Original Article

Ultrasound-guided percutaneous nephrostomy: Analysis of early complications in a prospective descriptive cross-sectional study at a tertiary care center

Bishnu Pandey, M.D.[(1)]
Shailendra Katwal, M.D.[(2)]
Sushmita Bhandari, M.B.B.S.[(3)]
Mukhtar Alam Ansari, Ph.D.[(4)]
From [(1)] Department of Radiology, TUTH, Institute of Medicine, Kathmandu, Nepal.
[(2)] Department of Radiology, Dadeldhura Subregional Hospital, Dadeldhura, Nepal.
[(3)] Shankar nagar health post, Butwol, Nepal.
[(4)] Department of Radiology, National Medical college, Birgunj, Nepal.
Address correspondence to S.K.(e-mail: shailendrakatwal@gmail.com)

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Abstract

Background: Percutaneous nephrostomy (PCN) is a crucial intervention for urinary obstruction. Understanding indications, complications, and materials used enhances its clinical application.

Objective: This study aims to identify PCN indications, assess tube types/materials, evaluate early complications, and determine PCN success rates, fostering improved outcomes and procedural refinement.

Materials and Methods: This study was carried out in the interventional radiology suite of the Department of Radiodiagnosis and Imaging, Tribhuvan University Teaching Hospital (TUTH) on 74 patients for one year. Patients of all age groups

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who underwent PCN were included in the study. Indications for PCN were identified before the procedure using various imaging modalities like Ultrasonography (USG), Computed Tomography (CT) scan, and more. The type of approach, calyx punctured, the size of the tube chosen, and the type of the drain material were all recorded during the procedure or in the post-procedure note. The patients were evaluated daily, and USG was done in every patient after 48 hours of the procedure to evaluate in terms of any complications.

Results: Ninety-eight PCNs were done on 74 patients, of whom 58 were males and 40 were females. The main reasons for PCN were calculus disease with hydronephrosis (44.9%), calculus disease with pyonephrosis (22.4%), and obstructive uropathy due to bladder or cervix carcinoma. The success rate for PCN on the first attempt was 89.8%, while 6.1% required two attempts and 4.1% needed more than two attempts. Complications included tube dislodgement (8.2%), urinoma (5.1%), major bleeding (3%), and retroperitoneal hematoma (1%). No new cases of sepsis occurred post-procedure.

Conclusion: Percutaneous nephrostomy is a safe and simple procedure with low morbidity and no life-threatening complications.

Keywords: Early complications, Obstructive uropathy, Percutaneous nephrostomy, Ultrasonography.

Introduction

Percutaneous nephrostomy (PCN) is an interventional procedure used to relieve obstruction in the urinary collecting system when natural drainage or surgical nephrostomy is not feasible. PCN was first performed in 1955 for draining hydronephrotic kidneys [1]. The advantages of percutaneous insertion under local anesthesia include quick recovery and early discharge without general anesthesia-related complications. The imaging modalities commonly used for the localization of the pelvicalyceal system are ultrasound and fluoroscopy. Sometimes CT scan may be required in case of emphysematous pyelonephritis where the visualization of the pelvicalyceal system is difficult because the air obscures its visualization. Magnetic resonance imaging (MRI) presents an appealing option for guiding percutaneous procedures, such as percutaneous nephrostomy (PCN), due to its radiation-free nature and the ability to provide high-resolution and multiplanar visualization [2,3]. PCN is crucial in patients with pyonephrosis, allowing urinary tract decompression and direct sampling of urine for culture and sensitivity to initiate appropriate antibiotic treatment. In cases of ureteral obstruction caused by stones, PCN provides immediate decompression, protects renal function, and allows elective management of the underlying cause [4,5]. Prolonged obstruction with infection can lead to progressive damage to the nephrons [6].

PCN may have a higher success rate than retrograde double J ureteral stenting in patients with malignancy, especially when there is an extrinsic compression [7]. Decompressing the renal pelvicalyceal system improves the renal function in pelvic malignancies [8].

This procedure is also valuable for evaluating the functional reserve of hydronephrotic kidneys in benign conditions and is the preferred procedure for temporary urinary tract drainage in both adults and children. It is often sufficient for healing post-surgical leaks.

Under local anesthesia, PCN is a feasible life-saving procedure for critically ill patients who cannot undergo general anesthesia due to various conditions. It

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also serves as an entry point for other interventional uro-radiological and endo-urological procedures [1].

