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Outcome of Percutaneous Nephrostomy for the Management of Pyonephrosis

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OBJECTIVE: The aim of this study was to evaluate the efficacy of percutaneous nephrostomy (PCN) drainage for the interim management of pyonephrosis.

METHODS: Ninety-two consecutive patients (29 men, 63 women; mean age, 57 years; range, 23–88) who underwent PCN for the treatment of pyonephrosis from 1996 to 1999 were evaluated retrospectively. The clinical presentation, bacteriology and patient outcomes were analyzed.

RESULTS: The majority (77%) of patients had underlying obstructing urinary calculi. Other causes of obstruction included strictures (9%), papillary necrosis (7%), pelvi-ureteric junction obstruction (4%) and malignant stricture (3%). The microorganisms cultured were *Escherichia coli* (30%), *Klebsiella* (19%), *Proteus* (8%), *Pseudomonas* (5%), *Enterococcus* (5%), and *Candida* spp (5%). The microorganisms were sensitive to gentamicin (79%), ceftriaxone (71%), cephalexin (54%), nitrofurantoin (40%), cotrimoxazole (35%), nalidixic acid (32%) and ampicillin (29%). Only 30% of bladder urine cultures were positive for microorganisms; the addition of PCN cultures improved this yield to 58%. The antibiotic regimen was revised according to the PCN culture whenever there was a discrepancy. After PCN, 69% of patients underwent minimally invasive procedures as definitive treatment of the obstructing lesion. Only 14% of patients required open surgery. There was low procedure-related morbidity (14%) and low overall mortality (2%).

CONCLUSIONS: PCN cultures yield important bacteriological information. The procedure is associated with minimal morbidity, facilitates definitive treatment and provides therapeutic benefit. (*Asian J Surg* 2002;25(3):215–9)

Introduction

Pyonephrosis is a potentially fatal condition in which infection occurs in an obstructed collecting system, resulting in gross accumulation of pus. The resulting septicaemia and possible septicaemic shock can be life threatening, especially in patients with underlying pre-morbid medical conditions. Although potent intravenous antibiotics are effective in some cases, urgent de-compression of the collecting system often is required upon failure of medical treatment. Percutaneous nephrostomy (PCN) for drainage of pyonephrosis was first described in 1976[1] and has since gained wide acceptance. In light of the availability of modern broad-spectrum antibiotics and improved diagnostic imaging, the role of PCN is revisited. The purpose of this study was to evaluate the efficacy of PCN for the management of pyonephrosis, and to study the causative microorganisms and the use of PCN cultures in the selection of antibiotic therapy.

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Materials and Methods

From January 1996 to December 1999, the records of 92 consecutive patients (29 men and 63 women; mean age, 57 years; range, 23–88 years) who underwent PCN for the treatment of pyonephrosis were reviewed retrospectively. Pyonephrosis was defined by the following clinical criteria: 1) systemic symptoms and signs suggestive

of upper urinary tract infection, supported by abnormal laboratory findings including pyuria, 2) elevated white blood cell count, 3) elevated serum creatinine, 4) radiological findings of hydronephrosis on ultrasonography or computed tomography and 5) the confirmatory finding of turbid urine or pus on the initial percutaneous aspirate. Only patients with positive aspirate were deemed to have pyonephrosis. Certain ultrasonographic criteria for distinguishing pyonephrosis from simple hydronephrosis, such as persistent dependent echoes and shifting urine-debris level were useful adjuncts to the clinical diagnosis. Patients who underwent percutaneous drainage for renal or perinephric abscess were excluded from this study. PCN for the relief of obstructive uropathy from malignant conditions was excluded from our study if there was no evidence of pyonephrosis.

The indication for PCN was failure of sepsis resolution despite adequate medical treatment. The decision and exact timing for PCN was based on the individual physician's judgement. In general, persistent fever, loin pain, vomiting or lethargy, and failure to show improvement of condition within 24–48 hours after admission were taken as failed medical treatment. Patients with haemodynamic disturbances and those with multiple medical co-morbidities were offered intervention early.

