

Single Centre Review of Radiologically-guided Percutaneous Nephrostomies: A Report of 273 Procedures

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Abstract

Introduction: To evaluate the technical success and complications associated with radiologically-guided percutaneous nephrostomies (PCNs) in a single centre. **Materials and Methods:** A total of 273 PCNs performed in 190 patients in our hospital over a 3-year period from January 1997 to December 1999 were retrospectively reviewed. The study population consisted of 97 males and 93 females, ranging in age from 13 to 91 years. The main indications were urinary obstruction (77.7%), pyonephrosis (18.3%) and urinary diversion (4%). Demographic variables, technical and risk factors related to the procedure, complications, effect on urine cultures and body temperature; and subsequent patient management were examined. **Results:** The technical success rate was 99%. The 30-day mortality was 7.2%, none of which were procedure related. Haemorrhage requiring transfusion occurred in 4.3% while septicaemia affected 3.2% of patients. Drainage catheter complications included catheter dislodgement and blockage which were 11.9% and 4.1%, respectively. Thirty-one per cent of PCNs subsequently underwent ureteric stenting as the definitive treatment modality. **Conclusion:** Radiologically-guided PCN is a safe procedure with a high technical success rate.

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Key words: Catheter dislodgement, Haemorrhage, Septicaemia, Urinary obstruction

Introduction

Percutaneous nephrostomy (PCN) is a well-established technique in the armamentarium of an interventional radiologist when dealing with urinary obstruction. It provides temporary relief in obstructive uropathy and stabilises the patients for subsequent definitive treatment. It has also been utilised on a permanent basis for palliation particularly in malignant obstruction.

The aim of this study was to evaluate the technical success and complications associated with radiologically-guided PCNs in a single centre.

Materials and Methods

A total of 273 PCNs attempted in 190 patients in our hospital over a 3-year period from January 1997 to December 1999 were retrospectively reviewed.

All PCNs were performed by or supervised by a staff interventional radiologist. The main indications for PCN

were urinary obstruction, pyonephrosis and urinary diversion. PCNs performed specifically for subsequent percutaneous nephrolithotomy were excluded. Prophylactic antibiotics were not routinely administered. Those that were on antibiotics were administered based on clinical suspicion of infection or pyonephrosis by the referring doctor.

The coagulation profile was routinely obtained in all patients prior to the procedure. An abnormal prothrombin time or an abnormal partial thromboplastin time was corrected by fresh frozen plasma and/or platelets. Local anaesthetic in the form of lignocaine 1% was administered prior to the puncture in all cases but pre-medication and sedation were not routine.

The patient was placed in a prone position and percutaneous puncture performed under fluoroscopic or ultrasound guidance. When only fluoroscopy was utilised, an antegrade pyelogram was first obtained with a 22G

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Chiba needle placed via the posterior approach. This was followed by a second puncture of a suitable calyx using a 19G sheathed needle (Webb, Cook, Queensland, Australia). When ultrasound was utilised, direct puncture of a lower pole postero-lateral calyx was performed with a 19G or 21G needle. The first few millilitres of urine aspirated from the collecting system were sent for microbiology/culture and sensitivity.

The subsequent steps for both methods were similar. A 0.035" teflon J guidewire (Guidewire PTFE coated, Angiomed/Bard, Karlsruhe, Germany) or a 0.018" platinum tip guidewire (Cope mandril guide, Cook, Bloomington, IN, USA) was inserted under fluoroscopic guidance and the puncture channel was serially widened with dilators up to one French size larger than the drainage catheter. Eventually, a self-retaining nephrostomy catheter (8.5F or 10.2F Cope loop nephrostomy, Cook, Queensland, Australia) was then guided over the wire into the renal pelvis and secured by tightening the loop. In some situations, the obstructing ureteric lesion was crossed and an 8F multiple side hole drainage catheter (Soft drain pigtail, Angiomed/Bard, Karlsruhe, Germany) was positioned with the tip within the bladder for internal and external drainage. This catheter did not have a self-retaining loop mechanism and was secured by silk sutures to the skin. The nephrostomy catheter was then connected to a urine bag for free gravity drainage within a closed system after covering the puncture site with a sterile gauze. The patients were closely monitored for a day following the procedure.

Demographic variables, technical and risk factors related to the procedure, complications, effect on urine cultures and body temperature, and subsequent patient management were reviewed by analysing the case records.

