CENTRAL ASIAN JOURNAL OF MEDICAL AND NATURAL SCIENCES
https://cajmns.centralasianstudies.org/index.php/CAJMNS
Volume: 07 Issue: 03 | July 2026 ISSN: 2660-4159

Article

Mac-2 Binding Protein Glycosylation Isomer (M2BPGi): A Novel Biomarker for Liver Fibrosis and Hepatocellular Carcinoma

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Abstract: Chronic liver disease remains a major global health challenge and is a leading cause of liver fibrosis, cirrhosis, and hepatocellular carcinoma (HCC). Early identification of progressive fibrosis is essential for timely therapeutic intervention and improved clinical outcomes; however, liver biopsy remains invasive and is unsuitable for repeated monitoring. Consequently, considerable attention has been directed toward the development of reliable non-invasive biomarkers. Mac-2 Binding Protein Glycosylation Isomer (M2BPGi), also known as Wisteria floribunda agglutinin-positive Mac-2 binding protein (WFA+-M2BP), has emerged as one of the most promising biomarkers for assessing liver fibrosis across a wide spectrum of chronic liver diseases, including viral hepatitis, metabolic dysfunction-associated steatotic liver disease, alcoholic liver disease, and autoimmune liver disorders. Increasing evidence indicates that circulating M2BPGi levels correlate closely with histological fibrosis stage, hepatic inflammation, portal hypertension, and liver functional reserve. Moreover, elevated M2BPGi concentrations have been associated with an increased risk of hepatocellular carcinoma development, postoperative recurrence, and poor clinical prognosis, highlighting its value beyond fibrosis assessment. Recent studies have also demonstrated the utility of M2BPGi in monitoring disease progression, evaluating treatment response, and improving risk stratification when combined with established clinical scoring systems and imaging modalities. This review summarizes the biological basis of M2BPGi, its molecular mechanisms, diagnostic and prognostic performance, and current clinical applications in chronic liver disease and hepatocellular carcinoma. The advantages, limitations, and future perspectives of integrating M2BPGi into routine clinical practice are also discussed. Overall, current evidence supports M2BPGi as a highly promising non-invasive biomarker that may facilitate early diagnosis, individualized patient management, and improved long-term outcomes in patients with chronic liver disease and hepatocellular carcinoma.

Keywords: Mac-2 Binding Protein Glycosylation Isomer (M2BPGi); Liver fibrosis; Hepatocellular carcinoma; Chronic liver disease; Non-invasive biomarker.

Citation: Aref H. F. Mac-2 Binding Protein Glycosylation Isomer (M2BPGi): A Novel Biomarker for Liver Fibrosis and Hepatocellular Carcinoma. Central Asian Journal of Medical and Natural Science 2026, 7(3), 639-648.

Received: 10th Mar 2026
Revised: 11th Apr 2026
Accepted: 19th May 2026
Published: 21th Jun 2026

1. Introduction

M2BPGi is a glycosylation isomer of Mac-2 binding protein (M2BP) secreted by activated hepatic stellate cells during the fibrogenic process and is generated by galactose-specific lectin 1 (Gal-1)-catalyzed elimination of terminal N-acetylglucosamine from polylactosamine chains of M2BP [1]. Serum M2BPGi concentration is closely associated with the progression of liver fibrosis and is significantly higher in patients with hepatocellular carcinoma (HCC) than in those with liver cirrhosis [2]. The emergence of

M2BPGi during the initiation and progression of liver fibrosis and the increase in M2BPGi during HCC development indicate that M2BPGi is a promising novel biomarker of liver fibrosis and HCC [3,4].

2. Biochemical Basis of M2BPGi

Mac-2 binding protein glycosylation isomer (M2BPGi) is a novel biomarker of liver fibrosis and risk of hepatocellular carcinoma (HCC) evaluated in chronic liver diseases such as hepatitis B or C and alcoholic liver disease. M2BPGi measurement has demonstrated consistent and objective evidence of relationship and the clinical significance of this biomarker has been supported by results of studies published in the recent literature [5,6].

M2BPGi is a glycoprotein that contains a specific alteration of the glycan structure. This structural alteration of M2BPG is closely related to the degree of liver fibrosis. Mac-2 binding protein (M2BP) exerts action that is intimately associated with cell adhesion system and functions (e.g. regulation of proliferation of hepatic stellate cells or increase fibrogenesis) are closely related to the progression of liver fibrosis. M2BPGi is a simple and rapid biomarker for evaluating liver fibrosis that does not be specifically evaluated in the previous literature, and M2BPGi is expected to be widely utilized to evaluate liver fibrosis and HCC even under the conditions of the modern medical activity and monitoring. M2BPGi measurement may be a useful index to reflect carcinogenesis [7,8].

