

**Comparison of MRI diffusion weighted imaging and apparent diffusion coefficient(adc) of spleen and liver in cirrhotic patients with patients having no cirrhosis.**

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**Type of Publication:** Original Research Article

**Conflicts of Interest:** Nil

**Abstract**

**Background & objectives:** Cirrhosis is a state of hyper dynamic circulation and in view of portal hypertension, there is a splanchnic hyperaemia. This splanchnic hyperaemia is assessed by taking spleen as the representative organ of the splanchnic circulation. Aim of our study is to find the difference in ADC (Apparent Diffusion Coefficient) mapping of spleen and liver in cirrhotic and normal patients. Also to find the correlation of ADC (Apparent Diffusion Coefficient) value of the spleen and liver to Child Pugh class and severity of portal hypertension in cirrhotic patients.

**Materials & methods:** Adult patients with chronic liver disease who underwent abdominal MRI were taken as cases for study. DWI and ADC values of liver and spleen were calculated. The following causes of liver cirrhosis were recorded like alcoholism, chronic hepatitis C, chronic hepatitis B, Non-alcoholic fatty liver disease, autoimmune and cryptogenic/idiopathic. Patients were ascertained Child– Pugh score based on their clinical parameters. Following signs of portal hypertension were recorded: splenomegaly, ascites, portocaval anastomoses. Adult patients without any history of liver disease and having normal liver function test and

undergone abdominal MRI of the upper abdomen, including echo planar DWI, for other diseases (trauma, degenerative disease of dorsolumbar spine) were taken as the comparison group. Quantitative Variables will be expressed as mean, standard deviation. Qualitative variable will be expressed as frequency and percentage. A p-value < 0.05 is considered statistically significant. Data analysis will be performed using SPSS ver 16. For comparison of two groups, student To compute the correlation between ADC of spleen and severity of cirrhosis in terms of child Pugh score- by using Piersons/ spearman correlation coefficient will be used.

**Results:** Compared with the control group, cirrhotic patients had significantly higher spleen ADC (mean spleen ADC in mm<sup>2</sup>/ sec – cirrhotic 909±61, control 830±44) and lower liver ADC (mean liver ADC in mm<sup>2</sup>/ sec – cirrhotic 979±63, control 1197±72).The spleen ADC increased with increase in Child Pugh grades (Mean spleen ADC Child A- 859±63, Child B- 906±69, Child C- 989±48) while the liver ADC decreased with severity of child Pugh score. Spleen ADC were higher in the presence of increased severity of portal hypertension (oesophageal varices > grade 2, splenomegaly and a portal vein diameter of >13mm).

**Conclusion:** The mean Liver ADC values were significantly lower and the mean spleen ADC values were significantly higher in cases compared to controls. As the portal vein diameter increases the spleen ADC increases and liver ADC decreases. Similarly as the grade of oesophageal varices increases, the spleen ADC increases. The various surrogate markers of portal hypertension showed a significant negative correlation with liver ADC and a Thus the study evaluated the predictive capability of ADC values to the severity of chronic liver disease and Portal hypertension.

**Keywords:** MRI, DWI, ADC.

## Introduction

Chronic liver disease is a major spectrum of disease due to various a etiologies which deteriorates to cirrhosis in significant proportion of these patients.

The development of Portal hypertension is a common consequence of chronic liver diseases due to Archi tectural changes caused by progressive hepatic fibrosis. Consequences of Portal hypertension include ascites, portocaval anastomoses like oesophageal and gastric varices, hepatic encephalopathy and sepsis. In patients with advanced hepatic fibrosis and Portal hypertension, splenomegaly is also a common finding.

Magnetic resonance imaging (MRI) is used increasingly for the visualization of anatomical changes in patients with liver cirrhosis. Furthermore, diffusion-weighted imaging (DWI) has emerged as a promising imaging technique for noninvasive assessment of liver fibrosis and cirrhosis (1). Several reports have shown that ADC is significantly lower in cirrhotic livers compared with non-cirrhotic livers, most probably due to the fibrotic distortion of lobular architecture which restricts water molecule motion. However, ADC values vary significantly between studies, mainly due to differences in imaging parameters.

