Original Article

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# A Histopathological Study on Adrenal Tumours in a Tertiary Care Centre in Chennai

Pathology Section

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## ABSTRACT

**Introduction:** The lesions of the adrenal gland are quite rarely encountered in surgical pathology. Primary adrenal neoplasms have a varied clinical presentation, being functional or nonfunctional, symptomatic or asymptomatic, or detected as incidentalomas in radiological evaluation. Histomorphological examination aided by Immunohistochemistry (IHC) when needed, constitutes the mainstay in the diagnosis of adrenal neoplasms.

**Aim:** To document and analyse the clinicopathological features of the tumours of adrenal gland encountered in the surgical pathology laboratory of a tertiary care hospital.

**Materials and Methods:** This was a retrospective observational study including the tissue samples of adrenal gland submitted for histopathological evaluation in the Institute of Pathology, Madras Medical College, Chennai, a tertiary referral centre over a period of seven and half years from January 2010 to June 2017. The various neoplastic and non-neoplastic conditions encountered were analysed with reference to age, gender, clinical characteristics (functional status, radiological findings, biochemical investigations), gross and histopathological features including IHC based on the data retrieved from the registers in the surgical pathology section of the institute. Also, Haematoxylin and Eosin stained Formalin Fixed Paraffin Embedded (FFPE) tissue sections of the study sample were reviewed microscopically to study the histopathological features.

**Results:** The study group which included only adults showed that primary adrenal neoplasms were the most frequently encountered lesions with majority of the cases (82%, 60/73 cases) in 20-50 years age group and with a female preponderance (66%, 48/73 cases). Pheochromocytoma, the commonest tumour observed was generally functional (64.7%, 22/34 cases). Weiss system had a score of more than three in all the Adrenal Cortical Carcinomas (ACC) studied.

**Conclusion:** The spectrum of primary adrenal neoplasms studied showed a varied clinical presentation. They were generally unilateral and solitary. Pheochromocytoma, followed by ACC and adenoma were the frequent tumours encountered. Weiss system has an invaluable role in the diagnosis of ACCs. IHC plays a key role in diagnosing metastatic tumours.

**Keywords:** Adrenal cortex neoplasms, Myelolipoma, Pheochromocytoma

## INTRODUCTION

The adrenal is an endocrine gland with two distinct compartments, cortex and medulla, that differ embryologically and functionally [1]. The adrenal cortex of mesodermal origin produces the steroid hormones aldosterone, cortisol and testosterone, and the adrenal medulla of neural crest origin produces catecholamines [1]. Adrenal glands received for histopathological evaluation are removed either as a part of radical nephrectomy or for surgical excision of an adrenal tumour [2]. Needle biopsy of adrenal is less often performed, the only role being to confirm malignancy, when there is suspicion of metastatic involvement or to confirm the diagnosis of ACC when radical resection is deemed not possible [2].

The primary adrenal tumours may be functional or nonfunctional presenting with nonspecific symptoms, or remain asymptomatic and are detected as incidentalomas in radioimaging studies. The lesions of the adrenal, quite often presenting a diagnostic challenge to the surgical pathologist must be guided by the patient's clinical, biochemical and radiological profile for better evaluation. Since adrenal gland specimens are one among the rarely received tissue samples in the surgical pathology section, this retrospective study was carried out to document the observations regarding the clinicopathologic and demographic profile of the adrenal tumours reported in the institute.

## MATERIALS AND METHODS

A retrospective observational study was done including all the adrenal gland specimens submitted for histopathological evaluation in the Institute of Pathology, Madras Medical College, a tertiary referral centre over a period of seven and half years from January 2010 to June 2017. The study sample included the needle biopsies from adrenal gland and adrenalectomies done for a pathologic process of the adrenal gland. Adrenal gland removed as a part of radical nephrectomy for primary renal pathology is excluded from the study. A total of 88 cases studied included, 78 adrenalectomies and 10 needle biopsies. The study sample had 79 neoplasms, 7 nonneoplastic conditions and 2 inconclusive needle biopsies. The neoplastic and non-neoplastic conditions observed were analysed with reference to age, gender, clinical features (including functional status, radiological findings and relevant biochemical investigations done), gross and histopathological features including immunohistochemical findings based on the data retrieved from the histopathology registers in the institute. Haematoxylin and Eosin stained FFPE tissue sections were examined microscopically and the histopathologilical features recorded. Weiss scoring was done for all the adrenocortical tumours. The IHC, whenever needed had been done with a panel of markers including inhibin, calretinin, Melan-A, vimentin (positive in ACC), chromogranin (positive in pheochromocytoma), CK, CD10 (positive in metastatic renal cell carcinoma) as required pertaining to the cases considered.

