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Case Report

A rare entity in a pediatric patient: coexistence of emphysematous cystitis and emphysematous pyelonephritis

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ABSTRACT

Background. Emphysematous cystitis (EC) and emphysematous pyelonephritis (EPN) are rare urinary tract infections. They have a wide spectrum of clinical manifestations; ranging from asymptomatic to septic shock at presentation. In children, EC and EPN are rare complications of urinary tract infections (UTIs). Their diagnosis is based on clinical manifestations, laboratory results and characteristic radiological findings of gas within the collecting system, renal parenchyma and/or perinephric tissue. Computed tomography is the best radiological option in the diagnosis of EC and EPN. Despite the availability of various treatment modalities including medical and/or surgical treatment alternatives, these life-threatening conditions have high mortality rates reaching up to 70 percent.

Case. Urinary tract infection was detected in the examinations of an 11-year-old female patient suffering from lower abdominal pain, vomiting and dysuria for two days. Air was detected in the bladder wall on X-ray. EC was detected in the abdominal ultrasonography. Air formations in the bladder lumen and calyces of both kidneys in abdominal computed tomography confirmed the presence of EPN.

Conclusions. Individualized treatment should be instituted according to the severity of EC and EPN, and the overall health condition of the patient.

Key words: emphysematous pyelonephritis, emphysematous cystitis, Enterobacter aerogenes, child.

Emphysematous cystitis (EC) is a rare, life-threatening clinical condition caused by gas-producing microorganisms in the bladder. The presence of gas in the urinary tract was first described in 1671 in a patient who stated that air came from the urethra. Eisenlohr first detected intramural gas in the bladder in an autopsy in the late 1800s,.[1] EC was defined as Bailey's disease in 1961.[2] EC is common in diabetic elderly women. In a study of 153 adult patients with EC, 63.4% of cases were female and 66.7% were diabetic.[3]

Emphysematous pyelonephritis (EPN) is an uncommon but severe necrotizing infection of the kidneys, characterized by gas formation in the renal parenchyma, perinephric tissue or collecting system after a urinary tract infections (UTI).[4] It is most commonly caused by gas-producing bacteria in the kidney. This condition was first described by Kelly and MacCullum[5] in 1898 in an adult patient. The first pediatric case reported in 1985 was a 10-year-old girl.[6] More than 80% of reported adult cases were predominantly diabetic female patients. However, not all pediatric cases were diabetic.[6,7]

In children, EC and EPN are rare conditions that occur as complications of UTIs. We did

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not find any reports in the English literature on children with both EPN and EC. It is more common in diabetic adult women. Diabetes mellitus, neurogenic bladder and advanced age are important risk factors for the development of EC and EPN.[8] Early diagnosis and treatment of EC and EPN is extremely important for the prevention of serious morbidities such as bladder necrosis and sepsis. Since it does not have typical clinical findings, the diagnosis can be made by imaging studies rather than physical examination.

In this case report, we present a rare case in children with recurrent EC associated with EPN.

Case Report

An 11-year-old girl presented with complaints of lower abdominal pain, vomiting and dysuria for two days. Her past medical records were uneventful and vital signs were stable. The patient was not febrile. Body temperature was 36.5°C. The patient had no history of change in urine color, dysuria, or abdominal pain in her background. There was no urgency, nocturia, day or night urinary incontinence, difficulty in initiating voiding, intermittent voiding, post-void dripping, but there were complaints of urinary retention, decreased frequency of voiding (≤ 3/day) and urination. The patient had no constipation.

On physical examination, suprapubic and bilateral costovertebral angle tenderness was detected. The patient was evaluated according to the Dysfunctional Voiding Scoring System (DVSS).[9] No symptoms were detected, except for a decrease in the frequency of voiding and urinary retention. Laboratory test results were as follows: white blood cells 11,240/mm^3, hemoglobin 11 g/dL, and platelets 212,000/mm^3; blood glucose 100 mg/dL, urea 22 mg/dL, creatinine 0.44 mg/dL, potassium 4.5 mEq/L, and sodium 140 mEq/L; and C-reactive protein (CRP) 77.2 mg/L (0-5 mg/L) and procalcitonin 0.21 mg/L (0-0.12 mg/L). In the urinalysis, the leukocyte count was 21 cells/HPF, leukocyte esterase (+++), erythrocyte negative, nitrite negative, and urine protein negative. The urine sample for urine culture was taken from the patient's midstream urine. Culture of urine yielded 100,000 colonies of *Enterobacter aerogenes* per ml. The air level in the bladder lumen under the anterior wall was detected in the standing abdominal X-ray (Fig. 1). Both air and echogenicity in the bladder lumen and an increase in bladder wall thickness (6.5 mm) detected in the abdominal ultrasonography (US) were evaluated as EC. In addition, the diameter of the renal pelvises was 7 mm, and there was 20 mm of residual urine in the bladder after voiding. Computed tomography (CT) imaging was performed after ultrasonographic evaluation of the patient with abdominal pain at her first admission. CT was performed to exclude conditions such as trauma, colovesical and vesicovaginal fistula, gas gangrene of the uterus and vagina, which are included in the differential diagnosis of EC. On the CT scan, air formations were present in the bladder lumen

