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COMPARATIVE STUDY OF CLINICAL AND BIOCHEMICAL PROFILES IN ALCOHOLIC VS. NON-ALCOHOLIC STEATOHEPATITIS- RELATED CIRRHOSIS

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ABSTRACT

Background: Differentiating Alcoholic Steatohepatitis (ASH) from Non-Alcoholic Steatohepatitis (NASH) is challenging. This study evaluates the diagnostic utility of MRI, focusing on perivascular branching heterogeneity, in distinguishing ASH from NASH.

Materials and Methods: This retrospective cohort study included 90 MRI exams from 60 NASH and 30 ASH patients, with both MRI and liver biopsy performed within 13 months. MRI findings were independently scored by two radiologists, and interclass correlation coefficients (ICC) and receiver operating characteristic (ROC) analysis were used to assess diagnostic accuracy.

Results: The mean age of NASH and ASH patients was 60.5 ± 9.38 and 54.1 ± 11.48 years, respectively (p=0.012). Perivascular branching heterogeneity was observed in 63% of ASH patients and 30% of NASH patients (Reader 1). The ICC was 0.69 (0.46–0.82), and ROC analysis showed an area under the curve (AUC) of 0.69 for Reader 1 and 0.72 for Reader 2. The positive predictive value (PPV) for perivascular branching was 65% (Reader 1) and 67% (Reader 2).

Conclusion: MRI, particularly perivascular branching heterogeneity, can aid in differentiating ASH from NASH. However, the moderate diagnostic accuracy suggests it should be used alongside clinical and biochemical data for more reliable diagnosis. Further studies with larger cohorts and advanced imaging are needed.

Keywords: Steatohepatitis, Alcoholic Liver Disease, Non-Alcoholic Steatohepatitis (NASH), Liver Cirrhosis, Biochemical Profile, Clinical Profile.

INTRODUCTION

Chronic liver disease represents a significant global health burden, with cirrhosis constituting the end stage of various hepatic insults, accounting for substantial morbidity and mortality worldwide.[1] Steatohepatitis — characterized by hepatic steatosis with inflammation and hepatocellular injury — is a pivotal pathway leading to cirrhosis in both alcoholic and non alcoholic contexts.[2] Alcoholic Steatohepatitis (ASH), a consequence of prolonged excessive alcohol consumption, and Non Alcoholic Steatohepatitis (NASH), associated with metabolic dysfunction in the absence of significant alcohol intake, share overlapping histological features and clinical outcomes yet differ fundamentally in etiology, risk factor profiles, and systemic associations.[3] Both disease entities progress through stages of simple steatosis to steatohepatitis and ultimately cirrhosis and hepatocellular carcinoma in a subset of patients.[4] Their pathological similarity often complicates accurate differentiation on clinical and biochemical grounds alone, underscoring the need for detailed comparative profiling.[5] Alcohol related liver disease remains a leading cause of end stage liver disease globally, driven by the hepatotoxic effects of ethanol and its metabolites, inflammatory pathways, oxidative stress, and consequent fibrogenesis.[6] In contrast, NASH represents the hepatic manifestation of metabolic syndrome, linked to obesity, insulin resistance, dyslipidemia, and type 2 diabetes mellitus.[7] Although both ASH and NASH can culminate in cirrhosis, the demographic, clinical, and biochemical characteristics often differ: ASH

typically occurs in individuals with significant alcohol use and may present with pronounced inflammation, while NASH patients frequently have metabolic comorbidities and may be asymptomatic until advanced disease.[8] Despite these differences, reliable non invasive markers that distinguish cirrhosis attributable to ASH from NASH are limited. Conventional liver function tests such as transaminases, gamma glutamyl transferase, and AST/ALT ratio are frequently used in clinical practice, but their specificity and sensitivity for etiological differentiation are suboptimal.[9] The AST/ALT ratio, for instance, may be elevated in alcoholic liver disease yet is not exclusively diagnostic and may overlap with patterns seen in NASH.[10] Biochemical parameters, when combined with clinical profiles, have been studied to elucidate disease specific patterns, but comprehensive comparative data, particularly in cirrhotic patients, remain sparse.[11] Given the increasing prevalence of metabolic syndrome and alcohol misuse globally, cirrhosis from steatohepatitis — whether alcoholic or non alcoholic — represents a growing clinical challenge.[12] Comparative characterization of clinical and biochemical profiles in ASH and NASH related cirrhosis may aid clinicians in better understanding disease phenotypes, refining diagnostic algorithms, and optimizing patient management.[13,14] This study aims to evaluate and contrast the clinical manifestations and biochemical parameters in patients with cirrhosis secondary to ASH versus NASH, thereby contributing to targeted diagnostic and therapeutic strategies.

