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ORIGINAL RESEARCH

Assessing the Impact of Ultrasound-Guided Percutaneous Nephrostomy on Patient Outcomes in Low-Resource Settings: Experiences from Northern Nigeria

Anas Ismail[1]*, Abbas Muhammad Rabiu[1], Ahmad Bashir Umar[2], Yusuf Lawal[1], Mashhud Hadi Gwadabe[2], Maryam Ahmad Said[2], Muzammil Abdullahi[3], Abdulkarim Iya[4], Atiku Jibrilla[4], Abubakar Dahiru[4], Abdulkadir Musa Tabari[5]

1. Department of Radiology, Bayero University, Kano, Nigeria
2. Department of Radiology, Aminu Kano Teaching Hospital, Kano, Nigeria
3. Department of Surgery, Faculty of Clinical Sciences, Bayero University, Kano, Nigeria
4. Department of Surgery, Aminu Kano Teaching Hospital, Kano, Nigeria
5. Department of Radiology, Barau Dikko Teaching Hospital, Kaduna, Nigeria

* **Corresponding author.** Contact: aismail.rad@buk.edu.ng

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Abstract

Purpose: Percutaneous nephrostomy (PCN) is a procedure that decompresses or provides access to the renal collecting system. There is a shortage of data about the complications and outcomes of PCN in low- and middle-income countries. This study aimed to provide insight into the complications and outcomes of PCN in Nigeria.

Methods and materials: This prospective study included 55 patients who underwent ultrasound-guided PCN. Serum creatinine levels were measured pre-procedure and at intervals of one day, one week, and one month post-PCN. The patients were followed after the procedure to evaluate for post-procedural complications and changes in renal function. The categorical data was expressed as proportions and percentages. The student's t-test compares means between groups for continuous variables. A P value of <0.05 was considered statistically significant.

Results: There were 32 male patients and 23 female patients. Up to 80% of patients had bilateral PCN. Some patients (27.2%) developed minor complications such as pain, wire impaction, bleeding, or vomiting. During the late post-procedure and follow-up periods, 72.7% had no complication, 12.7% had dislodged tube(s), 10.9% had unilateral tube blockage, and 1.8% had bilateral tube blockage. The study also showed a significant reduction of serum creatinine in 80% of the subjects. 12.7% of the patients died, 5.5% of patients were lost to follow-up, and 1.8% had fluctuating creatinine levels.

Conclusion: Ultrasound-guided PCN is a viable technique or an effective technique with a low rate of serious complications. When performed appropriately in the right clinical context, it significantly improves patient outcomes.

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Introduction

Percutaneous nephrostomy (PCN) is a vital procedure for managing obstructive uropathy, which, if untreated, can lead to serious complications. These include hydronephrosis, renal tubular atrophy, infections, urosepsis, electrolyte imbalances, hypertension, stone formation, and renal scarring. Progressive renal damage can result in acute kidney injury, chronic kidney disease, and eventual loss of renal function. PCN helps alleviate obstruction, preserving renal function and preventing irreversible damage (1). Introduced in 1955 to bypass urinary obstructions causing hydronephrosis, PCN has since evolved and now serves a broader range of clinical applications, even in non-dilated calyceal systems (1-3). PCN remains a crucial treatment option, especially in resource-limited settings where advanced urological interventions are unavailable. It ensures effective renal drainage, relieves urinary obstruction, and provides access to the upper urinary tract for further therapeutic procedures. Its role in preserving renal function and preventing complications underscores its continued importance in urological care (4-10).

In low-resource settings like Nigeria, the utility of PCN is particularly significant due to limited access to modern endo-urological technology and expertise. At Aminu Kano Teaching Hospital, PCN plays a pivotal role in the management of upper urinary tract obstructions, offering a cost-effective and accessible solution to many patients. However, despite its importance, data on the complications, outcomes, and overall effectiveness of PCN in such settings is limited, making it difficult for health policymakers to evaluate its full potential in improving healthcare outcomes.

This study seeks to address this gap by reviewing the outcomes of PCN procedures performed at Aminu Kano Teaching Hospital. The findings will provide valuable insights into the success rates, complications, and clinical improvements in patients with obstructive uropathy. Policymakers and public health practitioners will benefit from understanding how PCN can reduce the morbidity and financial burden associated with untreated urinary obstructions, thus promoting its integration into healthcare strategies at both local and national levels.

