Radiology Case Reports 17 (2022) 4223–4226

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/radcr

Case Report

A case report on ultrasound evaluation of pediatric post-operative abdominal pain ☆

Alexander B. White, BA[a,*], *Daniel R. Bacon, MD*[b], *Kristen Olinger, MD*[c], *Jeffrey J. Dehmer, MD*[d]

[a] *University of North Carolina, School of Medicine, 1001 Bondurant Hall, CB #9535, Chapel Hill, NC 27599, USA*
[b] *Department of Surgery, The Ohio State University College of Medicine, Suite 670, 395 W. 12th Ave, Columbus, OH 43210-1267, USA*
[c] *Department of Radiology, University of North Carolina School of Medicine, 2000 Old Clinic Building, CB #7510, Chapel Hill, NC 27599, USA*
[d] *Pediatric Surgery, Novant Health – New Hanover Regional Medical Center, 2131 S. 17th St, PO Box 9000, Wilmington, NC 28401-7407, USA*

ARTICLE INFO

Article history:
Received 16 July 2022
Revised 9 August 2022
Accepted 13 August 2022

Keywords:
Ultrasound
Ultrasonography
Pediatrics
Surgery
Computed tomography
Radiation

ABSTRACT

Pediatric post-operative abdominal pain can present a unique diagnostic challenge. The case presented here describes a 9-year-old female who presented with fever and worsening abdominal pain 4 days after laparoscopic resection of a benign ovarian teratoma. Computed tomography failed to provide adequate diagnostic imaging. Ultrasound was subsequently used to rule-out a major post-operative complication and ultimately led to a successful non-operative approach while avoiding repeat radiation exposure. Thin body habitus, increased radiosensitivity of pediatric organs, and increased lifetime risk of cancer complicate the use of computed tomography in the pediatric population. Ultrasound, when correlated to clinical findings, has unique advantages over CT such as detailed delineation of soft tissue structures and dynamic assessment of anatomy that make it advantageous in the pediatric post-operative setting.

Introduction

The role of ultrasound for post-operative pain evaluation in the pediatric population may be of particular benefit when evaluating whether further operative management or cross-sectional imaging is warranted. Ultrasound is often used in the pediatric population in acute care settings for time-sensitive imaging of the pediatric abdomen when evaluating pyloric stenosis, intussusception and appendicitis [1,2]. Ultrasound has also been successfully used in the evaluation of pediatric blunt trauma to identify intra-abdominal hemorrhage [3]. Focused assessment with sonography in trauma (FAST) exams enables providers to use bedside ultrasound to identify pathology that could warrant surgical intervention [4]. Ultrasound has a strong positive likelihood ratio (14.5) for identifying pediatric hemoperitoneum, and in the hemodynamically stable child, a positive ultrasound warrants imag-

☆ Competing Interests: None.

* Corresponding author.
E-mail address: alexander_white@med.unc.edu (A.B. White).

https://doi.org/10.1016/j.radcr.2022.08.040

ing of the abdomen with computed tomography (CT) [3]. The use of ultrasound prior to CT is of particular value in pediatric patients in order to minimize radiation exposure. Frequency of CT use in children is increasing, however, implementation of CT regulations is delayed in the pediatric population compared to adult guidelines [5,6]. This delay in regulation disproportionately affects children from non-pediatric referring institutions, which have been associated with producing scans of lower technical quality while utilizing higher doses of radiation [7,8]. Furthermore, pediatric patients have increased radiosensitivity of certain tissues such as the thyroid, gonads, and breast tissue [9]. Postnatal CT exposure has been associated with increased lifetime risk of leukemia and brain cancer [10,11]. Children inherently have a longer lifespan for accumulating imaging studies with ionizing radiation and radiation-related cancer to occur and there is often a lack of physical, size-based adjustments in technique and radiation dosing [9,12].

Ultrasound findings in correlation with clinical findings may steer surgical intervention without the need for CT imaging in certain settings. One example is the use of US as the primary imaging modality for the pediatric female pelvis, whereby US can differentiate hemorrhage and complex free fluid from decompressed bowel loops due to lack of peristalsis [13]. While ultrasound has been predominantly used in the initial evaluation of abdominal and pelvic pain in pediatric patients, its role in the post-operative evaluation of pediatric surgical patients is incompletely described and may aid in diagnostic accuracy.