Despite the fact that patients with cirrhosis and portal hypertension frequently suffer from splenomegaly, several authors have proposed to use the spleen as a reference organ for ADC measurements of liver parenchyma in order to decrease variability of liver ADC.

## Materials and methods

### Study setting

Department of Radio diagnosis/ Medical& surgical gastroenterology Sree Gokulam Medical College and

Research Foundation, Venjaramoodu, Thiruvananthapuram.

**Study period:** February 2022 to December 2022

### **Aims & objectives**

#### **Aims**

To find the difference in ADC (Apparent Diffusion Coefficient) mapping of spleen and liver in cirrhotic and normal patients.

#### **Objective's primary objective**

To analyse the ADC (Apparent Diffusion Coefficient) value of the spleen and liver in cirrhotic patients and to compare with patients having no cirrhosis.

#### **Secondary objectives**

- To analyse the correlation of the spleen and liver ADC (Apparent Diffusion Coefficient) to the severity of cirrhosis in terms of Child Pugh's status (CTP)
- To analyse the correlation of ADC (Apparent Diffusion Coefficient) value of the spleen in chronic liver disease patients to surrogate markers of portal hypertension in the form of grade of oesophageal varices, increased portal vein diameter and splenomegaly.

**Study design:** Case- Control study.

**Sample size:** 80 patients; 40 each in case and control group.

#### **Study population**

#### **Inclusion criteria**

- All patients with age > 20 years, attending medical/surgical gastroenterology department, diagnosed with cirrhosis of various aetiology based on altered biochemical parameters (blood routine examination, liver function tests) and undergoing MRI abdomen were included as cases.
- Patients with age > 20 years, who doesn't have a history of consumption of alcohol or history of chronic

or acute liver disease, undergoing MRI abdomen in Department of Radiodiagnosis for diseases like degenerative disease of dorsal spine, acute abdomen (like appendicitis) and trauma (not caused due to consumption of alcohol) were taken for comparison as controls.

#### **Exclusion criteria**

- Absolute contraindication to MRI (patients having MRI incompatible metallic prosthesis insitu).
- Patient who refused MRI.
- Claustrophobic patients.
- Patient who were not willing to participate in the study.

#### **MR Protocol**

MR examinations were performed using a 1.5-T system (Magnetom Essensa; Siemens).

DWI were performed using an echo planar imaging in the axial plane using the following parameters

Repetition time/echo time=6825-6930/ 68-76, Slice Thickness=6 mm, Field of View= 250× 380 mm, Matrix size up to 192× 144 and b values of 50, 300 and 600 mm<sup>2</sup>/s

#### **ADC Calculation**

A region of interest (measuring 1 cm<sup>2</sup>) was placed on slices in the right lobe of the liver and the spleen. Four different ROI were placed and average of the ADC value was taken.

#### **Data collection**

#### **Cases**

MRI Diffusion Weighted Imaging (DWI) - Apparent Diffusion Coefficient (ADC) values of liver and spleen was documented. Patients were assigned Child Pugh score based on their biochemical parameters. Features of Portal hypertension (ascites, splenomegaly, increased portal vein diameter) were assessed in MRI sequences.

Oesophageal varices, if present on endoscopy, were graded according to Conn’s classification (Grade 1 to 4).

