

Battling EPN: Sparing Scalpels with Smart Drainage Strategies

Dr. Santosh Kumar Soni^{1*}; Dr. Nikunj Jain²; Dr. Krishnanand³

¹ Resident, ² Consultant Urologist, ³ Head of Department

^{1,2,3}JK Hospital & LN Medical College, Bhopal, Madhya Pradesh, India

Corresponding Author: Dr. Santosh Kumar Soni*

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Abstract:

➤ Introduction:

Emphysematous pyelonephritis (EPN) is a necrotizing, gas-forming infection of the renal parenchyma and perinephric tissues, predominantly affecting patients with uncontrolled diabetes mellitus. Historically associated with high mortality and managed with emergent nephrectomy, contemporary management has shifted toward renal preservation using percutaneous drainage (PCD) combined with culture-directed antimicrobial therapy. This study evaluates outcomes of a drainage-first strategy in patients with EPN and identifies predictors of successful renal salvage.

➤ Methods:

A prospective analysis was conducted of consecutive patients diagnosed with EPN at a tertiary referral centre between December 2024 and November 2025. Diagnosis and classification were based on contrast-enhanced computed tomography using the Huang and Tseng system. All patients received broad-spectrum intravenous antibiotics and hemodynamic resuscitation. Image-guided percutaneous catheter drainage was performed in patients with Class 2–4 disease or those with sepsis not responding to medical therapy. Primary outcomes included renal salvage rate and in-hospital mortality.

➤ Results:

A total of 18 patients were included. According to Huang–Tseng classification had Class 1, Class 2, Class 3A/3B, and Class 4 disease. Initial management with antibiotics plus PCD was undertaken while 1 required upfront nephrectomy due to refractory septic shock. Renal salvage was achieved in 17 patients managed with drainage-first strategy. No mortality in our study. Predictors of failure of conservative management includes diabetes altered sensorium, and extensive parenchymal destruction on imaging.

➤ Conclusions:

A structured drainage-first approach combined with aggressive resuscitation and tailored antibiotics enables high renal salvage rates in EPN, even in advanced radiological classes. Early risk stratification is critical to identify patients who may require prompt nephrectomy. Contemporary management should prioritise organ preservation where feasible, reserving surgery for refractory or non-responding cases.

Keywords: Emphysematous Pyelonephritis, Gas-Forming Infection, DJ Stenting, Nephrectomy.

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I. INTRODUCTION

Emphysematous pyelonephritis (EPN) is a life-threatening necrotising infection of the renal parenchyma characterised by gas formation within the kidney and/or surrounding tissues. Historically associated with mortality

rates as high as 40–90%, EPN was traditionally managed with emergency nephrectomy. Contemporary practice, however, increasingly favours organ-preserving strategies facilitated by early cross-sectional imaging and interventional radiology.

EPN predominantly affects patients with poorly controlled diabetes mellitus and immunocompromised states. Gas formation results from facultative anaerobic organisms, most commonly *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Proteus mirabilis*. The Huang and Tseng radiological classification remains the most widely adopted severity stratification system and guides therapeutic decision making.

Despite advances in management, uncertainty persists regarding optimal intervention in higher-class disease and in patients presenting with multiple prognostic risk factors. This prospective study evaluates outcomes of a structured, minimally invasive, stepwise management strategy in a contemporary cohort.

II. METHOD

A. Study Design and Setting

Prospective observational study conducted at LN Medical College & J.K. Hospital, Bhopal, India, between December 2024 and November 2025.

B. Study Population

Eighteen consecutive adult patients with CT-confirmed EPN were included.

C. Diagnostic Protocol

Diagnosis was confirmed by CT KUB (plain or contrast-enhanced based on renal function). Urine and blood cultures were obtained prior to antibiotic therapy.

D. Objectives:

➤ To study:

- The clinical features, radiological classification and risk factors of Emphysematous Pyelonephritis.
- To study different management modalities of Emphysematous pyelonephritis and their outcomes.

E. Presentation

The clinical presentation of emphysematous pyelonephritis (EPN) is frequently non-specific and varies

according to the extent of renal parenchymal involvement. The disease may have an insidious onset, manifesting as dull aching flank pain, and can rapidly progress to severe sepsis or septic shock. The classical clinical triad of fever, flank pain, and nausea constitutes the most common presentation. In advanced cases with systemic involvement, patients may present with altered sensorium.

