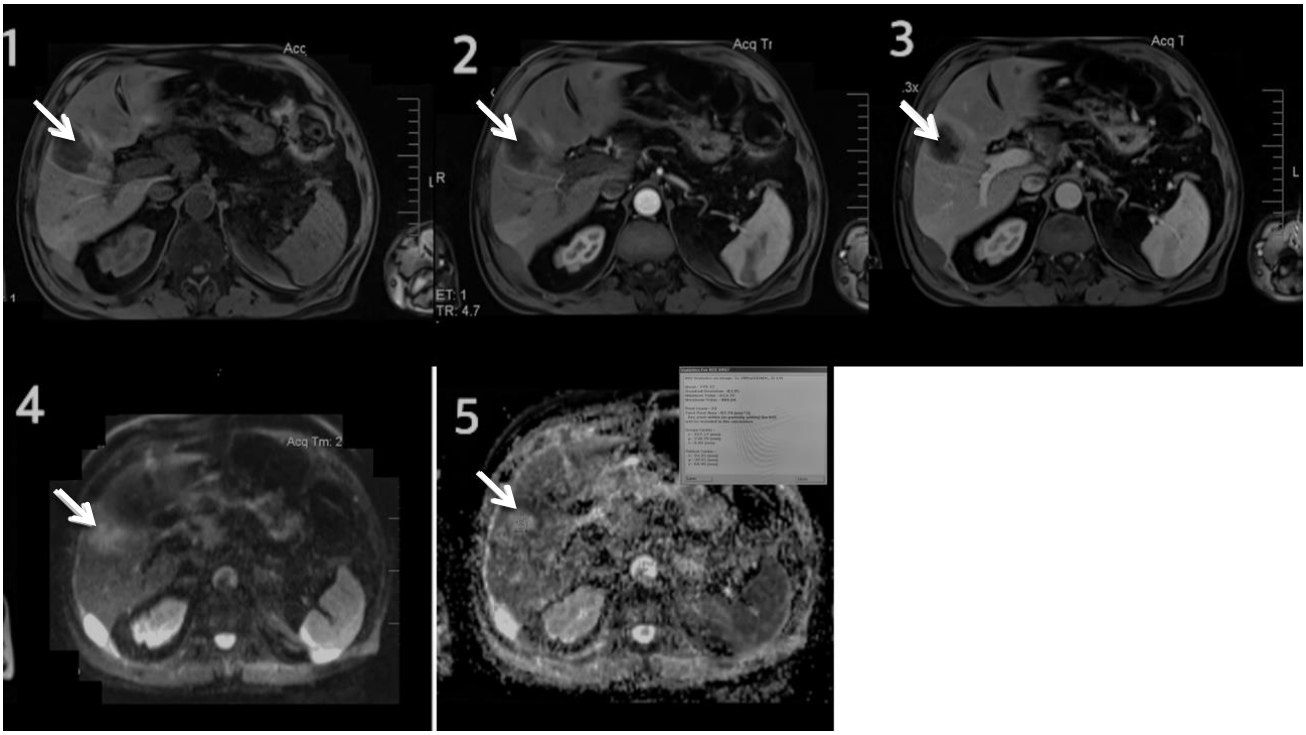
Figure(3-5): MRI of forty years old women with hemangioma , (1) T1 weighted image show low signal lesion , (2) T2 weighted image show high signal lesion , (3) DWI b500 and (4) DWI b1000 also show high signal lesion , (5) on ADC map the lesion show low signal with ADC value 1.824×10^{-3} mm^2 / sec



Figure(3-6): MRI of forty four years old man with hepatic cyst , (1) T1 weighted image show homogeneous very low signal lesion , (2) T1 C+ the lesion not enhance, (3) T2 weighted image show very high signal lesion, (4) DWI b500 and (5) DWI b 1000 show moderate signal lesion , (6) on ADC map the lesion show high signal with ADC value $3{,}425 \times 10^{-3}$ mm^2 / sec



Figuer(3-7): MRI of sixty-five old man with hepatocellular carcinoma , (1) T2 weighted image show hyperintense lesions, (2) T1 C+ arterial phase show heterogeneous enhancement ,(3) T1C+ portal venous phase show washout apperance ,(4) DWI b 500 show high signal lesion , (5) on ADC map the lesion show low signal (restricted diffusion) with ADC value 965×10^{-3} mm^2 / sec



Figuer(3-8): MRI of fifty eight years old man has CA prostate with metastasis to liver (1) T1-weighted image show hypointense lesion ,(2)artetial phase T1-weighted image the lesion show ring enhancement (3) venous phase T1-weighted image the lesion show ring enhancement (4) DWI show restriction (5) on ADC map the lesion with ADC value 749 × 10^{-3} mm^2 / sec

CHAPTER FOUR

❖ DISCUSSION

Magnatics resonance images are of great benefit in given comprehension and biggest accuracy in diagnosis of focal liver lesions with additional advantages that have non ionizing radiation, MRI characters makes the strength non invasive assessment tool[20].

