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Radiology Section

Diagnosis of Retroperitoneal Tumours using Computed Tomography- A Cross-sectional Study

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ABSTRACT

Introduction: Retroperitoneum is one of the largest and complex anatomical spaces in the body where, even before the clinical presentation, the tumours often grow silently to large sizes. Therefore, an early and accurate diagnosis is crucial. Among the various imaging modalities, Computed Tomography (CT) is the preferred imaging technique for the evaluation of retroperitoneal tumours. It plays an important role in determining the epicenter of tumour, size, tumour composition, extent, vascularity and effects on adjacent structures, and thus aids in treatment planning.

Aim: The study aimed to evaluate various CT imaging findings of retroperitoneal tumours and to associate it with histopathological findings.

Materials and Methods: A cross-sectional study was done at Department of Radiology in the tertiary care hospital for a duration of 12 months from 1st January 2019 to 31st December 2019. The study included 30 patients. Each patient was subjected to plain and contrast enhanced CT to characterise the retroperitoneal tumour. The results were tabulated and evaluated descriptively by Microsoft Excel 2016 and presented in figures, tables, frequency graphs and pie charts.

Results: Out of 30 patients, 17 (56.6%) were males and 13 (43.3%) were females. Most commonly affected age group was seventh decade, followed by sixth decade. Histopathology confirmed the radiologic diagnosis in 26 cases. A total of 80% of the lesions were malignant and 20% were benign. Primary retroperitoneal tumours were the most common tumours (11 cases) accounting for 36.6% of cases. Among primary retroperitoneal tumours, lymphoma (four cases) was the most common tumour followed by lymph nodal metastases (three cases). Other four tumours were liposarcoma, extra-adrenal neuroblastoma, paraganglioma and lymphangioma. Majority of the tumours were solid (29 cases) and only one case was cystic. Heterogeneous enhancement was the most common pattern of enhancement which was seen in 23 cases. Infiltration of adjacent organ was seen in five cases, vascular encasement in seven cases and distant metastasis in six cases.

Conclusion: The collective evaluation of various CT imaging findings of retroperitoneal tumours which includes the epicentre of lesion, tumour composition (solid, cystic, fat, calcification, necrosis), enhancement pattern, size, effect on adjacent organs (displacement or infiltration), vascular encasement and distant metastasis helps to arrive at an accurate radiologic diagnosis and thus guides in therapeutic planning.

Keywords: Adrenal metastases, Beak sign, Lymph nodal metastases, Lymphoma, Neuroblastoma, Renal cell carcinoma

INTRODUCTION

Retroperitoneal tumours constitute diverse pathologic types of lesions, arising in the retroperitoneal spaces and pose a diagnostic challenge for the radiologists [1]. Malignant retroperitoneal tumours occur more commonly than the benign ones [2]. Knowledge of retroperitoneal anatomy and imaging characteristics of various retroperitoneal tumours provides important clues to narrow down the differential diagnosis and guides in clinical management. Several diagnostic modalities can be used for the evaluation of retroperitoneal tumours which include conventional methods (plain radiography, intravenous urography, retroperitoneal lymphography and angiography), Ultrasonography (USG), CT and Magnetic Resonance Imaging (MRI). USG is the initial imaging modality since it is inexpensive, easily available and easy to perform with lack of ionising radiation but the evaluation remains incomplete because of the large size of tumours which does not allow to precisely define the epicenter and relations with adjacent organs. MRI has the drawbacks of high cost, longer scan time and limited availability.

Even before the clinical presentation, the retroperitoneal tumours can have widespread extension due to the loose connective tissue [3]. Hence while imaging, the initial step is to confirm if the tumour is situated within the retroperitoneal space though it is difficult to determine when the lesion has reached a large size. However, this can be decided on the basis of displacement of normal anatomic structures [1,4]. Anterior displacement of the retroperitoneal organs firmly indicates that the tumour is of retroperitoneal origin. The retroperitoneal tumours are further classified into those originating from retroperitoneal organs and primary retroperitoneal tumours which arise independent of retroperitoneal organs. Before a tumour can be ascertained as primarily retroperitoneal, the possibility of its origin from a retroperitoneal organ needs to be excluded. The radiologic signs which aid in determining the organ of origin include the “beak sign,” “embedded organ sign,” “phantom (invisible) organ sign,” and “prominent feeding artery sign” [1,5]. The diagnosis of primary retroperitoneal tumour is considered when there is no definite sign to suggest an organ of origin. Among the primary retroperitoneal tumours, 70-80% is malignant which constitute 0.1-0.2% of all malignant tumours in the body [6].