Moreover, documenting the outcomes of PCN in this setting will help justify investments in training, equipment procurement, and capacity building for minimally invasive urological procedures in Nigeria and other West African countries. The results of this audit will serve as baseline data for future studies and may influence policy decisions regarding resource allocation and the prioritization of PCN as a standard procedure for managing obstructive uropathy. By promoting the wider adoption of PCN, we can reduce the health and economic impacts of this condition, particularly in underserved populations.

Methods and materials

This is a prospective cohort study of all consenting patients who had percutaneous nephrostomy at the Department of Radiology of Aminu Kano Teaching Hospital in Nigeria.

Approval was obtained from the Research Ethics Committee of Aminu Kano Teaching Hospital (AKTH/MAC/SUB/12A/P-3/V1/2220). Confidentiality and anonymity of patients were observed. Patients' ages and sex, including the clinical diagnosis, were extracted from the records of the Department of Radiology and individual patients' case notes.

All 55 consenting patients had percutaneous nephrostomy tubes inserted under ultrasound guidance following routine pre-procedure baseline serum clotting profile (with emphasis on prothrombin time and international normalized ratio [INR]) and complete blood count. Any clotting abnormalities were corrected either by vitamin K supplements or fresh whole blood transfusion. In addition, they had pre-PCN imaging (ultrasound, abdominal computed tomography, or computed tomographic urography).

Patients were scanned in a prone position with a NORTEK CS-50 ultrasound machine (Shenzhen, China, 2014) using a 3.5MHZ curvilinear transducer, and images of transverse/longitudinal sections of the kidney were obtained to identify the degree of hydronephrosis. Afterwards, the ideal puncture site into the kidney was identified via a posterior calyx approach. As soon as the initial puncture site was chosen, it was cleaned and draped. Local anesthesia (5~10ml of 2% lidocaine) was infiltrated subcutaneously at the puncture site.

Using the Seldinger technique under real-time ultrasound guidance, an 18G long access needle (Hakko Co. Ltd, Nagano-ken, Japan) was inserted into the target lower calyx; then a curved J tip 0.038-inch guidewire (Cook, Bloomington, IN, USA) was passed through the needle sheath into collecting system with the help of an assistant (Figure 1). Thereafter, the sheath was removed, and the wire was retained. Further skin and fascia incision was widened to allow for serial dilatation using plastic disposable percutaneous dilators. Over the guide wire, the drainage catheter set without inner metallic stylet was introduced into the collecting system, after which the metallic trocar was removed. The drainage catheter was then advanced into the collecting system further following over the guide wire with ultrasound guidance. Finally, after confirming the drainage catheter head was curled in the collecting system, the guide wire was removed (Figures 2 and 3). The safety string lock was tightened, and the catheter was secured to the skin using silk 4-0 and connected to a drainage bag.

Urine samples were obtained and sent for microbiological investigation and culture. All patients were placed on bed rest for two hours post-procedure before being discharged

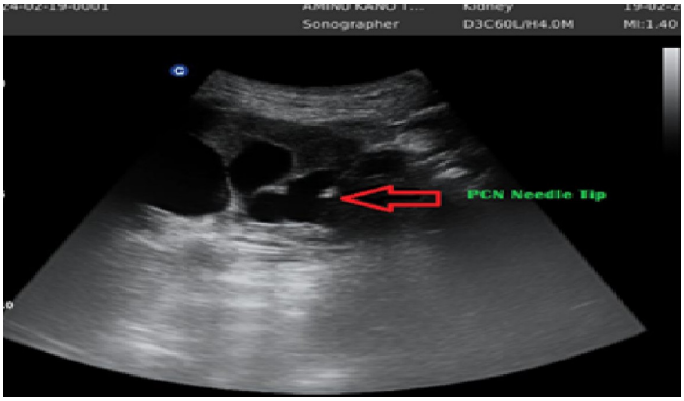

Figure 1. A gray scale longitudinal sonogram of the kidney, showing severely dilated renal calyces. The inserted PCN puncture needle is shown by the arrow.

