**Brief Report**
Volume 8:5, 2023

Journal of Molecular Histology and Medical Physiology

ISSN: 2684-494X

Open Access

# Addressing Drug-induced Hepatic Steatosis: Overcoming Obstacles with Non-invasive Approaches

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## Abstract

Drug candidates have the potential to trigger hepatic steatosis, a condition characterized by the accumulation of lipids in liver cells without observable morphological alterations. Clinical investigations have identified two distinct fat deposition patterns: diffuse and non-diffuse. The more prevalent diffuse pattern contrasts with the non-diffuse category, which encompasses various subtypes, including geographic, focal, sub-capsular, multifocal, and perivascular patterns. Given the narrow safety margins associated with drug-induced hepatic steatosis, it is imperative to devise means for monitoring its incidence and severity in both preclinical and clinical research settings. Nevertheless, the conventional gold standard for diagnosing hepatic steatosis, liver biopsy, presents numerous drawbacks such as invasiveness, risk of bleeding and complications, as well as sampling inaccuracies due to the uneven distribution of fat within the liver. Consequently, liver biopsy falls short in terms of suitability for monitoring drug-induced hepatic steatosis, leaving a void in established monitoring methods for this condition.

**Keywords:** Drugs • Clinical medicine • MRI

## Introduction

Hepatic steatosis, also known as fatty liver disease, denotes the accumulation of lipids within liver cells. While the diffuse form of hepatic steatosis prevails, non-diffuse variants, including geographic, focal, subcapsular, multifocal, and perivascular patterns, can also manifest. In the context of preclinical and clinical investigations, it is paramount to monitor the emergence and severity of drug-induced hepatic steatosis. Conventional liver biopsy, the gold standard for hepatic steatosis diagnosis, entails invasiveness, with attendant risks of hemorrhage, morbidity, and sampling inaccuracies. Hence, non-invasive monitoring approaches are favored. Presented below are non-invasive methodologies suitable for tracking non-diffuse hepatic steatosis.

**Magnetic Resonance Imaging (MRI):** MRI is a non-invasive imaging modality endowed with high sensitivity and specificity for detecting hepatic steatosis. It facilitates the quantification and spatial mapping of lipid accumulation in the liver, including non-diffuse patterns. MRI is radiation-free and safe, rendering it valuable for monitoring the progression of hepatic steatosis over time.

**H-Magnetic Resonance Spectroscopy (H-MRS):** H-MRS is a non-invasive technique proficient in quantifying liver fat content. It furnishes insights into the composition of hepatic lipids, aiding in the differentiation between non-alcoholic fatty liver disease (NAFLD) and alcoholic fatty liver disease (AFLD). Additionally, H-MRS is instrumental in gauging the effectiveness of hepatic steatosis treatments [1,2].

## Description

The Methionine Choline Deficient (MCD) Diet serves as a dietary regimen employed to instigate hepatic steatosis in animal models. This diet is characterized by its low content of methionine and choline, essential nutrients vital for proper liver function. By reducing these elements, the MCD diet prompts the accumulation of lipids within the liver, effectively replicating the pathophysiological conditions observed in non-alcoholic fatty liver disease (NAFLD). Importantly, this dietary approach can be leveraged to induce non-diffuse hepatic steatosis in animal models, with the progress of the condition monitored through non-invasive techniques like MRI and H-MRS [3].

While blood tests are valuable tools for tracking liver function and identifying markers indicative of hepatic steatosis, such as elevated alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels, they possess limitations. These tests lack specificity for hepatic steatosis and may not possess the sensitivity required to detect non-diffuse patterns of hepatic steatosis. In contrast, non-invasive methods like MRI and H-MRS prove more effective for monitoring non-diffuse hepatic steatosis in both preclinical and clinical contexts. Therefore, these non-invasive approaches offer valuable insights into the incidence and severity of drug-induced hepatic steatosis.

Hepatic steatosis, characterized by lipid accumulation within hepatocytes, represents a growing global health concern. It can result from various factors, including obesity, type 2 diabetes, alcohol consumption, and specific medications. The pharmaceutical industry faces increasing concern regarding drug-induced hepatic steatosis, given the rising number of drugs associated with this condition. Hence, the development of non-invasive monitoring methods is imperative [4].

Liver biopsy traditionally serves as the gold standard for hepatic steatosis diagnosis. However, this method, entailing invasiveness, carries inherent risks such as hemorrhage and morbidity. Furthermore, liver biopsy's diagnostic accuracy is compromised by sampling errors attributed to the heterogeneous distribution of fat within the liver, potentially yielding false-negative results. In contrast, magnetic resonance imaging (MRI) presents a non-invasive alternative for visualizing hepatic fat content. The proton density fat fraction (PDFF), a quantitative MRI technique, has gained prominence in assessing hepatic steatosis in both preclinical and clinical settings, with PDFF values exceeding 5% indicating the presence of hepatic steatosis. However, the widespread adoption of MRI is limited by accessibility and the associated high equipment costs [5].

H-Magnetic Resonance Spectroscopy (H-MRS) represents another non-invasive technique for evaluating hepatic lipid content. It accomplishes this by measuring the signal intensity of hydrogen atoms within specific lipid molecules. H-MRS has demonstrated reliability in detecting hepatic steatosis,

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**Received:** 02 September, 2023; Manuscript No. jmhmp-23-114875; **Editor assigned:** 04 September, 2023, PreQC No. P-114875; **Reviewed:** 16 September, 2023, QC No. Q-114875; **Revised:** 21 September, 2023, Manuscript No. R-114875; **Published:** 28 September, 2023, DOI: 10.37421/2684-494X.2023.8.93

offering high sensitivity and specificity. Nonetheless, the technique's adoption is hindered by limited equipment availability and the associated expenses [6].

## Conclusion

The MCD diet induces liver injury and fat accumulation, rendering it a valuable model for investigating drug-induced hepatic steatosis. However, it falls short in fully mirroring human physiological responses. Various blood biomarkers, including alanine aminotransferase, aspartate aminotransferase and gamma-glutamyl transferase, have been utilized to gauge liver function and identify hepatic injury, making them viable candidates for monitoring drug-induced hepatic steatosis. Nevertheless, their applicability is hindered by a lack of specificity for hepatic steatosis, as they may be influenced by other factors such as inflammation and viral infections. The rising concern surrounding drug-induced hepatic steatosis underscores the urgency of developing non-invasive monitoring techniques. While liver biopsy stands as the gold standard, its invasiveness and associated risks remain significant drawbacks. Non-invasive approaches like MRI, H-MRS, the MCD diet, and blood biomarkers have shown promise in hepatic steatosis detection. Nonetheless, these methods have their respective limitations, necessitating further research to enhance their accuracy and accessibility.

## Acknowledgement

None.

## Conflict of Interest

None.

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**How to cite this article:** Athmakur, Eshitha. “Addressing Drug-Induced Hepatic Steatosis: Overcoming Obstacles with Non-Invasive Approaches.” *J Mol Hist Med Phys* 8 (2023): 93.