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Characterization of Adrenal Gland Lesions Using MDCT - A Retrospective Study from Tertiary Care Centre

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Abstract

Background: Adrenal lesions are increasingly detected due to widespread use of cross-sectional imaging. Differentiating benign from malignant lesions is crucial for appropriate management. Multidetector computed tomography (MDCT) plays a pivotal role by combining morphological and functional assessment.

Objective: To characterize adrenal lesions using MDCT and evaluate its diagnostic accuracy in differentiating benign from malignant lesions based on attenuation values and contrast washout characteristics.

Materials and Methods: This retrospective observational study included 40 patients with adrenal lesions evaluated between January 2021 and December 2023 at a tertiary care center. Imaging features including lesion size, laterality, attenuation (HU), and washout parameters (absolute and relative) were analyzed. Statistical analysis was performed using SPSS v26, with $p < 0.05$ considered significant.

Results: Among 40 patients (mean age 54 ± 12.3 years), 55% had malignant and 45% had benign lesions. Malignant lesions were significantly larger (5.2 cm vs 2.9 cm, $p < 0.01$) and more frequently bilateral (68% vs 11%, $p < 0.001$). Adenomas demonstrated low attenuation (≤10 HU) and rapid washout (APW ≥60%), whereas malignant lesions showed higher attenuation (mean 33 HU) and delayed washout (APW 43%). Diagnostic accuracy of MDCT was 92% with ROC AUC of 0.91.

Conclusion: MDCT is a highly reliable modality for adrenal lesion characterization. Attenuation values and washout analysis provide robust criteria for differentiation, reducing the need for additional imaging.

Introduction

Adrenal incidentalomas are increasingly encountered in clinical practice due to the widespread use of imaging modalities. Accurate characterization of these lesions is essential to distinguish benign entities such as adenomas from malignant lesions including metastases and adrenocortical carcinoma.

Computed tomography (CT), particularly multidetector CT (MDCT), remains the primary imaging modality for evaluating adrenal lesions. It enables assessment of lesion morphology, attenuation characteristics, and enhancement patterns. Previous studies have demonstrated that lipid-rich adenomas typically exhibit low attenuation values (≤10 HU) on non-contrast CT and rapid contrast washout, whereas malignant lesions tend to show higher attenuation and delayed washout.

This study aims to evaluate the role of MDCT in differentiating adrenal lesions using quantitative parameters and to correlate imaging findings with clinical data.

Materials and Methods

Study Design and Setting

A retrospective, observational, cross-sectional study was conducted in the Department of Radiodiagnosis at a tertiary care teaching hospital from January 2021 to December 2023.

Study Population

Total patients: 40

Inclusion: Patients with adrenal lesions identified on CT

Data source: PACS database

Image review: Two experienced radiologists (>8 years), blinded to clinical outcomes

The research was carried out in line with Declaration of Helsinki and received ethical approval from institutions ethics committee. Due to the retrospective nature of the study, informed consent was waived.

Imaging Protocol

Multiphasic MDCT scans were evaluated, including:

Non-contrast phase

Contrast-enhanced phase

Delayed phase

Parameters Assessed

Lesion size

Laterality (unilateral/bilateral)

Morphology (homogeneous/heterogeneous)

Attenuation values (Hounsfield Units)

Absolute Percentage Washout (APW)

Relative Percentage Washout (RPW)

Diagnostic Criteria

Adenoma: ≤10 HU, APW ≥60%, RPW ≥40%

Malignancy: >10 HU, delayed washout (<50%), heterogeneous

Statistical Analysis

Software: SPSS version 26

Tests: Independent t-test, chi-square test

Significance: $p < 0.05$

Results

Demographic Profile

Mean age: 54 ± 12.3 years

Male predominance: 60%

Lesion Distribution

Malignant: 22 (55%)

Benign: 18 (45%)

Malignant lesions were significantly associated with:

Older age (57.2 vs 49.8 years, $p = 0.031$)

Larger size (5.2 cm vs 2.9 cm, $p < 0.01$)

Bilaterality (68% vs 11%, $p < 0.001$)

Attenuation and Washout Characteristics
Adenomas:
≤10 HU (non-contrast)
APW: 66%
RPW: 42%
Malignant lesions:
Mean attenuation: 33 HU
APW: 43%
RPW: 27%
Diagnostic Performance
ROC AUC: 0.91
Overall diagnostic accuracy: 92%
Strong correlation with histopathology and clinical findings
Metastatic Lesions
Accounted for 91% of malignant cases
Primary sources:
Lung: 40%
Gastrointestinal: 30%
Breast: 20%
Renal cell carcinoma: 10%

