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Imaging features of various adrenal lesions

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ABSTRACT

Aim: To study the role of different imaging modalities in the detection and characterization of Adrenal lesions. **Materials and Methods:** In the present study for a period of 1 year comprised of 45 patients. All patients with Adrenal masses were evaluated with ultrasonography, NECT, CECT and few were further evaluated by MRI. Confirmation of diagnosis was by histopathology, clinical course or by pre and post operative confirmation of imaging findings wherever possible. **Results:** Of 45 cases 22 were benign, 16 were malignant and 07 were infectious. The distribution of Benign and malignant lesions were 48.8 : 35.5. In our study most of the Adrenal lesions are mixed echogenic constituting 15 (33.3%), which include both benign and malignant lesions. Most of the mixed echogenic lesions are malignant. Necrosis was commonly noted in most of the lesions constituting 12 (26.6%) of cases which is seen in Benign and Malignant and also in small & large lesions. Plain CT was done in 40 cases out of which 18 (40%) shoed mixed attenuation. Among them most were Malignant lesions. Calcifications are easily detected and are in Infectious and Malignant lesions constituting 10 (44%) of cases. CECT was done in 39 cases out of which most of them showed Non-Homogenous enhancement 19 (42.2%). In our study MRI was done only in 7 cases out of it 3 were Adenoma, which show more than 40% signal drop in T1 out of phase images which is diagnostic of Adenoma and differentiate it from Adenoma. Most of the lesions in our study were Metastasis mostly from Carcinoma Lung. Second common lesion in our study was Adrenal Adenoma. Ultra sound was done in all cases among which it could detect 34 (75 %) Lesions were detected. Plain CT was done in 40 cases among which 34 (185%) and CECT was done in 39 cases and diagnostic accuracy of CECT was 100%. **Conclusion:** This study detected the role of imaging modulaties in the detection and characterisation of adrenal lesions. It analysed imaging features of various adrenal lesions.

Key words: Adrenal, ultrasonography, malignant

Introduction

Adrenal masses comprise of a wide spectrum of infectious, Benign malignant lesions. They are being diagnosed with increasing frequency. Clinical presentation of adrenal lesions is variable. Most of the functioning tumours are suspected clinically and confirmed by laboratory studies prior to imaging as in case of phaeochromocytoma [1] however adrenal masses without endocrine syndromes need proper workup and careful radiological evaluation. In our department adrenal lesions are being diagnosed by different imaging modalities like ultrasonography, CT Scan, MRI studies. Each modality has some advantages & limitations of these CT remains the imaging modality of choice in the defection & characterization of lesion. MRI offers an alternative method for imaging adrenal gland [2].

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Materials and methods

In the present study extending from October 2012 to November 2013 comprised of 45 patients attending Osmania General Hospital and MNJ Institute of Oncology and Regional Cancer Center. All patients with Adrenal masses were evaluated with ultrasonography, NECT, CECT and few were further evaluated by MRI. Confirmation of diagnosis was by histopathology, clinical course or by pre and post

operative confirmation of imaging findings wherever possible. In this study of 45 cases, most of the cases were detected as incidental findings.

Ultrasonography: Ultrasonography was done using Siemens Sonoline Adara and Esaote my Lab 50x-vision mutli-frequency (3.5-6 MHz) convex transducer probe. linear-array transducer (5Hz - 10 Hz). A detailed scan of all upper abdominal organs was done with proper preparation of the patient, prior fasting for a period of 6-8 hrs. On ultrasound, identification of mass lesion, location, size, shape and margins were noted. IVC was assessed for any displacement by the lesion. Other organs were evaluated for associated pathology. Presence of lymph nodal involvement, ascites, and pleural effusion was assessed. A provisional diagnosis was made and subsequently patients were further advised CT or MR imaging.

Computed Tomography: Equipment Used: TOSHIBA, Asteion TSX - 021A Spinal CT was used in Osmania General Hospital. Siemen's Somatom Sensation 64 slice multi detector row CT scanner was used in MNJ Institute of Oncology and Regional Cancer Center.

Computed Tomography protocol: Fasting of 6-8 hrs, Oral contrast, IV contrast-60ml iopromide, Rate of infusion of 3 ml/sec, Phase delay of precontrast, 70 ssec & 15 min, Extent of Coverage of Diaphragmatic dome to iliac crest, Thickness/speed of 2.5mm max number of detectors, Interval of 2.5 mm,FOV of 250 mm, KV of 120, KV/MA of Auto mA.