Major contraindications to PCN include uncorrected coagulopathy and uncooperative patients. Severe hyperkalemia(>7mEq/L) can be managed with dialysis before the procedure [1].

However, complications can still occur following this seemingly simple intervention. Early complications of PCN, occurring immediately or within 48 hours, include bleeding, infection, retroperitoneal hematoma, extravasation, urinoma, and perforation of adjacent viscera. Tube dislodgement and blockage, typically considered late complications, can also occur within 24 hours.

A comprehensive assessment is required to determine the incidence of various early complications linked with diverse PCN approaches and drainage materials within the Nepalese population. There's also a lack of holistic evaluation regarding the success rate of PCN, insights into optimal procedural techniques and material selection, as well as a complete understanding of image-guided PCN.

Our study aims to investigate image-guided percutaneous nephrostomy (PCN), encompassing common indications, procedural techniques, and the incidence of early complications. Additionally, the research seeks to evaluate the overall success rate of PCN procedures. Through these objectives, a more comprehensive understanding of image-guided PCN is aimed to be achieved.

Materials and methods

Study design and target population

This descriptive prospective cross-sectional study was carried out in the interventional radiology suite of the Department of Radiodiagnosis and Imaging, Tribhuvan University Teaching Hospital (TUTH) for one year. Ethical approval was obtained from the Institutional Review Committee. Consent was taken from each participant.

The study included all patients who underwent PCN in the department, totaling 98 procedures in 74 patients. Inclusion criteria were patients of all ages and genders who underwent PCN and gave consent for the study, while those who did not give consent or attend follow-up sessions were excluded.

Methodology and data collection

Patients were informed about the purpose of the procedure, anesthesia options, potential complications, and benefits compared to other surgeries. Platelets and coagulation were checked and corrected if abnormal. Urine analysis was checked for infection. Intravenous antibiotics were initiated based on a positive urine analysis. Imaging via ultrasound or fluoroscopy localized the pelvicalyceal system. Patients were positioned and secured, and the puncture site was marked using ultrasound. Local anesthetics were used, with sedation if needed. Infants received general anesthesia.

The marked site was incised, and an 18-gauge Chiba needle punctured the selected calyx under ultrasound. Contrast and a guidewire were introduced. Serial dilators expanded the tract, using 8-10 F catheters for non-infected drainage. A contrast check ensured proper catheter placement. Sutures secured the catheter, connected to a collection bag for gravity drainage.

Data on indications, drain tube size, material drained, and intra-procedural complications were recorded from the procedure note. Common complications

included bleeding, subcapsular hematoma, sepsis, vessel and bowel injury, urinoma formation, tube dislodgement, and unsuccessful drainage. Major bleeding requiring intervention was documented, while minor bleeding and hematuria were not.

Sepsis was defined based on specific Severe Inflammatory Response Syndrome (SIRS) criteria with documented infection [9].

Vessel and bowel punctures occurred when contrast entered these structures. The procedure was considered unsuccessful if no urine was drained despite pelvicalyceal system dilatation. The success rate was determined based on the number of attempts in the study.

Definition

Technical success of percutaneous nephrostomy refers to ensuring effective urinary drainage, extracting stone or ureteral stent placement with a catheter of a suitable diameter and route. The success rate should involve the consideration of the number of kidneys treated and the number of patients undergoing treatment [10].

Minor and Major complications: Complications were classified by the guidelines set forth by the Society of Interventional Radiology (SIR) [11].

Minor complications include:

(A) cases without the need for therapy or resulting consequences,
(B) cases requiring only nominal therapy with no subsequent consequences.

Major complications include:

(C) complications necessitating therapy and resulting in brief hospitalization (<48 hours),
(D) requiring significant therapy and associated with an unplanned escalation in the level of care, extended hospitalization (>48 hours),
(E) leading to permanent adverse effects,
(F) ultimately resulting in death.

Results

The study included 74 patients who underwent a total of 98 PCNs for various indications. The age of the patients ranged from 1 month to 80 years, categorized into age groups: 0-10 years, 10-40 years, and >40 years. The highest number of patients was in the ≥40 years age group (69.4%). All the PCN cases were carried out with a pigtail catheter.

Calculus disease accounted for over 50% of the PCNs performed (44 PCN for hydronephrosis and 22 for pyonephrosis), followed by malignant etiology, ureteric stricture, PUJ stenosis, and posterior urethral valves. Most PCNs (58) were performed in the right kidney, with one case involving a grafted kidney located in the right iliac fossa.