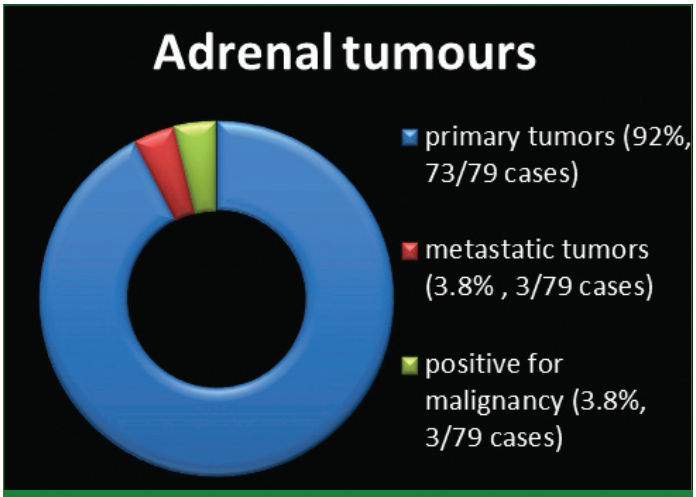
## STATISTICAL ANALYSIS

The data was collected on Microsoft Excel and descriptive statistics was analysed.

## RESULTS

Neoplasms constituted the majority of the adrenal lesions (89.8%, 79/88 cases) encountered in the study. The non-neoplastic conditions

accounted for 8% (7/88 cases) and two cases of needle biopsy (2.3%, 2/88 cases) received were inconclusive with inadequate tissue for evaluation. Of the neoplasms noted, primary adrenal neoplasms constituted 92% (73/79 cases) and three cases showed metastatic involvement of the adrenal. Three cases of tru-cut biopsy received were reported as positive for malignancy without tumour categorisation, since no tissue was available for further evaluation [Table/Fig-1,2].




**[Table/Fig-1]:** Proportion of adrenal tumours.

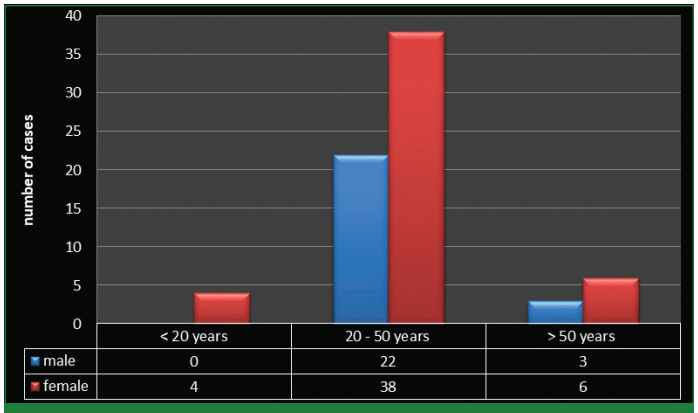
The study group had adults of age from 14 years to 71 years with 32 males and 56 females, showing a slight female predilection (1:1.8). The type of surgical procedure done and the demographic characteristics of the tumours encountered were shown in [Table/Fig-2]. The primary adrenal neoplasms were more frequent in 20-50 years age group with 82% (60/73) cases and females were more commonly affected than males (1:1.9; M=25, F=48 cases) constituting 66% [Table/Fig-3]. Of the primary adrenal tumours, pheochromocytoma was the commonest, noted in 47% (34/73cases) followed by ACC in 20% (15/73 cases), Adrenal Cortical Adenoma (ACA) in 15% (11/73 cases). The clinicopathological features of the major tumour categories observed, pheochromocytoma, ACC, ACA, adrenal myelolipoma and ganglioneuroma were shown in [Table/Fig-4].