Most events were calculated on the basis of the number of procedures performed as a number of patients had repeated nephrostomies. Mortality and morbidity figures were obtained with the number of patients as the denominator.

Risk factors were analysed using the Pearson chi-square test, the Fisher's exact test and the Mann-Whitney U test where appropriate. Haemorrhage requiring blood transfusion was correlated with the pre-procedural prothrombin time, partial thromboplastin time, platelet count, puncture needle size, tube size, the number of nephrostomies placed and the absence of hydronephrosis. Septicaemia was analysed with respect to the presence of urinary calculi, obstruction, diabetes, prior antibiotic administration and indication.

Results

The study population consisted of 97 males and 93 females, with an age range of 13 to 91 years (mean

57.3 years). Sixty of these patients underwent more than one PCN.

The duration of nephrostomy drainage ranged from 2 to 115 days (mean 14.2 days). One hundred and nineteen (43.6%) PCNs were performed on the right and 101 (37%) were done on the left. Twenty-four (17.6%) procedures involved bilateral punctures and a total of 5 (1.8%) punctures were performed on transplant kidneys.

Five PCNs were performed on 4 renal transplant patients with all the transplant kidneys located in the right iliac fossa.

Two hundred and twelve PCNs (77.7%) were performed for urinary obstruction. Fifty procedures (18.3%) were performed for suspected pyonephrosis and the remaining 4% were for urinary diversion.

One hundred and fifty-two procedures (55.7%) were performed on patients with malignancy; of which, the top 3 cancers were of the bladder (14.7%), cervix (11%) and recto-sigmoid colon (10.6%). Forty-three procedures (15.8%) were done on patients with a history of urinary stone disease. A total of 62 procedures (22%) were performed on patients with diabetes; in whom 25 (9.2%) had a history of cancer and 16 (5.9%) had a history of stone disease.

Fluoroscopy was used as the mode of puncture guidance in 135 procedures (49.5%) and ultrasound guidance was employed in 138 procedures (50.5%). There was an observed tendency to use ultrasound for milder degrees of hydronephrosis with 84% of procedures with mild hydronephrosis utilising ultrasound guidance. This was found to be statistically significant by the Mann-Whitney U test ($P = 0.001$).

In the data available, an upper pole calyx was punctured in 12 procedures (4.4%) with the mid pole and lower poles being the more popular sites of access during PCN. No pneumothorax was encountered, but a single case had subsequent computed tomographic (CT) evidence of the catheter encroaching into the liver and a repeat nephrostomy was performed. There was no significant clinical sequelae in this patient.

The technical success rate was 99%. All 4 cases of failed PCNs were in non-dilated systems; ultrasound guidance was utilised in 1 and the rest had fluoroscopic guidance.

Eighteen patients died within 30 days of nephrostomy placement, giving a 30-day mortality of 7.2%. However, none of these were procedure related. Eleven patients had an underlying malignancy, 3 had pre-existing fulminant sepsis, 3 had both malignancy and sepsis, and the remaining patient had a cerebral infarct and underlying malignancy. The most common indication for PCN in these patients was obstructive uropathy (15 patients). The mean age for this

group of patients was 67.6 years which was significantly higher ($P = 0.003$ independent-samples t -test) than the mean age of 56.8 years for the rest of the study population.

Haemorrhage requiring blood transfusion occurred in 8 patients (4.3%), all of whom had either normal coagulation profile (3 patients) or prior correction of coagulopathy (5 patients). Coagulopathy denoted in this study as an abnormal value in the prothrombin time, partial thromboplastin time or platelet count was present in 57 (21.2%) of the procedures. Utilising the Pearson chi-square test, an abnormal coagulation profile was statistically significant in predicting haemorrhage requiring blood transfusion ($P = 0.001$). The degree of hydronephrosis, repeated nephrostomies, puncture needle or drainage catheter size were not predictive of risk for haemorrhage requiring blood transfusion.

The overall incidence of post-procedural septicaemia in this study was 3.2% ($n = 6$) of patients or 2.2% of procedures. Three of these nephrostomies were performed for pyonephrosis, 2 for urinary obstruction while the remaining procedure was for urinary diversion. Only 1 of the patients had diabetes and calculous disease and these were therefore not predictive of this complication. No temperature change occurred following PCN in all 6 patients. Only 1 of the 6 had received antibiotics before the procedure. Intravenous antibiotics were administered before the commencement of PCN in 37.2% of procedures with ceftriaxone (Rocephine®) being the most frequent choice (82%). The incidence of septicaemia (3%) occurring in the group not on antibiotics was higher than those on antibiotics (1%) but using the Fisher's exact test, this was not statistically significant.

