

RADIOLOGICAL MANAGEMENT OF EMPHYSEMATOUS PYELONEPHRITIS: A REPORT OF 3 CASE

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Abstract

Emphysematous pyelonephritis is a necrotic kidney infection characterized by the presence of gas within the renal parenchyma, the excretory cavities, or the peri-renal spaces.

Objective : *Our main objective is to evaluate the various epidemiological, diagnostic, and evolutionary aspects of emphysematous pyelonephritis (EPN), as well as the role of conservative treatment, highlighting the importance of CT scans in the management of this condition in the urology department at Amitié Hospital in Nouakchott, Mauritania.*

Material and methods : *This was a retrospective and descriptive study focusing on emphysematous pyelonephritis cases recorded from the hospital admission registers of Amitié Hospital in Nouakchott. The study period was 2 years (2016 to 2017). For each case, we collected epidemiological, clinical, biological, radiological, therapeutic, and evolutionary data.*

Results : *We collected three medical records related to cases of emphysematous pyelonephritis, representing an incidence of 1.5 cases per year in the urology department. The average age of the patients was 51.6 years (with extremes ranging from 46 to 60 years). The medical history was primarily characterized by the presence of diabetes, which was found in all patients. The most common reason for consultation was febrile low back pain with a general deterioration in health. Biologically, the complete blood count revealed leukocytosis in only one patient, while the other two had normal white blood cell counts. Microcytic hypochromic anemia was observed in two patients. Additionally, C-reactive protein (CRP) levels were above 12 mg/L in all patients. Hyperglycemia was noted in all cases, with extreme values up to 4 g/L. Urine testing using a reactive strip identified diabetic ketoacidosis in one patient, while the urine cytobacteriological examination was only performed in one patient, which returned positive. The non-contrast urinary tract imaging (AUSP) showed gas densities in the renal area in one case, while for the others, AUSP was not performed. Ultrasound, performed on all patients, revealed gas bubbles in all cases. The diagnosis was confirmed by a CT scan in all patients. Treatment consisted of draining the purulent and gas collections through percutaneous drainage under CT guidance for all patients.*

Conclusion : *In a diabetic patient, any pyelonephritis resistant to antibiotics should raise suspicion of emphysematous pyelonephritis, warranting a CT scan to confirm the diagnosis and guide treatment. Medical treatment alone can be effective, especially in cases that are detected early.*

Keywords : *Emphysematous pyelonephritis, diabetes, uroCT, percutaneous drainage, Mauritania*

Introduction

Emphysematous pyelonephritis (EPN) is a severe and necrotizing form of acute bacterial pyelonephritis. It is characterized by the presence of gas within the renal parenchyma, excretory cavities, and/or perirenal spaces. This condition is typically encountered in diabetic patients, particularly women [3]. The most commonly associated

etiological factor is poorly controlled diabetes [9]. Without early diagnosis and prompt management, the condition can progress to a fatal outcome due to septic shock and multiorgan failure. Computed tomography (CT) is the diagnostic modality of choice, allowing positive identification through the detection of gas and classification into four prognostic stages [13]. Management remains a topic of debate: while surgical intervention and purely medical treatment are options, percutaneous drainage has a significant role [9].

Our objective is to evaluate the epidemiological, diagnostic, and clinical aspects of EPN, as well as the role of conservative treatment, highlighting the importance of CT imaging in the management of this condition at the Urology Department of Amitié Hospital in Nouakchott, Mauritania.

Materials and Methods

This was a retrospective and descriptive study of emphysematous pyelonephritis cases, identified from hospitalization records and operating room logs at Amitié Hospital in Nouakchott. The study period extended from January 1, 2016, to December 31, 2017. For each case, we collected epidemiological, clinical, biological, radiological, therapeutic, and outcome data.

Results

-Epidemiology

Frequency

We identified three medical records of emphysematous pyelonephritis cases, corresponding to an incidence of 1.5 cases per year in the urology department.

Age

The mean age of patients was 51.6 years (range: 46 to 60 years).

Medical History

All patients had a history of diabetes.

-Clinical Presentation

Consultation Delay

The average time to consultation was 5.8 days (range: 5–7 days) after symptom onset.