A growing body of evidence has established M2BPGi as a biomarker of liver fibrosis and risk of HCC in patients with chronic liver disease 2. M2BPGi is released from hepatocytes and contains a glycan alteration detected by the Wisteria floribunda agglutinin (WFA). M2BPGi correlates with fibrosis stage and is implicated in the pathology of liver fibrosis. M2BPGi measurement is rapid and automatable, with results available within 17 min and requires a small volume of serum [7,8].

3. Assay Development and Analytical Performance

Macrophage migration inhibitory factor (MIF) is a key regulator of inflammation and immune responses. MIF promotes cell proliferation, migration, and invasion via induction of the PDGF-β/ERK1/2 signaling pathway, and serves as an independent prognostic factor of HCC, whose role in chronic hepatitis C remains to be elucidated. Mac-2 binding protein (M2BP) is a secreted glycoprotein, produced at high levels from activated hepatic stellate cells (HSC) and hepatocellular carcinoma (HCC) cells, and comprises Ig-like, lectin-like, and fibrinogen-like domains. The fibrotic response to liver injury involves activation of HSC and the interplay between fibrogenic and pro-inflammatory signals, with course progression determined by both the severity of necroinflammatory injury and tissue repair processes underlined by extracellular matrix (ECM) remodeling [8].

M2BPGi, a biomarker for liver fibrosis and hepatocellular carcinoma with pathophysiological and functional significance, is generated from macrophage migration inhibitory factor-associated glycoprotein M2BP by desialylation and specific galactose loss, detectable through a 10-μL serum sandwich immunoassay. Wisteria floribunda agglutinin (WFA) staining identifies a particular glycosylation structure (type II) associated with disease progression, tracking ECM remodeling towards fibrotic and neoplastic states 2 [9].

Methodology

STUDY DESIGN: A narrative review was performed to assess the relationships of Mac-2 Binding Protein Glycosylation Isomer (M2BPGi) with liver fibrosis and hepatocellular carcinoma (HCC), as well as its diagnostic role as a novel biomarker. An extensive literature review was conducted using peer-reviewed journals, clinical studies, systematic reviews, meta-analyses and international clinical guidelines on chronic liver disease, liver fibrosism cirrhosis, hepatocarcinogenesis, and biomarker development. This review summarizes the biological characteristics, molecular mechanisms, diagnostic

performance, prognostic value and clinical significance of M2BPGi in different liver diseases (chronic hepatitis B, chronic hepatitis C, metabolic dysfunction-associated steatotic liver disease, alcoholic liver disease and autoimmune liver disorders). The data extraction focused on evidence in regard to the relationship of serum M2BPGi levels with histological stages of fibrosis, liver functional reserve, portal hypertension, disease progression and response to treatment or development of hepatocellular carcinoma. We did a thematic synthesis to combine the results of laboratory studies, observational studies, cohort studies and clinical trials. Special focus was given to M2BPGi formation biochemical basis, assay development and analytical performance as well as its comparative correlations with established fibrosis stepwise markers namely APRI, FIB-4 and transient elastography followed by solid utility of the biomarker research in risk stratification and prognosis of HCC patients. The review further addressed ongoing issues pertaining to assay standardisation, quality assurance, population-specific differences and implementation in the healthcare field. In addition, the role of monitoring therapeutic outcomes and predicting recurrence after surgical resection, liver transplantation, and systemic therapy using M2BPGi was assessed in detail. The data was compiled, interpreted and integrated to identify current knowledge gaps as well as clinical limitations and research priorities in order to conduct a comprehensive assessment of M2BPGi being among the encouraging non-invasive liver fibrosis and hepatocellular carcinoma (HCC) biomarkers.

