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# Assessment of focal liver lesions using magnetic resonance imaging, with a comparison to histopathological findings

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**Abstract**
There has been a rise in the incidence of accidentally discovered focal liver lesions (FLL) due to the widespread use of cross-sectional imaging. Having a reliable method for detecting and characterizing Focal Liver Lesions (FLL) is crucial for ensuring appropriate patient therapy. Within the realm of FLL, attaining the maximal level of imaging precision is crucial in order to avoid unnecessary biopsies, which may result in post-procedural complications. In recent years, there has been a substantial rise in the advancement of cutting-edge imaging techniques. Currently, magnetic resonance imaging (MRI) is essential in the treatment of liver abnormalities. This imaging method utilizes a radiation-free technique and has a safe contrast agent profile. MRI plays a crucial role in accurately characterizing FLL without the need for intrusive procedures. The magnetic resonance imaging (MRI) approach has the capacity to provide comprehensive and highly precise diagnostic information, while also avoiding the use of any potentially hazardous ionizing radiation. Because of these specific attributes, magnetic resonance imaging has emerged as the preferred technique for the non-invasive assessment of localized liver lesions. This study focuses on the role of contrast agents that specifically target hepatocytes and provides a comprehensive overview of the most advanced magnetic resonance imaging (MRI) liver procedure. In addition, we provide a concise overview of the many types of sequences, as well as the unique attributes of imaging patients that exhibit non-cooperative behavior. This page provides a comprehensive analysis of the imaging features of both benign and malignant FLLs. Additionally, it includes a diagrammatic representation of a practical MRI technique.

**Keywords:** Malignant, benign, magnetic resonance, focal liver lesions, hepatobiliary contrast agents

## Introduction

The liver plays a vital role in numerous complex processes, including the metabolism of amino acids, carbohydrates, and lipids, as well as the synthesis of proteins [1]. When a metabolic pathway malfunctions, it usually leads to the manifestation of the fundamental pathophysiology of parenchymal disease. Parenchymal lesions can be either localized or diffuse, and a focal lesion may either originate from a different part of the body or spread to that area [2-4]. Liver lesions, also known as hepatic lesions, are abnormal growths or formations that occur on or inside the liver. Both benign and malignant tumors can occur. Benign liver lesions are more common than malignant ones. One of the most common noncancerous liver tumors is the hemangioma, which falls under the category of benign tumors [5-7]. Focal nodular hyperplasia is the second most prevalent type of benign tumor, encompassing hepatic adenomas, angiomyolipoma, and bile duct cyst adenomas. Most malignant liver lesions are metastases originating from other cancers, primarily those of the gastrointestinal tract (such as colon cancer, carcinoid tumors primarily found in the appendix, etc.), breast, ovarian, lung, renal, prostate, etc. Hepatocellular carcinoma, cholangiocarcinoma, mixed hepatocellular and cholangiocarcinoma, hepatoblastoma, bile duct cystadenocarcinoma, fibro lamellar carcinoma, and mesenchymal tissue tumors are the predominant types of malignant primary liver cancers [8-10]. Hepatoblastoma is the most prevalent malignant tumor found in children. Ultrasonography (USG) remains the preferred initial imaging technique due to its affordability and widespread availability. Clinical decision-making in liver illnesses is usually based on the results of an initial ultrasonography examination due to the lack of specific signs and symptoms. The capabilities of ultrasonography have been improved by the use of colour Doppler flow imaging (CDFI), Which allows for the evaluation of blood flow and perfusion. It allows for the simultaneous, real-time presentation of flow data from vessels within the scan and high-quality grayscale images of tissue. The sonologist can more accurately determine the type of lesion by utilizing CDFI to distinguish blood flow patterns within and around hepatic tumors [12]. Nevertheless, CDFI exhibits limited efficacy in identifying blood movement at low velocities within the abnormal blood vessels' microvasculature. Power Doppler encodes the mean frequency of the Doppler signals instead of traditional encoding methods. Power Doppler is a more precise method for visualizing small tumor arteries and blood vessels that are flowing slowly. The introduction of helical or spiral CT scanning has been a major breakthrough in hepatobiliary imaging. True volumetric CT data can be gathered more quickly utilizing helical (spiral) CT than with a normal scanner. Three key technical advancements the invention of the slip ring gantry, increased detector efficacy, and enhanced tube cooling capability have made routine helical CT of the abdomen practicable [13]. With its accelerated speed and narrow slice collimation, MDCT, a recent development in CT technology, has opened up a new dimension of improved spatial and temporal resolution. It combines the ability to capture multiphase data with a short scan time. Spiral CT boosts lesion detection as compared to portal phase alone because it may reveal vascular perfusion in arterial, portovenous, and delayed phases, which aids in the characterization of focal hepatic lesions [14]. Focal hepatic lesions pose a recurring challenge in the clinical setting. Non-invasive approaches, however, might be effective in finding and characterising these lesions [15]. Transabdominal sonography, CECT, and MRI are routinely utilized to obtain a non-invasive diagnosis of liver problems. For the evaluation of various localised hepatic pathologies, dynamic three-dimensional gradient-recalled-echo MR imaging gives dynamic contrast-enhanced thin-section images with fat saturation and a good signal-to-noise ratio. The majority of these lesions can be diagnosed with a full MR imaging examination that includes $T_2$-weighted and chemical shift $T_1$-weighted imaging and exhibits identifiable enhancement patterns. These enhancement patterns which include arterial phase enhancement, delayed phase enhancement, peripheral washout, ring enhancement, nodule-within-a-nodule enhancement, real central scar, pseudo central scar, and pseudo capsule, appear during certain phases of contrast-enhanced imaging. Therefore, becoming familiar with these improved patterns can help in diagnosing distinct localised lesions of the liver. Magnetic resonance venography, magnetic resonance cholangiopancreatography, and magnetic resonance angiography (MRCP) are imaging techniques that use magnetic resonance imaging (MRI) to visualize the veins, bile ducts, and blood vessels, respectively. Another alternative is the utilization of MR spectroscopy for biochemical imaging. The use of modern scanners and techniques has made it possible to conduct a comprehensive and non-invasive assessment of the liver, which is now readily accessible. There has been a heated debate about the most effective imaging technique for detecting liver lesions during the past two decades. Advancements in hardware, MR technique, and contrast chemicals have enabled MRI to fully and noninvasively scan the liver. For proper management of liver lesions, the radiologist needs a solid awareness of contemporary MRI techniques [15-17].

