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Research Article

Relationship Between Liver Function Tests and Magnetic Resonance Imaging Findings in Non-Alcoholic Fatty Liver Disease: A Cross-Sectional Study Using MRI Proton Density Fat Fraction

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Abstract: ***Introduction:*** Non-alcoholic fatty liver disease (NAFLD) is the commonest chronic liver disorder worldwide. Serum aminotransferases are widely used to screen for and monitor hepatic steatosis, yet their reliability as surrogates for the true quantitative fat burden is debated. Magnetic resonance imaging proton density fat fraction (MRI-PDFF) provides an accurate, non-invasive measure of hepatic fat content.Objective: To determine the relationship between conventional liver function tests and MRI-derived measures of hepatic steatosis and stiffness in patients with NAFLD, and to assess the proportion of patients with significant steatosis who have normal aminotransferase levels. **Materials and Methods:** One hundred and twenty adults with ultrasonographically suspected NAFLD underwent chemical-shift-encoded MRI for PDFF quantification and magnetic resonance elastography (MRE) for liver stiffness measurement, with same-day biochemical assessment including ALT, AST, ALP, GGT, bilirubin, albumin and platelet count. Steatosis was graded from PDFF using established thresholds. Associations were analysed using Pearson/Spearman correlation, ANOVA, ROC analysis and multivariable linear regression. **Results:** Mean age was 44.6 ± 11.9 years, mean BMI 29.8 ± 4.3 kg/m², and mean PDFF 14.8 ± 8.2% (range 5.4–38.6%). ALT correlated most strongly with PDFF ($r = 0.58$, $p < 0.001$), followed by GGT ($r = 0.51$) and AST ($r = 0.46$); ALP, bilirubin and albumin showed no significant correlation. ALT, AST and GGT rose significantly across PDFF grades ($p < 0.001$), whereas ALP, bilirubin and albumin did not. Critically, 40 of 120 patients (33.3%) had a normal ALT despite MRI-confirmed steatosis, including 4 of 24 (16.7%) with grade 3 steatosis. For detecting moderate-to-severe steatosis (PDFF ≥ 17.4%), ALT achieved an AUC of only 0.76. On multivariable analysis, ALT ($\beta = 0.34$), HOMA-IR ($\beta = 0.24$), GGT ($\beta = 0.21$) and BMI ($\beta = 0.18$) independently predicted PDFF (adjusted $R^2 = 0.39$). Liver stiffness correlated only weakly with PDFF ($r = 0.28$) but strongly with AST/ALT ratio and platelet count. **Conclusion:** Aminotransferases correlate moderately with quantitative hepatic fat but explain less than 35% of its variance, and a third of patients with MRI-proven steatosis have normal ALT. Liver function tests are therefore inadequate as a stand-alone screening or monitoring tool in NAFLD, and quantitative MRI should be preferred where accurate assessment of hepatic fat is required.

Keywords: Non-alcoholic fatty liver disease; Liver function tests; Alanine transaminase; Magnetic resonance imaging; Proton density fat fraction; Elasticity imaging techniques.

INTRODUCTION

Non-alcoholic fatty liver disease has emerged as the most prevalent chronic liver condition globally, affecting approximately a quarter of the adult population, with prevalence rising in parallel with obesity and type 2 diabetes mellitus.[1] The disease spans a histological continuum from simple steatosis through non-alcoholic steatohepatitis (NASH) with varying degrees of fibrosis, to cirrhosis and hepatocellular carcinoma.[2] The recognition that hepatic steatosis is fundamentally a manifestation of systemic metabolic dysfunction has driven a proposed redefinition of the entity as metabolic dysfunction-associated fatty liver disease, emphasising the centrality of insulin resistance and cardiometabolic risk rather than the exclusion of alternative aetiologies.[3,4]

