

ROLE OF MULTIDETECTOR COMPUTED TOMOGRAPHY IN EVALUATION OF PEDIATRIC ABDOMINAL TUMORSRashmi M. Nagaraju¹, Bhimarao²**HOW TO CITE THIS ARTICLE:**

Rashmi M. Nagaraju, Bhimarao. "Role of Multidetector Computed Tomography in Evaluation of Pediatric Abdominal Tumors". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 42, May 25; Page: 7352-7364, DOI: 10.14260/jemds/2015/1067

ABSTRACT: Background: A wide variety of tumors may affect pediatric abdomen, which arise from various organs. These may be benign or malignant. **OBJECTIVES:** (1) To assess the role of computed tomography in the evaluation of pediatric abdominal tumors- in localization and characterization. (2) To illustrate the common pediatric abdominal masses. **MATERIALS AND METHODS:** 30 patients in the age group 0 to 18 years with suspected abdominal mass underwent non contrast and contrast enhanced computed tomography. The lesions were evaluated in terms of location, organ of origin, CT characters (Including attenuation, enhancement, Presence of necrosis, cystic changes and calcifications) and extensions. Based on the age of the patient and the CT characters, provisional and differential diagnoses were given. These were correlated with the final diagnosis obtained after surgical and histopathological examination and the sensitivity of CT in locating and characterizing various abdominal masses was calculated. Results: Majority of patients in our study belonged to infantile age group (<1 year). Neuroblastomas were the most common tumor in our study followed by Wilms' tumor. Based on organ of origin, adrenal was the commonest organ of origin, followed by kidney and liver. Malignant tumors outnumbered benign tumors by 2:1. Multidetector computed tomography was an excellent imaging modality in localizing and characterizing these tumors. It had a diagnostic accuracy of 96.3 % and was 100 % sensitive in detecting calcifications. It thus helped in narrowing differential diagnosis and in most cases helped in providing a provisional diagnosis close to final histopathological diagnosis. It also helped to provide details of extensions and mass effect of these tumors, with local involvements and distant metastases, which in turn were very important in planning further management. **CONCLUSIONS:** Multidetector computed tomography (MDCT) is a very sensitive imaging modality. It is fast, reliable, significantly accurate method for localizing and characterizing various tumors arising from pediatric abdomen. It helps in narrowing differentials and arriving at a final diagnosis in most cases. It also provides significant information for operative management.

KEYWORDS: pediatric abdominal tumors, multidetector computed tomography, neuroblastoma, Wilms' tumor.

INTRODUCTION: A broad spectrum of tumors can involve the pediatric abdomen. These may originate from various organs and can be benign or malignant. The diagnosis is suggested mainly by the patient age and imaging appearance of the lesion, including its location, shape and internal architecture. Various tumors are common in certain age groups- neonatal, infantile, early childhood and adolescence.⁽¹⁾ Multidetector computed tomography (MDCT) with its multiplanar reconstruction is an excellent imaging modality to locate and characterize these lesions. It helps to develop a differential diagnosis, based on CT characteristics and patient age. It also helps to determine the local extent and distant metastases.

OBJECTIVES:

- To assess the role of computed tomography in the evaluation of pediatric abdominal tumors- in localization and characterization.
- To illustrate the common pediatric abdominal masses.

MATERIALS AND METHODS:

- 30 patients in the age group 0 to 18 years with clinically diagnosed abdominal mass were referred for computed tomography in our department. These patients underwent non contrast and contrast enhanced computed tomography using Siemens Somatom Emotion 6 Scanner (According to department protocol based on individual case).
- The lesions were evaluated in terms of location, organ of origin, CT characters (Including attenuation, enhancement, presence of necrosis, cystic changes and calcifications) and extensions.
- Based on the age of the patient and the CT characters, provisional and differential diagnoses were given.
- These were correlated with the final diagnosis obtained after surgical and histopathological examination.
- The CT diagnosis and final diagnosis were compared and the sensitivity of CT in locating and characterizing various abdominal masses was calculated.

DISCUSSION: A broad spectrum of tumors arising from various organs can involve the pediatric abdomen, which may be benign or malignant. The diagnosis is suggested mainly by patient age and imaging appearance of the lesion, including its location, organ of origin and internal architecture.⁽¹⁾

The patient's age is one of the most important factors that help narrow the potential differentials as certain masses are particularly common in certain age groups. Relevant history regarding time since onset of mass, rapidity of growth and mass effect on adjacent structures may add further to this information. The presence of constitutional symptoms, such as pallor, anorexia, fever, or weight loss, may point toward a malignant lesion, although non-specific.⁽¹⁾

Multidetector computed tomography (MDCT) is an excellent imaging modality which provides rapid and excellent images of such lesions. MDCT with multiplanar reconstructions provide vital information regarding location of the lesion, its organ of origin, enhancement characteristics in various phases of contrast administration, presence of necrotic areas & calcifications, areas of fat attenuation, extensions of the lesion, involvements & invasions and mass effect on adjacent structures. It also helps to determine the local extent and distant metastases. MDCT is used to develop differential diagnosis based on above mentioned features and in most of the cases, one can arrive at a definitive diagnosis. When a malignant lesion is suspected, CT scan of the chest, abdomen, and pelvis can be done to determine mass extension and infiltration into adjacent organs and vessels.^(2,3)

Neuroblastoma is the most common abdominal malignancy in infants.⁽⁴⁾ Wilms tumor is the second most common pediatric malignant abdominal tumor and the most common primary pediatric renal malignancy. A variety of other renal masses may be differentiated from Wilms tumor on the basis of their clinical and imaging features.⁽⁵⁾ Hepatic masses constitute only 5% to 6% of all intra-abdominal masses in children and primary hepatic neoplasms constitute only 0.5% to 2% of all

ORIGINAL ARTICLE

pediatric malignancies. Hepatic tumors in children include lesions unique to the pediatric age group and others that are more common in adults. Primary hepatic neoplasms are the third most common abdominal malignancy in childhood, after Wilms' tumor and neuroblastoma. The majority of liver tumors in children are malignant. Only about one third of the liver tumors are benign.⁽⁶⁾