CT is the appropriate tool in imaging of the retroperitoneum as the difference in attenuation between the retroperitoneal fat and organs helps in the detection of retroperitoneal diseases and increases its diagnostic accuracy [7]. Thus, the study was aimed to evaluate various CT imaging findings of retroperitoneal tumours and to associate it with histopathological findings.

MATERIALS AND METHODS

A cross-sectional study was done at Department of Radiology in Krishnarajendra Tertiary Care Hospital for a duration of 12 months from 1st January 2019 to 31st December 2019. Institute Ethics Committee approval was obtained (EC REG: ECR/134/Inst/KA/2013/RR-19). The patients of either sex, of any age group, who presented with clinically diagnosed retroperitoneal mass or ultrasound detected retroperitoneal mass were included. Clinical history was obtained with thorough physical examination and routine blood investigations including haemogram, urine analysis, random blood sugar, blood urea, serum creatinine, liver function tests, HBsAg and HIV serology. The patients who had history of allergy to iodinated contrast agents, deranged renal function tests, pregnant women, patients with unstable general condition and postoperative cases with residual or recurrent retroperitoneal tumours were excluded from the study.

Based on the inclusion and exclusion criteria, a total of 30 patients were included in the study after obtaining the informed written consent from the patients. CT of abdomen and pelvis was performed with 128 slice single source dual energy Somatom Definition Edge Siemens MDCT (Multidetector CT) machine. Preprocedure preparation included that the patients should be nil per oral for about six hours before conducting the study, with normal renal function tests. Initially, unenhanced study was done followed by intravenous contrast study and the iodinated contrast agents namely Iopromide (Ultravist) or Iohexol (Omnipaque) were used at 2ml/kg body weight. Scans were obtained in portal phase. Arterial and delayed scans were also obtained whenever necessary.

Scanning protocol: Region from both domes of diaphragm to pubic symphysis was included. Patients were asked to lie in supine position with arms above head and following parameters were used: 300 mA, 100 kV, pitch: 0.8, tube rotation time: 0.5s, slice thickness: 5 mm, scan orientation: craniocaudal, scan delay: 45s and FOV: 350 mm. The images were reconstructed to obtain 1mm sections in sagittal and coronal planes.

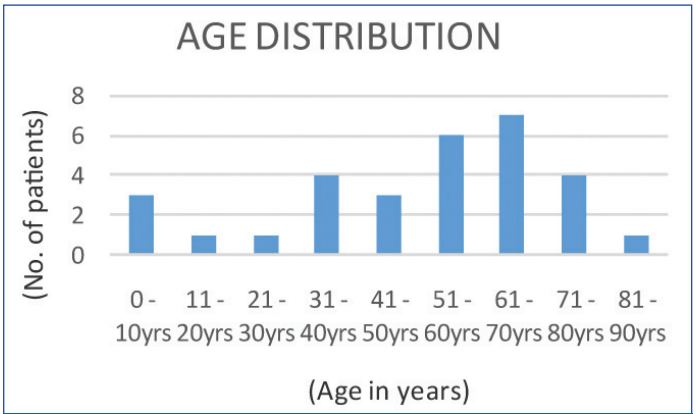
All sections were evaluated for the exact location and origin of retroperitoneal tumours, its extent, tumour composition, enhancement pattern, displacement of adjacent structures, local invasion, vascular encasement and distant metastases. Patients were further evaluated by fine needle aspiration cytology, biopsy, and/or other operative procedure for histopathological examination wherever possible.

STATISTICAL ANALYSIS

The results of the study were tabulated and evaluated descriptively using Microsoft Excel 2016. Also, the results were presented in figures, tables, frequency graphs and pie charts.

