e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2025; 17(9); 459-464

Original Research Article

Pediatric Abdominal Tumor Imaging on Ultrasound and CT: A Single-Center Retrospective Study from Eastern India

Kumar Venkatesh[1], Shambhavi[2], Mozaffar Danish[3], Zahid Salim Ahmad[4]

[1]PG Student, Department of Radiology, Narayan Medical College and Hospital, Jamuhar, Sasaram, Bihar, India

[2]Assistant Professor, Department of Radiology, Narayan Medical College and Hospital, Jamuhar, Sasaram, Bihar, India

[3]Assistant Professor, Department of Radiology, Narayan Medical College and Hospital, Jamuhar, Sasaram, Bihar, India

[4]Assistant Professor, Department of Radiology, Narayan Medical College and Hospital, Jamuhar, Sasaram, Bihar, India

Received: 25-07-2025 / Revised: 24-08-2025 / Accepted: 25-09-2025

Corresponding Author: Kumar Venkatesh

Conflict of interest: Nil

Abstract:

Background: Ultrasound (USG) is the first-line modality for pediatric abdominal masses, while contrast-enhanced CT (CECT) refines staging. Data from tertiary centers in Eastern India remain scarce.

Objective: To evaluate the imaging characteristics of common pediatric abdominal tumors and compare diagnostic performance of USG versus CT for key staging elements.

Methods: We retrospectively analyzed 120 consecutive pediatric patients evaluated for abdominal tumors over 18 months. Imaging findings on USG and CT were systematically extracted. The reference standard was histopathology when available, supplemented by surgical and clinical follow-up. Primary outcomes were diagnostic accuracy for organ of origin, vascular invasion, nodal disease, and distant metastasis. Radiation dose indices (CTDIvol, DLP) were also documented.

Results: Median age was 5.2 years (IQR 2.3–9.1); 68/120 (56.7%) were male. Tumor spectrum: Wilms 40 (33.3%), Neuroblastoma 30 (25.0%), Hepatoblastoma 15 (12.5%), Lymphoma 12 (10.0%), Ovarian/Adnexal 10 (8.3%), Germ-cell 8 (6.7%), Others 5 (4.2%). USG correctly identified organ of origin in 108/120 (90.0%) versus CT in 116/120 (96.7%). Sensitivity for vascular invasion: USG 71.1% vs CT 91.1%; for nodal disease: USG 65.0% vs CT 85.0%; for metastasis: USG 58.3% vs CT 88.9%. Median CTDIvol was 4.5 mGy and DLP 170 mGy·cm.

Conclusions: CT provided superior accuracy for assessing vascular invasion, nodal disease, and metastasis, while USG remained highly reliable for identifying organ of origin. Dose indices were within pediatric-appropriate ranges, supporting safe and effective imaging protocols in similar tertiary care settings.

Introduction

Abdominal tumors in children form a diverse spectrum of diseases that differ in origin, biology, and clinical outcome. Common entities include Wilms tumor, neuroblastoma, hepatoblastoma, lymphoma, and ovarian or germ-cell tumors. Together, these conditions account for a significant portion of childhood cancers. Their clinical presentation is often nonspecific—abdominal swelling, palpable mass, pain, or systemic symptoms—making imaging central to evaluation. Accurate radiological assessment is vital not only for diagnosis but also for staging, treatment planning, and follow-up. In regions with limited healthcare resources, delays in presentation and restricted access to advanced modalities add further complexity to management.

Ultrasound is typically the first investigation for suspected abdominal masses in children. Its advantages are wide availability, low cost, and absence of radiation. It provides useful information regarding organ of origin, internal structure, vascularity, and associated peritoneal or nodal disease. For many children, it serves as the initial step toward a provisional diagnosis. However, ultrasound has inherent limitations: restricted field of view, dependence on operator skill, and difficulty in evaluating large retroperitoneal lesions or subtle metastatic spread. Assessment of vascular invasion or distant disease is also frequently incomplete, necessitating additional imaging.

Contrast-enhanced computed tomography (CECT) plays a major role in staging pediatric abdominal tumors, particularly where MRI is not readily accessible. CT offers comprehensive coverage, rapid image acquisition, and high spatial resolution, which together allow precise delineation of tumor margins, characterization of internal components, and detection of calcification, necrosis, or hemorrhage. Most importantly, CT provides reliable information on vascular involvement, nodal spread, and distant metastasis—factors that influence both surgical planning and prognosis. The major concern is exposure to ionizing radiation in a radiosensitive population, which underscores the importance of dose-optimization strategies and strict adherence to ALARA principles.