In our study, the posterolateral approach was the most commonly used for PCN insertion (93.9%), followed by the posterior approach (5.1%). An anterior approach was used in a single case involving a grafted kidney. The interpolar region was punctured in nearly two-thirds of PCNs, while the upper pole calyx was chosen only for the grafted kidney. The majority of drained kidneys had an 8F tube, and turbid material was obtained in 60% of PCNs, with clear fluid obtained in the remaining 40%.

Complications associated with PCN are listed below:

- Tube dislodgement,
- Sepsis,
- Urinoma,
- Major bleeding,
- Retroperitoneal hematoma,
- Injury to vessels,
- Injury to viscera,
- Cardiac arrest,
- Pneumothorax.

Tube dislodgement was the most common complication. Major bleeding as a complication was seen but none required embolization or blood transfusion. Perinephric urinoma was also noted; however, none of the patients developed cardiac arrest, pneumothorax, or hydrothorax (Figure 1).

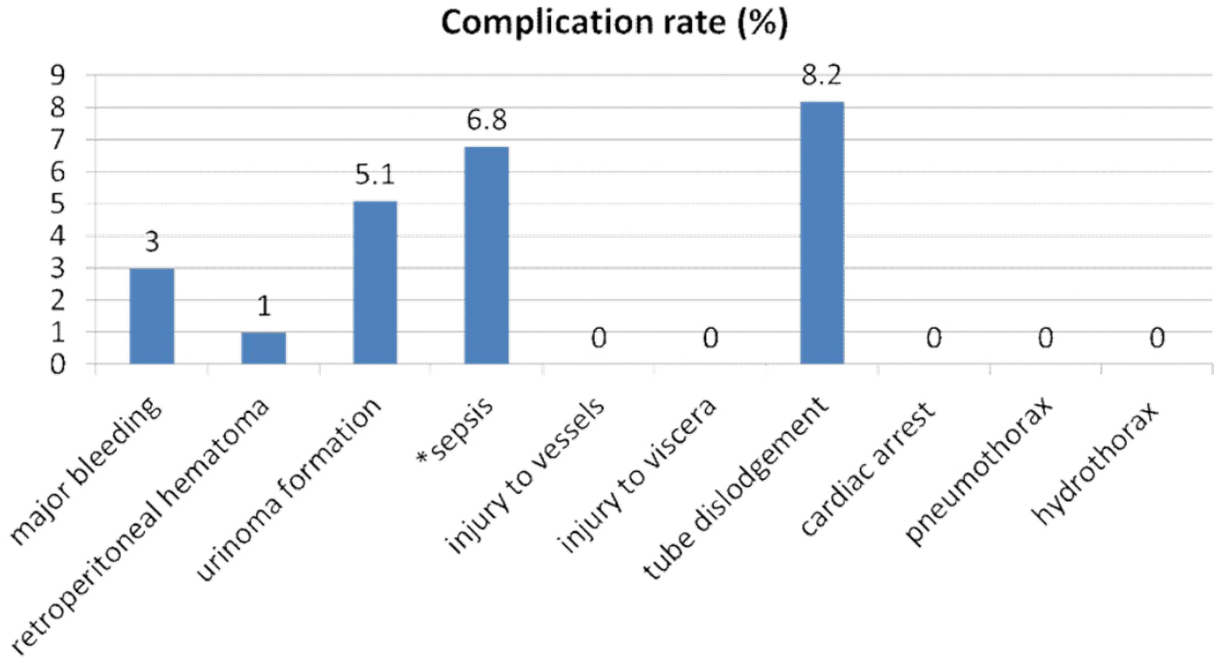

Figure 1. *Complication rate as per the number of PCN performed.*

*The number and percentage calculated in sepsis as a complication was based on the number of patients, unlike other complication rates which were calculated based on the number of PCNs done.

The success rate of PCN in our department was 100% despite the number of attempts. Nearly 90% of PCNs were successful in the first attempt, while approximately 6% of PCNs required two attempts for successful insertion of the PCN tube.

Discussion

PCN as a urinary diversion procedure is relatively safe and effective and can be performed under local anesthesia. PCN is a commonly performed procedure to preserve the renal function in any case with post-renal obstruction.