RESULTS

In present study, the total number of patients were 30. Of these, 17 (56.6%) were males and 13 (43.3%) were females. Most commonly affected age group was 61-70 years [Table/Fig-1]. Youngest patient was aged nine months whereas the oldest patient aged 88 years and the mean age was 51.8 years (SD 23.85). A total of 80% of the lesions were malignant and 20% of the lesions were benign.



[Table/Fig-1]: Age distribution of patients.

The most common clinical symptom was pain abdomen, with duration of pain varying from one week to three months. Other symptoms included loss of weight, mass per abdomen, loss of appetite, jaundice, haematuria with either frank blood or just few drops with urine and low grade fever. Most of the patients presented with two or more clinical symptoms [Table/Fig-2].

Clinical symptom	Number of cases
Pain abdomen	20
Loss of weight	12
Mass per abdomen	9
Loss of appetite	7
Jaundice	5
Haematuria	4
Fever	3

[Table/Fig-2]: Clinical presentation of patients.

Primary retroperitoneal tumours were the most common tumours (11 cases). Among primary retroperitoneal tumours, lymphoma (four cases) was the most common tumour followed by lymph nodal metastases (three cases). Other four tumours were liposarcoma, neuroblastoma, paraganglioma and lymphangioma. Among adrenal tumours, metastases (three cases) were the most common tumours with lung carcinoma being the primary in all the three cases. Among renal tumours, Renal Cell Carcinoma (RCC) (three cases) was the most common tumour. Periampullary carcinoma (five cases) was the most common overall retroperitoneal tumour in present study [Table/Fig-3].

Distribution of tumours	No. of cases	Percentage (%)
Renal origin	6	20
Adrenal origin	8	26.6
Periampullary origin	5	16.8
Primary retroperitoneal tumours	11	36.6

[Table/Fig-3]: Distribution of retroperitoneal tumours based on organ of origin.

In this study, tumour in 19 cases measured <10 cm in greatest dimension and 11 cases measured >10 cm. Paraspinal location was the most common epicentre of the tumours (11 cases). Majority of the tumours were solid (29 cases) and only one case was cystic. Four cases showed areas of fat attenuation, five cases showed calcification and necrosis was found in 18 cases. Heterogeneous enhancement was the most common pattern of enhancement which was seen in 23 cases. Displacement of adjacent organ was seen in 12 cases and infiltration of adjacent organ was seen in five cases. Vascular encasement was seen in seven cases and distant metastasis was seen in six cases [Table/Fig-4].

Characteristics of tumours	Category	Number of cases	Percentage (%)
Size	<10 cm (in greatest dimension)	19	63.3
	>10 cm	11	36.7
Epicenter of the tumour	Pararenal spaces	7	23.3
	Paraspinal region	11	36.7
	Periampullary region	5	16.7
	Pre and para-aortic region	7	23.3
Tumour composition			
Nature of lesion	Solid	29	96.7
	Cystic	1	3.33
Fat	Present	4	13.3
	Absent	26	86.7
Calcification	Present	5	16.7
	Absent	25	83.3

(contd...)

Necrosis in solid tumours	Present	18	60
	Absent	12	40
Enhancement pattern	No enhancement	2	6.7
	Homogeneous enhancement	5	16.6
	Heterogeneous enhancement	23	76.7
Effect on adjacent structures			
Displacement of adjacent organ	Present	12	40
	Absent	18	60
Infiltration of adjacent organ	Present	5	16.7
	Absent	25	83.3
Vascular encasement	Present	7	23.3
	Absent	23	76.7
Distant metastasis	Present	6	20
	Absent	24	80
Benign vs Malignant	Benign	6	20
	Malignant	24	80

[Table/Fig-4]: Various imaging characteristics of retroperitoneal tumours.

Out of 30 cases, histopathological examination was obtained in 26 cases which showed similar findings as in CT diagnosis [Table/Fig-5].