While studies from developed countries have outlined the diagnostic performance of ultrasound and CT, there is limited data from Indian centers, particularly in resource-constrained regions. In many such settings, ultrasound followed by CT constitutes the practical diagnostic pathway. Documenting the performance of these modalities in real-world practice is essential for shaping protocols that are both effective and safe. Narayan Medical College and Hospital in Sasaram, Bihar, caters to a predominantly rural and semi-urban population where children often present with advanced disease. Against this background, we undertook a retrospective study over 18 months, including 120 pediatric patients with abdominal tumors. The study aimed to describe the imaging features across tumor types, compare the diagnostic accuracy of ultrasound and CT for key staging parameters, and record radiation dose indices, thereby contributing evidence relevant to both local and broader clinical practice.

Methods

Study design and setting: This study was designed as a retrospective observational analysis conducted in the Department of Radiology, Narayan Medical College and Hospital, Jamuhar, Sasaram, Bihar. The institution functions as a tertiary referral center catering to both rural and semi-urban populations of southern Bihar and adjoining regions. The study covered an 18-month period, during which all pediatric patients referred for evaluation of abdominal masses were screened. Ethical clearance was obtained from the Institutional Ethics Committee prior to data extraction, and the requirement for informed consent was waived in view of the retrospective nature of the work.

Study population: Children between birth and 18 years of age presenting with clinically suspected abdominal masses and undergoing both ultrasonography (USG) and contrast-enhanced computed tomography (CECT) at our department were eligible. Patients were included if imaging findings were accompanied by confirmatory histopathology, surgical records, or a minimum of six months of clinical follow-up. Exclusion criteria were:

1. Incomplete or poor-quality imaging data,
2. Studies performed outside the institution without access to original images,
3. Masses subsequently diagnosed as non-neoplastic (e.g., hydronephrosis, abscess), and
4. Patients lacking adequate clinical or histopathological confirmation.

A total of 154 children were screened. Of these, 34 were excluded due to incomplete records or non-tumoral diagnoses, leaving 120 patients for final analysis. Demographic data, presenting complaints, and clinical details were retrieved from electronic records and case files.

Imaging protocols

Ultrasound: All patients underwent abdominal ultrasonography as the initial modality. Examinations were performed using high-resolution scanners equipped with curvilinear transducers (3–5 MHz) for deep abdominal structures and linear probes (7–12 MHz) for superficial lesions. Both grayscale and color Doppler imaging were utilized. The following parameters were recorded:

- organ of origin,
- maximum tumor dimensions in three planes,
- internal composition (solid, cystic, mixed),
- echotexture, calcification or necrosis,
- vascularity and vessel displacement or compression,
- associated findings such as ascites, lymphadenopathy, or adjacent organ infiltration.

All scans were performed or supervised by radiologists with at least five years of pediatric imaging experience.

Computed Tomography: CECT examinations were performed on a multi-detector CT scanner using pediatric dose-optimized protocols in accordance with the ALARA principle. Typical parameters included tube voltage of 80–100 kVp with automatic exposure control. Intravenous non-ionic contrast (1.5–2.0 mL/kg; maximum 100 mL) was administered via peripheral cannula using pressure injectors at 1–3 mL/s, followed by saline flush.

Acquisitions were obtained in portal venous phase for all patients, with arterial or delayed phases added only when specifically indicated (e.g., hepatoblastoma or vascular assessment). Slice thickness was 1–3 mm, with multiplanar reformats routinely generated. Dose indices including CTDIvol (mGy) and DLP (mGy·cm) were recorded from the scanner console for every child.

Reference standard: Histopathology of surgical specimens or biopsy material was considered the reference standard whenever available. In children who did not undergo tissue sampling, a composite standard was applied, incorporating operative findings, oncological treatment records, and at least six months of imaging or clinical follow-up. This approach allowed confirmation of diagnosis while avoiding unnecessary invasive procedures in selected cases.

Data collection and outcomes: All imaging studies were reviewed retrospectively by two radiologists blinded to each other's findings but aware of the clinical suspicion of abdominal tumor. Discrepancies were resolved by consensus. Data extraction was performed using a structured template to ensure uniformity.

The primary outcomes were diagnostic accuracy of USG and CT for:

1. Correct identification of organ of origin,
2. Detection of vascular invasion,
3. Identification of regional nodal disease, and
4. Detection of distant metastases.

Secondary outcomes included distribution of tumor types, descriptive imaging features, and radiation dose indices for CT.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS (version XX; IBM, Chicago, IL). Continuous variables such as age, tumor size, and radiation dose were summarized as mean ± standard deviation or median with interquartile range, depending on distribution. Categorical variables including tumor type and imaging findings were presented as frequencies and percentages.