In routine practice, the diagnostic pathway commonly begins with incidentally discovered elevation of serum aminotransferases or with a bright liver on abdominal ultrasonography. Alanine aminotransferase (ALT), being relatively liver-specific, has traditionally served as the principal biochemical marker of hepatocellular injury, and serial ALT measurement is frequently used to gauge disease activity and response to lifestyle intervention.[2] However, several observations challenge the assumption that ALT faithfully reflects the underlying hepatic fat burden. Mofrad and colleagues demonstrated in a landmark study that the full histological spectrum of NAFLD — including advanced fibrosis and cirrhosis — occurs in patients with persistently normal ALT values, indicating that a normal aminotransferase provides no assurance of benign disease.[5] The definition of the normal range has itself been questioned, with Prati et al. proposing substantially lower upper limits of normal after excluding subjects with occult metabolic or viral liver disease from the reference population.[6]

Conventional ultrasonography, though inexpensive and widely available, is operator-dependent, poorly sensitive for steatosis below approximately 20–30%, and inherently non-quantitative, limiting its value for grading or longitudinal monitoring.[2] Liver biopsy remains the histological reference standard but is invasive, subject to sampling error and inter-observer variability in grading, and is unsuitable for repeated assessment.[7]

Against this background, chemical-shift-encoded magnetic resonance imaging measuring proton density fat fraction (MRI-PDFF) has become established as an accurate, precise and fully quantitative biomarker of hepatic triglyceride content.[8] PDFF represents the fraction of mobile protons attributable to fat and is confounder-corrected for T1 bias, T2* decay and the multi-peak spectral complexity of fat, rendering it largely independent of field strength, vendor and pulse-sequence variation.[8,9] Validation against histology has shown strong correlation with pathologist-assigned steatosis grade, and consensus PDFF thresholds for grades 1 to 3 have been derived.[9,10] MRI-PDFF has consequently been adopted as a primary endpoint in NASH therapeutic trials, where relative reductions of 30% or more have been shown to associate with histological response.[11,12] Magnetic resonance elastography, frequently performed in the same session, adds a quantitative measure of liver stiffness that reflects fibrosis rather than fat.[7]

Despite the increasing availability of quantitative MRI, most clinicians continue to rely on liver function tests for initial assessment and follow-up of NAFLD, and the precise degree of concordance between these two modalities is not firmly established across diverse populations. Clarifying this relationship has direct practical consequences: it determines whether a normal biochemical profile can safely exclude significant steatosis, whether serial ALT can serve as a proxy for changes in hepatic fat, and which patients should be preferentially referred for quantitative imaging.

The present study was therefore undertaken to examine the correlation between individual liver function test parameters and MRI-derived hepatic fat fraction and liver stiffness in patients with NAFLD, to compare biochemical profiles across MRI-defined steatosis grades, to quantify the proportion of patients with significant steatosis and normal aminotransferases, and to identify the independent biochemical and metabolic determinants of hepatic fat content.

MATERIALS AND METHODS

This prospective, observational, cross-sectional study was carried out jointly by the Departments of Radiodiagnosis and Biochemistry of a tertiary care teaching hospital over a period of 24 months. Institutional EthicsCommittee approval was obtained and all participants provided written informed consent prior to enrolment.

Study population: Adults aged 18–70 years referred with ultrasonographic evidence of hepatic steatosis (increased hepatic echogenicity, hepatorenal contrast, and/or posterior beam attenuation) were screened. Participants were included if they had no significant alcohol consumption, defined as less than 30 g/day in men and 20 g/day in women, verified by structured interview and corroborated by an accompanying family member. Exclusion criteria comprised chronic hepatitis B or C infection, autoimmune hepatitis, primary biliary cholangitis, Wilson disease, haemochromatosis, alpha-1 antitrypsin deficiency, drug-induced steatosis (amiodarone, methotrexate, tamoxifen, valproate, systemic corticosteroids), total parenteral nutrition, decompensated cirrhosis, hepatic malignancy, pregnancy, and any standard contraindication to MRI including cardiac pacemaker, ferromagnetic implant or severe claustrophobia. Patients unable to comply with breath-hold instructions or in whom image quality was non-diagnostic were also excluded.

Sample size. Based on an anticipated correlation coefficient of 0.45 between ALT and hepatic fat fraction, with a two-sided α of 0.05 and 90% power, a minimum of 49 subjects was required; the sample was expanded to 120 to permit meaningful subgroup analysis across three steatosis grades and stable multivariable modelling with up to eight predictors.

