ORIGINAL RESEARCH PAPER
Volume - 12 | Issue - 06 | June - 2023 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

DIAGNOSTIC ACCURACY OF ULTRASOUND IN THE EVALUATION OF CLINICALLY SUSPECTED PEDIATRIC ABDOMINAL MASS LESIONS.

Radio-Diagnosis

Dr. Sanika V. Patil Senior Registrar in Radiology at SVDS Municipal General Hospital, Mumbai, India.

Dr. Padma V. Badhe* Professor, Department of Radiology, Seth G.S.M.C. and K.E.M. Hospital, Mumbai, India. *Corresponding Author

Dr. Pawal Sambhaji K Assistant Professor, Department of Interventional Radiology D.Y. Patil Medical College and Research Centre, Pune, India.

ABSTRACT

Context: Sound knowledge of routine pediatric abdominal masses and clinical and radiographical features assists us to infer a differential diagnosis and formulate guidelines for their further management. **Aim:** This study aims to analyze the accuracy of Ultrasound in the evaluation of pediatric abdominal masses on the basis of their anatomical site, morphology, extent, and internal vascularity, and also to assess their relation with vital structures. **Setting and design:** This is a cross-sectional observational single-center study design. Consecutive pediatric (upto 12years) patients with suspected abdominal masses were evaluated, and those found to have a space-occupying abdominal mass on ultrasound were included in the study. **Methods and material:** Their Ultrasound diagnoses and final histopathological results were collated, to assess how accurate the initial Ultrasound diagnoses were. Sensitivity, specificity, positive and negative predictive value, and accuracy of ultrasound in diagnosing various abdominal masses were calculated. **Results:** 68 patients with abdominal masses were included, of which 43 were intraperitoneal. Out of 68 patients, the histopathological results of 62 patients were available. Overall, there was a good correlation between the ultrasound diagnoses and histopathological results in 50/62 patients. In our study, ultrasound was able to diagnose duplication, hydatid, and choledochal cysts, hemangioendotheliomas and pancreatic pseudocysts with 100% accuracy, sensitivity, and specificity. **Conclusions:** With its non-invasiveness, wide availability, and ease of use without the risks associated with ionizing radiation exposure, ultrasound is an excellent imaging modality for the initial evaluation of a suspected pediatric abdominal mass. When a mass is present, the ultrasound features and clinical presentation of the patient can lead to a focused differential diagnosis in most cases. In a few cases, optimal ultrasound examination may even facilitate a definite diagnosis without the need for additional imaging studies.

KEYWORDS

ultrasound, abdominal mass, pediatric tumor, histopathology correlation

INTRODUCTION:

Pediatric abdominal masses are quite common in a busy pediatric imaging practice and can occur anytime from the newborn period to adolescence having varied etiologies and clinical presentations. Sound knowledge of routine pediatric abdominal masses and clinical and radiographical features assists us to infer a differential diagnosis and formulate guidelines for their further management.[1] The accuracy of Ultrasound as a diagnostic modality is underrepresented in the published literature. Radiographs were used in the past for diagnosis but with the advent of newer cross-sectional modalities like ultrasound (US), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI), the accuracy of diagnosis has increased tremendously. Ultrasound deserves a special mention in this regard given its lack of radiation or necessity of patient sedation, making it more appealing for use in the pediatric population [2] Its easy availability and affordable cost, prove ultrasound to be a very useful asset for any developing country. In many cases, ultrasound alone is enough to diagnose certain abdominal masses, thereby cutting down the cost and treatment delays. The purpose of this study is to review the diagnostic accuracy of ultrasound for abdominal mass lesions in the pediatric age group by its correlation with pathological findings.