The MRI study plays important role in focal liver lesion management, by means of safe contrast test and technique that is free from radiation[21].

-Regarding demographic characters of our study, our patients with age range from 20-70 years old, mean age 57.2±10.4. Patients below 50 years age constituted 23.8% of sample and 76.2% of patients with age 50 years or more. Male to female ratio was 1.6:1, female patients 37.5% and male constitute 62.5% of the sample, this in line of study by Testa ML[22] and Okasha Mohammed[23].

In addition Amr Abdelsamed thesis included thirty patient 20 male and 10 female, with range of age from 33-60 year[24]. Elma Jahic, in Vienna reported more high boundary of age from 19 to 82 because different in population composition[25].

other study by T. Pankaj Jain[26] , found female predominant, 66% female, 34% male. These difference because nature of cross sectional study depend on visitors number in determine period[25].

-Our MRI results of liver lesion as shown in table 2 were 38.7% presented haemangioma, 6.4% have focal nodular hyperplasia FNH, 4.8% have hepatic adenoma, hepatocellular carcinomas in 13%, liver metastasis were 19.3%, cyst appear in 9.7% and finally cholingiocarcinoma reported in 8.1%, it consisted with prior studies by Latif et al. [27] and by Areij Alzubaidi Iraqi

study[28], but it differ from study by Elma Jahic who reported malignant lesions more than benign one in his sample[25].

Testa study also presented 21% hemangioma, 23% cyst, 1% hepatic adenoma and 1% focal nodular hyperplasia[22].
While in the other study show out of 25 focal liver lesion, 36% hepatocellalr carcinoma, 3.5%FNH, 3.5% cyst, 13% hemangioma, 6.8% cholangiocarcinomas, 16.8% regenerative nodules) and 7% have metastatic lesion[24].

The difference in the results of studies may be due to variation in risk factors ,incidence and chronic diseases that epidemic in his population that differ from our sample[20].

-Table_3 in our result show male predominance in presentation of benign and malignant lesions, 54% of benign occure in male and 46% was in female. For malignant lesions, there were 68% in male and 32% in female.

Our result were with line of prior studies which are show predominance of male lesions, with explanation appear to be related to both behavioral risk factors and biologic factor[22,28].

-Table_4 shows haemangioma presented in male more than female and identical figure shown by hepatocellular carcinoma, liver metastasis, cyst lesion and cholangeocarcinoma, While focal nodular hyperplasia and hepatic adenoma were seen in female more than in male. It agree with Areij Alzubaidi Iraqi study[28] and differ from study by Latif et al[27] and T. Pankaj Jain[26] these might be variable gender distribution in their studies or geographical variation according to site of studies[10].

-In present study the average ADC value of benign lesion were 1.8±0.7(10^{-3} mm^2 /s) and for malignant lesions were 1.3±0.4(10^{-3} mm^2 /s), these differences were statistically significant, p-value < 0.001.

Mean while, high value presented by cyst lesion was 2.95±0.98, haemangioma was 2.2±1.4, focal nodular hyperplasias (FNHs) was 1.8±0.7, hepatic adenoma was 1.73±0.8, hepatocellular carcinoma 1.3±0.5 and liver metastasis have 1.03±0.4. the difference was also statistically significant. these results are close to the study by Areij Alzubaidi Iraqi study[28].

The similar findings are reported by Elma Jahic[25] who demonstrated the mean ADC value is consistent method for distinction between benign and malignant focal liver lesion. He stated that mean ADC value for benign liver lesion was l.79(1.23-2.37 $\times 10^{-3}$ mm^2 /s, and for malignant lesion value are 1.14(1.03- 1.33) $\times 10^{-3}$ mm^2 /s, these value show significant difference with p-value < 0.002[25].

