

# Emphysematous Pyelonephritis

## Disparities observed in the use of percutaneous drainage techniques

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**ABSTRACT: Objectives:** The recent drop in the mortality rates of emphysematous pyelonephritis, a serious medical condition, is attributable to renal percutaneous drainage (PCD) techniques that have also reduced the necessity for surgery. Since the difference in the objectives of the two specific techniques, i.e. PCD and percutaneous nephrostomy (PCN), is often overlooked, this study aimed to highlight the inconsistencies in the use of these two techniques.

**Methods:** A retrospective study of 17 patients was conducted over a 10-year period from January 2008 to December 2017 at The Royal Hospital, Muscat, Oman. All patients had undergone abdominal computerised tomography. The obtained images were reviewed and categorised based on Huang and Tseng's classification. **Results:** From the sample, 13 patients (76%) were categorised as class I and II, three (17%) as class IIIA and one (6%) as class IIIB. Five patients from the class I and II categories underwent drainage of the pelvicalyceal system, four by PCN and one by a double-J stent insertion. PCN was performed on all the class IIIA and IIIB patients. One class IIIB patient required PCD for localised gas and fluid collection but later underwent emergency nephrectomy. There were no mortalities.

**Conclusion:** The favourable outcome of this study was in keeping with those of the more recent studies. However, despite the present classifications and guidelines, wide variations were reported in the use of percutaneous drains with PCD, ranging from 2.5–91%. The lack of precise guidelines may be a cause of these disparities in clinical management.

**Keywords:** Renal Infection; Pyelonephritis; Drainage; Percutaneous Nephrostomy; Oman.

### ADVANCES IN KNOWLEDGE

- Recent trends demonstrate a significant decrease in the nephrectomy and mortality rates of emphysematous pyelonephritis (EPN). The favourable outcome of this 10-year study with no deaths is in keeping with the recent trends.
- The use of percutaneous drains is well established as an essential part of the management of EPN. However, guidelines do not provide precise details for the deployment of 'parenchymal' drainage or percutaneous nephrostomy drainage.

### APPLICATION TO PATIENT CARE

- Numerous studies have reported diverse and inconsistent use of 'parenchymal' drainage and percutaneous nephrostomy. Specific details on the extent of collected parenchymal gas and/or fluid requiring drainage and the appropriate number of drains to use are not defined in existing guidelines and left to the discretion of clinicians.
- Lack of precise guidelines leads to variations in the management of care and uncertainty in clinical and radiological assessments. Furthermore, these diverse and inconsistent practices may negatively impact morbidity and mortality rates.

EMPHYSEMATOUS PYELONEPHRITIS (EPN) IS A serious and often necrotising infection of the kidney that is associated with the presence of gas in the renal parenchyma, collecting system or perinephric tissue. Earlier studies have reported high rates of nephrectomy and mortality reaching 50%.<sup>1</sup> However, recent studies have highlighted changing trends in the clinical spectrum and reported significantly lower mortality rates of 0–37.5%.<sup>2–6</sup> The outcome for the current 10-year-long study on 17 patients in a tertiary hospital reported no deaths and only two nephrectomies. Percutaneous drainage (PCD) techniques of the kidney have played a major role in reducing the need for surgery and mortality rates. At the same time, some studies have reported wide variations in clinical management, particularly in the use of the two different percutaneous techniques, i.e. percutaneous nephrostomy (PCN) and PCD of

the kidney. However, the difference in the objective of the two techniques is often overlooked. This gap in extant literature may lead to the suboptimal treatment of patients, which affects the clinical outcomes. Thus, this study aimed to highlight the inconsistencies in the use of these two techniques, which, to the best of the researchers' knowledge, has not been documented before.

## Methods

A retrospective review of the electronic database was conducted from January 2008 to December 2017 at The Royal Hospital, Muscat, Oman. The records of all patients who were admitted with a diagnosis of EPN were retrieved and analysed. These records included patients' demographic data such as age, gender, body mass index (BMI) and the laboratory results (i.e.

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full blood count, renal function tests, glycosylated haemoglobin, random blood sugar and blood and urine cultures). All patients routinely underwent abdominal non-contrast computerised tomography (NCCT) and contrast-enhanced computerised tomography when not contra-indicated. The obtained images were retrospectively reviewed and categorised based on Huang and Tseng's classification.<sup>7</sup> The treatment given was recorded, including the initial medical management and the type of drainage procedures performed. To remove the obstruction of the pelvicalyceal system (PCS), PCN was performed or a double-J stent (DJS) was inserted, whereas PCD was deployed for the drainage of parenchymal or perinephric gas, with or without fluid collections.