MDCT protocol: Breath-hold scans are obtained at 3mm width, 4.5 pitch, 3mm slice thickness. 5mm scans are larger masses. Nonionic contrast 150-ml is administered intravenously at 2-3cc/sec, and the scan is required at 70 sec & 10 minutes after injection on plain CT the various characteristics of the lesions such as attenuation, presence of calcification, haemorrhage or necrosis and other associated findings were noted.

Contrast enhanced CT: On each phase the lesion was judged to be of homogenous or heterogeneous attenuation. Homogenous lesions were scored as benign, hypo, iso or hyper attenuating relative to the adjacent renal parenchyma. Lung bases were looked for pleural effusion or basal consolidation. Presence of lymph nodal involvement, ascites, and pleural effusion was assessed.

MRI: In our department MRI done on GE machine. Seven patients underwent an MRI scan, the conventional T1 and T2.Post-contrast T1W images, chemical shift imaging.

Table 1:MRI adrenal glands protocol: Differentiation between adenoma and non adenoma

Sequence	Plane	TR/TE	Flip/ ETL	BW(KHz)	FOV (cm)	Slice/gap	Matrix (F/P)	NEX
Localizer FGRE dual	Axial	90-150/2.1 & 4.2	75	16	32-40	5-6/01	256/128 -192	1
FRFSE	Axial	1500-3000/100		32	32-40	5-6/01	256/160	1
SSFSE	Coronal	∞/100	100+	62.5	32-40	6/01	256/160-192	0.5

Table 2: shows further characterisation or staging of malignancy

Sequence	Plane	TR/TE	Flip/ ETL	BW(KHz)	FOV (cm)	Slice/gap	Matrix (F/P)	NEX
3D TOF SPGR	Axial	Min/min	200	31	32-40	6/50%	320/160X 0.7 0.8	0.5
GRASS	Axial	30/6	33.3	15	32-40	5/01	256/128-192	1
FMPSP GR	Axial	150/ 4.2	700	16	32-40	5-8/01	256/128-192	1

Imaging Parameters: The imaging parameters assessed on USG, CT MR images were: Location, Number and size of adrenal lesions, Symmetry, Echopatterns, CT attenuation values with enhancement patterns,MR intensities on T1W, T2@, post-contrast & chemical shift imaging.

Associated findings: Concomitant involvement of other intra-abdominal organs like liver, pancreas, and lymph nodes.

Follow up: Confirmation of our imaging diagnosis was done by Histopathological and pre and post operative correlation wherever available. In the remaining cases, clinical course, response to therapy and follow up imaging studies helped in confirming our diagnosis.

Results

In the present study done for a period of 1 year comprised of 45 patients. All patients with Adrenal masses were evaluated with ultrasonography, NECT, CECT and few were further evaluated by MRI. Confirmation of diagnosis was by histopathology, clinical course or by pre and post operative confirmation of imaging findings .

Table 3: Demographic distribution

Age in Years	No. of Cases	Percentages %
0 – 1	01	1.1 %
1 – 10	04	8.8 %
11 – 20	04	8.8 %
21 – 30	09	20 %
31 - 40	10	22 %
41 - 50	12	26 %
51 - 60	04	8.8 %
61 - 70	01	1.1 %
Sex		
Male	28	62.2 %
Female	17	37.8 %
Clinical Examination		
Pallor	02	4.4%
Hirsuitism	05	11.4%
Striae	02	4.4%
Truncal Obesity	06	13.3%
Hypertension	11	24.4%
Pain & Distension abdomen	08	17.7%
Oedema	06	13.3%
Asymptomatic	05	11.1%
Location of masses		
Left	11	24.4 %
Right	22	48.8 %
Billateral	12	26.6 %
Size of mass		
1 - 5 cm	28	62.2 %
> 5 cm	17	37.8 %

Age & Sex study of 45 cases of suspected suprarenal masses was done using different imaging modalities, namely plain X-rays abdomen, Ultrasonography and CT scan. It was noted that the age group included in the study varied from 2 years to 70 years and the maximum number of cases were in the age group 35-50 years. There was slight male predominance with a male: female ratio 1.7:1. In our study youngest patients was 8 months old & oldest was 65 years. Most of the patients were in the age group between 41 - 50 years constituting 26% and next common group was between 31-40 years. Sex ratio Male: Female was **1.7: 1** indicates male population is more affected than females. Most of the cases in our study presented with Hypertension constituting 22%. Rest of the patients have variable clinical presentation and some are asymptomatic. Most of the lesions in our study are seen on Right side & the evidence of this in literature is not clear. Out of 45 cases, the size of lesions < 5cm were 28 (62%) and >5cm seen in 17 (37 %) of patients which include both benign and malignant lesions.

