Discordance between Clinical Parameters and 99mTc-GSA Scintigraphy in Predicting Liver Dysfunction: A case report

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Authors' Contributions

- Arman Nessipkhan: Conception and design, acquisition of data, analysis and interpretation of data, drafting the article.
- Takashi Kudo: Critical revision of the article for important intellectual content, final approval of the version to be published.

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Ethical Statement/Human and Animal Rights

The reporting of this case was approved by the Ethics Committee of Nagasaki University Hospital (No.20122149) and followed the revised guidelines of the Declaration of Helsinki (2000). Written informed consent was waived by the Ethics Committee of Nagasaki University Hospital.

Disclosures

The authors declare no conflicts of interest related to this study.

Consent

Yes, written informed consent was obtained from the patient's family for the submission of this manuscript for publication.

ABSTRACT

We present a retrospective case report highlighting severe discordance between clinical parameters and quantitative parameters derived from 99mTc-GSA liver scintigraphy in a patient undergoing planned valve surgery for severe tricuspid/mitral (TR/MR) valve regurgitation. Despite mild to moderate liver damage suggested by clinical evaluations, the 99mTc-GSA parameters indicated extremely severe liver dysfunction. The patient, who underwent successful valve surgery, ultimately succumbed to severe liver failure within one-month post-operation, emphasizing the importance of 99mTc-GSA as a powerful prognostic tool.

BACKGROUND

The precise assessment of liver function and hepatic functional reserve is crucial in clinical practice, guiding therapeutic decisions and patient management. Technetium-99m galactosyl human serum albumin (99mTc-GSA) scintigraphy has emerged as a valuable tool for evaluating hepatic functional reserve in clinical liver imaging. This radiopharmaceutical specifically binds to asialoglycoprotein receptors on hepatic cells, providing an accurate reflection of liver function based on its uptake [1]. Various parameters derived from 99mTc-GSA scintigraphy, such as HH15 (the ratio of blood activity at 15 minutes to 3 minutes after injection) and LHL15 (the ratio of liver activity to the sum of liver and blood activity at 15 minutes), are commonly used to evaluate liver function. These parameters can reveal subtle hepatic abnormalities that may not be evident through traditional clinical assessments [2]. Additional parameters like Rmax (maximal removal rate) and Clearance have also been proposed to enhance the accuracy of liver function evaluation [3]. Despite the utility of these parameters, discrepancies can sometimes occur between them and other clinical indicators. Such discordances highlight the complexities of liver function assessment and underscore the need for a multifaceted approach in clinical practice [4]. This case report aims to explore these complexities through a detailed examination of a clinical case, providing valuable insights into the nuances of liver function assessment and the potential for improving diagnostic and therapeutic strategies [5].

CASE REPORT

Patient History

A 79-year-old woman presented with complaints of heart failure symptoms and abdominal pain attributed to severe tricuspid/mitral (TR/MR) valve regurgitation. The patient had a 15-year history of atrial fibrillation and recurrent hospitalizations due to heart failure. Continuous therapy with

diuretics was administered to manage heart failure symptoms. Two months prior to admission to Nagasaki University Hospital, the patient developed edema, ascites, and weight gain indicative of worsening heart failure and was subsequently diagnosed with advanced TR during hospitalization.

IMAGING FINDINGS

Abdominal ultrasound

Liver Texture: The ultrasound examination revealed a liver edge that appeared dull but with a smooth surface. This presentation is often suggestive of a liver undergoing chronic changes, which may resemble cirrhosis. Importantly, there were no signs of liver tumors or masses, which helps rule out neoplastic causes of liver alteration.

Computed Tomography (CT)

Liver Morphology: The CT scan showed a mildly dull liver edge, consistent with chronic liver damage but not definitive for cirrhosis. This finding aligns with the ultrasound results and supports the presence of chronic hepatic changes rather than overt cirrhosis. The scan also revealed mild splenomegaly and no varices, along with a severely dilated inferior vena cava (IVC) and cardiomegaly with pericardial effusion.

