# Ultrasound in the diagnosis of cystic intra-abdominal lesions in children - a cross-sectional study from a tertiary care hospital in South India

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## ABSTRACT

**Introduction:** Pediatric abdominal cystic swellings are very common in clinical practice, with widely variable differential diagnoses. Demarcation of the organ of origin and possible nature of pathology is hence very essential. **Objective:** The objective of the study was to study the pattern of ultrasound diagnosed intra-abdominal cystic swellings in children and to evaluate the role of ultrasound as the primary imaging modality in these lesions. **Materials and Methods:** A hospital-based cross-sectional study was conducted in the Department of Radiodiagnosis, of a Medical College of Kerala, India. Study participants were children below 12 years presenting with intra-abdominal cystic swellings who underwent abdominal ultrasonography. Direct visualization at the time of surgery or histopathological diagnosis was the gold standard. Percentage of concordance between radiological findings and final diagnosis was calculated. Significance of ultra-sonological findings associated to malignancy was assessed using Chi-square test. **Results:** In this study, the most common organ of origin for the cysts was the kidney, and the most common diagnosis was hydronephrosis. In 62 out of the total of 65 cases, ultrasound was able to rightly predict the pathology as to benign or malignant, with an overall accuracy of 95.3%. It had a sensitivity of 71.4%, specificity of 96.6%, and positive predictive value of 83.3%, and negative predictive value of 98.2% in determining the benign or malignant nature of a cyst. **Conclusions:** Ultrasound was found to be highly accurate in ascertaining the organ of origin, and in predicting whether a cyst is benign or malignant.

**Key words:** *Children, Cystic lesions, Intra-abdominal lesions, Tumors, Ultrasonography*

Intra-abdominal cystic lesions are often encountered in infancy and childhood, and these may be either congenital or acquired. In many cases, imaging surveillance on a periodic basis will be appropriate, and surgery can be resorted to when features suggestive of malignant change are seen or if the child becomes more symptomatic. Hydronephrosis characterized by dilatation of the renal pelvis in communication with dilated calyces, is the most frequent abdominal cystic mass in neonates and infants [1,2] and it is managed differently from other common abdominal cysts in children.

With the advent of newer investigations such as the computed tomography (CT) scan and the magnetic resonance imaging (MRI) scan, ultrasonography (USG) has been less used to diagnose intra-abdominal tumors in adults as the latter is limited by bowel gas obscuration and operator dependency [3,4]. However, USG is the workhorse of pediatric abdominal imaging as it does not involve ionizing radiation, is easily available, rarely requires sedation, is portable, less costly and is suited to the body habitus of children. Ultrasound imaging in correlation with the clinical history and physical examination findings can usually aid in narrowing the differential diagnosis which is helpful in charting out a follow-up plan and segregating surgical from non-surgical cases [5-8].

Solid lesions have a more varied spectrum of appearances, and hence, these may require additional workup such as contrast enhanced CT and/or MRI. On the other hand, cystic lesions are well characterized by the initial ultrasound itself, which is regarded as the investigation of choice in such cases. The main advantage of ultrasound is that the internal morphology of the cyst is well delineated as the problems of partial volume imaging as in CT scans do not exist. Very thin septa, loculations, papillary projections, particulate nature of the cyst contents, wall thickness, pericystic collections, internal debris, presence of gas, fistulous communications, and calcifications can all be made out easily by ultrasound [9,10]. Repeated re-assessments are also easily feasible with ultrasound. Ultrasound examination of the rest of the abdomen also helps to assess the presence of other supportive clinical findings such as ascites, lymph node enlargement, features suggestive of inflammation, ductal dilatation, vascular thrombosis, metastases to other organs, and involvement of surrounding structures.

Aims of the present study were to document the pattern of intra-abdominal cystic lesions and to evaluate the accuracy of ultrasound in identifying the structural characteristics of the cyst and other intra-abdominal pathological changes in the pediatric age group.

## MATERIALS AND METHODS

A hospital-based cross-sectional study was conducted in the Department of Radiodiagnosis of a large, public tertiary care teaching centre, in the state of Kerala, India, from July 2013 to September 2014. All the patients satisfying all the inclusion criteria were consecutively enrolled in the study during the study period. An informed written consent was obtained from the parents or legal guardians of the patient for performing ultrasound examination and for using the data for the study. Ascent from the child was sought in case of older children. The study protocol has been approved by the Human Ethics Committee of Government Medical College, Kozhikode.

