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Current management strategies of emphysematous pyelonephritis – Our institutional experience

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ABSTRACT

Background: Emphysematous pyelonephritis (EPN) is commonly seen in uncontrolled diabetes patients. Appropriate identifications of risk factors and timely management underline the outcome in such patients. **Aims and Objectives:** The objectives of this study were to study the various risk factors, clinical features, and radiological classification of EPN. The specific objective of this study was to study various management approaches such as medical management, minimally invasive procedures, and nephrectomy. **Materials and Methods:** We prospectively analyzed 128 patients from January 2021 to July 2022 – documented clinical data, laboratory data, imaging findings, interventions, and outcomes of patients with EPN. **Results:** Among 128 patients, 96 were female and 32 were male. Among them, 110 were diabetic. All had symptoms of fever and flank pain. Based on CT findings, EPN was classified as Class 1 (n = 30), Class 2 (n = 54), Class 3a (n = 24), Class 3b (n = 16), and Class 4 (n = 4). *Escherichia coli* (n = 75) most common organism grown. Majority were treated with antibiotics. Thirty-six patients underwent percutaneous drainage, 12 patients percutaneous nephrostomy, and 25 patients subjected to DJ stenting. Nephrectomy was done in 7.8%. Mortality rate in our study was 6.25%. **Conclusion:** EPN management requires multidisciplinary approach including adequate hydration and electrolyte imbalance management, broad spectrum antibiotics, strict glycemic control, effective urinary drainage, and lastly nephrectomy.

Key words: Emphysematous pyelonephritis; Percutaneous nephrostomy; *Escherichia coli*

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INTRODUCTION

Emphysematous pyelonephritis (EPN) is a severe, necrotizing infection of kidney, due to both aerobic and anaerobic gas forming organisms.[1,2] It mainly affects renal parenchyma. Bilateral involvement is not uncommon.

The clinical presentation of EPN is similar to uncomplicated pyelonephritis but is a more aggressive condition with high morbidity and mortality with mortality estimates as high as 90%.[3]

Diabetes mellitus (DM) is important comorbid factor. Predisposing factors along with diabetes are immunocompromised status, chronic kidney disease (CKD), patients on immunosuppressive drugs, urinary tract obstruction secondary to calculus, vascular compromise. Emphysematous pyelitis is a rare infection of urinary collecting system due to gas forming organisms and should be treated as a separate clinical entity.

The most prevalent causative organism is *Escherichia coli*, a lactose-fermenter, which metabolizes lactose and glucose to produce high levels of carbon dioxide and hydrogen resulting in significant gas formation.[4] *Clostridium* and *Bacteroides fragilis* which are anaerobes are also noted along with fungi like *Candida*. Most common symptoms include fever and flank pain.

In present era, CT scan adds as an important tool in the

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early diagnosis of EPN patients, which helps in managing patients in less aggressive manners such as medical management and minimally invasive procedures.

Management modalities vary from conservative approaches such as adequate hydration, appropriate antibiotics, and glycemic control to interventions such as percutaneous drainage, DJ stenting, and as a last resort nephrectomy. Historically, the prognosis in these patients has been poor with high mortality rate.[2,5]

Aims and objectives

General: To study the various risk factors, clinical features, radiological classification of emphysematous pyelonephritis.

Specific: To study various management approaches like medical management, minimally invasive procedures and nephrectomy.

MATERIALS AND METHODS

We prospectively analyzed the clinical, laboratory, radiological findings, and treatment approaches of 128 patients with EPN at our hospital from January 2021 to July 2022; Patients were diagnosed and classified based on their computed tomographic (CT) data using Huang and Tseng classification.

Inclusion criteria

Patients diagnosed with CT findings of EPN were included in the study. Patients who presented in Emergency and Casualty in unstable clinical parameters were resuscitated and later subjected to CT, included in study if confirmed as EPN.

Exclusion criteria

History of urinary tract instrumentation in recent past, genito urinary fistula, and recent trauma was excluded from the study.

Prognostic factors included in study are glycemic index, renal parameters, serum albumin level, platelet count, shock on presentation, and level of consciousness.