PCN was performed under fluoroscopic or ultrasound guidance according to the preference and experience of the interventional radiologist. There was a tendency to utilize ultrasound in minimally-dilated pelvi-calyceal systems. Bedside ultrasound-guided puncture was also utilized for occasional patients who were severely toxic and staying in the intensive care unit. The puncture technique involved the use of a 19G sheathed needle or 22G Chiba needle for initial puncture and for aspiration of pus for culture. Subsequently, a self-retaining Cope loop nephrostomy catheter (Cook, Queensland, Australia) was inserted for drainage. After the initial PCN, an antegrade nephrostogram was performed between 48 and 72 hours to delineate the exact nature of the obstruction and configuration of the urinary tract.

All medical records were reviewed for aetiology, clinical presentation, laboratory and microbiological culture reports, definitive treatment, complications and patient outcome.

Results

The most common pre-existing medical conditions were diabetes (83%), hypertension (37%), history of previous urinary calculi (26%), ischaemic heart disease (9%) and history of hydronephrosis (7%). The presenting symptoms were fever (89%), abdominal or loin pain (77%), vomiting (23%), dysuria (14%) and haematuria (2%). Septicaemic shock was present in 11% of patients, acute renal failure in 2% and pulmonary oedema in 1% at first presentation.

Analysis of basic investigations showed that 47% of the patients had a total white cell count of ≥ 15,000 /ml. Fifty-five percent of patients had an increased serum creatinine of ≥ 141 mmol/L. Eighty-eight percent of patients had greater than five white blood cells per high-power field on urinalysis.

The commonly employed diagnostic imaging modalities were ultrasonography (75%), computed tomography (25%), intravenous urography (9%), and retrograde pyelography (2%).

Ureteric obstruction was caused by urinary calculi in 77% of patients. Less common causes were benign stricture (9%), papillary necrosis (7%), pelvi-ureteric junction obstruction (4%) and malignant stricture (3%).

Analysis of cultures from PCN, bladder urine and blood showed that 65 patients (70%) had positive cultures from at least one specimen, and seven patients (8%) had more than one organism isolated. Overall, the most common microorganisms isolated were *E. coli* (30%), *Klebsiella* (19%), *Proteus* (8%), *Pseudomonas* (5%), *Enterococcus* (5%) and *Candida* supp(5%) (Table 1).

The common antibiotics to which the microorganisms were sensitive included gentamicin (79%), ceftriaxone (71%), cephalexin (54%), nitrofurantoin (40%), cotrimoxazole (35%), nalidixic acid (32%) and ampicillin (29%) (Table 2). Sensitivity to ciprofloxacin was not routinely tested. For bladder urine alone, 30% of cultures were positive for microorganisms. Diagnostic yield was improved by factoring in the results of PCN cultures and blood cultures (Table 3). For patients who had both bladder urine and PCN cultures, 58% had either culture positive. For patients who had bladder urine, blood and PCN cultures performed, the positive rate was 71%.

The results of bladder urine and blood culture did not necessarily correlate with PCN cultures. In patients who had both bladder urine and PCN urine aspirate sent for bacteriology, the cultures were identical in only 27%. In 51% of cases, bladder urine culture was negative, while PCN aspirate culture was positive. Likewise, in patients who had both blood and PCN cultures, the cultures

Table 1. Organisms grown from percutaneous nephrostomy (PCN) aspirate, bladder urine, blood cultures and overall culture positive rate from any one of the specimens