The inclusion criteria were children below 12 years of age, who have undergone USG abdomen, and were detected to have an intra-abdominal cystic lesion and a post-scan surgical correlation and/or histopathological diagnosis was available. Those children in whom the final diagnosis was not available were excluded from the analysis. Depending on the diagnosis, some of these patients underwent the definitive surgical procedure. The findings of USG were evaluated against findings of the surgeon at the time of laparotomy, or FNAC, biopsy, or histopathological examination as was relevant in the respective cases.

A structured pro forma was used to extract the data present in case sheets and scan report. The study variables included demographic details, the site of lesions, organ system involved, the physiological characteristics of the lesion, pathological features of the lesion, and the diagnosis. Sonological diagnoses were correlated with the pathological diagnosis to evaluate the validity of ultrasound scans in cystic intra-abdominal lesions among children. The nature of the lesion, benign versus malignant according to the final pathological analysis was the major outcome variable for analysis in the current study.

The data collected were entered into Microsoft Excel to prepare the master chart and analyzed using SPSS software version 16. All clinical, radiological, and pathological characteristics were reported in percentage. The information on the agreement between the radiological and pathological diagnoses was given in terms of percentage of concordance. All the diagnoses on which the two modalities were discordant were tabulated separately. Malignant lesions were compared with benign lesions in their ultrasound features. Cross-tabulations and statistical significance of associations were tested using Chi-square test with a maximum alpha error of 5%.

## RESULTS

Out of 66 participants, 10 (15.2%) were neonates, 6 (9.1%) were infants, 18 (27.3%) were <5 years, and the rest 32 (48.5%) were children in the age group 5–12 years. Half of the participants (n=33, 50%) were girl children. For 17 children (25.8%), lesion in the abdomen was not confined to a single quadrant. Of the localized lesions, the left lumbar (n=11, 16.7%) and the pelvis (n=11, 16.7%) were the most common quadrants involved. Details are given in Table 1. The shape of the lesion on ultrasound was round in 23 (34.8%) followed by reniform shape (n=21, 31.8%). Eight lesions (12.1%) were found to be irregular in shape. The sonological findings include particles in 17 (25.8%) cases, solid component in 15 (22.7%) lesions, septae in 10 (15.2%) cases, lymphadenopathy in 3 (4.5%), metastases and infiltration in 2 (3%) cases, and each and ascites in 1 (1.5%) patient.

On USG, the most common organ of origin of the lesion was renal (n=28, 42.4%), followed by retroperitoneal (n=16, 24.2%) as

**Table 1: Location of swelling/lesion**

| Site | n (%) |
|---|---|
| Left lumbar | 11 (16.7) |
| Right lumbar | 9 (13.6) |
| Pelvis | 11 (16.7) |
| Right hypochondrium | 8 (12.1) |
| Left hypochondrium | 2 (3.0) |
| Epigastrium | 4 (6.1) |
| Hypogastrium | 4 (6.1) |
| Involving more than one quadrant | 17 (25.8) |

**Table 2: Organs and organ systems affected by the lesion**

| Variable | Category | n (%) |
|---|---|---|
| Organ system involved | Renal | 28 (42.4) |
| | Ovary | 8 (12.1) |
| | GIT | 5 (7.6) |
| | Hepatobiliary | 7 (10.6) |
| | retroperitoneal | 16 (24.2) |
| | Spleen | 2 (3.0) |
| Broad classification of lesions* | Vitellointestinal duct anomalies | 4 (6.1) |
| | Ovarian cysts | 8 (12.1) |
| | Obstructive uropathy | 18 (27.3) |
| | Congenital renal anomalies | 4 (6.1) |
| | Hepatobiliary and pancreatic lesions | 11 (16.7) |
| | Tumor with cystic degeneration | 10 (15.2) |
| | GI cysts | 4 (6.1) |
| | Others | 7 (10.6) |

***Vitellointestinal duct anomalies - urachal cyst, umbilical cyst. Ovarian cysts - benign ovarian cyst. Obstructive uropathy - hydronephrosis, duplex kidney with hydronephrosis and ureterocoele. Congenital renal anomalies - multicystic dysplastic kidney, multilocular renal cyst. Hepatobiliary and pancreatic lesions - choledochal cyst, pyogenic liver abscess, pseudocyst of pancreas, amoebic liver abscess, subcapsular hematoma, Caroli's disease. A Tumor with cystic degeneration - wilms tumor, retroperitoneal teratoma, sacrococcygeal teratoma, neuroblastoma, rhabdomyosarcoma. GI cysts - mucocele of appendix, enteric duplication cyst. Others - lymphangioma, splenic cyst, psoas abscess, anterior sacral meningocoele. GI: Gastrointestinal**

shown in Table 2. The most common pathology as per ultrasound was obstructive uropathy (n=18, 27.3%). Hepatobiliary and pancreatic lesions were found in 11 cases (16.7%). Tumors with cystic degeneration were found in 10 patients (15.2%). Details are given in Table 2. In 55 (83.3%) patients, the USG diagnosis was in concordance with the final haptoglobin-related protein (HPR) diagnosis. The details of the cases with discordance between the USG and HPR diagnosis are listed in Table 3.

