ORIGINAL RESEARCH PAPER

Radiology

ROLE OF MDCT IN DIFFERENTIATION OF ADRENAL MASSES: ASSESSING THE UTILITY OF WASHOUT IMAGING

KEY WORDS: Contrast Enhanced MDCT (Multi Detector Computed Tomography), adrenal lesions.

Dr. Maniesh Bhagat — Professor and head of radiodiagnosis, Sri Aurobindo Institute of Medical Sciences and Post Graduate Institute, India

Dr. Akash chaturvedi* — Resident, Sri Aurobindo Institute of Medical Sciences and Post Graduate Institute, India*Corresponding Author

ABSTRACT

Aim: To assess the role of Contrast Enhanced Multi-detector Computed Tomography in evaluation of adrenal masses. Objectives: 1. To evaluate the accuracy of the washout in the differential diagnosis between adenomas and nonadenomas and to compare the obtained results in delayed CT scans at 5, 10 and 15 minutes. **Methods:** This was a prospective, cross-sectional study. The study included 50 patients clinically suspected case of adrenal lesions and were subjected to Contrast Enhanced MDCT examination. Absolute and relative wash-out percentage values (APW and RPW) were calculated. **Results:** Differential diagnosis between adenomas and non-adenomas was obtained in 48/50 (96%) cases, with sensitivity, specificity, and accuracy values of 96%, 95%, and 96%, respectively. **Conclusion:** The evaluation of the wash-out values in CT scans performed at 5 , 10 , and 15 provides comparable diagnostic results. CT scans performed at 5 are, therefore, to be preferred, since they reduce the examination time and patient discomfort.

INTRODUCTION

In recent years, the detection of adrenal expansive lesions during CT examinations has become common, even in patients without endocrinological symptoms, because of the increasing number of investigations carried out for different clinical problems, with a prevalence varying from 0.35% to 9% in different series [1,2].

After recognizing an expansive adrenal lesion, the differentiation between adenomas and nonadenomas becomes crucial for patient's prognosis and for the choice of the therapeutic approach [3–6].

The role of CT for differential diagnosis has been studied in numerous investigations, and the accuracy of CT scans before and after injection of contrast material has been reported, even using dual energy CT scanners [7].

In case of unenhanced CT scans, intralesional density values of less than 10 HU indicate an adenoma with high accuracy. In contrast, intralesional density values greater than 10 HU are more common in nonadenomas, but they cannot exclude the possibility of adenomas with low-intra-cytoplasmic fat content [8–11].

CT scans after injection of contrast material mainly offer the evaluation of the peak density and intralesional washout for differential diagnosis between adenomas and nonadenomas. There is no unanimous agreement in the literature for the optimal scan delay to evaluate this parameter; according to some authors, the optimal delay is represented by 10 minutes after intravenous injection of contrast material, to others 15 minutes, and according to other experiences, earlier CT scans performed at 5 minutes can be used in this field [12–21]. The purpose of this study is to evaluate the accuracy of the wash-out in the differential diagnosis between adenomas and nonadenomas and to compare the results obtained in CT scans performed at 5, 10, and 15 minutes after intravenous injection of contrast material

MATERIALS AND METHOD

Prospective Cross- sectional study was carried out from 1st April 2021 to 30th September 2022 in the department of Radiodiagnosis, SAMC & PG Institute, Indore. Patients with clinical presentation of pain in abdomen and vague symptom of raised blood pressure, palpitations were referred from various department of our institute to the department of Radio diagnosis, were subjected to CECT examination after taking written informed consent and data were recorded. The final study population of our study was 50.

Inclusion criteria

Patients with clinical suspicious cases of adrenal mass referred for CECT abdomen study with in the study duration

Exclusion criteria

The following patients will be excluded from the study -
1. Patients who are not willing to give consent.
2. Pregnant female.
3. Elevated serum creatinine level > 1.5 mg/dl.
4. Patients with sensitivity to contrast agent (Allergic reactions).