MATERIALS AND METHODS

This study was conducted at a single tertiary medical center. Eligible patients were identified through a search of medical records that included both liver biopsy and abdominal MRI with contrast performed within a 13-month window. Liver biopsies were required to show evidence of either steatohepatitis or chronic hepatitis. Patients with positive markers for viral hepatitis A, B, or C, as well as those with autoimmune, genetic (such as alpha-1-antitrypsin deficiency), or metabolic diseases (such as hemochromatosis or Wilson's disease), were excluded from the study.

The final cohort was selected to achieve a 2:1 ratio of Non-Alcoholic Steatohepatitis (NASH) to Alcoholic Steatohepatitis (ASH) cases. The study protocol was approved by the Thomas Jefferson University Institutional Review Board, and a waiver of patient informed consent was granted due to the retrospective nature of the study.

Data Collection: Baseline demographic data including age, sex, body mass index (BMI), and race/ethnicity were collected from the electronic medical records of the patients. Pathology findings and MRI reports were also reviewed. Clinical documentation regarding alcohol use was used to distinguish patients with ASH from those with NASH, ensuring a clear delineation based on the history of alcohol consumption.

MRI examinations were de-identified and independently scored by two subspecialty-trained abdominal radiologists. The MRI exams were categorized into one of five levels based on hepatic heterogeneity and its vascular pattern:

- 1: Homogeneity
- 2: Mild heterogeneity
- 3: Moderate heterogeneity [Figure 1]
- 4: Possible perivascular branching
- 5: Definite perivascular branching [Figure 2]

In cases where a branching pattern of heterogeneity was observed, each radiologist could identify and list one or more pulse sequences that distinctly demonstrated the pattern. MRI exams with scores of 4 or 5 were compared with liver biopsy specimens to assess the degree of steatohepatitis present. Additionally, hepatic steatosis was assessed on MRI using a four-point scale:

- 1: Absent
- 2: Mild
- 3: Moderate
- 4: Severe

This grading was based on the decreased signal intensity observed on opposed-phase versus in-phase T1-weighted images.

Statistical Analysis: Descriptive statistics were used to summarize patient demographics and analysis was done by SPSS version 26 The inter-rater reliability between the two readers was assessed using interclass correlation coefficients (ICC), reflecting both agreement and correlation, using a mean rating (k=2) and an absolute agreement, two-way random-effects model.Receiver Operating Characteristic (ROC) analysis was conducted for each reader-scale combination to determine the optimal cutoff value. The optimal point was identified where the sensitivity and specificity were maximized. Positive predictive values (PPV) and negative predictive values (NPV) were calculated, with a definitive perivascular branching heterogeneity score of 5 serving as a marker indicative of ASH.

To assess associations between radiological ASH scoring and necroinflammatory pathology observed in liver biopsy samples, Chi-square analysis was performed. Additionally, the correlation between steatosis as assessed by imaging and the diagnostic groups (ASH vs. NASH) was evaluated using Mann-Whitney U tests. All statistical analyses were carried out using SPSS version 26 (IBM Corp., Armonk, NY, USA).