Main Symptoms

The most common reason for consultation was febrile lower back pain associated with a deterioration in general condition.

Renal involvement was localized to the right kidney in two patients and to the left kidney in one patient.

The clinical presentation resembled that of common acute pyelonephritis in two cases.

In one patient, the examination revealed an inflammatory lumbar mass, while another patient presented with diabetic ketoacidosis.

- Laboratory Findings

- The complete blood count revealed leukocytosis in one patient, while the other two had normal white blood cell levels.
- Two patients exhibited hypochromic microcytic anemia.
- C-reactive protein (CRP) levels were elevated above 12 mg/L in all patients.
- Hyperglycemia was observed in all cases, with extreme values reaching up to 4 g/L.

The urine dipstick test identified diabetic ketoacidosis in one patient. Urine culture and sensitivity testing was conducted in only one patient, yielding positive results with the isolation of *Klebsiella pneumoniae*, which was sensitive to amoxicillin-clavulanic acid.

- Imaging

- A plain abdominal X-ray (AUSP) identified gas lucencies in the renal region in one case; it was not performed in the other cases.
- Ultrasonography, conducted for all patients, revealed gas bubbles in every case. No obstruction of the excretory pathways was noted in any patient.
- The diagnosis was confirmed via urological CT scans performed on all patients. These scans demonstrated gas presence within the renal space and retroperitoneal air diffusion in all cases, corresponding to stage 3B of the condition.

Table I : Uro-TDM Results According to Huang and Tseng's Classification

Stage (TDM)	numbers
Stade 1	0
Stade 2	0
Stade 3A	0
Stade 3B	3
Stade 4	0



Figure 1: Axial cut of a uro-CT scan showing a right retroperitoneal hydro-aeric image with delayed secretion, suggestive of stage 3A emphysematous pyelonephritis (PNE).



Figure 2: Coronal reconstruction of a uro-CT scan showing the presence of two collections, one in the upper pole and the other in the lower pole, containing air bubbles associated with mild infiltration of the surrounding fat, consistent with a stage 3A emphysematous pyelonephritis (PNE) according to the CT classification of Hung and Tseng.

Treatment

The treatment involved the drainage of purulent and gas collections, performed through percutaneous drainage under CT guidance in all of our patients.

Evolution:

The clinical, biological, and radiological evolution was favorable, with renal preservation in all our patients.

Clinically, all patients presented with apyrexia within 48 hours after the initiation of resuscitation measures, correction of electrolyte disturbances, and the start of appropriate antibiotic therapy.

Biologically, the complete blood count (CBC) and CRP levels showed normalization of CRP in all patients, as well as resolution of leukocytosis.

The follow-up uroscanner revealed a complete disappearance of gas in the retroperitoneal spaces.

Discussion

Emphysematous pyelonephritis (EPN) is a severe and necrotizing form of acute bacterial pyelonephritis, resulting from the production of gas within the renal parenchyma. Often, the infection, and consequently the gas, extends through the renal capsule into the perirenal space [12].

Emphysematous pyelonephritis is a rare condition. In 1995, fewer than 200 cases had been described [9]. Since then, the incidence appears to be increasing, with over 100 publications on the subject indexed in Medline. This may be attributed to better awareness of the disease, the widespread use of tomography, which more sensitively detects gas, or the rising incidence of diabetes in Asia and industrialized countries (with a 3% annual increase in France) [10]. In Aziz El Majdoub's 2015 study, the incidence was 0.7 cases per year [3].

In our series, the incidence was 1.5 cases per year.

Emphysematous pyelonephritis is a rare infection that primarily affects adults. The average age of onset was 53 years in the Kaiser study [9], 55 years in the Pagnoux study [14], and 54.6 years in the Derouiche study [4].

These results are similar to those in our series, where the average age was 51.6 years, with extremes ranging from 46 to 60 years.

Most studies conclude a female predominance [9]. Michaeli et al. [8] report a sex ratio of 1/1.8 (64% women and 36% men), which is consistent with the findings of our study.

The left kidney is affected in 53% to 60% of cases, compared to 35% for the right kidney [8]. Bilateral forms are rare (5 to 20%) and are particularly severe [11].

In our series, renal involvement was localized to the left side in only one patient, and to the right side in two other patients.