Case report

A 9-year-old female underwent a laparoscopic right ovarian cystectomy for a benign mature teratoma. On post-operative day 4 she developed intermittent fevers (max 102.8°F) and transient abdominal and shoulder pain. She was seen in pediatric surgery clinic on post-operative day 4 and was found to have small-volume pneumoperitoneum on her plain films that was deemed within normal limits following a laparoscopic procedure. Her abdominal exam was relatively benign, and the decision was made to proceed with watchful waiting at home with close follow-up. On post-operative day 5, the patient reported persistent shoulder and abdominal pain, a temperature of 100.9°F overnight, and loose green stools. She was admitted for observation and underwent a CT abdomen/pelvis with oral and intravenous contrast that showed an obscured lower pelvic mass without extravasation of either oral or intravenous contrast (Figs. 1 and 2). However, the study sensitivity was poor secondary to the patient's thin body habitus, making detailed delineation of pelvic structures unclear. She had a negative stool panel work-up and a normocytic anemia of 10.1 g/dL (pre-op 11.3 g/dL). On post-operative day 6 (hospital day 2), the patient experienced acute worsening of abdominal pain with rebound tenderness. Abdominal and transabdominal pelvic ultrasound were performed in lieu of repeat CT imaging or immediate laparoscopy. This showed complex free fluid in the hepatorenal space (Figs. 3 and 4). There was also a focal hematoma in the lower pelvis measuring 7.5×6.6×4.3 cm that demonstrated an absence of internal Doppler flow, suggesting a hematoma with low likelihood of active bleed (Figs. 5 and 6). She was discharged home on hospital day 2 to close follow-up without further post-operative issues.

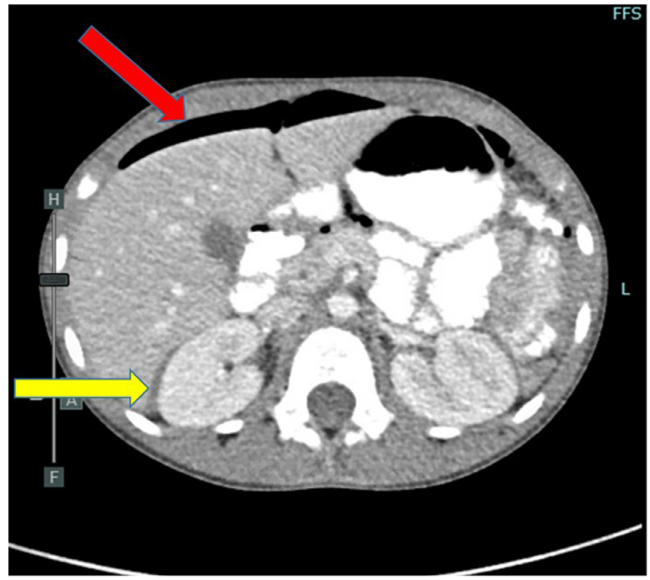

Fig. 1 – Axial view – CT abdomen/pelvis with IV and PO contrast demonstrating small-volume pneumoperitoneum (red arrow) and complex free fluid in the hepatorenal space (yellow arrow).

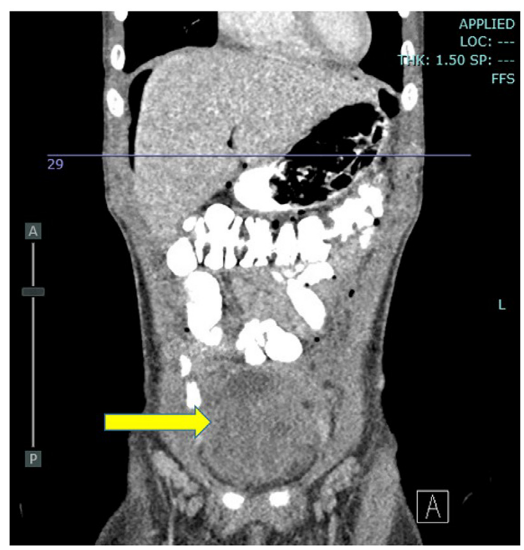

Fig. 2 – Coronal view – CT abdomen/pelvis with IV and PO contrast demonstrating complex hyperdense mass external to bowel located within the pelvis (yellow arrow).

