

**Research Article**

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Complications of Percutaneous Nephrostomy Tube Insertion: Single Center Experience

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Background & Aims: Percutaneous nephrostomy (PCN) is an essential image-guided procedure for relieving urinary obstruction. However, complication rates vary widely depending on patient characteristics and procedural factors. This study aimed to evaluate the incidence and predictors of post-PCN complications, with a particular focus on sepsis, in a tertiary referral center serving a high-risk population.

Methods: A retrospective cohort study was conducted including all adult patients who underwent PCN between January 1, 2019 and December 31, 2023, at a single tertiary institution. Demographic, clinical, and procedural data were extracted from electronic records. Overall and specific complication rates were calculated. Binary logistic regression analyses were performed to identify factors independently associated with (1) any complication and (2) sepsis occurrence.

Results: A total of 529 PCN procedures were performed in 204 patients (mean age, 60.1 ± 14.4 years; 49% male). The overall technical success rate was 100%. Complications occurred in 66% of procedures, with sepsis developing in 23.5% and septic shock in 5.4%. On multivariate analysis, tumor-related obstruction was independently associated with the occurrence of any complication ($p < 0.05$), while older age was independently associated with sepsis ($p < 0.05$). Tumor obstruction did not predict sepsis specifically after adjusting for confounders.

Conclusions: Although PCN achieved a high technical success rate, complication and sepsis rates were considerably higher than those typically reported. This likely reflects the high-risk nature of the population, characterized by malignant obstruction and advanced age. These findings highlight the importance of pre-procedural risk stratification, infection control optimization, and vigilant post-procedural monitoring. Prospective multicenter studies are needed to establish risk-adjusted benchmarks for high-risk patient groups in the region.

Keywords: Percutaneous nephrostomy tube; PCN; nephrostomy; complications

Abbreviations: BMI: Body mass index; CI: Confidence Interval; DM: Diabetes Mellitus; ICU: Intensive Care Unit; IRB: Institutional Review Board; OR: Odds Ratio; PCN: Percutaneous Nephrostomy

Introduction

Percutaneous nephrostomy (PCN) tube placement is an image-guided procedure that provides access to the renal collecting system in both native and transplanted kidneys [1]. Indications include urinary drainage in patients with intrinsic or extrinsic obstruction, urinary diversion in cases of leaks or fistulas, and access to the collecting system for interventional procedures such as stent placement or removal [1]. PCN is generally considered a safe and effective procedure, with reported success rates ranging from 82% to 100% [1]. Despite its overall safety, complications may occur. Clinical practice and quality improvement guidelines provide benchmark complication rates for PCN, offering a framework to assess procedural risks and support informed decision-making in patient care [1]. These benchmarks also serve as performance indicators, where rates exceeding the expected thresholds should prompt internal review and quality assurance measures.

Complications following PCN are typically categorized as major or minor [1]. Major complications include events requiring hospital admission or escalation of care, resulting in prolonged hospitalization, permanent adverse outcomes, or death. Minor complications are self-limited events or those requiring observation only [1]. The combined incidence of minor and major complications has been reported in approximately 10% of patients [1-4], although rates may vary depending on procedural technique and patient-related factors [1]. To date, there are no published data from centers in Saudi Arabia describing PCN outcomes. Therefore, this study aimed to evaluate the success and complication rates of PCN procedures performed at our tertiary care center and to identify factors associated with the occurrence of complications.

Materials and Methods

Study Design and Population

This retrospective study included all patients aged ≥ 18 years who underwent percutaneous nephrostomy (PCN) insertion or exchange, unilaterally or bilaterally, at King Abdullah Medical City (KAMC), a tertiary care hospital in Makkah, Saudi Arabia, between January 1, 2019, and December 31, 2023. Patients younger than 18 years and those who underwent PCN in transplanted kidneys were excluded. The study was approved by the Institutional Review Board of KAMC (IRB number: 23-1183). Eligible patients were identified through the radiology department database. Collected data included patient demographics (age, sex, body mass index [BMI]), history of diabetes mellitus (DM), serum creatinine levels, procedural indication, imaging findings, procedural details, outcomes, and complications.

Definitions

Procedural success was defined as the return of urine following withdrawal of the trocar. Major complications included sepsis, bowel injury, bleeding requiring transfusion, embolization or nephrectomy, pleural complications, hospital admission from daycare (length of stay recorded), intensive care unit (ICU) admission due to a procedural complication (with length of stay),

and death likely related to the PCN procedure. Minor complications included leakage, occlusion, dislodgement, malpositioning, hematuria, minor self-limiting bleeding at the exit site, hematoma not requiring transfusion, exit-site infection or cellulitis, and uncomplicated urinary tract infection. Definitions of sepsis and septic shock followed the criteria of the Society of Critical Care Medicine (SCCM) and the European Society of Intensive Care Medicine (ESICM) [5].

