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Clinical profile and outcome of emphysematous pyelonephritis presenting to a tertiary care hospital

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Abstract

Background Emphysematous pyelonephritis is a necrotizing infection of the renal parenchyma by gas-forming organisms. The diagnosis of emphysematous pyelonephritis is made by clinical features and the detection of air in the renal parenchyma. In the past, nephrectomy was considered the only treatment option with a high mortality rate, but with advances in minimally invasive conservative techniques and better antibiotic treatment, the rate of kidney salvage has increased.

Case presentation From January 2019 to December 2022, eight cases of emphysematous pyelonephritis were diagnosed based on clinical features and documentation of gas in the renal parenchyma by a Computed tomography scan. The mean age was 61.75 ± 4.3 years. 62.5% were female and 75% were diabetics. *E. coli* was the most common pathogen (87.5%). All 8 patients underwent early interventions in the form of DJ stenting or percutaneous nephrostomy tube insertion with only one patient requiring nephrectomy without any immediate mortality.

Conclusion Emphysematous pyelonephritis is more common in women and the elderly. Diabetes mellitus and nephrolithiasis are major risk factors. *E. coli* was the most frequently isolated pathogen. Early diagnosis and early minimally invasive intervention in the form of a DJ stenting or percutaneous nephrostomy reduced the rate of nephrectomy and mortality.

Keywords Emphysematous pyelonephritis, Urinary tract infection, Obstructive nephropathy, Diabetic kidney disease

1 Background

Emphysematous pyelonephritis (EPN) is an acute necrotizing infection of the renal parenchyma and perirenal tissue resulting in the formation of gas within the renal parenchyma, collecting system, or perinephric tissue [1-3]. More than 90% of all cases of EPN occur in

patients with diabetes mellitus (DM). Moreover, it is commonly seen in patients with obstructive uropathy, polycystic kidney disease, and end-stage renal disease. EPN is a life-threatening infection with a mortality rate as high as 80% in earlier studies [4, 5]. Earlier the treatment of choice was nephrectomy to prevent life-threatening complications but in recent times with the development of advanced imaging techniques and minimally invasive interventions nephrectomy and mortality can be avoided. In this study, we have analyzed the characteristics of 8 patients with EPN concerning patient demographics, clinical presentation, investigations, diagnosis, microbiological findings, treatment modality, and outcome.



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2 Case presentation

The study was carried out at Dhiraj Hospital, SBKS medical institute and research center, Vadodara. The study included 8 diagnosed cases of EPN admitted during the period from Janurary 2019 to December 2022. The diagnosis of EPN was done based on clinical features and documentation of gas within the renal parenchyma, collecting system, or perinephric tissue on computed tomography (CT) scan. The clinical, laboratory, radiological, and microbiological findings, treatment modality, and outcome of these patients were reviewed retrospectively.

A Total of 8 cases were diagnosed to have Emphysematous pyelonephritis. The mean age was 61.75 ± 4.3 years. 5 (62.5%) out of 8 were female, 6 (75%) were diabetic and 3 (37.5%) were having nephrolithiasis. Urine culture was positive in 7 (87.5%) patients. E. coli was the most common isolate seen in 6 (85.7%) patients out of 7 culturepositive samples. 4 (50%) patients had bilateral EPN, 3 (37.5%) had left EPN and 1 (12.5%) had right EPN. All patients were treated with intravenous antibiotics according to the culture sensitivities or with empirical antibiotics in culture negative cases. All patients were given appropriate supportive care. All patients underwent DJ stenting. 5 (62.5%) patients required only DJ stenting, 1 (12.5%) patient required DJ stenting with perinephric drainage of infected urinoma, 1 (12.5%) patient required DJ stenting plus percutaneous nephrostomy tube insertion and 1 (12.5%) patient required DJ stenting followed by nephrectomy. All patients improved at discharge and had improved renal function after 1 month of follow-up. DJ stent was removed after 1 month in all cases. There was no immediate mortality.

The clinical details of each case are presented in Table 1. Table 2 contains information about the hematological & metabolic panel, urine analysis, culture report, interventions, and outcome of each of the patients in the study.

