

Available online at www.sciencedirect.com

ScienceDirect

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

Case Report

Unraveling the uncommon: Pneumoperitoneum induced by emphysematous pyelonephritis ☆,☆☆

Oumaima Mesbah, MD*, Badr Kabila, MD, Basma Beqqali, MD, Omar El Aoufir, PhD, Laila Jroundi, PhD

Emergency Radiology Department, Ibn Sina University Hospital, Faculty of Medicine and Pharmacy of Rabat, Mohamed V University, Rabat, Morocco

ARTICLE INFO

Article history:

Received 6 November 2024

Revised 16 November 2024

Accepted 21 November 2024

Keywords:

Emphysematous pyelonephritis

Pneumoperitoneum

Computed tomography

Nephrectomy

ABSTRACT

Emphysematous pyelonephritis is a necrotizing infection of the renal parenchyma by gas-forming organisms, with a risk of the gas extending into peri-nephric or para-renal spaces and in advanced cases, the involvement may be extensive and bilateral. It is a common complication in patients with long-term diabetes, primarily caused by Gram-negative organisms or, in some cases, anaerobes. The diagnosis of emphysematous pyelonephritis is made by clinical features and confirmed by computed tomography. Treatment is decided based on the computed tomography classification, with minimally invasive conservative techniques and antibiotic treatment before considering nephrectomy. We present a case of a 30-year-old woman with an emphysematous pyelonephritis associated with pneumoperitoneum.

© 2024 The Authors. Published by Elsevier Inc. on behalf of University of Washington.

This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

Introduction

Emphysematous pyelonephritis (EPN) is a severe and often life-threatening renal infection characterized by the presence of gas within the renal parenchyma and surrounding structures. First described by Kelly and MacCallum in 1898, EPN has since been recognized under various names such as renal emphysema, pyelonephritis emphysematosa, and pneumonephritis [1,2]. This condition is most commonly associated with underlying diabetes mellitus and can progress

rapidly, leading to significant morbidity and mortality if not promptly diagnosed and treated.

In 1962, Schultz and Klorfein proposed the term “emphysematous pyelonephritis” to highlight the critical connection between acute renal infection and the formation of gas, thereby standardizing the terminology and focusing attention on its clinical implications [3]. EPN typically presents with severe symptoms including fever, flank pain, and nausea, and requires urgent medical intervention [4]. Computed tomography is the best diagnostic modality for

☆ Competing Interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☆☆ Acknowledgments: The author(s) received no financial support for the research, authorship, and/or publication of this article.

* Corresponding author.

E-mail address: Oumaima.mesbah@gmail.com (O. Mesbah).

<https://doi.org/10.1016/j.radcr.2024.11.056>

1930-0433/© 2024 The Authors. Published by Elsevier Inc. on behalf of University of Washington. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

emphysematous pyelonephritis, confirming it diagnostic, showing a destroyed renal parenchyma with streaks of gas with or without extension to the extrarenal space.

Case report

A 30-year-old woman, with no family or personal past history, presented with a chief complaint of abdominal pain and fever which have been developing for the past 5 days. A general examination showed a regular pulse, an elevated heart rate and a normal blood pressure of 120/80 mm/Hg. Physical examination revealed a high fever and a tender abdomen with a maximum pain at the right loin. Basic investigations on admission reported high blood sugar (40 mmol/L, reference range 3.9–5.6 mmol/L). Urine routine and microscopy showed excess white blood cells but negative results for ketones. She had acute renal failure (s. urea: 15 mmol/L, (reference range: 1.8–7.1 mmol). Creatinine 243 μ mol/L, (reference range 61.9–114.9 μ mol/L). Blood count showed leukocytosis (18×10^9 /L, reference range: 4500–11,000 cells/L) with dominant polymorphs and thrombocytopenia (92×10^9 /L, reference range: $150\text{--}450 \times 10^9$ /L). She was diagnosed as acute pyelonephritis with sepsis and uncontrolled hyperglycemia. Ultrasonography could not depict the right kidney adequately, an abdominal computed tomography with contrast enhancement was performed. It showed mild left pleural effusion with a very enlarged right heterogeneous kidney with greater than one-third renal parenchymal destruction associated to multiple areas of air density extending to the perinephric, pararenal and intraperitoneal perihepatic space associated to a psoas abscess and pelvic intraperitoneal fluid. The left kidney had normal findings (Fig. 1).