Glycosylated hemoglobin was done for all the patients to know about their glycemic control. Poor glycemic control was labeled if glycosylated hemoglobin of more than 7%.

Acute kidney injury was defined as elevation of serum creatinine of more than 1.5 mg/dl. Serum albumin <3.5 g/dl was considered as hypoalbuminemia thrombocytopenia was defined as platelet count <1.5 lakhs/cu mm. Shock was defined as systolic blood pressure <90 mm Hg. Altered sensorium was considered if patient had disorientation to time place and person.

All the patients were started on broad spectrum intravenous antibiotics and, then, changed to culture specific antibiotics. Conservative management included antibiotic therapy and supportive measures.

Patients on clinical deterioration such as sepsis (fever, vomiting, and with increasing white blood counts) increasing renal parameters, hydroureteronephrosis, and increasing renal and perinephric gas shadows or collection on repeat CT scans were advised to undergo minimally invasive procedures such as percutaneous nephrostomy/drainage and DJ stenting.

Percutaneous nephrostomy/drainage was done under local anesthesia, under ultrasound guidance at bedside using 10 F nephrostomy tube for drainage. DJ stenting was also done under local anesthesia using 5 Fr, 26 cm DJ stent. Retroperitoneal open nephrectomy was done through loin incision.

RESULTS

Among the 128 patients, 96 were female and 32 were male (Table 1). In our study, the mean age group of presentation of patients with EPN was 61.69. Youngest patient was 42 years of age and oldest was 85 years of age. The male-to-female ratio was 1:3. Among them, 110 patients were diabetic. The mean HbA1c in our series was 10.5. Ten patients were immunologically compromised, eight were CKD patients. All had symptoms of fever and flank pain. Right kidney was involved in 58.5 % of patients (n=75), left in 38.2 % of patients and four patients had bilateral disease (Table 2).

Based on CT imaging findings, EPN was classified as Class 1 (n=30), Class 2 (n=54), Class 3a (n=24), Class 3b (n=16) and Class4 (n=4) (Table 5). *E. coli* (n=75), *Klebsiella* (n=35), and *Proteus* (n=2) were grown in cultures, Candida was seen in four patients, mixed cultures in 12 patients (Figure 1). Thrombocytopenia and shock were seen in 50% and 25 % of the patients respectively. Table 3 and Table 4 highlights the Clinical features and Risk factors associated with EPN. Majority were treated with antibiotics. Thirty-six patients underwent percutaneous drainage, 12 patient's percutaneous nephrostomy, and 25 patients subjected to DJ stenting. Nephrectomy (ten patients) was done in 7.8%. Mortality rate in our study was 6.25% (n=8) (Figure 2). Image 1 is a CT KUB (Plain) axial section of Class 3 EPN. X Ray Kub (Image 2) is suggestive of Bilateral stenting in case of EPN.

Patients were followed up for 6 months. Four patients died in hospital in initial presentation and another four patients were readmitted for progression of symptoms and were clinically deteriorating and expired within 12 h of readmission. One patient progressed from unilateral disease to bilateral disease and was managed successfully with conservative line of treatment.

DISCUSSION

EPN was a life-threatening UTI. In 2000, Huang and Tseng[2] studied 32 patients in 11 years with EPN, which was the largest reported study, with the disease. Aswathaman et al.,[1] reported 42 patients in 6 years. In our study, we have 128 patients with EPN in 1 year 6 months.

EPN is a severe, necrotizing infection characterized by bacterial production of gas within the renal parenchyma. The conditions required for the generation of EPN are as follows:

1. The presence of pathogenic bacteria capable of mixed acid fermentation[6]
2. High levels of glucose in tissue
3. Impaired tissue perfusion.[7]

The mean age group of presentation, described by Wan et al.,[5] and Aswathaman et al.,[1] in their study was 54.7 and 53.2, respectively. In our study, the mean age group of presentation of patients with EPN was 61.69. Youngest patient was 42 years of age and oldest was 85 years of age. The male-to-female ratio in Wan's study was 1:6. In our study, male-to-female ratio was 1: 3. UTI being more common in females may be the cause for increased incidence. *E. coli* was the most common organism seen in both Huang et al., and Wan et al., series 69% and 58%, respectively, followed by *Klebsiella pneumoniae* 29% and 24%, respectively. In our study, *E. coli* was grown in 58.5% of patients and *Klebsiella* in 27.3% of patients. Candida species causing EPN was reported by Shokeir et al.,[8] They have also observed high mortality with Candida growth.