Discussion

In this case presentation, ultrasound was successfully utilized to elucidate abdominal and pelvic findings after an initial CT

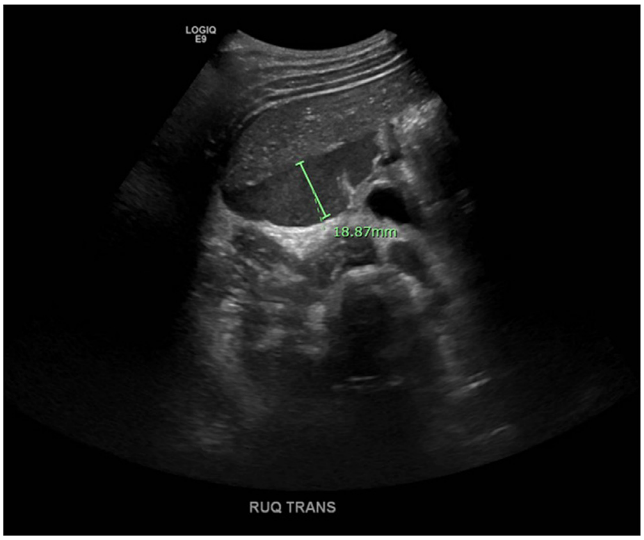

Fig. 3 – Right upper quadrant transabdominal ultrasound demonstrating complex free fluid in the hepatorenal space 1.9-cm wide suggesting hemoperitoneum.

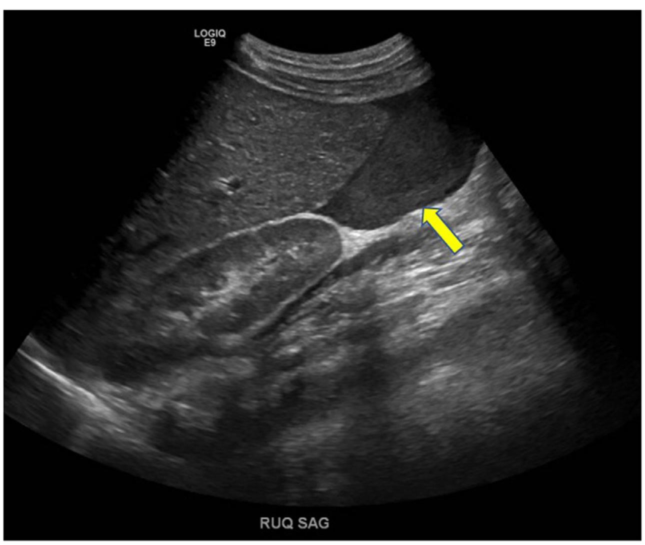

Fig. 4 – Right upper quadrant sagittal ultrasound demonstrating hemoperitoneum along the inferior hepatic margin.

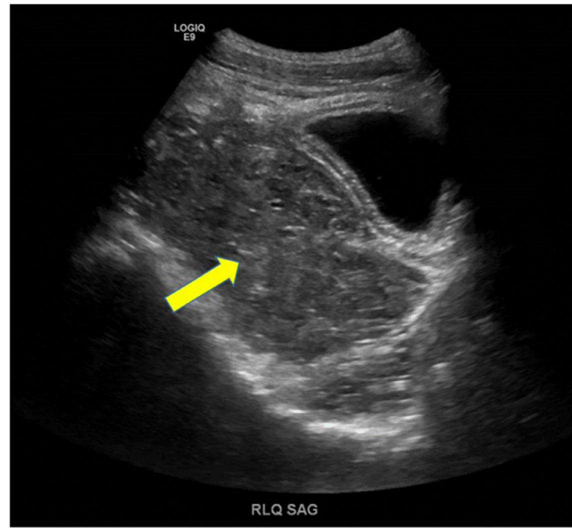

Fig. 5 – Right lower quadrant sagittal ultrasound demonstrating heterogeneous mass external to bowel measuring 7.5 x 6.6 x 4.3 cm consistent with focal hematoma.