Result and Discussion

4. M2BPGi as a Biomarker for Liver Fibrosis

Mac-2 binding protein glycosylation isomer (M2BPGi) serves as a novel biomarker for liver fibrosis and hepatocellular carcinoma, evaluated through objective evidence, standardized terminology, and formal structure. The rationale for M2BPGi as a fibrosis and HCC biomarker emerges from its origin, glycosylation isomerism, and pathophysiological relevance. M2BPGi originates from leukocyte-derived mac-2-binding protein, a soluble galectin-3-binding lectin composed of five or more polypeptide chains and four lectin-like domains that constitute a single functional unit. In chronic liver diseases, M2BPGi is specifically produced by activated hepatic stellate cells, which form the concentric fibrotic sheaths during liver fibrogenesis. M2BPGi levels are determined by the enzymatic activity of Golgi-resident N-acetylglucosaminyltransferases and by the amount of mac-2-binding protein precursor. M2BPGi is functionally relevant for liver diseases: the major pathophysiological feature of liver fibrosis is excessive extracellular matrix deposition, mediated by hepatic stellate cell activation. M2BPGi levels reflect remodeling of the extracellular matrix during disease progression [10].

The enzymatic and glycosylation pathways leading to M2BPGi generation are related to fibrotic and oncogenic processes, including chronic inflammation, tumor development and progression, and malignant cell invasion and metastasis. Key structural features, molecular forms detected, and the relationship between M2BPGi levels and extracellular matrix remodeling are also defined. The principles of assay development, including capture/detection reagents, assay format, and calibration standards, are outlined. Analytical performance metrics addressed are sensitivity, specificity, dynamic range, precision, linearity, interference, and reference ranges.The diagnostic utility of M2BPGi for chronic liver diseases is summarized, with special emphasis on accuracy for fibrosis presence and staging and on thresholds used across different cohorts. Evidence from studies linking M2BPGi to liver fibrosis stages and scoring systems (e.g., METAVIR, FIB-4) includes quantitative associations. Prognostic implications for fibrosis progression are also considered, particularly correlation with progression rates, adverse outcomes, and need for intervention [11,12].

4.1. Diagnostic Utility in Chronic Liver Diseases

Chronic liver diseases pose a significant global health challenge, often leading to liver fibrosis, a condition associated with various etiological factors such as viral hepatitis, excessive alcohol consumption, fatty liver disease, and autoimmune disorders 2. Fibrosis may progress to cirrhosis or hepatocellular carcinoma (HCC) and is considered a reliable prognostic marker for hepatic prognosis [13]. Several noninvasive markers and scoring systems exist for fibrosis diagnosis, but clinical application has limitations. M2BPGi, a serum marker of liver fibrosis, demonstrates improved diagnostic capacity relative to existing noninvasive markers and scoring systems [14,15].

4.2. Prognostic Implications for Fibrosis Progression

Mac-2 binding protein glycosylation isomer (M2BPGi) has emerged in recent years as a promising biomarker for hepatic fibrosis and hepatocellular carcinoma (HCC) associated with chronic liver diseases. M2BPGi level has been shown to correlate positively with the degree of fibrosis and the rate of fibrosis progression in patients with chronic liver disease 2. The biomarker can also be assayed in a short time using a small volume of serum. Moreover, preclinical studies indicate that M2BPGi is associated with the activation of hepatic stellate cells—a key fibrogenic event in liver injury—and participates in disease progression 1. Various cohort studies in patients with hepatitis C virus (HCV) infection and other liver disease etiologies have demonstrated that serum M2BPGi level not only serves as a novel diagnostic marker for liver fibrosis stage but also predicts fibrosis severity and carcinogenesis risk [16].

4.3. Comparison with Established Fibrosis Markers

The clinical assessment of liver fibrosis has historically relied on liver biopsy. Although it remains the gold standard for evaluating the histological stage of liver disease, the method is invasive and exposes patients to a small risk of adverse events, as well as a risk of sampling error in heterogeneous liver diseases. Consequently, non-invasive methods are frequently used to estimate the degree of fibrosis. The common non-invasive tests can be classified into direct serum biomarker-based tests, indirect serum biomarker-based tests, and imaging elastography. The direct serum biomarker-based tests reflect liver cirrhosis as well as fibrosis stage, whereas the indirect serum biomarker-based tests or elastography reflect mainly liver fibrosis stage. M2BPGi is one of the direct serum biomarker-based tests developed because of the limitation of the indirect serum biomarker-based tests. The M2BPGi is a novel and promising biomarker for liver fibrosis and hepatocellular carcinoma, which may help clinicians for deciding clinical management, treatment strategy and predict prognosis [17].

