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ORIGINAL PAPER

Emergency treatment of obstructive pyelonephritis: A single center series

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Summary ***Objective: This study aims to compare two different drainage methods, percutaneous nephrostomy (PCN) and retrograde ureteral double-J (DJ) stent insertion, in patients with obstructive pyelonephritis (OP).***
Methods: The study included 77 patients who presented to the emergency department due to stones. Type of decompression treatment (PCN or DJ stent), fever, white blood cell count (WBC), C-reactive protein (CRP) levels, urine culture, blood culture, presence of additional diseases, and antibiotic treatment were evaluated for these patients. Emergency decompressive treatment was not randomly assigned. The clinician chose the appropriate treatment method based on the patient's condition after obtaining an informed consent. Patients under the age of 18 were categorized into three subgroups: infants, children under 10 years, and adolescents.
Results: Of the 77 patients, 31 were in the DJ stent group and 46 were in the PCN group. Patients in the PCN group exhibited significantly higher fever levels before the procedure (37.6 ± 1.0°C). Additionally, the positivity rate of urine and blood cultures was higher in the PCN group. The average time to stone treatment after infection and medical treatment, as well as fever control, was shorter in the PCN group (9 ± 2.3 days). Empiric treatment with Ceftriaxone (1 g IV) was confirmed by sensitivity results of urine or blood culture in 45% of cases. None of the patients developed advanced urosepsis after the procedure, but the resolution of infection parameters was faster in the PCN group (7 ± 3.3 days).
Conclusions: Both PCN and DJ stent insertion are effective and safe methods for managing obstructive pyelonephritis. It was observed that the PCN method under local anesthesia was useful in quickly controlling fever and allowing early surgical treatment. Finally, third-generation cephalosporin antibiotics are beneficial for empiric initial treatment.

KEY WORDS: *Kidney stone; Obstruction; Pyelonephritis; DJ stent; Percutaneous nephrostomy.*

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INTRODUCTION

Pyelonephritis is termed as *obstructive pyelonephritis* (OP) when it is associated with urinary tract obstruction. The primary cause of OP is typically an urinary stone that obstruct the urinary system. Acute OP due to urolithiasis represents a medical-surgical emergency and often leads to critical complications (1). The mortality rate among patients with sepsis secondary to acute complex OP is reported to be approximately 2% (2). Emergency decompression of the renal collecting system is required for two types of patients with obstructive urolithiasis: those with advanced urinary tract infection and those who develop renal failure. The main methods for treating them are *double-J* (DJ) ureteral stent or *percutaneous nephrostomy* (PCN) tube insertion (3). The superiority between these two methods in resolving the problem remains controversial. Factors such as the suitability or ease of the method, clinical resources, experience, evolving complications, and their severity are still uncertain and debatable (4).
While it is generally accepted that the stone should not be treated at the same time of decompression of the urinary system, there is no consensus on whether stone surgery should be performed after decompression (5). To address this gap in the literature and determine the feasibility of the chosen method, it is crucial to consider the risks of complications, the recovery process, the occurrence of urosepsis, the appropriate timing of stone treatment, and the modality of antibiotic management.

MATERIALS AND METHODS

Patient selection

This retrospective study included patients with *obstructive pyelonephritis* (OP) secondary to urolithiasis who underwent PCN or retrograde ureteral DJ stent insertion between January 2020 and January 2022. The study utilized hospital archive records and was approved by the *University Local Ethics Committee*. The study protocol was reviewed and approved by the *Institutional Review Board of our University College of Medicine* (approval number: 58119). Informed consent was obtained by all subjects when they were enrolled.
A total of 77 patients were included, encompassing individuals of more than 6 months of age with complete hospital records. Pregnant women were excluded from this study. None of the patients had undergone treatment of obstructive stones before medical intervention. Patients were categorized into two groups based on the drainage method. Upon presentation to the emergency room or urology outpatient clinic, patients with stones were evalu-

ated for fever, *white blood cell* count (WBC), *C-reactive protein* (CRP) levels, urine culture, blood culture, presence of additional diseases, and antibiotic treatment (Table 1). Complications, treatment duration, and post-treatment stone surgery timing were recorded for patients undergoing DJ stent or PCN insertion, and the suitability and success rates of the methods were compared.

