MAGNETIC RESONANCE IMAGING ROLE IN QUANTIFICATION OF LIVER FAT IN DIABETIC PATIENTS IN A TERTIARY HEALTH CENTRE.

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ABSTRACT:

Introduction: Liver steatosis, a condition characterized by excessive liver fat accumulation, is linked to metabolic syndromes like obesity, diabetes, hypertension, and cardiovascular disease. Liver biopsy is the gold standard for diagnosing liver steatosis, but it is invasive and carries risks. Advanced MRI techniques, like Proton Density Fat Fraction (PDFF), offer accurate, non-invasive measurements of hepatic fat. This study aims to assess the utility of MRI in measuring liver fat in diabetic patients, a population prone to liver steatosis. Conventional MRI techniques have limitations, such as reduced accuracy and confounding factors.

Objectives: to quantify liver fat using Magnetic Resonance Imaging (MRI) in diabetic patients and investigate the prevalence, characteristics, and relationship between diabetes mellitus and fatty liver disease.

Methods: This cross sectional study was conducted to quantify hepatic fat using MRI in diabetic cases A total of 60 cases were included.

MRI Procedure: Based on inclusion criteria with informed consent MRI was taken with the required MR sequences.

Results: On assessing the association between the age and two groups (DM present and DM absent), there was no remarkable association, noted.

On assessing the association between the gender and two groups(DM present and DM absent), there was no remarkable association, noted.

Mean difference in BMI between groups was not significant.

On assessing the association between the grades of steatosis among the diabetics and non diabetics, there was a remarkable association, noted.

Mean PDFF in the diabetic cases were 21.4% and non diabetic cases were 15.6%. Mean difference in PDFF between groups was significant.

Among diabetic individuals, the mean PDFF was reported as 18.3 and 22.3 among the steatosis grades < 2 and ≥ 2, respectively. Notably, the mean difference in PDFF was significantly differs with severity of steatosis.

Among non diabetic individuals, the mean PDFF were 12.3 and 16.3 among the steatosis grade < 2 and ≥ 2, respectively. On assessing the mean difference there was a significant difference noted.

Conclusions: Severity of steatosis and PDFF were significantly linked with the presence of DM. We infer that all cases with diabetes mellitus showed remarkably high PDFF and hence all subjects with DM can be subjected for assessment of PDFF, periodically. Additionally, long term multicentric studies can be performed in order to get a in depth picture.

1. Introduction

Liver steatosis is characterized by excessive fat accumulation in the liver and is linked to metabolic syndrome, including obesity, type 2 diabetes (T2DM), hypertension, and cardiovascular disease. Liver steatosis can progress to non-alcoholic steatohepatitis (NASH), cirrhosis, and increase the risk of liver cancer (HCC).[1] Liver biopsy is the gold standard for diagnosing Liver steatosis, but is invasive and carries risks. Non-invasive imaging techniques like ultrasound (US) and computed tomography (CT) can detect fatty liver but have limited ability to quantify fat content.[2] Advanced MRI techniques, including Proton Density Fat Fraction (PDFF) imaging, offer more accurate, non-invasive measurement of hepatic fat. PDFF corrects for factors like noise bias and spectral complexity, providing reliable fat content measurements during a brief procedure.[3] This study aims to assess the utility of MRI in measuring liver fat in diabetic patients, a population particularly prone to liver steatosis.

Magnetic Resonance Imaging (MRI) utilizes various contrast processes to detect and measure liver fat by identifying proton signals in both fat and water. Advanced MRI techniques, such as Proton Density Fat Fraction (PDFF), which represents the ratio of fat protons to total protons.[4]

The PDFF is expressed as a percentage (0-100%) and correlates strongly with histologic steatosis grades. Additionally, PDFF values align with semi-automated histologic measurements of hepatic fat levels in digitalized biopsy specimens. To standardize and improve PDFF's practicality, the Quantitative Imaging Biomarkers Alliance (QIBA)-PDFF group was established.