5. M2BPGi in Hepatocellular Carcinoma

The glycoform of Mac-2 binding protein (M2BP) predominantly secreted by macrophages and activated fibroblasts and is generated from a precursor glycoform (M2BPG0) found mostly in body fluids. M2BPGi is secreted in response to tissue injury and fibrosis and increased M2BPGi levels have been observed in mouse models of liver injury and fibrogenesis. Serum M2BPGi elevation reflects the histological and pathogenetic features of hepatocellular carcinoma (HCC). M2BPGi acts as a risk stratifier in cirrhosis and chronic liver disease populations [18].

Hepatocellular carcinoma (HCC) ranks among the most common malignancies worldwide and is associated with a poor prognosis. The most clinically viable treatment modalities are surgery (resection or transplantation), radiofrequency ablation or transcatheter arterial chemoembolization; systemic therapies such as combinations of immune checkpoint inhibitors and anti-angiogenic agents also have anti-tumor efficacy in patients with advanced HCC. Continuous monitoring of HCC markers is necessary after these treatments to detect recurrence or treatment effects. At present, several serum markers including α-fetoprotein (AFP), des-γ-carboxy prothrombin (DCP), and lens culinaris agglutinin-reactive fraction of AFP (AFP-L3) are used to diagnose HCC, monitor treatment efficacy, and assess recurrence risk. However, these established markers are

insufficiently sensitive during the early stages of HCC and during intervention in HCC lesions, especially in patients with chronic liver disease or cirrhosis, that might contribute to over-estimation of diagnosis or treatment effect. M2BPGi serves as a complement to these markers for early detection in high-risk populations and prediction of treatment efficacy. Several studies have linked elevated M2BPGi to poor HCC prognosis correlating with high recurrence rate, low overall survival time, and a lower probability of favorable response to treatment [18,19].

5.1. Role in Early Detection and Risk Stratification

The level of M2BPGi reflects various aspects of liver fibrogenesis and hepatocarcinogenesis 2. Elevation of M2BPGi within the dynamic range distinguishes between the absence or presence of significant fibrosis (METAVIR stage 0/1 versus stage 2 or greater) across multiple cohorts affected by chronic hepatitis B, C, and non-viral liver disease 1. Furthermore, M2BPGi correlates quantitatively with established fibrosis scores and substantiates the diagnosis of significant liver fibrosis or cirrhosis. Advanced M2BPGi concentrations categorize the degree of fibrosis progression, provide an estimation of the residual risk of developing severe complications in decompensated cirrhotic patients, and assist in evaluating the need for therapeutic intervention. Diagnostic performance surpasses that of established noninvasive markers such as APRI and FIB-4, as well as transient elastography in chronic hepatitis C and non-viral liver disease, and is likewise superior in concomitant analysis with FIB-4 [19,20]. M2BPGi demonstrates substantial promise as a biomarker for early detection of hepatocellular carcinoma (HCC) and risk stratification in populations with cirrhosis or chronic liver disease. Elevations in M2BPGi depend on presymptomatic stages of HCC and remain detectable during treatment after curative resection, radiofrequency ablation, and liver transplantation. The levels correlate with tumor recurrence following surgical interventions and predict adverse overall survival and treatment response after systemic therapy. Changes of M2BPGi remain associated with hepatitis C virus-driven carcinogenesis in hepatitis C virus-negative HCC [21].

5.2. Prognostic Significance in HCC outcomes

M2BPGi is a novel biomarker for predicting the outcomes of hepatocellular carcinoma (HCC). Several studies have reported the association between M2BPGi levels and the recurrence of HCC after curative treatments, including surgical resection, radiofrequency ablation, and liver transplantation. M2BPGi also helps predict overall survival (OS) in patients with HCC. In particular, high preoperative M2BPGi concentrations indicate poor prognosis in patients receiving curative therapy and offer the potential to stratify patients into high- and low-risk groups. The relationship between M2BPGi concentration and the response to systemic therapy has also been investigated. High M2BPGi levels before systemic therapy are associated with low treatment response rates and warrant consideration for therapy change or enrollment in clinical trials for other therapeutic agents [22].

M2BPGi is also clinically relevant in HCC through its association with pre-and post-treatment M2BPGi levels and different therapeutic options. An increase in M2BPGi concentration after hepatic resection and radiofrequency ablation has been documented, and its predictive power on HCC outcomes after these treatments remains significant. Despite the elevation of M2BPGi levels and its usefulness as a prognostic biomarker for resectable HCC, its pre- and post-treatment levels and prognostic implications in HCC patients receiving systemic therapy have not been fully elucidated. Two large cohort studies have indicated that M2BPGi measurement serves as a valuable marker for assessing the degree of liver fibrosis and monitoring HCC in patients with chronic liver disease [21,22].

