Original Research Paper

Volume - 15 | Issue - 07 | July - 2025 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Medical Science

PERCUTANEOUS NEPHROSTOMY IN NON-DILATED RENAL COLLECTING SYSTEM KIDNEYS: TECHNIQUE, SUCCESS RATE, AND COMPLICATION PROFILE

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KEYWORDS :

INTRODUCTION

Percutaneous nephrostomy is the placement of a drainage catheter into the renal collecting system to drain urine in an obstructed kidney or for urinary diversion in case of urine leak (1). It is relatively straightforward in cases with dilated pelvicalyceal system; however non-dilated systems pose a technical challenge for the procedure (2). Indications for PCN placement in a non-dilated system include urine leaks from ureteral or bladder injury, vesicovaginal fistulas, or urinary diversion prior to radical cystectomy for bladder tumour (1, 3).Various methods have been described using ultrasound, fluoroscopy guidance, or both for the same in literature with variable success and complication rates (2, 4). Complications include perinephric hematoma, hematuria, sepsis, and adjacent organ injury, which are encountered more frequently than in a dilated system (5).Some of the methods described are administration of intravenous contrast prior to the procedure so as to opacify the collecting system and the renal calyces, direct puncture of the renal pelvis and administration of contrast to opacify and distend the renal pelvis prior to calyceal puncture under fluoroscopy or CT guidance, and administration of diuretics and intravenous fluids to distend the collecting system (6, 7).Initial access into the collecting system percutaneously has been performed using a micropuncture needle, which adds to the cost of the procedure (5). The aim of this study was to evaluate the feasibility and the technical outcome of percutaneous nephrostomy in a non-dilated collecting system using diuretics and intravenous fluids to distend the collecting system followed by access through an 18G puncture needle (1).

METHODS

This was a single institution retrospective study carried out in 12 patients (16 kidneys) undergoing percutaneous nephrostomy in a non-dilated collecting system using ultrasound and fluoroscopy guidance from January 2023 – January 2024 conducted to evaluate the technical success rate and complications. Overall 15 patients (20 kidneys) underwent PCN placement in a non-dilated system during this period, however, 3 patients (4 kidneys) were excluded from the study due to use of intravenous contrast media to opacify the collecting system (1 patient, 2 kidneys) and use of 21 G micropuncture set (2 patients, 2 kidneys). The institutional review board of this hospital approved the retrospective nature of this study and the subsequent need to obtain written informed consent was waived off.

Study Population

The 4 grade ultrasound grading system was used to classify the degree of hydronephrosis. Non-dilated system was defined as a renal collecting system with no calyceal dilatation on ultrasound (Grade 0-1). Mere splitting of the calyceal system was excluded from the study. All patients in the study had normal coagulograms (platelet counts > 100000/cu mm) and INR >1.5 as per our departmental protocol. No patients were under any anticoagulant or antiplatelet medications.

PCN Placement Technique

All the procedures were performed by interventional radiologists or residents in interventional training. Patients were kept in prone position and padding was kept underneath the abdomen on the intended site of the procedure. Cleaning and draping of the back was performed. Intravenous bolus dose of frusemide (20 mg irrespective of body weight) was given at the start of the procedure followed by rapid infusion of normal saline until the procedure was completed. The kidneys were continuously visualized with ultrasound till the dilatation of the PCS occurred. Local anaesthetic (2% lignocaine) was injected and access was taken to either the lower or middle pole calyx in the posterolateral bloodless plane of Brodel using a 18 G Vygon needle under ultrasound access(Fig 1). Colour doppler was used to avoid transgression of major vessels and subsequent vascular injury. Once the clear return of urine from the puncture needle was obtained, 3-5 ml of diluted iodinated contrast (urograffin) was injected to opacify the PCS under fluoroscopy guidance. Fluoroscopy was used only after puncture of the renal calyx to minimize the radiation dose to the patient. Then a 0.035" 80 cm long straight tip amplatz wire was inserted and maneuvered into the proximal ureter. In case of difficulty, a cut-short picard 5F angiographic catheter was used to maneuvre the wire into the ureter. This was followed by a series of dilatation using 6/7/8F fascial dilators and finally a 8F pigtail tube was inserted. With adequate distention of the pelvicalyceal system, the pigtail loop was formed whereas it was left straight in the proximal ureter in cases with inadequate pelvi-calyceal distention. The catheter was sutured to the skin, connected to a collection bag and sterile dressing applied. Patients were shifted back to the parent units post procedure for observation.