The origin of emphysematous pyelonephritis is kidney infection by a variety of gas-forming bacteria, which are exceptionally strict anaerobic germs. The majority are Gram-negative bacilli from the Enterobacteriaceae family [15].

In 60% to 70% of cases, *Escherichia coli* is isolated through urine cytobacteriological examination or blood cultures, and it does not differ from the strains found in usual pyelonephritis cases [15].

In our series, bacteriological testing was performed in only one patient, who had isolated *Klebsiella pneumoniae*. According to a study conducted by Blanco M, *Klebsiella pneumoniae* was isolated in 5% of pyelonephritis cases [5].

Diabetes is the primary contributing factor, present in 70% to 90% of emphysematous pyelonephritis cases [9]. However, cases of PNE in non-diabetic patients have also been reported [1]. In our series, all our patients were diabetic, which aligns with the data in the literature. The second etiological factor is the obstruction of the urinary tract (such as stones, vascular compression, or congenital obstruction) (Figure 9), which is noted in 20% to 41% of cases [9]. In our observation, none of our patients had urinary tract obstruction.

In the context of emphysematous pyelonephritis, the low back pain can be explained by [9]:

- Obstruction of the urinary tract.
- Edema of the renal parenchyma and perirenal structures.

In our series, low back pain was the primary reason for consultation.

In the literature, dysuria was present in almost all patients [9]. In our series, two of our patients presented this symptom.

The complete blood count can be useful in assessing the severity of the infection, either through significant leukocytosis or, conversely, leukopenia [19]. In our series, the blood count revealed leukocytosis of 13,000 cells/mm³ in one patient, along with microcytic hypochromic anemia in two patients. Anemia can have a clinically more or less severe character, depending on how well it is tolerated or in the case of a marked inflammatory or infectious syndrome. In such situations, a blood transfusion may be necessary [19].

In our series, one patient received two units of isogroup, isorhesus blood. Inflammatory markers are not useful in assessing the severity of the infection and do not influence treatment decisions [19].

The normalization of C-reactive protein (CRP) is a marker of therapeutic efficacy [9]. The CRP level was above 12 mg/l in all of our patients. When coupled with the detection of glucose in the urine using urine test strips, it is a very effective diagnostic tool for acidotic decompensation [9]. Hyperglycemia was noted in all cases, with extreme values around 4 g/l. Creatinine measurement remains the most widely used test to assess renal function since its value reflects the glomerular filtration rate. In the literature, there are very few series that discuss renal insufficiency in patients with emphysematous pyelonephritis [4].

In our series, only one patient presented with acute functional renal insufficiency, which regressed after resuscitation measures. In the context of emphysematous pyelonephritis, an unprepared urinary tree (AUSP) can reveal renal emphysema (65%) or retro-pneumoperitoneum and can help detect any radio-opaque lithiasis-related obstructions [9]. In our series, AUSP allowed the detection of gas presence in one of our patients. In emphysematous pyelonephritis, renal ultrasound is difficult to interpret. It may show hyperechoic areas with posterior attenuation and reverberation corresponding to gas bubbles, but it does not provide a precise assessment of the disease's extent [19]. It also helps to detect urinary tract obstructions and can guide the identification of the nature of the obstruction [4].

Ultrasound, performed on all our patients, revealed gas bubbles in every case. Computed tomography (CT) is the reference exam for the positive diagnosis, etiology, and follow-up of emphysematous pyelonephritis. It is highly sensitive (100%) for detecting the presence of gas in the renal parenchyma and assessing parenchymal destruction. It also allows for the examination of perirenal spaces and provides a clearer understanding of lesion extension [9]. Huang and Tseng established another CT classification with therapeutic implications [4]. This classification divides emphysematous pyelonephritis into 4 stages:

- Stage 1: Gas only in the excretory pathways
- Stage 2: Gas in the renal parenchyma without extension into the extrarenal space
- Stage 3A: Extension of gas or abscess into the perinephric space
- Stage 3B: Extension of gas or abscess into the paranephric space
- Stage 4: Bilateral emphysematous pyelonephritis or on a solitary kidney

All of our patients were classified as stage 3A (Figures 1 and 2). Emphysematous pyelonephritis is a medical-surgical emergency [4]. The correction of glycemic disturbances is a constant principle in the therapeutic management of emphysematous pyelonephritis [9], as most patients affected by this condition are diabetic.

