

Outcome of conservative and minimally invasive management in emphysematous pyelonephritis

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Abstract

Context: Developing countries.

Introduction: Emphysematous pyelonephritis (EPN) is a urologic emergency characterized by acute necrotizing infection with the presence of gas in the kidney, perinephric space, and/or urinary collecting system.

Materials and Methods: It is a retrospective study of inpatients at the Department of Urology, RG Kar Medical College and Hospital, Kolkata, which includes twenty patients diagnosed as EPN between September of 2018 and May of 2020.

Results: Patients were classified as per computed tomography (CT) severity grading proposed by Huang and Tseng. In our study, medical management with antibiotics was effective in 10% of patients. Twenty percent of patients were treated with medical management and internal ureteral stenting. Fifty percent of the patients were treated with medical management and percutaneous nephrostomy (PCN). Ten percent needed PCN drainage in addition to Double J (DJ) stenting. Ten percent needed percutaneous drainage of perinephric abscess along with PCN. Ten percent of patients were treated with open drainage in addition to DJ stenting and percutaneous drainage of perinephric collection as they failed to respond to minimally invasive intervention alone, with repeat ultrasonography showing persistent collection. There was no mortality in the group.

Conclusion: EPN patients are mostly moribund with multiple comorbidities. It is vital to comprehend the management with a prompt CT imaging. Proactive hemodynamic stabilization, antimicrobial therapy, complementing it with DJ stenting and/or PCN in cases not responding to antibiotics alone, can treat most of the patients with this pathology.

Keywords: Antibiotics, nephrectomy, open surgical drainage, percutaneous nephrostomy, perinephric abscess, pyelonephritis

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INTRODUCTION

Emphysematous pyelonephritis (EPN) is a urologic emergency characterized by acute necrotizing infection

with the presence of gas in the renal parenchyma, pelvicalyceal system, and perinephric space. It is caused by gas-forming uropathogens.^[1] It is common in patients with

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diabetes, urolithiasis, urinary tract obstruction, and renal insufficiency. It is postulated that high tissue glucose levels provide an appropriate environment for the gas-forming bacteria such as *Escherichia coli*. The overall mortality rate has been reported to be between 20% and 80%.^[2,3] Most experts advocate an aggressive and interventionist approach.^[4] However, a positive outcome with conservative management has also been reported.^[5,6]

MATERIALS AND METHODS

It is a retrospective study done at a tertiary care referral urological center in Eastern India in the Department of Urology, from September 2018 to May 2020. This study includes twenty patients diagnosed as EPN on computed tomography (CT) of the whole abdomen. Patients suspected clinically of EPN were subjected to CT with/without contrast depending on the renal functional status. The following patient-related factors were astutely studied: demography, symptoms, duration of disease, comorbidities with duration, site of involvement, serum creatinine, altered sensorium, and features of shock as well as past and treatment history. Charlson Co-morbidity Index (CCI), which calculates estimated 10-year survival with comorbidities, was calculated for every patient.^[7] They were investigated with complete blood counts, urine analysis and culture sensitivity, renal parameters, serum electrolyte levels, and imaging such as plain abdominal roentgenograms, ultrasonography (USG) of the abdomen, and CT findings with CT severity grading, presence of calculi with obstruction, perinephric or paranephric abscess, and presence of gas in the collecting system [Figure 1]. Treatment-related factors such as medical or surgical management, duration of antibiotics, duration of hospital stay, subsequent management for renal calculi, and nephrectomy were also studied. A few patients responded solely to antibiotics, whereas others underwent Double J (DJ) stenting and percutaneous nephrostomy (PCN). EPN was graded as per CT severity proposed by Huang *et al.*^[8] Patients were categorized based on Kidney Disease: Improving Global Outcomes guidelines and the estimated

glomerular filtration rate was calculated using Modification of Diet in Renal Disease formula.