Accuracy of ultrasound was fairly high, and discordance with final diagnoses was observed only in 11 out of 66 cases (Table 3). Even in these 11 cases, ultrasound findings did not alter the therapeutic decision, except in two cases: A cystic inflammatory pseudotumor was diagnosed as cystic Rhabdomyosarcoma, and a Rhabdomyosarcoma was falsely diagnosed as sacrococcygeal teratoma. A case of Meckel's diverticulum with torsion was sonologically mistaken to be an infected duplication cyst as it showed gut wall signature with echogenic mucosal layer and hypoechoic muscle layer. There were also sediments inside the cyst (could be explained as due to hemorrhage following ulceration of ectopic gastric mucosa in the Meckel's diverticulum). There was minimal free fluid in the peritoneal cavity. Clinically, the patient was febrile. This prompted a provisional diagnosis of infected duplication cyst. The intraoperative findings were of Meckel's diverticulitis with torsion.

**Table 3: Cases with discordance between USG diagnosis and HPR diagnosis**

| USG diagnosis | HPR diagnosis |
|---|---|
| Solid and cystic tumor of ovarian origin? Malignant | Immature teratoma |
| Anterior sacral meningocele | Sacrococcygeal teratoma with cystic degeneration |
| Sacrococcygeal teratoma | Rhabdomyosarcoma |
| Hydronephrosis | Multicystic dysplastic kidney |
| Infected duplication cyst | Meckel's diverticulum |
| Mesenteric cyst | Omental cyst |
| Multilocular renal cyst | Mesoblastic nephroma |
| Pseudocyst of pancreas | Splenic cyst |
| Urachal cyst | Enteric duplication cyst |
| Pseudocyst of pancreas | Mesenteric cyst |
| Cystic Rhabdomyosarcoma | Inflammatory pseudotumor |

**USG: Ultrasonography, HPR: Haptoglobin-related protein**

A renal lesion with multiple cysts of varying sizes connected by CT septae, absence of solid component, lymph node enlargement, or other sonographic evidence of local infiltration was diagnosed by ultrasound as multilocular renal cyst; however, the HPR diagnosis was mesoblastic nephroma. A large cyst was noted in the epigastrium, located anterior to the pancreas and displacing the spleen laterally, and hence, was diagnosed sonologically as a pseudocyst of the pancreas. The visualized area of splenic parenchyma appeared to be normal. The patient gave a history of abdominal trauma about 9 months back. Multiple cysts as described can occur in this condition also due to hemorrhage and necrosis. Intraoperatively, the cyst turned out to be originating from the spleen.

Nine patients (13.6%) were found to be having malignancy according to pathological analysis. In detecting the malignant nature of a cystic swelling, the ultrasound had a sensitivity of 71.4%, specificity of 96.6%, positive predictive value of 83.3%, and negative predictive value of 98.2%. Overall, the attribution of benign or malignant diagnosis by USG was confirmed in 62 patients, giving an overall accuracy of 95.3%. The comparison of radiological findings in benign and malignant lesions is given in Table 4. Significant findings associated with malignant lesions were an irregular shape, the presence of solid component, lymph nodes, infiltration, and metastases. Malignant lesions were generally larger in size than the benign lesions (Table 4).

**Table 4: Ultrasound findings associated to malignant intra-abdominal cystic lesions**

| Variable | Category | Malignant (%) | Benign (%) | p |
|---|---|---|---|---|
| Shape | Round | 4 (44.4) | 19 (33.3) | 0.004 |
| | Ovoid | 1 (11.1) | 13 (22.8) | |
| | Reniform | 0 (0) | 21 (36.8) | |
| | Irregular | 4 (44.4) | 4 (7) | |
| Presence of wall | Present | 4 (44.4) | 27 (47.4) | 0.870 |
| Septae | Present | 2 (22.2) | 8 (14.0) | 0.524 |
| Solid component | Present | 9 (100) | 6 (10.5) | <0.001 |
| Ascites | Present | 0 (0) | 1 (1.8) | 0.689 |
| Particles | Present | 1 (11.1) | 16 (28.1) | 0.280 |
| Lymph nodes | Present | 2 (22.2) | 1 (1.8) | 0.006 |
| Infiltration | Present | 2 (22.2) | 0 (0) | <0.001 |
| Metastases | Present | 2 (22.2) | 0 (0sss) | <0.001 |
| Anthropometric dimension | Mean (SD) | 8.11 (3.29) | 7.25 (2.23) | 0.321 |
| Transverse dimension | Mean (SD) | 7.07 (2.83) | 5.67 (1.71) | 0.043 |
| Craniocaudal dimension | Mean (SD) | 6.00 (2.57) | 4.45 (1.26) | 0.005 |
| Wall thickness (mm) | Mean (SD) | 6.75 (3.86) | 4.85 (2.52) | 0.198 |