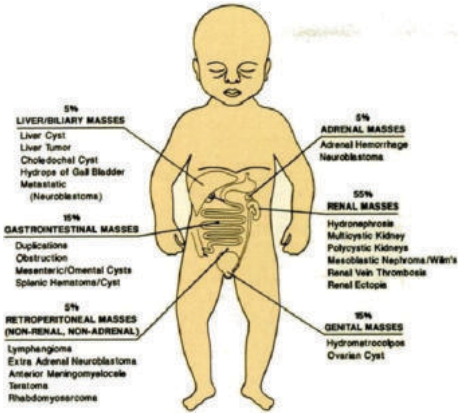

Fig 1. Distribution of abdominal masses in pediatric age group by organ system. [3]

SUBJECTS AND METHODS:

In this non-interventional cross-sectional observational single-center study design, an Ultrasound examination of 68 consecutive patients with abdominal mass lesions was performed at a tertiary care center, for a period of 12 months. The complete study was approved by Institute's Ethical Committee (IEC). Any pediatric (up to 12yrs of age) patient with a suspected abdominal mass as suggested clinically was selected and evaluated. Those who were found to have a spaceoccupying abdominal mass lesion on ultrasound were included in the study. Those patients presenting with abdominal pathologies but without a definitive space-occupying mass lesion on ultrasound were excluded from the study. Informed consent was obtained from the parents/ legal guardians of the patient, and assent was obtained from the patients 7 years or more in age. The study included taking consent, a brief clinical history, and a relevant systemic examination followed by ultrasound. B-mode followed by color Doppler sonographic examination of the abdomen was performed using 3.5-5 MHz curvilinear and 5-7 MHz linear probes on a PHILIPS HD11 XE machine. Ultrasound characteristics studied to make the diagnoses included the echogenicity of the mass, number, and location of the lesion, its relationship with the neighboring structures, its organ of origin, presence of intralesional fat or necrosis if any, and vascularity was taken into consideration. The final histopathological diagnosis of all patients who underwent a biopsy or surgery was noted in the respective case record form. The data were collected, evaluated, and compiled into a comprehensive table. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic value of ultrasound in the diagnosis of pediatric abdominal mass lesions were calculated using the standard definitions.

RESULTS:

In our study, a total of 68 patients including 9 neonates, 13 infants, and 46 children, with abdominal mass lesions were studied. All patients presented with abdominal swelling with different clinical diagnoses. The results and observations with reference to different parameters were as follows. 38 (56%) of patients were male and 30 (44%) were female. 45 (66%) of the abdominal mass lesions were benign in nature while 23 (34%) were malignant in nature. Out of 62, 43 lesions were intraperitoneal, 30 were extraperitoneal and 5 were both intra and extraperitoneal. The ultrasound appearance of 32 (47%) abdominal mass lesions was solid, 25 (36.7%) were cystic and 11 (16.1%) showed

mixed heterogenous appearance. The most common site location of the abdominal masses was the bowel (16%) followed by the kidney (13%). Of the above mass lesions, 35 (56%) showed significant internal vascularity while 33 (53%) were avascular on Doppler ultrasound assessment. 33 of the lesions were neoplastic, 19 were of congenital origin, 11 were infective and 2 were inflammatory in nature. Out of 68 patients, we got histopathology confirmation in 62 patients. Of the remaining 6 patients, one patient with an adrenal hemorrhagic cyst was followed up and the resolution of the cyst was noted. Hence, histopathological confirmation was not done. One patient had multiple intestinal polyps and was kept on regular follow-ups. Two patients had hemangioendothelioma and the diagnosis was confirmed on CT, MRI, and a falling trend of AFP levels. Both patients were conservatively managed and kept on the follow-up to look for spontaneous resolution. Two patients had pancreatic pseudocysts. The diagnosis was corroborated by CT/MRI and elevated serum amylase and lipase levels. Endoscopic drainage was performed in one patient and stent placement was done in the other patient presenting with pseudocyst Ultrasound correctly identified 50/62 (81%) of the pathologies, which correlated with post-biopsy or post-surgical histopathology. However, there was a discrepancy between the findings in 12 (19%) cases.

Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of ultrasound in diagnosing various abdominal masses in our study group have been calculated and tabulated.

Data Analysis-

Table 1: Distribution Of Patients According To The Site Of Origin Of The Mass Lesion.