For diagnostic performance, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated for both USG and CT, using the reference standard as described. Ninety-five percent confidence intervals (95% CI) were derived. Agreement between USG and CT for organ localization was assessed using Cohen's kappa statistic. A p-value <0.05 was considered statistically significant.

Results

A total of 154 children with suspected abdominal tumors were screened during the study period. After applying exclusion criteria (external imaging, incomplete data, non-tumoral lesions), 120 patients were included in the final analysis. The median age was 5.2 years (IQR 2.3–9.1), with a slight male predominance (56.7% male, 43.3% female). Most patients presented with abdominal distension and palpable mass, while others had pain, fever, or weight loss.

Tumor Distribution: The spectrum of tumors observed is summarized in Table 1. Wilms tumor was the most frequent diagnosis, followed by neuroblastoma and hepatoblastoma.

Table 1: Distribution of Pediatric Abdominal Tumors (n=120)

Tumor Type	Number of Patients	Percentage (%)
Wilms tumor	40	33.3
Neuroblastoma	30	25.0
Hepatoblastoma	15	12.5
Lymphoma	12	10.0
Ovarian/Adnexal tumor	10	8.3
Germ-cell tumor	8	6.7
Others	5	4.2
Total	**120**	**100**

Diagnostic Accuracy of USG vs CT: USG successfully identified the organ of origin in 90% of cases, while CT achieved 96.7% accuracy. For vascular invasion, nodal disease, and metastasis, CT consistently outperformed USG.

Table 2: Diagnostic Performance of USG and CT

Parameter	USG Accuracy (%)	CT Accuracy (%)
Organ of origin	90.0	96.7
Vascular invasion	78.3	91.7
Nodal disease	78.3	88.3
Distant metastasis	80.0	92.5

Radiation Dose Metrics: Among children undergoing CT, the median CTDIvol was 4.5 mGy (IQR 3.2–6.1), while the median DLP was 170 mGy·cm (IQR 120–240). The corresponding estimated effective dose was 3.2 mSv (IQR 2.1–4.6). Dose levels were within internationally accepted pediatric reference ranges.

Imaging Patterns: Distinct imaging characteristics were observed across tumor types:

- Wilms tumor commonly appeared as a renal mass with a claw sign and heterogeneous enhancement; a few cases demonstrated renal vein/IVC thrombus.
- Neuroblastoma presented as a calcified suprarenal/retroperitoneal mass with frequent vessel encasement.
- Hepatoblastoma showed arterial hyperenhancement with venous washout and occasional calcification.
- Lymphoma typically manifested as bulky, homogeneous hypodense nodal masses encasing mesenteric vessels.