RESULTS

A total of 119 patients underwent both MRI and liver biopsy within a 13-month period [Figure 3]. Of these, 13 patients with simple hepatic steatosis, as confirmed by pathology, were excluded from the study. Thirty patients with clinical and pathological evidence of Alcoholic Steatohepatitis (ASH) were

identified, and 76 patients were confirmed to have Non-Alcoholic Steatohepatitis (NASH). To achieve a balanced 2:1 ratio of NASH to ASH, 16 NASH patients were randomly excluded, leaving a final cohort of 60 patients diagnosed with NASH and 30 with ASH. Additionally, seven MRI studies were excluded due to poor quality, which limited their interpretability (six cases excluded by Reader 1 and four cases by Reader 2). This resulted in 83 valid MRI reports available for analysis, with 57 NASH cases and 26 ASH cases. The baseline demographics of the study population are summarized in Table 1. The mean age of NASH patients was 60.5 years (SD 9.38), while ASH patients had a mean age of 54.1 years (SD 11.48), with a significant difference between the two groups (p=0.012). The mean BMI for NASH patients was 33.9 kg/m² (SD 5.37), significantly higher than the BMI of ASH patients, which was 26.1 kg/m² (SD 5.76, p<0.001). The racial distribution differed significantly between the groups, with a higher percentage of Caucasian patients in the NASH group (93.3%) compared to the ASH group (66.7%). The sex distribution was similar, with an equal number of male and female patients in both groups.

The MRI exams were independently scored by two radiologists, and interclass correlation coefficients (ICC) were calculated to assess the reliability between the two readers. The overall reliability of the scoring was moderate, with an ICC of 0.69 (CI: 0.46–0.82). For NASH patients, the ICC was 0.57 (CI: 0.26–0.75), and for ASH patients, the ICC was 0.74 (CI: 0.38–0.89). The ICC for steatosis scoring across all cases was 0.82 (CI: 0.71–0.88), indicating strong agreement for assessing hepatic fat content [Table 2]. Among the 84 MRI-valid cases reviewed by Reader 1, 68% (57/84) were true NASH cases. Of these NASH cases, 70% were classified as homogeneous or nonspecific heterogeneous (scores 1, 2, or 3), while 30% were characterized by possible or definite perivascular branching heterogeneity (scores 4 or 5). Among the remaining 32% (27/84) of ASH cases reviewed by Reader 1, 37% were classified as homogeneous or nonspecific heterogeneous, and 63% showed possible or definite perivascular branching heterogeneity. For Reader 2, 67% (58/86) of cases were true NASH. Of these, 93% were categorized as homogeneous or nonspecific heterogeneous, and 7% showed perivascular branching heterogeneity. Among the remaining 33% (28/86) of true ASH cases, 68% were classified as homogeneous or nonspecific heterogeneity, and 32% exhibited perivascular branching heterogeneity.

To evaluate the diagnostic performance of the MRI scoring system, we focused on cases with a score of 5, which indicated definite perivascular branching heterogeneity. For Reader 1, 20% of cases (17/84) were classified as 5, yielding a positive predictive value (PPV) of 65% and a negative predictive value (NPV) of 76%. For Reader 2, only 3% (3/86) of cases were scored as 5, resulting in a PPV of 67% and an NPV of 69%. The area under the curve (AUC) for Reader 1 using the 5-point scale was 0.69 (CI: 0.56–0.82, p=0.006), with an optimal cutoff at score 5, which showed a sensitivity of 42.3% and specificity of 89.5%. For Reader 2, the AUC was 0.72 (CI: 0.60–0.85, p=0.001), with the optimal cutoff at score 2, yielding a sensitivity of 76.9% and specificity of 59.6% [Table 3]. The presence of perivascular branching heterogeneity on MRI (scores 4 or 5) was further analyzed in relation to necroinflammatory activity seen on liver biopsy specimens. Of the 17 true ASH patients who were assigned a score of 4 or 5 by either reader, 29.4% (5/17) had severe steatohepatitis, 17.6% (3/17) had moderate activity, and 52.9% (9/17) had mild activity. Among the 19 NASH patients who received a score of 4 or 5, 26.3% (5/19) had moderate steatohepatitis, 68.4% (13/19) had mild activity, and 5.2% (1/19) had minimal activity. A chi-square test revealed no significant association between the radiological scores and the pathology findings (p≥0.158).