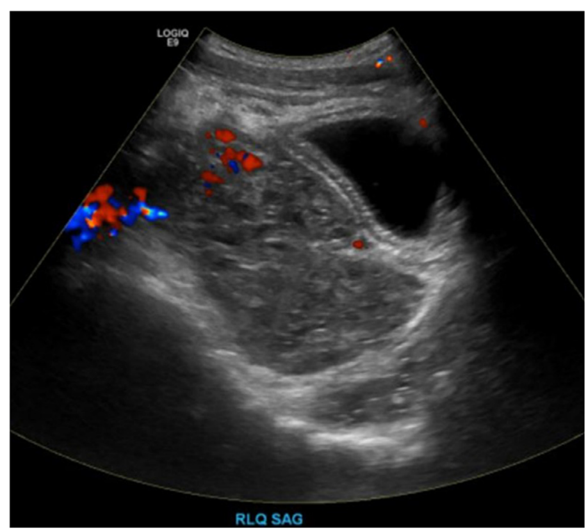

Fig. 6 – Right lower quadrant sagittal ultrasound demonstrating an absence of internal Doppler flow suggesting hematoma without active bleed.

scan failed to provide a definitive diagnosis. This illustrates a potential role for ultrasound in the triage of post-operative pediatric patients when determining if operative management is required while minimizing further radiation exposure. There has been a recent movement to preferentially employ contrast-enhanced ultrasound to identify intraabdominal organ injury and inform further surgical management due to its comparable diagnostic accuracy to contrast-enhanced CT in the pediatric population [14,15]. Ultrasound can potentially produce a more detailed image compared to CT regarding internal composition of a finding, associated vascularity, and relationship with adjacent structures. With the patient described in this case, the team attributed her post-operative symptoms to peritoneal irritation by the space-occupying hematoma that was identified on ultrasound. A non-operative management strategy was utilized and was successful.

The concept of using ultrasound in the post-operative period has already been established in the adult population. For example, ultrasound is used in the soft tissue evaluation of post-hip arthroplasty pain in the setting of normal radiography [16]. Ultrasound can detect hip effusions, bursitis, tendinitis, infections, and thromboses with adequate sensitivity in this post-operative setting [17]. Additionally, in vascular surgery, duplex ultrasound demonstrates safe and effective post-operative evaluation of endoleaks when compared to concurrent computed tomography angiography (PPV 0.88; NPV 0.94) [18]. While these post-operative applications of ultrasound are distinct from the pediatric abdomen, they nonetheless describe a clinical framework for the post-operative use of ultrasound. When considering the increased radiosensitivity of pediatric organs, anatomic interference encountered with CT, and comparable diagnostic accuracy, there exists a need for risk-mitigating diagnostic modalities such as ultrasound within the pediatric population.

An important consideration is that the clinical utility of pediatric post-operative ultrasound relies on the skill of the sonographer or physician as well as the appropriate correlation of physical exam and laboratory findings. Furthermore, ultrasound has limitations over CT, including limited assessment for bowel injury, challenges associated with small field of view, and potential for poor visualization of the anatomy in patients with prominent bowel gas or large body habitus. The financial cost of diagnostic ultrasound warrants mention, and has been reported as 4-7 times less expensive than abdominal CT amongst uninsured patients when comparing national minimum and maximum prices, respectively [19]. Despite the limitations described above, ultrasound offers a safe diagnostic modality that is more cost-effective and better suited for pediatric anatomy.

Conclusion

Ultrasound is non-invasive, cost-effective, and can provide superior imaging quality in a certain subset of cases of pediatric post-operative pain. There exists a framework for the incorporation of ultrasound as a diagnostic tool in the post-operative pediatric setting when the etiology of pain is unclear. Ultrasound has a unique position to aid the surgeon in determining whether additional radiation exposure is warranted, and whether further surgical intervention should be pursued.

Patient consent

Written patient consent was obtained for the use of medical imaging and case details for teaching publication purposes in a deidentified manner.

REFERENCES

[1] Copeland DR, Cosper GH, McMahon LE, Boneti C, Little DC, Dassinger MS, et al. Return of the surgeon in the diagnosis of pyloric stenosis. J Pediatr Surg 2009;44(6):1189–92. doi:10.1016/J.JPEDSURG.2009.02.025.

[2] Burford JM, Dassinger MS, Smith SD. Surgeon-performed ultrasound as a diagnostic tool in appendicitis. J Pediatr Surg 2011;46(6):1115–20. doi:10.1016/J.JPEDSURG.2011.03.040.

[3] Holmes JF, Gladman A, Chang CH. Performance of abdominal ultrasonography in pediatric blunt trauma patients: a meta-analysis. J Pediatr Surg 2007;42(9):1588–94. doi:10.1016/J.JPEDSURG.2007.04.023.