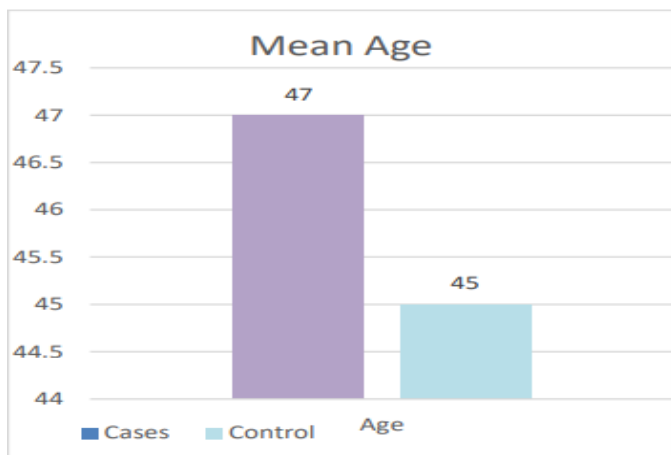
**Controls/Comparison group**

MRI Diffusion Weighted Imaging ADC (Apparent Diffusion Coefficient) values of liver and spleen were documented.

**Results**

**Baseline Demographic characteristics** A total of 80 participants were enrolled in the study and 40 were in cirrhotic patients and 40 were participants in the control group. The mean age of the study population was  $47 \pm 5.2$  years in cirrhotic patients and  $45 \pm 7.2$  years in the control groups. Male: Female ratio was 4: 1 in both cases and control.

Graph 1:



Graph 2:

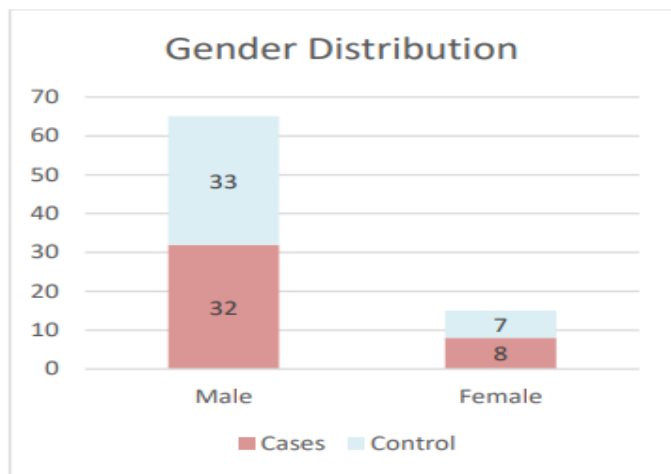


Table 1:

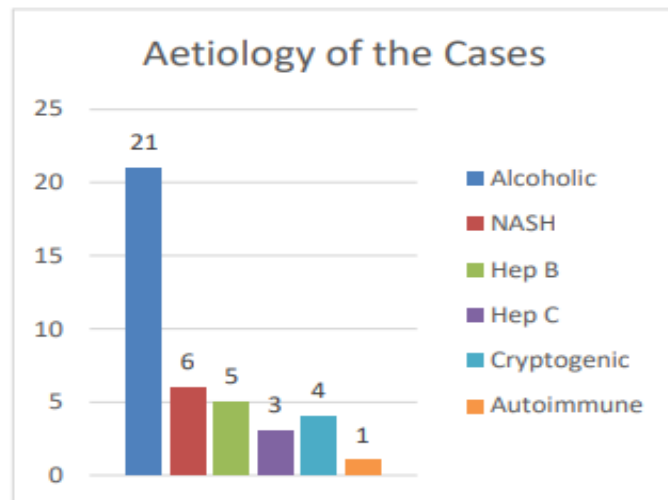
	CASES N=40	CONTROL N=40
Male	32 (80 %)	33 (82.5 %)
Female	8 (20 %)	7 (17.5 %)

**Aetiology of the Cases** Out of 40 enrolled in the study as case, the majority of the patients were alcoholic (52.5 %) followed by NASH (15 %) and hepatitis B (12.5%) as mentioned in the table below.

