



Ultrasound in Emergency Medicine

DIAGNOSIS OF AN ACUTE LOBAR NEPHRONIA IN THE EMERGENCY DEPARTMENT USING POINT-OF-CARE ULTRASOUND

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Abstract—Background: Over the past decade, point-of-care ultrasound (POCUS) has been performed increasingly in pediatric emergency medicine for a variety of indications. POCUS is a focused, limited, goal-directed examination at the bedside performed and interpreted by a physician trained in POCUS with the purpose of answering a specific question. Applying POCUS for immediate evaluation of specific emergent complaints may allow for faster and safer management of ill patients in the pediatric emergency department (ED). **Case Report:** A 5-year-old female presented to the pediatric ED with fever, vomiting, and back pain. Based on the real-time gray scale and color Doppler POCUS findings, a diagnosis of an acute lobar nephronia (ALN) was made by a pediatric emergency physician and the patient was admitted to the hospital before laboratory and urinalysis findings were resulted. This case report illustrates how POCUS and knowledge of the sonographic characteristics of an ALN were beneficial for shortening the time to decision for admission, rapidly ruling out hydronephrosis (which may have required other interventions), and conveying important information to the admitting team. **Why Should an Emergency Physician Be Aware of This?:** Performing a kidney POCUS and knowing the sonographic characteristics of an ALN can assist in its diagnosis, especially in patients where pyuria is absent. In addition, performing a kidney POCUS in patients with a suspected upper urinary tract infection may shorten the time to deci-

sion for admission and improve communication with the pediatric admitting resident regarding diagnosis and indication. © 2019 Elsevier Inc. All rights reserved.

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INTRODUCTION

Point-of-care ultrasound (POCUS) can expedite clinical decision-making, direct follow-up diagnostic imaging, aid in procedural guidance, and improve patient satisfaction (1–6). The success of POCUS depends largely on the skill and experience of the sonographer and many studies have demonstrated that pediatric emergency physicians can be trained in POCUS for a variety of applications with focused training (7–11). However, there are limited data on the use of POCUS for assessing the urinary tract in the emergency department (ED) by emergency physicians and, in cases where POCUS is applied, it is mainly used to look for hydronephrosis (12). While one case report described the POCUS findings of an emphysematous pyelonephritis in the adult ED, using POCUS to evaluate upper urinary tract infections in the ED remains controversial (13,14). Nevertheless, one study suggested that early POCUS assessment of patients with suspected upper urinary tract infections can greatly impact its diagnosis and

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management (14). This report illustrates how POCUS assisted in the diagnosis of an acute lobar nephronia (ALN) in the pediatric ED and rapidly ruled out hydronephrosis, which was beneficial for shortening the time to decision for admission and improving communication with the pediatric admitting resident.

CASE REPORT

A 5-year-old female with a medical history significant for constipation and five previous urinary tract infections presented to the pediatric ED with a 2-day history of fever, abdominal pain, dysuria, and bilateral flank pain. She had been vomiting for 1 day and had only one episode of urination on the day of presentation.

Vital signs revealed a temperature of 37.6°C, a heart rate of 150 beats/min, a respiratory rate of 28 breaths/min, and oxygen saturation of 98% in room air. On examination the patient was alert and nontoxic. Her neck was supple and her mucous membranes moist. The chest was clear to auscultation, the heart sounds were normal, and she was well-perfusing. The abdomen was soft, non-distended, and without masses or hepatosplenomegaly. She had right cost-overtebral angle tenderness. Her spine was normal without any tufts and she had a normal neurologic examination. Based on the patient's history and physical examination findings, blood and urine tests and an abdominal ultrasound (US) were ordered and the patient was started on i.v. fluids.

In addition, a physician with knowledge in pediatric POCUS was asked to evaluate her urinary tract using US.

A gray scale and color Doppler kidney and bladder POCUS were performed immediately after obtaining

blood and urine. Both kidneys were evaluated from the back in the paravertebral line with the patient lying in prone using a C9-3 curved array transducer (Zonare Inc., Mountain View, CA). In long axis view, a hyperechoic mass was visible in the mid pole of the right kidney (Video 1, Figure 1). A transverse view in the paravertebral line confirmed the hyperechoic mass which measured approximately 2 cm × 1.5 cm × 1.5 cm in size. There was no hydronephrosis. Color Doppler POCUS demonstrated absence of flow to the mass (Figure 2). The left kidney appeared normal on both gray scale and color Doppler POCUS without any masses or hydronephrosis. The bladder was evaluated in sagittal and transverse views with the patient in supine and revealed a thickened bladder wall suspicious for a urinary tract infection (Figure 3) (15).