Pheochromocytoma, the commonest tumour encountered was generally unilateral constituting 94% (32/34 cases), except for two cases of bilateral pheochromocytoma (6%) encountered in a 45-year-old female and 21-year-old male patient. The tumour was more frequent in 4th and 5th decades (67.6%, 23/34 cases) with a female predilection (1:1.8). Many patients were symptomatic with functional tumours (64.7%, 22/34 cases) showing elevated levels of serum catecholamines and their metabolites (adrenaline, noradrenaline, dopamine, metanephrine), and/or elevated urine vanillyl mandelic acid and metanephrine levels and adrenal mass in imaging (CT/MRI). Morphologically, the tumours showed the characteristic zellballen configuration [Table/Fig-4,5a-5c], with focal areas of nuclear pleomorphism, bizarre giant cells in some tumours and increased mitotic activity with atypical mitotic figures seen in occasional tumours. None of the tumours showed capsular or vascular invasion. In two doubtful cases, IHC was done to confirm the diagnosis, which showed diffuse strong cytoplasmic positivity with chromogranin and synaptophysin in chief cells and nuclear positivity with S100 in sustentacular cells.

ACC was more common in 5th and 6th decades (60%, 9/15 cases) with no gender predilection. They were predominantly nonfunctional (86.7%, 13/15 cases); two cases with no hormonal manifestations had elevated serum DHEAS (dehydroepiandrosterone sulfate) and cortisol levels. The tumours were large, more than 6 cm in size with a variegated cut surface showing characteristic histomorphological features [Table/Fig-4,6a-c]. Some tumours showed multinucleation and giant cells with bizarre nuclei. The mitotic activity was >5/50 High Power Field (HPF) in ten cases (66.7%) and atypical mitosis was seen frequently. Venous invasion was seen in four cases (26.7%) including one case with left renal vein invasion noted in a tumour arising from the left adrenal gland. Capsular invasion was seen in eight cases (53%); tumour invasion in the periadrenal fat in six cases (40%). Direct extension of the tumour into the ipsilateral kidney seen in two cases (13%). Weiss scoring was done and all the tumours had a score of more than three. In most cases, correlation of histopathological features with clinical and laboratory findings helped in arriving at the diagnosis. Immunohistochemical study with a panel of markers (inhibin, calretinin, Melan-A, chromogranin, CD10) was needed in two cases to confirm the histopathological

| Neoplasms | Common age group affected | Mean age (years) | Number of cases | | | Surgical procedure done |
|---|---|---|---|---|---|---|
| | | | Male | Female | Total | |
| Tumours of adrenal cortex | | | | | | |
| Adrenal cortical carcinoma | 5th and 6th decade | 45.4 | 7 | 8 | 15 | Adrenalectomy- 12<br>Adrenalectomy & nephrectomy- 3 |
| Adrenal cortical adenoma | 4th decade | 35.8 | 3 | 8 | 11 | Adrenalectomy |
| Tumours of adrenal medulla | | | | | | |
| Pheochromocytoma | 4th and 5th decade | 38.7 | 12 | 22 | 34 | Adrenalectomy |
| Ganglioneuroma | 3rd decade | 27.3 | 0 | 3 | 3 | Adrenalectomy |
| Mesenchymal & stromal tumours | | | | | | |
| Adrenal myelolipoma | 4th and 5th decade | 46.4 | 3 | 2 | 5 | Adrenalectomy |
| Schwannoma | | | 0 | 1 | 1 | Adrenalectomy |
| Nerve sheath tumour | | | 0 | 1 | 1 | Needle biopsy |
| Lipoma | | | 0 | 1 | 1 | Adrenalectomy |
| Angiomyolipoma | | | 0 | 1 | 1 | Adrenalectomy |
| Hemangioma | | | 0 | 1 | 1 | Needle biopsy |
| Secondary tumours | | | | | | |
| Metastatic RCC | 5th and 6th decade | 55.3 | 1 | 0 | 1 | Needle biopsy |
| Metastatic carcinomatous deposit | | | 2 | 0 | 2 | Needle biopsy |
| Positive for malignancy | 6th decade | 54.7 | 1 | 2 | 3 | Needle biopsy |
| Total | | | 29 | 50 | 79 | |

**[Table/Fig-2]:** Demographic characteristics and surgical details of the adrenal tumours.




**[Table/Fig-3]:** Age and gender distribution of primary adrenal tumours.

diagnosis, where the tumour cells showed positive staining with inhibin, calretinin, Melan-A and negative staining with chromogranin and CD10.

