ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 7 No. 1 March 2021*

Pattern of Findings among Pediatric Patients Undergoing Abdominal CT scan in Sub-Saharan African Population

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Abstract

Multi-Detector Computed Tomography (MDCT) with its multiplanar reconstruction is an excellent imaging modality to locate, characterize and differentiate various lesions. Broad spectrum of abdominal lesions can be seen in the pediatrics, which may originate from various organs and can be benign or malignant. The study was retrospectively conducted in the Department of Radiology Aminu Kano Teaching Hospital, Kano from March 2020 to September 2020. Ninety request forms and corresponding CT reports were retrieved from radiology archive. Sex, age and clinical indications were obtained from request forms while the CT findings were obtained from the radiologist report. The mean, standard deviation, frequency and range were obtained using descriptive statistics. The data was analyzed using (IBM SPSS) Version 22.0. Abdominal swelling in males and females was 9 (18.8%) and 9 (25.7) respectively and this was reported as the most frequent indication, followed by abdominal mass 6 (12.5%) and 7 (20.0%) and then jaundice 4 (8.3%) and 3 (8.6%) for male and female respectively. The most frequent CT findings was normal study 5 (10.4%) and 7 (20.0%) for males and females respectively, followed by hepatoblastoma 2 (4.2%) for males and cystic intra-abdominal mass 4 (11.4%) with mesenteric cyst as differential for females. This study confirms the potentiality of computed tomography in differentiation and characterization of solid and cystic lesion; however, some cases require further histological approach. Majority of the pediatric abdominal masses are of renal origin followed by hepatobiliary lesions.

Keywords: Computed tomography, Patterns, Findings, Nephroblastoma, hepatoblastoma

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Introduction

Computed tomography (CT) is a medical imaging procedure that uses computer – processed combination of many x-ray measurements taken from different angles to produce cross-sectional images of an object or volumetric data sets (Practice Parameter, 2019).Pediatrics is a field of medicine that is concerned with the health of infants, children, and adolescents; their growth, development and their opportunity to achieve full potential as adults. Broad spectrum of abdominal tumors can be seen in the pediatrics, which may originate from various organs and can be benign or malignant (Gupta *et al.,* 2018). Their suggestive diagnosis is mainly dependent on the patient age and imaging features of the lesion including its location, shape and internal architecture. Various tumors are common in certain age groups (from neonatal through adolescence) (Nagaraju and Bhimarao, 2015).

Multidetector computed tomography (MDCT) with its multiplanar reconstruction is an excellent imaging modality to locate, characterize and differentiate 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 (Nagaraju and Bhimarao, 2015). The advantages of CT over ultrasonography and plain radiography are; presenting image of internal organs without superimposition and capability of performing high-resolution multi-planar and 3D reconstructions which aid diagnosis by allowing the detection of subtle lesions.It also provide better visualization of bone details, calcifications and stone (Aklan and Makhalfy, 2018). The use of high dose of ionizing radiation, high cost of examination, use of large volume of contrast medium and relatively less availability is among the disadvantages of computed tomography(Michael *et al.,* 1997).

Indications for pediatric abdominal CT scan include detection of Wilms tumor, nephroma, renal cyst, renal cell carcinoma, hepatoblastoma, hemangioma, infantile hemangioendothelioma, lymphoma, neuroblastoma, teratoma, sacrococcygeal teratoma, hydronephrosis, urinary calculi, post-operative investigation, congenital anomalies, evaluation of bowel obstruction, perforation, appendicitis and GI bleeding. Other imaging modalities for abdominal imaging include Plain Film Radiography, Ultrasonography (US), Magnetic resonance imaging (MRI) and Nuclear Imaging (Practice Parameter, 2019).

Based on standard practices, every facility is expected to document patterns of findings of the procedures performed on pediatric patients which could serve as a guide for practitioners and for policy making by the management. However, empirical study shows that, pattern of findings among pediatric patients undergoing abdominal CT scan in Aminu Kano Teaching Hospital has not been documented. The study will serve as a guide to the clinical practitioners toward diagnostic workup and treatment of patients with various forms of pediatric abdominal abnormalities. The study aims at evaluating the pattern of finding among pediatric patients that undergo abdominal CT scan.