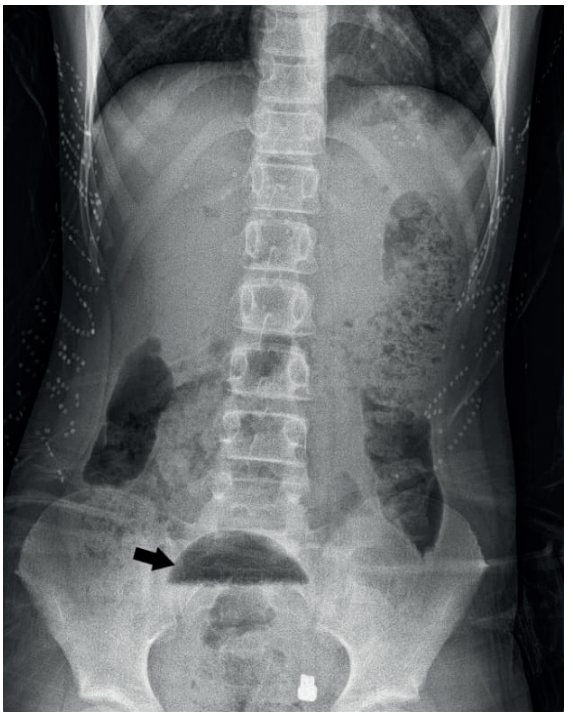

Fig. 1. Level of gas formation in the bladder on the standing abdominal X-ray (black arrow).

and the calyces of both kidneys, and the bladder wall was slightly edematous (Fig. 2).

The patient was hospitalized and intravenous fluids and ceftriaxone treatment were started. Then the patient was trained to correct her voiding habit. On the fifth day of antibiotic therapy, control urine analysis revealed no leukocyte and its culture yielded no bacterial growth. No vesicoureteral reflux was detected in voiding cystourethrography (VCUG). In the follow-up, control CRP and procalcitonin were normal. On the 10th day of treatment, Tc99m dimercaptosuccinic acid (DMSA) scintigraphy showed that the left kidney was smaller than the right kidney, and inhomogeneous activity uptake and hypoactive notches in the upper and middle outer parts of the kidneys were observed. Hypoactive areas in the upper pole of the left kidney were compatible with cortical defect. Contributions of right and left kidneys to total kidney functions were determined as 34% and 66%, respectively. The patient, whose intravenous antibiotic treatment continued for 14 days, was discharged from the hospital with antibiotic prophylaxis. Trimethoprim-sulphamethoxazole was started as antibiotic prophylaxis. The patient was not symptomatic when she applied for the follow-up visit one month later. In the urinalysis the leukocyte count was 7 cells/hpf, leukocyte esterase (+++), erythrocyte negative, nitrite negative and protein negative. Catalase positive *Staphylococcus aureus* was recovered from the urine culture. In the urinary US, the post-voiding bladder wall thickness was measured as 7 mm and several millimetric-sized air formations were observed under the anterior bladder wall. Repeated urinalysis after oral antibiotic was normal and urine culture was negative. Control urinary US was also unremarkable. The patient was given voiding training because of her hypoactive bladder. In the control DMSA repeated at the sixth month, it was observed that the notching, suggesting scar formation, continued in the upper pole and lateral of the middle part of the right kidney, as in the previous image. Contributions of left and right kidneys to total renal DMSA uptake were calculated as 65.3% and 34.7%, respectively. Informed consent was obtained from the family to publish this report.

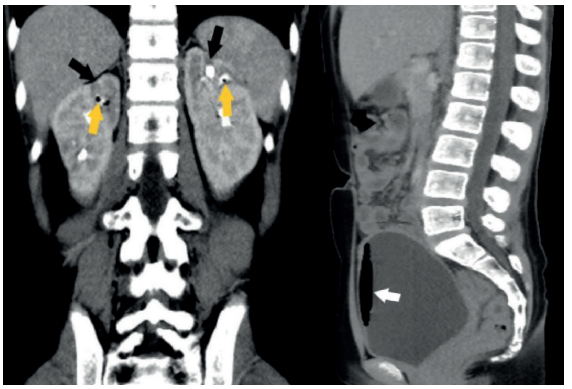

Fig. 2. In the coronal contrast -enhanced abdominal computed tomography (CT) image, the size of the right kidney was smaller than the contralateral one. More prominent on the right, there were hypodense areas in both renal cortices, suggesting a scar formation, causing focal recessions (black arrows). There were gas appearances within the bilateral renal calyces (yellow arrows). Leveled gas formation in the bladder lumen seen in the sagittal contrast-enhanced CT image of the abdomen (arrow).