On physical examination, costovertebral angle tenderness is commonly elicited, particularly in severe infection. Extension of gas into the subcutaneous tissues may result in palpable crepitus. Laboratory evaluation typically demonstrates leukocytosis, elevated serum creatinine, and hyperglycaemia. Urinalysis may reveal pyuria and glycosuria. Urine and blood cultures should be obtained prior to initiation of antimicrobial therapy to guide subsequent management.

➤ Management:

• All Patients Received:

- ✓ Hemodynamic stabilization
- ✓ Oxygen support
- ✓ Hourly urine output monitoring
- ✓ Inotropic support when required
- ✓ Glycaemic control
- ✓ Intravenous cefoperazone–sulbactam ± aminoglycoside (modified according to culture)

F. Investigation:

Imaging studies are necessary when diagnosing EPN. Computed tomography (CT) is the most valuable examination for EPN, which can be used to identify the infected kidney and gas accumulation, and provide an accurate assessment of the extent of infection[1]. The characteristic findings include intraparenchymal, intracalyceal, often extending into the subcapsular space or across Gerota’s fascia[2]. On CT, infected kidneys appear heterogeneous and embedded with hypodense abscesses containing fluid and gas.

An imaging-based classification system was first described in 1996 by Wan *et al.*

Table 1 Huang and Tseng Focused Primarily on the Gas Distribution

Grading	Description
Class 1	Gas is present only in the renal collecting system
Class 2	Gas is present in the renal parenchyma, without extension to the extrarenal area
Class 3A	Gas or abscess are present in the perinephric space
Class 3B	Gas or abscess are present in the pararenal space
Class 4	Bilateral involvement can be observed

Increase in the gas distribution reflects an increase in the infection area, which is associated with an increase in the mortality rate, with Class 4 having the worst outcomes.

G. Treatment:

➤ Antibiotics:

All the patients were started on intravenous antibiotics cefaperazone + sulbactam and aminoglycoside if the renal

parameters are normal and then changed to culture specific antibiotics.

➤ Drainage:

• Minimal Invasive Procedures Includes:

- ✓ DJ stenting
- ✓ Percutaneous nephrostomy

✓ Percutaneous drainage

Table 2 Indications for Minimal Invasive Procedures

Procedures	Indications
DJ stenting	All class 1 and selected class 2
Percutaneous nephrostomy	Most of class 2 and all grade 3
Percutaneous drainage	Extensive perinephric and paranephric collection

Repeat CT scans were performed to assess the improvement weekly till the patient is discharged. DTPA Renogram was performed after 4 to 6 weeks to know about the function of the kidney. Patients with Class 1 and Class 2 EPN had a near normal GFR and did not have any reduction in renal function. Patients with Class 3 and Class 4 EPN had reduced function on the affected side. The mean relative function of the affected kidney was 39%. Patient with recurrent EPN became dialysis dependent and small contracted kidney noted on follow up by ultrasound.

➤ *Nephrectomy Done in:*

- Not improving on minimal invasive treatment- Life saving (immediate/emergent) nephrectomy

- Non-functioning renal unit- Delayed nephrectomy, to decrease chance of EPN[3].

III. RESULTS

There does not seem to be any racial prevalence. EPN has been reported in all the parts of the world. The incidence of EPN is on the higher side in India. In our study, the mean age group of presentation of patients with EPN was 51. The youngest patient was 30 years old and the oldest patient was 62 years old. EPN common in female patients. In our study male to female ratio was 1:2.

The reason for EPN being more common in female sex may be due to the fact that UTI is more common in females[4].

Table 3 Sex Distribution

Sex	Number of patients
Male	6
Female	12

In our study E. coli was seen in 7, followed by klebsiella in 4, Pseudomonas growth was seen in 3 and mix growth seen in 4 patients, 10% mixed growth of organisms have been observed in Sugandh shetty's6 series. Candida Albicans growth not seen in none of patient. Candida species

causing EPN was reported by ShoKeir *et al.* in 1998. They have also observed high mortality with Candida growth. Rare organisms such as Clostridium species and Aspergillus famigatus was also reported by Alan and Richard *et al.*

Table 4 Urine Cultures

Organism	Number of patient
E.coli	7
Klebsiella pneumonia	4
Pseudomonas	3
Mixed	4
Total	18

Patients with a very high HbA1c > 11.5 % had a higher class of EPN (class 3 & class 4), whereas patients with HbA1c < 11.5 had class 1 & class 2 EPN. Higher the HbA1c, higher the class of EPN.