Site of origin	No. of patients	Percentage
Retroperitoneal and pelvic soft tissue	10	13 %
Pancreas	2	3 %
Adrenal	4	5 %
Mesentery	4	5 %
Lymph node	5	7 %
Spleen	5	7 %
Ovary	5	7 %
Biliary tree	9	12 %
Liver	9	12 %
Kidney	10	13 %
Bowel	12	16 %

Table 2: Correlation Of Usg Diagnosis With Histopathology

Name of pathology	Imaging Diagnosis	Histopathology
Neuroblastoma	4	4
Duplication cyst	4	4
Polyps	2	2
Appendiceal lump	1	1
Choledochal cyst	9	9
Hydatid cyst	4	4
Mesenchymal Hamartoma	1	1
Liver abscess	2	2
Tuberculosis	3	3
Lymphoma	7	5
Leukemia	2	2
Mesenteric Lymphangioma	1	2
Teratoma	4	3
Dysgerminoma	1	0
Yolk sac tumour	0	1
Sex cord - stromal tumour	0	1
Rhabdomyosarcoma	2	1
Mesenteric abscess	0	1
Angiomyolipoma	2	0
Wilms	4	2
CCSK	0	1
Malignant rhabdoid tumour of the kidney	0	1
RCC	0	2
PNET	2	2
SCT	6	6
Ovarian cyst	1	1
Epithelial cyst	0	1
Total	62	62

Table 3: Accuracy Of Ultrasound In Diagnosis

Diagnosis	USG & Histopathology Correlated	USG & Histopathology Discrepant
No. of patients	50 (81 %)	12 (19 %)

Table 4: Case Wise Data Analysis

Diagnosis	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Duplication cysts	100	100	100	100	100
Lymphoma	100	96.4	71.4	100	96.8
Neuroblastoma	75	98.2	75	98.2	96.8
Choledochal cysts	100	100	100	100	100
Hydatid cysts	100	100	100	100	100
Sacrococcygeal teratoma	83.3	98.2	83.3	98.2	96.8
Pseudocysts	100	100	100	100	100
Hemangioendotheliomas	100	100	100	100	100
Wilms' tumour	100	96.6	50	100	96.8
Malignant round cell tumours (RMS & PNET)	100	98.3	75	100	98.4

Table 5: Usg & Histopathology Discrepant Cases

Sr. No.	Imaging Diagnosis	Histopathology Diagnosis
1	Lymphoma	Mesenteric lymphangioma
2	Rhabdomyosarcoma	Perforated Meckel's diverticulum with mesenteric abscess
3	Dysgerminoma	Ovarian haemorrhagic cyst
4	Lymphoma	Ovarian sex cord-stromal tumour
5	Neuroblastoma	Yolk sac tumour (Non-seminomatous GCT)
6	Angiomyolipoma	Translocation associated RCC
7	Angiomyolipoma	Translocation associated RCC
8	Wilms' tumour	CCSK
9	Wilms' tumour	Malignant rhabdoid tumour of the kidney
10	Ovarian cyst	Cystic SCT
11	Dermoid cyst	Benign epithelial cyst
12	SCT	Presacral neuroblastoma

DISCUSSION:

Abdominal lesions are a very common entity that could be seen in routine clinical and radiological examinations. Though clinical examination forms a very strong tool in diagnosing abdominal masses radiological investigation forms strong support in confirming the clinical diagnosis.[4] Nevertheless, the clinical findings in the abdominal lesions often have low specificity, and, in most situations, additional imaging studies are required. When evaluating a child's abdominal mass, the patient's age, sex, history, and clinical findings are the most important parameters to be included in the process of establishing a diagnosis. This renders pediatric radiology a distinct clinical specialty.[5]

The pediatric study group has been divided into these three groups because the differential diagnoses change with age and thereby making it easier to narrow down the list of differentials. Commonly neonatal abdominal mass lesions will be due to benign lesions in the retroperitoneum such as hydronephrosis and multicystic dysplastic kidney. [5] These pathologies are not included in this study as the palpable lump represents an enlarged kidney secondary to an obstructive component without a definite space-occupying lesion. Similarly, several other pathologies like intussusception, fecal masses, intestinal atresia with proximal bowel dilatation, hydrops of gall bladder, hydrometrocolpos, and hepatosplenomegaly present like an abdominal mass but are not included in the study. When an abdominal mass is suspected by clinical examination or plain film radiography, ultrasound is the initial imaging modality of choice in infants and children.[6]

Often a focused differential diagnosis can be formed from the imaging characteristics on ultrasound. This allows for an appropriate discussion of clinical management and further imaging studies may be recommended if necessary.