Materials and Methods

This study was retrospectively conducted in the Department of Radiology Aminu Kano Teaching Hospital, Kano from March 2020 to September 2020. The ethical approval to conduct the study was obtained from the Human Research and Ethics Committee of the Aminu Kano Teaching Hospital, Nigeria. A total of 90 pediatric Radiology request forms and corresponding CT report were retrieved from the archive of the department. The sex, age, and clinical

indications were obtained from the patient's request forms and recorded in the data capture sheet. The CT findings were obtained from radiologist's report and recorded in the data capture sheet. Only descriptive statistics was employed in the data analysis; mean, standard deviation, frequency and range were obtained. The data was analyzed using Statistical package for Social Sciences (IBM SPSS) Version 22.0.

Results

Fifty-two (55.3%) were males while 38 (44.7%) were females, 7 (7.8%) had inadequately filled request forms; 4 (4.4%) and 3 (3.3%) for males and females respectively in which clinical indication was not written. The mean age, standard deviation and range of the pediatric subject were found to be 7.48 ± 5.14 (0.06 – 17) years; 7.13 ± 4.59 (0.17 – 17) years and 7.96 ± 5.83 (0.06 – 17) years for males and females respectively. However, Table 1 shows age group distribution of the pediatric subjects involved in the study.

Table 1 shows that majority ofthesubjects were within 1 – 5 years age group [27 (30.0%)] followed by 6 – 10 [25 (27.8%)] and then 11 – 15 [20 (22.2%)] age group.

Table 1: Age group distribution of pediatrics.

Age Group (Years)	Male F (%)	Female F (%)	Total F (%)
< 1	**5 (5.6)**	**5 (5.6)**	**10 (11.1)**
1 – 5	**17 (18.9)**	**10 (11.1)**	**27 (30.0)**
6 – 10	**16 (17.8)**	**9 (10.0)**	**25 (27.8)**
11 – 15	**12 (13.3)**	**8 (8.9)**	**20 (22.2)**
≥ 16	**2 (2.2)**	**6 (6.7)**	**8 (8.9)**
Total	**52 (57.8)**	**38 (42.2)**	**90 (100)**

Table 2 shows that abdominal swelling was found to be more frequent having9 (18.8%) and 9 (25.7) for pediatric male and female respectively. This was followed by abdominal mass 6 (12.5%) and 7 (20.0%), and jaundice 4 (8.3%) and 3 (8.6%) for males and females respectively. Among the least frequent are abdominal swelling 1 (2.9%) and pelvic pain 1 (2.9%) for malesand females respectively.

Table 2: Clinical history/indication among pediatric patients

S/N	Indication	Male F (%)	Female F (%)
1.	Abdominal swelling	9 (18.8)	9 (25.7)
2.	Abdominal mass	6 (12.5)	7 (20.0)
3.	Jaundice	4 (8.3)	3 (8.6)
4.	Nephroblastoma	4 (8.3)	-
5.	Abdominal pain	3 (6.3)	3 (8.6)
6.	Epigastric mass	-	2 (5.7)
7.	Epigastric pain	2 (4.2)	-
8.	Pelvic mass	2 (4.2)	1 (2.9)
9.	? hepatoblastoma	2 (4.2)	-
10.	Abdominal pain and swelling	1 (2.1)	1 (2.9)
11.	Metastatic liver deposit	2 (4.2)	-
12.	Hepatitis	2 (4.2)	-
13.	Renal tumor	2 (4.2)	-
14.	Others	9 (18.8%)	9 (25.7%)
Total		**48 (100%)**	**35 (100%)**

F= Frequency

Among four male pediatric patients with clinical history omitted in their request form, 2 (50%)had Computed Tomography (CT) findings of normal study, 1 (25%)had multiple intra-abdominal mass likely lymphomas, also, 1 (25%) patient had CT findings of urinary bladder tumor, bilateral hydronephrosis, para-aortic lymphadenopathies and multiple simple hepatic cyst. While abdominal tuberculosis, appendicitis and hepatoblastoma were CT findings seen in three consecutive female patients respectively.