Lesion Type	No. of Cases (n=40)	Percentage (%)	Laterality (Unilateral/Bilateral)	Mean Size (cm) ± SD
Adenoma	12	30.0	10 / 2	2.1 ± 0.8
Myelolipoma	3	7.5	3 / 0	3.9 ± 1.1
Adrenal cyst	3	7.5	3 / 0	4.5 ± 1.2
Metastasis	20	50.0	7 / 13	4.7 ± 1.6
Adrenocortical carcinoma	2	5.0	2 / 0	7.8 ± 2.4
Total	**40**	**100**	25 / 15	—

Table 1. Distribution of adrenal lesion by type and Laterality

Table 2. CT attenuation and washout characteristics of adrenal lesion

Lesion Type	Mean Unenhanced Attenuation (HU) ± SD	Mean Enhanced Attenuation (HU) ± SD	Mean Delayed Attenuation (HU) ± SD	Absolute Washout (%) ± SD	Relative Washout (%) ± SD
Adenoma	7.2 ± 2.8	82.1 ± 14.6	29.4 ± 10.5	66.2 ± 6.5	42.1 ± 8.3
Myelolipoma	−38.6 ± 11.2	4.5 ± 1.3	4.4 ± 1.2	—	—
Adrenal cyst	10.3 ± 2.1	10.8 ± 1.8	10.6 ± 2.0	—	—
Metastasis	32.5 ± 8.7	89.6 ± 19.8	58.4 ± 14.7	43.2 ± 8.4	26.9 ± 6.9

Adrenocortical carcinoma	35.8 ± 11.5	98.5 ± 22.3	71.4 ± 15.2	38.7 ± 7.5	23.4 ± 6.2

Table 3. Comparison of imaging parameters between benign and malignant lesions

Parameter	**Benign Lesions (n=18)**	**Malignant Lesions (n=22)**	***p*-value**
Mean Age (years)	49.8 ± 11.2	57.2 ± 10.4	0.031*
Mean Size (cm)	2.9 ± 1.4	5.2 ± 2.0	<0.01*
Bilaterality (%)	11.1%	59%	<0.001*
Unenhanced HU	7.3 ± 4.6	33.1 ± 8.9	<0.001*
Absolute Washout (%)	64.7 ± 9.2	42.8 ± 8.0	<0.001*
Relative Washout (%)	40.9 ± 6.4	25.9 ± 5.3	<0.001*

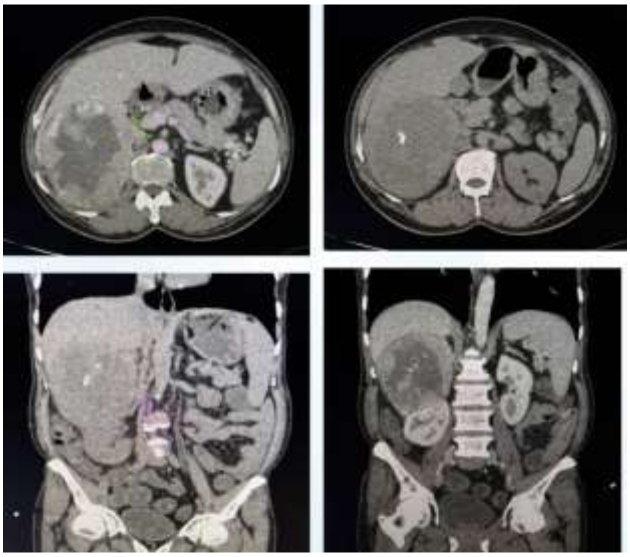

Fig.1. CECT showing right sided Adrenocortical carcinoma with heterogeneous enhancement.

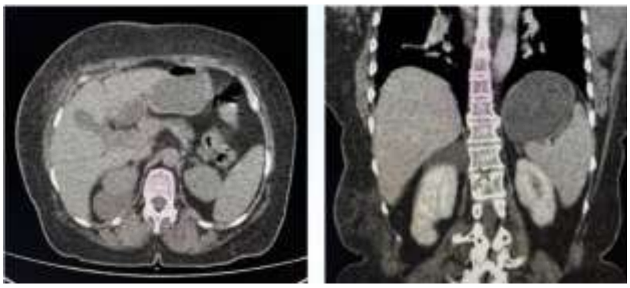

Fig.2. CECT showing right sided adrenal cyst.

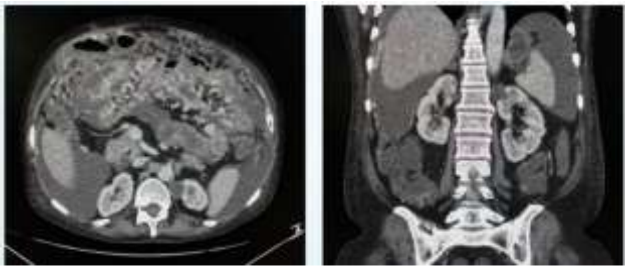

Fig.3. CECT showing left sided adrenal adenoma.