Table 5 EPN Class and Number of Patients

EPN class	Number of patients
Class 1	6
Class 2	7
Class 3	5
Class 4	0

In our study, one patient had pre-existing chronic kidney disease (CKD) at presentation. The presence of CKD and the requirement for haemodialysis during the course of treatment have been identified as adverse prognostic indicator. In this patient, renal function deteriorated following the onset of EPN. None in our series required haemodialysis. Consistent with previous reports, patients with pre-existing CKD are

associated with poorer outcomes [5], although in our series they were successfully managed with minimally invasive approaches.

Altered sensorium was observed in four patients, all of whom had higher radiological grades of disease (Class 3 or 4). These patients required minimally invasive intervention in

addition to intensive care support and experienced prolonged hospitalisation. Similar observations have been reported in the series by Huang et al. and Sukanatha Shetty et al. [6]. In contrast, Karthikeyan et al. reported progression to dialysis dependency in patients presenting with altered sensorium, while Huang and Tseng noted the need for emergency nephrectomy in such cases. 1 patient in our series required nephrectomy.

Acute renal impairment and altered sensorium have been described by Huang and Tseng et al. as independent predictors of poor prognosis in EPN. The presence of more than two risk factors has also been associated with adverse outcomes, with nephrectomy frequently required in Huang’s series. Karthikeyan et al. similarly suggested that patients with two or more risk factors, irrespective of radiological class, often required surgical intervention. In contrast, two patients in our cohort with more than two risk factors were successfully managed with minimally invasive techniques.

Table 6 Risk Factors

Risk factors	No. of patients
Deranged renal parameter	14
Shock	8
Altered sensorium	4
Poorly controlled DM	12
CKD	4

Nephrectomy was done in 1 patients. Patients who underwent nephrectomy had nonfunctional renal unit on follow up DTPA renogram after 6 weeks. This clearly shows that patients with more than two risk factors can also be managed conservatively and early appropriate treatment will help to salvage the kidney[7].

Table 7 Treatment

Treatment	No. of patients
Antibiotic + DJ stent	9
Antibiotic + DJ stent + PCN	5
Antibiotic + DJ stent + PCD + PCN	3
Antibiotic + DJ stent + Nephrectomy	1
Total	18

IV. DISCUSSION

Emphysematous pyelonephritis should be suspected in every diabetic patient, presenting with features of acute pyelonephritis presents with fever, flank pain and raised TLC.

- E. coli is the most common organism associated with EPN.
- CT scan is the imaging modality of choice for diagnosis of EPN.
- EPN can be successfully treated with conservative and minimally invasive interventions, irrespective of class of EPN and the number of risk factors[8].
- Cystoscopy and DJ stenting is preferred treatment especially for grade 1 EPN.
- PCN and PCD preferred from grade 2 to grade 4 EPN.
- Aggressive and early intervention will help to salvage the kidneys in class 3 and class 4 EPN.
- However, nephrectomy should be promptly attempted for patients not responding to conservative methods and patients with extensive, fulminant course of disease[9].
- Pre-existing CKD status, shock at presentation and altered sensorium are the poor prognostic factors in this study[10].

EPN is classified in four stages based on radiological findings, guiding management from conservative treatment to surgical intervention.

Prompt DJ stenting or PCN (urine diversion) is mandatorily required, nephrectomy is needed in life threatening conditions.

Management includes aggressive resuscitation, glycaemic control, antibiotics, and drainage procedures.

➤ *Limitations*

- Small sample size
- Single-centre experience
- Lack of multivariate statistical modelling

➤ *Conflict of Interest*

- The author declares no conflict of interest



Fig 1 Air in Parenchyma

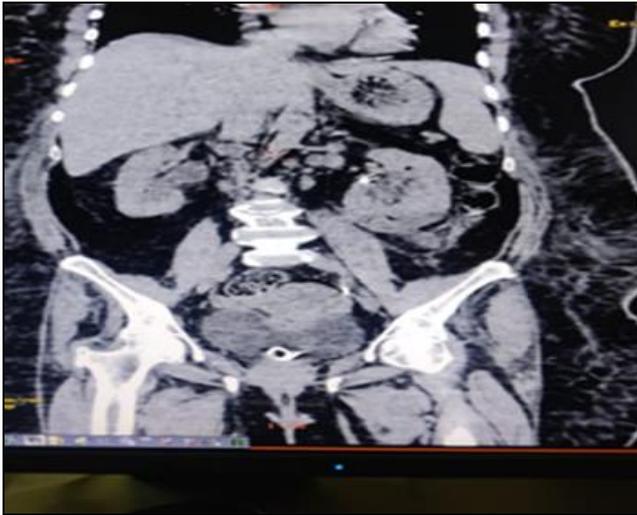


Fig 2 Resolved Air

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