The Incidence of DM in Karthikeyan's, Huang's, studies were 93% and 96% respectively. In our study it was 85.9 %.

HbA1c was estimated in all patients. The mean HbA1c in our series was 10.5; this clearly shows the poor diabetic control of patients. Patients with a very high HbA1c >11.5% had a higher class of EPN (Class 3a and Class 3b), whereas patients with HbA1c <11.5 had Class 1 and Class 2 EPN. Higher the HbA1c, higher the class of EPN.

Patients with very high HbA1c also had problems such as Fournier's gangrene, diabetic foot, and fungal maxillary sinusitis. They had a longer hospital stay. Probably, HbA1c may be a good prognostic marker in patients with EPN; however, more studies are required to confirm this.

Proteinuria was used as a prognostic factor in Wan and Huang series. However, proteinuria did not have any significance with the outcome and with the class of EPN, so we decided to use S. albumin levels as a prognostic factor and was low in 12 patients.

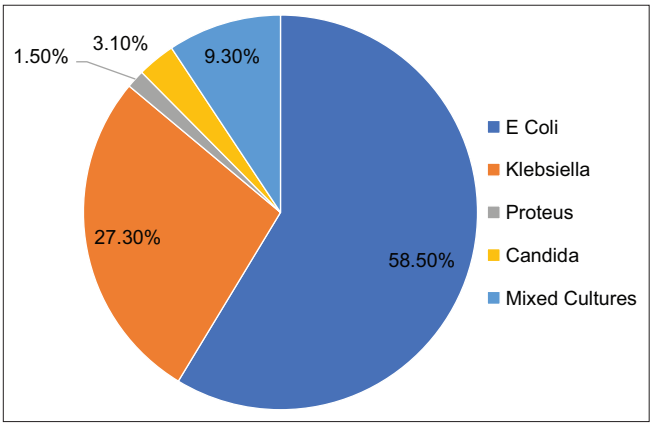

Figure 1: Organisms noted in urine cultures

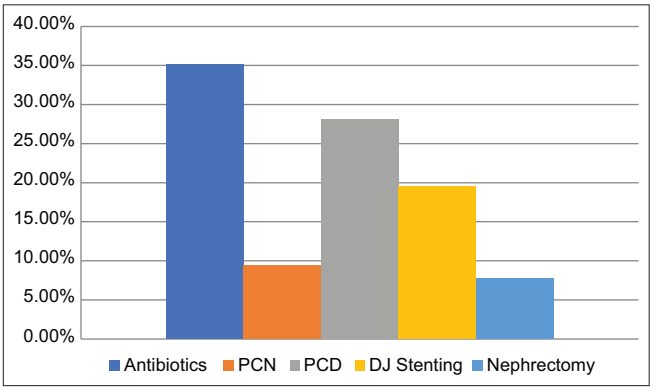

Figure 2: Treatment approaches

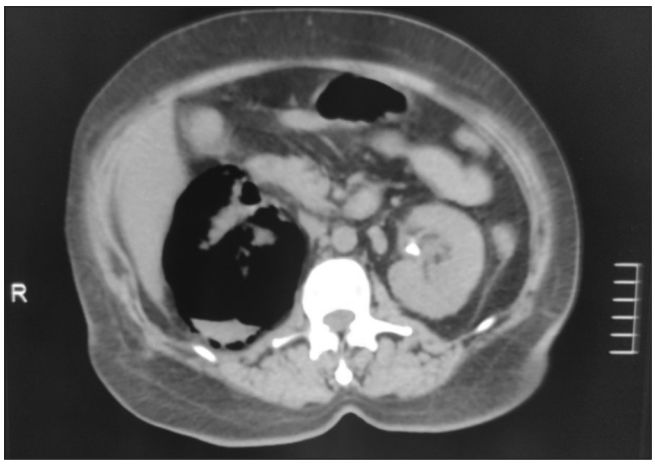

Image 1: Class 3 EPN (CT KUB plain)