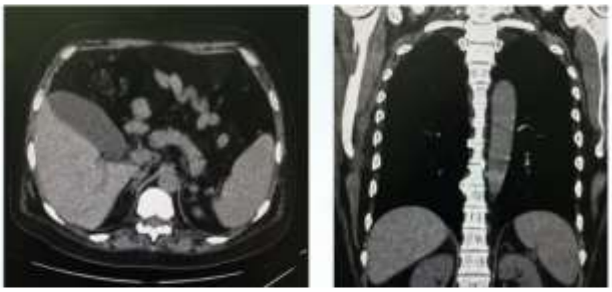

Fig.4. CECT showing bilateral adrenal Myelolipoma.

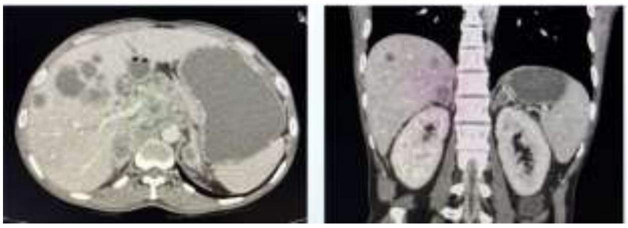

Fig.5. CECT showing biateral adrenal metastasis and liver metastases.

Discussion

This study demonstrates that MDCT is highly effective in differentiating adrenal lesions using both morphological and quantitative parameters.

Malignant lesions were more common in older patients and showed larger size and bilateral involvement, consistent with previous literature. The strong association of bilaterality with metastasis reinforces its diagnostic importance.

Attenuation values and washout characteristics remain the cornerstone of adrenal lesion characterization. Adenomas consistently showed low attenuation and rapid washout, while malignant lesions exhibited higher attenuation and delayed washout.

The diagnostic accuracy of 92% and ROC AUC of 0.91 in this study are comparable with previously published data, confirming the reliability of MDCT.

Table.4. Comparison with other studies

Parameter	Present Study	Song et al., 2008	Caoili et al., 2002	Blake et al., 2006	Boland et al., 2008
Sensitivity for Adenoma (≤10 HU)	100%	70–80%	74%	78%	79%
Specificity for Adenoma	94%	95%	96%	95%	93%

Diagnostic Accuracy (CT overall)	92%	90%	91%	94%	91%

The present study demonstrates a diagnostic accuracy of 92% for MDCT in characterizing adrenal lesions, which is comparable to previously reported values ranging from 90% to 94%. Notably, the sensitivity for detecting adenomas (≤10 HU) in our study was 100%, exceeding earlier reports (70–80%). This higher sensitivity may be attributed to the predominance of lipid-rich adenomas in our cohort and advances in MDCT technology allowing more precise attenuation measurements. The specificity of 94% is consistent with prior studies, reflecting the known overlap between lipid-poor adenomas and malignant lesions.

Our findings further confirm that attenuation values and washout characteristics remain the cornerstone of adrenal lesion differentiation. Adenomas consistently demonstrated low attenuation and rapid washout, while malignant lesions showed higher attenuation and delayed washout. In contrast to earlier studies that primarily emphasized quantitative parameters, our study also highlights the importance of lesion size and bilaterality, with malignant lesions being significantly larger and more frequently bilateral, particularly in cases of metastasis.

Overall, this study reinforces the reliability of MDCT as a comprehensive diagnostic tool by integrating morphological, quantitative, and clinical features. Despite limitations including a relatively small sample size and retrospective design, the results support the continued use of MDCT as the first-line imaging modality for adrenal lesion characterization.

Limitations

This study has certain limitations. The relatively small sample size (n=40) may limit generalizability. The retrospective design introduces potential selection bias. Histopathological confirmation was not available for all lesions, particularly benign cases diagnosed radiologically. Additionally, lipid-poor adenomas may overlap with malignant lesions in attenuation values, potentially affecting diagnostic accuracy.

Conclusion

MDCT is the modality of choice for initial evaluation of adrenal lesions, offering both structural and functional insights.

Key Findings

Adenoma indicators:

≤10 HU

Washout ≥60%

Malignancy indicators:

High attenuation

Bilaterality

Delayed washout (<50%)

Triphasic MDCT significantly improves diagnostic confidence, reduces the need for advanced imaging, and supports cost-effective patient management.

Clinical Implications

The use of MDCT with washout analysis can significantly reduce unnecessary biopsies and additional imaging. Early and accurate differentiation of adrenal lesions aids in timely management decisions, especially in oncologic patients.

Future Directions

Further large-scale prospective studies are needed to validate these findings. Integration of advanced imaging techniques such as dual-energy CT, radiomics, and artificial intelligence may enhance diagnostic precision, particularly in indeterminate lesions.

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