RESULTS

In this study, the mean age was 51.2 years with male-to-female ratio of 1:4 (4:16). The median duration of symptoms was 16.5 days (range: 9–60 days). Fever and flank pain were seen in 90% (18 out of 20) of patients, vomiting in 80% (16) of patients, and hematuria in 30% (6) of patients. Eighty percent (16 out of 20) of patients had tachycardia, 40% (8 out of 20) of patients had hypotension (defined as systolic blood pressure <90 mmHg), 50% (10 out of 20) renal angle tenderness, and 20% (4 out of 20) palpable kidney.

Most of the patients (16 out of 20; 80%) were in the age group of 31–60 years. Comorbidities were observed in substantial number of participants. Ninety percent (18 out of 20) of patients were diabetic, 77.8% (14 out of 18) of whom were females. All male patients were diabetic. Fifty percent (10 out of 20) of patients were hypertensive, 20% (4) had ischemic heart disease, and 30% (6) had chronic obstructive airway disease. Two patients had a history of intermittent claudication in the calf muscles. None of the patients gave a history of any urinary tract surgery or instrumentation in the recent past. Female patients overall had a lower Charlson Comorbidity Index score (better life expectancy). Two male patients had CCI of 5 (21% estimated 10-year survival), and the other two had CCI of 6 (2% estimated 10 years survival) [Table 1].

Sixty percent of patients had left-sided involvement. There were no participants with bilateral renal involvement. Imaging demonstrated renal calculi in 50% (10 out of 20) of patients with pararenal or perinephric abscess in 80% (16 out of 20) of patients. As per Huang and Tseng classification, 20% (4 out of 20) of patients were categorized as Class 2 EPN and 50% (10 out of 20) of patients as class 3B EPN. Eight out of these class 3B EPN were females. The other 30% of patients were categorized as class 3A EPN [Table 2].



Figure 1: Emphysematous pyelonephritis. (a) Gas in the left renal parenchyma (Grade 2 Emphysematous pyelonephritis). (b) Gas in the left pelvicalyceal system, perinephric space with abscess and renal calculi (Class 3A Emphysematous pyelonephritis). (c) Extensive gas and abscess in the right pararenal space (Grade 3B)

At presentation, 12 patients had eGFR <60 ml/min/1.73 m² out of which two patients had eGFR <30 ml/min/1.73 m². Dyselectrolytemia was seen in 50% (10 out of 20) of patients. All the 18 diabetic patients had a random blood sugar level of more than 180 mg/dl at presentation. Eighty percent of patients were anemic (hemoglobin level in males <12 g/dl and females <11 g/dl). Leukocytosis (total leukocyte count >11000 cumm) was present in 50% of the patients. None of the patients had thrombocytopenia. Elevated erythrocyte sedimentation rate was seen in all patients.

Urine culture was sterile in 40% of the participants, probably due to prior antibiotic intake prescribed by general practitioners. *E. coli* was isolated from the urine samples of 50% of patients and proteus species in the remaining 10%. Meropenem was sensitive in all the cases, followed by amikacin in 50% of patients. All the patients in the study were started on injectable antibiotics. In addition, correction of hydration and respiratory status with dyselectrolytemia was given priority.

Twenty-four minimally invasive and two open procedures were undertaken in 18 participants. DJ stenting was carried out as the primary minimally invasive measure in 40% of patients (Class 3B EPN – 4; Class 3A EPN – 2, and Class 2 EPN – 2). PCN was carried out as the primary minimally invasive measure in 50% of patients (Class 3A EPN - 4; Class 3B EPN - 6). Those belonging to Class 2 EPN and Class 3A EPN needed no further intervention. Out of the remaining four patients (both class 3B EPN), two underwent percutaneous drainage initially for perinephric abscess and later open surgical drainage. The other two patients had to undergo PCN in addition to previously placed DJ stent.