Procedure

Informed consent was obtained from all patients after explanation of the procedure's benefits, risks, and alternatives. Patients were positioned prone on the fluoroscopy table, and the skin was prepared with 0.5% chlorhexidine gluconate and draped in a sterile fashion. Local anesthesia was administered using 10 mL of 1% lidocaine. PCN was performed either by an experienced radiologist or by a trainee under direct supervision. The posterolateral calyx was punctured using a 21G $\times$ 15 cm Neff needle (Boston Scientific) under ultrasound guidance (Philips, 3.5–5 MHz curved transducer). Contrast medium (Xenetix), diluted 1:2 with normal saline, was injected through the puncture needle. Successful access was confirmed by urine return upon trocar withdrawal, followed by visualization of the collecting system with 10 mL of diluted iodinated contrast. A guidewire was then advanced: a standard J-tip 0.035" guidewire (Angiotech) was used for dilated collecting systems, while a hydrophilic Radifocus® 0.035" guidewire (Terumo) was used for non-dilated systems. After removing the trocar needle, an 8F drainage catheter was advanced over the guidewire into the renal pelvis under fluoroscopic guidance. The catheter was secured using silk sutures or a StatLock device and connected to a closed drainage system.

Statistical Analysis

Data were compiled and analyzed using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) on a Windows 10 platform. The complication rate was calculated based on the total number of patients treated. Separate binary logistic regression models were used to identify factors associated with any complication and with sepsis. Candidate predictors included age, sex, BMI, diabetes status, and the underlying cause of obstruction. Causes were grouped into three categories (stones, tumors, and others) to ensure adequate sample sizes. Each regression model was adjusted for age, sex, BMI, diabetes, and cause of obstruction. A complete-case analysis was applied, excluding records with missing data. Results were reported as odds ratios (ORs) with corresponding 95% confidence intervals (CIs). A two-sided p-value < 0.05 was considered statistically significant.

Results

During the study period, 529 percutaneous nephrostomy (PCN) procedures were performed on 204 patients, whose data were retrospectively reviewed. Patient demographics and clinical characteristics are summarized in Table 1. The mean age was 60.1 ± 14.4 years, and malignant obstruction was the most common indication for PCN placement.

Table 1: Demographics of studied Population (204 patients).

Demographic Variable	Number (%)
Gender [number (%)]	
Male	100 (49.0%)
Female	104 (51.0%)
Age [number (%)]	
≤ 50	48 (23.5%)
> 50	156 (76.5%)
Body Mass Index [number (%)]	
< 30 Kg/m ²	169 (82.8%)
> 30 Kg/m ²	33 (16.2%)
Unknown	2 (1.0 %)
Diabetes Mellitus [number (%)]	
Yes	58 (28.4%)
No	146 (71.6%)
Indication for the procedure [number (%)]	
Obstruction from stones	16 (7.8%)
Obstruction from a tumor	170 (83.3%)
Obstruction from a stricture	4 (2.0%)
Pyonephrosis	6 (3.0%)
Others	8 (3.9%)
Type of Malignancy* [number (%)]	
Colorectal	51 (30.0%)
Endometrial	21 (12.3%)
Cervical	20 (11.8%)
Bladder	44 (25.9%)
Prostate	9 (5.3%)
Ovarian	8 (4.7%)
Urethral	5 (2.9%)
Others	12 (7.1%)

* Among the 170 patients diagnosed with malignancy

The procedure was technically successful in all cases (100%). Complications occurred in 135 patients, corresponding to a prevalence of 66%. In multivariable logistic regression, age, sex, and BMI were not significant predictors of complications (all $p > 0.1$). Diabetes showed a modest but non-significant positive association (adjusted OR 1.46; 95% CI 0.72–2.94; $p = 0.29$). Tumor-related obstruction was independently associated with higher odds of complications (adjusted OR 2.37; 95% CI 1.02–5.48; $p = 0.044$), indicating approximately 2.4-fold greater odds compared with non-tumor causes after adjusting for age, sex, BMI, and diabetes.

Sepsis was the most frequent complication, occurring in 48 patients (23.5%), with 11 (5.4%) developing septic shock. A multivariable logistic regression analysis was conducted to identify

risk factors for sepsis using a grouped model, adjusting for age, sex, body mass index (BMI), diabetes, and the underlying cause of obstruction, with stone as the reference category (Table 2). Results showed that older age was associated with slightly higher odds of sepsis (adjusted OR, 1.03 per year; 95% CI, 1.01–1.06; $p = 0.01$). After adjustment for these covariates, neither tumor nor the grouped “other” causes were significantly associated with sepsis compared with stones ($p > 0.70$ for both; confidence intervals were wide, reflecting limited precision). Sex, BMI, and diabetes were also not significantly associated with sepsis in this adjusted model.

Other major and minor complications are summarized in Table 3. The mean length of stay was 9.0 days for patients admitted from daycare and 8.6 days for ICU admissions.

Table 2: Multi-variate logistic regression analysis for sepsis (grouped model).

Variable	Odd Ratio	95% Confidence Interval	p-Value
Age (per year)	1.03	(1.01–1.06)	0.01
Age (per year)	1.05	(0.52–2.12)	0.89
Body Mass Index (per unit)	1.0	(0.94–1.05)	0.87
Diabetes (Yes vs. No)	1.4	(0.65–2.99)	0.39
Cause (Tumor vs. stone)	1.19	(0.30–4.77)	0.81
Other causes* (vs. Stone)	1.39	(0.24–7.87)	0.71

* Others include: Stricture / Pyonephrosis /others

Table 3: Rate of complications observed in the study.