Conventional MRI techniques, such as In-Phase (IP) and Out-of-Phase (OP) imaging, can subjectively assess liver steatosis. However, IP-OP has limitations, including reduced accuracy due to confounding factors and inability to quantify hepatic fat beyond 50%. Furthermore, concurrent conditions like iron overload can affect signal intensity, hindering accurate steatosis assessment.[5] Advanced MRI techniques like CSE-MRI and MRS offer more precise and reliable measurements.

2. Objectives

This study aims to quantify liver fat using Magnetic Resonance Imaging (MRI) in diabetic patients and investigate the prevalence, characteristics, and relationship between diabetes mellitus and fatty liver disease.

3. Methods

This cross sectional study was conducted to quantify hepatic fat using MRI in diabetic cases
A total of 60 cases were included.

Cases of all ages who were referred to Department of Radiodiagnosis

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Clinically diagnosed cases of Diabetes mellitus and non-diabetics were selected based on inclusion and exclusion criteria

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With informed consent, MRI upper abdomen was taken with the required MR sequences.

↓

Fat volume fraction was calculated from MR, and the results were compared between two groups.

Data analysis

SPSS-19 was used to evaluate the data after it was entered into an Excel sheet. For quantitative variables, descriptive statistics including mean, standard deviation, and proportions (%) were computed. The independent sample t test was performed to evaluate the hypothesis using the Chi Square test. A p-value of less than 0.05 was deemed statistically significant.

Fat Quantification using Magnetic Resonance Imaging

MRI may detect and measurement of amount of fat in liver by identifying the proton signals that are found in both fat and water. Hepatic steatosis assessment has progressed from qualitative estimations of hepatic steatosis obtained from traditional MRI methods to quantify MRS and MRI approaches that allow accurate and precise determination of hepatic fat content. When used appropriately, CSE-MRI and MRS can function as techniques that measure PDFF.

The ratio of the unconfounded signal from mobile fat protons to total of un- confounded sign from mobile fat protons and the un-confounded signal through protons that move water particles is known as the PDFF[49]. A percentage ranging from 0 to 100% is used to express MRI-based PDFF, and it is highly correlated with histologic steatosis grades[50-53]. Additionally, PDFF and the amount of hepatic fat levels as determined by semi-automated histologic measurement on digitalized biopsy specimens are correlated[54].The QIBA-PDFF group was recently formed in order to improve PDFF's value, standardization, and practicality as a QIB across many platforms[55].

Conventional MRI

Liver steatosis can be subjectively assessed using traditional imaging or fat suppression techniques based on discernible signal variations[56]. In-Phase takes advantage of the gradient echo signals of fat and water's TE-dependent phase interference effect[56].

Protons undergo phase disruption at regular intervals because they precess at distinct frequencies in fat and water molecules. As a result, at In-Phase time, signals of fat and water add, and at Opposed phase, they cancel[56].

Within the constrained range of 0%–50% fat signal fraction, subjective assessment of hepatic fat by IP-OP is feasible[56]. Since hepatic fat-fractions more than 50% are rare but do happen, this limit is usually regarded as appropriate. Although IP-OP can be used to estimate hepatic steatosis qualitatively, its accuracy is diminished by confounding circumstances, making it inappropriate for quantifying hepatic fat[56].