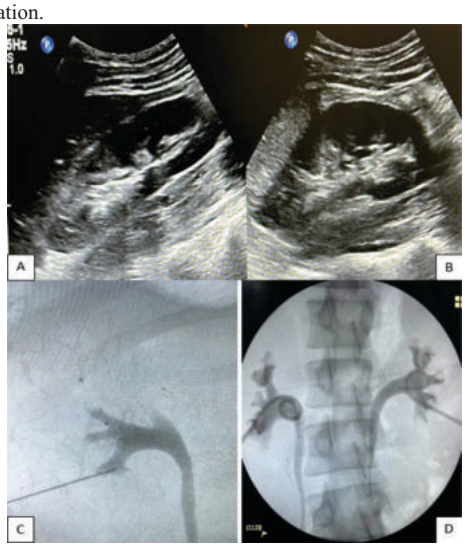

Fig 1A- USG images showing undilated PCS , B- Mild splitting of

PCS after Furosemide and NS infusion, C – Nephrogram after puncturing lower calyx D- Final Nephrogram after PCN placement

Data Collection

Data on the technical success rate, complications, time required to attain pcs distention after administration of diuretic and IV fluids were recorded for each patient. In case of bilateral pcn, data regarding each kidney was recorded separately as two individual procedures. Successful procedure was defined as the placement of the pigtail catheter into the pelvicalyceal system or the proximal ureter and opacification of the collecting system on antegrade urography. Time required for pcs distention was calculated from the start of frusemide injection upto attainment of splitting of the calyceal system. The complications if any were graded according to the SIR guidelines.

RESULTS

Overall 16 PCN placements were performed in 12 patients. Among them 4 (33.3%) were males and 8 (66.7%) were female patients. The average age of the patient population was 53.8 years. The most common indication for performing the procedure was post hysterectomy ureteral injury. 4 patients underwent bilateral whereas 8 patients underwent unilateral PCN catheter placement. 20 mg of furosemide was the diuretic used in each patient and the average volume of IV fluid (0.9% normal saline) used was 285.8 ml. The technical success rate of the procedure was 100%. 14 procedures were successful in a single attempt while 2 procedures required two attempts at puncture. Only two of the patients (1 kidney each) had a blood-tinged urinary output which settled on its own. This was unrelated to the number of attempts at puncture. No instance of major vascular injury, hematoma or persistent hematuria occurred. Adequate PCS distention occurred in all patients and the average time to adequate calyceal distention was 241.5 s. There was no instance of urinary or surgical site infection related to the procedure. One patient came back with accidental slippage of catheter at 2 weeks in whom a new pigtail catheter was inserted via the same tract under fluoroscopy guidance. Patients were followed up monthly for catheter exchange until definitive treatment of the underlying ailment was performed.

DISCUSSION

Percutaneous nephrostomy is indicated for relieving the urinary obstruction due to stone disease, tumour, or strictures, urinary diversion for urine leak in conditions such as vesicovaginal fistula, iatrogenic or penetrating trauma, hemorrhagic cystitis, or for access for various diagnostic and therapeutic urological procedures (8, 9). Although the procedure can be easily accomplished in a kidney with dilated pelvicalyceal system, indications in an undilated sytem poses a technical challenge in accurate localization and puncture of the pelvicalyceal system with increased risks of vascular injury and procedure failure (10). Success rates of calyceal puncture in an undilated system of only 85% has been described in literature (11). Multiple needle punctures through the renal parenchyma, catheter and guidewire manipulations in a minimally dilated or non-dilated system and the long procedure times due to technical complexity lead to increased risks of complications like vascular injury (retroperitoneal hemorrhage and hematuria) and infections (urosepsis and surgical site infection) (11, 12).

