

Predictors of Outcome in Emphysematous Pyelonephritis: A Case Based Study

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Received: 21-04-2023 / Revised: 21-05-2023 / Accepted: 25-06-2023

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Conflict of interest: Nil

Abstract:

Background: Emphysematous pyelonephritis (EPN) is a necrotizing infection which results in gas within the renal parenchyma, collecting system, or perinephric tissue.

Objective: To analyze the characteristics of patients with EPN with respect to patient demographics, diagnostic investigations, microbiological findings, treatment modality and outcome, and the influence of prognostic factors on the outcome.

Materials and Methods: The study was carried out in the Department of Urology at GRMC, Gwalior which is the only tertiary care hospital. The study involved 30 consecutive diagnosed cases of EPN admitted during the period 2022 to 2023. The diagnosis of EPN was based on clinical features and documentation of gas within the renal parenchyma, collecting system, or perinephric tissue on computed tomography (CT) of abdomen. We retrospectively reviewed the clinical, laboratory, radiological, and microbiological findings, treatment modality, and outcome of these patients.

Results: The subjects had a mean age of 49 ± 1.3 years (range 20–70 years). All the study subjects had DM (23 type 2 and 3 type 1); the mean duration of diabetes was 6.8 ± 5.3 years and two patients had their DM diagnosed during the episode of EPN. Four patients including two with type 2 diabetes had diabetic ketoacidosis while four others had nonketotic hyperosmolar state. Two patients had renal stones, one of whom had grade III hydronephrosis. Of 26 patients, 20 (76.9%) had two or more bad prognostic factors

Conclusions: In this series of patients with EPN, all had DM, nearly all were women, and *E. coli* was the most frequently isolated pathogen. Nearly a third of our patients had bilateral disease. We recommend early aggressive medical treatment and suggest that nephrectomy should be considered only if patients deteriorate or do not improve on conservative treatment.

Keywords: Conservative treatment, diabetes mellitus, emphysematous pyelonephritis, necrotizing pyelonephritis.

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Introduction

In developing nations, infections continue to be a key factor in the morbidity and death of diabetic patients.[1] There are few cases of emphysematous pyelonephritis

(EPN) acute renal parenchymal necrotizing infection and Gas builds up within the renal perirenal tissue, the collecting system, or parenchyma.[2,3] Over 90% of

all EPN instances involve people with diabetes mellitus (DM).[4,5] The first documented instance of EPN was reported in 1898 by Kelly and MacCallum.[6] Over fifty "Emphysematous pyelonephritis" was first used a century after then because of its concentration, Schultz and Klorfein propose it on the connection between gas formation and nature relating to the infectious process.[7] EPN is a potentially fatal infection according to past studies, had a mortality rate of up to 80%.[4,5] In this study, we analyzed the characteristics of 26 patients with EPN with respect to patient demographics, clinical presentation, diagnostic investigations, microbiological findings, treatment modality and outcome, and the influence of prognostic factors on the outcome.

Materials and Methods-

The study was carried out in the Department of Urology at GRMC, Gwalior which is the only tertiary care hospital. The study involved 30 consecutive diagnosed cases of EPN admitted during the period 2022 to 2023. The diagnosis of EPN was based on clinical features and documentation of gas within the renal parenchyma, collecting system, or perinephric tissue on computed tomography (CT) of abdomen. We retrospectively reviewed the clinical, laboratory, radiological, and microbiological findings, treatment modality, and outcome of these patients. The severity of EPN was graded as per the Huang classification. According to this classification, class 1 EPN is defined as gas in the collecting system only, class 2 as gas in the renal parenchyma with no extension to the extrarenal space, class 3A as extension of gas or abscess to the perinephric space, class 3 B as extension

of gas or abscess to the pararenal space, and class 4 as bilateral EPN or EPN in a solitary kidney.[8] Certain factors have been associated with poor outcome in EPN; these bad prognostic factors include thrombocytopenia, azotemia, hematuria, altered consciousness, shock (systolic blood pressure [BP] <90 mmHg) on initial presentation, severe proteinuria, need for emergency hemodialysis, severe hypoalbuminemia (serum albumin <3 g/dl), polymicrobial infections, and extension of infection to the perinephric space.[3,8] We applied these reported prognostic factors to our patients and tried to find out whether these factors correlated with failure of conservative treatment.