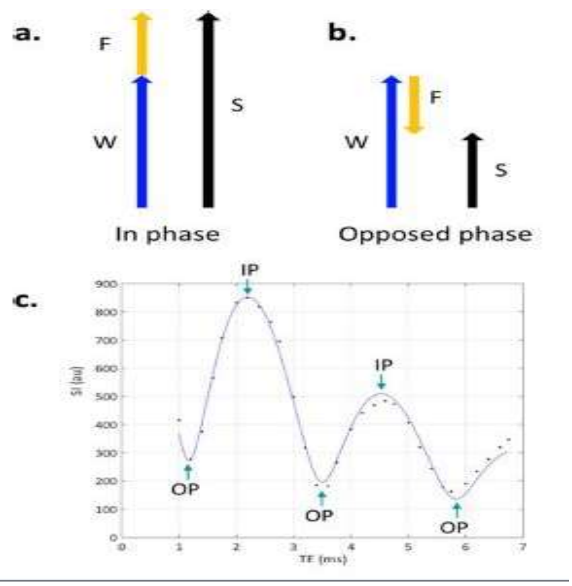

Fig 1 – **Principles of Dixon imaging**. If the image is acquired when the water and fat have the same phase (a), the signals from water (W) and fat (F) constructively interfere, and the total signal S = W + F. If the image is acquired when the water and fat are in opposed phase (b), W and F destructively interfere and S = W – F. (c) shows data from a single voxel in normal bone marrow (which contains both water and fat) using a gradient echo based Dixon acquisition with very closely spaced echo times. This data shows the signal oscillation over time as fat and water signals diphase, come back into phase and diphase again. There is progressive reduction in height of the IP peaks with increasing echo time owing to signal decay (in this case with the time constant T2*).

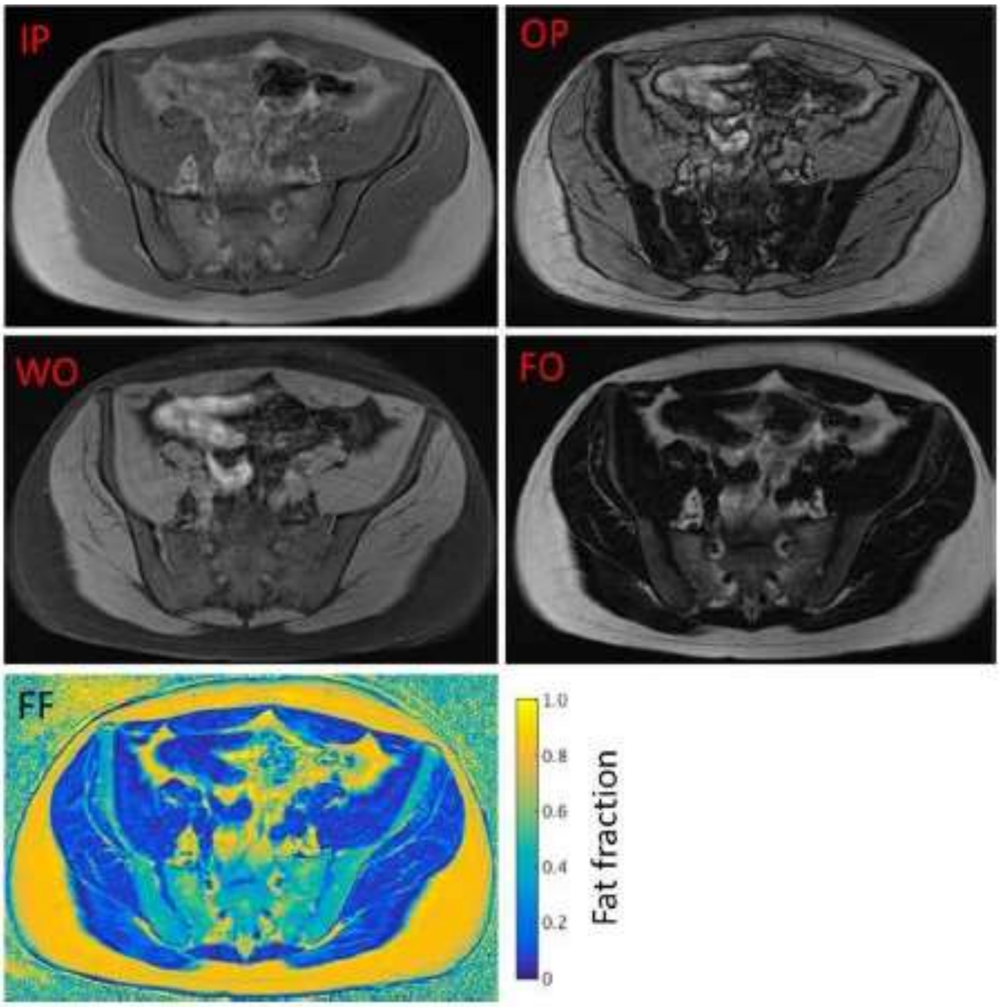

Fig 2 – Representative case of 49/M showing CSE-MR images. Images are acquired at IP and OP TEs. Addition and subtraction of these images produces water only (WO) and fat only (FO) images, respectively. Fat fraction (FF) maps is then generated from the WO and FO images as shown above.