CT Features of Common Pediatric Abdominal Tumors: Neuroblastoma (Fig. 1): These are usually large, heterogeneous, lobulated soft tissue mass that shows heterogeneous enhancement on contrast study. Approximately 80%–90% of NBs demonstrate stippled and curvilinear calcifications on CT scans. Low-attenuation areas of necrosis or hemorrhage are frequently seen. Vascular encasement and compression of the renal vessels and other adjacent vessels may occur, although vascular invasion is rare. Regional invasion of psoas and paraspinal musculature may occur, and invasion of the neural foramen into the epidural space is also frequent. Adenopathy of the renal hilum, porta hepatis, and retroperitoneum may be seen. Metastatic disease of the liver and lung are readily evaluated with CT. CT is helpful in staging of disease.^(4,7)

Ganglioneuroblastoma (Fig. 2): They are similar in appearance compared to neuroblastoma, other than for organ of origin, arising from sympathetic chain. Adrenals are usually identified separately from the lesion.⁽⁴⁾

Wilms' Tumor (Fig. 3): It is seen as a large well defined heterogeneous mass arising from kidney, which enhances to a lesser degree compared to normal renal parenchyma. Site of origin is seen as stretching and splaying giving a 'beak' like appearance. Low attenuation areas within the lesion may represent necrosis/fat deposition. Calcification is relatively rare. Capsular and vascular invasion may be seen and is well evaluated in contrast study. Regional lymphadenopathy, peritoneal, mesenteric and omental involvement can occur, which is well depicted by CT.^(5,8,9)

Mesoblastic Nephroma (Fig. 4): It appears as large solid intrarenal mass involving renal sinus which is usually homogeneous. It demonstrates minimal or no enhancement on post contrast study. Entrapment of collecting system may lead to leakage of excreted contrast into the lesion. These lesions may also be discovered antenatally during a routine prenatal ultrasonography.⁽⁵⁾

Hepatoblastoma (Fig. 5): They appear as iso to hyperdense masses on plain CT with ~ 50 % cases showing coarse dense calcifications. They demonstrate heterogeneous enhancement on contrast study with rim and septal enhancement.^(10,11)

Hepatic Hemangioma (Fig. 6): They appear as well defined hypodense lesion showing early dense peripheral nodular enhancement with progressive centripetal fill in.^(12,13)

Infantile Hemangioendothelioma (Fig. 7): They appear as well defined homogeneous hypodense masses with calcifications in ~ 49% cases. Early peripheral nodular enhancement with gradual centripetal fill in may be noted similar to adult hemangiomas. In large masses, there may not be complete central filling. Clinically the patient may present with high output congestive heart failure.^(13,14)

ORIGINAL ARTICLE

Lymphomas: These are common lesions in pediatric age group, usually of Non-Hodgkin's variety. Multiple homogeneously enhancing retroperitoneal lymph nodes forming conglomerate masses are usually seen. These may encase vessels, without significant luminal narrowing.

Teratomas: Mature teratomas are predominantly cystic lesion containing mixture of fat, hair, debris and calcifications. Calcifications are often localized to solid globular protuberance (Mural nodule or dermoid plug) arising from cyst wall. Immature or malignant teratomas may be predominantly solid with heterogeneously enhancing soft tissue areas within. These lesions may arise from ovaries (Fig. 8) or may be of primary retroperitoneal origin (Fig. 9).

Sacrococcygeal Teratoma (Fig. 10): These are similar in appearances to retroperitoneal teratomas, arising from sacrococcygeal region with variable external and internal components. Variable destruction of the sacrococcygeal spine may be present. They can be entirely internal or predominantly external. Fluid, fat and calcifications are often present. Malignant tumors may be predominantly solid.⁽¹⁵⁾

Hamartomas (Fig. 11): These are benign lesions, usually overgrowth of normal tissue. They usually contain calcifications. They can be heterogeneous and demonstrate minimal to variable enhancement. They may arise from any organ within the abdomen.

RESULTS:

- Majority of patients in our study were below 1 year of age,⁽¹¹⁾ followed by 1-5 years age group.⁽⁹⁾ There was near equal gender distribution (Fig. 12).
- Of the 30 cases, majority,⁽⁷⁾ were neuroblastomas, predominantly in infants (< 1 year). It was followed by Wilms tumor,⁽⁶⁾ especially in the early childhood (Fig. 13).
- Of the 8 cases diagnosed with renal masses, 6 were Wilms tumor, followed by mesoblastic nephromas.⁽²⁾ Of the 8 cases diagnosed with liver masses, 4 were hemangiomas, followed by hepatoblastomas,⁽³⁾ and epitheloid hemangioendothelioma.⁽¹⁾ One case of extra adrenal ganglioneuroblastoma was noted. One case of multicystic retroperitoneal teratoma, one case of ovarian teratoma and 2 cases of sacrococcygeal teratomas were noted. A case of splenic hamartoma, arising exophytically and extending to lumbar region was diagnosed intraoperatively. A provisional diagnosis of mesenteric/bowel neoplasm was suggested on CT.
- Based on the organ of origin, majority of the tumors arose from kidneys,⁽⁹⁾ followed by liver,⁽⁸⁾ and adrenal.⁽⁷⁾ (Fig. 14).
- Malignant pathologies outnumbered benign lesions by 2: 1 ratio. (Fig. 15)
- CT had a diagnostic accuracy of 96.3% in identifying the organ of origin of abdominal tumors in our study with 29/30 cases being correctly localized. One case of splenic hamartoma was thought to arise from mesentery / bowel.
- Leonidas JC et al (1977) studied 24 infants and children and compared CT with excretory urography. They concluded that CT is a single noninvasive examination involving minimal ionizing radiation, comparable to that offered by a combination of multiple radiological. They also suggested CT may become an excellent screening procedure in the investigation of abdominal and pelvic masses. The high cost of CT scanning may be offset by the benefits cited.⁽¹⁶⁾

ORIGINAL ARTICLE

- Shukla A et al (2014) in their study on 20 children with renal and adrenal tumors found CT to be 90 % accurate in diagnosis.⁽¹⁷⁾
- Computed tomography was 100 % sensitive in detecting calcifications.
- CT with multiplanar reformation was an excellent imaging modality with high diagnostic accuracy, for:
 1. Localizing the lesions, with respect to organ of origin.
 2. Characterization, in terms of enhancement, identifying necrotic areas and calcifications, for which CT was 100 % sensitive.
 3. Extensions and mass effect on adjacent structures.

