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RESEARCH ARTICLE

A prospective technical validation study comparing Proton Density Fat Fraction by Magnetic Resonance Imaging and Liver Attenuation Index by Computed Tomography for the quantitative assessment of hepatic steatosis in living liver donors with histopathological correlation as standard reference

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ABSTRACT

Background: Accurate quantification of hepatic steatosis is crucial in living liver donors to ensure safety and optimal graft function. Although liver biopsy is the reference standard, it is invasive and limited by sampling variability. Computed tomography (CT) derived liver attenuation index (LAI) is commonly used for non-invasive liver fat quantification; however, its accuracy is affected by confounding factors such as iron deposition, fibrosis, edema and medications, and involves ionizing radiation. Magnetic resonance imaging (MRI) derived proton density fat fraction (PDFF) has emerged as a more reliable non-invasive technique for liver fat quantification. The objective of the study is to compare the diagnostic accuracy of MRI- derived proton density fat fraction and CT – derived Liver attenuation index in quantifying hepatic steatosis in living liver donors using histopathology as the standard reference.

Methods: In this prospective observational study, 30 voluntary liver donors underwent non-contrast CT and multi-echo MRI. Liver attenuation index was calculated as the difference between mean hepatic and splenic attenuation on CT, and MRI- proton density fat fraction was obtained using mDIXON Quant sequence. Histopathological steatosis grading served as the reference standard. A point biserial correlation was done to find out correlation between liver attenuation index, proton density fat fraction and steatosis. Receiver operating characteristic (ROC) curves were created to find out diagnostic characteristics of liver attenuation index and proton density fat fraction for predicting steatosis.

Results: Histopathology demonstrated steatosis in 5 out of 30 donors (16.7%). CT – derived Liver attenuation index demonstrated moderative negative correlation with steatosis ($r= -0.545$, $p=0.002$) and limited diagnostic performance (AUC 0.116; sensitivity 40%, specificity 24% at cut off <6.5HU). MRI- derived proton density fat fraction demonstrated strong correlation ($r=0.825$, $p=0.001$) and excellent diagnostic accuracy (AUC 0.992, sensitivity 100%, specificity 96% at cut off >6.75%).

Conclusion: MRI derived proton density fat fraction provides superior accuracy compared with CT derived liver attenuation index for detecting hepatic steatosis, particularly mild disease, and represent a reliable, non-invasive, radiation-free alternative for pre-operative evaluation of living liver donors.

Introduction

Liver transplantation is accepted as a treatment option for end stage liver disease. Now-a days live donor liver transplantation (LDLT) is preferred instead of deceased liver transplantation as there is long waiting list, difficulty in finding suitable liver and inability to plan operation. The pre-transplant radiological preparation of living donor includes the evaluation of degree of steatosis, hepatic venous and arterial anatomy, bile duct anatomy and variation, focal parenchymal lesions and volumetric evaluation of the donor liver.

Post-transplant morbidity and mortality is approximately 21% and 0.5% for the donor in LDLT[1]. Hepatic steatosis affects graft function, increases the risk of postoperative complication for the donor and prevents regeneration of the liver after resection. Therefore, the determination of pre-operative hepatic steatosis is essential to reduce the potential complications in donors and to increase the success of the operation.

Liver biopsy is the gold standard to diagnose hepatic steatosis. Apart from liver fat content, it also gives information about other key histological features such as steatosis zonality, fat droplet size (macrovesicular vs microvesicular), iron overload, inflammation, cellular injury and fibrosis. The major limitation of liver biopsy is lack of representation of sample to changes in the liver as a whole because most features of diffuse liver disease (steatosis, fibrosis, iron overload etc) are inherently heterogeneous. The accuracy of liver sample for assessing hepatic steatosis have been studied by various authors. Studies have shown that there is significant variability even in closely spaced samples[2–4].

Now-a days, as a part of pre-transplant work up, CT is done to quantify the liver fat content, to assess the hepatic venous and arterial anatomy and for volumetric evaluation of the donor liver, and MRCP is done to assess the biliary duct system.

Non-enhanced CT examination is a non-invasive test used as a common tool for assessing liver fat with acceptable accuracy. Hepatic steatosis cause liver attenuation to be reduced. Spleen is an appropriate organ for comparison, as splenic attenuation is not affected by diffuse pathological process. There are different methods for quantitative estimation of liver fat by CT, which include hepatic attenuation measurement, liver attenuation index and hepatic attenuation difference at dual energy CT. In hepatic attenuation measurement technique, at unenhanced CT, the attenuation value of liver is measured by drawing ROI (region of interest). Typically, normal liver have higher attenuation than spleen ranging from 50-65HU. Fatty infiltration is diagnosed if the hepatic attenuation is <40HU [5]. Study done by Kodama et al found that hepatic attenuation of 40HU represents fatty change of approximately 30%[5]. The attenuation of right hepatic lobe was found to be lesser than that of left lobe because of differential distribution fat in liver. In diffuse fatty liver, particularly no-cirrhotic liver, there is preferential fatty infiltration towards the right lobe of liver. This is because of physiological greater portal flow to the right lobe than to left lobe of liver [6,7]. The sensitivity and specificity of CT for mild steatosis (cut off values at liver biopsy 10-20%) is 57% and 88% and for high grade steatosis (cut off values at liver biopsy >25%), the sensitivity of CT increases to 72% and specificity to 95%[4,8].