Patients was recruited in the study on pro-data basis and all the patients participating in the study were explained clearly about the purpose and nature of the study in the language they can understand and written informed consent was taken before including them in the study. Patients with clinical suspicion of having adrenal masses were further evaluated with CT scan. The CT scan examinations were performed using a SIEMENS 64 slice multidetector CT scanner (somatom definition AS).

CECT was perform after injecting maximum of 100 mL of non-ionic iodinated contrast medium: Omniscan/Iohexol (iodine concentration, 300 mg/mL) through an 18-20-gauge intravenous cannula at a rate of 3 mL/sec followed by a 20 ml saline flush at a rate of 2 ml/sec. Scanning in the arterial phase (scan time 20.5 sec.) After 60 sec from the contrast given, venous phase scanning (scan time 20.5 sec.) was done.

Coronal and sagittal reformation of the images was obtained with use of maximal intensity projection (MIP), Multiplanar Reformation (MPR) and volume rendering technique (VRT). The axial as well as reformatted coronal and sagittal images was evaluated.

Axial and reconstructed images were analyzed and the following parameters were considered:

(i) densitometry of the lesion in unenhanced scans;

(ii) densitometry after contrast material injection, assessed by applying a large round or oval region of interest (ROI) excluding any calcification, areas of necrosis, or cystic degeneration;

(iii)absolute intralesional percentage wash-out (APW) in scans at 5 ,10 ,and 15 ;

(iv)relative intralesional percentage wash-out (RPW) in scans at 5 ,10 ,and 15 .

In order to calculate the APW and RPW values, the following formulas were used, respectively: APW = 100 ([EA-DA]/[EA-PA]); RPW = 100 ([EA-DA]/[EA]), where EA = early-phase post contrast attenuation; DA = delayed-phase post contrast attenuation; PA = pre contrast attenuation. An APW of more than 60% and an RPW of more than 40% were considered significant for adenoma, independently from the used scan delay [12].

The findings were recorded on pre-structured proforma for the study and descriptive statistics were carry out for identification of characteristics of the collected data.

RESULT

Mean densitometric values for each type of lesion are reported in Tables 1 and 2. The densitometric values of the adenomas in unenhanced scans ranged between 6 and 19.4 HU (mean 4.6 HU; standard deviation 0.9). In particular, density values of less than 10 HU were found in 16 out of 22 (72.7%) cases; values of more than 10 HU were found in 6 out of 22 (27.3) cases. During the study period, a total of 25 patients, who fulfilled the selection criteria, were included in the present study. The age distribution was from 1-75 years and this followed a normal distribution curve. The most common affected age group was of 40-60 years (8, 32%) followed by >60 years (7, 28%), and others (Table 1). The group studied included 16 males and 19 females making 64.00% and 36.00%, respectively

TABLE 1: MEAN DENSITOMETRIC VALUES OBTAINED IN GROUP 1.

	ADENOMAS	NON ADENOMAS
MEAN DENSITY IN UNENHANCED PHASE(HU)	3	31,4
MEAN DENSITY IN PORTAL PHASE(HU)	76,8	85,9
MEAN DENSITY IN 5' DELAYED PHASE (HU)	24,8	66,1
MEAN DENSITY IN 10' DELAYED PHASE (HU)	21	61,3
5' MEAN APW	69,80%	25,10%
5' MEAN RPW	67,20%	15,80%
10' MEAN APW	75,90%	33,50%
10' MEAN RPW	73,51%	20,50%

TABLE 2: MEAN DENSITOMETRIC VALUES OBTAINED IN GROUP 2.

