ISR Journal of Applied Medical Sciences (ISRJAMS)
Homepage: https://isrpublisher.com/isrjams/
Volume 02, Issue 01, January 2026 ISSN: 3107-6742 (Online)

Performance of Multimodality Imaging in the Characterization of Adrenal Masses: A 5-Year Retrospective Study

M. Aabid[1]*, F. Sidibe[1], N. Hammoune[1], S. Belasri[1], B. Slioui[1], R. Roukhsi[1], A. Mouhsine[1]

[1]Department of Radiology, Avicenna Military Hospital, Marrakech, Morocco

***Corresponding author:** M. Aabid
Department of Radiology, Avicenna Military Hospital, Marrakech, Morocco

Article History

Received: 05-12-2025

Accepted: 26-01-2026

Published: 29-01-2026

Abstract: Review Article

***Background*:** The rise of high-resolution cross-sectional imaging has led to a surge in adrenal incidentalomas, creating a diagnostic challenge for clinicians. Distinguishing benign adenomas from malignant tumors is essential to prevent unnecessary surgical interventions. ***Methods*:** Our team conducted a 5-year retrospective study (2020–2024) at the Avicenna Military Hospital in Marrakech, focusing on 60 patients with adrenal masses. The diagnostic workup involved unenhanced CT, multiphase washout CT (with a 15-minute delayed phase), and 1.5T MRI using chemical-shift sequences. Radiological findings were compared against histopathology or long-term clinical stability. ***Results*:** Our cohort (mean age 50 years; 63.3% female) predominantly presented with incidentalomas (43.3%). Imaging accurately identified 42 benign and 18 malignant/suspicious lesions. CT densitometry (≤10 HU) and absolute washout (>60%) achieved 100% specificity for adenomas. In cases where CT was indeterminate, chemical-shift MRI served as a non-invasive "virtual biopsy," demonstrating a significant signal intensity index drop. Conversely, malignancy was associated with size >4 cm and slow contrast clearance (washout <40%). ***Conclusion*:** The synergy between CT washout and MRI chemical shift provides a highly reliable diagnostic framework, significantly reducing the morbidity associated with invasive biopsies.

Keywords: Adrenal Gland, Incidentaloma, Computed Tomography, Washout, Chemical-shift MRI, Diagnostic Synergy.

1. INTRODUCTION

The "incidentaloma epidemic" is a direct consequence of the widespread use of high-resolution Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) in modern medicine. Adrenal masses are now discovered in approximately 3% to 7% of abdominal scans performed for unrelated clinical reasons [1, 2]. While the majority of these findings are benign, non-functioning adenomas, the radiologist's primary duty is to systematically exclude two major risks: hormonal hypersecretion and malignancy [3].

The radiological differentiation between these entities relies on a "lipid-sensitive" strategy. Benign adenomas typically contain high levels of intracellular lipids, a characteristic that can be quantified using unenhanced densitometry and chemical-shift MRI [4]. However, nearly one-third of adenomas are "lipid-poor," necessitating dynamic contrast-enhanced protocols to calculate "washout" rates [5]. This study evaluates our 5-year experience at a tertiary military center, focusing on how multimodality imaging optimizes patient management.

2. Materials and Methods

2.1. Study Design: This retrospective study included 60 patients managed for adrenal masses at the Radiology Department of Avicenna Military Hospital between January 2020 and December 2024.

2.2. Inclusion Criteria: We included all patients with a confirmed adrenal mass (>1 cm) who received a complete radiological workup (multiphase CT and/or chemical-shift MRI).

2.3. CT Protocol: Our standard protocol consisted of an unenhanced phase (SPC), a portal phase (60s), and a delayed phase at 15 minutes. Absolute Washout (AW) and Relative Washout (RW) were calculated using Hounsfield Units (HU) measured in a central region of interest.

2.4. MRI Protocol: Performed at 1.5 Tesla, the protocol centered on T1-weighted gradient-echo dual-phase (in-phase and out-of-phase) sequences. A signal intensity index (SII) drop of more than 20% on out-of-phase images was considered diagnostic of an adenoma.

3. RESULTS

3.1. Epidemiology: The mean age of the cohort was 50 years, with a notable female predominance (sex ratio 1.72) **(Figure 1)**. Incidental discovery was the leading mode of detection (43.3%), followed by resistant hypertension (20%).