Dual energy CT involves scanning with two different tube potentials, usually at 140 and 80kVp. Dual energy CT may be used to evaluate focal and diffuse fatty infiltration in liver by measuring change in hepatic attenuation between images acquired at lower and higher tube potentials[9,10]. The attenuation of fatty liver changes more markedly with change in tube potential than that of normal liver. An increase in fatty content leads to decrease in CT attenuation at low energy, as the energy level increases, the fat attenuation increases[10]. The change in attenuation increased as the fat content in the liver increased. This is applicable only if the iron content of the liver is not increased. An attenuation change by >10HU with tube potential change from 140 to 80kVp indicates fatty infiltration of >25%[10]. It has lower sensitivity for mild steatosis and accuracy is reduced by significant iron overload. However, there is paucity of literature to validate the utility of dual-energy CT to accurately predict the degree of hepatic steatosis[11].

The liver attenuation index (LAI) is measured as the difference between mean hepatic attenuation and mean splenic attenuation[6].

LAI = mean hepatic attenuation - mean splenic attenuation

In study done by Limanond et al[12] on living related liver donors, showed that LAI > 5 HU correctly predicted the absence of significant macrovesicular steatosis (ie, ≤5% fat), LAI of -10 to 5HU were suggestive of mild to moderate steatosis (ie, 6-30% fat) and LAI of <-10HU were suggestive of moderate to severe hepatic steatosis (ie, ≥30% fat) with a specificity of 100%. In study done by Park et al, found specificity of 100% for detection of steatosis of >30% when LAI was less than -9HU[13].

However, the presence of iron, copper, glycogen, fibrosis or oedema can affect the attenuation values leading to errors in fat quantification by CT. And also, the use of some drugs such as amiodarone increases the liver attenuation and confounds the ability of CT to quantify fat. Liver attenuation is also affected by beam hardening in patients with large body habitus, kilovolt peak settings, and vendor-specific filters, although these effects are small[14]. And other main disadvantage of CT is the radiation exposure.

MRI is a very sensitive non-invasive method in determination, characterisation and grading of fat in liver. MRI techniques like chemical shift imaging, rapid spin echo imaging and MR spectroscopy are used to detect the presence and to quantify the amount of fat in the liver. Conventional qualitative methods used in the past include in-phase and opposed-phase imaging or fat-suppression methods (T1-weighted gradient-echo and T2-weighted fast spin-echo sequences). Although these methods enable qualitative assessment of steatosis, they are unsuitable for quantitative assessment as a result of multiple confounding factors. Over recent years, proton density fat fraction (PDFF) has emerged as the preferred non-invasive quantitative imaging technique in the diagnosis and grading of hepatic steatosis[15,16].

Multi-echo proton density fat fraction (PDFF) is one MRI technique that evaluates fat fraction of liver, which uses complex chemical shift based water-fat separation technique. This technique uses both magnitude and phase information from three or more images acquired at echo times appropriate for more accurate separation of water and fat signals. Decomposition methods use complex data to separate water and fat signals including the phase information and estimating the field map (B_0 inhomogenity). This method provide estimated of fat fraction with dynamic range of 0-100% (Figure 1) as compared to conventional chemical shift based technique with dynamic range of 0-50%[15].