The 8.5F self-retaining Cope loop catheter was the preferred drainage catheter (73%) followed by the multiple sidehole catheter (24.7%).

Catheter dislodgement following nephrostomy occurred in 32 procedures (11.9%) whereas catheter blockage

requiring change of tube occurred in 11 (4.1%). Twenty-nine out of the 32 dislodgements were with the Cope loop catheter (91.6%) while the remaining 3 were with multiple sidehole catheters. The 11 instances of tube blockage occurred in six 8.5F Cope loops and 5 multiple sidehole catheters. Using the Fisher's exact test, the type of catheter used was not a significant factor in either dislodgement or blockage.

Recurrent dislodgement was a feature in 6 patients; in which 2 involved dislodgements of different types of catheter. Using the Mann-Whitney U test, there were significantly more tube complications in repeated nephrostomies ($P < 0.0005$).

Thirty per cent ($n = 82$) of procedures did not go on to other definitive forms of treatment. Thirty-one per cent ($n = 83$) subsequently had ureteric stenting as the definitive treatment modality. Ten per cent ($n = 26$) underwent percutaneous nephrolithotomy, 3.7% had ureteroscopy/laser lithotripsy while 7.4% went for extracorporeal shockwave lithotripsy. Surgery was the subsequent treatment in 10.7% of procedures while other treatment modalities constituted 7.5%.

Although the majority (77.7%) displayed no change in the pre- and post-procedural body temperature, in the subgroup of procedures performed for pyonephrosis, there was a significant fall in body temperature following nephrostomy ($P < 0.0005$). There was significant correlation between aspiration of pus and clinical assessment of pyonephrosis ($P < 0.0005$) as well as the ensuing fall in temperature ($P = 0.005$).

Discussion

The reported incidence of success and complications following PCN varies with the institution of practice, technique and type of catheter used (Table I). This study supports earlier evidence that PCN is a safe procedure with

TABLE I: SUMMARISED RESULTS OF SUCCESS AND COMPLICATIONS FOLLOWING PERCUTANEOUS NEPHROSTOMIES (PCNs) (modified from Farrell and Hicks⁷)

Author	PCN Nos.	Imaging guidance	Technical success (%)	Haemorrhage transfusion* (%)	Tube dislodge (%)	Catheter type**
Stables ¹	33	US or FL	91	0	9	A or B
Claes et al ²	89	US	100	0	10	P
Vehmas et al ³	264	US or FL	91	NA	NA	All Types
Nielsen and Grossman ⁴	128	US	90	0	18	P
Kehinde et al ⁵	127	US	100	NA	18	P
Mahaffey et al ⁶	100	US	100	2	11	C, M or B
Farrell and Hicks ⁷	454	US or FL	99	3.3	0.9	C
Present study	273	US or FL	99	4.3	11.9	C, P or S

* Transfusion rate expressed as per patient

** A: angiographic; B: balloon; C: Cope self-retaining pigtail; M: malecot; P: pigtail with no retention mechanism specified; S: straight FL: fluoroscopy; US: ultrasound

TABLE II: COMPLICATIONS FOLLOWING 273 PERCUTANEOUS NEPHROSTOMIES

Complications	No of procedures	% of procedures	% of patients
Patient			
Haemorrhage requiring blood transfusion	8	3.3	4.3
Septicaemia	6	2.2	3.2
Catheter			
Dislodgement	32	11.9	16.7
Blockage	11	4.1	5.9
Total		21.5	30.1

a high technical success and a low overall patient complication rate of 5.5% (Table II). This was despite the higher average age and poor condition, specifically underlying malignancy, of the subjects in the study population compared to other studies.

Ultrasound and fluoroscopy were almost equally employed to access the collecting system in this study. Both imaging modalities are complimentary tools and there was a tendency to use ultrasound for lesser degrees of hydronephrosis. Ultrasound provided the opportunity to utilise the “single-stick” method of gaining access to the renal pelvis as well as prevented injury to adjacent organs.