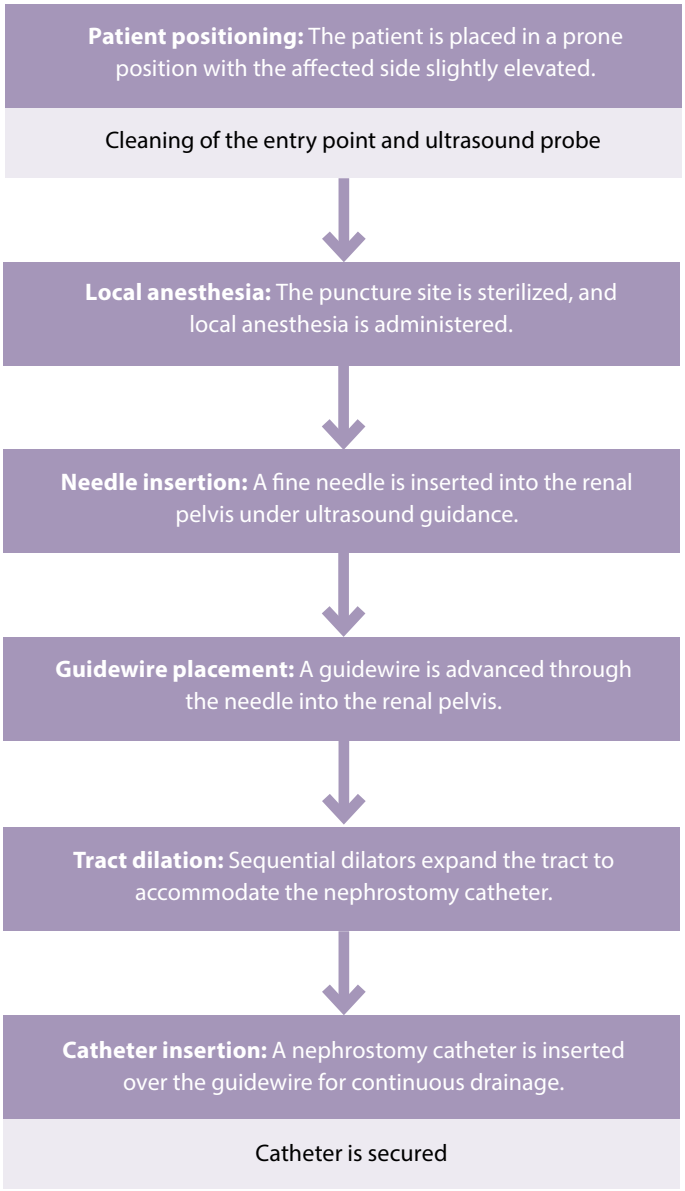

Figure 2. A step-by-step guide to ultrasound-guided percutaneous nephrostomy (PCN).

Figure 3. Deployment of the percutaneous nephrostomy tube using a metal stiffener over the guide wire.

to the ward, while the outpatients were usually observed/monitored for four hours before being discharged. Amoxicillin-clavulanate (875 mg/125 mg twice daily) prophylaxis was given for one day prior and two days post procedure.

We obtained pre-PCN and serial serum creatinine on day one, one week, and one month post PCN. Patients were monitored for a minimum of one month for the presence of complications such as puncture site collections, intractable pain at the puncture site, lack of drainage of urine via PCN tubes, and tube/catheter dislodgement or evidence of infection (urosepsis). Deaths were monitored and recorded. We also documented whether patients continued dialysis.

Data analysis

Data were analyzed using the R programming software Version 4.0 (Free Software Foundation, Boston, MA, USA). In the descriptive analyses, categorical data results were expressed as proportions and percentages.

Continuous data were assessed for normality. Those that were normally distributed were summarized using means

and standard deviation, while those that were skewed were summarized using the median and interquartile range.

The student's t-test to compare means between two groups for continuous variables was used. A confidence interval of 95% was used, and a P value of < 0.05 was considered statistically significant.

Results

A total of 55 patients had PCN during the study period. Thirty-two (58.2%) of the patients were male and 23 (41.8%) were female.

Forty-four (80%) patients had their tubes inserted bilaterally, while 6 (10.9%) and 5 (9.1%) had their tubes inserted only on the right and left sides, respectively.

The most frequent indication for PCN in our study was advanced cervical cancer (30.9%), followed by advanced urinary bladder cancer (29.1%). The least frequent were prostate cancer (1.8%) and retroperitoneal tumors (1.8%).

A total of 56.4% of the patients had no post-procedure complications, except for procedure-related discomfort during the immediate (intra-procedure) periods. However, some patients developed minor complications including pain at puncture sites (21.8%), guide wire entrapment (1.8%), bleeding (1.8%), and vomiting (1.8%). During the late post-procedure and follow-up periods, 72.7% had no complication, 12.7% had dislodged tube(s), 10.9% had unilateral tube blockage, and 1.8% had bilateral tube blockage. This is summarized in Table 1.

The post-procedure clinical status and laboratory work-up of patients during the follow-up periods revealed that out of the 55 patients, 80% were clinically stable with significantly reduced creatinine levels, 12.7% of the patients died, 5.5% of patients were lost to follow-up, and 1.8% had fluctuating creatinine levels but were otherwise clinically stable. This is summarized in Table 2, Table 3, and Figure 4.