ACA showed a female predilection (M:F,1:4.5). Clinically, functional tumours constituted 54.5% (6/11 cases) including an oncocytic variant associated with cushing's syndrome and two patients with virilisation. Two patients presented as incidentalomas, detected radiologically while evaluating for non-adrenal related conditions. Grossly, the tumours were small, circumscribed, encapsulated, nodular masses with microscopy showing round to polygonal cells with moderate eosinophilic cytoplasm and central round, vesicular nuclei arranged in solid nests, cords and trabeculae [Table/Fig.4,7a,b]. In some tumours, scattered cells with large, hyperchromatic nuclei seen. Mitotic figures were rare. With Weiss scoring, all the tumours had a score of less than three. The oncocytic variant was composed of polygonal cells with abundant granular eosinophilic cytoplasm and distinct nucleoli.

Adrenal myelolipoma, a rare benign tumour accounted for 6.8% (5/73) cases and showed a slight male predilection. All the tumours were nonfunctional. Three cases were detected as incidentalomas, One case of bilateral adrenal myelolipoma was reported in a 41-year-old male patient, who presented with abdominal pain and increasing abdominal distension. The tumours showed the characteristic morphological features with varying proportions of mature adipose tissue and hematopoietic elements [Table/Fig-4,8a,b]. Areas of haemorrhage and infarction seen in large tumours. Ganglioneuromas constituted 4% (3/73) of primary adrenal tumours. All the three were female patients in 3rd decade, presented with nonspecific abdominal pain and a heteroechogenic adrenal mass in CT/MRI. Morphologically, they were large solid tumours showing singly scattered and groups of ganglion cells in a neuromatous stroma [Table/Fig-4]. The other rare primary tumours encountered were one each of schwannoma, lipoma, haemangioma, peripheral nerve sheath tumour and angiomyolipoma. Schwannoma showed immunopositivity with S100 in tumour cells and was negative for SMA and desmin. Haemangioma and peripheral nerve sheath tumour, diagnosed in needle biopsies could not be subtyped, since the tissue was inadequate for further evaluation.

Metastatic involvement of the adrenal was observed in three cases (3.8%); all were male patients more than 40 years of age. One was a known case of left clear cell renal cell carcinoma, who underwent left radical nephrectomy and presented two years later with right adrenal metastasis; the other two were metastasis from unknown primary. The needle biopsies studied in these cases were evaluated with appropriate panel of immunohistochemical markers such as vimentin, inhibin, calretinin, chromogranin, CD10 and CK as needed.

The non-neoplastic lesions encountered included adrenal cysts, of vascular endothelial type, pseudocyst, hydatid cyst and an adrenal abscess [Table/Fig-9]. The vascular endothelial cyst showed CD31 immunoreactivity in the lining endothelial cells.

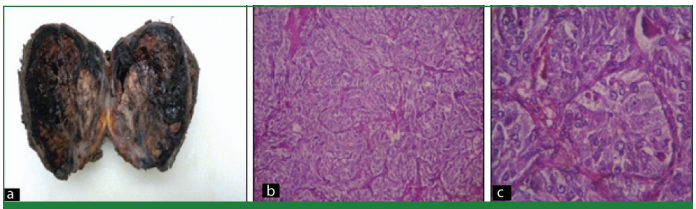
## DISCUSSION

Primary adrenal neoplasms were the commonly encountered adrenal lesions in surgical pathology in the current study. They were more frequent in 3rd to 5th decades of life and females more commonly affected than males. Majority of the primary tumours were solitary, unilateral (96%), except for two cases of bilateral pheochromocytoma and one case of bilateral myelolipoma. Among them, pheochromocytomas constituted the majority, followed by adrenal cortical tumours including carcinomas and adenomas [Table/Fig-10].