## Materials and Methods

A prospective study was conducted on patients who were sent to the Department of Radio-Diagnosis, Sambhram Institute of Medical Sciences and Research, Bangalore, Karnataka, India, for diagnosis from February 2020 to January 2021. These patients had clinical, biochemical, ultrasound, and CT evidence of liver pathology. At the beginning, a minimum of 60 cases are selected. However, it is possible to increase the number of cases if they are available during the study time.

### Inclusion criteria

From a clinical perspective, patients with localized hepatic lesions were suspected based on the presence of positive symptoms and abnormal liver function tests (LFT). Patients who have been found to have liver abnormalities in earlier imaging studies Patients who are in a state of good physical well-being but have abnormal liver imaging, along with other symptoms or conditions. Patients exhibiting equivocal liver abnormalities detected using ultrasound (USG) or Computed Tomography (CT).

### Exclusion criteria

Patients with cardiac pacemakers, prosthetic heart valves, cochlear implants, or any metallic implants. The patient has a previous medical record of claustrophobia. All patients who refuse to participate in the trial. The individual has stage 4 or 5 chronic kidney disease (CKD) with renal failure, indicated by an estimated glomerular filtration rate (eGFR) of less than 40ml/min/1.732.

## Results

**Table 1:** Radiological vs clinical diagnosis

| Final Diagnosis | Number of Cases | Clinical Diagnosis | |
|---|---|---|---|
| | | Same | Different |
| Focal Fatty infiltration | 3 | - | 2 (Hepatitis)<br>1 (Liver abscess) |
| Simple hepatic Cyst | 4 | - | 2 (Incidental) 2 (COL) |
| Liver abscess | 8 | 5 | 2 (Hydatid cyst)<br>3 (Cholelithiasis) |
| Kochs granuloma | 2 | 1 | - |
| Haemangioma | 8 | - | 4 (APD)<br>4 (Incidental) |
| Regenerative nodule | 2 | - | 2 (Liver Abscess) |
| Cholangiocarcinoma | 4 | 1 | 2 (HCC) |
| Hepatocellular carcinoma | 8 | 4 | 2 (Cholangio carcinoma) |