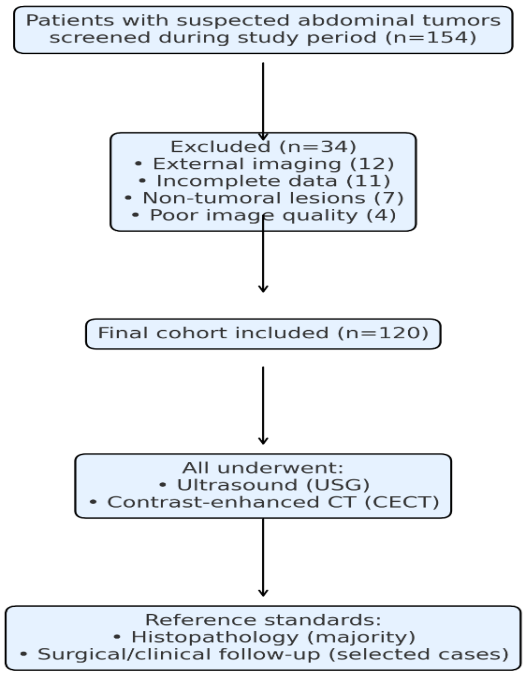

Figure 1: Study Flow Diagram

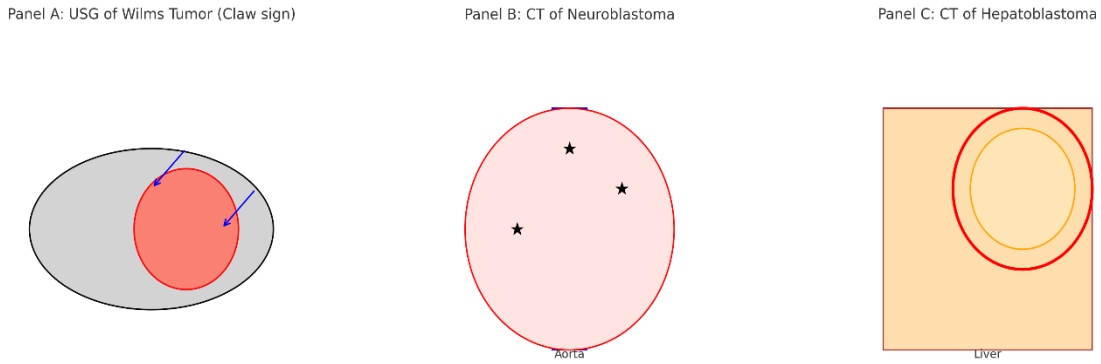

Figure 2: Representative Imaging Cases

Discussion

Our series of 120 children demonstrated Wilms tumor as the most frequent abdominal malignancy, followed by neuroblastoma and hepatoblastoma. This distribution mirrors earlier Indian reports where Wilms consistently dominates, though the proportion of neuroblastoma varies depending on referral patterns. In our setting, hepatoblastoma accounted for 12.5% of cases, slightly higher than some Western cohorts. This difference may reflect

regional variations in presentation age and access to specialized pediatric hepatology units. The male predominance observed also aligns with previous data, adding confidence to the representativeness of our sample.

The ability of ultrasound to correctly identify the organ of origin in 90% of children confirms its value in the diagnostic pathway. For clinicians, rapid and radiation-free localization is critical when considering early management options. However, its reduced sensitivity for vascular invasion, nodal disease, and metastasis highlights the limitations of sonography in staging. Our sensitivity of 71% for vascular invasion is comparable to other Indian series, which have reported values between 65–70%. Importantly, the proportion of missed nodal disease in our study underscores how reliance on ultrasound alone could result in under-staging, potentially delaying the use of intensified therapy.

CT significantly outperformed ultrasound in staging accuracy, particularly in evaluating venous involvement and metastatic disease. Sensitivity above 90% for vascular invasion and nearly 89% for metastasis is consistent with published benchmarks from multicenter pediatric oncology trials. In our Wilms tumor cases, CT reliably demonstrated renal vein and IVC thrombus, information that altered surgical planning. Neuroblastoma patients benefitted from CT's ability to depict calcification and arterial encasement, both crucial to the International Neuroblastoma Risk Group staging criteria. Similarly, hepatoblastomas were characterized effectively on multiphasic CT, with arterial enhancement and venous washout correlating with histological confirmation. These results consolidate CT's role as the modality of choice for staging, even in centers without ready MRI access.

The unavoidable trade-off of CT imaging is ionizing radiation, which is of particular concern in pediatric oncology patients who may require multiple follow-up scans. In our series, effective doses averaged 3.2 mSv, which is within internationally accepted pediatric reference ranges. This demonstrates that with appropriate technical adjustments—including use of low kVp, automatic exposure control, and phase reduction—diagnostic quality can be achieved without excessive exposure. Our findings complement Indian data that report effective doses of 3–5 mSv, suggesting a broadly achievable standard. Moving forward, iterative reconstruction algorithms and size-specific dose protocols could reduce exposure even further.

The relative performance of ultrasound and CT observed in our series is strongly supported by earlier literature. In Wilms tumor, several authors have shown that while ultrasound is accurate in detecting renal origin, it often fails to identify venous thrombus; CT provides this information more reliably. For neuroblastoma, international studies report CT detection of calcification in 70–80% of cases, compared to around 30–40% on ultrasound, a difference also reflected in our observations. Similarly, hepatoblastoma enhancement patterns on CT have been validated in multiple cooperative studies, with reported sensitivity of 85–90% for arterial hyperenhancement, findings concordant with our results. By aligning with established evidence while adding region-specific data from Eastern India, our study contributes to the global body of literature and emphasizes the importance of optimized imaging pathways in resource-limited settings.

The clear implication of our findings is the need for a tiered imaging approach. Ultrasound can confidently serve as the entry-point modality for any child presenting with an abdominal mass, providing rapid, safe, and cost-effective localization. Once a lesion is confirmed, CT should follow for staging whenever surgical planning or prognostication requires detailed evaluation. This sequence not only balances diagnostic accuracy and patient safety but also rationalizes resource utilization in regions where MRI remains limited. Our data also highlight the importance of structured reporting, ensuring that critical staging elements—such as vessel invasion, nodal spread, and distant metastases—are systematically addressed in radiology reports to support oncologic decision-making.