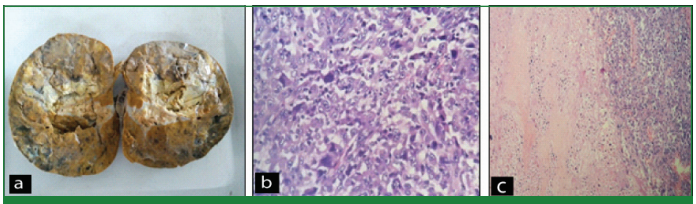
Adrenal cortical tumours comprising 36% of the primary adrenal tumours showed a female predilection (M:F;1:1.6), with an average age of 45.4 years for ACC and 35.8 years for ACA. The adrenal

| Neoplasm | Clinical presentation | Gross morphology | | | Microscopy |
|---|---|---|---|---|---|
| | | Size range (cm) | Mean size (cm) | Cut surface | |
| Pheochromocytoma | Functional tumours with hormonal manifestations (64.7%, 22/34 cases)<br>Nonunctional tumours with constitutional symptoms, symptoms of mass effect (35.3%, 12/34 cases) | 4-10 | 7 | Circumscribed, solid, soft to firm with areas of cystic change, haemorrhage | Growth pattern- nesting (Zellballen pattern), trabeculae, solid<br>Neoplastic cells- polygonal with granular eosinophilic cytoplasm, central vesicular nuclei, prominent nucleoli |
| Adrenal cortical carcinoma | Nonfunctional tumours with constitutional symptoms or symptoms of mass effect (86.7%, 13/15 cases)<br>Functional tumours* (13.3%, 2/15 cases) | 6.5-20 | 10.7 | Solid nodular mass with variegated cut surface (yellow brown solid areas, areas of necrosis, haemorrhage); cystic change noted in some tumours | Growth pattern- diffuse sheets, nests, cords with intervening delicate vascular channels<br>Neoplastic cells with eosinophilic cytoplasm and nuclear atypia; giant cells with bizarre nuclei, multinucleation, increased mitosis, atypical mitotic figures |
| Adrenal cortical adenoma | Functional tumours†<br>(54.5%, 6/11 cases)<br>Nonfunctional tumours (45.5%, 5/11 cases)-<br>Constitutional symptoms (3/11 cases)<br>- Incidentalomas (2/11 cases) | 1.8 – 5 | 3.4 | Circumscribed solid nodular mass with homogenous tan cut surface | Growth pattern-Solid nests, cords, trabeculae<br>Neoplastic cells-Round to polygonal with moderate eosinophilic to vacuolated cytoplasm and central vesicular nuclei. |
| Adrenal myelolipoma | All were nonfunctional tumours (100%, 5/5 cases)<br>- Symptoms of mass effect (2/5 cases),<br>- Incidentalomas (3/5 cases) | 4-20 | 12 | Circumscribed solid mass with areas of haemorrhage, yellow fatty tissue | Admixture of mature adipose tissue and haematopoietic elements in varying proportions |
| Ganglioneuroma | Symptoms of mass effect (100%, 3/3 cases) | 9-16 | 12.3 | Solid firm mass with homogenous grey white cut surface | Singly scattered and groups of ganglion cells in a neuromatous stroma. |

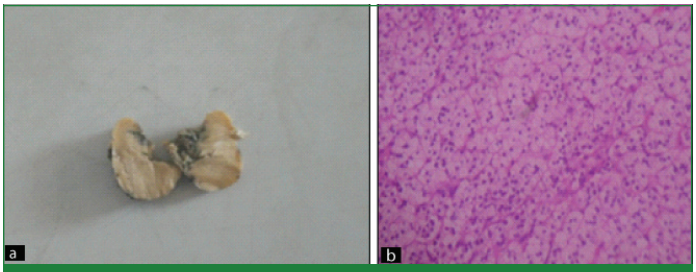
**[Table/Fig-4]:** Clinical and pathological profile of major adrenal tumors.
*Two cases had elevated serum DHEAS (dehydroepiandrosterone) and cortisol levels; †Two cases had increased serum aldosterone, one with increased serum cortisol, two presented with virilisation, one oncocytic variant presented with cushing's syndrome