Table 4 : Shows classification of lesions, ultrasonography-echogenecity, ultrasonography-other features

Lesion	No of patients	Percentage
Benign	22	48.8 %
Malignant	16	35.5%
Infectious	07	15.5%
Echogenecity		
Mixed	15	33.3 %
Hypo	12	26.6 %
Iso	04	8.8 %
Hyper	02	4.4 %
Not Detected	12	26.6 %
Ultrasonography		
Calcification	06	13.3%
Necrosis	12	26.6%
IVC displacement	06	13.3%
Lymph node involvement	04	08.8%
Ascites	05	11.1%
CT Plain-Attenuation		
Hyperdense	01	2.2 %
Hypodense	10	22.2 %
Mixed	18	40 %
Isodense to Kidney	08	17.7 %
CT Plain- Other features		
Calcification	10	22.2 %
Ascites	07	15.5 %
IVC Displacement	06	13.3 %
Lymph node enlargement	06	13.3 %
CECT		
Non Homogenous	19	42.2 %
Homogeneous	11	24.4 %
No enhancement	06	13.3 %

Of 45 cases 22 were benign, 16 were malignant and 07 were infectious. The distribution of Benign and malignant lesions were 48.8 : 35.5. In our study most of the Adrenal lesions are mixed echogenic constituting 15 (33.3%), which include both benign and malignant lesions. Most of the mixed echogenic lesions are malignant. Necrosis was commonly noted in most of the lesions constituting 12 (26.6%) of cases which is seen in Benign and Malignant and also in small & large lesions. Plain CT was done in 40 cases out of which 18 (40%) shoed mixed attenuation. Among them most were Malignant lesions. Calcifications are easily detected and are in Infectious and Malignant lesions constituting 10 (44%) of cases. CECT was done in 39 cases out of which most of them showed Non-Homogenous enhancement 19 (42.2%). In our study MRI was done only in 7 cases out of it 3 were Adenoma, which show more than 40% signal drop in T1 out of phase images which is diagnostic of Adenoma and differentiate it from Adenoma

Table 5: Radiological diagnosis

Radiological Diagnosis	No. of Cases	Percentage
Metastases	09	20%
Pheochromocytoma	02	4.4%
Adenoma	06	13.3%
Carcinoma	04	8.8%
Neuroblastoma	02	4.4%
Congenital Adrenal Hyperplasia	02	4.4%
Adrenal Cyst/Infective	06	13.3%

Adrenal Hemorrhage	03	6.6%
Benign Hyperplasia	03	6.6%
Myelolipoma	03	6.6%
Calcification / Atrophy	05	11.1%

Most of the lesions in our study were Metastasis mostly from Carcinoma Lung. Second common lesion in our study was Adrenal Adenoma

Table 6: Imaging modality

Imaging Modality	No. of Cases	No. of Percentages	% of detection of Lesion
USG	45	34	75.5%
Plain CT	40	34	85.0%
CECT	39	39	100 5%
MRI	07	07	100%

Ultra sound was done in all cases among which it could detect 34 (75 %) Lesions were detected. Plain CT was done in 40 cases among which 34 (185%) and CECT was done in 39 cases and diagnostic accuracy of CECT was 100%. MRI was done in 07 cases in diagnostic accuracy of 100%. MRI has high sensitivity and specificity in differentiating Adrenal masses.

Discussion

It was noted that the age group included in the study varied from 2 years to 70 years and the maximum number of cases were in the age group 35-50 years. There was slight male predominance with a male: female ratio 1.7:1. In our study youngest patients was 8 months old & oldest was 65 years. Most of the patients were in the age group between 41 - 50 years constituting 26% and next common group was between 31-40 years. Sex ratio Male: Female was **1.7: 1** indicates male population is more affected than females. Most of the cases in our study presented with Hypertension constituting 22%.Rest of the patients have variable clinical presentation and some are asymptomatic. Most of the lesions in our study are seen on Right side & the evidence of this in literature is not clear. Out of 45 cases, the size of lesions < 5cm were 28 (62%) and >5cm seen in 17 (37 %) of patients which include both benign and malignant lesions.

L.L.Berland et al studied 34 patients in the group of 23-73 years out of which 19 were male and 18 were female.[3]

D.M.Ikeda et al [4] evaluated 17 proved cases of adrenal masses in which 12 were men and 5 were woman and the age group was 26-75 years.