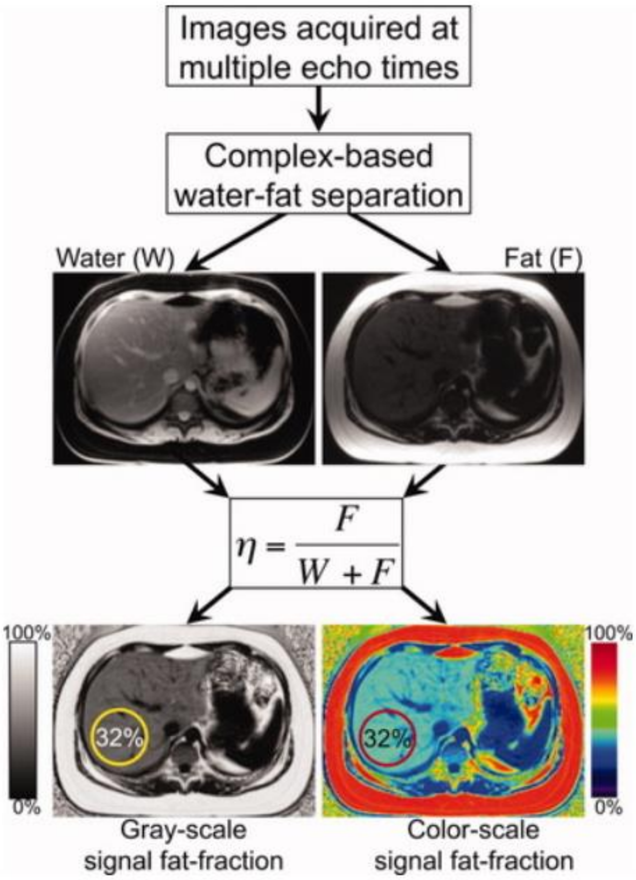

Figure 1: Signal fat fraction map with full dynamic range 0 -100%: Calculated on pixel-by-pixel basis using complex based water-fat separation methods. η is Signal fat fraction, W and F are signal contribution from water and fat.

PDFF can be defined as density of hydrogen protons attributed to fat, or the fraction of "un-confounded" proton signal from mobile fat, normalized by the total hydrogen proton density from all mobile protons.

Conventional MRI techniques for liver fat quantification are limited by T1 bias [17–19], T2* decay[17,20], multifrequency signal-interference effects of protons in fat[17,21], noise bias[22], eddy currents[23,24], concomitant gradients and even temperature [25]; and they may not be accurate in the quantification of liver fat. Advanced MRI technique eliminates these biases seen with conventional MRI-techniques and can provide the magnetic resonance imaging -estimated proton density fat fraction (MRI-PDFF). In addition to it, MRI-PDFF allows fat mapping of the entire liver[15]. This prospective technical validation study intends to compare MRI derived PDFF with CT derived LAI for quantitative assessment of hepatic steatosis in voluntary liver donors using histopathology as the reference standard.

Methodology

CASES:

This prospective study was conducted in the department of radiodiagnosis at Aster Malabar Institute of Medical Sciences at Calicut, Kerala, India, between October 2022 and June 2023. The study protocol was approved by the Scientific Research Committee and Institutional Ethics Committee, and all participants provided written informed consent.

Inclusion criteria: Living liver donor candidates who were referred for CT-liver attenuation index and MRCP as part of routine pre-transplant work up who subsequently underwent donor hepatectomy and in whom intraoperative liver biopsy specimens were obtained were included in the study.

Exclusion criteria: Candidates with known contraindication to MRI or inability to tolerate MRI due to general health conditions, and subjects who did not undergo surgery were excluded.

After applying the inclusion and exclusion criteria, thirty voluntary liver donor candidates (13 male and 17 female) undergoing routine preoperative evaluation for living donor liver transplantation were included in the final analysis.

IMAGING ACQUISITION TECHNIQUE:

Computed tomography protocol: Non-contrast CT abdomen was performed in all voluntary liver donor candidates using GE Optima 660 -128 slice multidetector CT scanner as part of routine liver transplantation work up. A uniform imaging protocol was used for all candidates. Scanning and reconstruction parameters were 100-120kV; 200-300 mA; 512x512 pixels; rotation interval of 0.6sec and pitch of 0.98. All acquired images were transferred to Picture Archiving and Communication System (PACS) workstation for analysis.

Magnetic resonance imaging protocol: MR examinations were performed using Philips Ingenia Elition 3Tesla MRI. Magnetic resonance cholangiography (MRCP) was performed for evaluation of the biliary anatomy as part of the donor assessment protocol. In addition to it, mDIXON – Quant sequence was acquired for quantification of liver fat. mDIXON – Quant sequence is a three dimensional fast field echo (3D FFE) multiecho sequence which is acquired in just one breath hold. Detailed sequence parameters are provided in Table 1.

Table 1: mDIXON – Quant sequence parameters

mDIXON – Quant sequence parameters	
TR	5.6 ms.
TE1/ delta TE	0.97 ms/ 0.7 ms.
Flip angle	5°
Number of echoes	6
FOV	400 x 350 x 210mm
Number of slices	70
Slice gap	-3
Breadth holding	yes
Scan time	13 sec.

mDIXON – Quant sequence produce fat-only, water-only, R2* maps and fat fraction maps. Fat fraction maps were transferred to Picture Archiving and Communication System (PACS) workstation for analysis.

IMAGING ANALYSIS:

CT- derived LAI: CT images were reviewed in PACS workstation. Mean hepatic attenuation was calculated by drawing 10 random circular ROI (region of interest) with a diameter of 10mm in liver involving all segments avoiding areas of visible hepatic vascular structures and biliary structures. Similarly mean splenic attenuation was calculated by drawing 5 random circular ROI with a diameter of 10mm in spleen (Figure 2). LAI was calculated using the formula:

LAI = mean hepatic attenuation - mean splenic attenuation.