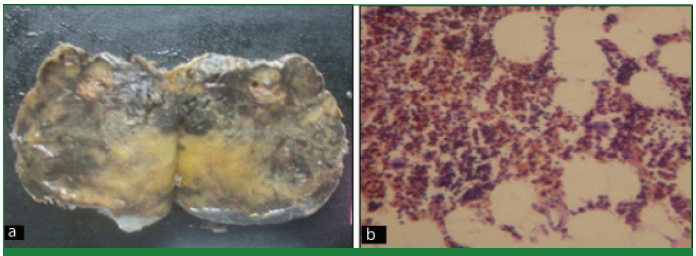

**[Table/Fig-5]:** Pheochromocytoma: a) Gross: nodular mass with solid greytan areas, brown haemorrhagic, cystic areas and focal yellow white areas; b) H&E: tumour cells in zellballen configuration (100x) c) H&E: tumour cells with abundant granular eosinophilic cytoplasm and round vesicular nuclei (400x).




**[Table/Fig-6]:** Adrenal cortical carcinoma a) Gross: solid tumour with soft to firm, greytan areas, pale yellow necrotic areas and focal haemorrhagic areas; b) H&E: sheets of tumour cells with marked nuclear pleomorphism, bizarre nuclei and tumour giant cells (400x). c) H&E: extensive areas of coagulative necrosis (100x).




**[Table/Fig-7]:** Adrenal cortical adenoma a) Gross: solid tan white homogenous nodular mass b) H&E: polygonal cells with clear to pale eosinophilic cytoplasm and uniform central round nuclei (400x).

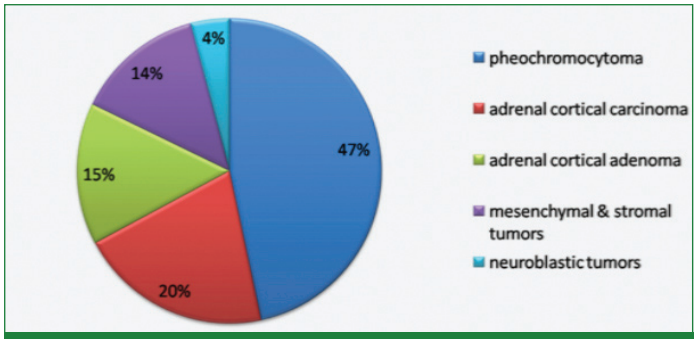



**[Table/Fig-8]:** Myelolipoma a) Gross: soft, solid mass with yellow, tan areas and brown haemorrhagic areas; b) H&E: mature adipocytes admixed with haematopoietic elements (400x).

| Disease category | Number of cases | Age/ Sex | Surgical procedure done |
|---|---|---|---|
| 1. Adrenal cyst | | | |
| i) Vascular endothelial cyst | 2 | 36/F<br>24/M | Laparoscopic adrenalectomy |
| ii) Pseudocyst | 2 | 39/F<br>36/F | Adrenalectomy |
| iii) Hydatid cyst | 1 | 60/F | Adrenalectomy |
| 2. Adrenal abscess | 1 | 57/M | Adrenalectomy |
| 3. Needle biopsy to rule out tuberculosis showed no evidence of TB | 1 | 47/M | Needle biopsy |

**[Table/Fig-9]:** Non-neoplastic diseases of the adrenal.
M: Male; F: Female; TB: Tuberculosis

cortical tumours had a varied clinical presentation. Functional tumours constituted 30.8% and 69.2% were nonfunctional tumours. Mukherjee G et al., in their study noted 47.4% functional tumours and 52.6% nonfunctional tumours [3]. Other observations include the study by Jain M et al., which showed the majority of adrenal cortical tumours to be functional [4], whereas Mondal SK et al., Blanes A and Cano D in their studies noted majority to be nonfunctional [5,6].