Clinical and biochemical assessment. Anthropometric measurements (height, weight, body mass index, waist circumference) and blood pressure were recorded. After an overnight fast of at least eight hours, venous blood was drawn on the same day as imaging for ALT, AST, alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), total and direct bilirubin, serum albumin, total protein, prothrombin time/INR, complete blood count with platelet count, fasting plasma glucose, fasting insulin, HbA1c and a full lipid profile. Liver enzymes were assayed by standardised IFCC-recommended kinetic methods on an automated analyser without pyridoxal-5'-phosphate supplementation. The upper limits of normal for ALT were taken as 33 U/L for men and 25 U/L for women in accordance with the revised healthy-range criteria.[6] Insulin resistance was estimated by HOMA-IR, calculated as fasting insulin (µIU/mL) × fasting glucose (mmol/L) / 22.5. Metabolic syndrome was defined by harmonised IDF/AHA criteria.

MRI protocol. Imaging was performed on a 1.5-Tesla scanner using a phased-array body coil, with participants supine and fasting for at least four hours. A confounder-corrected, chemical-shift-encoded three-dimensional multi-echo gradient-echo sequence with low flip angle was acquired in a single breath-hold to generate PDFF parametric maps, with correction for T1 bias, T2* decay

and the multi-frequency spectral model of fat.[8] Circular regions of interest of at least 300 mm² were placed in all nine Couinaud segments, avoiding large vessels, biliary structures and artefact; the mean of these values constituted the hepatic PDFF. Steatosis was graded using validated thresholds: grade 0 (< 6.4%), grade 1 (6.4–17.3%), grade 2 (17.4–22.0%) and grade 3 (≥ 22.1%).[10] Magnetic resonance elastography was performed in the same session using a passive acoustic driver at 60 Hz with a gradient-echo sequence, and mean liver stiffness was measured in kilopascals from confidence-masked elastograms; a threshold of 2.97 kPa was used to indicate significant (≥ F2) fibrosis.[7] All images were analysed independently by two radiologists blinded to biochemical data, and inter-observer agreement was assessed by intraclass correlation coefficient.

Statistical analysis. Analyses were performed in SPSS version 26.0. Normality was tested by Shapiro–Wilk. Normally distributed data are presented as mean ± SD and skewed data as median (IQR); enzyme values were log-transformed before parametric analysis. Comparisons across steatosis grades used one-way ANOVA with Tukey post-hoc testing or Kruskal–Wallis with Dunn correction, and categorical comparisons used chi-square or Fisher exact tests with trend analysis where appropriate. Correlations with PDFF and liver stiffness were assessed by Pearson and Spearman coefficients. ROC analysis determined the discriminatory performance of ALT and GGT for moderate-to-severe steatosis (PDFF ≥ 17.4%), with optimal cut-offs by the Youden index. Multivariable linear regression with PDFF as the dependent variable included covariates significant at $p < 0.10$ on univariate testing, with collinearity assessed by variance inflation factor. Statistical significance was set at a two-tailed $p < 0.05$.

RESULTS

Table 1. Baseline demographic, anthropometric and metabolic characteristics (n = 120)

Variable	Value
Age (years), mean ± SD	44.6 ± 11.9
Male, n (%)	68 (56.7)
Female, n (%)	52 (43.3)
Body mass index (kg/m²), mean ± SD	29.8 ± 4.3
Waist circumference (cm), mean ± SD	98.4 ± 10.2
Systolic blood pressure (mmHg), mean ± SD	128.6 ± 14.2
Fasting plasma glucose (mg/dL), mean ± SD	108.4 ± 28.6
HbA1c (%), mean ± SD	6.2 ± 1.1
Fasting insulin (µIU/mL), median (IQR)	14.6 (9.8–21.4)
HOMA-IR, median (IQR)	3.82 (2.46–5.94)
Total cholesterol (mg/dL), mean ± SD	196.4 ± 38.2
Serum triglycerides (mg/dL), median (IQR)	168 (124–228)
HDL cholesterol (mg/dL), mean ± SD	42.6 ± 9.8
Comorbidities, n (%)	
Type 2 diabetes mellitus	39 (32.5)
Dyslipidaemia	61 (50.8)
Hypertension	44 (36.7)
Obesity (BMI ≥ 30 kg/m²)	52 (43.3)
Metabolic syndrome	57 (47.5)