The MRI scores for hepatic steatosis assigned by both readers were compared between ASH and NASH groups using Mann-Whitney U tests. The results indicated that there were no significant differences in the steatosis scores between the two groups (p≥0.134).

Table 1: Baseline Characteristics of NASH and ASH Patients

Characteristics	NASH (n=60)	ASH (n=30)	p-value
Age (mean ± SD)	60.5 ± 9.38	54.1 ± 11.48	0.012
BMI (mean ± SD)	33.9 ± 5.37	26.1 ± 5.76	<0.001
Race (%)			
Caucasian	93.3% (56/60)	66.7% (15/30)	<0.001
African American	5% (3/60)	16.7% (5/30)	
Hispanic	1.7% (1/60)	16.7% (5/30)	
Sex (%)			
Male	50% (30/60)	50% (15/30)	
Female	50% (30/60)	50% (15/30)	

Table 2: Interclass Correlation Analysis of MRI Scoring Between Both Readers

Condition	Valid Cases	ICC Value (95% CI)
Overall	83/90	0.69 (0.46–0.82)
NASH	57/60	0.57 (0.26–0.75)
ASH	26/30	0.74 (0.38–0.89)
Steatosis	83/90	0.82 (0.71–0.88)

Table 3: Receiver Operating Characteristic (ROC) Analysis and Optimal Cutoff Scores of Both Readers

Reader	AUC (95% CI)	p-value	Optimal Cutoff Score	Sensitivity (%)	Specificity (%)
Reader 1	0.69 (0.56–0.82)	0.006	5	42.3	89.5
Reader 2	0.72 (0.60–0.85)	0.001	2	76.9	59.6