The diagnosis of emphysematous pyelonephritis with pneumoperitoneum was made. An emergency nephrectomy was performed through a lumbar incision, following brief resuscitation that included triple antibiotic therapy and insulin therapy. Postoperatively, the improvement in the patient's overall condition was dramatic, with fever resolution by the 24th hour and normalization of renal function by the 48th hour. All bacterial cultures (blood, urine, renal tissue) identified the presence of *Escherichia coli* sensitive to fluoroquinolones. The patient was discharged from the hospital on the 14th postoperative day with insulin therapy. Histological examination of the surgical specimen revealed acute suppurative pyelonephritis with papillary necrosis and vascular thromboses.

Discussion

The initial case of gas-forming renal infection was documented by Kelly and MacCallum in 1898 [1]. In 1962, Schultz and Klorfein recommended the term “emphysematous pyelonephritis” as the preferred designation because it highlights the connection between acute renal infection and gas formation [3].

The presence of gas in the kidney can arise from various causes, including medical procedures, fistulas connecting the gastrointestinal or respiratory tracts, or more commonly, gas production by local microorganisms.

Several microorganisms, including *E. coli*, *Klebsiella*, *Aerobacter*, *Pseudomonas*, *Proteus*, and occasionally *Candida albicans*, can generate carbon dioxide and hydrogen through glucose fermentation. Anaerobic gas production by clostridia and bacteroides is much less common and has mainly been observed following surgical procedures. Additional local (e.g., obstruction, ischemia) or systemic (e.g., diabetes, immunosuppression) factors contribute to the development of this syndrome [5].

The clinical symptoms of emphysematous pyelonephritis often mirror those of typical upper urinary tract infections, with fever, abdominal pain, and back pain being predominant symptoms [4].

Huang and Tseng found that 79% of patients experienced fever, 71% had abdominal or back pain, 17% suffered from nausea and vomiting, 19% showed signs of lethargy and confusion, 13% experienced dyspnea, and 29% were in shock [6].

Laboratory testing can reveal an elevated glycosylated hemoglobin, leukocytosis, thrombocytopenia and pyuria.

Clinical indicators with substantial negative prognostic value in emphysematous pyelonephritis include shock, renal failure and low levels of platelets in the blood. In contrast, factors like age, glycemic levels, and the location of the infection, do not significantly impact the outcome. The best predictors of a good outcome are a brief period between the onset of symptoms and the start of treatment and a nonobstructive unilateral disease [6].

An abdominal CT scan confirms the diagnosis and details the extent of the lesions, which may occasionally be bilateral. After contrast medium injection, the scan can reveal asymmetry in kidney enhancement and delayed contrast medium excretion. During the nephrographic phase, focal necrosis or abscesses may be observed. The differential diagnosis for emphysematous pyelonephritis includes renal abscess, iatrogenic gas presence, post-traumatic infarction, and perforation of hollow organs [7].

EPN is classified according to Huang and Tseng based on imaging findings [6]:

- Class 1, gas only in the collecting system.
- Class 2, gas in the renal parenchyma without extension to the extrarenal space.
- Class 3A, Gas or abscess in the perinephric space.
- Class 3B, extension of gas or abscess to the pararenal space.
- Class 4, bilateral EPN or a solitary kidney with disease.

Treatment for classes 1 and 2, combined antibiotic therapy and percutaneous nephrostomy tube drainage (PCD) have a success rate of 66%, while the mortality rate for treatment with antibiotics alone stays high [8]. For classes 3 and 4, depending on the presence of negative prognostic, antibiotic therapy and PCD may be attempted but ultimately nephrectomy may be recommended and sometimes necessary [9].