One of the techniques described in literature for the localization of renal calyx under fluoroscopy or CT guidance is the intravenous administration of iodinated contrast agent prior to the procedure (6). However, this leads to increased procedure time, risks of renal injury due to contrast agent in an already compromised kidney and increased radiation dose to the patient and the operator (13). In contrast, use of diuretic and IV fluids to distend the pelvicalyceal system and percutaneous puncture under ultrasound guidance as in our series avoid these shortcomings (14).

Others have described a method of double puncture whereby the renal pelvis is first punctured directly as a blind method followed by injection of diluted contrast agent to subsequently distend it. The calyx is then punctured under fluoroscopy guidance (15). However, this adds to the complexity of the procedure with obvious increased risks of injuring the renal vessels in the renal sinus. We used a single puncture technique under ultrasound guidance after obtaining calyceal dilatation with use of diuretics and fluids which reduces the chances of vascular injury (14).

Some studies have described the use of a micropuncture needle for initial access to the minimally dilated system (5). In contrast to this, we have used a 18 G Vygon needle for initial access under ultrasound guidance with 100% technical success without any complications in our series. We found better needle tip visualization with 18 G needle on ultrasound guidance. Also avoidance of the micro-puncture set significantly reduced the cost of the procedure. Performing the initial access under ultrasound guidance with use of fluoroscopy only for wire and catheter manipulation led to decreased radiation dose to the patients and the operators (16).

Other studies have also described the use of diuretic (furosemide) in IV fluid infusion with calyceal dilatation obtained at an average of 15 minutes (17). In contrast, we found that calyceal dilatation occurred more rapidly with administration of frusemide as a bolus dose followed by rapid infusion of IV fluid (average time to calyceal dilatation of approximately 4 minutes). This effectively reduced the overall procedure time. Also adequate calyceal dilatation was attained with a minimum dose of 20 mg of frusemide in all patients irrespective of body weight in our study (vs 40 mg used in other series) to decrease the risk of hypotension and ototoxicity (18).

In this study, the patients were placed in a prone position with a padding underneath the abdomen. This rendered the kidney more superficial and the distance between the probe and the calyces decreased and lesser movement of kidneys with diaphragmatic excursions with respiration (19). The Brödel's bloodless plane was also better defined avoiding the vascular injury. Also the prone position easily avoids the risks of colonic transgression that can sometimes happen when the procedure is performed in a lateral or supine approach (20).

Furosemide is a potent loop diuretic which acts on the proximal and distal tubules as well as the loop of Henle of renal collecting system. It increases the excretion of sodium and water by inhibiting their reabsorption (21). The adverse effects described with frusemide use include fluid depletion and hypotension, ototoxicity, electrolyte disturbances, renal toxicity, and hypersensitivity reactions (21). None of our patients were hypotensive and using a minimum dose along with IV fluid administration helped avoid these complications in our patients.

Limitations

The first limitation of this study is the limited sample size. A larger sample size is likely necessary to establish or refute the success and complication rate of the procedure. Another limitation is that the protocol cannot be applied in patients with hypotension or renal impairment due to added risks with use of IV frusemide. Also this protocol cannot be applied in patients who have recently undergone abdominal surgery or those that are in respiratory distress who cannot lie down prone for the procedure.

Conclusion

This study advocates the use of sonography guided calyceal puncture for percutaneous nesphrostomy tube placement in an undilated pelvicalyceal system using an 18G puncture needle after causing calyceal dilatation using a minimum dose of a diuretic and intravenous fluids as a feasible and effective method significantly reducing the cost, procedure time and radiation dose with a very low rate of complications and a high technical success.

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