Interpretation of these Images

While these findings are indicative of liver pathology, they do not conclusively confirm end-stage cirrhosis but rather suggest a liver affected by a chronic process or early stage of cirrhosis, possibly influenced by underlying cardiac conditions. They suggest a systemic condition affecting the liver, most likely cardiac-related congestive changes, rather than primary hepatic pathology, although this is inconclusive as the assessment of protein in ascites, such as the serum-ascites albumin gradient (SAAG), was not performed preoperatively.

PREOPERATIVE EVALUATION

MELD Score Evaluation

The pertinent values were as follows: creatinine (Cre) of 0.74 mg/dL, total bilirubin (Bil) of 2.1 mg/dL, International Normalized Ratio (INR) of 1.2, and sodium (Na) level of 138 mmol/L. Utilizing the MELD formula:

$$MELD=9.57\times\ln(Cre)+3.78\times\ln(Bil)+11.2\times\ln(INR)+6.43$$

This calculation resulted in a MELD score of approximately 19.79. This score indicates a moderate risk of mortality from liver-related complications associated with the surgical intervention.

Liver and Heart Function Assessment

Initial liver function assessment revealed the following values: AST 38 (U/L), ALT 29 (U/L), GGT 105 μg/dL, and ammonia 174 μg/dL. The patient had a Child-Pugh Score of 7 (Class B), indicating moderately severe liver disease. Specific findings included the absence of encephalopathy, mild to moderate ascites, bilirubin level at 2.2 mg/dL, albumin level at 3.8 g/dL, and prothrombin time (PT%) at 80%. Heart function assessment showed a left ventricular ejection fraction (LVEF) of 75%. Further functional liver assessment using Technetium-99m galactosyl human serum albumin (99mTc-GSA) scintigraphy revealed an HH15 value of 0.727, indicating moderate to severe liver damage, and an LHL15 value of 0.669, suggesting extremely severe liver damage. The details are summarized in Table 1.

Surgery and Postoperative Outcome

Tricuspid valve surgery was performed approximately one month after liver function assessment. The surgery was successful, and the patient's TR improved postoperatively. However, her bilirubin levels gradually increased, and on the postoperative day, her consciousness dropped, leading to admission to the ICU due to liver failure. Despite intensive care, the patient succumbed to liver failure 34 days after surgery.

DISCUSSION

Etiology & Demographics

Technetium-99m galactosyl human serum albumin (99mTc-GSA) liver scintigraphy plays a pivotal role in evaluating hepatic functional reserve in patients with liver diseases. The utility of 99mTc-GSA extends to assessing hepatic functions in various post-hepatic disorders, making it a valuable tool in clinical practice.

Considering the available data of negative HBsAg and HCV antibody results, severe IVC dilatation, heart failure, and cardiomegaly the liver dysfunction in this patient is indicative of congestive liver failure/hepatopathy, rather than viral hepatitis or cirrhosis.

Clinical & Imaging Findings

The observed severe discordance between LHL15 and the Child-Pugh score in our case study underscores the complexity of liver function assessment. While conventional clinical parameters suggested only moderately severe dysfunction, LHL15 indicated extremely severe liver damage. This discordance emphasizes the potential of 99mTc-GSA scintigraphy to uncover subtle hepatic abnormalities that may not be evident through traditional assessments.

Treatment & Prognosis

In our retrospective study, we focused on four key parameters derived from 99mTc-GSA liver scintigraphy: HH15, LHL15, Rmax (maximal removal rate), and Clearance. Our objective was to explore their relationships and understand their predictive value in the context of liver function and postoperative outcomes [3]. The conflicting evidence regarding the prognostic value of LHL15 and HH15 necessitates a comprehensive understanding of their respective strengths and limitations.