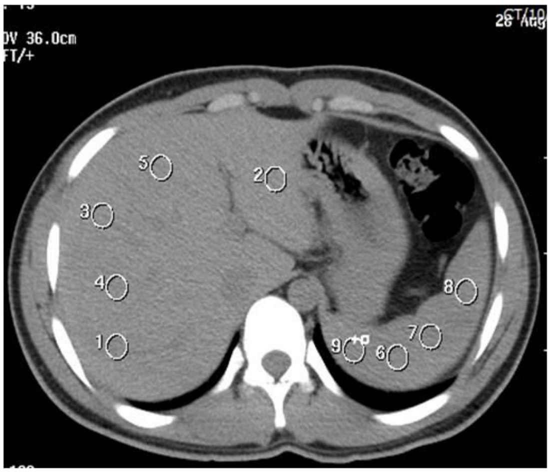

Figure 2: Drawing ROI for calculating LAI

MRI- derived PDFF: The MRI proton density fat fraction maps obtained were analysed on the workstation. The signal intensity on PDFF maps corresponds to the percentage of fat within the liver parenchyma. To obtain liver proton density fat fraction, ROI with a diameter of 10mm was placed at all segments of liver avoiding visible blood vessels, bile duct, focal lesions and artifacts. The mean value from all ROIs was recorded the liver PDFF (Figure 3).

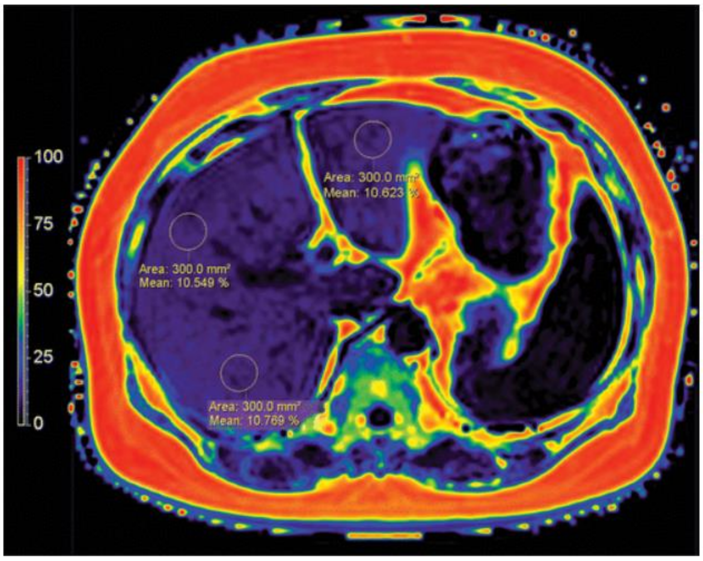

Figure 3: Drawing ROI for calculating PDFF

DONOR BIOPSY:

Liver biopsy specimens were obtained intraoperatively as part of routine donor surgery. Histopathological evaluation was performed by an experienced pathologist blinded to imaging findings. Hepatic steatosis was graded according to non-alcoholic steatohepatitis clinical research network (NASH- CRN) scoring system, based on the percentage of hepatocytes containing fat. As per NASH-CRN system, steatosis is graded as: Grade 0: <5%, grade 1: 5-33%, grade 2: 34-66% and grade 3: >66%. In addition to it, hepatocyte ballooning and lobular inflammation were scored according to NASH-CRN system (Table 2). The sum of steatosis, ballooning and lobular inflammation scores constituted the NAFLD activity score (NAS), ranging from 0 to 8.

Table 2: NASH – CRN system

Histologic feature	Score	Definition
Steatosis	0	<5%
	1	5-33%
	2	34-66%
	3	>66%
+		
Hepatocyte ballooning	0	None
	1	Few
	2	Many
+		
Lobular inflammation	0	None
	1	1-2 foci per 20x field
	2	2-4 foci per 20x field
	3	>4 foci per 20x field
= NAFLD activity score (NAS); range 0-8		

STATISTICAL ANALYSIS:
All the data collected were coded and entered into a Microsoft Excel spreadsheet which was re-checked and analysed using Statistical Package for the Social Sciences (SPSS version 21.0). Quantitative variables were summarized using mean and standard deviation (SD), while categorical variables were represented as frequencies and percentages. A point biserial correlation analysis was performed to assess the relationship between LAI, PDFF and hepatic steatosis. Receiver operating characteristic (ROC) curves were created to evaluate the diagnostic performance of CT-LAI and MRI-PDFF in predicting hepatic steatosis. The area under curve (AUC), sensitivity, specificity and optimal cut off values were calculated. A p value of <0.05 was considered statistically significant.