Table 3 shows that normal study was found to be the most frequent CT finding among male pediatric subject 5 (10.4%) followed by hepatoblastoma 2 (4.2%), hepatic mass 2 (4.2%), and renal cell carcinoma with liver metastasis 2 (4.2%). On the other hand, normal study had the highest frequency of7 (20.0%) among female pediatric subject followed by cystic intra-abdominal mass 4 (11.4%), abdominal tuberculosis 2 (5.7%), intra-abdominal mass possibly lymphoma 2 (5.7%) and right nephroblastoma 2 (5.7%). Pancreatic pseudocyst 1 (2.1%) and 1 (2.9%) and hepatomegaly 1 (2.1%) and 1 (2.9%) were the CT findings with the least frequency among both male and female subjects.

Table 3: Distribution of computed tomography (CT) findings among pediatric patients.

S/N	CT Findings	Male F (%)	Female F (%)
1.	NS	5 (10.4)	7 (20.0)
2.	ABD TB	-	2 (5.7)
3.	CIAM D. MC	-	4 (11.4)
4.	IAM ? L	-	2 (5.7)
5.	HB	2 (4.2)	-
6.	HeM D. HB	2 (4.2)	-
7.	RCC with M-L1	2 (4.2)	-
8.	HM ?Hts1 (2.1)	1 (2.9)	
9.	PPC	1 (2.1)	1 (2.9)
10.	RNB	1 (2.1)	2 (5.7)
11.	Others	34 (70.7%)	16 (45.7%)
Total		**48 (100%)**	**35 (100%)**

F= Frequency

Key: NS=Normal Study, ABD TB=Abdominal Tuberculosis, CIAM=Cystic Intra-Abdominal Mass, D=Differential, MC=Mesenteric Cyst, IAM=Intra-Abdominal Mass, L=Lymphoma, PPC=Pancreatic Pseudocyst, RNB=Right Nephroblastoma, HB=Hepatoblastoma, HeM=Hepatic Mass.

Though normal study was the most frequent finding with a frequency of 14 (15.6%) as observed in table 4, however, based on the organ of origin nephroblastoma 8 (8.9%) was the most frequent renal pathology followed by renal tumor 5 (5.6%). While, hepatoblastoma 4 (4.4%) was the most frequent liver pathology followed by hepatic mass 2 (2.2%)

Table 4: Distribution of common CT findings based on organs of origin

Organs	CT Findings	Frequency	Percentage (%)
	Normal study	14	15.6
Renal	Nephroblastoma	8	8.9
	Hydronephrosis	8	8.9
	Renal tumor	5	5.6
	Renal tumor ?Nephroblastom	4	4.4
	Renal cell carcinoma	1	1.1
	Renal calculi	1	1.1
	Renal function impairment	1	1.1
	Multiple simple renal cyst	1	1.1
Liver	Hepatoblastoma	4	4.4
	Hepatic mass Diff. hepatoblastoma	2	2.2
	Primary liver cell carcinoma Diff. hepatoblastoma	1	1.1
	Hepatocellular carcinoma	1	1.1
	Liver abscess ?Amoebic liver abscess	1	1.1
GIT/Peritoneum	Cystic intra-abdominal mass Diff. mesenteric cyst	5	5.6
	Abdominal TB	4	4.4
	Sacrococcygeal teratoma	3	3.3
	Rhabdomyosarcoma	2	2.2
	Retroperitoneal tumor Diff. rhabdomyosarcoma	1	1.1
	Neuroblastoma and pheochromocytoma	1	1.1
	Multiple intra-abdominal masses Diff. neuroblastoma	1	1.1
	Para-aortic lymphadenopathies Diff. abdominal TB	1	1.1
	Intra-abdominal mass ?Nephroblastoma	1	1.1