During an ultrasound examination, there are certain features of the mass that should be noted, including echogenicity and vascularity,

which help define the internal characteristics and may even aid in determining the organ of origin. The larger the abdominal mass, the more difficult it may be to discern the organ of origin. Continuity of the mass with a specific organ and any displacement or mass effect on the organ's internal vascularity may also point to the correct etiology of an abdominal mass. After determining the organ of origin, the rest of the organs and adjoining structures should be closely examined to look for direct or indirect involvement, such as invasion of surrounding solid organs, invasion into blood vessels or thrombosis, lymphadenopathy, or involvement of distant organs to suggest metastatic disease. When abdominal masses are investigated by ultrasound, the sonographer should use the appropriate transducer and preserve suitable soft-tissue penetration[7]. Curved array or linear array transducers may be used, depending on the patient body habitus. Imaging can be done in different planes and positions for an appropriate acoustic window. Fluid intake during the examination may also help in some cases to distinguish the bowel from the organ or mass being evaluated or to provide an improved window. One of the most important considerations in formulating a differential diagnosis is the patient's age. For example, the most encountered abdominal masses in neonates are rarely present in older children and vice versa.

After understanding the respective pathological entities, a specific list of differential diagnoses can be made after considering ultrasound findings and patient demographics, such as age and sex. If indicated, suggestions for any additional imperative imaging can be made. [8] Our study group consists of 38 (56 %) male and 30 (44%) female patients. Common abdominal malignancies like Wilms'and Neuroblastoma do not have a sex predilection. Sacrococcygeal teratoma, choledochal cysts, and adrenocortical tumors are commoner in females; and mesenchymal hamartoma and clear cell sarcoma of the kidney have a male predominance. Ovarian masses are exclusive to female patients. In general, benign lesions are far more common than malignant ones and, in our study, there were 45 (66 %) benign mass lesions and 23 (34 %) malignant masses. Ultrasound is definitive in most benign masses and coupled with clinical and laboratory findings, it may be the sole radiological investigation required for diagnosis.

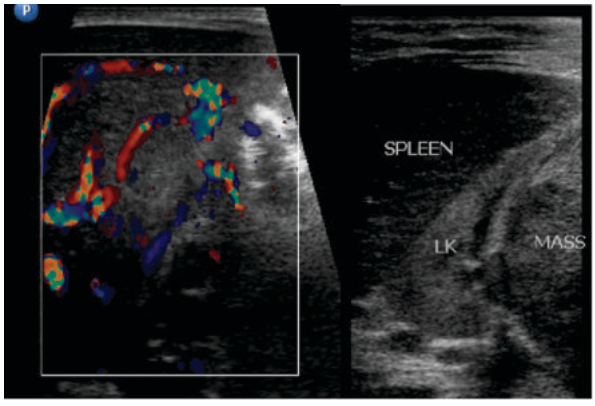

Figure 3: Malignant rhabdoid tumour of the kidney – A large solid vascular hypoechoic mass is seen arising from the lower pole of the left kidney (LK). Preserved upper pole parenchyma is seen in the second image. Ultrasound features of Wilms', CCSK, and Malignant rhabdoid tumors are similar and they are indistinguishable many times.

The estimated diagnostic accuracy of the ultrasound in detecting a pathological pediatric abdominal mass was high. This is comparable to reports in an Ethiopian study showing diagnostic accuracy at 88.9%.[9] Reports by other authors in separate studies show similar values of 78%,[10]82%,[11] and 85%[12]. Sensitivity, specificity, and positive predictive values were equally high and encouraging in our study as compared to other studies.[9,11] This is also similar to the reports by Barker and Lindsell,[11]and Kebede and Nigussie.[9]

While the diagnostic accuracy in specific disease conditions such as duplication cysts, hydatid cysts, choledochal cysts, hemangio endotheliomas and pancreatic pseudocysts, showed 100% accuracy, sensitivity, and specificity; indices obtained for Wilms tumor, lymphoma, and neuroblastoma show that ultrasound diagnosed these conditions at 96.8% diagnostic accuracy. The diagnostic accuracy of ultrasound for lymphomas and neuroblastomas was high contrary to the report of a Nigerian study.[13] While other reports [9,12] show high diagnostic accuracy for lymphoma and leukemia, like our study.