In a study (n=300) conducted by Ali et al, the commonest cause for PCN was obstructive uropathy due to stone diseases either in the kidney or in the ureter which accounted for 77.3% of patients. Malignancy was the second largest group with 13.3% of patients having carcinoma of the urinary bladder and 4.0% having carcinoma of the cervix, rectum, prostate, abdominal lymphoma, and retroperitoneal fibrosis. In 4.33% of patients, upper urinary tract obstruction was seen, of which 3.33% patients were due to ureteric stricture and 1% was due to accidental ligation of the ureter during an obstetric surgery [12]. Similar to this study, our study also showed the commonest (67.3%) indication for PCN to be obstruction due to the calculus disease. Although malignancy was also the second most common (23.5%) reason for PCN in our study, only carcinoma bladder (13.3%) and carcinoma cervix (10.2%) were seen. Other indications were PUJ stenosis (3.1%), ureteric stricture (4.1%), and posterior urethral valve (2%).

The success rate of PCN in many previous studies was found to be between 84 to 100% [13-15]. In our study, the success rate was calculated as per the number of attempts made because all the patients who had PCN attempts ultimately became successful despite the number of attempts. Therefore, the ultimate success rate came out to be 100%. However, only 89.8% of PCNs were successful in the first attempt.

In a study conducted by E. Radecka and A. Magnusson (n=401), in 569 PCN performed, the early major complications (within 2 days) were cardiac arrest (0.24%), major bleeding requiring transfusion (0.24%), hydrothorax (0.24%), and urosepsis (0.5%) [14]. In the study conducted by Ali et al (n=300), early complications comprised sepsis (2%), retroperitoneal hematoma (1.6%), hematuria (0.6%), and urinoma (0.3%). Total early complications were noted in 4.66% of patients, while late complications were noted in 7.33% of patients. The low incidence of

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complications observed in this study shows that PCN is a safe technique with low morbidity and no major life-threatening complications [12]. In a study performed by Farrel et al (n=303), major bleeding requiring transfusion was seen in 2.8% [4]. In a study conducted by Lee et al (n=160), the complications seen were sepsis (6%), hematuria requiring blood transfusion (2.4%), catheter displacement or mal-position (4.8%), pelvic perforation (4.3%), paralytic ileus (2.4%), pneumonia/atelectasis (1.8%) and pleural effusion (1.2%). The overall complication rate was 34%, of which 6% were major and 28% were minor [13]. In our study, none of the patients developed cardiac arrest. Pneumothorax or hydrothorax was not seen in our study probably because none of the native kidneys were punctured via the upper pole calyx as puncturing the upper pole calyx increases the chances of traversing the pleura compared to puncturing the interpolar region or lower pole calyx [16]. In our study, major bleeding was seen in 3% of the PCNs performed which were managed by providing a tamponade effect in the form of clamping of the catheter for 24 hours and none of them required blood transfusion or embolization of the bleeding vessel.

Tube dislodgement in our study came out to be the most common complication probably because of mishandling of the tube while flushing the tube or during tube site dressing. Besides, the higher rate of tube dislodgement could be due to the insertion of a PCN tube even in kidneys with thinned-out renal parenchyma which cannot provide an adequate anchoring effect to the tube. Moreover, PCNs were performed in kidneys with large sialolithiasis in which the PCN tube was placed in the calyx rather than in the renal pelvis preventing adequate coiling of the tube and resulting in the easy displacement of the tube. These may be the reasons for tube dislodgement to be the commonest complication. A retrospective study conducted by Bayne et al in 475 PCNL cases showed the BMI of the patient is a major determinant of tube dislodgement instead of the tube properties [17].

Perinephric urinoma formation was seen in 5.1% of PCNs performed which were all seen in difficult cases necessitating multiple punctures for successful insertion of the tube creating the tract between the pelvicalyceal system and the perinephric space resulting in urinary leakage into the perinephric space.

This study includes single-center nature, a relatively small sample size, and a short duration, which might restrict the extrapolation of findings to larger and more diverse populations. Additionally, the study's reliance on participant consent and follow-up attendance could introduce selection bias, and the exclusion of certain complications like minor bleeding, and hematuria might lead to an incomplete understanding of the overall procedure-related outcomes. Future research should encompass multi-center collaboration, larger sample sizes, longer study durations, and comprehensive complication assessment to enhance validity.

Conclusion

This study on percutaneous nephrostomy (PCN) assessed its effectiveness, complications, and success rates. Conducted over a year at a teaching hospital, the study reported a 100% success rate, with 90% achieving success on the first attempt. Major complications were infrequent, including manageable cases of tube dislodgement and perinephric urinoma formation. These findings underscore PCN's feasibility and safety for urinary obstruction management, aiding future patient care enhancements.