Diff = Differential, TB = Tuberculosis

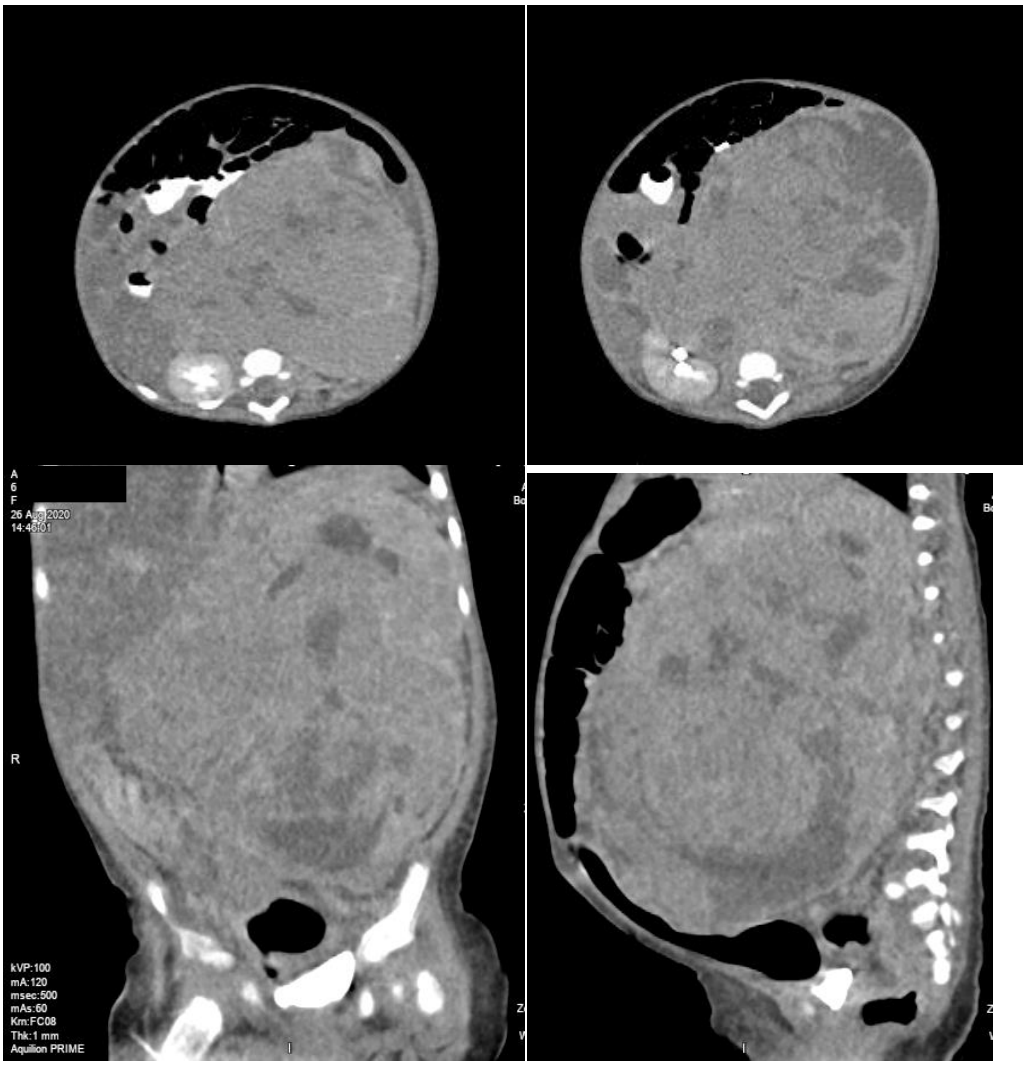

Fig. 1: Shows an axial, coronal and sagittal post IV contrast CT images of a 6month old baby showing huge multilobulated retroperitoneal mass lesion suggestive of nephroblastoma.The patient has a history of abdominal swelling and abdominal mass on ultrasound.