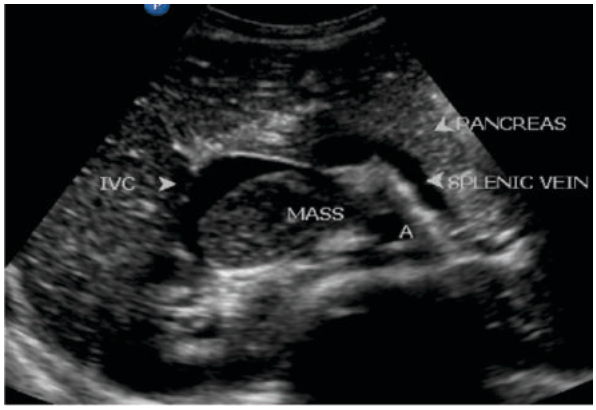

Figure 2: Hodgkin's lymphoma. A – Aorta and IVC – Inferior Venacava. A 10 year old male presented with severe anaemia and ultrasound of the abdomen revealed retroperitoneal lymphadenopathy. The image shows enlarged retroperitoneal lymph node causing mild compression of the IVC. All the lymph nodes were homogeneous and none of them showed necrosis or calcification.

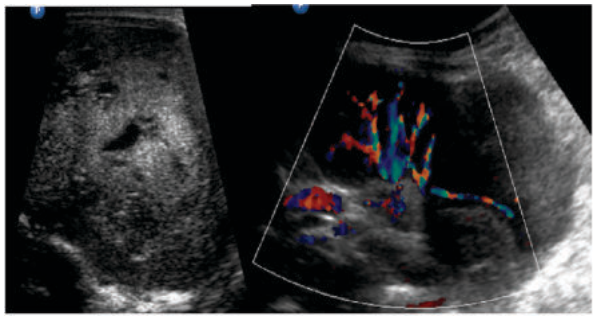

Figure 2: Hemangioendothelioma of liver – A 3 day old male child presented with symptoms of congestive heart failure. Ultrasound of the abdomen revealed an echogenic mass lesion in the liver with few cystic areas. Doppler shows high velocity arterial flow throughout the lesion. Serum AFP was 75000 ng/ml.

One report found the ultrasound alone to be specifically insufficient in identifying the adrenal gland in children and providing pathological diagnosis and staging of adrenal neoplasm.[14] It was concluded, however, that the ultrasound in a patient with adrenal neoplasm is useful as a guide to further diagnostic workup or can sometimes obviate the need for a CT scan or MRI. [14,15]

The overall low PPV (50%) for Wim's tumor observed in this study implies that clinicians should be careful to rule out other differentials. In other words, if a diagnosis of Wilm's tumor is made on Ultrasound in pediatric patients with a renal mass lesion, then it will only be true in about 50% of the children. Radiologists should be cautious before giving provisional histological and prognostic assumptions. The involved physician, or the oncologist, should be informed immediately about the morphological ultrasound findings. [6] A case–control study may be required to further validate this concern.

We had a few limitations in our study- one was the limited number of patients since we conducted our study on 68 patients only. So, further research with a large number of patients and including a higher proportion of histopathological reports is warranted. Another limitation was performing abdominal ultrasound in children with large body habitus and excessive bowel gas. [2]

Enhanced techniques can help in improving this diagnostic accuracy. The diagnostic capacity of ultrasonography is extremely dependent on the available equipment and expertise of the sonographer, is adversely affected by bone and gas artifacts and provides less precise anatomic detail than computed tomography and little or no functional information.[4,1]

Key Message:

The current study had interesting outcomes regarding the role of Ultrasound in the diagnosis of space-occupying abdominal masses in the pediatric age group.

With its non-invasiveness, wide availability, and ease of use without the risks associated with ionizing radiation exposure, ultrasound is an excellent imaging modality for the initial evaluation of a suspected pediatric abdominal mass. When a mass is present, the sonographic features and the clinical presentation and age of the patient can lead to a focused differential diagnosis in most cases. In certain cases, ultrasound examination may even expedite a definitive diagnosis without the requirement of supplemental imaging studies.

Acknowledgment: N/A

REFERENCES:

[1] Yu DC;Grabowski MJ;Kozakewich HP;Perez-Atayde AR;Voss SD;Shamberger RC;Weldon CB; (n.d.). Primary lung tumors in children and adolescents: A 90-Year experience. Journal of pediatric surgery. Retrieved February 15, 2023, from https://pubmed.ncbi.nlm.nih.gov/20620301/.