We defined conservative treatment of EPN as medical treatment alone or a combination of medical treatment and percutaneous catheter drainage. The success of conservative treatment was defined as clinical resolution and disappearance/decrease in gas on follow-up imaging during hospitalization and after discharge from hospital. As per the protocol followed at our department, the treatment included early adequate fluid resuscitation, rapid control of glycemia through insulin infusion, close clinical and biochemical monitoring, electrolyte management, initiation of two potent antibiotics at diagnosis, and percutaneous catheter drainage (if required). The antibiotics included a third-generation cephalosporin and fluoroquinolone patients who had septic shock received vancomycin and imipenem. The antibiotics were revised if indicated by the results of susceptibility testing of the isolated organism. All patients were followed up for at least 6 months after discharge from the hospital and consented for publication

of their data; for the single patient who died, consent was provided by her son. The study was approved by the Institutional Ethical Committee.

Statistical Analysis-

Data so obtained were subjected to statistical analysis. Data analysis was done by SPSS software ® version 22.0. Descriptive

statistical analysis, which included frequency and percentages, was used to characterize the data. Inferential statistics included chi-square test and independent samples t test for different dependent variables of the study and $p < 0.05$ was considered statistically significant.

Results

Table 1: Baseline characteristics of study participants

Characteristic	n (%) patients
Age (years)*	49 (1.3)
Female	24 (92.3)
DM	26 (100)
DKA	4 (15.3)
NKHS	4 (15.3)
Duration of DM (years)*	6.8 (5.3)
Diabetic neuropathy	18 (69.2)
Diabetic nephropathy	11 (42.3)
Diabetic retinopathy	7 (26.9)
Renal stones	2 (7.6)
Obstructive uropathy	1 (3.8)

As per table 1 All but two of the subjects were females. The subjects had a mean age of 49 ± 1.3 years (range 20–70 years). All the study subjects had DM (23 type 2 and 3 type 1); the mean duration of diabetes was 6.8 ± 5.3 years and two patients had their DM diagnosed during the episode of

EPN. Four patients including two with type 2 diabetes had diabetic ketoacidosis while four others had nonketotic hyperosmolar state. Two patients had renal stones, one of whom had grade III hydronephrosis.

Table 2: The computed tomography class, prognostic factors, treatment, and outcome

Computed tomography class	Bad prognostic factors	Treatment		Outcome		
		Medical alone	Medical and PCD*	Nephrectomy Survived	Death	
1 and 2 (n=10)	<2 (n=6)	5	1	0	6	0
	≥ 2 (n=4)	3	1	0	4	0
3 and 4 (n=16)	<2 (n=0)	0	0	0	0	0
	≥ 2 (n=16)	9	5	2	15	1

As per table 2 all patients had ultrasonography and CT of abdomen;

while the former was diagnostic in 73.1%, the latter revealed the diagnosis in all. The

left kidney was involved in 10, the right in 8, and both kidneys in 8 patients. We classified our patients on the basis of Huang classification with three (11.5%) in class 1, seven (26.9%) in class 2, four

(15.3%) in class 3A, four (15.3%) and 8 (30.8%) in class 4. Of 26 patients, 20 (76.9%) had two or more bad prognostic factors.

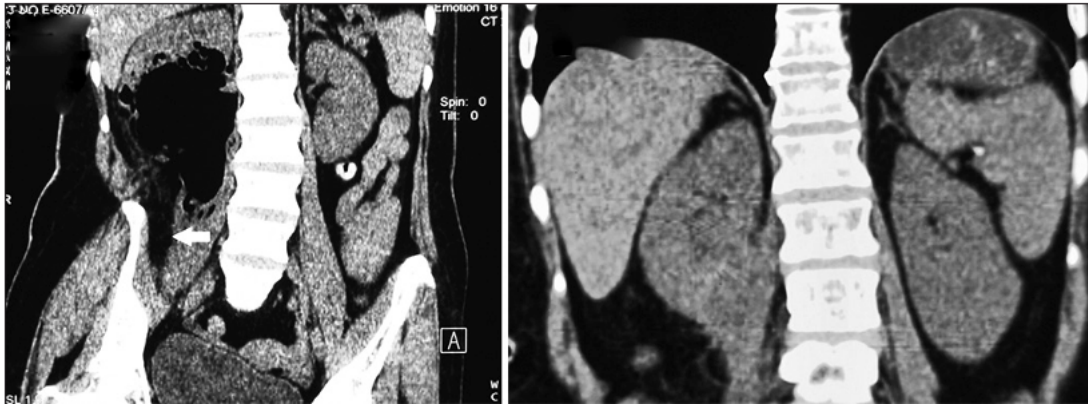


Figure 1: (a) Computed tomography showing the right kidney replaced by the gas and extension of gas to the right psoas muscle (white arrow) (class 3B emphysematous pyelonephritis); (b) disappearance of gas 4 weeks after initiation of treatment