Results

A total of 30 candidates were included in the final analysis, which included 13 males and 17 females. Most of the candidates (40%) were in the age group of 31-40yrs. 33.3% were aged ≤ 30yrs, 23.3% were aged between 41-50yrs and 3.3% were aged >50yrs with mean age of 35yrs.

HISTOPATHOLOGICAL ANALYSIS:
Histopathological evaluation revealed hepatic steatosis in 5 out of 30 donor candidates (16.7%), all of them demonstrated Grade 1 steatosis corresponding to 5-33% hepatocellular fat content according to NASH- CRN system. The remaining 25 candidates (83.3%) showed no significant steatosis, with hepatocellular fat content <5% (Grade 0) (Table 3).

Table 3: Biopsy grading of steatosis in study population

Biopsy grading of steatosis-no. (%)	
Grade 1: <5%	25 (83.3%)
Garde 2: 5-33%	5 (16.7%)
Grade 3: 34-66%	0
Garde 4: >66%	0

Hepatocyte ballooning was absent in all candidates. Lobular inflammation was identified in only 2 of 30 candidates (6.7%), it was in mild in severity (Figure 4). Overall, these findings indicate a low prevalence of hepatic steatosis and minimal inflammatory activity within the study population

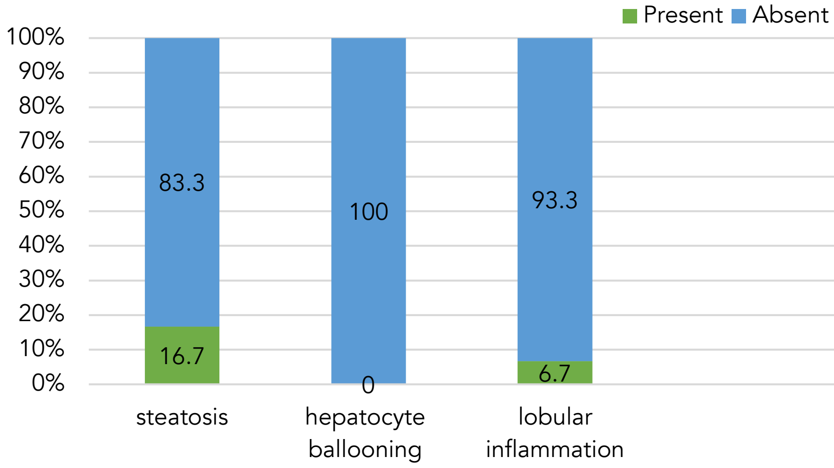

Figure 4: Distribution of steatosis, hepatocyte ballooning and lobular inflammation in study population

CORRELATION BETWEEN CT-LAI AND HEPATIC STEATOSIS:

The CT- LAI in the study group ranged from -1.1 HU to +17.4 HU, with mean value of +9.2 HU. Among the subjects without hepatic steatosis, LAI values ranged from +4.2 HU to +17.4 HU, with mean of +10.3 HU and a median of +10HU. In subjects with hepatic steatosis, LAI values ranged from -1.1 HU to +8 HU, with mean of +3.5 HU and a median of + 3.7HU (Table 4). These findings indicates that lower LAI values are associated with subjects who exhibit steatosis, while higher LAI values are observed in subjects without steatosis.

Table 4: Maximum, minimum and mean LAI values in entire study population, in patients without steatosis and patients with steatosis

Study population	
Maximum LAI	+17.4 HU
Minimum LAI	-1.1 HU
Mean LAI	+ 9.2 HU
Patients without steatosis	
Maximum LAI	+ 17.4 HU
Minimum LAI	+ 4.2 HU
Mean LAI	+ 10.3 HU
Patients with steatosis	
Maximum LAI	+ 8 HU
Minimum LAI	- 1.1 HU
Mean LAI	+ 3.5 HU

Figure 5 shows an axial CT section at the level of liver in a subject with biopsy proven grade 1 steatosis. ROI were drawn on liver and spleen, and the calculated LAI was +5HU.

Figure 5: CT-LAI of this candidate was +5HU

The point biserial correlation was performed to determine the correlation between LAI and hepatic steatosis (Table 5)

Table 5: Correlation between CT- LAI and hepatic steatosis.

Variables	Correlation coefficient(r)	p value
LAI * Steatosis	-0.545	.002

There was moderate negative correlation between LAI and hepatic steatosis, which is statistically significant (r= -0.545, p=.002). A negative correlation suggests that as LAI value increases there is tendency for a decrease in the presence or severity of hepatic steatosis within the study population.