**Table 1:** Characteristics and clinical features of patients treated for emphysematous pyelonephritis over a 10-year period at The Royal Hospital, Muscat (N = 17)

Characteristics	Outcome
Mean age in years (range)	55 (31–82)
Male:Female	5:12
Mean BMI (range)	26.5 (18.5–41)
Clinical features	n
Loin pain	12
Fever	14
Septic shock	4
Diabetes mellitus	13
Urinary obstruction	2

BMI = body mass index.

Any other surgical interventions performed were also noted (i.e. emergency nephrectomy, open drainage or elective operations). The initial medical management consisted of adequate intravenous hydration, broad-spectrum antibiotics and glycaemic control. Haemodynamically unstable patients were managed in high-dependency care units (HDUs) or intensive care units (ICUs). The period of outpatient follow-up ranged from 12 to 18 months.

Ethical permission for the study was granted by the Scientific Research Committee of the Royal Hospital (SRC#106/2019)

## Results

A total of 17 patients were treated for EPN over the 10-year period under consideration for this study. The median patient age was 55 years and the ages ranged from 31 to 82 years. The female patients outnumbered males at a ratio of 12:5 and 13 patients (76%) had a history of diabetes mellitus. These demographics and clinical features were presented at the time of admission [Table 1].

Regarding symptoms, fever was the most common symptom; four patients presented with severe sepsis associated with unstable vital signs requiring management in an HDU or ICU admission. Two out of the four non-diabetic patients presented with upper tract urinary calculi—one had an upper ureteric stone and a smaller non-obstructing renal calculus while the other had a stone at the pelviureteric junction (PUJ); both patients had significant hydronephrosis. The other two

**Table 2:** Summarisation of the comparison between the clinical characteristics of emphysematous pyelonephritis patients from the present study and seven other studies

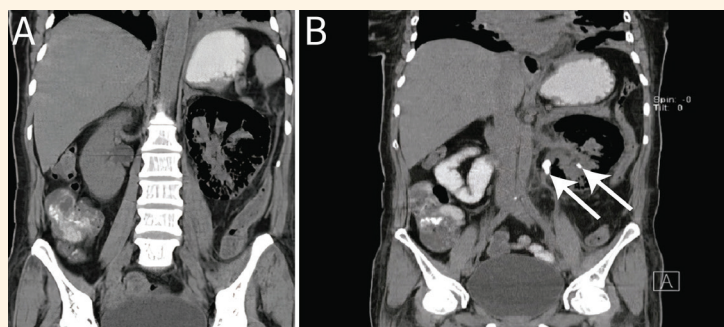
Author (year)	Frequency							
	Patients	Class I + II	Class III + IV	DJS	PCN	PCD	Emergency nephrectomy	Deaths
Huang and Tseng <sup>7</sup> (2000)	48	16	32	N/A	N/A	41 (13*)	8	9
Kangjam <i>et al.</i> <sup>9</sup> (2015)	8	5	3	0	0	7 <sup>†</sup>	3	3
Narlawar <i>et al.</i> <sup>10</sup> (2004)	11	11	0	N/A	N/A	11 (4*)	3	1
Sokhal <i>et al.</i> <sup>3</sup> (2017)	74	45	29	18	N/A	0	4 (2 <sup>‡</sup> )	6
Das and Pal <sup>5</sup> (2016)	15	10	5	7	4	0	0	0
Sharma <i>et al.</i> <sup>6</sup> (2013)	14	9	5	3	0	3 (1*)	0 (1 <sup>‡</sup> )	0
Sandeep <i>et al.</i> <sup>11</sup> (2018)	72	N/A	N/A	25	0	1	1	2
Present study	17	13	4	1	8	1	1	0

DJS = double-J stenting; PCN = percutaneous nephrostomy; PCD = percutaneous drainage; N/A = not available.

\*Number of patients for whom PCD failed.

<sup>†</sup>Five patients had one PCD and two had multiple PCD.

<sup>‡</sup>Number of patients for whom open drainage was performed.



**Figure 1: A and B:** Computerised tomographic scans showing class IIIA emphysematous pyelonephritis of the left kidney of a patient, with one stone in the upper ureter and another in the kidney (arrows).

non-diabetic cases were elderly hypertensive females with a history of chronic renal disease.