Given the patient's age, history, physical examination, and POCUS findings, ALN was suspected and the patient was started on i.v. ceftriaxone and admitting orders to the hospital were written before laboratory findings and urinalysis were resulted.

Blood and urine results were consistent with an ALN. Significant laboratory tests included a white blood count of 21,109/mm with 74% neutrophils. C-reactive protein and sedimentation rate were elevated at 210 mg/dL and 59, respectively. Electrolytes and serum creatinine were normal. Urinalysis was significant for 3 + ketones, 2 + blood, 3 + leukocyte esterase, and 2 + urine protein. Urine specific gravity was > 1.030. Microscopic urinalysis showed a white blood cell count > 182 per high-power field with white blood cell clumps and bacteria. The urine culture was positive for Gram-negative rods with a final

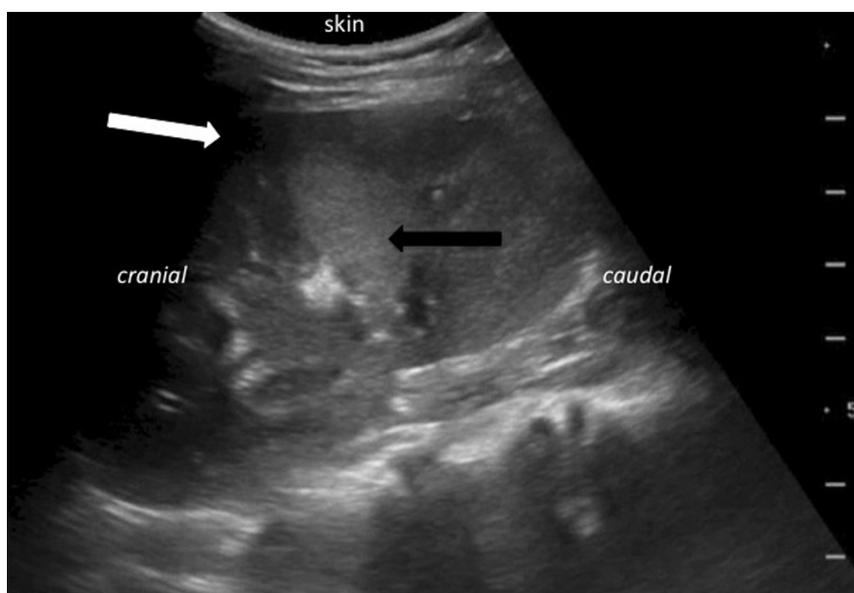


Figure 1. Long axis view of the right kidney in the paravertebral line. Black arrow, hyperechoic mass in the mid pole of the right kidney; white arrow, 12th rib with acoustic shadowing; orientation in italic letters.