DISCUSSION

Computed tomography plays an important role in the characterisation of retroperitoneal tumours by determining its location, origin, extent, composition (fat, calcification, and necrosis), enhancement pattern, effect on adjacent structures and distant metastases. The characteristic imaging findings can help narrow down the differential diagnosis and therefore aids in treatment planning [8].

Malignant lesions were more common than the benign lesions. Similar findings were also seen in the studies conducted by Chaudhari A et al., and Stephens DH et al., [Table/Fig-6] [9,10]. But the number of benign cases in Stephens DH et al., was less compared to our study [10]. This is because 10 recurrent cases were included in the Stephens DH et al., study which were all malignant, while no recurrent cases were included in current study. Both the above studies concluded that CT has a major role in the diagnosis of retroperitoneal tumours and their recurrences. Even in cases of advanced tumours, the knowledge provided by CT has been invaluable in developing a rational approach for its management.

Primary retroperitoneal tumours constituted maximum cases in this study accounting for 36.6% (11/30) of cases with lymph nodal mass being the maximum accounting for 63.63% (7/11) of cases. Similar findings were seen in the study conducted by Chinwan D et al., in which most common retroperitoneal masses encountered were primary retroperitoneal masses accounting for 43.3% (13/30) of cases with lymph nodal mass (23%) being the maximum [11]. This similarity could be due to similar number of total cases studied and demographic factors.

The identification of fat and calcification in the retroperitoneal tumours significantly shortens the list of differential diagnoses. In this study, four cases showed areas of fat attenuation within the lesion, among which three cases were benign and one case was malignant

Sl. No.	Age (years)	Gender	Various imaging characteristics								Histopathological examination	Benign/ Malignant
			Calcification	Fat density	Necrosis	Enhancement pattern	Effect on adjacent organ	Vascular encasement	Distant metastasis	CT diagnosis		
1	70	M	Yes	No	Yes	Hetero	Dis	No	No	RCC	RCC	Ma
2	39	F	No	No	Yes	Hetero	Inf	No	Yes (Lung)	RCC	RCC	Ma
3	80	M	No	No	No	Homo	No	Yes	No	Lymphoma	HL	Ma
4	41	M	No	No	Yes	Hetero	No	No	NA	Lymph node metastasis	Metastasis	Ma
5	60	M	No	No	No	Homo	No	Yes	No	Lymphoma	NHL	Ma
6	80	M	No	No	Yes	Hetero	Dis	No	Yes (Lung)	TCC	TCC	Ma
7	1 Yr. 6 Mon	M	No	No	Yes	Hetero	Inf	Yes	Yes (Skull)	Adrenal neuroblastoma	Neuroblastoma	Ma
8	9 Mon	F	Yes	No	Yes	Hetero	Dis	No	No	Extra adrenal neuroblastoma	Neuroblastoma	Ma
9	40	F	No	No	Yes	Hetero	No	No	No	Pheochromocytoma	Not Done	B
10	65	M	No	No	No	Homo	No	Yes	No	Lymphoma	NHL	Ma
11	80	F	No	Yes	No	Hetero	Dis	No	No	Liposarcoma	Liposarcoma	Ma
12	20	F	No	No	No	No	Dis	No	No	Lymphangioma	Lymphangioma	B
13	50	F	No	No	Yes	Hetero	Dis	No	No	Periampullary carcinoma	Adenocarcinoma	Ma
14	53	M	No	No	Yes	Hetero	Inf	No	Yes (Liver)	Periampullary carcinoma	Adenocarcinoma	Ma
15	55	F	No	No	Yes	Hetero	Inf	Yes	Yes (Liver)	Periampullary carcinoma	Adenocarcinoma	Ma
16	75	M	Yes	No	Yes	Hetero	Dis	Yes	No	Periampullary carcinoma	Adenocarcinoma	Ma
17	60	F	No	No	Yes	Hetero	Inf	No	No	RCC	RCC	Ma
18	62	F	No	Yes	No	Homo	No	No	No	Adrenal adenoma	Not Done	B
19	5	M	Yes	No	Yes	Hetero	Dis	No	No	Adrenal neuroblastoma	Neuroblastoma	Ma
20	70	M	No	No	No	Hetero	No	No	NA	Adrenal metastasis (Lung Primary)	Metastasis	Ma
21	32	F	No	Yes	No	No	No	No	No	Adrenal myelolipoma	Not Done	B
22	48	M	No	No	Yes	Hetero	No	No	NA	Lymph node metastasis	Metastasis	Ma
23	70	M	No	No	No	Hetero	No	No	NA	Adrenal metastasis (Lung Primary)	Metastasis	Ma
24	88	F	No	No	No	Hetero	No	No	NA	Adrenal metastasis (Lung Primary)	Not Done	Ma
25	56	M	No	No	No	Homo	No	No	No	Lymphoma	NHL	Ma
26	58	M	No	No	Yes	Hetero	No	No	NA	Lymph node metastasis	Metastasis	Ma
27	65	M	No	Yes	No	Hetero	Dis	No	No	Angiomyolipoma	Angiomyolipoma	B
28	23	F	No	No	Yes	Hetero	Dis	No	No	Paraganglioma	Paraganglioma	B