	PCN (%)	Bladder urine (%)	Blood (%)	Overall (%)
Number of cultures	73	83	86	92
Number of positive cultures*	37 (51)	25 (30)	37 (43)	65 (70)
Escherichia coli	16 (21)	9 (11)	17 (20)	28 (30)
Klebsiella spp	7 (10)	2 (2)	6 (7)	12 (19)
Proteus spp	3 (4)	1 (1)	6 (7)	9 (8)
Pseudomonas spp	5 (7)	1 (1)	–	5 (5)
Enterococcus spp	4 (6)	1 (1)	–	5 (5)
Candida spp	3 (4)	5 (6)	2 (2)	5 (5)
Staphylococcus spp	1 (1)	1 (1)	2 (2)	3 (3)
Citrobacter spp	2 (3)	2 (2)	1 (1)	2 (2)
Gram negative bacillus	1 (1)	1 (1)	1 (1)	2 (2)
Acinetobacter spp	–	1 (1)	1 (1)	2 (2)
Group D *Streptococcus*	1 (1)	1 (1)	1 (1)	1 (1)
Group B *Streptococcus*	–	1 (1)	–	1 (1)
Enterobacter spp	–	1 (1)	–	1 (1)
Bacillus spp	–	–	1 (1)	1 (1)

*Patients with multiple organisms counted as one event.

were identical in only 24%. In 46% of cases, blood cultures were negative, while PCN cultures were positive (Table 4).

Based on the culture results, the empirical broad-spectrum antibiotic regime was modified. The antibiotics used for definitive treatment were ceftriaxone (70%), gentamicin (14%) and ciprofloxacin (12%).

Sixty-nine percent of patients had minimally invasive procedures performed as definitive treatment after PCN. These procedures included extracorporeal shockwave lithotripsy (24%), percutaneous nephrolithotripsy (15%), ureteric stenting (12%), ureteroscopic lithotripsy (10%), endopyelotomy (1%) and combined procedures (7%). Open surgery was performed in 14% of patients. The procedures included nephrectomy (12%), ureterolithotomy (1%) and ileal loop replacement (1%). The remaining 17% of patients did not undergo any intervention after PCN. The reasons included spontaneous resolution of obstruction (passage of stone or sloughed papillae); or the patient was deemed unfit for surgery, refused surgery, was lost to follow-up or died (n = 2).

Specific complications related to PCN were uncommon, but included slipped catheter (8%), minor haemorrhage (2%), wound infection (2%) and

Table 2. Antibiogram of microorganisms to commonly prescribed first-line antibiotics

Antibiotic	*Escherichia coli*	*Klebsiella* spp	*Proteus* spp	*Pseudomonas* spp	*Enterococcus* spp	*Staphylococcus* spp
Ceftriaxone	90	83	82	25		
Gentamicin	93	92	82	75		50
Cephalexin	38	83	64	25		75
Ampicillin	13		64	25	100	25
Cotrimoxazole	30	42		25		75
Nalidixic acid	28	42	27			
Nitrofurantoin	35	50		25	100	

Values are given as percentage of microorganisms sensitive to listed antibiotics.

Table 3. Incidence of positive cultures from different specimens

Available specimen	Positive cultures (%)
Bladder urine	25/83 (30)
Blood	37/86 (43)
PCN	37/73 (51)
Bladder urine + PCN	37/64 (58)
Bladder urine + blood	45/77 (58)
Blood + PCN	46/68 (68)
Bladder urine + blood + PCN	42/59 (71)

PCN = percutaneous nephrostomy aspirate.

extravasation (1%). The mortality rate was 2%, due to septicaemic shock in one patient and pneumonia in another.

Discussion

Barbaric et al first described PCN for drainage of pyonephrosis in 1976.[1] Subsequently, Lang and Price demonstrated that PCN for obstructed renal systems achieved rapid control of infections and decreased mortality from gram-negative septicaemia (7%), compared to treatment with antibiotics and steroids alone (40%) or surgical decompression (13%).[2] Other authors reported on the advantages of PCN.[3–5] Firstly, the procedure can be done under local anaesthesia. Secondly, evacuation of pus and necrotic material reduces bacterial burden.[3] In addition, decompressing the collecting system improves renal perfusion and function, and hence, the entry of antibiotics into the renal parenchyma.[4] Sufficient control of sepsis and return of renal function can be achieved and nephrectomy can be avoided.[3,5] Upon control of the initial sepsis, PCN allows follow-up antegrade pyelography for anatomical evaluation and delineation of the obstructing lesion. With the advent of percutaneous endoscopic techniques, PCN can serve as an access for subsequent definitive procedures. Where indicated, PCN facilitates differential renal function studies and intrarenal pressure measurement as in the standard Whitaker test. Finally, direct irrigation with saline, antibiotics and antifungals is possible with the PCN *in situ*.[5]