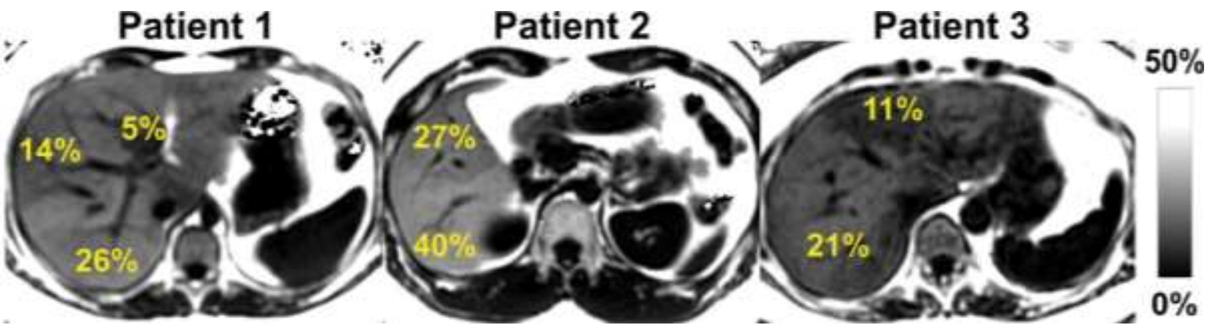

Fig 3 – Representative cases. Patient 1- 51 year old male, Patient 2 – 57 years old male with DM, Patient 3 – 42 year old male with no h/o DM. Showing Chemical shift–encoded (CSE) MRI assessment of fat content over the entire liver. 3- dimensional CSE MRI proton density fat fraction (PDFF) maps in three different patients with heterogeneous pattern of steatosis.

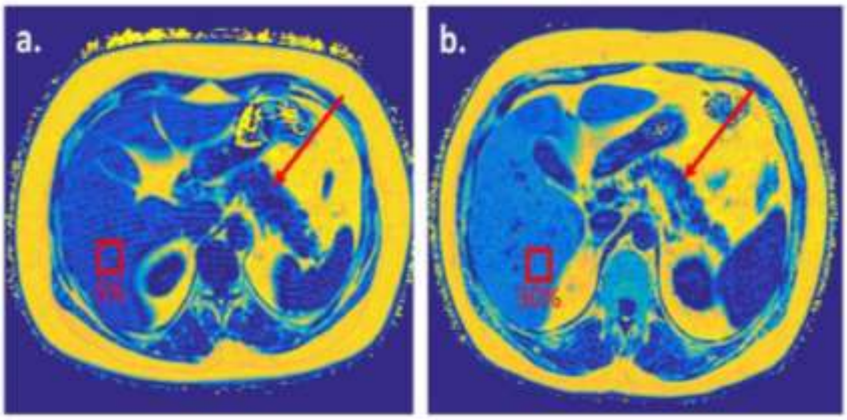

Fig 4– PDFF maps of comparable axial slice through the abdomen in two patients.

(a) 32 year old male- Shows low hepatic and pancreatic fat

(b) 45 year old female- Shows NAFLD, with heterogenous left and right steatosis and pancreatic interlobular fatty infiltration.

The pancreas is arrowed in both patients, region of interest have been placed on the liver to demonstrate differences in hepatic PDFF.

<u>Inclusion criteria:</u>

- Cases with any age group and from both gender

<u>Exclusion criteria:</u>

- Cases with metallic foreign body (metal sliver) in their eye
- Cases with aneurysm clip in their brain.
- Cases with metallic devices
- Cases who are bed ridden or psychiatric ill cases.

Each participant received a thorough explanation of the study along with guarantees that their identity would be kept completely private and that they might decline to participate. Prior to the interview, the study participants provided written informed consent. Following the acquisition of signed informed consent, the lead investigator used a pre-structured proforma to evaluate each participant 's clinical presentation.