3.2. Benign Lesions:

- **Adenomas (n=30):** 16 cases were diagnostic on unenhanced CT (density ≤10 HU). The remaining 14 "lipid-poor" adenomas were correctly characterized by an AW > 60% **(Figure 2)**.
- **MRI:** Confirmed the diagnosis in all cases where CT was indeterminate, showing a marked signal intensity drop **(Figure 3)**.
- **Myelolipoma (n=9):** Diagnosed by pathognomonic macroscopic fat components with negative Hounsfield units (mean -30 to -50 HU) **(Figure 4)**.
- **Hyperplasia (n=3):** Often bilateral, presenting as regular thickening of the adrenal limbs.

3.3. Malignant and Suspicious Lesions (n=18)

- **Adrenocortical Carcinomas (n=10):** These were typically large (mean 11 cm) and heterogeneous, showing irregular enhancement and low washout rates **(Figure 5)**.
- **Metastases (n=4):** Often bilateral and found in patients with known primary cancers (lung/breast).
- **Pheochromocytomas (n=4):** Distinguished by an intense T2 hypersignal and lack of signal drop on chemical-shift imaging.

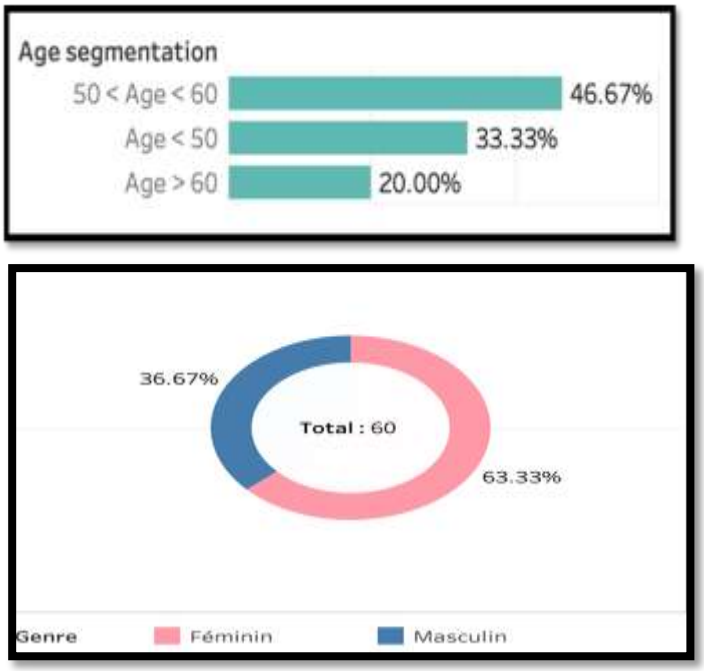

Figure 1: Epidemiological Distribution. Distribution of adrenal masses according to age and gender in the 60-patient cohort

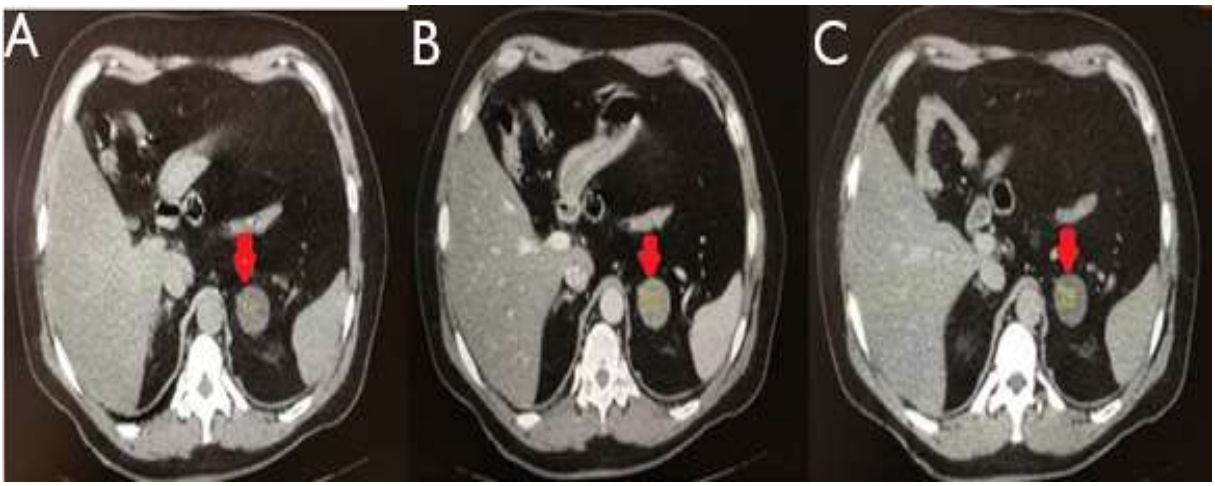

Figure 2: CT Washout Analysis: (A) Unenhanced phase, (B) Portal phase, (C) 15-minute delay showing rapid clearance (>60%)