Based on Huang and Tseng's classification, 13 patients (76%) were categorised as class I and II, three patients (17%) as class IIIA and one patient (6%) as class IIIB [Figures 1A and B]. There were no class IV patients. Five patients from the class I and II categories underwent drainage of the pelvicalyceal system—four by PCN and one by DJS insertion. PCN was performed on all the class IIIA and IIIB patients, but only one class IIIB patient underwent PCD for localised gas and fluid collection. This patient failed to respond to conservative treatment, which is why an emergency nephrectomy was performed within 72 hours. One of the class IIIA patients had elective nephrectomy for a non-functioning kidney with stones. The follow-up clinic was visited by 12 patients (71%) and all of them were investigated using NCCT scans, which, on review, showed clearance of the gas previously seen in the earlier images. There were no mortalities in this study.

## Discussion

EPN is considered a life-threatening necrotising infection that is common among diabetic individuals, immunocompromised patients and those with obstructive urolithiasis. Characteristically, gas is formed and accumulates as part of the infective process. In the present study, 13 of the 17 patients (75%) had uncontrolled diabetes mellitus. It is postulated that four factors are involved in the pathogenesis of EPN, namely, gas-forming bacteria, high tissue glucose levels, impaired tissue perfusion and defective immune response.<sup>8</sup> The other four non-diabetic patients presented with a deranged renal function—two of them had obstructive uropathy due to a mid-ureteric calculus in one and a PUJ calculus in another. It is reported that up to 95% of patients with EPN have underlying uncontrolled diabetes mellitus, whereas the risk of

EPN, secondary to obstructive uropathy, is significantly less with a range of 25–40%.<sup>8</sup>

The classification of EPN was based on computerised tomography (CT) imaging, which is considered the best radiological modality.<sup>5</sup> On this basis, Wan *et al.* in 1996 described EPN as Type 1, a severe form and a milder Type 2 form of the disease. Huang and Tseng later described a more detailed CT classification with sub-categories and four risk factors, namely, thrombocytopenia, acute renal function impairment, altered sensorium and shock. These factors are said to have added value as a guide to selecting the various management options and assisting in the prediction of the prognostic value and outcomes.<sup>5,6</sup> The method of performing PCN differs from PCD, in that its purpose is to enter and drain the PCS; however, PCD is not designed to puncture the PCS but to drain parenchymal gas and/or pus. To the best of the researchers' knowledge, after a careful search of existing literature, no guidelines describing the extent of gas or fluid collections that should be drained, the number of drains to be inserted or the duration of drainage could be found.

As stated, all class III patients in this study underwent PCN and only one of them underwent a PCD procedure. A wide variation in the type and numbers of drainage procedures performed was reported in a series [Table 2].

In the first three studies, PCD was performed on combined total of 91% (n = 65) of the patients.<sup>7,9,10</sup> Approximately 51% of these cases were classified as groups III and IV. In contrast, only 2.6% of the 192 patients in the other five series underwent PCD insertion, although 22.4% of them were categorised into class III and class IV.<sup>3,5,6,11</sup> There is a wide disparity in the numbers of PCN and DJS insertions with some studies reporting no drainage of the pelvicalyceal system.<sup>9</sup> This contradicts one of the largest series which reported that a third of their patients underwent DJS insertions, without PCN being formed in any of the patients and only one PCD insertion [Table 2].<sup>11</sup>

Despite the present classifications and guidelines, there is a great difference in the use of PCD and PCN. This may have resulted from surgeons being less conversant with the management of this rare disease, uncertainty in the interpretation of radiological images and lack of clarity in the existing guidelines regarding PCD. Furthermore, interventional radiologists may be more familiar and, as such, less hesitant to perform PCN as opposed to PCD. Complications of PCD that include bleeding, septic shock and injury to adjacent organs are well documented and might be significant.<sup>12</sup> The combined mortality rate of the five studies with only a 2.6% PCD insertion rate was 4.2%. This is in contrast to a 20% mortality rate found in the three studies with a 91% PCD insertion rate.<sup>7,9,10</sup>

Most of these studies are retrospective and demonstrate heterogeneity with some unavailable data, e.g. the extent of the gas/pus drained, the number of PCDs per patient and the duration of the drainage, which may be as long as 12 weeks.<sup>13</sup> These limitations do not allow for valid comparisons and statistical analyses. Although it is not possible to draw conclusions, it is apparent that there is a lack of consistency and standardisation that may affect morbidity and mortality rates.

## Conclusion

The favourable outcome of this study is in keeping with the outcomes from recent studies. However, despite the available classifications and guidelines, wide deviations were reported in the usage of the two PCD techniques that ranged from 2.5% to 91%. The lack of more precise guidelines may be a cause of these disparities in clinical management.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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## AUTHORS' CONTRIBUTION

SAB conceptualised the work. MAS, ME and IAS collected the data. SAB and KG drafted and edited

the manuscript. MNMAH reviewed the radiological images. All authors approved the final version of the manuscript.

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