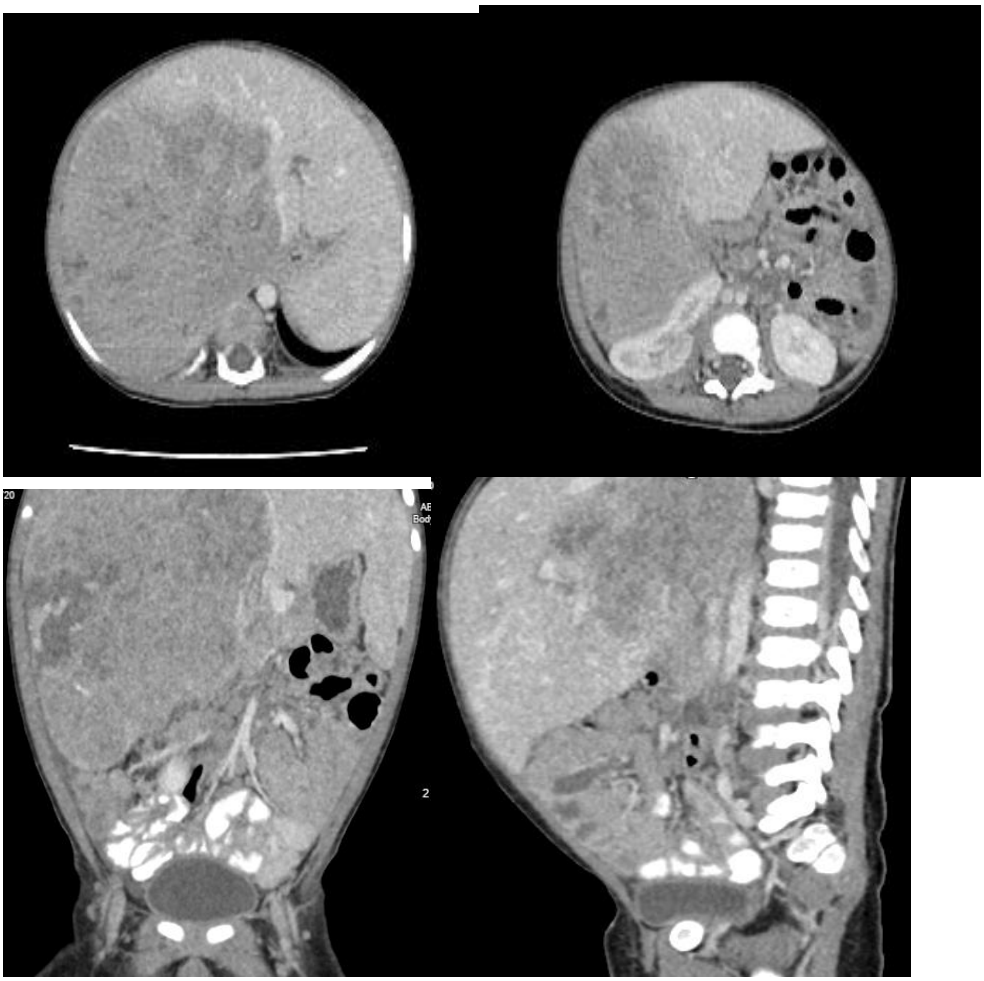

Fig. 2: Shows an axial, coronal and sagittal post IV contrast CT images of a 18month old baby showing huge intra-hepatic mass lesion suggestive of Hepatoblastoma. The patient has a history of abdominal swelling, jaundice and hepatic mass on ultrasound.

Discussion

Computed tomography has an increasing application in the evaluation of pediatric abdominal masses. However, advances in computed tomographic (CT) technology, including the introduction of multi detector row CT and the development of real time three-dimensional (3D) imaging systems, has expanded the usefulness of CT in evaluation of pediatric abdominal masses and reduced the need for sedation in non-cooperative pediatrics. CT has been is proven to be an essential imaging modality in tumor staging and differentiation as well as finding the cause of an abdominal swelling, unexplained abdominal pain and an acute abdominal pain and among pediatrics(Gupta *et al.,* 2018).

The reported mean age, standard deviation and rage in the current study were similar to the findings of the study conducted by Bahinipati *et al.*(2016) who found mean age and range of 7.5 years and 0.03 – 15 years respectively, this similarity might be due to fact both studies consider general abdominal pathologies along wide pediatric age range. However, current study contradicted the study conducted by Adegboyega *et al.*(2014) that reported mean age of 3 years. This difference may be because Adegboyega *et al.*(2014)used as mall sample size and tailored their study toward children with Wilms' tumor only. Also, contrary to the findings of the

current study as shown in Table 1, was the study by Nagaratu & Bhimarao, (2015) that reported the majority of the pediatric patients were below one year followed by 1 – 5 years age group. The differences might be because Nagaratu & Bhimarao, (2015) uses a very small sample size.
Furthermore, this study reported 83 (92.2%) subject had properly filled request forms out of which abdominal swelling was the clinical indication with the highest frequency 21 (23.3%), followed by abdominal mass 14 (15.6%), abdominal pain 10 (11.1%), jaundice 7 (7.8%) and nephroblastoma 4 (4.4%). This was similar to study conducted by Bahinipati *et al.*(2016)that reported abdominal mass 56% as the most frequent clinical indication, this similarity might be due to the fact that both studies were conducted in developing countries and that, they both consider patients with wide range of clinical indication. However, 7 (7.8%) subjects had no clinical history or indication on their request forms. This was not in line with the guidelines for standard practice, which clearly suggested that, all radiology request cards should be adequately and legibly completed, and clinical history most be clearly stated. The simple reason was that, clinical history serves as a strong guide for radiologist interpreting the images for the diagnosis of pathological conditions because some pathological processes involving pediatrics are age specific and related, it indirectly helps to reduce the investigation time and improve the quality of service offered to the patients and also helps in justification for the radiation exposure so as to reduce radiation dose administered to the patient (Abubakar *et al.*, 2015; Dambatta *et al.*, 2019)