Discussion:

EPN is a rare necrotizing infection that is most frequently found in diabetic people. Each of our patients had diabetes. EPN is a disease that affects women more often than men of 3:1.[9] There was significantly more female domination in our series than startling (12:1) in comparison to other series. the elevated occurs more frequently in women maybe because to their heightened risk of urinary tract infection.[2] The only guys that are an exception to this feminine domination are a renal transplant recipient is more prone to experience pain.[10] In our series, the most prevalent clinical traits were include chills and fever, flank discomfort, and renal angular sensitivity, nausea, and dysuria. These indicators and exhibit no distinguishing characteristics of EPN the typical pyelonephritis.

In a study by Huang et al., five of the six gas samples contained H₂ and all the gas

samples contained CO₂. [8] Our patients had had poor glycemic control before getting EPN as reflected by high average HbA_{1c}. Apart from DM, our patients had no significant predisposing factors such as obstructive uropathy for the development of EPN. In our series, renal stones were present only in two patients causing obstructive uropathy in one patient.

In EPN, 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. [11] Huang et al. have reported that 67, 25, and 8% of the 48 patients with EPN had left sided, right sided, and bilateral disease, respectively. [8] In our series, the left kidney was involved in 38.5% patients and the right kidney was involved in 30.8% patients. In the literature, bilateral EPN is reported to occur in up to 10% of patients. [10] In our series, a much larger

proportion of patients (30.8%) had bilateral EPN. To the best of our knowledge, this is the highest reported percentage of bilateral involvement in patients with EPN. Some studies have focused on the factors that are associated with poor outcome in EPN. Wan and Rullard reported that thrombocytopenia, azotemia, and hematuria were predictors of poor outcome in EPN.[9].

An Indian study by Kapoor et al. reported that altered mental status, thrombocytopenia, renal failure, and severe hyponatremia at presentation are associated with higher mortality rates whereas extensive renal parenchymal destruction is associated with a need for nephrectomy.[13]

Our findings seriously question this radical approach as 13 of our 16 patients with extensive (class 3 or 4) EPN responded to conservative treatment. Similar results have been reported by Lu et al.[14] It is supposed that high tissue glucose levels may cause a fulminant course in patients with DM because it can provide gas forming microbes with a microenvironment more favorable for growth and catabolism.[3] In our series, glycemic control had no prognostic significance as all but one of our patients despite having poor glycemic control as reflected by their high mean HbA1c of $10.7 \pm 2.4\%$ recovered. Similarly, other studies have concluded that glycemic control is not a prognostic factor in patients with EPN.[9-11].

The treatment of EPN is controversial. Traditionally, early nephrectomy has been considered the treatment of choice in EPN with few reports suggesting increased mortality with medical therapy as compared to surgery.[15,16] However, surgery is often poorly tolerated in EPN due to poor hemo-

dynamic status; the mortality rate in a series by Ahlering et al. advocating emergency nephrectomy was 42%.[17].

Our results also reflect the evolving trends in the management of EPN as the success rate of conservative treatment in our series was 88.5%. About a third (8/26) of our patients had bilateral EPN. Nephrectomy in such patients would obviously necessitate lifelong renal replacement therapy. Successful nonsurgical management of bilateral EPN has been previously reported by us and others.[18] Seven of our 8 patients with bilateral EPN responded to medical treatment alone (5 patients) or a combination of medical treatment and percutaneous catheter drainage (2 patients) while one patient expired.

Conclusion

All of the EPN patients in this group had DM, almost all of them were female, and *E. coli* was the most frequently isolated pathogen. Bilateral illness affected over one-third of our patients. Despite having two or more unfavorable prognostic factors EPN (class 3 or 4) and extensive in the majority of our patients saw a remarkable success with conservative treatment just two patients required nephrectomy at an 88.5% rate and one patient died despite receiving conservative care. We recommend prompt and aggressive medical care, and that nephrectomy should only be considered if patients get worse might respond poorly to conventional therapy.

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