Table 1: Classification of patients with emphysematous pyelonephritis based on Charlson Comorbidity Index (n=20)

CCI	Males, n (%)	Females, n (%)	Total
0	0	2 (12.5)	2
1	0	0	0
2	0	6 (37.5)	6
3	0	2 (12.5)	2
4	0	2 (12.5)	2
5	2 (50)	4 (25)	6
6	2 (50)	0	2

CCI: Charlson Comorbidity Index

Table 2: Computed tomography severity grading of emphysematous pyelonephritis as proposed by Huang and Tseng (n=20)

Class of EPN	Grade description	Males, n (%)	Females, n (%)	Total (%)
1	Gas confined to collecting system	0	0	0
2	Gas confined to renal parenchyma alone	0	4 (25)	4 (20)
3A	Perinephric extension of gas or abscess	2 (50)	4 (25)	6 (30)
3B	Extension of gas beyond Gerota fascia	2 (50)	8 (50)	10 (50)
4	Bilateral EPN or EPN in solitary kidney	0	0	0

EPN: Emphysematous pyelonephritis

Four out of six patients of Class 3B EPN also recovered with PCN alone with the remaining two patients undergoing subsequent percutaneous drainage of perinephric abscess [Figure 2]. None of the patients had to undergo an emergent nephrectomy. Urine culture was repeated 5 days after initiation of treatment, and the patients were advised oral antibiotics according to the culture sensitivity report on discharge.

The median duration of hospital stay was 10.5 days (range: 6–25 days). All the patients were managed in general ward. The median duration of stay for males was 17.5 days and for females was 10.5 days. Median duration of hospital stay for Class 2 EPN was 6.5 days, for Class 3A EPN was 10 days, and for class 3B EPN was 14 days.

There was no mortality in the group. The patients were followed up 14 days after discharge. Patients were asked to repeat USG, renal function tests, and urine culture after 4 weeks to look for anatomical, physiological, and microbiological status of the urinary system.

All the patients remained symptom free during the follow-up period. Out of ten patients with renal calculi with obstructive uropathy, eight patients underwent percutaneous nephrolithotomy after 3 months. The incidence of renal calculi in patients with ureteropelvic junction obstruction is nearly 20%. In our study, 10% (2) of patients underwent open pyelolithotomy with dismembered pyeloplasty for secondary ureteropelvic junction obstruction. Two patients underwent elective open simple nephrectomy after 3 months for nonfunctional kidney and refractory flank pain. They were diabetic and belonged to Class 3A EPN.

DISCUSSION

EPN (also called pneumonephritis and Renal Emphysema) is a rare clinical entity. It is a urologic emergency associated with acute necrotizing parenchymal and perinephric infection. The first case of pneumaturia was reported in 1671. In 1898, Kelly and MacCullum reported the first gas-forming renal infection. In 1962, Schultz and Klorfein termed it as EPN.^[9]

E. coli (82%) and *Klebsiella* species (12%) are the most common organisms.^[10] We isolated *E. coli* in 50% of our patients. Other organisms responsible are *Pseudomonas aeruginosa*, *Bacteroides*, *Aerobacter aerogenes*, *Proteus mirabilis*, *Candida albicans*, *Cryptococcus neoformans*, *Klebsiella pneumoniae*, *Aspergillus fumigatus*, *Clostridium septicum*, and *Entamoeba histolytica*. It is a polymicrobial infection in 10% of the cases. The exact pathogenesis is poorly understood. EPN is common in patients with uncontrolled diabetes with high level of glycosylated hemoglobin, renal stones, renal failure, immunosuppression, obstructed upper tract, and polycystic kidney disease. Fermentation of glucose produces nitrogen (60%), hydrogen (15%), carbon dioxide (5%), and oxygen (8%). Concomitant diabetic microangiopathy slows the transit of catabolic products causing gas accumulation. In our study, 90% of the patients were diabetic. In a similar study, by Karthikeyan *et al.*, DM was seen in 84.8%.^[11] Ninety-three percent of patients in Aswathaman *et al.* study were diabetic.^[12]

Ratio of male:female in our study was 1:4. In a similar study by Karthikeyan *et al.*, male: female ratio was 1:1.4.^[11] Urinary tract obstruction has been reported to cause EPN in



Figure 2: Two pigtail drains. One drain placed at the right pelviccalyceal system (percutaneous nephrostomy) and the other drain in the perinephric space to drain perinephric abscess