Surgical technique for DJ stent insertion

Patients received comprehensive information regarding the interventional procedure and provided informed consent by signing a consent form. Prior to the procedure, all patients received 1 g of ceftriaxone intravenously as antibiotic prophylaxis. Under sterile conditions and either local or spinal anesthesia, a 17 Fr cystoscope was inserted into the bladder through the urethral orifice. Subsequently, a 4.7 Fr, 26 cm DJ stent was inserted using a guide wire for adult patients, while the size of the DJ stent for patients under 12 years of age was adjusted accordingly.
Fluoroscopy was utilized to verify the accurate positioning of the DJ stent.

Surgical technique for percutaneous nephrostomy

After obtaining patient information and consent, the renal system was visualized using ultrasonography under local anesthesia. Following identification of a suitable calix, access to the system was achieved using a Chiba needle. The system was visualized under fluoroscopy with the administration of contrast agent. A suitable guidewire was passed through the skin, and dilatation was performed to facilitate the insertion of a 16 Fr nephrostomy tube (8-10 Fr for children) into the kidney.

Statistical methods

Mean, standard deviation, median, minimum, maximum, frequency, and ratio values were used in the descriptive statistics of the data. The distribution of variables was measured using the Kolmogorov-Smirnov test.
Independent sample t-tests and Mann-Whitney U-tests were used in the analysis of quantitative independent data. The chi-square test was used in the analysis of qualitative independent data, and the Fischer test was used when the chi-square test conditions were not met. The SPSS 27.0 program was used in the analysis.

Results

The characteristics of patients who received decompression treatment by the two methods are summarized in Table 1 and Table 2, which also include data on the time interval to stone treatment after infection, and on the time for infection parameters to subside.
Patients under the age of 18 were categorized into three subgroups: infants, children under 10 years, and adolescents. We treated 12 pediatric patients under the age of 18 divided into three groups: infants (0-2 years), children under 10 years (3-9 years), and adolescents (10-18 years). The majority of the pediatric patients were adolescents, who showed a clinical presentation similar to adult cases. Specifically, 1 patient was an infant (8.3%), two patients were children under 10 years (16.7%), and nine patients were adolescents (75%).

We analyzed the antibiotic sensitivity profiles of the pathogens isolated from both urine and blood cultures. The most commonly isolated pathogen was Escherichia coli, which exhibited high sensitivity to beta-lactam antibiotics, particularly ceftriaxone, with a sensitivity rate of 85%. This aligns with our empirical use of ceftriaxone as first-line therapy in obstructive pyelonephritis cases. Other pathogens such as Klebsiella pneumoniae and Pseudomonas aeruginosa showed variable sensitivity, with Klebsiella demonstrating 70% sensitivity to Ertapenem and Pseudomonas showing significant resistance to many common antibiotics but retaining sensitivity to Ceftazidime and Piperacillin-tazobactam. Candida species, detected in a subset of patients, responded well to Fluconazole. This data underscores the importance of culture-based antimicrobial stewardship in the management of obstructive pyelonephritis, ensuring that empirical treatment is adjusted based on pathogen sensitivity profiles to improve outcomes and reduce resistance development.

Table 1.
General characteristics of patients who underwent PCN and DJ stent (n:77).

		Min-Max	Median	Mean ± ss/n-%
Age		0.8 - 81.0	31.0	35.1 ± 24.3
Gender	Female			35 45.5%
	Male			42 54.5%
Fever		36.0 - 39.3	37.9	37.4 ± 1.0
Pulse		68.0 - 122.0	92.0	94.0 ± 12.9
WBC		4.0 - 41.0	11.0	13.1 ± 6.9
CRP		0.0 - 42.0	6.7	10.3 ± 10.2
Urine culture	(-)			46 59.7%
(pathogen)	(+)			31 40.3%
	E Coli			19 61.3%
	Candida			5 16.1%
	Klebsiella			3 9.7%
	Psodomonas			2 6.5%
	Enterobacter			1 3.2%
	Enterokok			1 3.2%
Blood culture	(-)			68 88.3%
	(+)			9 11.7%
	Candida			7 77.8%
	E Coli			1 11.1%
	Klebsiella			1 11.1%
Comorbidity	(-)			34 44.2%
	(+)			43 55.8%
Applied antibiotics	Ceftriazone			36 46.8%
	Ertapenem			23 29.9%
	Cephaxon			3 3.9%
	Amikacin			2 2.6%
	Cilapem			2 2.6%
	Fluconazole			2 2.6%
	Vancomicin+Imipenem			2 2.6%
	Gentamicin			1 1.3%
	Ceftazidime			1 1.3%
	Meropenem			1 1.3%
	Meropenem+Tazocin			1 1.3%
	Cilanem			1 1.3%
	Imipenem			1 1.3%
	Ceftriazone+Metronidazole			1 1.3%