	ADENOMAS	NON ADENOMAS
MEAN DENSITY IN UNENHANCED PHASE(HU)	5,27	27,1
MEAN DENSITY IN PORTAL PHASE(HU)	80,2	61,3
MEAN DENSITY IN 5' DELAYED PHASE (HU)	32,58	53,66
MEAN DENSITY IN 10' DELAYED PHASE (HU)	24,35	53,66
5' MEAN APW	63,06%	22,05%
5' MEAN RPW	54,65%	12,51%
10' MEAN APW	73,81%	35,50%
10' MEAN RPW	65,57%	19,95%

Non-adenomas presented an unenhanced density from between 14 and 43.9 HU (mean 29.5 HU; standard deviation 9.2).

After intravenous injection of contrast material, in the portal venous phase, adenomas showed a mean enhancement of 77.5 HU (range 38.2 to 132.4 HU), while non-adenomatous lesions a mean value of 75.4 HU (range 38.2–188.1 HU).

Among the group of patients studied at 5 and 10 minutes, in the scans at 5 , the mean values of APW for adenomas ranged between 61% and 79.2% (mean: 69.8%) and in the scans at 10 , between 72.7% and 80.7% (mean: 75.9%). Non-adenomas ranged between 0.7% and 60.3% (mean: 25.1%) at 5 and between 10.5% and 70.5% (mean: 33.5%) at 10 (Figure 1). The values of RPW for adenomas ranged between 57.9% and 78.8% (mean 67.2%) at 5 and between 62.9% and 82.1% (mean 73.5%) at 10 . For non-adenomas, RPW ranged between 0.4% and 52.5% (mean 15.8%) at 5 and between 5.3% and 61.4% (mean 20.5%) at 10 .

Fig 1 : CECT axial images showing an ill heterogeneously enhancing defined hypodense lesion in left adrenal gland- s/o Pheochromocytoma. It has Unenhanced attenuation values: 43,9 +- 41HU. Absolute percentage wash-out at 5 : 9%. Relative percentage wash-out at 5 : 3,9%. Absolute percentage wash-out at 10 : 12,5%. Relative percentage wash-out at 10 : 5,3%

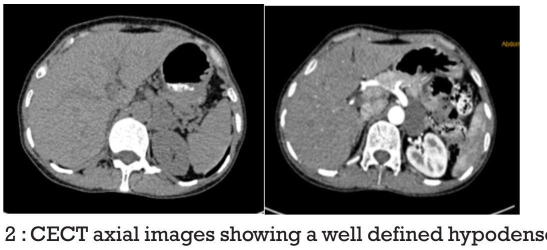

Fig 2 : CECT axial images showing a well defined hypodense lesion in left adrenal gland – s/o adrenal adenoma. It has unenhanced attenuation values: 19,8 HU. Absolute percentage wash-out at 5 : 65,3%. Relative percentage wash-out at 5 : 55,8%. Absolute percentage wash-out at 15 : 82,5%. Relative percentage wash-out at 15 : 70,4%.

Basing on the wash-out of the examined lesions, a differential diagnosis between adenomas and non-adenomas was obtained in 48/50 (96%) cases, with sensitivity, specificity, and diagnostic accuracy values of 96%, 95%, and 96%, respectively. In particular, APW and RPW provided comparable results, and densitometric values obtained by using different scan delays did not cause significant diagnostic changes.

Among the two cases of incorrect diagnosis, one was the case of an adrenal metastasis from renal cell carcinoma in which the obtained wash-out values were significant for adenoma. In particular, APW values of 60.3% at 5 and 70.5% at 10 were obtained in this patient, and 52.5% at 5 and 61.4% at 10 were found for RPW. The second case was represented by a lipid-poor adenoma in which the obtained wash-out values were significant for non-adenoma. In particular, APW was 35.6% at 5 and 44.2% at 15 , while the RPW was 31.3% at 5 and 39.4% at 15 .

