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CASE REPORT

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Morphological transition after medical treatment of emphysematous pyelonephritis over time—case report

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Abstract

Background Emphysematous pyelonephritis (EPN) is a necrotizing infection characterized by the production of gas in the renal parenchyma, collecting system or perirenal tissue. The treatment strategy, especially for surgical intervention, in EPN has been based on the Huang and Wan classifications. Huang's classification is based on the extent of gas and abscess spillover, while Wan's classification is based on the morphology of gas and fluid retention. Wan's classification type I EPN is considered more severe compared to type II EPN and pathophisyological mechanisms are speculated as the cause of the different presentation but the actual cause is unknown. In the present case, conservative treatment of EPN in the early stages of the disease allowed us to show that Wan's classification may represent a time series of morphologic changes throughout EPN.

Case presentation A 72-year-old woman treated for diabetes was admitted because of suspected treatment-resistant pyelonephritis. Her CT scan at presentation was suggestive of EPN and antibiotics was started. After additional medical treatment, a follow-up of CT image showed that the initial appearance of bubbly gas formation changed into a fluid-forming abscess. This transition shows that type I is an early phase image of EPN and type II image is seen following the early phase. Thereafter no change was seen in CT image and residing inflammation led to planned nephrectomy on day 35. Antibiotics were discontinued and no recurrence was confirmed.

Conclusions Wan's type I and II EPN has been often reported as different pathophysiological entities. Our case shows that these two subtypes may represent stages in the progression of EPN. Medical treatment for type I may permit safe nephrectomy for type II EPN.

Keywords Emphysematous pyelonephritis, Computed tomography, X-ray image, Changes in gas image, Type2 diabetes

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Background

Emphysematous pyelonephritis (EPN) is a severe form of renal parenchymal infection leading to necrosis of the kidney. It is well known that diabetes is the most common risk factor [1, 2] and when medical treatment for urinary tract infection is not effective, CT scans are helpful to rule out any treatment-resistant status [3]. One example is EPN which consists of features of acute necrotizing infection of the renal parenchyma and surrounding tissues, typically diagnosed by gas formation [1, 4]. Treatment for EPN, either antibiotic, drainage, nephrectomy or any of the combination, is often guided by risk factors and CT imaging at initial presentation [5]. Though cases of EPN have been repeatedly reported, the chronological changes on CT image of medically treated EPN is not well known. We herein report the trajectory of EPN in a diabetic patient who was successfully treated medically at first and show the chronological changes in CT image.

Case presentation

A 72-year-old woman had been treated for diabetes on insulin therapy for 18 years, complicated with diabetic kidney disease. Her glycosylated hemoglobin (HbA1c) one month prior was found to be 8.3%. She presented to the hospital with fever, fatigue, and left lateral abdominal pain 5 days prior. Upon initial examination, she was alert with body temperature of 37.8℃, blood pressure 133/91 mmHg, heart rate 131 bpm, tachypneic and oxygen saturation 98% ambient air. She was medium built and there was spontaneous pain in the left side of the abdomen and bilateral pitting leg edema. She had history of uterine cancer with metastatic lung cancer which was radically cured after surgery and chemotherapy. Recent medications were Insulin lispro(7 U-7 U-7 U), Insulin Glargine 7 U, and sitagliptin 25 mg. Blood tests revealed white blood cells (WBC) $23.9 \times 10^3/\mu L$, hemoglobin 10.2 g/dL, platelet count $3.9 \times 10^4/\mu L$, blood urea nitrogen 94.7 mg/dL, creatinine 5.16 mg/dL, Na 117 mEq/L, K 4.7 mEq/L, Cl 80 mEq/L, C-reactive protein (CRP) 39.52 mg/dL, procalcitonin > 100 ng/mL, prothrombin time 17.3 s, activated partial thromboplastin time 38.3 s, fibrinogen degradation products 67.7 μg/mL, D-dimer 28.7 μg/mL and blood glucose 725 mg/dl. Her venous blood gas was pH 7.407, PCO_2: 20.7, PO_2: 78.2, HCO_3: 12.8, and lactate 3.7 mmol/L. Urine tests were protein 2+, glucose 4+, ketones±, blood 3+. A CT scan of the abdomen demonstrated an atrophic right kidney and global multilocular gas in the swollen left renal parenchyma (Fig. 1). There were not urolithiasis and hydronephrosis. Based on these examinations she was diagnosed with EPN, disseminated intravascular coagulation, hyperosmolar hyperglycemic syndrome, pseudo-hyponatremia, and acute on chronic kidney disease hence she was transferred to the Intensive Care Unit (ICU).