The cohort was middle-aged, overweight-to-obese, and carried a substantial burden of metabolic comorbidity, with nearly half meeting criteria for metabolic syndrome and a median HOMA-IR indicating pronounced insulin resistance. This profile is characteristic of clinic-based NAFLD populations and supports the current conceptualisation of the disease as a hepatic manifestation of systemic metabolic dysfunction.

Table 2. Liver function tests and MRI parameters in the study population (n = 120)

Parameter	Median (IQR) or Mean ± SD	Range	Abnormal, n (%)
ALT (U/L)	48 (32–74)	14–186	80 (66.7)
AST (U/L)	38 (28–56)	16–142	62 (51.7)
AST/ALT ratio	0.82 ± 0.26	0.41–1.68	—
ALP (U/L)	96 ± 28	48–186	14 (11.7)
GGT (U/L)	62 (38–104)	16–312	71 (59.2)
Total bilirubin (mg/dL)	0.8 ± 0.3	0.3–1.8	6 (5.0)
Serum albumin (g/dL)	4.2 ± 0.4	3.2–5.0	4 (3.3)

INR	1.02 ± 0.09	0.86–1.28	3 (2.5)
Platelet count (×10⁹/L)	238 ± 62	108–412	9 (7.5)
MRI-PDFF (%)	**14.8 ± 8.2**	**5.4–38.6**	—
Grade 1 steatosis (6.4–17.3%), n (%)	63 (52.5)		
Grade 2 steatosis (17.4–22.0%), n (%)	33 (27.5)		
Grade 3 steatosis (≥ 22.1%), n (%)	24 (20.0)		
MRE liver stiffness (kPa)	**2.84 ± 0.92**	**1.62–6.48**	—
Stiffness ≥ 2.97 kPa (≥ F2 fibrosis), n (%)	34 (28.3)		

Two-thirds of patients had an elevated ALT by revised normal limits, but a substantial minority did not. Cholestatic and synthetic-function parameters — ALP, bilirubin, albumin and INR — were abnormal in only a small fraction, consistent with the predominantly hepatocellular and non-cholestatic nature of NAFLD. MRI-PDFF spanned a wide range, with grade 1 steatosis predominating and one-fifth of patients showing severe fat accumulation. Just over a quarter had elastographic evidence of significant fibrosis. Inter-observer agreement was excellent for PDFF (ICC = 0.96, 95% CI 0.94–0.97) and very good for stiffness (ICC = 0.92, 95% CI 0.89–0.95).

Table 3. Comparison of liver function tests across MRI-PDFF steatosis grades

Parameter	**Grade 1 (6.4–17.3%) n = 63**	**Grade 2 (17.4–22.0%) n = 33**	**Grade 3 (≥ 22.1%) n = 24**	**p value**
ALT (U/L), median (IQR)	38 (28–52)	56 (42–78)	82 (61–108)	< 0.001
AST (U/L), median (IQR)	31 (24–42)	42 (33–56)	58 (44–79)	< 0.001
GGT (U/L), median (IQR)	46 (32–68)	72 (52–98)	104 (76–148)	< 0.001
ALP (U/L), mean ± SD	92 ± 26	98 ± 29	104 ± 31	0.212
Total bilirubin (mg/dL), mean ± SD	0.8 ± 0.3	0.8 ± 0.3	0.9 ± 0.4	0.541
Serum albumin (g/dL), mean ± SD	4.3 ± 0.4	4.2 ± 0.4	4.1 ± 0.5	0.184
AST/ALT ratio, mean ± SD	0.86 ± 0.24	0.80 ± 0.26	0.74 ± 0.28	0.118
Platelet count (×10⁹/L), mean ± SD	244 ± 58	236 ± 64	228 ± 70	0.516
BMI (kg/m²), mean ± SD	28.4 ± 3.9	30.6 ± 4.1	32.4 ± 4.4	< 0.001
HOMA-IR, median (IQR)	3.14 (2.08–4.62)	4.28 (2.96–6.18)	5.86 (4.02–8.44)	< 0.001
MRE stiffness (kPa), mean ± SD	2.68 ± 0.82	2.92 ± 0.94	3.18 ± 1.06	0.048
Type 2 diabetes, n (%)	15 (23.8)	12 (36.4)	12 (50.0)	0.048