This study as shown in Table 4 reported that, normal CT findings were the most frequent 14 (15.6%), this was contrary to findings of study conducted by Nagaratu & Bhimarao, (2015) and Bahinipati *et al.*(2016)that reported renal mass (55%) and neuroblastoma (23.3%) respectively as the most frequent findings. The reason for the differences might be because the previous conducted their studies on patients diagnosed with one or more abdominal lesion.
Furthermore, as indicated in Table 4, the findings of the current study reported that, lesions of renal origin are most common 30 (33.3%) out of which 8 (8.9%) had nephroblastoma, 9 (10.0%) had renal tumor (4 had nephroblastoma as differential), 1 (1.1%) had renal cell carcinoma, 1 (1.1%) had multiple simple renal cyst and 1 (1.1%) had bilateral renal function impairment. This was similar to the study by Gupta *et al.*(2018)that reported that26 (28%) of pediatrics abdominal lesion were of renal origin. The similarity may be because, both studies were conducted in developing countries and their sample size was larger compared to other studies. Contrary to the current study was the previous study by Bahinipati *et al.* (2016) that reported 56% of pediatric patients with abdominal mass were of renal origin, this difference might be due to small sample size used in the previous study. Furthermore, among patients with nephroblastoma about 37.5% were bilateral with a boys to girls ratio of 2:1. These findings were contrary to the findings of Adegboyega *et al.*(2014) who reported that25% of nephroblastoma were bilateral and they were all boys, the contradiction might be because the only patients with Wilms' tumor were considered in previous study and their sample size was small. Also, among patients presented with nephroblastoma 62.5% were with the age group of 1 – 5years, this was in conformity with study by Gupta *et al.*(2018) that reported 60% of patients presented with nephroblastoma before 5years. Furthermore, Adegboyega *et al.*(2014) reported only 4 patients with hydronephrosis, this was contrary to the findings of the current study which found 8 patients with hydronephrosis.

The findings of the current study reported hepatobiliary masses in 9 (10.0%) patients out of which 4 had hepatoblastoma, 2 hepatocellular carcinoma, 2 hepatic mass and 1 liver abscess.

This was contrary to the findings of Gupta *et al.*(2018) who found 8 (16%) patients presented with hepatobiliary masses out of which only 2 were hepatoblastoma, 1 hepatocellular carcinoma and choledochal cyst. Adeyiga *et al.*(2012) postulated that, hepatoblastoma is a malignant hepatic tumor and most common hepatic malignancy in the pediatric population and that it affects boys twice as often as girls. This was partly in conformity with the findings of the current study which reported hepatoblastoma 4 (44.4%) as the most prevalent hepatic lesion as mentioned above, meanwhile, on the other hand the postulation was contrary to the current study in which hepatoblastoma was found to had ratio of 1:1 among boys and girls respectively. However, three male pediatric patients were reported to had hepatoblastoma as differential of hepatic mass and hepatocellular carcinoma, this means histology evaluation was needed for further characterization of mass lesions.

As observed in Table 4, about 9 (10.0%) of pediatrics had Gastrointestinal tract related lesions out of which 4 had abdominal tuberculosis and 5 had cystic intra-abdominal mass in which mesenteric cyst was a differential. This was similar to Gupta *et al.* (2018) the similarity was because both studies were conducted on patients presenting with wide range of abdominal lesions and their sample size was not very small.