ADVANTAGES: Computed tomography is relatively fast technique and in most cases do not require use of sedation or anesthesia.

LIMITATIONS: Computed tomography involves use of ionizing radiation, which is especially hazardous in the pediatric age group, leading to development of biological effects including carcinogenesis in later age group. However this risk is significantly reduced by using appropriate factors and safety procedures.

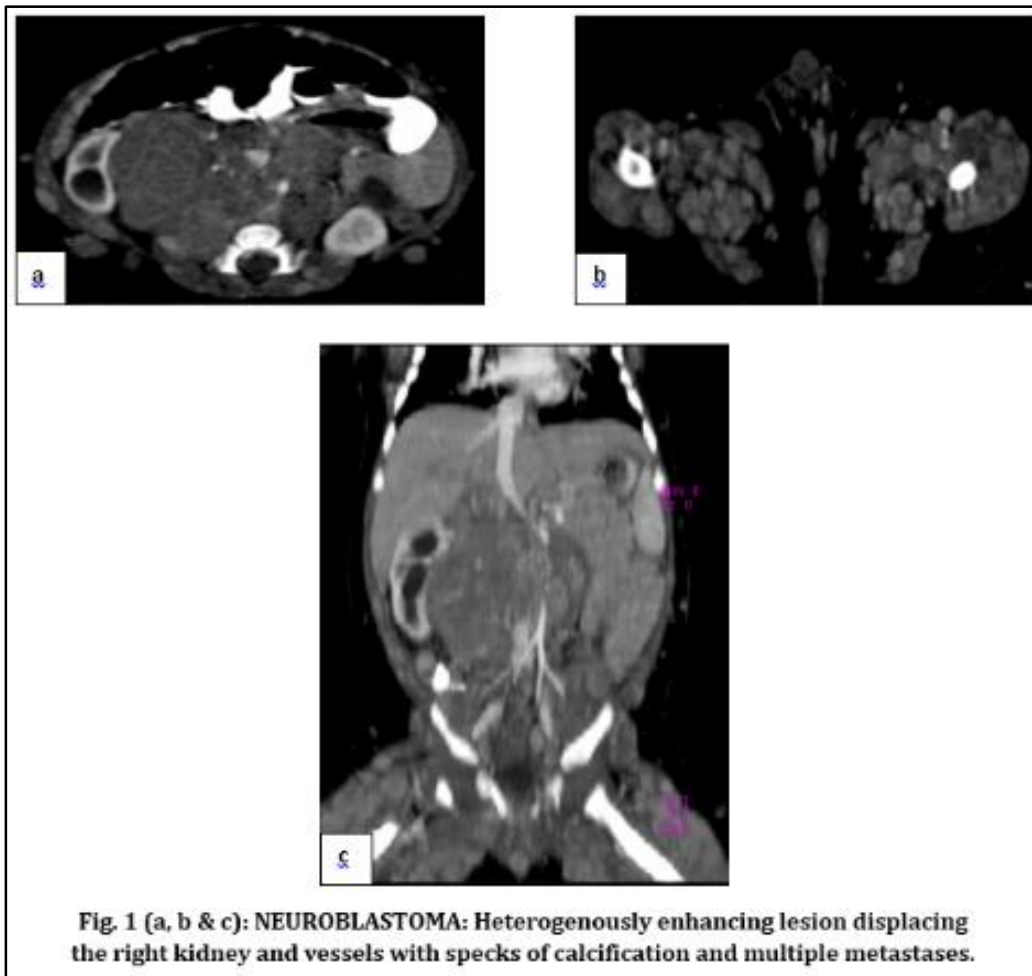
CONCLUSIONS: The pediatric patient with an abdominal mass needs rapid clinical evaluation and appropriate management, which is surgical in majority of cases. Age and imaging appearances provide valuable information for developing differential diagnosis. Multidetector computed tomography (MDCT) is a very sensitive imaging modality with high diagnostic accuracy. It is fast, reliable, significantly accurate method for localizing and characterizing various tumors arising from pediatric abdomen. It helps in narrowing differentials and arriving at a final diagnosis in most cases. It also provides significant information for operative management.

REFERENCES:

1. Rahhal et al. A Child with an Abdominal Mass. *Pediatric Rounds*: 37 – 42.
2. Golden CB, Feusner JH. Malignant abdominal masses in children: quick guide to evaluation and diagnosis. *Pediatr Clin North Am* 2002; 49: 1369–92, viii.
3. Chandler JC, Gauderer MW. The neonate with an abdominal mass. *Pediatr Clin North Am* 2004; 51: 979–97, ix.
4. Lonergan G F et al. Neuroblastoma, Ganglioneuroblastoma and Ganglioneuroma: Radiologic-Pathologic Correlation. *Radio Graphics* 2002; 22: 911–934.
5. Lowe L H et al. Pediatric Renal Masses: Wilms Tumor and Beyond. *Radio Graphics* 2000; 20: 1585–1603.
6. Dong Quotient, Chen J. (2011). *CT Scan of Pediatric Liver Tumors, CT Scanning - Techniques and Applications*, Dr. Karupppasamy Subburaj (Ed.), ISBN: 978-953-307-943-1.
7. Hirons MP, Owens CM. Radiology of neuroblastoma in children. *Eur Radiol* 2001; 11: 2071-81.
8. Fernbach SK, Feinstein KA, Donaldson JS, et al. Nephroblastomatosis: Comparison of CT with US and urography. *Radiology* 1988; 166: 153.
9. Remain TAH, Siegel MJ, Shackeyord GD: Wilms' tumor in children: Abdominal CT and US evaluation. *Radiology* 1986; 160: 501-05.