4. Results

Table 1: In the present study, there were 6.7%, 18.3%, 35% and 40% of cases in the age groups of 18-30 years, 31-40 years, 41-50 years and 51-60 years, respectively. On assessing the association between the age and two groups, there was no remarkable association, noted.

Age group between groups

Age group	DM-Present	DM -Absent	Total	p value
18-30 years	2 (3.3)	2 (3.3)	4 (6.7)	0.9314
31-40 years	6 (10.0)	5 (8.3)	11 (18.3)	
41-50 years	10 (16.7)	11 (18.3)	21 (35.0)	
51-60 years	12 (20.0)	12 (20.0)	24 (40.0)	
Total	30 (50.0)	30 (50.0)	60 (100.0)	

Table 2: In the present study, there were 48.3%, and 51.7%of cases were males and females, respectively. On assessing the association between the gender and two groups, there was no remarkable association, noted.

Gender between groups

Gender	DM-Present	DM -Absent	Total	p value
Male	16 (26.7)	13 (21.7)	29 (48.3)	0.7354
Female	14 (23.3)	17 (28.3)	31 (51.7)	
Total	30 (50.0)	30 (50.0)	60 (100.0)	

Table 3: Mean BMI in the diabetic cases were 26.4 and non diabetic cases were 26.1. Mean difference in BMI between groups was not significant.

Mean BMI between groups

Parameter	DM-Present	DM -Absent	p value
BMI	26.4±2.1	26.1±2.7	0.8315

Table 4: On assessing the steatosis grades, there were 10%, 35%, 33.3% and 21.7%of cases had grade 0, grade 1, grade 2 and grade 3 steatosis, respectively. On assessing the association between the grades of steatosis among the diabetics and non diabetics, there was a remarkable association, noted.

Steatosis grades between groups

Steatosis grades	DM-Present	DM -Absent	Total	p value
Grade 0	1 (1.7)	5 (8.3)	6 (10.0)	0.0471*
Grade 1	8 (13.3)	13 (21.7)	21 (35.0)	
Grade 2	11 (18.3)	9 (15.0)	20 (33.3)	
Grade 3	10 (16.7)	3 (5.0)	13 (21.7)	
Total	30 (50.0)	30 (50.0)	60 (100.0)	

Table 5: Mean PDFF in the diabetic cases were 21.4% and non diabetic cases were 15.6%. Mean difference in PDFF between groups was significant.

Mean MRI-PDFF between groups

Parameter	DM-Present	DM -Absent	p value
MRI - PDFF (%)	21.4±2.6	15.6±3.5	<0.0001*

Table 6: Among diabetic individuals, the mean PDFF was reported as 18.3 and 22.3 among the steatosis grades < 2 and ≥ 2, respectively. Notably, the mean difference in PDFF was significantly differs with severity of steatosis.

Mean MRI – PDFF vs steatosis among diabetics

Parameter	Steatosis Grade <2	Steatosis Grades ≥2	p value
MRI - PDFF (%)	18.3±2.8	22.3±2.1	0.0145*

Table 7: Among non diabetic individuals, the mean PDFF were 12.3 and 16.3 among the steatosis grade < 2 and ≥ 2, respectively. On assessing the mean difference there was a significant difference noted.

Mean MRI – PDFF vs steatosis among non diabetics

Parameter	Steatosis Grade <2	Steatosis Grades ≥2	p value
MRI - PDFF (%)	12.3±3.8	16.3±3.1	<0.0001*

5. Discussion

In the present study, there were 6.7%, 18.3%, 35% and 40% of cases in the age groups of 18-30 years, 31-40 years, 41-50 years and 51-60 years, respectively. On assessing the association between the age and two groups, there was no remarkable association, noted.

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Among non diabetic individuals, the mean PDFF were 12.3 and 16.3 among the steatosis grade < 2 and ≥ 2, respectively. On assessing the mean difference there was a significant difference noted.

6. Conclusion

Severity of steatosis and PDFF were significantly linked with the presence of DM. We infer that all cases with diabetes mellitus showed remarkably high PDFF and hence all subjects with DM can be subjected for assessment of PDFF, periodically. Additionally, long term multicentric studies can be performed in order to get a in depth picture.

7. References

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