(contd...)

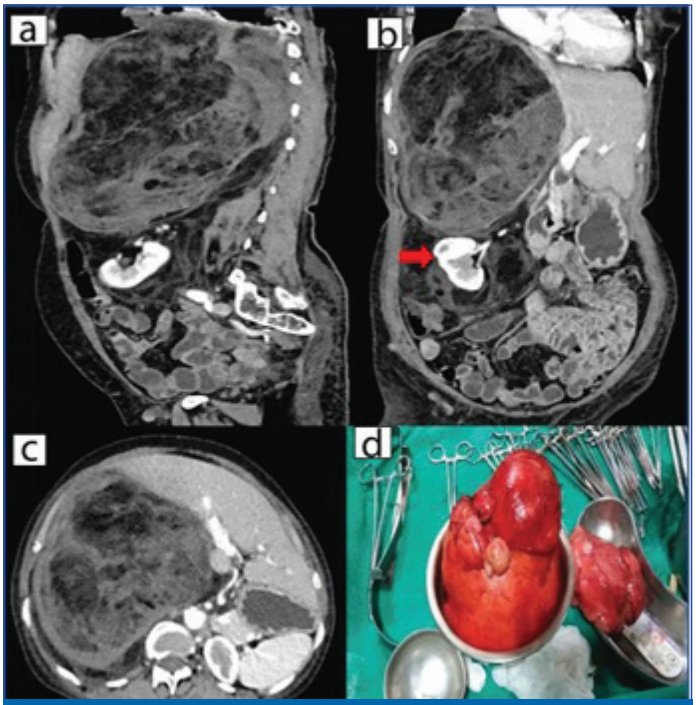
29	35	F	Yes	No	Yes	Hetero	Dis	No	Yes (Lung)	TCC	TCC	Ma
30	70	M	No	No	Yes	Hetero	Dis	Yes	No	Periampullary carcinoma	Adenocarcinoma	Ma

[Table/Fig-5]: Various imaging characteristics of retroperitoneal tumours with CT diagnosis and histopathological diagnosis.
Mon: Month; M: Male; F: Female; Hetero: Heterogeneous; Homo: Homogeneous; Dis: Displacement; Inf: Infiltration; NA: Not applicable; B: Benign; Ma: Malignant; RCC: Renal cell carcinoma; TCC: Transitional cell carcinoma; HL: Hodgkin lymphoma; NHL: Non-hodgkin lymphoma

Results	Chaudhari A et al., [9]	Stephens DH et al., [10]	Current study
Total no. of cases studied	30	19	30
No. of male patients	17 (56.6%)	12 (63.1%)	17 (56.6%)
No. of female patients	13 (43.3%)	7 (36.8%)	13 (43.3%)
Youngest case	6 months	2 years	9 months
Oldest case	65 years	72 years	88 years
No. of benign cases	11 (36.6%)	1 (5.3%)	6 (20%)
No. of malignant cases	19 (63.3%)	18 (94.7%)	24 (80%)