The single case of liver puncture fortunately did not lead to untoward complications for the patient. In fact, nephrostomy drainage was satisfactory and it was only picked up on a subsequent CT scan where it was noticed that the nephrostomy catheter was encroaching into segment 6 of the liver. Only fluoroscopy was utilised in image guidance for this patient and the use of ultrasound guidance could have prevented this complication. The risk of liver injury during PCN has never been reported although it has been quantified as minimal from a 11th to 12th posterior intercostal approach in full expiration. It is less likely to occur compared to puncturing the lung (29% on the right and 14% on the left) although the risk of liver injury is increased for more lateral catheter placements.⁸

No cases of pneumothorax were encountered in this series although the incidence of thoracic complications reported in the literature ranges from 0.15% to 12%.^{9,10}

The incidence of 4.3% for post-procedural haemorrhage requiring blood transfusion is comparable with earlier studies, especially when one takes into account the proportion of procedures (21.2%) performed on patients with abnormal coagulation profiles.

Sepsis following PCN has been reported to be as high as 20% (in a series of 20 patients) in the absence of prophylactic antibiotics² while studies in which prophylactic antibiotics were routinely administered quote a figure between 0.9%

and 3%.^{7,11} Larsen et al¹² recommended antibiotic prophylaxis for PCN as they considered it as having the same rate of infectious complications as transurethral surgery. Furthermore, there is a high incidence of infected urine in patients with upper urinary tract obstruction.

Although prophylactic antibiotics were not administered as a routine in this study, there was no significant overall increase in incidence of sepsis compared to other similar studies. However, the higher incidence of sepsis occurring in the group without antibiotic prophylaxis (3%) when compared to those on antibiotics (1%) suggests that prophylactic antibiotics may have a role to play in reducing the incidence of infective complications following PCN.

Ceftriaxone was the commonest antibiotic (82%) prescribed by the clinician in-charge when infection was strongly suspected. Larsen et al¹² believed that the long-acting third generation cephalosporins come closest to the ideal spectrum of activity and are recommended as drugs of choice for urological prophylaxis. One perioperative dose or a 24-hour regimen of cephalosporin or penicillin appears to be just as effective as extended (3 to 4 day) therapy.¹²

The notion that repeated PCNs performed on the same patient result in more complications was true for catheter-related problems but not for haemorrhage or sepsis.

As stated at the outset, PCNs performed specifically for nephrolithotomy which in any case were not performed in the radiology department were excluded, as these required larger calibre tracts. Previous studies have shown that haemorrhage and septicaemia occurred more often in such procedures.

Among the complications affecting tube function, catheter dislodgement has been noted to be more common. Mahaffey et al⁶ attributed this to the type of catheter inserted, with the single J pigtail nephrostomy catheter identified as one of the problematic catheters due to its pliable nature and absence of an intra-renal retention mechanism. The Cope loop used popularly in this study offers two points of fixation but only the self-retention loop was deployed with no additional suturing to the skin. Other postulated causes of tube slippage include patient movement which distracts the kidney from the skin and patient obesity, in whom the motion of the fascia within a thick abdominal wall may dislodge the tube.⁶

The overall tube complication rate from dislodgement and blockage was 16%. This was largely due to the relatively high tube dislodgement rate in 11.9% of procedures but this figure actually compares favourably with similar published studies where an assortment of nephrostomy catheter types were used (Table I). Farrell and Hicks's study,⁷ which

solely employed the self-retaining pigtail catheter in all patients and suturing the catheter to the skin, routinely reported an enviable dislodgement rate of 0.9%. Since the majority of the PCNs performed in this study utilised the self-retaining Cope loop as the drainage catheter, one can surmise that the practice of not securing the nephrostomy catheter to the skin with sutures presumably led to it slipping out of the renal pelvis accidentally when the patient moved and was not careful. The benefit of patient comfort from not having skin suturing has to be weighed against the disadvantage of tube slippages which may eventually require repunctures. An option to explore is the use of a stoma fixation ring applied to the skin to which the catheter can be sutured and secured. This, however, will add additional cost to the procedure as well as dressing changes and nephrostomy tube inspection. We now suture all our nephrostomy catheters to the skin to prevent dislodgement.

Tube occlusion, on the other hand, has been attributed to the physical properties and character of the draining fluid rather than the type and calibre of the catheter.⁶ This is not as significant a problem as tube dislodgement in this study.

Conclusion

Radiologically-guided PCN is a safe procedure with a high technical success rate. A pre-procedural abnormal coagulation profile based on our guidelines was predictive of haemorrhage requiring blood transfusion. Prophylactic cover with the appropriate blood product is advised for such patients. There was a relatively high catheter dislodgement rate in our series despite the use of a self-retaining catheter and we feel that routine suturing

of the catheter to the skin is necessary to minimise this problem.

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