Image 2: X-ray KUB

Majority of patients with platelets <1 lakh were in Classes 3 and 4. The presence of altered sensorium was seen in higher class of EPN, similar observation was seen in Huang's, Shetty's series.[10]

Class 1 EPN was seen in 23% of patients. Class 1 EPN was described as benign by Aswathaman et al., as it had an excellent prognosis with antibiotic treatment alone, especially in the absence of obstruction. These patients were managed conservatively except in three patients who required PCD placement.

In our study, 42% of patients were under Class 2 EPN; this was the most common class in our study. Initially, all were managed conservatively and on clinical deterioration, 18 patients underwent percutaneous drainage, seven patients PCN, and ten cases posted for DJ stenting.

We had 24 patients with Class 3a. Among them, nine had perinephric abscess for whom per cutaneous drainage was done. Two patients undergone PCN and eight patients DJ stenting.

In Class 3b, out of 16 patients, six patients required DJ stenting, three patients were put on PCN, and for four patients percutaneous drainage was done.

Totally, four patients were in Class 4. In them, two required PCD placement and one required DJ stenting. Sixteen patients had Class 3b EPN. Among them, six patients required DJ stenting.

Ten patients needed nephrectomy (Class 2=1 patient, Class 3a=4 patients, Class 3b=3 patients, and Class 4=2 patients). All the ten patients had poor risk factors (Thrombocytopenia, altered renal function, hypoalbuminemia, shock, and poorly controlled diabetes). Eight patients were known CKD patients who required dialysis during course of treatment. All eight patients had thrombocytopenia, with platelet <80,000/cumm. One patient underwent nephrectomy on clinical deterioration and two patients died in intensive care unit.

Table 1: Sex distribution

Sex	Number of patients	%
Male	32	25
Female	96	75

Table 2: Side of involvement

Side	Number of patients	%
Right	75	58.5
Left	49	38.2
Bilateral	04	3.5

Table 3: Clinical features

Clinical features	Number of patients	Percentage
Fever	128	100
Flank pain	128	100
Tachycardia	90	70.3
Hypotension	22	17.1
Altered sensorium	16	12.5

Table 4: Risk factors

Risk factors	Number of patients	Percentage
Altered renal function	46	36
Thrombocytopenia	64	50
Hypoalbuminemia	40	31.25
Shock	32	25
Poorly controlled DM	22	17.1
CKD	8	6.25

CKD: Chronic kidney disease, DM: Diabetes mellitus

Table 5: EPN classification according to Huang and Tseng

Class of EPN	Number of patients	Percentage of patients
Class 1	30	23
Class 2	54	42
Class 3a	24	19
Class 3b	16	13
Class 4	4	3
Total	128	100

EPN: Emphysematous pyelonephritis

Limitations of the study

Major limitation of the study was the lesser duration of follow-up.

CONCLUSION

EPN management requires multidisciplinary approach including adequate hydration and electrolyte imbalance management, broad spectrum antibiotics, strict glycemic control, and effective urinary drainage, and finally, it might require nephrectomy as a salvage procedure.

The important clinical issue is to determine the best treatment for each patient so as to preserve the maximum renal functioning.

EPN is a clinical entity, requires high degree of suspicion, and timely goal-directed management, if provided appropriately it significantly reduces mortality rate and complications

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Authors' Contributions:
RR- Concept and design of the study, prepared first draft of manuscript; **SKP-** Interpreted the results; reviewed the literature and manuscript preparation; **RS-** Concept, coordination statistical analysis, interpretation and publication work; **SS-** Data Collection, Preparation of Manuscript, Revision of manuscript; **GRV, SG-** Preparation of Manuscript.

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