CORRELATION BETWEEN MRI-PDFF AND HEPATIC STEATOSIS:

The MRI-PDFF in the study group ranged from 1.5% to 12.5%, with mean value of 4.8%. Among subjects without hepatic steatosis, PDFF values ranged from 1.5% to 7.3%, with mean of 3.8% and a median of 3.6%. In subjects with hepatic steatosis, PDFF values ranged from 7% to 12.5%, with mean of 9.6% and median of 9.5% (Table 6). Higher PDFF values are associated with subjects who have steatosis, while lower PDFF values are observed in subjects without steatosis. This indicating that increased fat deposition in the liver leads to higher PDFF values.

Table 6: Maximum, minimum and mean PDFF values in entire study population, in patients without steatosis and patients with steatosis

Study population	
Maximum PDFF	12.5%
Minimum PDFF	1.5%
Mean PDFF	4.8%
Patients without steatosis	
Maximum PDFF	7.3%
Minimum PDFF	1.5%
Mean PDFF	3.8%
Patients with steatosis	
Maximum PDFF	12.5%
Minimum PDFF	7%
Mean PDFF	9.6%

Figure 6 shows the MRI-PDFF image of a subject with biopsy proven grade 1 steatosis, with a measured hepatic fat fraction of 7.3%.

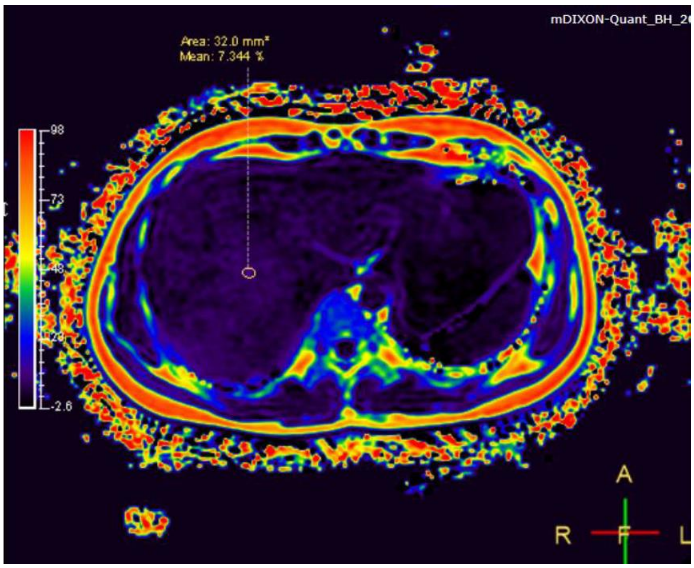

Figure 6: MRI-PDFF of this candidate was 7.3%

The point biserial correlation was run to determine the correlation between PDFF and hepatic steatosis (Table 7)

Table 7: Correlation between MRI- PDFF and hepatic steatosis.

Variables	Correlation coefficient(r)	p value
PDFF * Steatosis	0.825	.001

There was a strong positive correlation between PDFF and hepatic steatosis, which is statistically significant (r= 0.825, p=.001). This strong positive correlation suggests that higher PDFF values are strongly associated with an increased likelihood of severity of hepatic steatosis. The strong positive correlation supports the clinical utility of MRI-PDFF in assessing hepatic steatosis.

PREDICTIVE VALUES OF HEPATIC STEATOSIS USING CT-LAI:
To assess the performance of MRI-PDFF study to diagnose hepatic steatosis Receiver operating characteristic (ROC) curve was drawn (Figure 7).

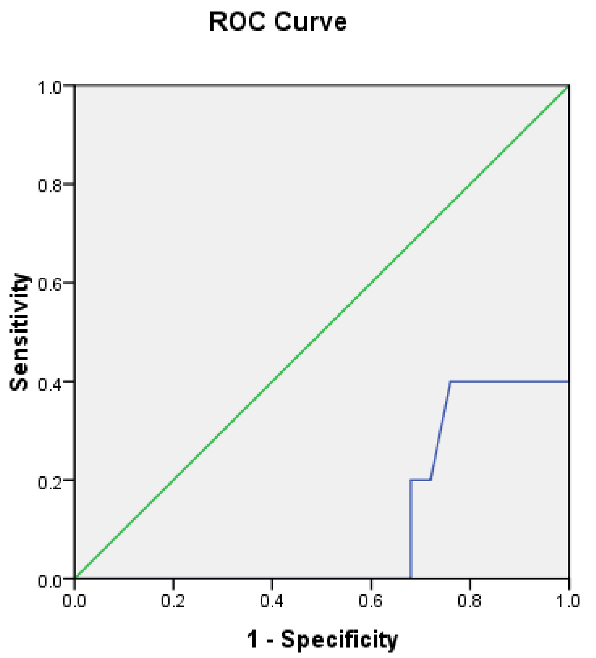

Figure 7: ROC curve for diagnosing hepatic steatosis using CT-LAI

The ROC curve is below the diagonal- suggesting poor performance. Area under ROC curve (AUC) for diagnosing hepatic steatosis was 0.116 (95% confidence interval (CI): -0.032-0.264) With a cut-off value of +6.5HU the sensitivity and specificity of CT- LAI study was 40% and 24% respectively (Table 8). This further confirms the poor performance of CT-LAI study in correctly identifying hepatic steatosis cases.