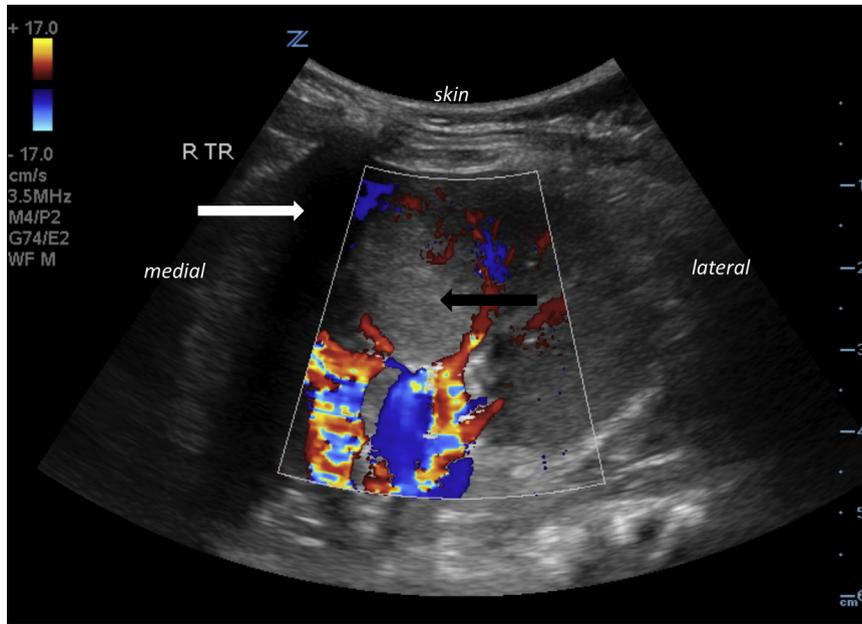


Figure 2. Short axis view of the right kidney in the paravertebral line. Black arrow, avascular hyperechoic mass in the mid pole of the right kidney; white arrow, 12th rib with acoustic shadowing; color Doppler point-of-care ultrasound showing absent flow to the mass; orientation in italic letters.

report 10,000 to 100,000 colony-forming units/mL *Escherichia coli* sensitive to ceftriaxone.

An abdominal US through the radiology department was ordered on the day of presentation and completed the following day. The gray scale US was consistent with a right-sided pyelonephritis (PN) and showed neph-

romegaly of the right kidney. A mass was not identified. The patient was treated with i.v. antibiotics for 3 days, after which she defervesced. She was sent home on cefdinir for 7 days and fully recovered. A follow-up radiology US performed on the kidneys and bladder several weeks later was normal.

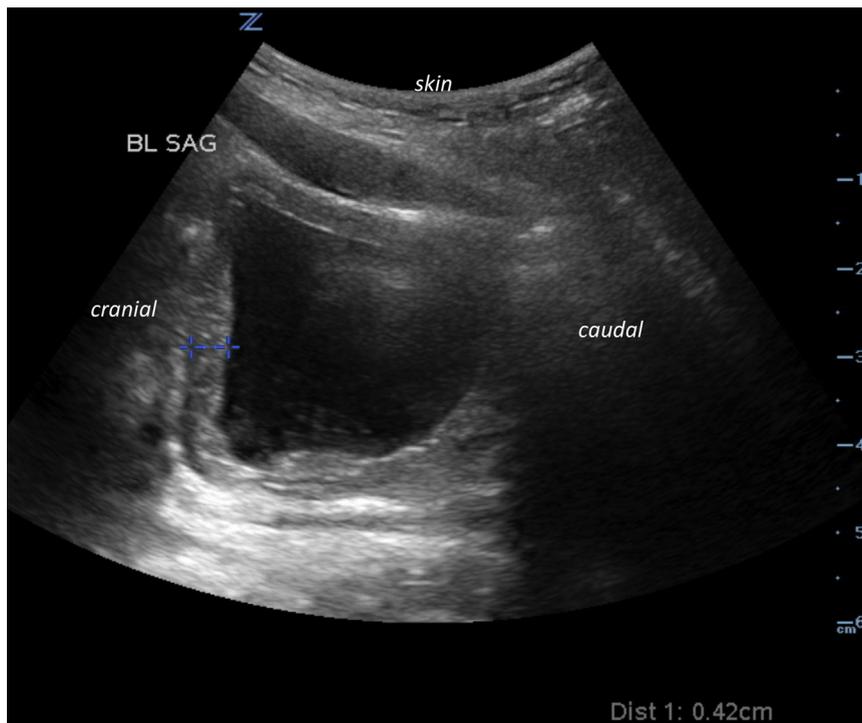


Figure 3. Sagittal view of the bladder. Bladder wall thickness 0.42 cm; orientation in italic letters.

DISCUSSION

The differential diagnosis of fever, vomiting, and back pain in a 5-year-old child is broad. Common diagnoses in the pediatric population include ALN, PN, and renal abscess. Nephrolithiasis, a renal tumor, and a renal infarct are also possible but less likely in children. Furthermore, non-renal causes are a possibility. In our case, the combination of the patient's age, history, and physical examination, together with the POCUS findings showing a wedge-shaped mass, pointed to an inflammatory renal process that made ALN the most likely diagnosis.