A clear stepwise increase was demonstrated for the three enzymes of hepatocellular and canalicular origin — ALT, AST and GGT — with median ALT more than doubling between grade 1 and grade 3 steatosis. In contrast, ALP, bilirubin, albumin and platelet count showed no significant variation across grades, confirming that quantitative fat burden influences the transaminase profile but not cholestatic or synthetic indices. BMI, HOMA-IR and diabetes prevalence all rose significantly with steatosis grade, underlining the metabolic gradient underlying fat accumulation. Liver stiffness increased only modestly across grades (p = 0.048), consistent with fibrosis being a partly independent process rather than a simple function of fat content.

Table 4. Correlation of biochemical and metabolic parameters with MRI-PDFF and liver stiffness (n = 120)

Parameter	**r with PDFF**	**p value**	**r with MRE stiffness**	**p value**
ALT (U/L)	0.58	< 0.001	0.19	0.038
GGT (U/L)	0.51	< 0.001	0.24	0.008
AST (U/L)	0.46	< 0.001	0.34	< 0.001
HOMA-IR	0.49	< 0.001	0.26	0.004
Body mass index	0.44	< 0.001	0.21	0.021
Waist circumference	0.41	< 0.001	0.18	0.049
Serum triglycerides	0.36	< 0.001	0.12	0.191
MRE liver stiffness	0.28	0.002	—	—
AST/ALT ratio	−0.21	0.021	0.42	< 0.001
Platelet count	−0.14	0.126	−0.38	< 0.001

ALP (U/L)	0.11	0.231	0.16	0.081
Serum albumin	−0.09	0.328	−0.27	0.003
Total bilirubin	0.06	0.514	0.13	0.156
HDL cholesterol	−0.24	0.008	−0.11	0.231
Age	0.08	0.384	0.31	0.001

ALT showed the strongest correlation with hepatic fat fraction, but the coefficient of 0.58 corresponds to a coefficient of determination of only 0.336 — meaning ALT accounted for approximately one-third of the variance in PDFF and left two-thirds unexplained. GGT and AST followed with moderate correlations. ALP, total bilirubin and albumin showed no meaningful relationship with fat content, confirming their irrelevance to steatosis quantification. A biologically informative dissociation emerged in the second column: the parameters best correlated with fibrosis (liver stiffness) were AST, AST/ALT ratio, platelet count, albumin and age — the classical components of non-invasive fibrosis scores — rather than the parameters best correlated with fat. The modest correlation between PDFF and stiffness (r = 0.28) confirms that steatosis and fibrosis are related but distinct dimensions of disease.

Table 5. Proportion of patients with normal aminotransferases across MRI-PDFF steatosis grades

Steatosis grade	n	Normal ALT, n (%)	Normal AST, n (%)	Both ALT and AST normal, n (%)
Grade 1 (6.4–17.3%)	63	27 (42.9)	38 (60.3)	24 (38.1)
Grade 2 (17.4–22.0%)	33	9 (27.3)	15 (45.5)	8 (24.2)
Grade 3 (≥ 22.1%)	24	4 (16.7)	5 (20.8)	3 (12.5)
Total	**120**	**40 (33.3)**	**58 (48.3)**	**35 (29.2)**
p for trend		0.038	0.004	0.041

This table conveys the single most clinically consequential finding of the study. One in three patients with MRI-confirmed hepatic steatosis had an ALT within the revised normal range, and almost one in three had both aminotransferases normal. Although the proportion with normal enzymes declined significantly as steatosis grade increased, it did not fall to zero: 4 of 24 patients (16.7%) with severe grade 3 steatosis — the group with the greatest fat burden — nonetheless had a normal ALT. A normal aminotransferase profile therefore cannot be used to exclude clinically significant hepatic steatosis, and reliance on liver function tests alone as a screening strategy would have missed a third of the affected patients in this cohort.