[2] Anupindi, S. A., Halverson, M., Khwaja, A., Jeckovic, M., Wang, X., & Bellah, R. D. (2014). Common and uncommon applications of bowel ultrasound with pathologic correlation in children. American Journal of Roentgenology, 202(5), 946–959. https://doi.org/10.2214/ajr.13.11661

[3] Schwartz, M., & Shaul, D. (1989, January 1). Abdominal masses in the newborn.: Semantic scholar. Pediatrics in review. Retrieved February 14, 2023, from https://www.semanticscholar.org/paper/Abdominal-masses-in-the-newborn.Schwartz-Shaul/8fee2daf2fb6c7ff113653c116f36fb916fd1d54.

[4] Sharma, N., Memon, A., Sharma, A. K., Dutt, V., & Sharma, M. (2014). Correlation of radiological investigations with clinical findings in cases of abdominal mass in the paediatric age group. African Journal of Paediatric Surgery, 11(2), 132. https://doi.org/10.4103/01896725.132803

[5] Merten, D. F., & Kirks, D. R. (1985). Diagnostic imaging of pediatric abdominal masses. Pediatric Clinics of North America, 32(6), 1397–1425. https://doi.org/10.1016/s0031-3955(16)34934-3

[6] Willi, U. V. (2006). Imaging the child with an abdominal mass. Diseases of The Abdomen and Pelvis, 224–231. https://doi.org/10.1007/88-470-0508-6_31

[7] SJ; H. G. E. S. (n.d.). Abdominal mass lesions in the newborn: Diagnosis and treatment. Clinics in perinatology. Retrieved February 15, 2023, from https://pubmed. ncbi.nlm.nih.gov/2656056/.

[8] Milla, S. S., Lee, E. Y., Buonomo, C., & Bramson, R. T. (2007). Ultrasound evaluation of pediatric abdominal masses. Ultrasound Clinics, 2(3), 541–559. https://doi.org/10.1016/j.cult.2007.08.002

[9] Kebede, A. G., & Nigussie, Y. (2011). Ultrasound evaluation of abdominal masses in Ethiopian child patients. Tropical Doctor, 41(3), 157–159. https://doi.org/10. 1258/td.2011.100253

[10] Annuar, Z., Sakijan, A. S., Annuar, N., & Kooi, G. H. (1990, January 1). Table 1 from ultrasound in the diagnosis of palpable abdominal masses in children.: Semantic scholar. The Medical journal of Malaysia. Retrieved February 15, 2023, from https://www.semanticscholar.org/paper/Ultrasound-in-the-diagnosis-of-palpable abdominal-Annuar-Sakijan/5f07737aab9dd188af15cc5bd10 627dfb5e2fc38/ figure/1.

[11] Barker, C. S., & Lindsell, D. R. M. (1990). Ultrasound of the palpable abdominal mass. Clinical Radiology, 41(2), 98–99. https://doi.org/10.1016/s0009-9260(05)80137-0

[12] Hill, B. A. (1975). Diagnostic sonography in general surgery. Archives of Surgery, 110(9), 1089. https://doi.org/10.1001/archsurg.1975.01360150033006

[13] Adedayo, A. A., Igashi, J. B., Mshelbwala, P. M., Nasir, A. A., Ameh, E. A., & Adeniran, J. O. (2019). Accuracy of ultrasonography in the evaluation of abdominal masses in children in Nigeria. African Journal of Paediatric Surgery, 16(1), 1. https://doi.org/10.4103/ajps.ajps_74_16

[14] Petrus, L. V., Hall, T. R., Boechat, M. I., Westra, S. J., Curran, J. G., Steckel, R. J., & Kangarloo, H. (1992). The pediatric patient with suspected ADRENAL NEOPLASM: Which radiological test to use? Medical and Pediatric Oncology, 20(1), 53–57. https://doi.org/10.1002/mpo.2950200111

[15] RL;, W. J. D. S. T. M. B. (n.d.). Giant cystic abdominal masses in children and adolescents: Ultrasonic differential diagnosis. AJR. American journal of roentgenology. Retrieved February 15, 2023, from https://pubmed.ncbi. nlm.nih.gov/417583/