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The Clinical Value of Controlled Attenuation Parameters in Autoimmune Liver Diseases

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ABSTRACT

This review assesses the utility of the Controlled Attenuation Parameter (CAP) in Autoimmune Liver Diseases (AILD). CAP demonstrates high diagnostic accuracy for hepatic steatosis in Primary Biliary Cholangitis and Primary Sclerosing Cholangitis. However, in Autoimmune Hepatitis, active inflammation can depress CAP values, complicating its interpretation. Therefore, CAP use in AILD requires disease-contextualized understanding.

KEYWORDS

Autoimmune liver diseases; Autoimmune hepatitis; Primary biliary cholangitis; Primary sclerosing cholangitis; Controlled attenuation parameter; Hepatic steatosis; Non-invasive diagnosis; Transient elastography

1 Introduction

Autoimmune Liver Diseases (AILD), including AIH, PBC, and PSC, represent a spectrum of chronic, immune-mediated disorders that pose significant diagnostic and management challenges. Accurate assessment of disease severity, progression, and comorbidities is paramount. Hepatic steatosis, once considered primarily a feature of metabolic dysfunction, is now recognized as a frequent comorbidity in AILD, with potential implications for disease course, treatment response, and long-term outcomes such as fibrosis progression [5].

Liver biopsy remains the historical reference standard for the concurrent assessment of inflammation, fibrosis, and steatosis. However, its invasive nature, associated risks, sampling variability, and cost limit its utility for serial monitoring. This has fueled the search for reliable, non-invasive biomarkers. Transient elastography (TE, e. g., FibroScan®) has revolutionized the non-invasive assessment of liver fibrosis through the Liver Stiffness Measurement (LSM). Concurrently, the same examination yields the Controlled Attenuation Parameter (CAP), a property directly correlated with hepatic fat content. While extensively validated in populations with metabolic dysfunction-associated steatotic liver disease (MASLD) [2, 3], the performance characteristics and clinical applicability of CAP in the unique microenvironment of AILD—where inflammation, cholestasis, and autoimmunity interplay—require careful elucidation.

This review aims to synthesize the current evidence on the diagnostic and prognostic value of CAP across the spectrum of AILD. A primary focus is placed on defining its accuracy, optimal cutoff values, and, crucially, the patient- and disease-specific factors that confound its interpretation, thereby providing a practical guide for clinicians.

2 Diagnostic Value of CAP Across AILD Subtypes

2.1 General Performance in AILD Cohorts

Large-scale studies have established CAP as a valid non-invasive tool for steatosis detection in mixed AILD populations. A pivotal retrospective study by Ni et al. involving 800 AILD patients demonstrated that CAP could effectively serve as a non-invasive diagnostic method for hepatic steatosis in this group [8]. The study reported strong diagnostic performance, with AUROC values of 0.878, 0.764, and 0.821 for detecting steatosis grades ⩾S1, ⩾S2, and S3, respectively. Corresponding optimal CAP cutoff values were established at 220.5 dB/m, 271.5 dB/m, and 283.5 dB/m [8]. This foundational work confirmed CAP's overall utility in the AILD population.

2.2 Disease-Specific Diagnostic Accuracy

Subsequent research has refined our understanding, revealing differences in CAP's performance across AILD subtypes.

A. Primary Biliary Cholangitis (PBC): CAP shows consistent and reliable performance in PBC. It exhibits good concordance with histological findings, positioning it as a practical surrogate for biopsy in assessing steatosis [6]. One study reported an AUROC of 0.81 with 71% sensitivity and 82% specificity for detecting steatosis in PBC [7]. This is particularly relevant given the emerging evidence that overlapping metabolic dysfunction-associated steatotic liver disease can negatively impact PBC outcomes, making its detection clinically important [5].

B. Primary Sclerosing Cholangitis (PSC): Evidence suggests CAP may have outstanding diagnostic accuracy in PSC. A well-characterized cohort study by Steinmann et al. reported an excellent AUROC of 0.93 for differentiating hepatic steatosis in PSC patients, indicating CAP is a highly accurate tool in this disease context [7].

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C. Autoimmune Hepatitis (AIH) and Overlap Syndromes: In AIH and PBC-AIH overlap syndromes, CAP values maintain a significant positive correlation with histologically quantified hepatic fat content and BMI, similar to other liver diseases [7]. This confirms CAP's fundamental ability to detect fat. However, as detailed in the following section, the diagnostic pathway in AIH is complicated by a major confounding variable.

