International Journal of Research in Medical Sciences
Das S et al. Int J Res Med Sci. 2025 Jul;13(7):2823-2827
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20252014

Original Research Article

Radiological and histopathological correlation of hepatic tumors in computed tomography and magnetic resonance imaging

Shantibhusan Das[1], Biswojeet B. Sahoo[2]*, Sudeb Ghosh[3]

[1]Department of Radiodiagnosis, SCB Medical College, Cuttack, Odisha, India
[2]Department of Radiodiagnosis, Maharaja Jajati Keshari Medical College and Hospital, Jajpur, Odisha, India
[3]Department of Pathology, Maharaja Jajati Keshari Medical College and Hospital, Jajpur, Odisha, India

Received: 14 May 2025
Revised: 13 June 2025
Accepted: 16 June 2025

***Correspondence:**
Dr. Biswojeet B. Sahoo,
E-mail: biswojeetbisworanjansahoo@gmail.com

ABSTRACT

Background: Hepatic tumors present a diagnostic challenge due to overlapping radiological features with both benign and malignant lesions. Differentiating these tumors accurately is essential for appropriate management. Correlating imaging findings with histopathology can enhance diagnostic confidence and reduce unnecessary interventions.
Methods: A prospective study was conducted at SCB Medical College, Cuttack, from January 2021 to December 2022, involving 100 patients with hepatic tumors. All patients underwent computed tomography (CT) and/or magnetic resonance imaging (MRI) followed by histopathological evaluation. Radiological findings were compared with histopathology and immunohistochemistry for diagnostic correlation.
Results: Out of 100 hepatic tumor cases, 58% showed hypervascularity and 82% had well-defined margins on imaging. T2 hyperintensity was observed in 77% and T1 hypointensity in 60% of lesions. Fat was detected radiologically and histologically in 40% of cases. Histopathology confirmed hepatocellular carcinoma in 45%, angiomyolipoma (AML) in 12%, and other benign tumors in the rest.
Conclusions: Radiological features alone may be insufficient for definitive diagnosis. Correlation with histopathology is essential, especially in fat-deficient lesions.

Keywords: Hepatic tumors, Angiomyolipoma, CT, MRI, Radiopathological correlation

INTRODUCTION

Hepatic tumors encompass a diverse group of lesions with variable radiological and histopathological features, often presenting a diagnostic challenge in clinical practice. Among these, angiomyolipoma (AML)—along with related entities such as angiomyelolipoma, angio-myomyelolipoma, and lymphangioleiomyo-matosis—illustrates the complexity arising from the proliferation of perivascular epithelioid cells. The considerable morphological heterogeneity of these tumors stems from varying proportions of blood vessels, adipose tissue, and epithelioid cells. Although AMLs are commonly encountered in the kidney, their hepatic counterparts are relatively rare and often difficult to distinguish from other liver tumors based on imaging alone.[1,2] While some authors suggest that hepatic AMLs can be reliably diagnosed using radiological techniques such as computed tomography (CT) and magnetic resonance imaging (MRI), retrospective pathological reviews of 25 and 30 patients, respectively, revealed that accurate preoperative diagnosis was achieved in fewer than half the cases.[1-4] This diagnostic uncertainty is further compounded by the radiological similarities between hepatic AML and other liver lesions, including hepatocellular carcinoma, adenoma, liposarcoma, lipoma, hamartoma, and even focal nodular hyperplasia. Histological interpretation also poses challenges, particularly when the fat content is low, and epithelioid cells exhibit marked pleomorphism and hyperchromasia, mimicking malignant features.[3,5]

Further complicating the diagnostic landscape, studies have shown that grade 1 primary hepatic neuroendocrine tumors (PHNETs) typically present as singular, solid nodules with rapid arterial phase enhancement on CT and MRI, while higher-grade tumors (e.g., grade 3) exhibit multiple lesions with internal necrosis and hemorrhage. Histopathologically, as per the 2010 World Health Organization (WHO) classification, higher-grade PHNETs are associated with decreasing apparent diffusion coefficient (ADC) values (e.g., grade 1: $1.39\pm0.20\times10^{-3}$ mm^2/s versus grade 3: $1.14\pm0.17\times10^{-3}$ mm^2/s) and progressive loss of tumor capsule integrity, reflecting increased tumor aggressiveness.[6] Similarly, radiological evaluations of hepatic rare malignant tumors (HRMTs) have identified distinct imaging patterns that aid in narrowing differential diagnoses. For instance, primary clear cell carcinoma of the liver (PCCCL) demonstrates prompt arterial phase enhancement followed by rapid washout, whereas malignant fibrous histiocytoma (MFH) and undifferentiated embryonal sarcomas (UESs) typically exhibit gradual delayed enhancement. On histopathological examination, most HRMTs are alpha-fetoprotein (AFP)-negative (with the exception of PCCCL and hepatoblastoma (HB)) and represent a broad spectrum of neoplasms such as sarcomas, lymphomas, and carcinoid tumors, each with distinct cellular and structural features.[7]