After discussing the POCUS findings with the treating attending, the patient was started on antibiotics and a hospital bed for admission was ordered before the laboratory findings and urinalysis were resulted. Although this patient most likely would have been admitted without the POCUS after laboratory findings and urinalysis were made available, the POCUS suggested the diagnosis of ALN, which shortened the time to decision for admission and provided more detailed information to the pediatric admitting resident regarding diagnosis and admitting indication.

ALN is a localized, non-liquefied renal infection involving one or more lobes and considered to be a midpoint in the spectrum of upper urinary tract infections ranging from uncomplicated PN to a more severe renal abscess (16,17). ALN is typically determined by the presence of a focal abnormality on imaging modalities, such as US or computed tomography (CT), in addition to clinical presentations, including fever, flank pain, leukocytosis, pyuria, and bacteriuria, all of which are similar to PN or a renal abscess (16,17). Thus, it is difficult to differentiate between the three entities in the beginning of the disease, and imaging has become extremely helpful in making the correct diagnosis (18,19).

CT with i.v. contrast is currently recognized as the most sensitive and specific imaging modality for diagnosing ALN, PN, and renal abscess, and is more accurate than US in detecting parenchymal abnormalities (18). However, CT scans expose patients to a significant amount of ionizing radiation and the risk from these scans is highest for very young children, owing to their enhanced radiosensitivity and longer life expectancy compared to adults (20–23). In addition, younger children may require sedation, with its inherent complications such as apnea, vomiting, and reaction to the contrast material.

Identifying ALN is a challenge for emergency physicians. Whereas ALN has been found in up to 19% of children admitted for a febrile urinary tract infection, pyuria was absent in 28%–69% of children in other series (24–26). A diagnosis of ALN in children requires admission to the hospital and a longer duration of antibiotic therapy compared to PN (17,27,28). Therefore, the ability to identify ALN in the ED with POCUS may help the

disposition decision for patients presenting to the ED with fever and abdominal pain. This may be even more beneficial for patients with a normal urinalysis, where physicians may dismiss a nephrogenic process and order an abdominal CT scan for further evaluation (29).

US examination of the right kidney can be accomplished with a 3.5- to 5-MHz probe and scanning in the mid axillary line using the liver as an acoustic window with the patient in supine or scanning in the paravertebral line with the patient in prone. The latter approach is more advantageous because the kidneys are much closer to the skin and, therefore, less depth is needed for evaluation and better resolution is achieved (30).

The bladder was evaluated in longitudinal and transverse views with the bladder wall thickness measuring 4.2 mm (Figure 3). Milosevic et al. evaluated the urinary bladder wall thickness in prepubertal girls and suggested an upper limit of normal bladder wall thickness of 3.9 mm with a negative predictive value of 100% (9).

Several reports have looked at gray scale and color Doppler US findings with regard to PN and ALN. On gray scale US, the kidneys appear normal in most patients with acute PN (31).

The hallmark of ALN is a wedge-shaped area of increased echogenicity (19,32). Both PN and ALN may show diffuse or focal enlargement of the affected kidney (19). Color Doppler US has also been used to improve the diagnosis of ALN in adults and children. It typically shows decreased perfusion in the affected parenchyma, which has been attributed to arteriolar vasoconstriction and interstitial edema in response to bacterial infection (33,34).

While power Doppler US is significantly more sensitive than color Doppler US, its increased sensitivity to motion, respiratory, and flash artifact may limit its application in children (35,36). Adding color Doppler to gray scale POCUS in children may improve sensitivity in diagnosing an upper urinary tract infection, as reported in our case.

A diagnosis of ALN requires admission to the hospital and relies on laboratory, urinary, and radiology US findings. However, our POCUS findings strongly suggested ALN and rapidly ruled out hydronephrosis. It shortened the time to decision for admission while waiting for laboratory, urinary, and radiology US findings, in addition to providing more detailed information to the admitting pediatric resident.

WHY SHOULD AN EMERGENCY PHYSICIAN BE AWARE OF THIS?

It is currently unclear which patients should receive a urinary tract POCUS. This case report illustrates that urinary tract POCUS, including color Doppler POCUS, may be

used to help diagnose ALN and allow for faster time to decision for admission to the hospital and improved communication with the admitting pediatric resident.

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SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.jemermed.2019.04.030>.

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