Ahmed Okasha concluded that, the ADC values of benign lesions are significantly higher than those of malignant lesions, with variable degrees of overlap between the different pathological entities[23].

Other study reported the ADC values of the 11 benign lesion were 1.78 x10^{-3} mm^2 /s. the mean ADC value of benign lesion was range from 1.2$\times 10^{-3}$ to 2.5 $\times 10^{-3} mm^2$/sec. The uppermost ADC values were for simple cyst.

The ADC values of the 19 malignant lesions were 1.05$\times 10^{-3} mm^2$/sec. Among the malignant lesions, the lowest ADC value was for metastasis hepatic lesion 1.04$\times 10^{-3}$ mm^2/sec. The difference between the ADC values of benign and malignant lesions was statistically significant (P < 0.0001) [24].

Our result supports similar previous findings where Onura MR *et al.* stated that the mean ADC values of benign lesions were higher than malignant lesions[29].

In study of Miller *et al.* reported the mean of ADC for liver malignant lesion were statistically lower than that of liver benign lesions, p < 0.04[30].

A study by Vergara et al, show the mean of benign liver lesion were higher than that of malignant hepatic lesion with p-value < 0.05[31].

Latif et al, illustrated the frequent measure of ADC at two different b value, one at 500 and second at 1000 diffusion gradient was very beneficial to discrimination between benign liver and malignant lesion. He was stated cut off value for ADC at b 500 and 1000 diffusion gradient which are show increase sensitivity and specificity in variation. In his work the average ADC value for benign hepatic lesion as following, focal nodular hyperplasia 1.78 $\times 10^{-3}$ mm^2/sec, for adenomas $1{,}81 \times 10^{-3}$ mm^2/sec , hemangiomas show 2.4×10^{-3} mm^2/sec and for cyst was 2.5×10^{-3} mm^2/sec. whereas the average ADC value of malignant lesions in his work presented as followings: hepatocellular carcinoma 1.25×10^{-3} mm^2/sec , ADC for metastasis 1.12×10^{-3} mm^2/sec and cholangiocarcinomas with 1.04×10^{-3} mm^2/sec[27].

A systemic reveiw by Taouli and Koh, study of DW images for assessment of liver lesion, they stated that, the mean ADC value for malignant lesion range from 0.91 to 1.45×10^{-3} mm^2/sec , while for benign lesion the ADC range from 1.5 to 2.89 $\times 10^{-3}$ mm^2/sec, on other hand the cyst lesion show ADC value 2.45 to 3.7 $\times 10^{-3}$ mm^2/sec[32].

In Testa ML study demonstrated the most critical cut off point was 1.23 $\times 10^{-3}$ mm^2/sec to distinction metastasis from solid benign lesion and had sensitivity 72% and 73% specificity with accuracy 70%[22].

But in previous study reported lower cut off value and low accuracy in differentiation of solid liver lesion from metastasis however still significant difference also present[33].

The higher ADC value was seen in cyst and hemangioma might be due to free distribution of water molecule inside its contents, whereas for hepatocellular carcinoma and metastasis had low ADC value due to higher cellularity than that of benign lesion[25].

These differences between variable study in calculation of ADC values might be for many reasons such as various types of hard ware used in different equipment, use changed b value because absence of standard protocol of work in images acquisition and variables sample of population under the studies[22]. With increasing use of DW images and important of finding will definitely prospect of uniformities parameters will be developed in images acquisition. Still of benefit ADC of DWI in monitoring of oncology therapy[20].

since visual interpretation of images and characterization of lesions depending on diffusion appearance of lesions has its limitation, therefore the calculation of the ADC values was of importance in lesions assessment[24].

-Table 6 show the appearance of various lesion in different stages of radiological examinations , cyst and hemangioma in usual MRI T1 appear hypo intense while in T2 hyper intense , in contrast cyst not enhance while hemangioma will be nodular. Hepatocellular carcinoma and metastasis appear in T1and T2 hyper intense and early enhanced in contrast. These result agree with studies of Elma Jahic[25], Okasha Mohammed[23] and Areij Alzubaidi Iraqi study[28].

Our mean ADC value as shown in table 7 used to differentiate between benigns and malignancy was 1.2 and this give high sensitivity 91% and specificity was 72%, area under curve 0.88 (0.79-0.91) and p-value 0.001. these result it close to study by Elma Jahic[25].