Table 6. Receiver operating characteristic analysis for detection of moderate-to-severe steatosis (MRI-PDFF ≥ 17.4%)

Parameter	AUC	95% CI	Optimal cut-off	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	p value
ALT	0.76	0.67–0.85	52 U/L	71.9	69.8	68.3	73.3	< 0.001
GGT	0.73	0.64–0.82	68 U/L	68.4	68.3	66.1	70.5	< 0.001
AST	0.69	0.59–0.79	41 U/L	64.9	66.7	63.8	67.7	0.001
ALP	0.54	0.43–0.65	98 U/L	52.6	55.6	51.7	56.5	0.462
ALT + GGT + BMI (combined model)	**0.83**	**0.76–0.90**	—	**78.9**	**76.2**	**74.6**	**80.3**	**< 0.001**

Even the best-performing single biochemical marker, ALT, achieved only fair-to-good discrimination for moderate-to-severe steatosis, with an AUC of 0.76 and a negative predictive value of 73.3% — meaning roughly one in four patients below the cut-off nonetheless had significant steatosis. ALP performed no better than chance (AUC 0.54, p = 0.462) and should not be used in this context. Combining ALT and GGT with BMI improved discrimination to an AUC of 0.83, a statistically significant increment over ALT alone (DeLong p = 0.021), but still fell well short of the accuracy achievable by direct MRI quantification. These figures argue against the use of biochemistry-based strategies as a substitute for imaging when accurate grading is required.

Table 7. Multivariable linear regression analysis of independent predictors of MRI-PDFF

Predictor variable	Unstandardised β	Standard error	Standardised β	95% CI for β	t	p value	VIF
Log ALT (U/L)	6.42	1.68	0.34	3.09–9.75	3.82	< 0.001	1.86
HOMA-IR	0.58	0.21	0.24	0.17–0.99	2.81	0.006	1.42
Log GGT (U/L)	3.86	1.55	0.21	0.79–6.93	2.49	0.014	1.71
Body mass index (kg/m²)	0.34	0.16	0.18	0.03–0.65	2.18	0.031	1.54

Type 2 diabetes mellitus	1.82	1.28	0.11	−0.72 to 4.36	1.42	0.158	1.38
Log AST (U/L)	1.64	1.90	0.08	−2.13 to 5.41	0.86	0.390	2.21
Serum triglycerides (mg/dL)	0.011	0.008	0.10	−0.005 to 0.027	1.38	0.171	1.26
Age (years)	−0.021	0.058	−0.03	−0.136 to 0.094	−0.36	0.719	1.19

Model summary: $R = 0.647$; $R^2 = 0.419$; adjusted $R^2 = 0.387$; $F(8,111) = 10.0$; $p < 0.001$; Durbin–Watson = 2.03.

After mutual adjustment, ALT remained the strongest independent biochemical predictor of hepatic fat fraction, but HOMA-IR ranked second — insulin resistance contributed information about fat burden over and above that carried by the enzymes themselves. GGT and BMI retained modest independent effects, whereas AST lost significance once ALT was in the model, reflecting the collinearity between the two transaminases (VIF 2.21). Critically, the full model explained only 38.7% of the variance in PDFF, leaving nearly two-thirds unaccounted for by the combination of all available clinical and biochemical variables. This residual variance is the quantitative expression of why liver function tests cannot replace direct measurement of hepatic fat.

DISCUSSION

This study quantifies a relationship that is often assumed but rarely measured: how closely conventional liver function tests track the true hepatic fat burden in NAFLD. The answer is that they track it moderately and incompletely. ALT emerged as the best individual biochemical correlate of MRI-PDFF ($r = 0.58$), yet accounted for only about a third of the variance in fat fraction, and a comprehensive multivariable model incorporating ALT, GGT, AST, BMI, HOMA-IR, triglycerides, diabetes and age explained less than 40%. The clinical corollary is that biochemistry provides a rough signal of steatosis but not a measurement of it.