3 Discussion

EPN is a severe, necrotizing infection with gas in renal parenchyma and can be fatal if not diagnosed early and treated promptly. The conditions required for the development of EPN are based on three pillars: (1) the presence of pathogenic bacteria with the ability to do mixed acid fermentation, (2) hyperglycemia in tissue, and (3) impaired perfusion to the tissue [6]. These factors can work together, resulting in a rapid disease progression. It predominantly affects the female gender. Diabetics are more prone to emphysematous pyelonephritis. Patients with ureteric obstruction who are non-diabetic can also develop EPN but the severity of the disease is less as compared to diabetic patients.

The pathogenesis of EPN includes gas-producing bacteria, high glucose concentration in the tissue, impaired tissue perfusion, and defective immune response which

Vitals Examination Sr no Age in years Sex Comorbidities Symptoms Case 1 66 Female DM, HT, CKD Fever, dysuria, anorexia, left flank pain Febrile, Pallor+, PE+ pulse: 110/MIN Abdomen: left renal angle tenderness+ BP: 130/90 MMHG 60 Female DM, HT, CKD Case 2 Fever, vomitina. Febrile. Pallor+ pulse: 120/min Bilateral flank pain, weakenss Abdomen: bilateral renal angle tender-BP: 100/70 mmhg ness+ Case 3 58 Female DM, HT, CKD, Fever, dysuria, anorexia, vomiting, left Febrile Pallor+, PE+ Pulse: 110/Min Nephrolithiasis flank pain Abdomen: left renal angle tenderness+ BP: 160/90 mmhg DM, HT, CKD Pallor+, PE+ Case 4 67 Male Fever, anorexia, nausea, weakness, Febrile Pulse: 140/min bilateral flank pain Abdomen: bilateral renal angle tender-BP: 136/90 mmhg ness+ Febrile, Female CKD Fever, abdominal pain Pallor+ Case 5 66 Nephrolithiasis pulse: 140/min Abdomen: bilateral renal angle tender-. BP: 80/50 mmhg ness+ Case 6 58 Female DM Fever, left flank pain Febrile, Pallor+, PE+ Pulse: 120/min Abdomen: left renal angle tenderness+ BP: 90/60 mmhg Case 7 63 Male PULSE: 112/MIN DM Anorexia, vomiting, weakness, right Abdomen: right renal angle tenderflank pain BP: 134/80 mmhg ness+ Case 8 56 Male Nephrolithiasis Fever, vomiting, bilateral flank pain Febrile Abdomen: bilateral renal angle tender-Pulse: 130/min ness+ BP: 100/60 mmhg

Table 1 Demographics and clinical features of the patients with emphysematous pyelonephritis

DM: diabetes mellitus, HT: hypertension, CKD: chronic kidney disease, PE: pedal edema