**[Table/Fig-10]:** Primary adrenal tumours- histomorphological spectrum encountered.

As with Jain M et al., the proportion of ACC was higher than ACA in the current study [4]. In this study, adenomas ranged in size from 1.8-5 cm with mean size of 3.4 cm and carcinomas ranged in size from 6.5-20 cm with mean size of 10.7 cm showing variegated cut surface. Also, Jain M et al., observed in their study, that none of the adenomas was greater than 5 cm and carcinomas lesser than 6 cm in size [4]. Mondal SK et al., also found ACCs ranging in size from 5-21 cm with mean size of 10.3 cm [5]. Size of the tumour is considered an important determinant of malignancy in an adrenal tumour [4,7]. The characteristic histologic features noted in ACC in this study include increased mitotic activity, atypical mitotic figures, necrosis, vascular invasion, capsular invasion, tumour invasion into periadrenal fat and ipsilateral kidney. Increased mitotic activity of >5/50 hpf (67%) and necrosis (67%) were the frequent histologic features noted.

Applying the Weiss scoring system in the current study, all the 15 cases of ACC had a score of >3. Jain M et al., in their retrospective study on 42 adrenal cortical tumours observed all the 23 cases of ACC had a score of >3 [4]; Mondal SK et al., also observed a score of >3 in all the 10 cases of ACC studied [5]. Although several groups have proposed different multifactorial diagnostic algorithms, including the Hough system and the van Slooten criteria, to differentiate benign from malignant adrenal cortical tumours, the Weiss system is the most widely accepted system [8]. The Weiss system described in 1984 [9], later revised in 1989 [10], and modified in 2002 [11], is an excellent tool to diagnose malignancy in adrenal cortical tumours [8]. The original Weiss system evaluates nine histological parameters which include:

- high nuclear grade(nuclear grades III and IV based on the criteria of Fuhrman et al.,),
- mitotic rate >5/50 high power fields,
- atypical mitotic figures,
- clear tumour cell cytoplasm (less than 25% tumour cells),
- diffuse architecture (greater than 33% of tumour),
- necrosis,
- venous invasion,
- sinusoidal invasion, and
- capsular invasion

A tumour is labeled malignant, when it meets three or more of these histological criteria [8,10]. Since some observers felt that recognition and interpretation of some of the Weiss criteria were subject to observer variability, a modified Weiss system was proposed in 2002 using 5 of the original criteria that include the mitotic rate, clear cell cytoplasm (scored 2 each), atypical mitosis, necrosis and capsular invasion (scored 1 each) with overall cut-off score for malignancy set at 3 [11]. The modified system correlated well with the original Weiss system. However, the original Weiss system is still the widely accepted and the most utilised system to diagnose malignancy in adrenal cortical tumours [8]. The Weiss system, however is not a reliable tool for prognosis [12]. Of the Weiss variables, mitotic count has the most prognostic validity [12]. ACCs are graded

into low-grade and high-grade carcinoma groups based on their mitotic rates (≤20 mitoses per 50 hpfs vs >20 mitoses per 50 hpfs) [1,8,12]. The common sites for metastasis include liver, lung, bone, peritoneum and lymph nodes [8,12]. In the current study, two cases had enlarged para-aortic nodes and one case had hepatic metastasis detected in CT scan. Immunohistochemical analysis when required, should be done with appropriate panel of markers; it aids the histological diagnosis showing immunopositivity with adrenal cortical markers, inhibin, calretinin, Melan-A and negative staining with chromogranin (positive with pheochromocytoma), CD10, CK (positive with renal cell carcinoma) [1,5].

Pheochromocytoma arising from chromaffin cells of adrenal medulla was the commonest tumour (47%) in this study. This is in accordance with Patel RD et al., and Kumari NS et al., who observed 68.9% and 50%, respectively, in their studies on primary adrenal tumours [13,14]. As with literature [1,8], pheochromocytoma was more frequent in 4th and 5th decades of life, with a mean age of 38.7 years in the current study. The study found a slight female predilection, while a roughly equal sex distribution was noted in most series [1,8]. Female preponderance was also noted by Kumari NS et al., in their study [14]. In accordance with literature [1], pheochromocytomas were mostly functional (64.7%), with hormonal manifestations including hypertension, headache, sweating, palpitations, chest pain and elevated levels of serum and/or urine catecholamines and metabolites. Immunohistochemical evaluation showing diffuse, strong positivity with chromogranin, synaptophysin in tumour cells, S100 in sustentacular cells and negative staining with adrenal cortical markers has a valid role in confirming the diagnosis [1]. However, it is impossible to differentiate benign from malignant tumours from a histologic perspective [12]. There is no molecular, genetic, biochemical or histologic markers to determine whether a tumour is malignant. Currently, malignancy is defined only by the presence of metastasis [8,12]. The recent WHO classification of the tumours of adrenal medulla (4th edition, 2017) has a single category, pheochromocytoma and does not have the previous categories, benign and malignant pheochromocytoma [8]. It is stated that, current thinking is that all pheochromocytomas have some malignant potential [8]. Though several putative adverse features have been identified in the retrospective studies on pheochromocytoma, there is currently no consensus in the use of any scoring system for risk assessment in pheochromocytoma or paraganglioma [8]. In the current study, one case had metastatic deposit of pheochromocytoma in omentum and another case of recurrent pheochromocytoma wes encountered.