Table 2:

Aetiology	Cases N=40	
	N	%
Alcoholic	21	52.5
NASH	6	15
Hepatitis B	5	12.5
Hepatitis C	3	7.5
Cryptogenic/Idiopathic	4	10
Autoimmune	1	2.5

Graph 3:



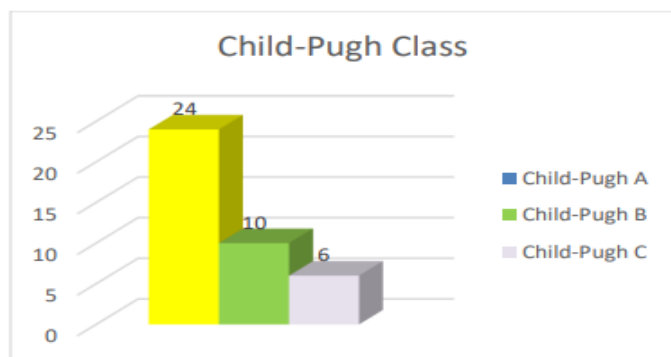
**Child-Pugh class of cirrhotic patients** The cases were classified based on Child-Pugh scoring and majority of

the patients were Child-Pugh class A (60%) followed by 25% in Child-Pugh class B.

Table 3:

Child-Pugh Classification	Cases	
	N=40	%
Child-Pugh class A	24	60%
Child-Pugh class B	10	25%
Child-Pugh class C	6	15%

Graph 4:



#### ADC Values of spleen and liver in Cases vs Controls

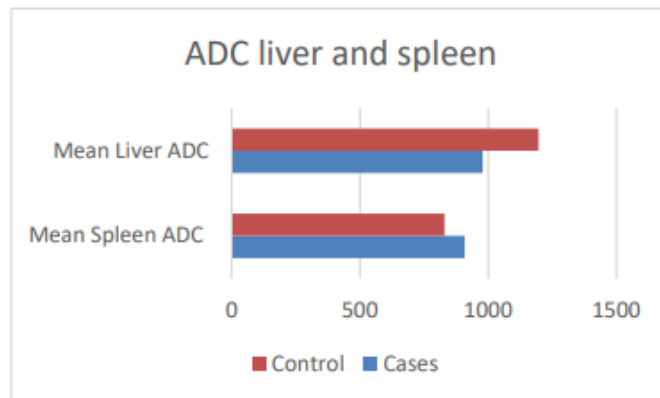
The mean ADC values were evaluated in the study population and the mean ADC values of spleen was significantly high in cases  $909 \pm 61 \text{ mm}^2/\text{s}$  as compared to the control group (p value < 0.05) and the mean liver ADC values were significantly lower in cases as compared to the control group as mentioned in the table below.

Table 4:

	Cases N=40	Control N=40	P value *
Mean Spleen ADC (mm <sup>2</sup> /s)	$909 \pm 61$	$830 \pm 44$	0.023
Mean Liver ADC (mm <sup>2</sup> /s)	$979 \pm 63$	$1197 \pm 72$	0.033

\* Unpaired T test

Graph 5:



ADC of spleen & Liver in relation with Surrogate Markers of Portal hypertension 5

ADC values of spleen and liver vs surrogate markers of Portal hypertension.

Table 5:

Portal Vein Diameter	Liver ADC ( mm <sup>2</sup> /s)	Spleen ADC ( mm <sup>2</sup> /s)
> 13 mm	$862 \pm 39$	$1004 \pm 52$
≤ 13 mm	$974 \pm 55$	$918 \pm 46$
Grade of Oesophageal Varices	Liver ADC (mm <sup>2</sup> /s)	Spleen ADC ( mm <sup>2</sup> /s)
> grade 2	$871 \pm 62$	$992 \pm 57$
≤ grade 2	$1012 \pm 44$	$896 \pm 62$
Splenomegaly	Liver ADC (mm <sup>2</sup> /s)	Spleen ADC ( mm <sup>2</sup> /s)
> 12.5 cm	$859 \pm 68$	$1012 \pm 58$
≤ 12.5 cm	$996 \pm 57$	$924 \pm 64$

The spleen ADC was significantly higher in patients with portal vein diameter >13 mm (p value 0,022), more than grade 2 oesophageal varices (p value 0.044), and splenomegaly >12.5cm (p value 0.011).