Furthermore, as indicated in Table 4, sacrococcygeal teratoma and rhabdomyosarcoma were seen in 3 (3.3%) and 2 (2.2%) cases respectively and one case of retroperitoneal tumor with rhabdomyosarcoma as differential, this was contrary to the previous by Gupta *et al.*(2018) who reported only one case each of sacrococcygeal teratoma, retroperitoneal yolk tumor and pelvic teratoma. However, current study reported only one case of neuroblastoma and one case of multiple intra-abdominal masses in which neuroblastoma is a differential. This was contrary to the study by Nagaratu & Bhimarao, (2015) who found neuroblastoma as the most common pediatric abdominal CT finding.

Conclusion

This study confirms the potential of computed tomography in differentiation and characterization of solid and cystic lesion; however, some cases may stillrequire further histological approach. The majority of the pediatric abdominal masses were of renal origin followed by hepatobiliary lesions.

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List of less frequent clinical indications and Pediatric abdominal CT scan findings that are classified as others in Table 2 and 3 respectively

Result of indications

The following indications for consecutive male pediatric patients classified as others in table 2, each with frequency of 1 (2.1%) and a total of 9 (18.8%).

Fibrosarcoma; Hepatic mass; Known pancreatic Cancer; Left flank pain; Mesenteric cyst; Pheochromocytoma; Pyloric stenosis; Sacrococcygeal teratoma; Urinary bladder tumor.

The following indications for consecutive female pediatric patients classified as others in table 2, each with has frequency of 1 (2.9%) and a total 9 (25.7%).

Abdominal mass with pain; Left Nephroblastoma; Metastatic Cancer; Ovarian Tumor; Post radiotherapy/chemo follow up; Rhabdomyosarcoma; ?Abdominal tuberculosis; ?Ovarian tumor.

Result of CT findings

The following CT findings for consecutive male pediatric patients classified as othersin table 3, each has frequency 1 (2.1%),and a total of 34 (70.7%).

Abdominal tuberculosis and lymphoma; Burkitt's lymphoma; Bilateral Hydroureteronephrosis; Bowel obstruction possibly Hirschsprung's disease; Bilateral renal calculi with bilateral hydronephrosis and left hydroureter; Bilateral renal function impairment secondary to bilateral hydroureteronephrosis and para-aortic lymphadenopathies with associated bilateral pleural effusion and ascites; Chronic pancreatitis; Cystic intra-abdominal mass with bilateral obstructive uropathy; Duodenal obstruction possibly due to duodenal fibrosis; Gastric tumor and sliding hiatal hernia; Right intra-abdominal mass likely right nephroblastoma; Rhabdomyosarcoma and lymphoma; Hepatic abscess likely amoebic liver abscess; Left nephroblastoma; Left renal tumor likely nephroblastoma; Left testicular agenesis; Multiple intra-abdominal masses with differential of neuroblastoma; Nephroblastoma; Nephroblastoma with metastasis to liver and lungs; Neuroblastoma and pheochromocytoma; Omental cyst with bilateral hydroureteronephrosis; Para-aortic lymphadenopathies with differential of abdominal tuberculosis and lymphoma; Pancreatic head tumor with metastasis to liver; Primary liver cell carcinoma, Right supra-renal tumor with intra-abdominal tumor likely metastasis with associated hepatomegaly and biliary tract obstruction; Splenic abscess; Sacrococcygeal teratoma with left obstructive uropathy and bowel obstruction; Sacrococcygeal teratoma and rhabdomyosarcoma; Splenomegaly with lymphoma and hyper-active malarial splenomegaly syndrome as differentials; Urinary bladder tumor; Teratoma, retroperitoneal rhabdomyosarcoma and omental fibroma.

The following CT findings for consecutive female pediatric patients classified as othersin table 3, each has frequency of 1 (2.9%)and a total 16 (45.7%).

Chronic liver disease; Hepatoblastoma with right hydronephrosis; Hepatocellular carcinoma with para-aortic lymphadenopathies; Hepatomegaly, bilateral pleural effusion and cholecystitis; Hepatomegaly with cholestasis and multiple left simple renal cysts; Left adnexal tumor likely ovarian carcinoma; Large bowel obstruction; Left renal tumor; Left renal tumor with metastasis to liver and lungs; Ovarian tumor with bilateral obstructive uropathy; Retroperitoneal tumor in which retroperitoneal rhabdomyosarcoma and fibrosarcoma are differentials; Right renal tumor possibly nephroblastoma; Sacrococcygeal teratoma; Teratoma and Lymphoma.