Treatment consists of parenteral insulin therapy adjusted based on capillary blood glucose levels [9]. Numerous authors have reported cases of emphysematous pyelonephritis successfully treated with antibiotics alone, without drainage or surgery, whether the form was unilateral [17] or bilateral [18]. The effectiveness and promptness of initial antibiotic therapy play a significant role in improving survival [7]. Antibiotics must be effective against Gram-negative bacilli, administered parenterally for optimal bioavailability, and used in synergistic combinations for greater efficacy. They should be administered in high doses to achieve tissue concentrations above the minimum inhibitory concentrations of the pathogens. One of the antibiotics should exhibit concentration-dependent efficacy for rapid bactericidal action (fluoroquinolones, aminoglycosides) and a post-antibiotic effect for prolonged activity. The initial empirical antibiotic therapy typically combines a third-generation cephalosporin or imipenem with a fluoroquinolone or aminoglycoside [9]. The main risks of therapeutic failure in emphysematous pyelonephritis are relapse and progression to chronicity [6]. These risks may be linked to inadequate duration of treatment during the acute phase. Currently, the duration of treatment for emphysematous pyelonephritis remains a subject of controversy [6].

Yun's study showed that the results obtained with 14 days of ciprofloxacin were not inferior to those obtained with 28 days of treatment with the same drug [19]. On the other hand, Asgari, in his study, recommends a treatment duration of 4 to 6 weeks [2]. In our series, an antibiotic treatment of 2 to 3 weeks was initiated for all our patients due to the

severity of the clinical symptoms, the immunocompromised background, and the scannographic data. Although medical treatment alone can be effective in some cases, recent studies have reported an average mortality rate of 44%. A surgical procedure, either percutaneous or endoscopic, is often necessary [19]. In our series, no patient underwent renal cavity drainage via nephrostomy, double J ureteral stent insertion, or surgical drainage via lumbar incision.

Nephrectomy is considered by some authors to be the treatment of choice for emphysematous pyelonephritis [19]. Its advantage is the radical treatment of the infectious focus, but in addition to the difficulties sometimes encountered due to local and regional inflammatory changes, the theoretical risk of gas embolism during renal manipulation should be noted [9]. In our series, no nephrectomy was performed. Percutaneous drainage was first described in 1986 by Hudson et al. as an effective conservative treatment for emphysematous pyelonephritis [16]. Since then, several teams have used it for this indication [2]. It can be performed under local anesthesia with scanographic guidance. This therapeutic approach requires strict monitoring in a medical-surgical setting, as it may be associated with septic discharge and subsequent collapse. The effectiveness of this conservative treatment combined with antibiotic therapy has been well established [9].

All our patients received this treatment. The average duration of drainage is 15 to 21 days, depending on the size and extent of the collection [9]. This exactly matches the treatment duration for our patients in this study. The prognosis of emphysematous pyelonephritis (EPN) is severe, with a mortality rate of 19%, regardless of the therapeutic approach [9]. In our series, the outcome was marked by a clear improvement in the clinical picture, with complete recovery for all our patients. This demonstrates the quality of care and the performance of the urology department in collaboration with the radiology department at the Amitié Hospital in Nouakchott.

Conclusion

Emphysematous pyelonephritis (EPN) remains a severe infection that threatens both vital and functional prognosis. It is crucial to suspect it early in the presence of urinary tract infection combined with severe clinical signs, particularly in diabetic patients. The pathophysiology of EPN is still debated, although the primary hypothesis is that of intrarenal fermentation of glucose by facultatively anaerobic Gram-negative bacteria in a tissue environment conducive to this process. Computed tomography (CT) is the key examination to establish the positive and topographical diagnosis. Therapeutic management is based on resuscitation measures, early adapted antibiotic therapy, in addition to percutaneous drainage of perirenal collections and urinary tract drainage in case of obstruction. The long-term prognosis of renal function depends on the degree of parenchymal destruction and the presence of associated nephropathy.

Conflicts of Interest

The authors declare no conflicts of interest.

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