Liver ADC was found to be significantly lower in those patients.

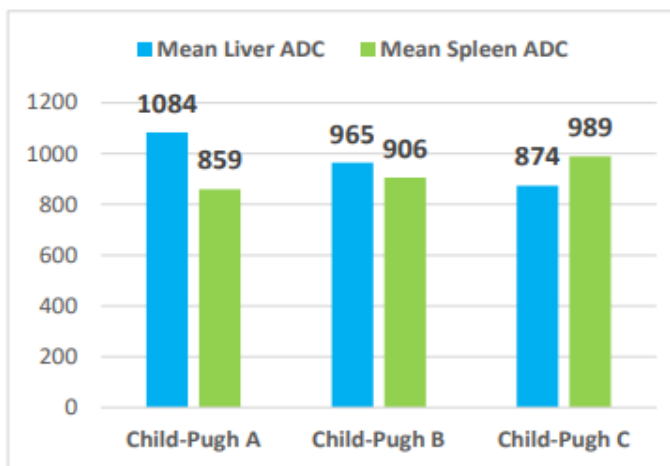
5. ADC values based on Child-Pugh scores.

Table 6:

	Mean Liver ADC (mm <sup>2</sup> /s)	Mean Spleen ADC (mm <sup>2</sup> /s)
Child-Pugh A	1084 ± 59	859 ± 63
Child-Pugh B	965 ± 53	906 ± 69
Child-Pugh C	874 ± 67	989 ± 48

It was observed that the mean spleen ADC values increased from Child-Pugh grade A to C significantly (P value 0.034) and the mean liver ADC decreased from Child-Pugh A to C. (P value 0.041)

Graph 6:



Correlation

Table 7:

	Liver ADC		Spleen ADC	
	R Value	P value*	R value*	P value*
Child-Pugh Scores	-0.667	0.0001	0.667	0.023
Portal Vein Diameter	-0.543	0.031	0.443	0.023
Splenomegaly	-0.663	0.0021	0.763	0.0221
Grade of Oesophageal varices	-0.553	0.031	0.443	0.021

\*Spearman's Correlation (P value<0.05)

The various surrogate markers of portal hypertension showed a significant negative correlation with liver

ADC and a significant positive correlation with spleen ADC values.

Representative cases



Figure 1: MR DWI and ADC of spleen and liver in CHILD PUGH Class A cirrhotic patient, ADC spleen: 888 mm<sup>2</sup>/sec, ADC of liver: 1043 mm<sup>2</sup>/sec

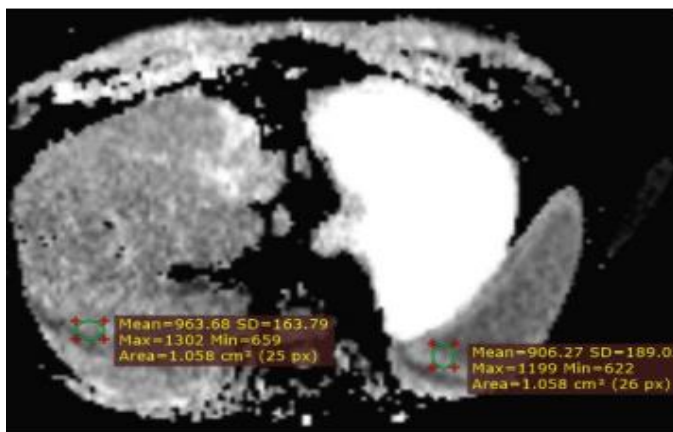


Figure 2: MR DWI and ADC of spleen and liver in CHILD PUGH Class B cirrhotic patient, ADC spleen: 906 mm<sup>2</sup>/sec, ADC of liver: 963 mm<sup>2</sup>/sec