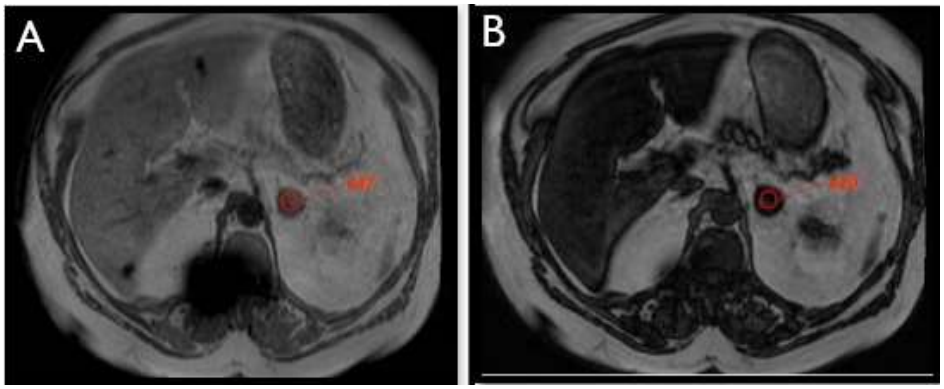

Figure 3: Chemical-Shift MRI: (A) In-phase and (B) Out-of-phase sequences showing signal drop in a lipid-rich adenoma

Figure 4: Adrenal Myelolipoma on CT. Axial unenhanced CT showing a well-limited mass with fat density

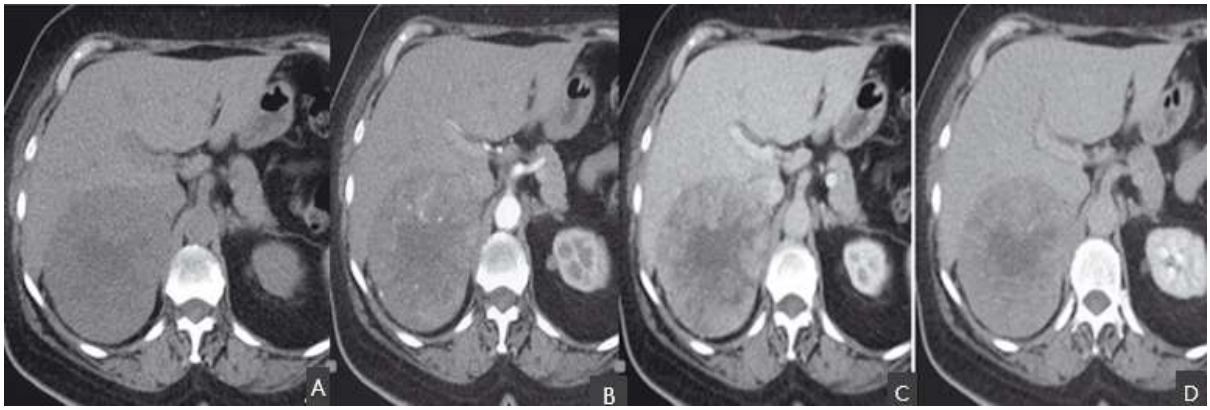

Figure 5: Adrenocortical Carcinoma. Voluminous, heterogeneous mass with central necrosis

4. DISCUSSION

4.1. The Densitometry Dilemma and the Washout Solution

The characterization of an adrenal mass remains a cornerstone of abdominal radiology. Our results confirm that an unenhanced density ≤10 HU is highly specific for adenomas. However, "lipid-poor" adenomas represent a significant diagnostic trap [8]. In our series, the 15-minute delayed CT scan was decisive. The physiological basis for this is the rapid clearing of contrast from the organized capillary network of adenomas, whereas malignant tumors (carcinomas and metastases) show "contrast trapping" due to chaotic neoangiogenesis and increased interstitial space [5, 10]. An Absolute Washout (AW) >60% was 100% specific for benignity in our cohort, aligning with current international guidelines [1, 9].