| | | | |
|---|---|---|---|
| | | | 2 (COL) |
| Metastases | 11 | 7 | 2 (HCC)<br>2 (COL) |
| Biliary hamartoma | 2 | - | 2 (PCLD) |
| Lymphoma | 1 | 1 | - |
| Hydatid cyst | 7 | 3 | 3 (Liver abscees)<br>3 (Cholelithiasis) |
| Hepatic adenoma | 2 | - | 1 (Cholelithiasis) |
| Poly cystic liver disease | 2 | 2 | - |
| Total | 60 | 25 | 35 |

**Table 2:** USG appearance of the hepatic lesions

| Appearance of lesions | Number of patients |
|---|---|
| Anechoic with peripheral calcification | 5 |
| Heterogenous | 25 |
| Hyperechoic | 10 |
| Hypoechoic | 8 |
| Anechoic | 8 |

**Table 3:** Appearance of all lesions on $T_1$w

| $T_1$ in phase /out phase | Number of patients | % |
|---|---|---|
| Low signal intensity | 38 | 72 |
| ISO to liver parenchyma | 2 | 1 |
| High signal intensity | 3 | 2 |
| Mixed signal intensity | 12 | 35 |

**Table 4:** Final diagnosis (pathological confirmation) vs radiological diagnosis

| Radiological Diagnosis | Number of Cases | Final diagnosis (Pathological Confirmation) | |
|---|---|---|---|
| | | Same | Different |
| Focal Fatty infiltration | 3 | 3 | _ |
| Simple Cyst | 4 | 4 | _ |
| Liver abscess | 7 | 8 | - |
| Kochs granuloma | 2 | 1 | - |
| Haemangioma | 8 | 8 | - |
| Regenerative nodule | 2 | 1 | - |
| Cholangiocarcinoma | 3 | 3 | - |
| Hydatid cyst | 7 | 7 | |
| Poly cystic liver disese | 1 | 1 | |
| Bilary hamartoma | 1 | 1 | |
| Hepatocellular carcinoma | 8 | 2 | 3 (Metastases)<br>3 (Cholangio carcinoma) |
| Hepatic adenoma | 1 | 1 | _ |
| Lymphoma | 1 | - | Kochs granuloma |
| Metastases | 11 | 8 | 2 (Regenerative nodule) |
| Total | 60 | 53 (92%) | 7 (8%) |

**Table 5:** Statistical indices of benign lesions

| Positive | |
|---|---|
| True positive | 35 |
| False positive | 0 |
| **Negative** | |
| False negative | 5 |
| True negative | 20 |
| **Output** | |
| Sensitivity | 95.66% |
| Specificity | 100% |
| Positive predictive value | 100% |
| Negative predictive value | 95.66% |

**Table 6:** Statistical indices of malignant lesions

| Positive | |
|---|---|
| True positive | 20 |
| False positive | 5 |
| **Negative** | |
| False negative | 0 |
| True negative | 35 |
| **Output** | |
| Sensitivity | 100% |
| Specificity | 95.66% |
| Positive predictive value | 95.66% |
| Negative predictive value | 100% |

## Discussion

The present investigation consisted patients who were referred to the department of Radio-diagnostic and imaging for diagnosis. These patients had clinical, biochemical, ultrasound, and CT evidence indicating liver pathology. Among the 70 patients referred by various clinical departments, 4 individuals with advanced cases of metastasis received chemotherapy for palliative purposes. Additionally, 3 metastasis patients died before fine needle aspiration cytology (FNAC) could be conducted. Furthermore, 4 patients who were suspected of having hepatocellular carcinoma (HCC) were lost to follow-up, preventing the possibility of performing FNAC. The study comprised a total of 60 incidents [18]. This investigation includes 60 patients with localized hepatic lesions. The study group consisted of 22 women and 38 males, representing 66% of the total participants. 57% of the patients fell between the age ranges of 31-60. According to the present investigation, 42% of the lesions were determined to be malignant. The most prevalent malignant primary hepatic tumor studied was metastases, which were detected in 20% of cases and were present in 80% of patients aged 8 or older. Matsui *et al*. (2005) [19] and Silverman *et al*. (2005) [20] reported comparable results in 2009. When hepatic masses were present, the most commonly reported symptom was abdominal pain (82%), followed by the presence of an abdominal mass (32%). The two most prevalent symptoms shared by metastases are pain and weight loss, accounting for 70% of cases. The predominant symptom of HCC was abdominal discomfort, reported by 71.42% of patients. The most prevalent clinical symptom was hepatomegaly, which was observed in 36% of patients and often manifested as a mass felt in the right hypochondrium. In 1997, Saini *et al*. identified these as the common clinical features linked with hepatobiliary illness. An accurate diagnosis could be determined only from the clinical characteristics in 38% of instances. Imaging plays a crucial role in diagnosing, identifying, and accurately outlining different types of lesions.