Meropenem 0.5 g q24h was administered for EPN but soon after ICU admission, she went into a state of shock requiring norepinephrine. She was treated with recombinant thrombomodulin-alpha for 6 days and received a total of 30 units of platelet transfusions against the DIC. Meanwhile, intensive diabetic management lowered her blood sugar level to 100–200 mg/dL. On day 4, she became anuric requiring hemodialysis and additional polymyxin B hemoperfusion was performed on day 3 and 4. Escherichia coli was detected from blood and

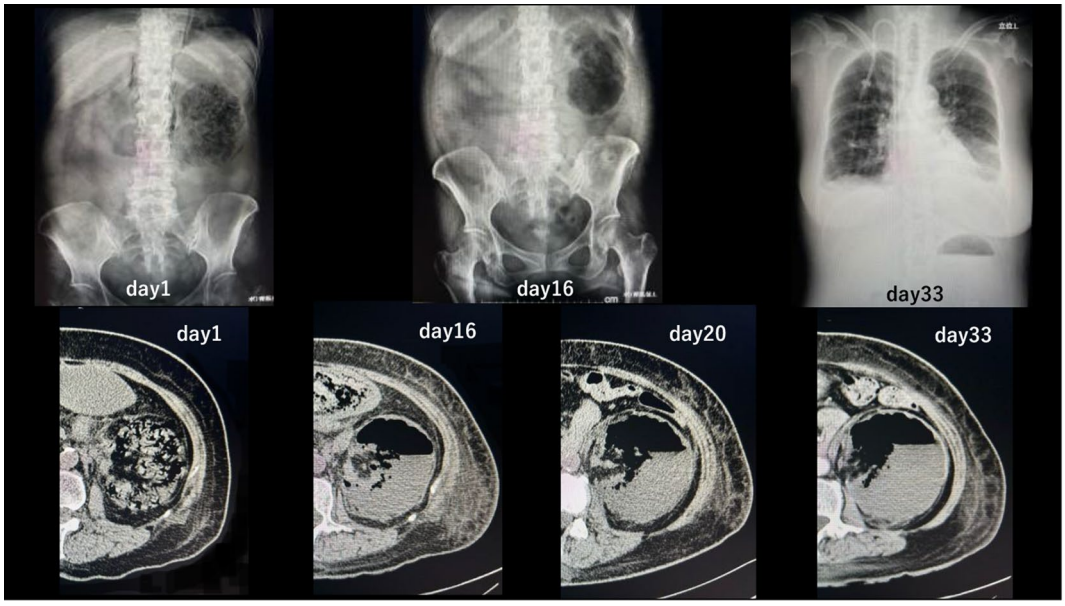

Fig. 1 Time series change of gas image in EPN. On admission, the entire renal parenchyma showed a multiple bubbly gas image. After successful medical treatment, gas image became more aggregated, and a separation of liquid and gas was observed

Fig. 2 Nephrectomized kidney. Photo of the nephrectomized kidney

urine cultures and the antibiotic was changed to ampicillin sulbactam 3 g q24h based on its drug sensitivity on day 8. We present the chronological changes on x-ray and simple CT of EPN over time (Fig. 1). A multifocal emphysematous image was present on admission but changed to two layers of liquid and gas components in the kidney after 15 days. Thereafter, no improvement in kidney function and inflammatory response was seen and CT image performed 31 days after admission revealed an iliopsoas abscess adjacent to the left kidney. So, on the 35th day elective nephrectomy and excision of the iliopsoas abscess was performed. The pathology of the excised kidney showed only necrotic tissue with severe neutrophilic infiltration and there was no normal renal tissue (Fig. 2). After nephrectomy, both WBC and CRP improved, and left-sided abdominal pain resolved quickly but unfortunately, she stayed on dialysis. Antimicrobials were discontinued 3 days postoperatively and no relapse is seen.

Discussion and conclusions

We presented the trajectory of a high-risk EPN in a patient who was medically treated at initial presentation and completed by elective nephrectomy. At presentation, widespread multilocular gas was confirmed in the whole swollen left kidney, which gradually dissolved and "liquified" to form a niveau in the retroperitoneum space mostly where the cortex occupied. The interval between this change was about less than 2 weeks. As far as we know, such graphical transitions based on Wan's classification of medically treated pyelonephritis has not been reported.

Studies on EPN have mainly focused on the CT morphology at presentation and the prognosis depending on the treatment either surgical or medical. The classification by Huang et al [1] is distinguished by CT scan and evaluated by the extension of gas inside or outside the infected kidney (Table 1). This classification is believed to represent the severity of the disease and therefore, related to prognosis. This case would be diagnosed as class 3A at initial presentation and 3B with the following formation of ilipsoas abscess, which is suggested to be a severe form of EPN. The report by Wan et al [2] is more simple and discriminates between two types of presentation as having (type II) or not having (type I) fluid collection (Table 2). Using this classification, this case would be type I at presentation and type II after several days of medical treatment. Our report shows that CT morphology may differ during the course of treatment. Indeed, in Wan's report [2], type I EPN was diagnosed 4 days after symptom onset and type II EPN was 11 days. Though the literature on EPN are based mostly on single or collective case reports, type I EPN has been related to higher mortality [1–3]. Reports including those from Wan [2, 3] have proposed that the two subtypes may represent different pathophysiologic responses to infection. It can be speculated from our case that during successful intensive medical treatment, type I transforms into type II though

Table 1 Huang's classification

Class1	Gas is confined within the renal pelvis
Class2	Gas confined to renal parenchyma
Class3A	Gas and pus spread to the perirenal area (within the renal fascia)
Class3B	Gas or pus extends outside the perirenal space (outside the renal fascia)
Class4	Emphysematous pyelonephritis in bilateral or unilateral renal patients

Table 2 Wan's classification

Type I	Parenchymal destruction with either absence of fluid collection or presence of streaky or mottled gas
Type II	Either renal or perirenal fluid collections with bubbly or loculated gas or gas in the collecting system

the extension of infection may not change unless drainage or nephrectomy is performed.