**SD: Standard deviation**

## DISCUSSION

Cystic abdominal masses are one of the most common clinical conditions of childhood requiring a radiological investigation. Ultrasound examination was the initial and perhaps only imaging investigation required in most of the patients in our series. It provided enough information to guide the therapeutic decision-making in most cases [11]. Intra-abdominal cystic lesions of the pediatric age group may vary along a vast range of differential diagnoses. The key to the accurate diagnosis of a particular lesion lies in the differentiation of it being of a solid parenchymatous or non parenchymatous in origin. Lesions of intra-abdominal solid parenchymatous origin are those which arise from the liver, kidney, spleen, pancreas, and adrenal gland, while lesions of non parenchymatous origin arise either from the bowel, mesentery, or retroperitoneum.

The initial step to reaching a definitive diagnosis lies in recognition of lesion as lying within the borders of a solid parenchymatous organ. Such a lesion will usually be surrounded by the parenchyma wholly, or at least partly if the swelling is exophytic. Considerations for differential diagnosis in these cases are usually limited to pathologies which arise from the involved solid organ. Although ultrasound is a very useful workhorse in the initial detection and diagnosis of intra-abdominal cystic lesions which arise from solid parenchymatous organs, the role is limited in the characterization of focal lesions which arise from non parenchymatous structures such as the bowel, mesentery, omentum, and the retroperitoneum. Due to the absence of typical clinical and imaging findings, the definitive diagnosis of large non parenchymatous lesions in children is more difficult to diagnose with ultrasound alone. Hence, appropriate additional imaging modalities should be chosen for detailed evaluation of anatomic location, margins with adjacent organs and extension to intra- and extra-peritoneal spaces [12,13].

Once the origin of a cystic lesion from a solid organ is confirmed, the next step is to differentiate whether it is benign or aggressive in nature. The presence of thick septations, solid components, wall nodularity, infiltrative margins, lymphadenopathy, and ascites points toward a more aggressive nature such as malignancy, whereas thin imperceptible walls, clear fluid, thin or no septations, and absence of solid component, ascites, lymphadenopathy, and systemic changes are more favorable for a benign and localized pathology. Once an aggressive/malignant lesion is suspected on ultrasound, the logical next step is the use of a higher modality such as CT or MRI for staging, characterization, and delineation of the adjacent borders. CT and MRI will considerably assist in the better characterization of such cases [12,13].

In most of the patients in our series, the primary role of the ultrasound was to ascertain the organ of origin of the cystic swellings. The most common locations of the swellings were either lumbar region or pelvis. Kidney was the most common organ involved. Kidneys are one of the most common organs of origin for cystic swellings of abdomen and ultrasound scan is the most useful primary investigation for its detection and follow-up [14-18].

It is seen that in one of the cases, a Rhabdomyoma was misdiagnosed as retroperitoneal teratoma and in another occasion, an inflammatory swelling was diagnosed as Rhabdomyosarcoma. The radiological diagnosis is often challenged by these tumors of cystic degeneration. Some of these tumors are rapidly progressing and are having a poor treatment outcome [19,20]. Other than imaging techniques, other investigations including tumor-marker assays may be also useful in case of these neoplasms [21]. A benign cystic swelling of the abdomen can induce severe inflammatory reaction and infiltration to surrounding tissue, and it could also be a reason for misdiagnosis as a malignant lesion [22].

The diagnostic ultrasound was found to be very useful investigation to predict malignancy in cystic lesions of the abdomen in children as previously reported [23]. The sensitivity of USG in this study was lower than that of MRI scan reported in the radiological detection of malignant tumors in a study among pediatric oncology patients (71% and 88%). However, the specificity was as good as that of MRI (around 95%) [24]. Among the radiological features suggestive of malignancies, the presence of solid components and infiltration was more suggestive of a malignant lesion as reported elsewhere [25].

## CONCLUSION

In this study, we highlighted the role of ultrasound as a simple and reliable initial investigation modality in the imaging of pediatric abdominal cystic swellings. In cases, where the ultrasound is equivocal or inconclusive, an additional imaging tool like the CT scan of the MR may be useful for problem-solving.

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