Table 8: Predictive values of hepatic steatosis using CT- LAI

Area under ROC curve	95% CI	P value	Cut off value	Sensitivity	Specificity
0.116	-.032-.264	.008	<6.5	40%	24%

PREDICTIVE VALUES OF HEPATIC STEATOSIS USING MRI-PDFF:
To assess the performance of MRI-PDFF study to diagnose hepatic steatosis ROC curve was drawn (Figure 8).

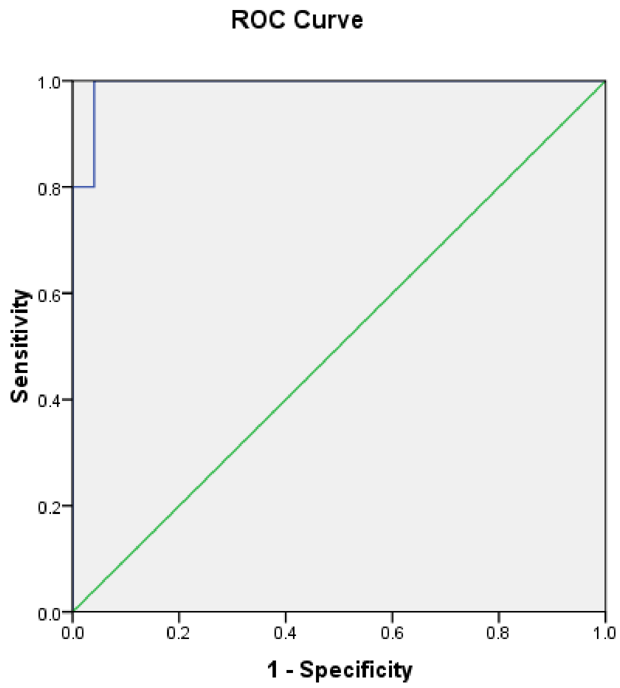

Figure 8: ROC curve for diagnosing hepatic steatosis using MRI-PDFF

The ROC curve of MRI-PDFF is above the diagonal. Area under ROC curve (AUC) for diagnosing hepatic steatosis was 0.992 (95% CI: 0.967-1.00). With a cut-off value of 6.75% the sensitivity and specificity of MRI-PDFF study was 100% and 96% respectively (Table 9). These values indicate that MRI-PDFF study is reliable and extremely accurate diagnostic tool for identifying the presence or absence of hepatic steatosis.

Table 9: Predictive values of hepatic steatosis using MRI-PDFF

Area under ROC curve	95% CI	P value	Cut off value	Sensitivity	Specificity
.992	.967-1.00	.001	>6.75	100.0%	96.0%

COMPARISON OF CT-LAI AND MRI-PDFF WITH RESPECT TO HEPATIC STEATOSIS:

Comparing the p values, lower p value of MRI-PDFF versus histopathologically detected hepatic steatosis indicates stronger statistical significance. (Table 10).

Table 10: Comparison of CT-LAI and MRI-PDFF with respect to hepatic steatosis by biopsy

Variable	Steatosis		P value
	Present	Absent	
LAI (HU)	3.5 ± 4.06	10.3 ± 4.1	.002
PDFF (%)	9.6 ± 2.0	3.8 ± 1.4	.001

Discussion

Pre-transplant evaluation of the liver is critical step in selecting suitable liver donors. Accurate quantification of hepatic steatosis is essential in the evaluation of potential living liver donor because steatotic graft are more vulnerable to ischemic-reperfusion injury and may adversely affect graft function[26,27]. Severe fatty liver significantly influences both the short and long term outcomes of liver transplantation[27].

The study comparing CT- LAI and MRI- PDFF in the context of liver transplantation provides valuable insights into the assessment of liver health and hepatic steatosis in voluntary liver donor candidates, thereby helping to identify suitable liver transplant candidates and predict post-transplant outcomes. This present prospective study was conducted to compare and validate the efficacy of MRI derived PDFF with CT derived LAI for quantitative assessment of hepatic steatosis in voluntary liver donors using histopathology as the reference standard.

In the present study, 30 individuals were enrolled within the age of 20-55yrs, of which majority of the participants (40%) were in the age group of 31-40yrs with mean age of 35yrs. Out of 30 participants, histopathology demonstrated hepatic steatosis in 5 of them (16.7%), in which all of them had Grade 1 steatosis, hepatocyte ballooning was absent in all subjects and only two subjects (6.7%) had lobular inflammation. Point biserial correlation showed moderate negative correlation (r= -0.545, p value=.002) between CT- LAI and hepatic steatosis. Similar negative correlations have been reported by Onur Levent Ulusoy et al [28](r= -0.510 , p value = 0.018) and Jahangir et al[29] (r= -0.579, p value= <0.05). Study done by Venkatraman Bhat et al[30], compared the correlation between liver attenuation of right and left lobe of liver with biopsy, and showed right lobe of liver has good correlation with histology grading.