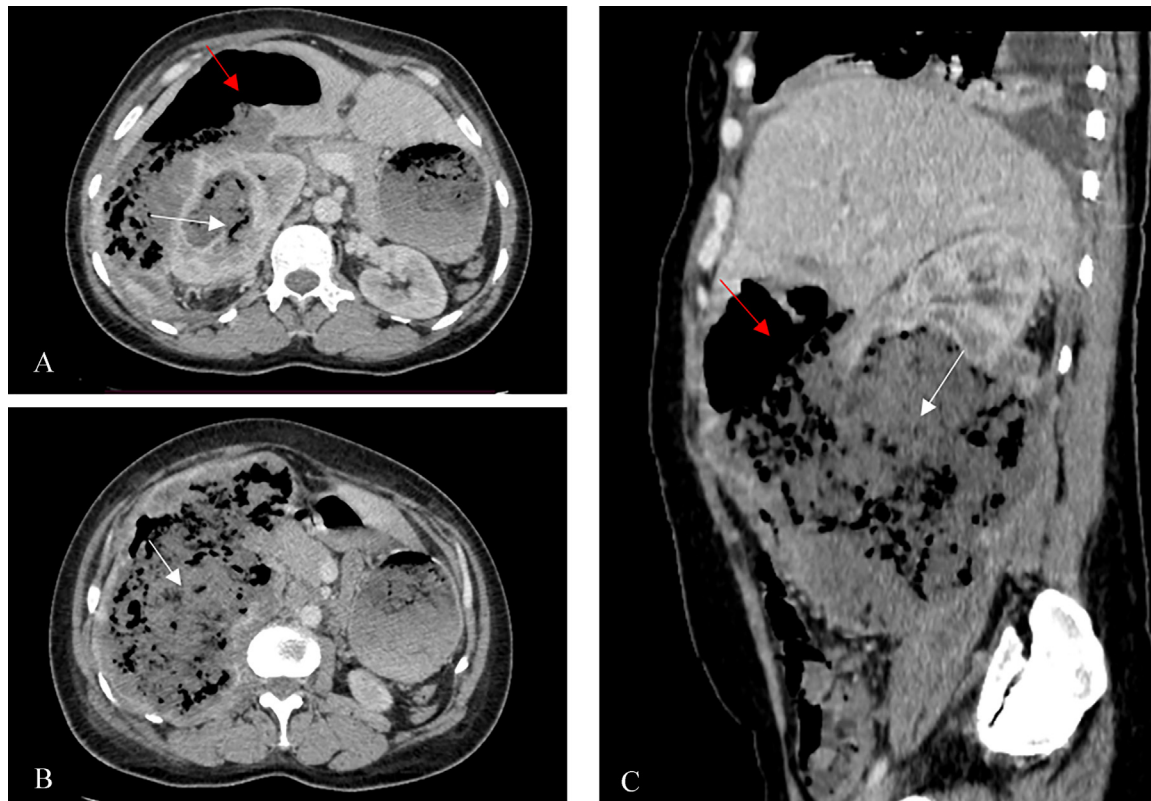


Fig. 1 – Right emphysematous pyelonephritis with pneumoperitoneum. Axial CT scan (A and B) and sagittal reconstructions (C) showing an enlarged right heterogeneous kidney with parenchymal destruction associated to multiple areas of air density (Red arrow), extending in perihepatic space (White arrow).

Conclusion

Emphysematous pyelonephritis is a rare and serious condition. Abdominal CT is the key examination, allowing for early diagnosis, assessment of the extent of the lesions, and aiding in the decision-making process regarding conservative or radical treatment.

Management must be immediate, involving brief resuscitation followed by emergency nephrectomy. Percutaneous drainage combined with medical treatment is a good alternative, as it can help preserve the kidney in certain localized, bilateral forms, or when occurring in a single kidney.

Ethical approval

No ethical approval was required for this article.

Patient consent

Written informed consent was obtained from the patient for the anonymized information to be published in this article.

REFERENCES

- [1] Michaeli J, Mogle P, Perlberg S, Heiman S, Caine M. Emphysematous pyelonephritis. *J Urol* 1984;131:203–8. doi:[10.1016/s0022-5347\(17\)50309-2](https://doi.org/10.1016/s0022-5347(17)50309-2).
- [2] Schultz EH, Klorfein EH. Emphysematous pyelonephritis. *J Urol* 1962;87:762–6. doi:[10.1016/S0022-5347\(17\)65043-2](https://doi.org/10.1016/S0022-5347(17)65043-2).
- [3] Kelly H, MacCallum W. Pneumatouria. *JAMA* 1898;31:3753–81. doi:[10.1001/jama.1898.92450080001001](https://doi.org/10.1001/jama.1898.92450080001001).
- [4] Sarah B. Dubbs MD, Sarah K Sommerkamp Evaluation and management of urinary tract infection in the Emergency department, RDMS [10.1016/j.emc.2019.07.007](https://doi.org/10.1016/j.emc.2019.07.007)
- [5] Emphysematous pyelonephritis L. Joris, G. van Daele, U. Timmermans and R.J. Rutsaert Departments of Intensive Care and Internal Medicine, St. Vincent Hospital, University of Antwerp, Belgium Received: 5 December 1987; accepted: 14 October 1988 DOI: [10.1007/BF01058575](https://doi.org/10.1007/BF01058575)
- [6] Huang JJ, Tseng CC. Emphysematous pyelonephritis: clinical radiological classification, management, prognosis and pathogenesis. *Arch Intern Med* 2000;160:797–805.
- [7] V Rafailidis, V Karadimou, C Liouliakis, D Kouglioumtzoglou Hippokratia emphysematous pyelonephritis: a case report. 2013; 17(4): 373–375.
- [8] Wan Y, Lee T, Bullard M, Tsai C. Acute gas-producing bacterial renal infection: correlation between imaging findings and clinical outcome. *Radiology* 1996;198:433–8.
- [9] Rasoul M, Keyvan R. Emphysematous urinary tract infections: diagnosis, treatment, and survival (case review series). *Am J Med Sci* 2007;333:111–16.