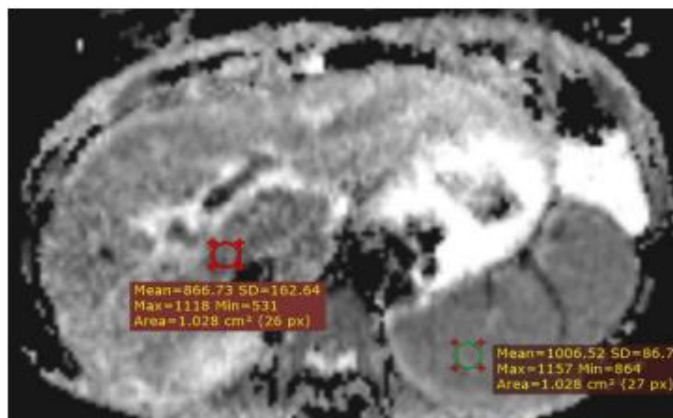


Figure: MR DWI and ADC of spleen and liver in CHILD PUGH Class C cirrhotic patient, ADC spleen: 1006 mm<sup>2</sup>/sec, ADC of liver: 866 mm<sup>2</sup>/sec

### Discussion

A total of 80 participants were included in the study with 40 in each group, where in mean age of the cirrhotic patients was  $47 \pm 5.2$  years. The majority of the patients with cirrhosis were males as compared to females with a ratio of 4: 1 in both the case and the control group in our present study.

The most common aetiology was alcoholic liver cirrhosis followed by viral related cirrhosis in our study. The majority of the patients included in our study were Child-Pugh class A (60%) followed Child Pugh class B. The mean Liver ADC values in cirrhotics were significantly lower than that of control group. The mean spleen ADC values were significantly higher in cirrhotics  $909 \pm 61$  (mm<sup>2</sup>/s).

However, this is in contradiction to the earlier reports except the one by Klasen et al (2), who found negative correlation between spleen and liver ADC in cirrhosis patients, but findings were in concordance with study by komalavally et al(3).

The spleen ADC values showed positive correlation with the Child-Pugh grades and surrogate markers of Portal hypertension. Patients with higher Child-Pugh score had higher spleen ADC values. The spleen ADC was significantly higher in patients with portal vein diameter >13 mm, more than grade 2 oesophageal varices, and splenomegaly >12.5cm. These two findings suggest that the spleen ADC is an indirect marker of splanchnic hyperaemia, thereby portal hypertension and liver ADC is an indirect marker for the severity of liver fibrosis The liver ADC values showed negative correlation with the Child-Pugh grades. Patients with higher Child-Pugh

score had lower Liver ADC values. One of the greatest hindrance to widespread adoption of DWI in the body is the lack of standardization (4).

In prior studies, two different diffusion sequences were used with b values of 0, 150, 250 and 400 mm<sup>2</sup>/s and 600 and 800 mm<sup>2</sup>/s, while in another study b values of 0, 300 and 500 mm<sup>2</sup>/s were applied. In our study b values of 50, 300 and 600 mm<sup>2</sup>/s were used.

### Conclusion

- Our study has shown that MRI Diffusion Weighted Imaging ADC measurement of spleen and liver was a simple cost-effective technique for evaluation of severity of cirrhosis and Portal hypertension avoiding the use of intravascular contrast agents.
- Our study evaluated the predictive capability of ADC values to the severity of chronic liver disease and Portal hypertension.
- Liver biopsy is considered as the gold standard for evaluating liver fibrosis in cirrhotic patients. But still it is invasive and has contraindications and complications. Our study, which evaluated liver ADC in various severity of cirrhosis, can be used as an alternative noninvasive technique for assessing hepatic fibrosis which could possibly replace invasive techniques in future.
- Spleen ADC correlated with the severity of Portal hypertension (in the form of surrogate markers of portal hypertension) thus could be used alternative to Hepatic Portal Venous Wedge Pressure Gradient measurement for assessing severity of Portal hypertension. Limitations of the Study
- This study included 80 subjects (with only 40 patients with cirrhosis), there is a need for studies with higher sample size to confidently generalised our findings in the population Funding: None Conflict of interest: None

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