The other rare neoplasms observed include ganglioneuroma arising from adrenal medulla, myelolipoma, schwannoma, lipoma, hemangioma and angiomyolipoma. Myelolipoma is the most common lipomatous tumour of the adrenal gland [15,16]. In the current study, myelolipoma was the most frequent mesenchymal tumour encountered, constituting 6.8% of primary adrenal tumours. Although literature showed no sex difference [1], the current study in accordance with the study by Lam KY and Lo CY, on lipomatous tumours of the adrenal [15] noted that myelolipomas showed a male predominance and were more frequent in 5th decade. As with Lam KY and Lo CY, the tumours showed no hormonal dysfunction; presented either as incidentalomas or with abdominal pain and distension [15]. The other lipomatous tumours found in the study were lipoma and angiomyolipoma. Angiomyolipoma, a tumour of perivascular epithelioid cell origin (called PEComas) commonly seen in the kidney was noted in the adrenal in the current study as an incidentaloma. The lipomatous tumours constitute an important differential diagnosis for incidental adrenal lesions [15]. Even, clinically aggressive tumours such as epithelioid angiomyolipoma and liposarcoma were rarely reported in literature [15]. The imaging studies cannot reliably distinguish the different lipomatous tumours. Hence with lipomatous lesions of the adrenal, a high index of suspicion should be maintained and in patients with symptoms, large lipomatous lesions (> 5 cm) and those showing a rapid growth, surgical excision followed by histopathological confirmation of the diagnosis is mandatory [15,16]. Metasatic involvement of the adrenal is not uncommon. As per literature, adrenal is the 4th most common site for metastatic involvement; it is bilateral in more than 50% and carcinoma, primarily adenocarcinoma constitute more than 90% of metastatic tumours [8]. In the current study, all the three cases of metastatic tumours encountered showed carcinomatous deposit and one case had bilateral involvement. IHC played a valuable role in differentiating metastasis from primary adrenal malignancies.

Of the non-neoplastic diseases, adrenal cysts were the common lesions noted in the current study. Adrenal cysts are a rare heterogenous group of lesions that include the following categories: i) endothelial cysts; ii) pseudocysts; iii) epithelial cysts; and iv) parasitic cysts [17,18]. Parasitic cysts in the adrenal are very rare, mostly caused by infection with echinococcus [17-19]. The treatment of choice of the adrenal cystic lesions is surgical excision, if possible by laparoscopic approach [17]. However, adequate tissue sampling should be done to rule out cystic change in neoplasms, which include the primary adrenal tumours (pheochromocytoma, ACA, ACC) and the metastatic tumours [17].

### Limitation(s)

Postoperative clinical follow-up data of the study population, not available with the pathology department is not included in the study and hence the treatment outcome and prognosis could not be evaluated.

## CONCLUSION(S)

Primary adrenal neoplasms constituted the major adrenal pathology in the current study. Of the non-neoplastic conditions, the rare cystic lesions constituted the majority. The primary tumours were generally unilateral, solitary; common in 3rd to 5th decades of life with a female predilection. Pheochromocytoma was the commonest tumour noted, many of them being functional. The adrenal cortical tumours (carcinoma and adenoma), the next frequent tumours studied showed a varied clinical presentation. The Weiss criteria served as an useful tool to distinguish ACC from adenoma. Of the Weiss variables, increased mitosis (>5/50 hpf) and necrosis are the frequently observed histologic parameters. IHC has a significant role in diagnosing primary adrenal tumours and also in differentiating metastatic tumours from primary malignancies.

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