ORIGINAL ARTICLE

10. Amendola MA, Blane CE, Amendola BE, Glazer GM. CT findings in hepatoblastoma. J Comput Assist Tomogr. 1984; 8: 1105-9.
11. Chung EM et al. Pediatric Liver Masses: Radiologic-Pathologic Correlation Part 2. Malignant Tumors. RadioGraphics 2011; 31: 483-507.
12. Abramson SJ, Lack EE, Teele RL. Benign vascular tumors of the liver in infants: Sonographic appearance. AJR 1982; 138: 629-32.
13. Chung EM et al. Pediatric Liver Masses: Radiologic-Pathologic Correlation Part 1. Benign Tumors. RadioGraphics 2010; 30: 801-826.
14. Smith WL, Franken EA, Mitros FA. Liver tumors in children. Semin Roentgenol 1983; 18: 136-48.
15. Wells RG, Sty JR. Imaging of sacrococcygeal germ cell tumors. RadioGraphics 1990; 10: 701-713.
16. Leonidas JC, Carter BL, Leape LL, Ramenofsky ML, Schwartz AM. Computed tomography in diagnosis of abdominal masses in infancy and childhood. Comparison with excretory urography. Archives of Disease in Childhood, 1978, 53, 120-125.
17. Shukla A, Pratap V. Multi-detector computed tomography of renal and adrenal tumours in children. Int J Sci Stud 2014; 2 (8): 70-74.



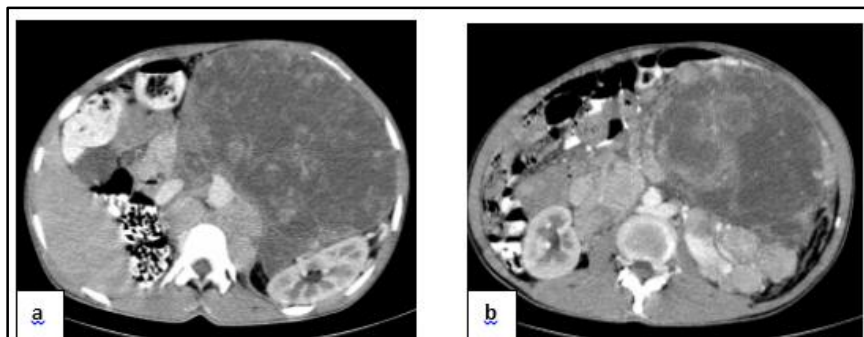


Fig. 2 (a & b): EXTRA ADRENAL GANGLIONEUROBLASTOMA: Heterogeneously enhancing lesion with central necrosis in left retroperitoneum with multiple metastatic deposits. Left adrenal separately visualised.



Fig. 3 (a & b): WILMS TUMOR: Large heterogeneously enhancing lesion replacing the kidney and extending to renal vein and inferior venacava