**Conclusions**

An examination was conducted on a group of 60 individuals with liver lesions, whose ages ranged from 2 to 70 years. The highest percentage of individuals, 36%, was found in the age group of 51 to 60 years. The male patients accounted for 66% of the total, with a male to female ratio of 2:1. The hepatic mass lesions consisted of 40% non-tumorous lesions, 18% benign hepatic tumors, and 42% malignant lesions. Within our series, 20% of all patients were diagnosed with metastatic illness. Accounting for 47.61% of all malignant cases, it was also the predominant malignant lesion. MRI demonstrates a sensitivity of 100% and a specificity of 93.55% for malignant mass lesions, while it exhibits a sensitivity of 93.55% and a specificity of 100% for benign disorders. A simple cyst on Doppler imaging appears as a well-defined, echo-free abnormality with increased sound transmission behind it, but without any blood flow. The diagnosis can be confirmed by analyzing the results of the USG and CT scans. However, the utilization of multiple MRI sequences yielded further information regarding the internal composition of the cyst. The distinctive characteristics of hydatid sand and floating membrane can be utilized to confirm the diagnosis of a hydatid cyst directly on the ultrasound (USG). A distinct finding observed on the $T_1$W and $T_2$W images of the MRI is the presence of a low intensity ring surrounding the lesion. Differentiating between amoebic and pyogenic abscess with sonography is often straightforward. Amoebic abscesses typically appear as solitary, well-defined, hypoechoic lesions with accentuated posterior features. Perilesional edema was identified on an MRI scan as being specific to an amoebic liver abscess. On ultrasonography (USG), hemangiomas are well defined and show a high level of echogenicity in small lesions. However, lesions bigger than 6 cm in size may exhibit a varied or inconsistent pattern. In $T_1$-weighted images of the magnetic resonance (MR), there is a decrease in signal intensity, whereas in $T_2$-weighted imaging, there is a significant increase in signal intensity. Additionally, there is a distinct pattern of peripheral nodular enhancement with delayed centripetal filling. Due to their bright appearance on $T_2$WI, haemangiomas can be effectively distinguished from small hepatocellular carcinoma (HCC) using MRI. Consequently, MR data are regarded as diagnostic. MRI is valuable in distinguishing between benign nodules and dysplastic nodules, which may include a malignant HCC center. Hepatocellular carcinoma (HCC) appears as a solid mass with different echogenicity from its surroundings, with poorly defined edges and widespread blood vessel formation. Metastatic lesions on USG had a varied appearance. The predominant sonographic pattern exhibited multiple distinct, solid hypoechoic liver lesions. The vascularity of the metastatic lesions is a direct reflection of the initial tumor's vascularity. Unlike hepatocellular carcinomas (HCCs), which have a scattered distribution of blood vessels, hypervascular metastasis displays a peripheral arrangement. The findings of the magnetic resonance (MR) scan are ambiguous. USG is unable to differentiate between focal fatty infiltration and hepatic lesions, whereas MRI has the capability to do so. Ultrasonography is a useful screening tool for hepatic lesions. Ultrasonography is recommended for all persons with suspected hepatic lesions to initially detect and locate the lesion. Magnetic Resonance Imaging (MRI), with a sensitivity rate of 92%, is a dependable diagnostic technique for detecting hepatic masses. The study findings highlight the advantages of employing multi-planar imaging and MRI with notable differentiation of soft tissues for identifying and describing various liver diseases. When there is suspicion of a hepatic lesion in a patient, it is recommended to perform an ultrasound (US) as the initial screening tool. CT and MRI should be used to further analyze the lesion and determine the stage of any malignant lesions.

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