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References

1. Young M, Leslie SW. Percutaneous Nephrostomy. [Updated 2023 June 26]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan- [cited 2023 Aug 13]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK493205/

2. Egilmez H, Oztoprak I, Atalar M, Cetin A, Gumus C, Gultekin Y, et al. The place of computed tomography as a guidance modality in percutaneous nephrostomy: analysis of a 10-year single-center experience. Acta Radiol 2007;48:806–13. doi: 10.1080/02841850701416528.

3. Kariniemi J, Sequeiros RB, Ojala R, Tervonen O. MRI-guided percutaneous nephrostomy: a feasibility study. Eur Radiol 2009;19:1296–301. doi: 10.1007/s00330-008-1235-z.

4. Farrell TA, Hicks ME. A review of radiologically guided percutaneous nephrostomies in 303 patients. J Vasc Interv Radiol 1997;8:769–74. doi: 10.1016/s1051-0443(97)70658-4.

5. Joshi HB, Adams S, Obadeyi OO, Rao PN. Nephrostomy tube or "JJ" ureteric stent in ureteric obstruction: assessment of patient perspectives using quality-of-life survey and utility analysis. Eur Urol 2001;39:695–701. doi: 10.1159/000052529.

6. Chung SY, Stein RJ, Landsittel D, Davies BJ, Cuellar DC, Hrebinko RL, et al. 15-year experience with the management of extrinsic ureteral obstruction with indwelling ureteral stents. J Urol 2004;172:592–5. doi: 10.1097/01.ju.0000130510.28768.f5.

7. Kraemer PC, Borre M. [Relief of upper urinary tract obstruction in patients with cancer of the prostate]. Ugeskr Laeger 2009;171:873–6. Danish.

8. Aravantinos E, Anagnostou T, Karatzas AD, Papakonstantinou W, Samarinas M, Melekos MD. Percutaneous nephrostomy in patients with tumors of advanced stage: treatment dilemmas and impact on clinical course and quality of life. J Endourol 2007;21:1297–302. doi: 10.1089/end.2006.0104.

9. Comstedt P, Storgaard M, Lassen AT. The Systemic Inflammatory Response Syndrome (SIRS) in acutely hospitalised medical patients: a cohort study. Scand J Trauma Resusc Emerg Med 2009;17:67. doi: 10.1186/1757-7241-17-67.

10. Pabon-Ramos WM, Dariushnia SR, Walker TG, d'Othée BJ, Ganguli S, Midia M, et al. Quality improvement guidelines for percutaneous nephrostomy. J Vasc Interv Radiol 2016;27:410–4. doi: 10.1016/j.jvir.2015.11.045.

11. Turo R, Horsu S, Broome J, Das S, Gulur DM, Pettersson B, et al. Complications of percutaneous nephrostomy in a district general hospital. Turk J Urol 2018;44:478–83. doi: 10.5152/tud.2018.37336.

12. Ali SM, Mehmood K, Faiq SM, Ali B, Naqvi SA, Rizvi AU. Frequency of complications in image guided percutaneous nephrostomy. J Pak Med Assoc 2013;63:816–20.

13. Lee WJ, Patel U, Patel S, Pillari GP. Emergency percutaneous nephrostomy: results and complications. J Vasc Interv Radiol 1994;5:135–9. doi: 10.1016/s1051-0443(94)71470-6.

14. Radecka E, Magnusson A. Complications associated with percutaneous nephrostomies. A retrospective study. Acta Radiol 2004;45:184–8. doi: 10.1080/02841850410003671.

15. Sood G, Sood A, Jindal A, Verma DK, Dhiman DS. Ultrasound guided percutaneous nephrostomy for obstructive uropathy in benign and malignant diseases. Int Braz J Urol 2006;32:281–6. doi: 10.1590/s1677-55382006000300004.

THE ASEAN JOURNAL OF RADIOLOGY
ISSN 2672-9393

16. Dyer RB, Regan JD, Kavanagh PV, Khatod EG, Chen MY, Zagoria RJ. Percutaneous nephrostomy with extensions of the technique: step by step. Radiographics 2002;22:503–25. doi: 10.1148/radiographics.22.3.g02ma19503.

17. Bayne D, Taylor ER, Hampson L, Chi T, Stoller ML. Determinants of nephrostomy tube dislodgment after percutaneous nephrolithotomy. J Endourol 2015;29:289–92. doi: 10.1089/end.2014.0387.