DISCUSSION

The detection of adrenal expansive lesions during CT examination is frequent, with a prevalence varying between 0.35% and 9% in different series [1, 2]. In 50%–80% of cases, they are represented by adenomas, whereas nonadenomas are most often represented by metastases, adrenal carcinomas (<5%), pheochromocytomas (5%), myelolipomas (5%–10%), and cysts (1%–5%) [22–24]. The metastases originate more often from carcinomas of the lung, breast, kidney, thyroid, colon, and melanoma and represent 20%–50% of adrenal masses diagnosed in patients with known neoplastic disease [3, 22, 25]. The differential diagnosis between adenomas and nonadenomas with imaging techniques is of particular importance for an adequate prognostic and therapeutic approach, being able to avoid the use of invasive procedures such as biopsy or unnecessary prolonged followup.

In the differentiation between adenomas and nonadenomas, morphological, histological, and physiological criteria are usually used.

The morphological criteria considering the size and the homogeneous or inhomogeneous appearance of the lesion provide useful elements for differential diagnosis between adenomas and nonadenomas but need to be always combined with other parameters. In particular, adenomas are most often lesions with regular margins, small in size, with a mean value of less than 3 cm, and have a homogeneous density. In autopsy series, only 2% of adrenal adenomas had a diameter greater than 4 cm and 0.03% over 6 cm. Metastases, carcinomas, and pheochromocytomas, on the contrary, have more frequently a diameter larger than 4 cm, irregular contours, and an inhomogeneous appearance for the presence of areas of necrosis, hemorrhage, and intralesional cystic degeneration [3, 5, 6, 23, 24, 26].

In our experience, the unenhanced scans were significant for the differential diagnosis between adenomas and nonadenomas in 75% of cases, and these data are substantially similar to those reported in the literature. In no case of nonadenomas, a basal density value of less than 10 HU was found.

The morphological criteria represent, therefore, an important parameter of evaluation but have some limitations. (I) They do not allow a diagnostic orientation in case of lipid-poor adenomas (approximately 30% of cases), which have a density greater than 10 HU. (ii) Unenhanced CT scans are often not used in the followup of cancer, and therefore the histological criteria cannot be evaluated. (iii)The possibility exists that an adrenal carcinoma contains foci of intracytoplasmic lipids [25], as well as exceptionally metastatic from clear cell renal carcinoma and hepatocellular carcinoma [3].

The physiological criteria are represented by the vascular enhancement and the washout of the lesion.

Regarding the intralesional wash-out, in 1989, Krestin et al. evaluated 38 adrenal masses by using MRI with Gd-DTPA and firstly emphasized that adenomas and nonadenomas could be differentiated on this basis, highlighting a more rapid wash-out of contrast material in case of adenomas compared with pheochromocytomasand malignancies, which tend to retain the contrast material for a longer period [26]. Numerous studies have subsequently emphasized the role of the analysis of intralesional washout in late CT scans after intravenous injection of contrast material, although there is no agreement yet on the timing of image acquisition and the values of wash-out to be considered significant for the differential diagnosis.

Some authors have evaluated the contribution of the late scans performed at 15 after the injection of contrast material, reporting a sensitivity and specificity of 79%–89% and 92%–96% for APW values of more than 60% and a sensitivity and a specificity of 82%–83% and 92%–93% for RPW values of more than 40% [14–17]. Other researchers experienced the use of scans at 10 and 5 minutes in order to obtain a simplification and a reduction of execution times for CT examinations. Blake et al. evaluated 122 adrenal masses by using a protocol that included CT scans in 10 , with a threshold value of 52% for the APW and 37.5% for the RPW, and reported a sensitivity and specificity of 100% and 98%, respectively [18].

In a series of 323 adrenal lesions, Sangwaiya et al., always using a delay of 10 and considering different threshold values for APW and RPW, obtained different results and reported sensitivity, specificity, and accuracy values, respectively, of 52.1%–71.3%, 80%–93.3%, and 64%–71.7% for APW and of 55.7%–81.4%, 93.7%–100%, and 57.9%–82% for RPW. According to these authors, anticipating the acquisition of delayed scans would not provide sufficient time for the wash-out of the adenomas to be completed; so, the scans at 10 minutes would not be effective in clinical practice [20]. Even regarding the wash-out estimated at 5 , there are conflicting opinions in the literature. Kamiyama et al. and Foti et al. reported accuracy values greater than 90% [19, 21], while Taffel et al., in a recent review, suggested that the further reduction of the acquisition time of late scans at 5 minutes would decrease significantly the sensitivity of the test, limiting the clinical value [3].