Clinical Presentation: Pain abdomen was the chief complaint in our study seen in 23 patients 60%, in 3 patients (15%) weight gain was seen in 6 (15%) and increase in body hair in 2 (4%) patients. On clinical examination 15 patients (35%) revealed Hypertension. **N.Berry** studied 270 patients of suspected Adrenal masses. Their clinical presentations were as followed - weight gain and hypercortisolism in 62 patients (23%), hypertension in 54 patients (20%), abdominal mass in 22 patients (8%). **William F Sample** in examined 11 cases with adrenal tumours. Among them 4 presented with features of cushings (36%), 5(45%) with hypertension and 2 with hirsuitism (18%).

Location of the lesion: In our study 22 cases were located on the right side (55%), 13 were left (30%) and 10 cases were bilateral (22%). The bilateral masses were due to bilateral adrenal hyperplasia and metastases which are more common in men and are mostly from bronchogenic carcinoma. **I**n study done by **Pena et al** Adrenal masses were examined in which 17 (28%) had bilateral lesions, out of which 9 were due to adrenal metastases.

Size of lesion: 28 (62%) of tumours were <5 cm. and 17 (37%) were >5 cm. Large size of the lesion was thought to be due to late presentation. Although most of the tumours <5cm were benign, some lesions >5cm were also benign. Metastatic lesions though large, some were <5cm. **Hamper** et al evaluated 26 patients of adrenal masses. The size of the lesion ranged from 3-12cm with mean of 5 cm. 11 patients had tumours were of more than 10cm size (40%). **Pena et al** studied 61 patients with adrenal tumours. The size of the lesions ranged from 1-12cm. Only 3 tumours were of more than 10cm size (4%)[5].

Ultrasound evaluation of adrenal masses: Ultrasonography was done in all cases in our series, as it is an easy, simple and readily available technique which requires no contrast media and has no complications or hazards. Out of 45 cases 15 (33.3%) showed mixed echotexture lesions, 12 were hypoechoic (26%), 4 were isoehoic (8%) and 2 were hyperechoic (4.4%). 6 cases (13.3%) showed calcification. **Hamper**

et al in reviewed 26 patients with Adrenocortical carcinoma. 21 cases showed heterogenous echotexture with focal or scattered echopenic or echogenic zones representing areas of tumour necrosis, haemorrhage and/or calcification[7].

Mixed echogenic lesions on ultrasound: In our study out of 23 mixed echotexture lesions 2 were neuroblastoma, 2 pheochromocytomas, 5 carcinomas and 5 were metastases. This suggests that both benign and malignant masses present as mixed echotexture masses. According to **Yeh et al** , focal areas of necrosis or haemorrhage are more likely to occur in large adrenal masses[6] This may cause inhomogenecity of the echo pattern, with areas of increased echoes and echo-free areas when liquifaction occurs. A large adrenal neoplasm is frequently malignant; however, a benign pheochromocytoma may become huge. Necrosis and haemorrhage can also occur in small pheochromocytomas. We had 2 cases of neuroblastoma, all occurred in children. All were more than 5cm size, showed mixed echotexture and areas of calcification. One (1) case showed liver metastases and 1 case showed liver metastases and 1 showed Lymph node involvement. **G.O. Alkinson** wrote that neuroblastoms is the most common malignant tumour in children, originating most often in the adrenal gland. The usual appearance is a complex mass comprising or displacing the kidney inferiorly. Most have variable echogenicity with areas of calcification, haemorrhage and necrosis.

CT evaluation of masses: Plain CT was done in 40 cases. 37.7% of them were of more than 5cm size and 62% of them were <5cm, the minimum size of the tumour which we could detect by CT was 2cm. 22 cases (40%) showed mixed attenuation values, 10 (22%) were hypodense and 8 (17.7%) were isodense, 10 cases showed 22% calcification. On contrast enhancement, 19 cases showed non homogenous enhancement and 11 cases showed homogenous enhancement. **Elliot K Fishman et al** reviewed CT findings in 38 patients with Adrenocortical carcinomas[8]. The primary tumours showed central low attenuation areas representing tumour necrosis in 26 patients (68%), irregular contrast enhancement in 16 patients (42%), detectable calcification in 9 (23%) patients and thin rim enhancement in 7 patients. **Hussian et al** analysed CT findings in 43 adrenal masses. They concluded that the size, contrast enhancement and irregular consistency emerged as an important discriminator of malignant from benign masses with few exception[9]. However no single criteria is specific for benign or malignant lesion. **Lincon Berland et al** reviewed a contrast enhanced dynamic CT scan in 37 patients with 44 small adrenal masses [28 benign, 16 malignant [3]. Features evaluated to suggest a benign diagnosis were homogeneous low attenuation, homogenous contrast enhancement, an enlarged gland with maintained configuration, a thin or absent rim, round or oval shape with sharp margins. Features studied to suggest a malignant diagnosis were a thick enhancing rim, invasion of adjacent structures, irregular or poorly defined margins and in homogenous attenuation. The positive predictive value of a benign diagnosis was 100% and of a malignant diagnosis was between 62-82%.