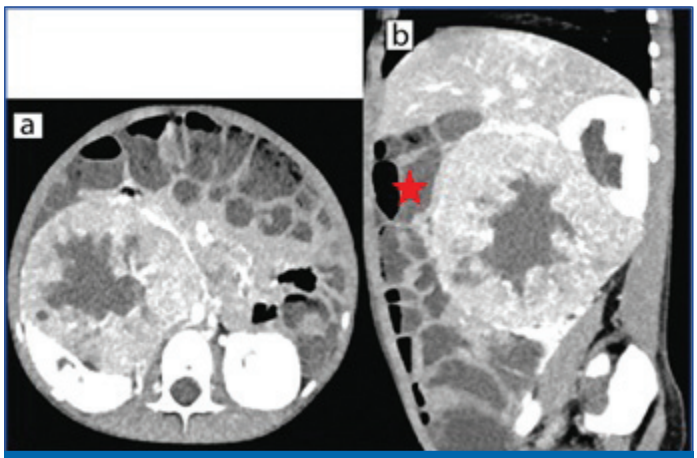
[Table/Fig-6]: Comparison of current study with two other similar studies.

[Table/Fig-7]. Thus, presence of fat was more commonly found in the benign lesions. Similar finding was seen in the study conducted by Bosniak M et al., which reported that angiomyolipoma was diagnosed by detecting fat in the renal lesion and presence of fat is the only radiologic finding that can differentiate angiomyolipoma from RCC [12]. Adrenal adenoma and myelolipoma showed areas of fat attenuation and the key feature which differentiates benign from malignant adrenal tumours is presence of significant intracellular cytoplasmic lipid [13].

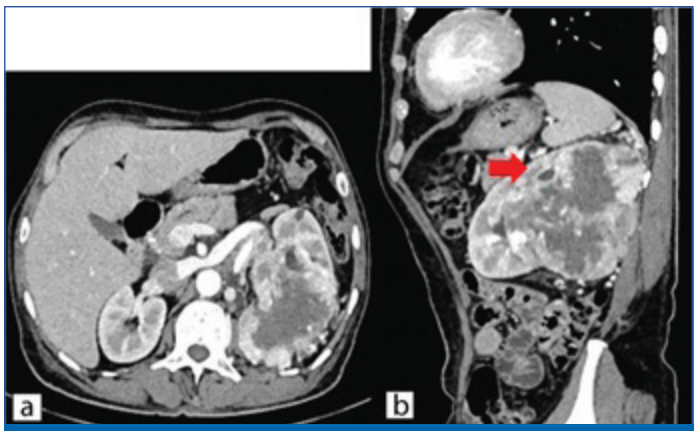


[Table/Fig-7]: Case of retroperitoneal liposarcoma: Contrast-enhanced CT abdomen: (a) Reformatted sagittal image; (b) Reformatted coronal image; (c) Axial image shows heterogeneous solid lesion in the retroperitoneum with predominant fatty components, few enhancing soft tissue components and septations within displacing liver anteriorly, inferior vena cava anteromedially; encasing and displacing right kidney inferiorly (red arrow); (d) Gross specimen of the resected tumour.

The presence of necrosis which appears as low attenuation with no contrast enhancement is an important finding most commonly found in the malignant tumours [1,9]. In this study, 18 cases showed necrosis, out of which 16 were malignant and two cases were benign which included pheochromocytoma and paraganglioma [Table/Fig-8]. RCC, on non-enhanced scan was seen as hypodense lesion and showed heterogeneous postcontrast enhancement with central necrosis [Table/Fig-9]. Calcifications were seen in 33.3% of cases and necrosis was seen in all the cases of RCC. Similar findings were seen in the studies conducted by Zagoria RJ et al.,



[Table/Fig-8]: Case of retroperitoneal paraganglioma: Contrast-enhanced CT abdomen: (a) Axial image; (b) Reformatted sagittal image show heterogeneously enhancing solid lesion with central non-enhancing area in the retroperitoneum displacing the ascending colon anteriorly (red asterisk), abutting right kidney posteriorly with compression and displacement of inferior vena cava anteromedially. No calcification within. The lesion shows negative "beak sign" with the right renal parenchyma which rules out renal origin.