To our knowledge, in a single paper already reported in the literature, washout curves evaluated by late scans acquired at intervals of 5 , 10 , 15 , 30 , and 45 were compared, and the authors concluded that a significantly more rapid wash-out for adenomas, compared to nonadenomas, was already evident at 5 , but the authors suggested the use of scans at 15 , being associated with higher sensitivity and specificity values for differential diagnosis (88%–96% for a 60% APW and 96%–100% for a 40% RPW), although no hypothesis in support of the proposed method was reported in this research [12].

Our results confirm the importance of wash-out in the differentiation between adenomas and nonadenomas, with sensitivity, specificity, and diagnostic accuracy values of 96%, 95%, and 96%, respectively. As proposed by Korobkin et al., our results have been obtained by considering APW of more than 60% and RPW of more than 40% as significant for adenomas [12].

The comparison of the wash-out calculated in CT scans at 5 and 10 (group 1) and at 5 and 15 (group 2) showed small variations of the obtained values and not significant changes for diagnostic accuracy, with high correlation between the APW and RPW.

In particular, in the first group of patients, the mean value of APW for adenomas was equal to 69.8% at 5 and 75.9% at 10 . For nonadenomas, it was 25.1% at 5 and 33.5% at 10 . The mean value of RPW for adenomas was 67.2% at 5 and 73.5% at 10 , while for nonadenomas, it was 15.8% at 5 and 20.5% at 10 .

In the second group of patients, by considering scans performed at 5 and 15 , mean values of APW of 63% at 5 and 73.8% at 15 and mean values of RPW of 54.6% at 5 and 65.5% at 15 emerged for adenomas. In case of nonadenomas, mean values of APW and RPW were, respectively, equal to 22% and 12.5% at 5 and to 35.5% and 19.9% at 15 .

In our experience, the densitometric changes useful for differential diagnosis, therefore, were already evident at 5 and did not significantly change at 10 and 15 . Even in the case of adrenal metastasis misdiagnosed as adenoma, values of absolute and relative wash-out significant for adenoma were observed both in the scans at 5 and 10 , as also in the case of the unrecognized adenoma, in which densitometric values significant for nonadenoma were detected both in the scans performed at 5 and 15 . It should be emphasized that in these two patients, neither unenhanced CT scans were significant for a correct diagnosis. The possibility that nonadenomatous lesions can mimic contrastographic features of adenomas is described in the literature especially in case of pheochromocytomas, which in the series reported by Park et al. showed an APW of more than 60% in delayed scans in 16% of cases [30].

Our research has important limitations essentially represented by the small number of considered patients, and, anyway, it does not contribute to the knowledge regarding the pathophysiology of the more rapid wash-out for adenomas than for nonadenomas. Our results, however, seem to confirm the hypothesis that such behavior is determined by an alteration of capillary permeability in case of nonadenomas, responsible for a prolonged intralesional persistence of contrast material [13]. In case of adenomas, capillary permeability is instead not changed, and the washout is rapid and therefore already evident at 5 and does not progress significantly in later CT scans

CONCLUSION

Multidetector computed tomography represents an extremely sensitive imaging tool for recognizing adrenal expansive lesions, being able to detect lesions of a few millimeters in diameter.

The intralesional washout is a very accurate parameter for differential diagnosis between adenomas and nonadenomas and is essential in the characterization of adenomas without intracytoplasmic lipids.

The evaluation of the wash-out obtained in CT scans performed at 5 , 10 , and 15 after the intravenous injection of contrast material provides diagnostic comparable results. CT scans performed at 5 are, therefore, to be preferred, since they reduce the examination time and patient discomfort.

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