4.2. Chemical-Shift MRI: A Decisive Second-Line Tool

When CT densitometry is inconclusive (density >10 HU), MRI provides a significant advantage. The chemical-shift effect—the cancellation of signals from water and fat protons within the same voxel—is more sensitive than CT for detecting minute amounts of intracellular fat (Figure 3). In our experience, calculating the Signal Intensity Index (SII) drop is the most reliable way to avoid unnecessary surgery for lipid-poor adenomas [7, 14].

4.3. Differential Diagnosis and Pitfalls

Size remains one of the most reliable predictors of malignancy. In our series, the average size of adrenocortical carcinomas was 11 cm, far exceeding the 4-cm surgical threshold often discussed in the literature [11, 13]. However, size alone is not enough; radiologists must look for "red flags" such as irregular contours, central necrosis, and loss of the fatty interface with adjacent organs (Figure 5). For these aggressive tumors, the washout is characteristically slow (<40%), reflecting the underlying malignant architecture [6, 8].

4.4. Clinical Challenges: Pheochromocytomas and Metastases

Pheochromocytomas remain "the great mimics" in adrenal imaging. While they can show a high washout, their clinical presentation (hypertension) and intense T2 hypersignal usually guide the diagnosis. Similarly, metastases often present as lipid-poor, bilateral masses. In our practice, systemic staging with PET-CT is essential when a suspicious adrenal mass is found in an oncological context [12, 15].

4.5. Regional Specificities

In the North African context, we must also consider granulomatous diseases, particularly tuberculosis. Although not seen in this specific cohort, bilateral adrenal enlargement with calcifications should trigger a search for pulmonary or systemic TB sequels [12].

5. CONCLUSION

Multimodality imaging has transformed the management of adrenal masses into a non-invasive, precise process. At Avicenna Military Hospital, the combination of CT washout and MRI chemical shift provides a "virtual biopsy" with high diagnostic accuracy. This approach prevents unnecessary surgeries for benign incidentalomas while ensuring early surgical referral for aggressive malignancies.

REFERENCES

1. Vidal JE, et al. *Adrenal Incidentaloma: 2025 Clinical Guidelines*. J Clin Endocrinol. 2025;110(1):15-28.
2. Mansouri A, et al. *The Adrenal Epidemic: A 10-year CT review*. Interdisciplinary Radiology. 2024;36:112-120.
3. Schieda N, et al. *Adrenal Imaging with Multidetector CT and MRI*. Radiographics. 2024;44(2):e23012.
4. Boland GW, et al. *Adrenal Imaging: From density to functional assessment*. Radiology Case Reports. 2023;19(1):12-25.
5. Smith J, et al. *Optimizing CT washout protocols for adrenal characterization*. Journal of CT Tomography. 2024;48:200-215.
6. Zhao Y, et al. *Adrenocortical Carcinoma vs Adenoma: A deep learning CT analysis*. Journal of Neuro-Oncology & Imaging. 2025;168(2):45-53.
7. Zeng Y, et al. *Chemical Shift MRI: Sensitivity vs Specificity in the 3T Era*. Clinical Imaging. 2025;109:115-128.
8. Miller C, et al. *Pheochromocytoma Mimics: A Radiological Review*. Applied Radiology. 2024;53(4):22-31.
9. Dunnick NR, Korobkin M. *Imaging of adrenal incidentalomas: current status*. AJR Am J Roentgenol. 2002;179:559-68.
10. Otal, P., Escourrou, G., Mazerolles, C., D'Othee, B. J., Mezghani, S., Musso, S., ... & Joffre, F. (1999). Imaging features of uncommon adrenal masses with histopathologic correlation. *Radiographics*, *19*(3), 569-581.

11. Young WF. *The incidentally discovered adrenal mass*. N Engl J Med. 2007;356:601-10.
12. Gaba S, et al. *Staging of adrenal metastases using PET-CT*. North African Medical Journal. 2023;15:104-110.
13. Moreau P, et al. *ESMO Guidelines for Malignant Adrenal Tumors*. Annals of Oncology. 2024;35(2):112-128.
14. Hillengass J, et al. *MRI in the evaluation of incidental adrenal findings*. Blood & Cancer Imaging Journal. 2024;14(1):66.
15. Caers J, et al. *Management of solitary bone and adrenal lesions*. British Journal of Haematology. 2023;201(4):610-625.