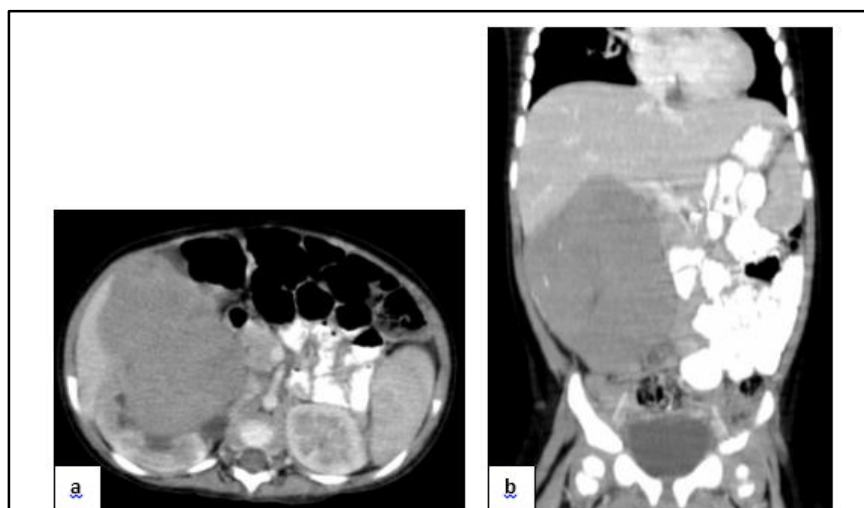
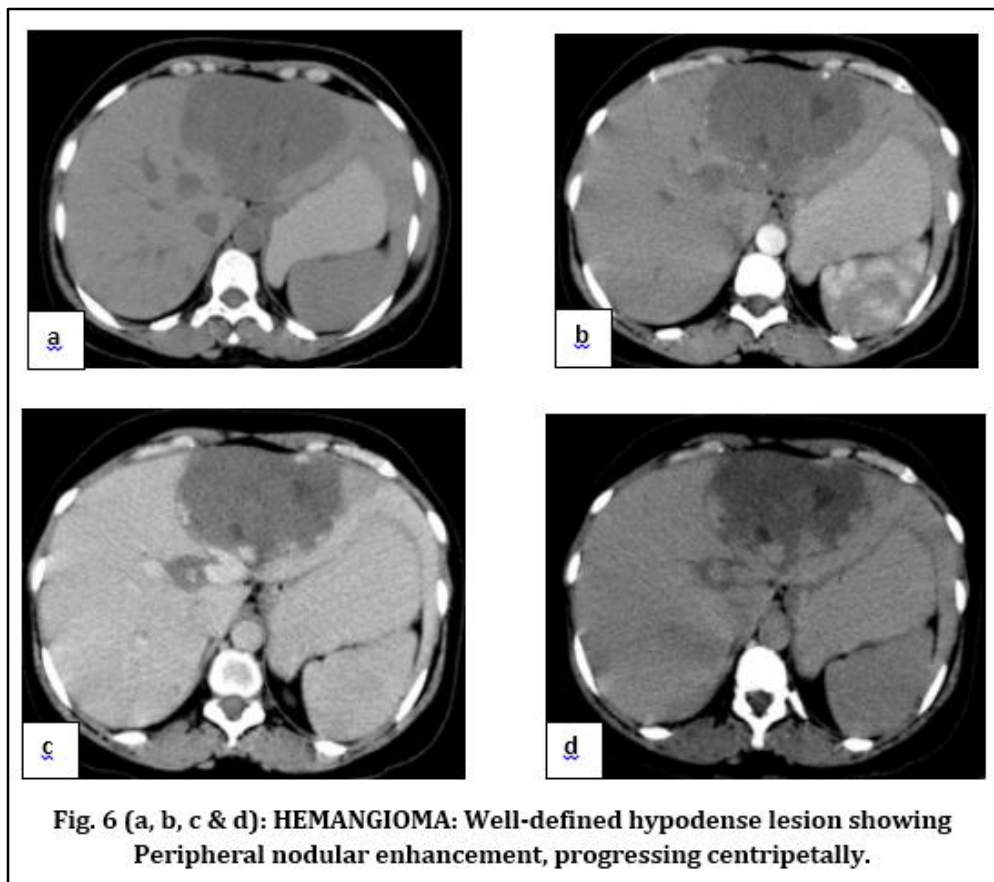
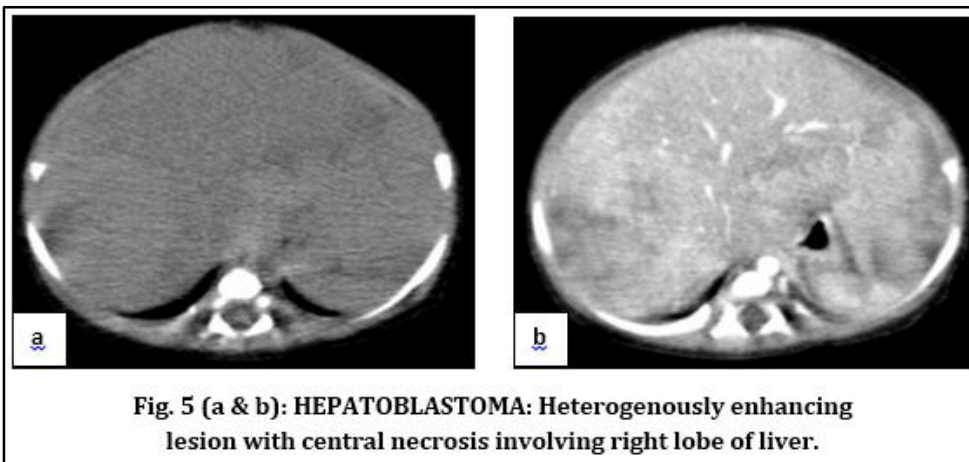


Fig. 4 (a & b): MESOBLASTIC NEPHROMA: Well defined solid lesion with homogenous enhancement arising from right kidney.



ORIGINAL ARTICLE

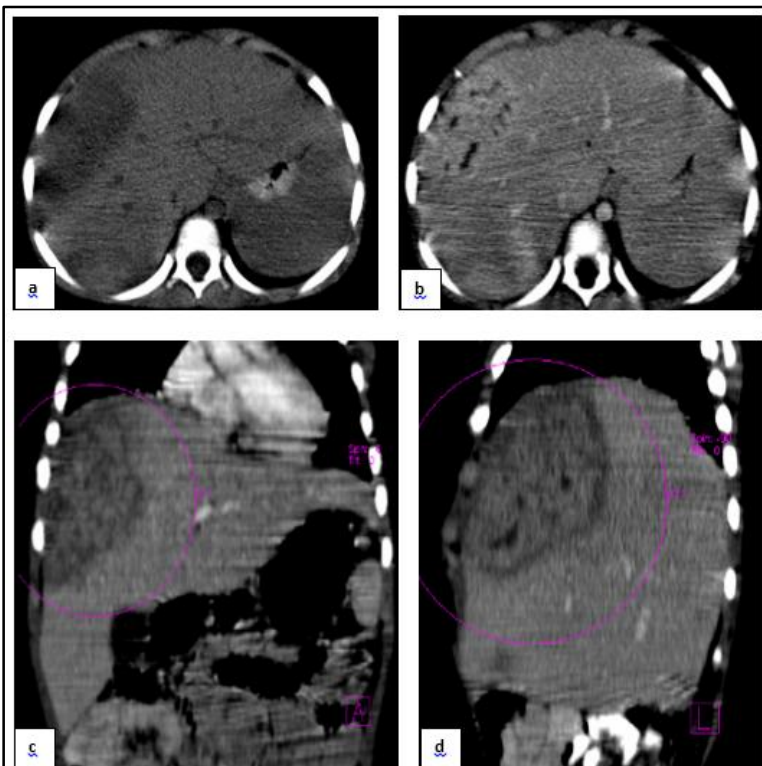


Fig. 7 (a, b, c & d): INFANTILE HEMANGIOENDOTHELIOMA: Heterogeneously enhancing lesion with central areas of linear necrosis and compressed hepatic capsule peripherally, involving right lobe of liver.