Comparisons have been made between decompression using PCN and ureteral stenting for the interim treatment of pyonephrosis.[6,7] Pearle et al attempted to address the issue of the optimal route of urgent decompression in a small randomized study comprising 42 patients.[7] They found that both the percutaneous route and the retrograde route were effective. However, 62% of PCN urine cultures were positive compared with only 19% of retrograde catheter urine cultures. At our institution, ureteral stenting for urgent decompression for pyonephrosis is not routine practice. This is because we believe that retrograde ureteral stenting has a number of disadvantages in the management of pyonephrosis compared with PCN. Firstly, the ureteric stent usually comes in smaller sizes, which provides less effective drainage. Secondly, ureteral stenting often needs to be performed in the operating room under general anaesthesia. Furthermore, there is the risk of perforating the ureter during manipulation. In addition, bacteraemia and septicaemia may flare up under the pressure of the irrigation fluid.

On the other hand, a distinct advantage of PCN is that nephrostomy cultures provide microbiological information that is not available in bladder urine cultures.[5,8] It was demonstrated in our study that the percentage of successful isolation of organisms in cultures increased when PCN cultures were included (Table 3). The pick-up rate from bladder urine cultures, combined bladder urine and nephrostomy cultures, and combined bladder urine, blood

Table 4. Matching of percutaneous nephrostomy aspirate, bladder urine and blood cultures

PCN and bladder urine	Frequency	Percentage	PCN and blood	Frequency	Percentage
Identical	10	27	Identical	11	24
Different	4	11	Different	2	4
PCN +ve, bladder urine –ve	19	51	PCN +, blood –	21	46
PCN –ve, bladder urine +ve	4	11	PCN –, blood +	12	26
Total	37	100	Total	46	100

PCN = percutaneous nephrostomy aspirate; + = positive; – = negative.

and nephrostomy cultures were 30%, 58% and 71%, respectively. Studies also showed that the disparity between bladder urine cultures and PCN cultures ranged from 37% to 52%.[3,8] This disparity was reflected in our study. The reason for the poor correlation between PCN and bladder urine cultures could be because complete ureteric obstruction often prevents microorganisms from travelling from the upper tract down to the bladder. In addition, antibiotics may inhibit bladder urine and blood culture growth despite significant infection in an obstructed kidney. The ability to identify the causative microorganism from PCN cultures is a major advantage, because appropriate antibiotics can be instituted instead of depending on empirical therapy.

PCN has made it possible to address acute urinary obstructions before proceeding to definitive surgical treatment. With improved diagnosis, early intervention by PCN and widespread use of endourological techniques, many patients are spared open surgery. Nephrectomy is now only indicated if the kidney is deemed non-functioning after adequate decompression by PCN and split creatinine clearance studies. In our study, the nephrectomy rate was 12%. This is a significant improvement from earlier studies, where the nephrectomy rates ranged from 35% to 88%.[8–11]

Eleven percent of patients developed septicaemic shock prior to PCN. This was a reflection of the potential hazard of pyonephrosis. In our study, the complications related to the procedure itself were uncommon and minor. With timely intervention, the mortality rate was decreased to a minimum of 2% for this life-threatening condition.

Conclusion

PCN is an important measure for interim management of pyonephrosis. PCN cultures yield valuable information that is not available from bladder urine or blood cultures, and allows selection of appropriate antibiotic therapy. The procedure often allows the kidney to be salvaged and facilitates subsequent definitive procedures. PCN is associated with minor morbidity, provides therapeutic benefit and is the recommended treatment for pyonephrosis after failed medical therapy.

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