Figure 4 shows a significant reduction in all the patients from the pre-procedure level to one-week post-procedure which tends to remain below 200 mmol/L for most of the patients at four weeks post-procedure. Only a few of the patients had a slight rise in their creatinine levels from one week post-procedure, with about slightly more than one-third of the baseline value at four weeks.

Discussion

Obstructive uropathy causing severe hydronephrosis or hydroureteronephrosis is a common urological emergency. Early intervention is crucial to prevent sustained high pelvicalyceal pressure from damaging renal tissues. If left untreated, this can lead to a progressive decline in glomerular filtration rate (GFR), impaired renal excretory

Table 1. Relative frequency of intra- and immediate post-procedure complications among PCN patients.

	Frequency (n)	Percentage (%)
Intra-procedure complications		
None	31	56.4
Pain	12	21.8
Several attempts	10	18.2
Vomiting	1	1.8
Bleeding	1	1.8
Total	55	100
Post-procedure complications		
None	40	72.7
Dislodged tube	7	12.7
Blocked tube (unilateral)	6	10.9
Blocked tube (bilateral)	1	1.8
Impacted guidewire	1	1.8
Total	55	100

Table 2: Post-procedure follow-up status among PCN patients at one month after the procedure.

Status	Frequency (n)	Percentage (%)
Stable with reduced serum creatinine levels	44	80.0
Died	7	12.7
Discontinued follow-up	3	5.5
Stable with fluctuating creatinine levels	1	1.8
Total	55	100

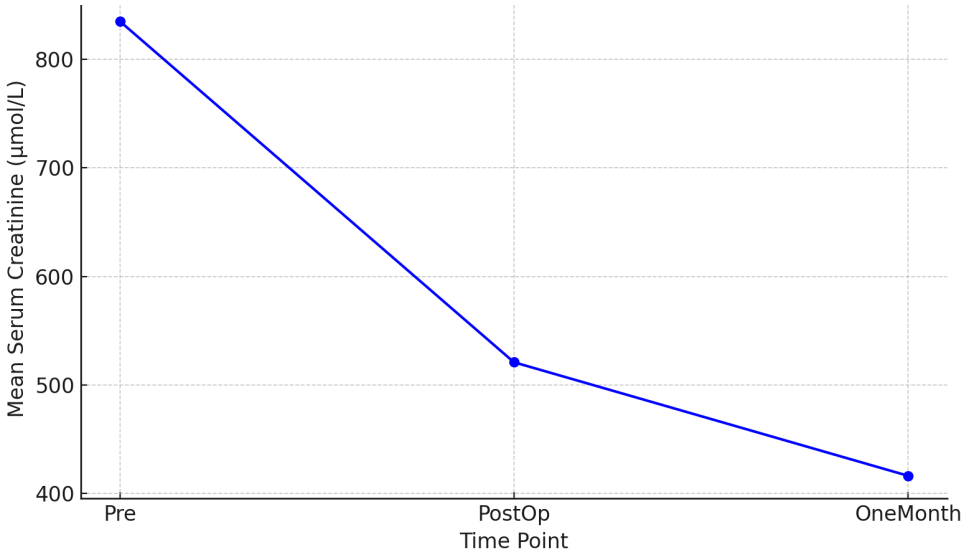

Figure 4. Pattern of changes in creatinine levels of PCN patients over time.

function, and ultimately, renal failure (11). Compared with fluoroscopy-assisted PCN, ultrasound-guided nephrostomy tube insertion is a relatively simple and cheaper interventional radiological technique (compared to endoscopic surgical procedures) with fewer complications for the timely relief of obstructive effects of hydronephrosis on the urinary tract.

In our study, the majority (58.2%) of patients who had ultrasound-guided PCN procedures were males. Though urinary tract obstructive diseases are generally commoner among males in our environment (12), which may have accounted for the predominance of males in our study. The majority patients in this study were also in their fifth, sixth, and seventh decades of life (65.4%). Previous researchers have reported that a large proportion of pelvic malignancies (urologic and gynecologic) that often cause upper urinary tract obstruction occur from the fifth decade of life on, hence the predominance of patients of this age group in our study (13,14). This is also consistent with the findings of Ahmed et al. in Zaria, Nigeria (15).