As for the prognosis of EPN, several studies have mentioned that altered mental status, thrombocytopenia, shock, hyponatremia and renal failure were significantly associated with mortality [1, 4–6]. CT images of higher class in Huang's classification and type I in Wan's, are all suggestive of higher mortality. In high-risk cases combined with many of these risk factors, such as ours, early surgical treatment may be poorly tolerated. In a meta-analysis of retrospective studies [5], emergent nephrectomy was a risk factor for mortality, which is probably the causal result of the most severely ill population. Percutaneous drainage (PCD) is another option that could have been considered. Recent reports on PCD suggest its use in localized gas formation, less than two risk factors, and for the preservation of kidney function [7]. However, given the atrophy of the remaining kidney on CT image and the prior kidney function of this case, the effects of the fatal infection on her residual kidney function seemed detrimental. Therefore, rather than aiming for the preservation of kidney function, selective surgery was considered. Selective nephrectomy after conservative therapy is suggested to have lower mortality (10%), and removal of a necrotic kidney is considered to prevent recurrence [8]. Reconsidering our case, selective nephrectomy may have been considered earlier as no change was proven after day 15 and withdrawal from dialysis seemed unlikely.

Diabetes mellitus (75–96%), obstructive uropathy including urolithiasis (22–49%), hypertension (39%), and female sex have been identified as risk factors for EPN in several studies [1, 8, 9]. Lesions are more frequently observed in the left kidney (52–56%) than in the right (37–41%), with bilateral involvement reported in 3–10% of cases [4]. This lateral predominance is thought to be attributable to the higher incidence of urinary tract obstruction on the left side (64% vs. 36%). However, regarding urinary tract obstruction, although it is considered a requisite factor in all non-diabetic cases, it is observed in only approximately half of diabetic patients [1], suggesting that obstruction is not a necessary condition for the development of EPN.

The unique feature of this case is that we were able to follow the morphological transition of EPN on CT image and show recovery from a high-risk case. Both classifications resemble the trajectory of EPN, rather than different pathophysiology, and evaluation in combination with the severity of the patient, may guide to selection of appropriate treatment options.

Abbreviations

EPN	Emphysematous pyelonephritis
CT	Computed tomography
ICU	Intensive Care Unit
PCD	Percutaneous drainage

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Not applicable.

Author contributions
All were involved in the medical treatment as a team. Dr. Uchida, Dr. Hara, and Dr. Kawarazaki provided advice in writing this report. Dr. Yamamoto was the main clinician and wrote the case report.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
All procedures performed in studies involving human participants were in accordance with the ethical standards of the Declaration of Helsinki 1964 and its later amendments. The name of the ethics committee that approved the study and the committee's reference number if appropriate; Not applicable.

Consent for publication
Written informed consent was obtained from the patient.

Clinical trial number
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Huang JJ, Tseng CC. Emphysematous pyelonephritis: clinicoradiological classification, management, prognosis, and pathogenesis. Arch Intern Med. 2000;160:797–805.
2. Wan YL, Lee TY, Bullard MJ, Tsai CC. Acute gas-producing bacterial renal infection: correlation between imaging findings and clinical outcome. Radiology. 1996;198:433–38.
3. Falagas ME, Alexiou VG, Giannopoulou KP, Siempos II. Risk factors for mortality in patients with emphysematous pyelonephritis: a meta-analysis. J Urol. 2007;178:880–85.
4. Kapoor R, Muruganandham K, Gulia AK, et al. Predictive factors for mortality and need for nephrectomy in patients with emphysematous pyelonephritis. BJU Int. 2010;105:986–89.
5. Desai R, Batura D. A systematic review and meta-analysis of risk factors and treatment choices in emphysematous pyelonephritis. Int Urol Nephrol. 2022;54:717–36.
6. Khaira A, Gupta A, Rana DS, Gupta A, Bhalla A, Khullar D. Retrospective analysis of clinical profile prognostic factors and outcomes of 19 patients of emphysematous pyelonephritis. Int Urol Nephrol. 2009;41:959–66.
7. Ubee SS, McGlynn L, Fordham M. Emphysematous pyelonephritis. BJU Int. 2011;107:1474–78.
8. Somani BK, Ghulam Nabi. Is percutaneous drainage the new gold standard in the management of emphysematous pyelonephritis? Evidence from a systematic review. J Urol. 2008;179:1844–49.
9. Batirel A, Regmi SK. Urological infections in the developing world: an increasing problem in developed countries. World J Urol. 2020;38(11):2681–91.

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