Table	A Haematological,	biochemical, microbiological ₁	profile, intervention and outcome o	of the patients		
Sr no	Metabolic panel	Urine analysis	Ct scan findings	Diagnosis	Interventions	Outcome
Case 1	HB: 10.6 GM/DL TC: 7900 CELLS/JuL RBS: 215 MG/DL CREAT: 2.4 MG/DL NA: 137 MEQ/L K: 4.1 MEQ/L K: 4.1 MEQ/L HBAIC: 8.6%	Albumin: nil Sugar: nil RBC: NIL/HPF WBC: 10-15/HPF CULTURE: <i>E-COLI</i>	Left bulky kidney with multiple air foci in the left kidney	Left emphysematous pyelonephritis	Left DJ Stenting	Recovered
Case 2	HB:8.9 GM/DL TC:12,750 CELLS/µL RBS: 304 MG/DL CREAT:3.5 MG/DL NA: 133 MEQ/L K: 3.4 MEQ/L K: 3.4 MEQ/L HBA1C: 10.8%	Albumin:2 + Sugar:2 + RBC:4–5 WBC:10–1 2 Culture: <i>E-coli</i>	Multiple air foci in bilateral kidneys with perinephric fat stranding	Bilateral emphysematous pyelone- phritis	Bilateral DJ stenting	Recovered
Case 3	HB: 8.0 GM/DL TC: 25,000 CELLS/µL RBS: 300 MG/DL CREAT: 5.0 MG/DL NA: 133 MEQ/L K: 5.6 MEQ/L HBA1C: 9%	Albumin:2 + Sugar:2 + RBC: 1–2 WBC: plenty Culture: <i>Kbleibeslla Pneumoniae</i>	Multiple air foci in left kidney with left perinephric fat stranding with b/l non-obstructive renal calculi	Left emphysematous pyelonephritis	Hemodialysis Left DJ stenting followed by nephrectomy	Recovered/ required left nephrectomy
Case 4	 HB: 6.3 GM/DL TC: 8600 CELLS/µL RBS: 290 MG/DL CREAT: 3 MG/DL NA: 135 MEQ/L K: 3.4 MEQ/L K: 3.4 MEQ/L 	Albumin:1 + Sugar.nil RBC:6-7 WBC: PLENTY Culture: <i>E-coli</i>	Multiple air foci in bilateral kidneys with perinephric fat stranding	Bilateral emphysematous pyelone- phritis	Bilateral DJ stenting	Recovered
Case 5	HB: 8.3 GM/DL TC: 5900 CELLS/JJL RBS:112 MG/DL CREAT: 8.4 MG/DL NA: 139 MEQ/L K: 4.0 MEQ/L	Albumin: 3 + Sugar: nil RBC: nil WBC:15-16 Culture: <i>E-coli</i>	Multiple air foci with perinephric fat stranding in bilateral kidneys with right stag horn calculus and left lower ureteric calculi (Fig. 1)	Bilateral emphysematous pyelone- phritis	Hemodialysis Bilateral DJ stenting with left PCN and right open nephrolithotomy	Recovered
Case 6	 НВ: 8.9 GM/DL TC: 18,900 CELLS/µL RBS: 258 MG/DL CREAT: 2.4 MG/DL NA: 139 MEQ/L K: 4.1 MEQ/L K: 4.1 MEQ/L K: 4.1 MEQ/L 	Albumin: 3 + Sugar: + 2 RBC: NIL WBC: PLENTY OF PUS CELLS Culture: <i>E-coli</i>	Multiple air foci in left kidney with perinephric fat stranding	Left emphysematous pyelonephritis	Left PCN with DJ stenting	Recovered

Sr no	Metabolic panel	Urine analysis	Ct scan findings	Diagnosis	Interventions	Outcome
Case 7	HB: 12.4 GM/DL TC: 7820 CELLS/µL RB: 302 MG/DL CREAT: 4.3 MG/DL NA: 123 MEO/L K: 3.2 MEO/L K: 3.2 MEO/L HBA1C: 10.1%	Albumin:+ 3 Sugar:+ 2 RBC: NIL WBC:40-50 Culture: negative	The right kidney was enlarged with significant peri nephric and periureteric fat stranding. There was dilation of the right pelvi-caliceal system with multiple air pockets. There was a urinoma formation in the right perinephric space extending unto the right iliac fossa (Fig. 2)	Right emphysematous pyelone- phritis	Right peri-nephric abscess drainage with right DJ stenting	Recovered
Case 8	 HB: 10.4 GM/DL TC: 7820 CELLS/µL RBS: 98 MG/DL CREAT: 4.3 MG/DL NA: 133 MEQ/L K: 3.4 MEQ/L K: 3.4 MEQ/L 	Albumin:+ 3 Sugar: nil RBC: 10–20 WBC:40–50 Culture: <i>E-coli</i>	Multiple air foci in bilateral kidneys with bilatereal non-obstructive calculi	Bilateral emphysematous pyelone- phritis	Bilateral DJ stenting	Recovered



Fig. 1 The CT shows multiple air pockets in bilateral renal parenchyma (White arrows) with large right staghorn calculus and left lower ureteric calculus (Black arrows)

occurs in DM [7]. The high tissue glucose level acts as a substrate for the microorganisms such as *E-coli* and other *Enterobacteriaceae*. They produce hydrogen (H2) and carbon dioxide (CO2) by glucose fermentation. In a study by Huang et al., five of the six gas samples contained H2 and all the gas samples contained CO2 [8].