Differential Diagnoses

In contrast to our case, literature has shown that HH15 may have a better response to severe liver injury, especially in patients with poor liver function [5]. Previous reports have indicated that HH15 is more sensitive to postoperative complications than LHL15. The discrepancy in these findings highlights the complexity of liver function assessment and underscores the need for individualized interpretation based on specific clinical contexts.

Clinical Assessments and Imaging Discordance

In the medical records and preoperative discussions, the surgical and internal medicine teams assessed the liver damage as mild to moderate, evidenced by a Child-Pugh score of 7. Although bilirubin levels were elevated, this was considered likely due to constitutional hyperbilirubinemia, not direct liver impairment. Furthermore, despite elevated ammonia levels, the patient exhibited no clinical signs of encephalopathy.

Based on these assessments, the medical team judged that the patient could safely undergo surgery. However, this evaluation was contrasted sharply by the results from the 99mTc-GSA scintigraphy, which showed the poorest liver function recorded in our hospital's history, a finding indicating strikingly poor hepatic function. This notable discrepancy suggests a significant discordance between the clinical findings and the GSA parameters, underscoring the complexities of accurately assessing liver function and the critical role of comprehensive diagnostics in surgical planning.

TEACHING POINT

Our case report underscores the significance of 99mTc-GSA scintigraphy, specifically LHL15, as a simple indicator for predicting extremely severe cases of liver failure. Despite seemingly tolerable liver damage according to clinical assessments, the patient's outcome demonstrates the critical role of 99mTc-GSA in prognostication, urging further research and clinical validation.

CONCLUSION

Our case report highlights the critical role of 99mTc-GSA scintigraphy in assessing liver function and predicting postoperative outcomes in patients with liver disease. The severe discordance between traditional clinical parameters and 99mTc-GSA parameters underscores the importance of incorporating advanced imaging techniques in clinical practice to uncover subtle hepatic abnormalities and guide therapeutic decisions.

QUESTIONS

Question 1: Which of the following is the primary advantage of 99mTc-GSA scintigraphy in evaluating liver function compared to traditional clinical parameters?

A) It provides a direct assessment of liver enzyme function
B) It measures hepatic functional reserve based on receptor binding
C) It replaces the need for liver biopsy
D) It only evaluates hepatic blood flow
E) It is superior to all other imaging techniques

Correct Answer: B) It measures hepatic functional reserve based on receptor binding
Explanation: Unlike clinical parameters such as the Child-Pugh score and MELD score, 99mTc-GSA scintigraphy directly quantifies hepatic receptor function, providing an objective measurement of hepatic reserve. [Background Section]

Question 2: In patients undergoing preoperative evaluation for cardiac surgery, why might 99mTc-GSA scintigraphy be a critical tool?

A) It improves cardiac risk stratification
B) It enhances visualization of heart valves
C) It provides an objective liver function assessment for surgical decision-making
D) It predicts long-term cardiac function
E) It is used as a screening tool for coronary artery disease

Correct Answer: C) It provides an objective liver function assessment for surgical decision-making
Explanation: Since liver dysfunction can significantly impact surgical outcomes, 99mTc-GSA scintigraphy provides quantitative insights into hepatic functional reserve, aiding in risk stratification for surgical decision-making. [Preoperative Evaluation Section]

Question 3: Which of the following 99mTc-GSA parameters suggests extremely severe liver dysfunction?

A) LHL15 = 0.9
B) HH15 = 0.5
C) LHL15 = 0.669
D) HH15 = 0.3
E) LHL15 = 0.75

Correct Answer: C) LHL15 = 0.669
Explanation: Lower LHL15 values correlate with reduced hepatic function, and an LHL15 value < 0.7 is associated with severe hepatic dysfunction. [Preoperative Evaluation Section]

Question 4: Which of the following imaging modalities is best suited for quantitative assessment of hepatic asialoglycoprotein receptor function?