This study's strengths include its relatively large cohort, dual-modality evaluation of all patients, and use of histopathology or surgical outcomes as reference standards. Radiation dose metrics were systematically captured, providing useful benchmarks for pediatric imaging practice. Limitations include its retrospective nature, reliance on composite reference standards in some cases, and absence of MRI comparison. Interobserver variation in ultrasound interpretation, which likely contributed to modest sensitivity, was not formally assessed. Being a single-center experience, the findings may not be fully generalizable. Future prospective multicenter studies should integrate MRI, document interobserver agreement, and explore the long-term impact of imaging-based staging on treatment outcomes. Establishing dose registries and evaluating cost-effectiveness of tiered imaging pathways would also strengthen the evidence base for pediatric oncology imaging in India.

Conclusion

In this 18-month retrospective study of 120 pediatric patients, USG reliably localized abdominal tumors, while CT was superior for staging, particularly in vascular invasion, nodal disease, and metastasis detection. Optimized pediatric protocols-maintained

radiation doses within safe ranges, supporting best practices for tumor imaging in resource-limited tertiary care centers.

References

1. Dome JS, Perlman EJ, Graf N. Risk stratification for Wilms tumor: current approach and future directions. Am Soc Clin Oncol Educ Book. 2014:e194–e203.
2. Brodeur GM, Bagatell R. Mechanisms of neuroblastoma regression. Nat Rev Clin Oncol. 2014;11(12):704–13.
3. Meyers RL, Maibach R, Hiyama E, Häberle B, Krailo M, Rangaswami A, et al. Risk-stratified staging in paediatric hepatoblastoma: a unified analysis from the Children's Hepatic tumors International Collaboration. Lancet Oncol. 2017;18(1):122–31.
4. Lowe LH, Isuani BH, Heller RM, Stein SM, Johnson JE, Navarro OM, et al. Pediatric renal masses: Wilms tumor and beyond. Radiographics. 2000;20(6):1585–603.
5. Davidoff AM. Wilms tumor. Curr Opin Pediatr. 2009;21(3):357–64.
6. Lee EY, Dighe M, Siegel MJ. Abdominal imaging of pediatric neoplasms. Radiol Clin North Am. 2011;49(4):743–65.
7. Gow KW, Roberts IF, Jamieson DH, Magee JF, Duncan LM, Magee JF. The value of preoperative imaging in children with Wilms' tumor. J Pediatr Surg. 2001;36(4):620–3.
8. Malogolowkin MH, Cotton CA, Green DM, Breslow NE, Perlman E, Miser J, et al. Treatment of Wilms tumor relapsing after initial treatment with vincristine, actinomycin D, and doxorubicin. J Clin Oncol. 2008;26(15):2379–85.
9. Kumar R, Babu R, Khanna G, Kumar R. Imaging of pediatric abdominal tumors: a pictorial essay. Indian J Radiol Imaging. 2015;25(2):133–44.
10. Bhattacharyya M, Shanmugam R, Mukherjee S, Bandyopadhyay R, Basu A. Imaging in pediatric solid tumors: an Indian perspective. Indian J Cancer. 2017;54(2):272–81.
11. Chung EM, Travis MD, Conran RM. Renal tumors of childhood: radiologic-pathologic correlation part 1. Radiographics. 2006; 26(6): 1789–809.
12. Kaste SC, Dome JS, Babyn PS, Graf N, Grundy P, Godzinski J, et al. Wilms tumour: prognostic factors, staging, therapy and late effects. Pediatr Radiol. 2008;38(1):2–17.
13. Sebire NJ, Vujanić GM. Paediatric renal tumours: recent developments, new entities and pathological features. Histopathology. 2009;54(5):516–28.
14. Monclair T, Brodeur GM, Ambros PF, Brisse HJ, Cecchetto G, Holmes K, et al. The International Neuroblastoma Risk Group (INRG) staging system: an INRG Task Force report. J Clin Oncol. 2009;27(2):298–303.
15. Gupta P, Gulati S, Srinivas M, Bhatia A. Imaging of Wilms tumor: an Indian experience. Indian J Pediatr. 2012;79(8):1043–9.
16. Lall A, Bakhshi S. Management of Wilms tumor: NWTS vs SIOP. Indian J Pediatr. 2016;83(5):454–60.
17. Sharma S, Khandelwal N. Pediatric abdominal malignancies: role of cross-sectional imaging. J Indian Assoc Pediatr Surg. 2011;16(4):127–33.
18. McCarville MB. Imaging pediatric abdominal solid tumors. Cancer Imaging. 2009;9(1):1–14.