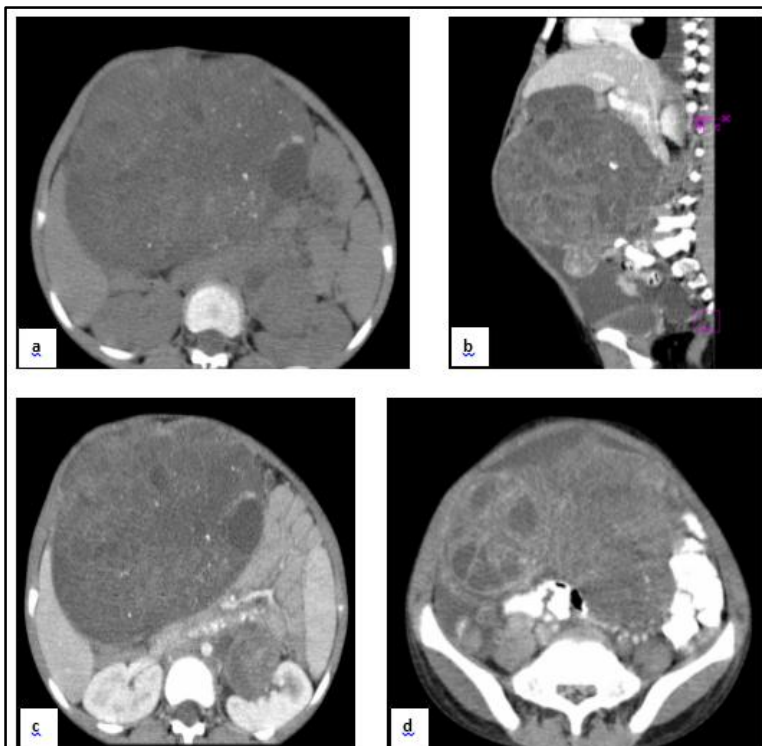


Fig. 8 (a, b, c & d): OVARIAN TERAOMA: Large heterogeneously enhancing lesion with areas of fat and calcification arising from left ovary

ORIGINAL ARTICLE

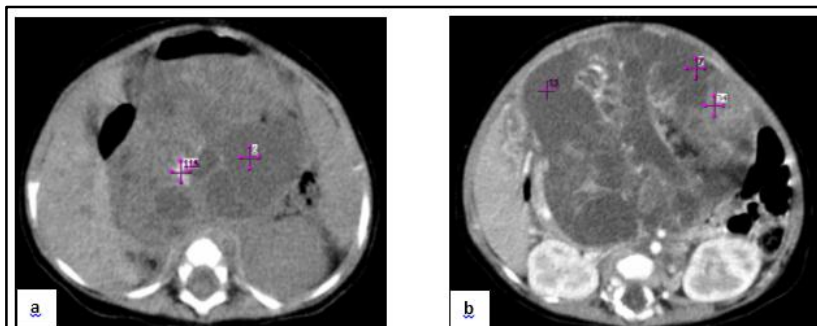


Fig. 9 (a & b): MULTICYSTIC RETROPERITONEAL TERATOMA: Heterogeneously enhancing lesion with areas of necrosis, fat and calcification, in the retroperitoneum.

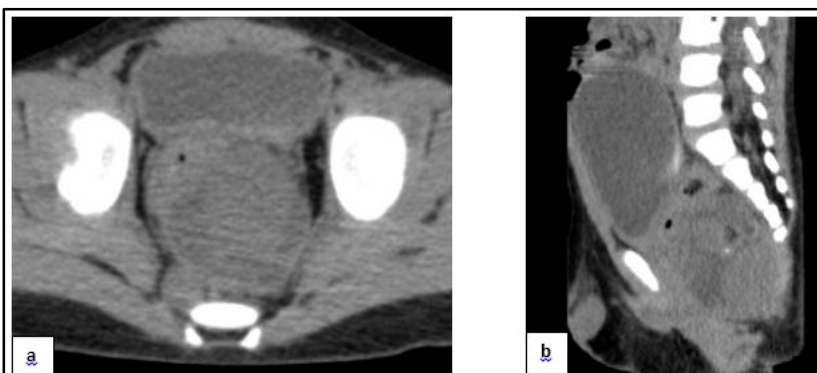


Fig. 10 (a & b): SACROCOCCYGEAL TERATOMA: Type IV sacrococcygeal teratoma with well-defined enhancing internal component with calcific foci.

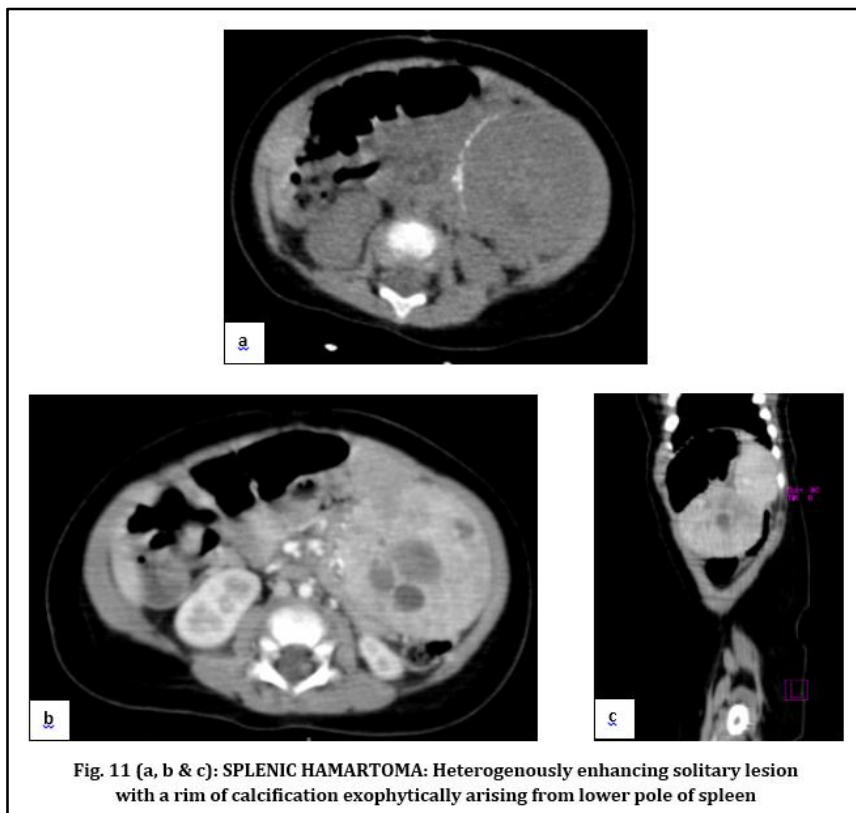


Fig. 11 (a, b & c): SPLENIC HAMARTOMA: Heterogeneously enhancing solitary lesion with a rim of calcification exophytically arising from lower pole of spleen