A study of Testa et al, found in their result cutoff value were 1.2 $\times 10^{-3}$ mm^2/sec used to distinct between benign from malignant liver lesion with accuracy reach to 70% and these figures were statistically significant[22].

18 Some authors used cut off point reach to 1.4[34,35].

Taouli and Koh on the work used value of mean ADC cutoff range from 1.41 $\times 10^{-3}$ - 1.73 $\times 10^{-3}$ mm^2 /s[32].

These difference in cutoff point of mean ADC between authors may be due type of instruments and experience of worker, or to variable lesions under study[27].

CHAPTER FIVE

CONCLUSION

1. ADC value is a reliable index for differentiating benign from malignant liver lesions .

2. The ADC value of benign hepatic lesions was higher than the ADC value of malignant hepatic lesions.

3. Diffusion weighted MR imaging is a good imaging modality for diagnosis and differentiated benign and malignant hepatic focal lesions.

❖ RECOMMENDATION

We recommend adding DWI and ADC to liver imaging protocols of focal liver lesion as it aids in the differentiation and discrimination between benign and malignant focal hepatic lesions through measurements of ADC values.

CHAPTER SIX

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وزاره التعليم العالي والبحث العلمي كلية الطب/جامعة بابل

فرع الجراحة

شعبة الأشعة التشخيصية

دور الرنين المغناطيسي (معامل الانتشار الضاهر والرنين المنتشر) في التمييز بين الإصابة الموضعية الحميدة والخبيثة في الكبد

أطروحة قدمت الى كليه الطب ,جامعة بابل حسب متطلبات الحصول على درجة الدبلوم العالي في الاشعة التشخيصية

مقدمه من قبل الطالبة

هدى عبداليمه اسماعيل

بكالوريوس طب وجراحه عامه

باشراف

الدكتور اسامه اياد عبدالستار

بروفسور اشعه تشخيصيه

الدكتور كاظم جلوب حسن

استاذ مساعد جراحة عامة

ملخص البحث

فحص الرنين المغناطيسي يعطي معلومات تشخيصية عالية الدقة و شاملة بالإضافة خلوه من مخاطر الاشعة المتأينة وهذا مما يجعله الفحص الرئيسي وبدون اي تداخل لتقيم افة الكبد البؤرية

هدف الدراسة

هدف هذه الدراسة هو استخدام انتشار الصورة المرجحة في تقيم افة الكبد البؤرية لمحاولة تميز الافة الحميدة من الافة السرطانية

المرضى والطرائق

هذه الدراسة هي دراسة مقطع عرضي للفترة من 2021/10/1 الى 2022/8/1 في مستشفى الحلة التعليمي ،ثم تشخيص المرضى المشمولين بالدراسة بالوسائل التصويرية الاخرى و تم تسجيل التاريخ المرضي والتقييم الكامل وتثبيتها في نموذج خاص لكل مريض ،تم اجراء الفحص الرنين المغناطيسي على جهاز 1.5 تسلا لكل مريض في وضع الاستلقاء و تم جمع المعلومات وتحليلها باستخدام برنامج الحزمة الإحصائية للعلوم الاجتماعية (spss) اصدار 23

النتائج

الدراسة شملت المرضى الذين متوسط عمرهم 20-70 سنة وبمعدل 10.4 ±57.2 للمرضى بعمر اقل من 50 سنه يمثلون 23.8% من العدد الكلي للمرضى اما المرضى بعمر يساوي او اكثر من 50 سنه يمثلون 76.2% ،نسبة الرجال الى النساء كانت1.6:1

كانت نتائج الرنين المغناطيسي للورم الدموي هي 38.7%،تضخم عقدي بؤري 6.4% ،الغده الكبدية 4.8%،سرطان الخلايا الكبدية 13%،نقائل الكبد 19.3%،اكياس الكبد9.7%،سرطان القنوات الصفراوية8.1%

كان معدل معامل الانتشار الضاهر للاورام الحميدة 0.7±1.8 (10^3 مليم^2 /ثانيه) والاورام الخبيثة كان 0.4± 1.3(10^3 مليم^2 /ثانيه)

وكانت هذه النتائج ذات دلالة إحصائية قيمة P اقل من 0.001

الاستنتاج

ان قيمة معامل الانتشار الضاهر لأفة الكبد الحميدة كانت اعلى من قيم معامل الانتشار الضاهر لأفة الكبد الخبيثة