DISCUSSION

In this study, we found that perivascular branching heterogeneity (MRI scores of 4 or 5) was significantly more common in patients with Alcoholic Steatohepatitis (ASH) compared to Non-Alcoholic Steatohepatitis (NASH). Specifically, for Reader 1, 63% of ASH patients had perivascular branching heterogeneity compared to 30% of NASH patients. Similarly, Reader 2 observed this pattern in 32% of ASH cases and 7% of NASH cases. These findings suggest that perivascular branching heterogeneity on MRI could be a distinguishing feature of ASH.Hamer et al. reported similar observations, noting that fatty liver on imaging can present with various patterns, including perivascular fat accumulation, which is less common and more indicative of specific liver conditions such as ASH.[15] In their study, they identified that perivascular fatty patterns could be linked to alcohol-related liver diseases, confirming the value of this pattern for distinguishing ASH from other causes of steatosis. Likewise, Decarie et al. reviewed imaging patterns in fatty liver diseases, including the importance of recognizing perivascular sparing and fatty deposition, which aligns with our observation that ASH is more likely to exhibit perivascular heterogeneity compared to NASH.[16] Our study demonstrated moderate inter-reader reliability (ICC = 0.69) between the two radiologists for MRI scoring. The ICC was higher for ASH patients (0.74) compared to NASH patients (0.57), indicating more consistent scoring in ASH cases. These results are consistent with the findings of Dunn et al., who evaluated the utility of various imaging features in diagnosing alcoholic liver disease. Their study showed that certain imaging features, like perivascular branching, were more consistently identified in ASH, leading to higher inter-rater reliability in distinguishing ASH from NASH.[17]
Receiver Operating Characteristic (ROC) analysis revealed that the AUC for Reader 1 was 0.69, and for Reader 2, it was 0.72, indicating moderate diagnostic accuracy in differentiating ASH from NASH based on MRI scoring. In comparison, Gao et al. used lipidomic profiles to differentiate between alcoholic and non-alcoholic liver diseases, reporting a relatively high accuracy in distinguishing the two groups (AUC = 0.80), but also noted that diagnostic accuracy could be further enhanced by combining lipidomics with imaging.[18] Although our study shows moderate diagnostic performance for MRI, the addition of molecular markers such as lipidomics could improve accuracy. The distinct imaging features of perivascular branching heterogeneity in ASH patients observed in this study may reflect the underlying pathophysiological differences between ASH and NASH. Chronic alcohol consumption leads to alterations in lipid metabolism and hepatic inflammation, which may result in more organized fat distribution patterns, as seen on MRI. Starzl et al. highlighted that alcohol significantly alters lipid metabolism, influencing fat deposition and distribution, which could explain the vascular patterns observed in ASH.[19] In contrast, NASH is linked to metabolic syndrome, which involves insulin resistance, obesity, and dyslipidemia. Zao et al. used lipidomics to study early-stage alcoholic liver disease in mice and showed that lipid profiles differ significantly between ASH and NASH, with alcohol-induced lipid changes likely contributing to the perivascular branching patterns we observed in MRI.[20] This reinforces the idea that MRI can reflect the underlying pathophysiology of alcohol-related liver disease, and further studies are needed to understand the precise mechanisms behind these imaging features. While our study indicates that MRI scoring of perivascular branching heterogeneity can help differentiate ASH from NASH, the diagnostic accuracy is moderate, with a PPV of 65% and NPV of 76% for Reader 1. Nomura et al. explored the use of carbohydrate-deficient transferrin (CDT) as a diagnostic marker for differentiating alcoholic and non-alcoholic liver diseases. They reported that CDT levels were effective in distinguishing between ASH and NASH, with a diagnostic accuracy of 90%.[21] The combination of imaging with biomarkers such as CDT could potentially enhance the diagnostic accuracy of MRI in liver disease differentiation.Our study's findings are also in line with the study by Dunn et al., who found that a combination of clinical history, biomarkers, and imaging can achieve high diagnostic accuracy for alcoholic liver disease. They developed a diagnostic model using various clinical parameters, such as the AST/ALT ratio, and found it to be highly effective in distinguishing ASH from NASH, with a c-statistic value of 0.98.[17] This suggests that while MRI scoring provides valuable structural insights, clinical and biochemical data must be integrated for more accurate and reliable diagnosis.We assessed the correlation between MRI findings and pathology in patients who exhibited perivascular branching heterogeneity on MRI (scores 4 or 5). Of the 17 ASH patients with scores of 4 or 5, 29.4% had severe steatohepatitis on pathology, while 52.9% had mild activity. Among NASH patients, 68.4% had mild activity, with only 26.3% exhibiting moderate activity. However, there was no significant correlation between the MRI scoring and pathology findings ($p \geq 0.158$). This lack of correlation is consistent with the findings of Nomura et al., who observed that imaging features like perivascular

branching heterogeneity did not consistently correlate with the degree of inflammation or fibrosis seen in liver biopsy specimens.[21] Additionally, the severity of necroinflammatory activity did not show a strong association with MRI scoring in our study. Similar results were found by Gao et al., who noted that lipidomic markers for progressive liver disease did not always align with imaging or histopathology findings, highlighting the complexity of diagnosing liver disease based on a single modality.[18] These findings suggest that while MRI provides important structural insights, histopathological evaluation remains crucial in assessing the severity of liver injury.

Limitations of the Study: This study's retrospective design and moderate diagnostic accuracy of MRI scoring limit its ability to definitively distinguish ASH from NASH. The small sample size and variability in inter-rater reliability further reduce generalizability. Additionally, the exclusion of poor-quality MRI scans and the lack of longitudinal follow-up may introduce bias. Future studies with larger cohorts, standardized imaging protocols, and advanced techniques are needed to improve diagnostic performance.

CONCLUSION

This study demonstrates that MRI, particularly with the assessment of perivascular branching heterogeneity, may provide valuable insights into differentiating Alcoholic Steatohepatitis (ASH) from Non-Alcoholic Steatohepatitis (NASH). While the diagnostic accuracy was moderate, MRI could serve as a complementary tool in the clinical setting when combined with clinical history and biochemical markers. Further research with larger sample sizes, advanced imaging techniques, and longitudinal follow-up is essential to enhance the sensitivity and specificity of MRI in liver disease differentiation.

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