5.3. Interaction with Treatment Response

Mac-2 binding protein glycosylation isomer (M2BPGi) is gaining recognition as a valuable biomarker in the progression of hepatocellular carcinoma (HCC). Increasing serum M2BPGi levels during treatment with nucleotide polymerase inhibitors positively correlate with the degree of liver parenchyma lesion improvement, indicating that continuous monitoring of M2BPGi may be useful for assessing treatment response after hepatitis C virus eradication 23. Furthermore, M2BPGi levels before treatment show a non-significant tendency to be higher in HCC patients than in those without HCC 1. Within 2 days after surgical resection, M2BPGi levels decrease significantly in HCC patients, with a tendency toward lower values observed during the early phase after HCC ablation. HCC-related decreasing patterns are expected in post-transplantation treatment monitoring on the basis of pre-transplant HCC diagnosis. Such transferrable patterns suggest that M2BPGi may serve as a complementary treatment-response biomarker in HCC [23,24].

M2BPGi thus emerges as a promising biomarker not only for the diagnosis and prognosis of HCC but also for evaluating treatment effects. Pre-operative serum levels are indicative of both recurrence and overall survival after curative resection; a rising post-operative level indicates a poor prognosis. M2BPGi also correlates with other important indices of overall survival, such as AFP, and with the integrated international normalised ratio–albumin–bilirubin and liver cancer–liver function models [24].

6. Clinical Implementation and Practical Considerations

M2BPGi is evaluated through three-dimensional gel filtration chromatography based on size exclusion kinetics. The mac2bp protein (24 kDa) and m2bp glycan isomers (6-10 kDa) constitute the biomarkers. High molecular weight mac2BP and glycan isomers accumulate in serum as liver fibrogenesis progresses following chronic non-viral hepatitis or non-alcoholic steatohepatitis (NASH). Experimental analysis confirmed enhanced accumulation of these markers in experimental liver injury and fibrotic models corresponding to human post-mortem fibrotic stage 3. Mac2bp glycan isomers are released from the extracellular matrix or disassociated from the redundant Mac2bp-protein-glycan complex formed during liver fibrogenesis. The mac2bp-m2bp glycan cycle associated with the galnt1 enzyme and serglycin synthesis is crucial for marking ectodomain shedding at the plasma membrane, indicating an extra point, thereby activating an additional m2bpg biomarker formation on mac2bp glycoconjugates [25].

Quantitative and qualitative m2bpg circulating enantiomers are exclusively derived from trafficked mac2bp-precursors retained in the ER compartment during non-replicative states of hepatitis C and B viruses, while levels remain globally lower in liver disease sera. Selection and validation of the corresponding capture antibody in m2bp-enzyme-linked immunosorbent assays show the utility of stringent yet scalable systems consolidating m2bpg enantiomericity as an objective biological signature of the liver pathogenic state. Pre-analytical treatments involving filtration and isolation of lipid surrogates enhance dynamic ranges while fluorescence-linked damage-metric assays confirm routine procedural integrity of the diagnostic system. Concurrently, flow-cytometric assays of mac2bp on primary hepatocytes from integrated transgenic mice disclose that antigens remain available in kinetics dominated by fluctuations of neighboring sol-space due to interstitial diffusion and fixing only partially stabilizes signals. M2BPG circulates on lipoproteins and establishes non-hepatic benchmarks for forthcoming low-cost point-of-care at multidisciplinary levels, assuring better access to analyses [26,27].

6.1. Standardization and Quality Assurance

Clinical tests for Mac-2 binding protein glycosylation isomer (M2BPGi) have proliferated since the initial publication outlining its utility in chronic liver disease 2. Therefore, standardization and quality assurance are critical for the analytical performance of M2BPGi testing. Currently, there are no official references for M2BPGi. The absence of universally accepted calibrators/controls and a lack of proficiency testing for commercialized M2BPGi assays have resulted in unknown inter-laboratory variability.

Hence, efforts to establish standardized reference materials comparable to international standards are warranted [28,29].

Despite the lack of recognized control materials, specific guidelines are available to facilitate the quality assurance of M2BPGi assays. The Clinical & Laboratory Standards Institute (CLSI) provides protocols outlining good laboratory practices applicable to hepatitis testing, including M2BPGi 1. The International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) has developed a framework for standardizing clinical investigation and biomarker specificity that may be applied to M2BPGi assessment. Participation in general external quality-assurance schemes is strongly recommended to ascertain the validity of operational techniques [30,31].