Differentiating adenomas from metastasis: In our study 19 (42.2%) showed inhomogenous enhancement, 11 (24.4%) showed homogenous enhancement. Both Benign & Malignant tumours show Homogeneous & Heterogeneous enhancement. It is the delayed enhancement & washout patterns that distinguish adenomas from carcinoma. Adenomas showed early enhancement, with >5cm. Out of which 210 (60.8%) showed typical pattern of enhancement i.e. they enhanced readily in the initial phase and on 10 minute delayed scan show >50% of contrast wash out is diagnostic of adenoma. 80 (23.1%) patients showed enhancement pattern, which remained increased on 10 min delayed scan with <50% agent wash out noted which is suggestive of metastastes ; 55 (15.9%) cases were inclusive**.**

MRI in characterisation of adrenal masses: In our study MRI was done in 7 cases. Out of which 3 cases of adenoma were confirmed on MRI based on chemical shift imaging. **Mayo Smith** et al K studied 78 patients for characterization of adrenal masses by the use of chemical shift imaging[10].To obtain chemical shift images, two breath-hold T1-weighted acquisitions are performed. The first uses a short echo time (2.2 m sec at 1.5 T) when the fat and water protons are out of phase, and a second in-phase acquisition uses a longer echo time (4.4 msec). The echo time chosen to obtain in-phase and out-of-phase images varies as a function of field strength. On out-of-phase images, there is signal drop-off in adenomas due o the intra-voxel signal cancellation of the lipid and water protons. Thus, on out-of-phase images, the adenoma appears darker than on in-phase images. In adrenal masses that do not contain lipid (eg. metastases), there is no significant signal loss on out-of-phase images, and thus the signal intensity of the adrenal gland is the same on in-phase and out-of-phase images. With the chemical shift technique, the sensitivity and specificity for differentiating adenomas from metastases ranges from 81% to 100% and 94% to 100% respectively. However MRI is an alternative but not superior to CT in detection and characterization of Adrenal lesions.

Conclusion

This study detected the role of imaging modulaties in the detection and characterisation of adrenal lesions. It analysed imaging features of various adrenal lesions. It also assessed the ability and limitations of each modality in detection and characterisation of adrenal lesions. It also evaluated and differentiated various adrenal masses based on CT and MRI features.

References

1. Applied Radiologist Anatomy Paul butter Adam WM Mitchell edition 2001 : 270.
2. The suprarenal glands (adrenal glans). In Netter FM : The CIBA Collection of Medical llustration. Vol.4 : Endocrine System and selected Metabolic Disease. Summit, NJ, CIBA Pharmaceutial, 1981, pp 77-108.
3. Berland LL, Silverman SG, Gore RM, et al. Managing incidental findings on abdominal CT: White paper of the ACR incidental findings committee. J Am Coll Radiol 2010;7(10):754-773.
4. Ikeda DM,Francis IR,Glazer GM, et al. The detection of adrenal tumours and hyperplasia in patients with primary aldosteronism: Comparison of scintigraphy ,CT and MRI imaging. AJR Am J Roentgenol. 1989;153:301-6.
5. Pena CS, Boland GW, Hahn PF, Lee MJ, Mueller PR. Characterization of indeterminate (lipid poor) adrenal masses; use of washout characteristics of contrast enhanced CT. Radiology,2000;217:798-802.
6. Yeh HC, Mitty HA, Rose J et al. Ultrasonography of adrenal masses: usual features. Radiology, 1978;127:217-218.
7. UM Hamper, EK Fishman, DS Hartman et al. Primary adrenocortical carcinoma: sonographic evaluation with clinical and pathologic correlation in 26 patients. AJR Am J Roentgenol,1987 ;148:915-919.
8. Ashkan A. Malayeri, Atif Zaheer, Elliot K Fishman, Katarzyna J. Macura.Adrenal masses : contemporary imaging characterization. Journal of computer assisted tomography, 37(4), 528-542.
9. Fazal Hussain, Zubair Ali Khan.European society of radiology.2016.
10. Mayo Smith, William W, Giles W.Boland, Richard B Noto, Michael J.Lee. State of the art adrenal imaging. 2001;21(4): 995-1012.

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