This study aims to systematically explore the radiological characteristics and corresponding histopathological findings of hepatic tumors, with a particular focus on CT and MRI correlation. Previous literature has emphasized histopathology and immunohistochemical findings in hepatic AMLs, yet comprehensive imaging-pathology correlation remains underreported, with only about 40 radiologically described cases in the literature.[2,8-14] Although many of these lesions undergo surgical resection, most hepatic AMLs—and several other benign hepatic tumors—may be managed conservatively. Improved awareness and collaboration between radiologists and pathologists are crucial for enhancing diagnostic accuracy and potentially reducing unnecessary surgical interventions.

METHODS

Study design and setting

This was a prospective study conducted over a period of two years, from January 2021 to December 2022, at the Department of Radiodiagnosis and Department of Pathology, SCB Medical College, Cuttack. A total of 100 patients with hepatic tumors underwent radiological evaluation by CT and/or MRI, followed by histopathological correlation.

Patient selection and inclusion criteria

Patients presenting with hepatic space-occupying lesions who underwent imaging followed by histopathological evaluation—either via resection or biopsy—were included in the study. All participants provided informed consent, and ethical clearance was obtained from the institutional review board. Cases of previously diagnosed liver tumors or patients with inadequate imaging or pathological data were excluded.

Imaging protocols: CT and MRI

All patients underwent contrast-enhanced CT (CECT) and/or magnetic resonance imaging (MRI) of the liver. CT scans were performed using multiphasic protocols, including arterial and portal venous phases, after intravenous administration of 100–150 ml of iodinated contrast material. CT scan reconstructions were done using thin slice protocols (3–5 mm). MRI was performed using T1-weighted and T2-weighted sequences, with additional fat-suppressed sequences in selected cases. Post-contrast imaging included T1-weighted spin echo and gradient echo sequences using Gd-DTPA or Mn-DPDP as contrast agents. Imaging parameters were adapted as per standard protocols, and where available, diffusion-weighted imaging (DWI) was also included. All imaging was reviewed by two experienced radiologists who reached a consensus regarding radiological diagnosis.

Histopathological evaluation and immunohistochemistry

Following imaging, surgical resection or ultrasound-guided core needle biopsy was performed depending on the clinical scenario. Resected or biopsied tissue was fixed in 4% neutral buffered formalin, processed routinely, and embedded in paraffin. Sections were stained using hematoxylin and eosin (H&E), Gomori's silver, and periodic acid–Schiff (PAS) stains with and without diastase digestion. For selected cases, immunohistochemical (IHC) analysis was performed using the APAAP method. Diagnosis was supported by positive staining for melanocytic markers such as HMB-45 (Dako, Denmark) and CD63 (NKI-C-3; Enzo, USA), and negative staining for pancytokeratin markers KL1 (Immunotech, France) and AE1/AE3 (Dako, Denmark).[15-17] The Ki-67 proliferation index was also evaluated to assess mitotic activity.

Image-pathology correlation

Radiological findings were systematically compared with histopathological and immunohistochemical results to assess diagnostic concordance. Special attention was given to cases with atypical imaging features or low fat content, which often pose diagnostic challenges in differentiating hepatic AMLs from other hepatic lesions such as hepatocellular carcinoma, adenoma, lipoma, and focal nodular hyperplasia.

RESULTS

Out of the 100 hepatic tumor cases analyzed in this study, the majority of lesions (42%) were under 5 cm in size, while 20% were larger than 10 cm. CT imaging revealed that 45% of tumors appeared hypodense without fat equivalence, whereas 30% exhibited iso- to hypodense characteristics with partial fat equivalence. Radiologically, 82% of tumors had smooth and well-defined margins, while 18% displayed nodular or ill-defined borders.

AML was diagnosed histologically in 12% of the cases, highlighting the challenge in differentiating these from other hepatic tumors on imaging alone. The radiological-histological correlation underscored the difficulty in preoperative diagnosis, particularly in fat-deficient AMLs, emphasizing the need for integrated diagnostic approaches combining imaging features and pathological confirmation (Table 1).

Table 1: Radiological and histopathological correlation of hepatic tumors (n=100).