Discussion

Immunosuppressive conditions other than diabetes mellitus, neurogenic bladder, urethral catheterization, vesicorectal fistula, end-stage kidney disease, bladder outlet obstruction are among risk factors for the development of EC. EC has nonspecific clinical manifestations ranging from asymptomatic or mildly symptomatic cases to cases with severe peritonitis and septic shock. Dysuria, hematuria, pollakiuria, fever, suprapubic tenderness, and pneumaturia are frequent symptoms of EC. Its more specific symptom of pneumaturia is very rarely observed. Thomas et al.[2] reported that 7% of their cases were asymptomatic and these cases were detected incidentally by abdominal imaging. In pediatric cases with EPN, vomiting, flank pain, nausea, fever, and dysuria are frequently observed. EPN should be considered in a patient with unresolved UTIs.[4-6]

Escherichia coli is the most common pathogen isolated in cases with EC and EPN. Additionally,

Klebsiella pneumoniae, *Enterobacter aerogenes*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, Citrobacter, *Staphylococcus aureus*, *Clostridium perfringens*, streptococci and Candida species have been reported as etiological agents.[4,7,10] Similarly, *Enterobacter aerogenes* was detected in the urine culture of our patient.

The pathogenesis of EPN is still unclear. Increased glucose levels in tissues, urinary tract obstruction, presence of gas-forming organisms, decreased host immunity, and impaired tissue perfusion may have a role in the pathogenesis of EPN.[11] Increased glucose levels in tissues, along with decreased blood flow to the kidneys, contribute to the anaerobic metabolism of glucose and lactate by gas-forming organisms resulting in the production of carbon dioxide, hydrogen, nitrogen, oxygen, and methane.[4,12]

To date, very few pediatric cases of EPN have been cited in the literature.[7,13] These patients have risk factors such as sepsis, end-stage kidney disease, HIV infection, kidney transplantation and urinary system obstruction.[13] No underlying risk factors were found in the present case.

CT is the best radiological option in the diagnosis of EC and EPN. Characteristic finding of EC is the appearance of small, multiple gas-filled vesicles under the bladder mucosa. Grupper et al.[11] reported that air vesicles could be seen in the bladder wall and bladder lumen in 94.4% and 3.7% of the cases, respectively. Air formation was detected in the bladder lumen and both renal calyces in our patient. CT is also useful in the differential diagnosis of EC: vesicovaginal and colovesical fistula, trauma, gas gangrene of uterus, and vagina. Ultrasound has a lower diagnostic sensitivity than CT, but it helps to measure bladder wall thickness and to determine possible echogenicities. In EPN, plain abdominal X-rays may show gas shadows in the affected kidney and a crescent-shaped gas around it. Abdominal radiograms are sensitive in detecting air in the renal collecting system, but they lack diagnostic specificity due to the superposition of intestinal gas.[7,12] Since previous studies have shown that US has a diagnostic accuracy between 50 to 86% in cases of EPN, CT is the recommended diagnostic tool in these cases.[12,14,15]

Treatment of EC includes intravenously administered broad-spectrum antibiotics, bladder drainage, glycemic control, and correction of the underlying predisposing conditions. Hence, treatment with ceftriaxone, fluoroquinolones, aminoglycosides or carbapenems should be initiated until the causative agent is isolated. However, there is no consensus on the duration of antibiotherapy. Surgical interventions including partial or total cystectomy are rarely necessary. In our case, since the isolated pathogen was sensitive to ceftriaxone, we preferred this drug as the empirical antibiotic treatment, and maintained the treatment for 14 days. If left untreated, EC may affect the kidneys or ureter and even result in the development of fatal complications.[16] Although the mortality rate in EC is approximately 7%, this rate rises to 14% if the upper urinary tract is affected.

Management of EPN necessitates delivery of supplemental oxygen, intravenous fluids, correction of acid-base imbalance, intravenous antibiotics and inotropes, and even renal replacement therapy in some patients. Clear-cut guidelines for the surgical treatment of these patients have not been established yet. The surgical treatment proposed by Huang and Tseng[17] is based on radiological classification of EPN.

Positional instillation of contrast (PIC) cystography can be considered if recurrent urinary tract infections continue in the follow-up of this case with pathological findings in DMSA screening. In studies, it has been reported that occult reflux can be detected with PIC cystography in patients with recurrent febrile urinary tract infections and no reflux with VCUG.[18] Although PIC cystography has the disadvantage of being applied under anesthesia, it also has advantages such as detecting occult

reflux, facilitating treatment with endoscopic injection if necessary, and being both diagnostic and therapeutic in the same anesthesia session.

In conclusion, although EC and EPN are generally seen in adult diabetic women, the present case shows that these conditions can also be seen in children, and EC can be also very rarely associated with EPN. Early diagnosis and appropriate treatment are vital for the successful treatment of these patients.

Ethical approval

Informed consent was obtained from the family to publish this report.

Author contribution

The authors confirm contribution to the paper as follows: study conception and design: BEA, AK, MKG; data collection: BEA, AK, MKG; analysis and interpretation of results: BEA, AK, MKG, YE; draft manuscript preparation: BEA, AK, MKG. All authors reviewed the results and approved the final version of the manuscript.

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Conflict of interest

The authors declare that there is no conflict of interest.

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