ORIGINAL ARTICLE

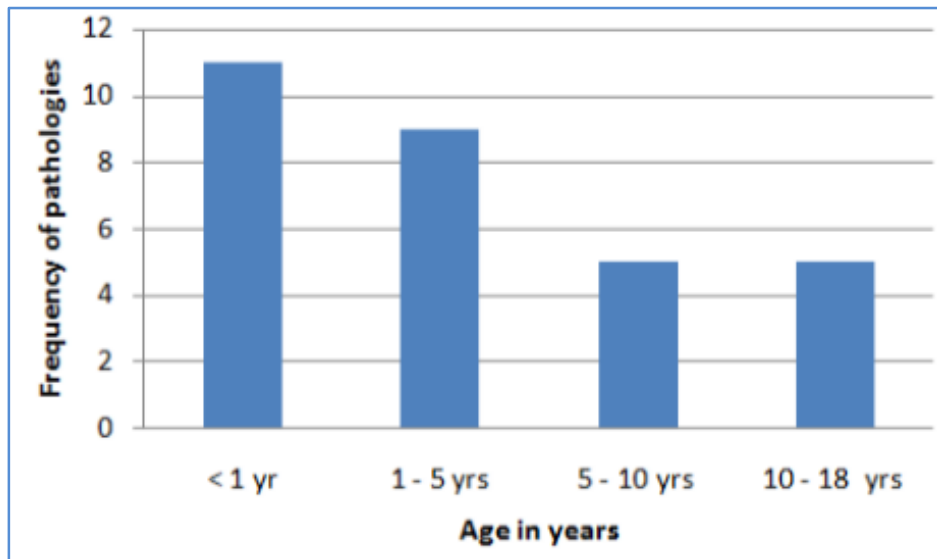


Fig. 12: Age distribution

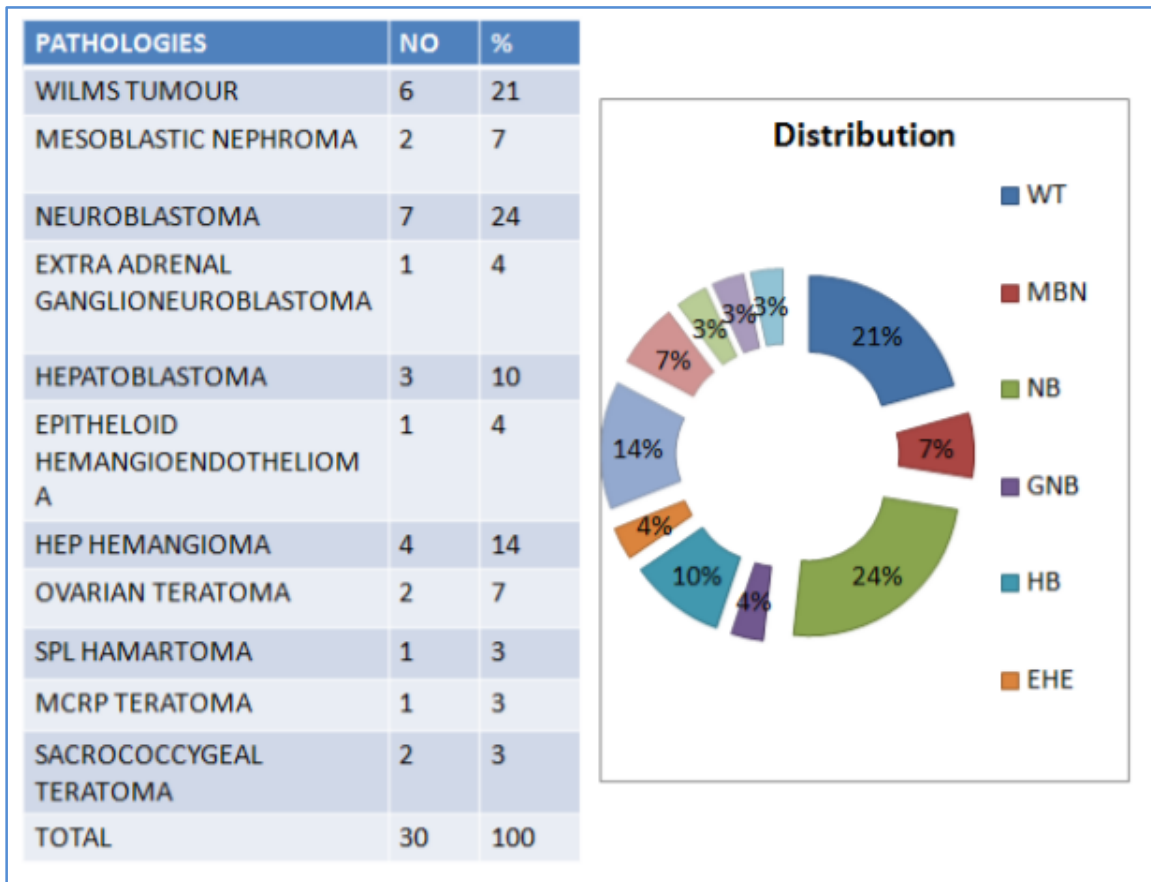


Fig. 13: Distribution of cases

ORIGINAL ARTICLE

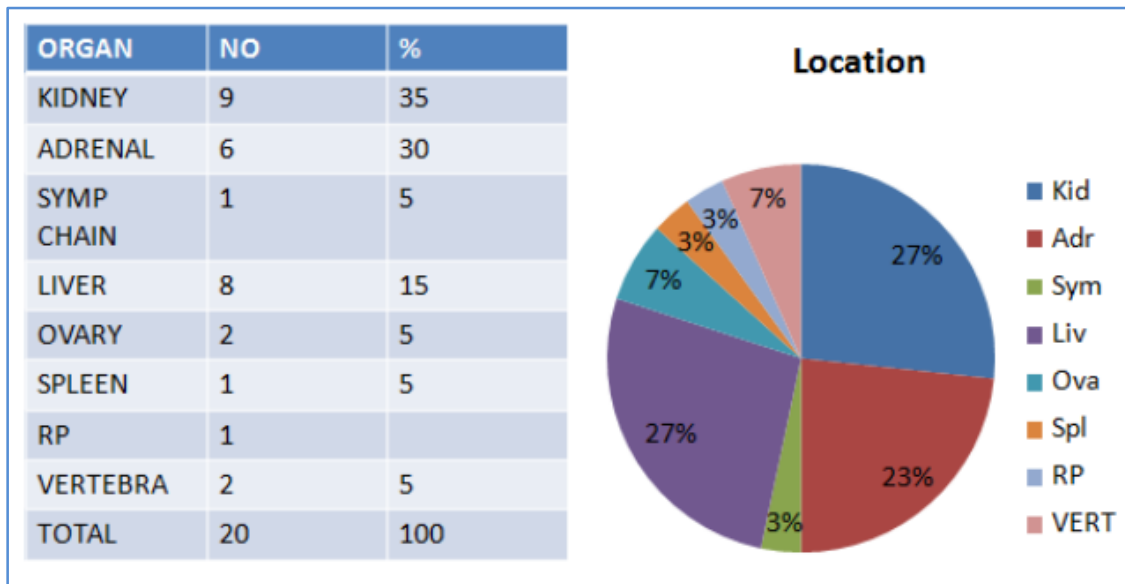


Fig. 14: Distribution based on organ of origin

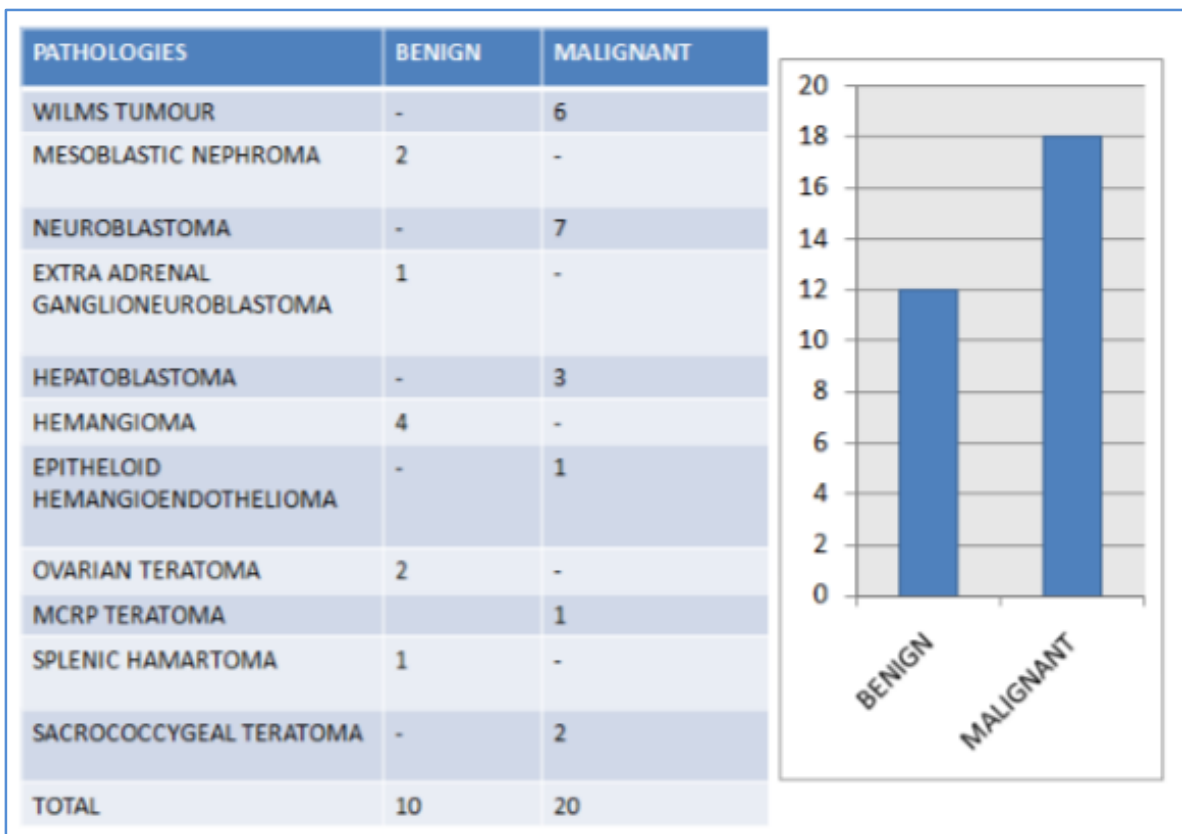


Fig. 15: Benign versus malignant pathologies

AUTHORS:

1. Rashmi M. Nagaraju
2. Bhimarao

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Radio-Diagnosis, P. K. DAS Institute of Medical Sciences, Palakkad, Kerala, India.
2. Senior Resident, Department of Radio-Diagnosis, P. K. DAS Institute of Medical Sciences, Palakkad, Kerala, India.

FINANCIAL OR OTHER**COMPETING INTERESTS:** None**NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:**

Dr. Rashmi M. Nagaraju,
Nagambika Nilaya,
86, Shivapura, Srirampura Post,
Manandavadi Road,
Mysore-570008,
Karnataka, India.
E-mail: rashmi83nagaraj@gmail.com

Date of Submission: 29/04/2015.
Date of Peer Review: 30/04/2015.
Date of Acceptance: 21/05/2015.
Date of Publishing: 23/05/2015.