In the present study, CT- LAI demonstrated poor diagnostic performance with an area under ROC curve (AUC) of 0.116 [95 % CI: -0.032-0.264]. With a cut-off value of +6.5HU, the sensitivity and specificity of CT- LAI in this study was 40% and 24% respectively. In contrast, study done by Onur Levent Ulusoy et al[28], reported a significantly higher AUC of 0.866, with higher sensitivity and specificity of 78% and 84% respectively. The lower diagnostic accuracy observed in the present study may be attributed to the predominance of mild steatosis in the study group and relatively low cut off value used. These results suggest that CT-LAI has limited ability to differentiate mild steatosis from normal liver parenchyma and may not be sufficiently reliable for early detection of hepatic fat. This might prompt a reconsideration of the method or the need for an alternative diagnostic approach for more accurate and reliable identification of mild hepatic steatosis.

MRI-PDFF, in contrast showed a strong positive correlation with hepatic steatosis (r= 0.825, p=.001). This is comparable with the study done by Onur Levent Ulusoy et al [28] (r= 0.736, p value= 0.005) and Joe et al[31] (r= 0.902, p value= <0.001). Tang et al[32] demonstrated significant correlation between MRI-PDFF and histologic steatosis grade in patients with non-alcoholic fatty liver disease, and also derived PDFF thresholds to distinguish patients with dichotomized steatosis grades. With the strong positive correlation, it indicates that higher MRI-PDFF values are associated with higher likelihood of hepatic steatosis. In the context of liver imaging, this suggest that MRI-PDFF may serve as a reliable indicator to assess the presence and severity of fatty liver.

MRI-PDFF demonstrated excellent diagnostic performance, with AUC of 0.992 [95 % CI: 0.967-1.00]. This suggest that MRI-PDFF is highly effective at discriminating between individuals with and without hepatic steatosis. With a cut-off value of 6.75%, the sensitivity and specificity of MRI-PDFF study was 100% and 96% respectively. These findings are comparable to those reported by Joe et al[31] (100 % sensitivity and 91% specificity) and Onur Levent Ulusoy et al[28] (AUC 0.976, sensitivity 83% and specificity 89%). Chiang et al[33] also reported high diagnostic accuracy with MRI-PDFF with sensitivity and specificity of 100% and 77% respectively with a cut off 3.42. With the excellent AUC, along with high sensitivity and specificity, suggests that MRI-PDFF is a highly reliable and accurate diagnostic tool for hepatic steatosis. With such high diagnostic performance, MRI-PDFF is highly effective in detecting and quantifying hepatic steatosis and also useful in monitoring the progression of fatty liver disease.

The ability to accurately assess liver fat content without the need for invasive procedure like liver biopsy not only reduces the associated risks and complications but also offers a more accessible and potentially more reliable method for evaluation. CT-LAI may be better in detecting moderate to severe steatosis, but insensitive in detecting mild levels of hepatic steatosis. MRI-PDFF seems to have an edge over CT-LAI in this context, likely due to its high sensitivity and specificity in detecting and quantifying even mild levels of hepatic steatosis which is important in case of liver transplantation. These studies have shown that

MRI- PDFF is more accurate in detecting and quantifying the degree of hepatic steatosis in healthy living related liver donors compared to CT-LAI, thus markedly reducing the radiation exposure and false results, and also can replace invasive liver biopsy and its associated complications like pain, bleeding, infection and interobserver variability.

LIMITATIONS

Present study was done in small sample size within limited period of time and there was insufficient number of cases with steatosis. CT and MRI of same patient was done during different visit, so dietary and life style modifications during that period must have biased the results.

Conclusion

CT- LAI and MRI-PDFF provide complementary information for assessing hepatic steatosis. CT- LAI being rapid and cost effective, serve as a initial screening tool for detecting significant hepatic steatosis; however, it has limited sensitivity for mild disease. This study have shown that MRI- PDFF is more accurate in detecting and quantifying the degree of hepatic steatosis compared to CT-LAI with high sensitivity and specificity, especially in case of mild hepatic steatosis, which is important in case of liver transplantation.

Thus, mDIXON-MRI sequence is a non-invasive and non-radiation modality that can be used as a reliable alternative to CT in preoperative assessment for hepatic steatosis. In addition, it may be used for longitudinal follow-up to monitor treatment response without concerns regarding radiation exposure.

Conflicts of Intrest Statement

The authors have no conflicts of interest to declare.

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