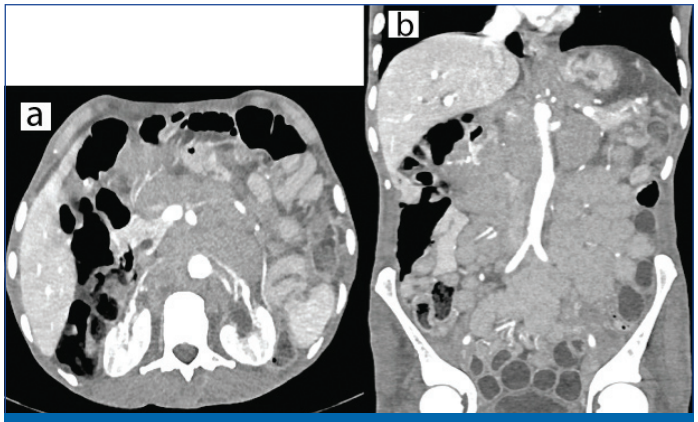
[Table/Fig-9]: Case of renal cell carcinoma: Contrast-enhanced CT abdomen: (a) Axial image; (b) Reformatted sagittal image show heterogeneously enhancing solid lesion in the retroperitoneum with few non-enhancing areas within (likely necrosis). The lesion shows positive "Beak sign (red arrow)" with left renal parenchyma which suggests renal origin.

which reported that calcifications were visible in 31% and necrosis was noted in 87.5% (7/8) of cases and Hatimota P et al., which showed that necrosis was found in 94% cases of RCC [14,15].

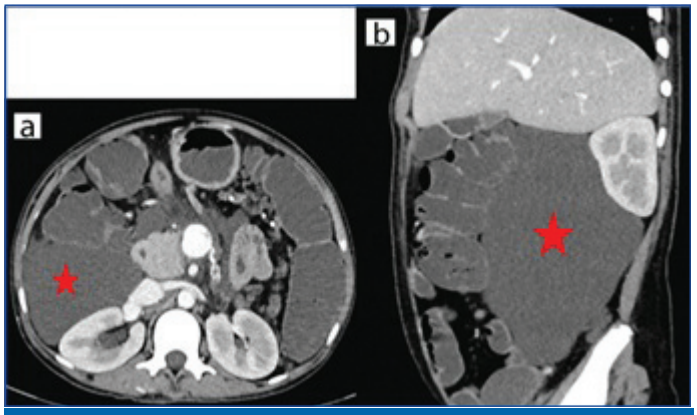
Vascular encasement is also a feature of malignant tumour and determines the surgical resectability of the tumour. In this study, all the seven cases which showed vascular encasement were malignant tumours which included lymphoma [Table/Fig-10], neuroblastoma and periampullary carcinoma. Among the cases with periampullary carcinoma, three out of five cases had vascular involvement. Similar findings were seen in the study conducted by Lee ES et al., which reported that Multidetector CT is best for the assessment of vascular involvement, which is the crucial factor for predicting the surgical resectability of the tumour [16].

In this study, there was one case of lymphangioma which was the only cystic lesion and appeared as non-enhancing multiloculated hypodense lesion of fluid attenuation [Table/Fig-11]. Similar finding was also seen in the study conducted by Hayasaka K et al., which stated that lymphangioma showed fluid attenuation [17].