Parameter	Number of patients (N)	Percentage (%)
Tumor size (cm)		
<5	42	42
5–10	38	38
>10	20	20
CT findings		
Hypodense (non–fat-equivalent)	45	45
Iso-/hypodense (partly fat-equivalent)	30	30
Isodense	25	25
MRI signal characteristics		
T1 hypointense	60	60
T1 hyperintense	18	18
T2 hyperintense	77	77
Mixed T1 signals	22	22
Vascularity (imaging)		
Hypervascular	58	58
Hypovascular	28	28
Isovascular	14	14
Tumor margin (radiological)		
Smooth and well-defined	82	82
Nodular/ill-defined	18	18
Fat content (imaging + histology)		
Present (partly fat/nests of lipocytes)	40	40
Absent (devoid of fat)	60	60
Histopathology diagnosis		
Angiomyolipoma	12	12
Hepatocellular carcinoma (HCC)	45	45
Hepatic adenoma	15	15
Focal nodular hyperplasia (FNH)	10	10
Lipoma/liposarcoma	6	6
Other benign lesions	12	12

DISCUSSION

Hepatic AMLs are rare mesenchymal tumors, with only about 100 cases reported in the literature. Imaging and histological features of hepatic AMLs are largely similar to their renal counterparts.[18] One distinguishing feature is the presence of extramedullary hematopoiesis, noted in about 40% of hepatic AMLs, unlike renal AMLs.[3] These foci are not integral to AML pathology but may reflect interactions with hepatic sinusoidal endothelium, as seen in other benign or malignant liver tumors.[4] Most hepatic AMLs are solitary, with multiplicity reported in only 6.7% of cases.[4,19,20] Their association with tuberous sclerosis (TS) ranges between 5.8–10%, with a higher incidence of multiple lesions.[3,4,8,21] The tumors predominantly affect females (63–83%), with ages ranging from 10 to 79 years and tumor sizes varying from 0.3 cm to 36 cm.[3,4]

Imaging modalities often provide non-specific findings for hepatic AMLs. Ultrasound typically shows inhomogeneous echotexture, and while Doppler ultrasound can differentiate renal AMLs.[20] Its role in hepatic AMLs remains uncertain. Hypervascularity is common, and angiography may reveal vascular blushes or arteriovenous (AV) shunting, though specificity remains low.[3,23-26] In our series, AV shunting was observed in one patient, aligning with earlier findings.[26] Advanced imaging such as CT and MRI with dynamic contrast can show early and prolonged enhancement in AMLs, but about 15% may be hypovascular.[2,3] In our cohort, three tumors were iso- or hypovascular. Liver-specific MRI contrast agents like Mn-DPDP (Teslascan) may help differentiate AMLs due to their lack of hepatocyte uptake and subsequent non-enhancement, in contrast to focal nodular hyperplasia or hepatocellular adenoma.[27,28] However, this absence of enhancement is not exclusive to AML and can be seen in other tumors such as dedifferentiated hepatocellular carcinoma and cholangiocarcinoma.[29,30]

Detection of intratumoral fat is often a key feature in diagnosing hepatic AMLs, but it is not consistently present. On CT, fat appears as areas with densities < ±20 HU, while MRI shows hyperintensity on T1 and T2-weighted images.[31,32] Nonetheless, fat is an unreliable marker, as hepatocellular adenomas and carcinomas may also contain fat, and some AMLs show minimal or no fat.[4,33] In our study, four patients had radiologically detectable fat, while histology revealed two tumors were entirely fat-deficient. Interestingly, one was a homogeneous, hypovascular lesion with benign features, while the other showed low malignant potential with a multinodular appearance, AV shunting, and a high proliferation index, highlighting the imaging diversity of fat-deficient hepatic AMLs.[15]

Histopathology alone may not provide a definitive diagnosis for hepatic AMLs, especially in fat-deficient or atypical cases. Immunohistochemical staining is critical, with AMLs showing positivity for HMB-45, a marker for premelanosome-associated glycoprotein.[4,34] This staining pattern distinguishes AMLs from other hepatic tumors, which are typically negative for HMB-45 but positive for keratin markers (KL1, AE1/AE3).[35] While hepatic AMLs are generally benign, rare malignant transformations have been reported, particularly in epithelioid variants.[15,17]

Limitations

A single-center design and a rather small sample size are among the drawbacks that could restrict how far the results can be applied. Furthermore, the little follow-up period might not accurately represent long-term results.

CONCLUSION

The study concluded that conservative management is usually recommended for asymptomatic, biopsy-confirmed AMLs, avoiding unnecessary surgery. Resection is justified for symptomatic or complicated tumors, with surgical intervention focused on minimizing tissue removal, as AMLs do not require safety margins or lymphadenectomy. Ultimately, accurate preoperative diagnosis, supported by close collaboration among clinicians, radiologists, and pathologists, is crucial for optimal management of hepatic tumors presenting with atypical imaging or histology, especially in non-cirrhotic livers where tumor markers remain normal.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Das S, Sahoo BB, Ghosh S. Radiological and histopathological correlation of hepatic tumors in computed tomography and magnetic resonance imaging. Int J Res Med Sci 2025;13:2823-7.