25%–40% of patients.^[13] In our study, 50% of the patients had renal calculi with obstructive uropathy. Maximum patients in our study presented with fever (90%), flank pain (90%), tachycardia (80%), and hypotension (40%). In the study by Karthikeyan *et al.*, the most common presentation was fever in 74.2% of patients, flank pain in 68.2%, 30.3% of patients had tachycardia, and 9.1% had hypotension.^[11]

In a contemporary study, medical management alone resulted in 50% mortality. Twenty-five cases underwent medical management with subsequent emergency nephrectomy, 13.5% were treated with medical management and percutaneous drainage, and 6.6% cases were managed with antibiotics and elective nephrectomy.^[14] In our study, medical management with antibiotics was effective in 10% of patients. Twenty percent of patients were treated with medical management and internal ureteral stenting. Fifty percent of the patients were treated with medical management and PCN. Ten percent needed PCN drainage in addition to DJ stenting. Ten percent needed percutaneous drainage of perinephric abscess along with PCN. Ten percent of patients were treated with open drainage in addition to DJ stenting and percutaneous drainage of perinephric collection as they failed to respond to minimally invasive intervention alone with repeat USG showing persistent collections [Table 3].

We had no mortality in our study. Karthikeyan *et al.* in a similar study noted mortality of 3% only.^[11] Conservative treatment was identified to have an odds ratio of 2.85 for mortality.^[15] In our study, the median delay in presentation to our center was 16.5 days. In a similar study by Aswathaman *et al.*, delay in presentation beyond 15 days contributed to 80% mortality.^[11] With the integration of advanced imaging technology, interventional radiology, goal-directed correction of fluid, acid balance, dyselectrolytemia, and antimicrobial therapy, better patient outcome is evident.

Table 3: Management of the patients in the study group

Initial treatment	Subsequent management	Additional management	Males, n (%)	Females, n (%)	EPN class	Total, n (%)
Antibiotics	None	None	0	2 (12.5)	2	2 (10)
Antibiotics	DJ stenting	None	0	2 (12.5)	2	2 (10)
Antibiotics	DJ stenting	None	2 (50)	0	3A	2 (10)
Antibiotics	Percutaneous nephrostomy drainage	None	0	4 (25)	3A	4 (20)
Antibiotics	Percutaneous nephrostomy drainage	None	0	4 (25)	3B	4 (20)
Antibiotics	DJ stenting	Percutaneous nephrostomy drainage	0	2 (12.5)	3B	2 (10)
Antibiotics	Percutaneous nephrostomy drainage	Percutaneous drainage of perinephric collection	0	2 (12.5)	3B	2 (10)
Antibiotics	DJ stenting	Percutaneous drainage of perinephric collection And* Open surgical drainage of perinephric collection	2 (50)	0	3B	2 (10)

*Patient failed to respond to percutaneous drainage alone with repeat USG showing persistent perinephric/paraneephric collection. Emergent management undertaken in the study group. DJ: Double J, EPN: Emphysematous pyelonephritis, USG: Ultrasonography

In a similar study, third-generation cephalosporins were recommended as the initial drug in their patients with EPN and carbapenem in patients with prior hospitalization or antibiotic use.^{116]} In our study, patients were mainly treated with carbapenem and amikacin (depending on the renal function). The success of conservative management has been reported in small case series and few case reports.^{117-21]}

There were a few limitations in this study. First, it is a retrospective study. Second, this study was conducted on a small patient population. The drawback of the conservative and minimally invasive management of EPN was that these patients had an overall increased hospital stay and treatment cost. They needed admission again after 4–6 weeks of their acute episodes for treatment of their underlying surgical pathology such as PCNL, open pyelolithotomy, pyeloplasty for pelviureteric junction obstruction, and also nephrectomy in two cases for nonfunctioning kidney with refractory urinary tract infection and flank pain.

CONCLUSION

EPN patients are mostly moribund with multiple comorbidities. It is vital to comprehend the management with a prompt CT imaging. Proactive hemodynamic stabilization, antimicrobial therapy, complementing it with DJ stenting and/or PCN in cases not responding to antibiotics alone can treat most of the patients with this pathology.

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Conflicts of interest

There are no conflicts of interest.

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