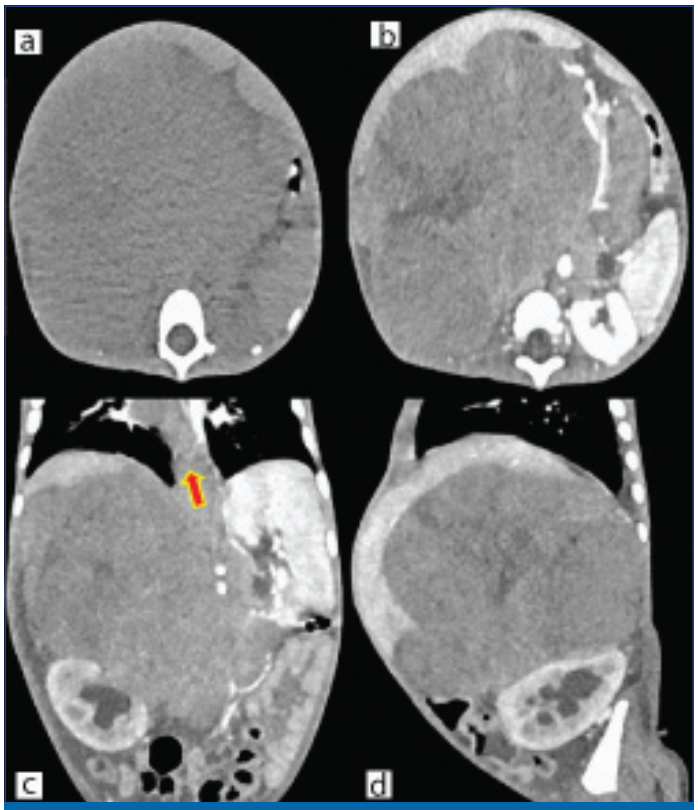
In this study, there were three cases of neuroblastoma (median age 1.5 years) in which one of the cases showed intrathoracic extension [Table/Fig-12]. Hugosson C et al., reviewed 31 children



[Table/Fig-10]: Case of retroperitoneal lymphoma: Contrast-enhanced CT abdomen: (a) Axial image; (b) Reformatted coronal image show multiple homogeneously enhancing lymph nodal mass in the retroperitoneum encasing abdominal aorta, bilateral renal vessels and superior mesenteric vessels with anterior displacement of abdominal aorta and superior mesenteric vessels.



[Table/Fig-11]: Case of retroperitoneal lymphangioma: Contrast-enhanced CT abdomen: (a) Axial image; (b) Reformatted sagittal image show non-enhancing multiloculated cystic lesion (red asterisk) in the retroperitoneum displacing ascending colon anteriorly and abutting right kidney posteriorly.



[Table/Fig-12]: Case of retroperitoneal neuroblastoma: Unenhanced and Contrast-enhanced CT abdomen: (a) Unenhanced axial image; (b) Axial image; (c) Reformatted coronal image; (d) Reformatted sagittal image show heterogeneously enhancing solid lesion in the retroperitoneum crossing the midline with intrathoracic extension (red arrow), displacing liver anteriorly and right kidney inferiorly with no calcification within. The lesion shows negative "beak sign" with the right renal parenchyma which rules out renal origin (important differential diagnosis being nephroblastoma).

with abdominal neuroblastomas (median age 2 years), with USG and CT [18]. They observed that CT and MRI were superior to USG. There was no significant difference between CT and MRI, in the assessment of the location or size of tumour. Intraspinal extension was more distinctly demonstrated with MRI. They concluded that either CT or MRI was best to assess the local disease while CT was best to assess the metastatic disease. Thus, imaging may be valuable for clinical assessment and pretreatment staging of abdominal neuroblastomas.

Limitation(s)

Limitations of this study were the small sample size and the inability to perform histopathological examination in four cases with adrenal lesions. The sample size was 30, since other studies on retroperitoneal tumours (Chaudhari A et al., Stephens DH et al., and Chinwan D et al.,) had similar sample size which could be due to less prevalence of the retroperitoneal tumours [9-11]. Also, the case with CT diagnosis of pheochromocytoma was not subjected to biopsy due to the risk of hypertensive crisis.

CONCLUSION(S)

Retroperitoneum is one of the complex anatomical spaces in the body and tumours arising from it pose a diagnostic challenge for radiologists. The basic purpose of this study was to use CT as an imaging tool to help arrive at the accurate radiologic diagnosis of retroperitoneal tumours based on various imaging characteristics. The collective evaluation of various imaging findings which include the epicentre of the lesion, tumour composition (solid, cystic, fat, calcification, necrosis) enhancement pattern, size of the tumour, effect on adjacent organs (displacement or infiltration), vascular encasement and distant metastasis helps to arrive at the accurate radiologic diagnosis and thus guides in therapeutic planning.

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