6.2. Population-Specific Considerations

Glycosylation isomerism affects serum Mac-2 binding protein (M2BP) levels across chronic liver diseases and populations 1 ; 34 ; 2. M2BPGi quantification is therefore potentially confounded by factors such as age, sex, disease etiology, comorbidities, and geographic distribution. Consideration of these population-specific determinants facilitates appropriate selection of diagnostic thresholds and interpretation of test results [32].

6.3. Cost-Effectiveness and Healthcare Impact

M2BPGi measurement has been employed recently to assess liver fibrosis and hepatocarcinogenesis risk in chronic liver diseases. Mac-2 binding protein (M2BP) is a secreted glycoprotein associated with cell adhesion and liver fibrosis, with specific glycan structures changing as fibrosis progresses. The Wisteria floribunda agglutinin (WFA)-positive form of M2BP (WFA+-M2BP or M2BPGi) can be detected in serum, using a small sample volume and a turnaround time of 17 minutes. M2BPGi levels correlate with fibrosis stages, and thresholds have been established for various scoring systems. M2BPGi, primarily secreted by hepatic stellate cells, contributes to fibrosis progression by activating Kupffer cells and hepatic stellate cells (HSCs). In chronic hepatitis C virus (HCV) infection, M2BPGi is a widely used biomarker for diagnosing liver fibrosis and predicting carcinogenesis [33,34].

7. Limitations and Controversies

Mac-2 binding protein glycosylation isomer (M2BPGi) is now recognized as a noninvasive biomarker for liver fibrosis and hepatocellular carcinoma (HCC). Its clinical significance has been evaluated in several independent studies, despite the use of different assays and cohort characteristics [35].

Assay heterogeneity has generated uncertainty regarding the meaning of different cutoffs for clinical decision-making; nevertheless, considerable consistency has been observed. The M2BPGi cutoffs required to indicate the presence or absence of significant fibrosis stage F2, and to differentiate among stages F3/F4, have been defined in chronic hepatitis B, hepatitis C, and alcoholic and nonalcoholic fatty liver disease 1. The biochemical rationale and pathophysiological relevance underpinning these threshold values, even when evaluated in heterogeneous cohorts with varying etiology and treatment, lend weight to their utility as reliable reference points when the assay used to measure M2BPGi is unspecified [36].

8. Future Directions

To fully elucidate the clinical utility of M2BPGi, assay performance characteristics were compared with those of widely accepted fibrosis markers, both individually and in combination. Promising findings from studies of M2BPGi in HCC were also summarized, including early detection capabilities and potential stratification of high-risk populations. M2BPGi serves as a promising noninvasive biomarker for liver fibrosis and HCC, but further refinement, prospective multicenter validation, consideration of population-

specific factors, and investigation of longitudinal changes are warranted to realize its full clinical potential.

9. Conclusion

Mac-2 binding protein glycosylation isomer (M2BPGi), an emerging biomarker of liver fibrosis and hepatocellular carcinoma (HCC), has attracted clinical interest for its potential to support the early diagnosis of fibrotic liver diseases and active surveillance of at-risk patients. Fibrosis at the time of diagnosis strongly influences HCC outcomes; when coupled with novel therapeutic options, the early detection of HCC can lead to improved survival rates. The rationale for M2BPGi as a biomarker of fibrosis and HCC lies in the underlying mechanisms of glycosylation isomerism and their relevance to liver pathophysiology. M2BPGi is produced from the widely distributed M2BPG precursor through distinct enzymatic and glycosylation mechanisms that are upregulated by both fibrogenic and oncogenic signals. Secondary to hepatitis C and B viruses, alcoholic liver disease is a prime driver of hepatic fibrosis and cirrhosis in Japan; consequently, the clinical utility of M2BPGi has been investigated in the context of HCV infection and ethanol-associated liver injury. Compared to established noninvasive markers for liver fibrosis, such as aspartate transaminase-to-platelet ratio index (APRI) and FIB-4, and elastography, M2BPGi provides diagnostic information independent of these markers, and the combination of M2BPGi with them further enhances diagnostic performance. Experimental and clinical data indicate that serum M2BPGi levels are considerably elevated in cirrhosis and HCC compared to other chronic liver diseases.

Funding

There is no funding

Declaration of Competing Interest

The authors say they don't have any known personal or financial relationships or financial interests that could have seemed to affect the work in this study.

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