[4] Bonasso PC, Dassinger MS, Wyrick DL, Gurien LA, Burford JM, Smith SD. Review of bedside surgeon-performed ultrasound in pediatric patients. J Pediatr Surg 2018;53(11):2279–89. doi:10.1016/J.JPEDSURG.2018.04.040.

[5] Donnelly LF, Frush DP. Pediatric multidetector body CT. Radiol Clin North Am 2003;41(3):637–55. doi:10.1016/S0033-8389(03)00036-8.

[6] Miglioretti DL, Johnson E, Williams A, Greenlee RT, Weinmann S, Solberg LI, et al. Pediatric computed tomography and associated radiation exposure and estimated cancer risk. JAMA Pediatr 2013;167(8):700. doi:10.1001/JAMAPEDIATRICS.2013.311.

[7] Rostad BS, Applegate KE, Kim T, Mansour RM, Milla SS. Multiphase acquisitions in pediatric abdominal-pelvic CT are a common practice and contribute to unnecessary radiation dose. Pediatr Radiol 2018;48(12):1714–23. doi:10.1007/S00247-018-4192-Y.

[8] Snow A, Milliren CE, Graham DA, Callahan MJ, MacDougall RD, Robertson RL, et al. Quality of pediatric abdominal CT scans performed at a dedicated children's hospital and its referring institutions: a multifactorial evaluation. Pediatr Radiol 2017;47(4):391–7. doi:10.1007/S00247-016-3768-7.

[9] Frush DP, Donnelly LF, Rosen NS. Computed tomography and radiation risks: what pediatric health care providers should know. Pediatrics 2003;112(4):951–7. doi:10.1542/PEDS.112.4.951.

[10] Abalo KD, Rage E, Leuraud K, Richardson DB, Ducou Le Pointe H, Laurier D, et al. Early life ionizing radiation exposure and cancer risks: systematic review and meta-analysis. Pediatr Radiol 2021;51(1):45–56. doi:10.1007/S00247-020-04803-0.

[11] Pearce MS, Salotti JA, Little MP, McHugh K, Lee C, Pyo Kim K, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. Lancet (London, England) 2012;380(9840):499. doi:10.1016/S0140-6736(12)60815-0.

[12] Brenner D, Elliston C, Hall E, Berdon W. Estimated risks of radiation-induced fatal cancer from pediatric CT. AJR Am J Roentgenol 2001;176(2):289–96. doi:10.2214/ajr.176.2.1760289.

[13] Back SJ, Maya CL, Zewdneh D, Epelman M. Emergent ultrasound evaluation of the pediatric female pelvis. Pediatr Radiol 2017;47(9):1134–43. doi:10.1007/S00247-017-3843-8.

[14] Paltiel HJ, Barth RA, Bruno C, Chen AE, Deganello A, Harkanyi Z, et al. Contrast-enhanced ultrasound of blunt abdominal trauma in children. Pediatr Radiol 2021;51(12):2253–69. doi:10.1007/S00247-020-04869-W.

[15] Menichini G, Sessa B, Trinci M, Galluzzo M, Miele V. Accuracy of contrast-enhanced ultrasound (CEUS) in the identification and characterization of traumatic solid organ lesions in children: a retrospective comparison with baseline US and CE-MDCT. Radiol Med 2015;120(11):989–1001. doi:10.1007/S11547-015-0535-Z.

[16] Miller TT. Sonography of joint replacements. Semin Musculoskelet Radiol 2006;10(1):79–85. doi:10.1055/S-2006-934218.

[17] Douis H, Dunlop DJ, Pearson AM, O'Hara JN, James SLJ. The role of ultrasound in the assessment of post-operative complications following hip arthroplasty. Skeletal Radiol 2012;41(9):1035–46. doi:10.1007/s00256-012-1390-9.

[18] Schaeffer JS, Shakhnovich I, Sieck KN, Kallies KJ, Davis CA, Cogbill TH. Duplex ultrasound surveillance after uncomplicated endovascular abdominal aortic aneurysm repair. Vasc Endovascular Surg 2017;51(5):295–300. doi:10.1177/1538574417708131.

[19] Hwang ME. Sonography and computed tomography in diagnosing acute appendicitis. Radiol Technol 2018;89(3):224–37. https://pubmed.ncbi.nlm.nih.gov/29298941/.