In our study, 5 out of 8 patients were female, and 75% of the patients were diabetic. 37.5% had nephrolithiasis as a risk factor.

The most common causative organism of EPN is *E-coli*. It is isolated in 47–90% of patients of EPN. The other commonly involved organisms include *Proteus mirabilis*, *Klebsiella pneumoniae*, *Enterococcus* species, and *Pseudomonas aeruginosa* [9, 10]. Supporting the literature, we also found that *E. coli* was isolated in 75% of our cases. *Klebsiella pneumonia* was also isolated in one of the patients. In our study, one patient was culture negative.

In EPN, the left kidney is more frequently involved than the right. A recent meta-analysis has reported that 52% of patients had left-sided, 37.7% right-sided, and 10.2% bilateral EPN [9]. In our series, the left kidney was involved in 37.5% of patients. In our series, a much larger



Fig. 2 The CT images of a patient with Emphysematous pyelonephritis. A & B: Transverse section showing multiple air pockets within Right renal parenchyma with peri-nephric fat stranding. C & D: Coronal section showing multiple air pockets within Right renal parenchyma and a well-defined collection with air pockets extending from the right renal pelvis to the right iliac fossa suggestive of urinoma formation

proportion of patients (50%) had bilateral EPN as compared to previous studies.

Traditionally, early nephrectomy was considered the treatment of choice in EPN with few reports suggesting increased mortality with medical therapy as compared to surgery, but surgery is often poorly tolerated in EPN due to the poor hemodynamic status of the patient. In 1996, Chen et al. reported that antibiotic therapy along with CT-guided percutaneous drainage was an acceptable alternative to nephrectomy. In that study, most patients received medical therapy with percutaneous therapy and only two patients required nephrectomy. The treatment of EPN has evolved over the years from invasive surgery to more conservative approaches due to the availability of better imaging modalities, potent antibiotics, and image-guided drainage.

A similar study done by Gite et al. showed that early intervention can help in salvaging the kidney and preventing mortality [11]. Also, another study by Jain et al. concluded that conservative management with an appropriate algorithm leads to reduced mortality and avoids unnecessary emergency nephrectomies [12].

Patients with EPN present with vague symptoms initially, but frequently undergo a sudden deterioration in their condition, requiring urgent medical intervention. Treatment of patients with EPN comprises resuscitation, correction of any electrolyte imbalance and hyperglycemia, and administration of antibiotics targeting Gram-negative bacteria. Ureteric obstruction is relieved by a percutaneous nephrostomy or stent. Definitive management is by percutaneous drainage or DJ stenting. Nephrectomy is advised when there is extensive diffuse gas with renal destruction not responding to conservative management.

4 Conclusions

According to our study, EPN is more common in women and the elderly. Diabetes mellitus and nephrolithiasis are major risk factors. *E. coli* was the most frequently isolated pathogen. A higher percentage of EPNs were bilateral in our study. All patients underwent interventions which included DJ stenting with or without peri-nephric drain insertion or percutaneous nephrostomy tube placement. Only one patient required a nephrectomy. All patients recovered without any mortality. Early diagnosis and minimally invasive intervention reduced the rates of nephrectomy and mortality.

Abbreviations

- EPN Emphysematous pyelonephritis
- DM Diabetes mellitus
- CT Computed tomography DI Double I
- DJ Double J

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Author contributions

The authors confirm their contribution to the paper as follows: study conception and design: HJ: Conception, data collection, design of the work, analysis, interpretation of data, drafting and revising manuscript. VS: data collection, drafting and revising manuscript. MP: design of the work, analysis, interpretation of data. All authors have read and approved the manuscript.

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Availability of data and materials

All the data regarding patients are available with us and can be provided with due request.

Declarations

Ethical approval and consent to participate

As this is a retrospective observational study Ethics committee approval was not taken. Consent of all the participants were taken.

Consent for publication

Consent was taken from all the participants.

Competing interests

The authors have no competing interests to declare.

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