Major Complications	Number of Patients (%)
Sepsis	48 (23.5%)
Bowel injury	1 (0.5%)
Bleeding requiring blood transfusion	1 (0.5%)
Bleeding requiring nephrectomy	1 (0.5%)
Pleural complications	1 (0.5%)
Requirement of admission from daycare	2 (0.9%)
Requirement of ICU admission	11 (5.4%)
Death	3 (1.5%)
Minor Complications	Number of Patients (%)
Leakage	22 (10.8%)
Occlusion	11 (5.3%)
Dislodgment	30 (14.7%)
Malpositioning	6 (2.9%)
Hematuria	11 (5.4%)
Hematoma	0
Minor bleeding from exit site	4 (1.9%)
Exit site infection/cellulitis	1 (0.5%)
Uncomplicated urinary tract infection	98 (48%)

Discussion

Many centers consider an overall post-PCN complication rate of approximately 10% (combining major and minor events) as a benchmark [1-3]. In this retrospective cohort, the observed complication rate of 66% was substantially higher. However, acceptable thresholds may vary between institutions depending on patient complexity and case mix. For instance, a systematic review reported overall PCN complication rates in cancer patients ranging from 7% to 87%, largely influenced by differences in study populations, definitions of complications, and follow-up duration [6]. In our study, tumor-related obstruction was identified as a significant risk factor for developing any complication, consistent with previous evidence showing that oncology patients experience higher complication rates and poorer outcomes following PCN insertion [6].

Sepsis following PCN can result from bacterial translocation during catheter placement or manipulation, particularly in patients

with infected or obstructed collecting systems [4,8]. The sepsis rate of 23.5% and septic shock rate of 5.4% observed in our cohort are markedly higher than the typically reported rates of 1–3% [1-4,8]. Several factors may explain this finding. Malignant obstruction was the most frequent indication for PCN in our cohort, and studies have shown sepsis rates in oncology patients reaching up to 55% [6]. Additionally, we did not assess other potential contributors, such as operator experience, use of prophylactic antibiotics, timing of decompression (urgent vs. elective), or pre-procedure infection status. It is also likely that many patients presented with acutely obstructed and/or infected systems, both of which significantly increase the risk of post-procedural sepsis [8,9].

Older age was independently associated with sepsis in our analysis. This may reflect the increased vulnerability of elderly patients, who often have multiple comorbidities, impaired immune responses, and altered renal function, all predisposing them to infection and delayed recovery. Tumor-related obstruction did not independently predict sepsis after adjustment for other factors,

suggesting that malignancy in our cohort was a broader predictor of complications (e.g. mechanical complications) rather than of sepsis specifically. The loss of significance after adjustment likely reflects confounding by age and comorbidities.

The high complication and sepsis rates observed have several clinical implications. They underscore the importance of pre-procedural risk stratification, particularly in older patients and those with malignant or infected obstruction. Optimizing infection control before intervention—including obtaining urine cultures, administering prophylactic antibiotics, draining infected systems urgently, and minimizing delays in decompression—is essential. Post-procedural vigilance is equally critical, with close monitoring of high-risk patients and early escalation if sepsis is suspected. Institutions performing PCN should regularly review their procedural protocols, including antibiotic prophylaxis policies, timing of elective versus emergency interventions, catheter exchange schedules, and coordination between interventional radiology, urology, and infectious disease teams.

This study has several limitations. Its retrospective design inherently limits causal inference and depends on the accuracy of recorded data. The absence of standardized definitions for minor and major complications may have introduced classification bias. Being conducted at a single tertiary referral center that receives complex, high-risk cases (e.g., malignant obstruction) likely inflated complication rates and limits generalizability. Furthermore, unmeasured variables (e.g. timing of decompression, operator experience, culture results, and antibiotic use) were not included in the analysis, restricting adjustment for confounders. Although the sample size was adequate for regression analysis, it may have been insufficient to detect weaker associations. Finally, as 529 procedures were performed across 204 patients, repeated procedures may have violated independence assumptions, potentially clustering complication risks.

Conclusion

In summary, while PCN demonstrated a 100% technical success rate, the overall complication rate—and particularly the 23.5% sepsis rate—was considerably higher than most published reports. This likely reflects the high-risk nature of the study population (older age, malignant obstruction, and potentially infected systems). These findings highlight the importance of comprehensive risk assessment, prompt drainage, appropriate antibiotic use, and

vigilant monitoring for sepsis. Tumor-related obstruction emerged as an independent risk factor for overall complications, while older age was associated with sepsis. Future multicenter prospective studies using standardized definitions and incorporating detailed infection- and drainage-related variables are warranted to refine quality benchmarks for high-risk populations in the Middle East region.

Acknowledgement

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Conflict of Interest

Authors declare no conflict of interest, and no funding support was received for this study.

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