The most immediately actionable finding is the prevalence of normal aminotransferases despite MRI-proven steatosis. A third of our cohort had a normal ALT, and this included 16.7% of patients with grade 3 disease. This closely parallels the observations of Mofrad et al., who documented the entire histological spectrum of NAFLD — from simple steatosis to established cirrhosis — in patients with persistently normal ALT, and it reinforces the argument that transaminase-based screening systematically underdetects disease.[5] The problem is compounded by the widespread continued use of laboratory upper limits derived from unscreened reference populations that themselves contained undiagnosed metabolic liver disease; adopting the revised, lower thresholds proposed by Prati et al. improves sensitivity but, as our data show, does not eliminate the false-negative problem.[6]

An instructive pattern emerges from the two correlation columns of Table 4. The biochemical parameters most closely associated with hepatic fat (ALT, GGT) were largely distinct from those most closely associated with liver stiffness (AST/ALT ratio, platelet count, albumin, age) — precisely the constituents of established non-invasive fibrosis indices such as the NAFLD fibrosis score.[13] This dissociation is mechanistically coherent: aminotransferase leakage reflects ongoing hepatocellular stress and lipotoxic injury, whereas fibrosis reflects cumulative matrix deposition and evolving portal hypertension. It also carries a practical warning, since fibrosis rather than steatosis grade is the principal determinant of liver-related and overall mortality in NAFLD.[2] A patient with modest steatosis and a mildly abnormal ALT may harbour more clinically important disease than one with florid steatosis and a strikingly elevated ALT.

The relative independence of steatosis and fibrosis in our data ($r = 0.28$ between PDFF and stiffness) supports the current practice of performing multiparametric MRI, in which PDFF and elastography are acquired in a single session to characterise both axes of disease. MRI-PDFF has been extensively validated against histology and has become the accepted quantitative endpoint in NASH trials, where relative reductions of at least 30% associate with histological improvement — a level of precision that serial ALT measurement cannot approach.[9,10,11,12] Our ROC data quantify this shortfall: even a combined ALT-GGT-BMI model reached an AUC of only 0.83 for moderate-to-severe steatosis.

Several limitations should be acknowledged. The single-centre, cross-sectional design precludes inference about causality or about how the biochemical–imaging relationship evolves with treatment or weight change. Liver biopsy was not performed, so PDFF and MRE served as reference standards; while both are well validated, MRE may overestimate stiffness in the presence of severe inflammation or hepatic congestion. Alcohol intake was assessed by structured interview without biochemical corroboration, introducing potential misclassification. The cohort was recruited from a hepatology clinic and is likely enriched for symptomatic or biochemically abnormal patients, which may inflate the apparent correlation relative to a community population. Finally, MRI availability and cost remain genuine barriers in many settings, and our findings should be interpreted as defining the limits of

biochemistry rather than as a universal mandate for imaging.

CONCLUSION

In patients with non-alcoholic fatty liver disease, serum ALT, AST and GGT correlate significantly and positively with MRI-derived hepatic proton density fat fraction and rise in a stepwise fashion across steatosis grades, whereas alkaline phosphatase, bilirubin and albumin show no such relationship. However, these correlations are only moderate: ALT, the best-performing marker, explained approximately one-third of the variance in hepatic fat, and a comprehensive multivariable model explained less than 40%. One in three patients with MRI-confirmed steatosis — including one in six with severe steatosis — had a normal ALT. Liver function tests are therefore useful as an initial, inexpensive prompt to further evaluation but are insufficient as a stand-alone tool for screening, grading or monitoring hepatic steatosis, and a normal biochemical profile does not exclude significant disease. Because the biochemical parameters associated with fibrosis differ from those associated with fat, and because fibrosis rather than steatosis drives prognosis, multiparametric MRI combining PDFF with elastography offers a more complete and clinically meaningful assessment, and should be preferred wherever accurate quantification is required or serial monitoring is planned.

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