3 Critical Confounders and Influential Factors

3.1 The Paramount Confounder: Hepatic Inflammation in AIH

The most significant and disease-specific factor affecting CAP interpretation is active hepatic inflammation, particularly in AIH. This presents a unique paradox: while LSM typically increases with inflammation, CAP values are artificially suppressed [7]. Steinmann et al. made the critical observation that CAP values in AIH patients increased significantly following successful treatment and resolution of inflammation [7]. This implies that a baseline CAP measurement taken during an active disease flare may be falsely low, potentially leading to a missed diagnosis of concomitant steatosis.

A low CAP value in a patient with untreated or active AIH does not reliably rule out hepatic steatosis. The authors proposed that using an adjusted, higher cutoff value (288 dB/m) for patients in whom inflammation has resolved significantly improved diagnostic accuracy [7]. This highlights the necessity for a two-step interpretive approach in AIH: first assess and treat inflammatory activity, then interpret CAP for steatosis, preferably using remission-phase cutoffs.

3.2 Other Influencing Variables

A. Body Mass Index (BMI): CAP consistently shows a strong positive correlation with BMI across all AILD subtypes ($\rho = 0.527$, $p<0.001$), aligning with physiological principles and observations in other liver diseases [7].

B. Disease Activity Over Time: The impact of disease activity on CAP appears most pronounced in AIH. In contrast, longitudinal studies in PBC and PSC patients showed relative stability of CAP values and its diagnostic performance over a median follow-up of 12 months, suggesting less confounding from disease fluctuation in these cholestatic disorders [7].

C. Technical Considerations: General principles of TE application remain crucial. Factors such as appropriate probe selection (M vs. XL based on skin-to-liver capsule distance), adequate fasting, and proper technique to obtain valid measurements are foundational to reliable CAP results.

4 Conclusion and Future Perspectives

The Controlled Attenuation Parameter is a powerful, non-invasive tool that has earned a place in the assessment of patients with Autoimmune Liver Diseases. It provides excellent diagnostic accuracy for hepatic steatosis in PBC and PSC, offering a viable alternative to biopsy for this specific component of liver pathology [2,6,7,8]. However, a nuanced, disease-aware approach is mandatory. In Autoimmune Hepatitis, CAP interpretation cannot be divorced from the context of inflammatory activity [7]. Clinicians must integrate CAP values with standard markers of AIH activity (e.g., transaminases, IgG, histology). The most prudent application in active AIH may be to defer definitive steatosis assessment via CAP until after the induction of remission. Future research should prioritize the validation of inflammation-adjusted CAP cutoff values in larger, prospective AIH cohorts. Furthermore, investigating the prognostic significance of CAP-quantified steatosis on the long-term outcomes of AILD patients, including fibrosis progression and response to therapy, will be essential to fully define its clinical value beyond mere diagnosis.

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References

[1] Ginès P, Krag A, Abraldes J G, et al. Liver cirrhosis[J]. Lancet (London, England), 2021, 398(10308): 1359-1376.
[2] Zhang J, Lin S, Jiang D, et al. Chronic hepatitis B and non-alcoholic fatty liver disease: Conspirators or competitors? [J]. Liver International: Official Journal of the International Association for the Study of the Liver, 2020, 40(3): 496-508.
[3] Huang S C, Liu C J. Chronic hepatitis B with concurrent metabolic dysfunction-associated fatty liver disease: Challenges and perspectives[J]. Clinical and Molecular Hepatology, 2023, 29(2): 320-331.
[4] Gaber Y, AbdAllah M, Salama A, et al. Metabolic-associated fatty liver disease and autoimmune hepatitis: an overlooked interaction[J]. Expert Review of Gastroenterology & Hepatology, 2021, 15(10): 1181-1189.
[5] Hernández-Pérez M, Riado D, Pena E, et al. The overlap with metabolic dysfunction-associated steatotic liver disease negatively affects outcomes of primary biliary cholangitis[J]. Alimentary pharmacology & therapeutics, 2024, 60(5): 613-619.
[6] Zhang Y, Meng F, Hu X, et al. Comparative diagnostic efficacy of two-dimensional shear wave and transient elastography in predicting the risk of esophagogastric varices and histological staging in patients with primary biliary cholangitis [J]. BMC gastroenterology, 2024, 24(1): 396.
[7] Steinmann S, Hartl J, Weidemann S, et al. Accuracy of controlled attenuation parameter measurement for the detection of steatosis in autoimmune liver diseases[J]. JHEP reports: innovation in hepatology, 2023, 5(12): 100898.
[8] Ni X X, Lian M, Wu H M, et al. Evaluation of controlled attenuation parameter in assessing hepatic steatosis in patients with autoimmune liver diseases[J]. World Journal of Gastroenterology, 2021, 27(1): 80-91.