A) Ultrasound Elastography
B) Contrast-Enhanced CT
C) MRI with Hepatobiliary Contrast Agent
D) 99mTc-GSA Scintigraphy
E) PET-CT with FDG

Correct Answer: D) 99mTc-GSA Scintigraphy
Explanation: 99mTc-GSA scintigraphy specifically measures asialoglycoprotein receptor function, providing objective data on hepatic reserve and predicting postoperative liver failure. [Discussion Section]

Question 5: What is a major limitation of using clinical scoring systems (e.g., Child-Pugh and MELD scores) in preoperative hepatic functional assessment?

A) They are not validated for liver disease severity
B) They do not account for hepatic functional reserve
C) They provide more accurate assessments than imaging
D) They can only be used for viral hepatitis
E) They do not include bilirubin levels

Correct Answer: B) They do not account for hepatic functional reserve

Explanation: Clinical scoring systems (e.g., MELD score, Child-Pugh score) provide indirect estimates of liver function but do not directly measure hepatic reserve, leading to potential misclassification of disease severity. [Discussion Section

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FIGURES

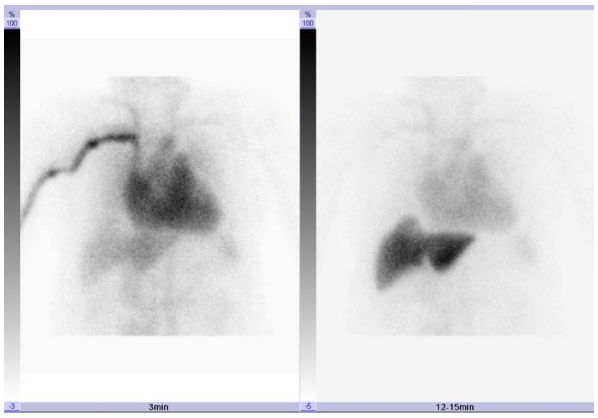

Figure 1: This figure illustrates images obtained at 3 minutes (left) and 12-15 minutes (right) after the injection of Technetium-99m Galactosyl Human Serum Albumin (99mTc-GSA). A notable distinction is observed between a normal subject and the patient under study. In the 12-15 minute image of the normal subject, the blood pool in the heart is not distinctly visible. However, in the patient, there is a clear and prominent presence of the blood pool in the heart. This visual disparity suggests a significant delay in the clearance of GSA from the blood in the patient, indicating a marked reduction in the clearance rate compared to a normal subject.

Table 1: Liver and Heart Function Assessment

Parameter	Value	Interpretation
Liver Function Assessment		
AST	38 U/L	Within normal range
ALT	29 U/L	Within normal range
GGT	105 µg/dL	Elevated
Ammonia	174 µg/dL	Significantly elevated
Hepatitis Testing		
Hepatitis B Surface Antigen (HBsAg)	Negative (<0.1)	Hepatitis B not the underlying cause of liver disease
Hepatitis C Virus Antibody (HCV antibody)	Negative (<0.1)	Hepatitis C not the etiological factor for the patient's liver condition
Child-Pugh Score	7 (Class B)	Moderately severe liver disease
- Encephalopathy	Absent (1 point)	No hepatic encephalopathy
- Ascites	Mild to moderate (2 points)	Mild to moderate ascites
- Bilirubin	2.2 mg/dL (2 points)	Elevated bilirubin
- Albumin	3.8 g/dL (1 point)	Lower side of normal
- Prothrombin Time (PT%)	80% (1 point)	Within normal range
Heart Function Assessment		
Left ventricular ejection fraction (LVEF)	75%	Good heart function
Functional Liver Assessment		
HH15	0.727	Moderate to severe damage
LHL15	0.669	Extremely severe damage

KEYWORDS

Liver Dysfunction; 99mTc-GSA Scintigraphy; Clinical Parameters; Valve Surgery; Hepatic Functional Reserve