Up to 80% of the patients had bilateral tube insertion; this is based on the fact that most patients in this study presented with bilateral obstruction, and most often in renal failure. Bilateral ureteric obstruction is more commonly seen in pelvic malignancies as also reported by Ahmed et al. in Zaria15. Our findings revealed advanced cervical cancer (30.9%) and bladder cancer (29.1%) to be the commonest malignant causes of urinary tract obstructions, while obstructed ureteric stones (21.8%) were the most common benign cause of obstructive uropathy. Previous reports (13,14) have indicated the presentation of pelvic malignancies in this environment that were mostly in the advanced stages of their disease, with high risk of local invasion of contiguous structures. These findings are also consistent with the study of Efesoy et al. in Turkey (16).

Most patients in this study did not develop complications within either intra-procedure (56.4%) or post-procedure (72.7%) periods. Minor complications recorded were either related to the localized pain at the needle puncture site and tube blockage/dislodgement, potentially due

Table 3. Comparison of mean serum creatinine levels between pre- and post-procedure period.

	Means			
	Pre-procedure	Post-procedure (One week)	*t*-test	*P* value
Serum creatinine levels	834.79 ± 409.39	520.89 ± 414.45	6.175	*0.001
	Pre-procedure	Post-procedure (Four weeks)	*t*-test	*P* value
	834.79 ± 409.39	416.39 ± 438.96	5.450	*0.001

*Significant at $P \leq 0.05$

to inappropriate tube handling post procedure. The low complication rate in the majority of our patients resulted in significant patient clinical improvement and markedly reduced serum creatinine levels (80%) post intervention. However, some deaths (12.7%) were recorded despite the intervention which may be attributable to primary disease progression. These findings are comparable with findings from other studies across the globe (17-19). On the other hand, severe complications of ultrasound-guided percutaneous nephrostomy, though absent in our study of 55 patients, include collecting system damage, urine leakage, vascular injuries (pseudoaneurysm, fistula, hemorrhage), perinephric hematoma, sepsis, and catheter displacement. Strict ultrasound guidance and meticulous technique are essential for minimizing these risks (20).

The marked reduction in serum creatinine level observed from one week to four weeks post intervention signified immediate relief of the high intra-luminal pelvi-calyceal pressure with gradual recovery in renal function. These highlight the effectiveness of PCN as a viable and minimally invasive alternative to existing treatment options in the overall management of patients with obstructive uropathy. Also, PCN helps secure adequate time for proper treatment planning of the primary cause of renal obstruction. However, some limitations of our study include the modest number of patient samples and the relatively short follow-up period of one-month post procedure, which did not permit monitoring of long-term complications.

Strengths and limitations

This study offers valuable insights into the feasibility and outcomes of percutaneous nephrostomy (PCN) in low-resource settings, particularly where healthcare access and technology are limited. It addresses a critical gap in the literature by documenting PCN outcomes in Northern Nigeria, providing key information for clinicians and policymakers in managing obstructive uropathy. The study emphasizes PCN as a minimally invasive treatment option, especially for advanced pelvic malignancies, demonstrating its effectiveness in reducing complications and improving renal function. The use of serum creatinine levels as a clinical marker offers objective evidence of PCN's positive impact. Additionally, the low complication rates in this study affirm PCN's safety and efficacy, supporting its broader use in resource-limited settings. The findings also have policy implications, encouraging investment in minimally invasive urological procedures and resource allocation for better healthcare outcomes.

This study's modest sample size of 55 patients limits the generalizability of the findings to a broader population. The one-month follow-up period may not capture long-term complications such as tube dislodgement, infection, or disease progression. The absence of a control group prevents direct comparison with other interventions like ureteral stenting or surgery. Additionally, the 5.5% loss to follow-up could affect the assessment of long-term outcomes, potentially underestimating complication rates. Finally, while patient deaths were recorded, they were attributed to disease progression without investigating whether PCN or related complications played a role.

Conclusion

This study confirms that percutaneous ultrasound-guided nephrostomy (PCN) is an effective treatment for obstructive uropathy, particularly in patients with advanced pelvic malignancies. Most patients experienced clinical stability post procedure, with marked improvements in renal function as evidenced by reduced serum creatinine levels. The procedure had a low complication rate, with only minor and manageable issues, highlighting its safety and practicality in low-resource settings. The observed deaths were likely due to disease progression rather than the procedure. Therefore, PCN provides critical time for planning definitive treatment, but further research with larger samples and extended follow-up is necessary to evaluate long-term outcomes.

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Disclosure of ethical statements

- Authors have no conflicts of interest to declare.
- Approval of the research protocol by an Institutional Reviewer Board was obtained with reference number (AKTH/MAC/SUB/12A/P-3/V1/2220).
- Informed Consent was obtained from each patient/research subject.

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