		Percutaneous nephrostomy		Dj Stent		P
		Mean ± ss/n-%	Median	Mean ± ss/n-%	Median	
Age		33.6 ± 25.2	29.0	37.3 ± 23.0	33.0	0.518 [t]
Gender	Female	20 43.5%		15 48.4%		0.67 [X²]
	Male	26 56.5%		16 51.6%		
Fever		37.6 ± 1.0	38.0	37.1 ± 1.0	37.0	0.048 [m]
Pulse		97.5 ± 13.0	95.5	88.7 ± 11.0	88.0	0.006 [m]
WBC		14.1 ± 8.1	12.0	11.6 ± 4.3	11.0	0.352 [m]
CRP		11.5 ± 10.5	10.0	8.4 ± 9.5	5.0	0.190 [m]
Urine culture	(-)	25 54.3%		21 67.7%		0.240 [X²]
	(+)	21 45.7%		10 32.3%		
	E Coli	14 66.7%		5 50.0%		
	Candida	3 14.3%		2 20.0%		
	Klebsiella	2 9.5%		1 10.0%		
	Psodomonas	1 4.8%		1 10.0%		
	Enterobacter	0 0.0%		1 10.0%		
	Enterokok	1 4.8%		0 0.0%		
Blood culture	(-)	39 84.8%		29 93.5%		0.240 [X²]
	(+)	7 15.2%		2 6.5%		
	Candida	5 71.4%		2 100.0%		
	E Coli	1 14.3%		0 0.0%		
	Klebsiella	1 14.3%		0 0.0%		
Comorbidity	(-)	21 45.7%		13 41.9%		0.747 [X²]
	(+)	25 54.3%		18 58.1%		
Time to stone treatment and fever control (day)		9 ± 2.3		11 ± 2.5		**0.047** [m]
Time to resolution of infection parameters (day)		7 ± 3.3		10 ± 3.4		**0.049** [m]

Table 2.
Statistical comparison of the information of patients who underwent PCN and DJ stent.

Table 3.
Comparative analysis of urine culture or blood culture results and antibiotic treatments administered between groups accordingly.

		Percutaneous nephrostomy				Dj Stent				P
		Mean ± ss/n-%	Median	Min-max	I.Q-3.Q	Mean ± ss/n-%	Median	Min-max	I.Q-3.Q	
Age		33.6 ± 25.2	29.0	0.8 - 81.0	10.5 - 56.0	37.3 ± 23.0	33.0	1.0 - 80.0	19.0 - 54.0	0.518 [t]
Gender	Female	20 43.5%				15 48.4%				0.67 [X²]
	Male	26 56.5%				16 51.6%				
Fever		37.6 ± 1.0	38.0	36.0 - 39.1	37.0 - 38.1	37.1 ± 1.0	37.0	36.0 - 39.3	36.0 - 38.0	0.048 [m]
Pulse		97.5 ± 13.0	95.5	74.0 - 122.0	86.0 - 110.0	88.7 ± 11.0	88.0	68.0 - 112.0	80.0 - 96.0	0.006 [m]
WBC		14.1 ± 8.1	12.0	4.0 - 41.0	8.0 - 18.0	11.6 ± 4.3	11.0	5.0 - 25.0	8.6 - 14.0	0.352 [m]
CRP		11.5 ± 10.5	10.0	0.0 - 42.0	1.9 - 19.5	8.4 ± 9.5	5.0	0.0 - 41.0	1.0 - 12.0	0.190 [m]
Urine culture	(-)	25 54.3%				21 67.7%				0.240 [X²]
	(+)	21 45.7%				10 32.3%				
	E Coli	14 66.7%				5 50.0%				
	Candida	3 14.3%				2 20.0%				
	Klebsiella	2 9.5%				1 10.0%				
	Psodomonas	1 4.8%				1 10.0%				
	Enterobacter	0 0.0%				1 10.0%				
	Enterokok	1 4.8%				0 0.0%				
Blood culture	(-)	39 84.8%				29 93.5%				0.240 [X²]
	(+)	7 15.2%				2 6.5%				
	Candida	5 71.4%				2 100.0%				
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	Klebsiella	1 14.3%				0 0.0%				
Comorbidity	(-)	21 45.7%				13 41.9%				0.747 [X²]
	(+)	25 54.3%				18 58.1%				
Applied antibiotics	Ceftriazon	17 37.0%				19 61.3%				
	Ertapenem	15 32.6%				8 25.8%				
	Cephaxon	3 6.5%				0 0.0%				
	Amikacin	2 4.3%				0 0.0%				
	Cilapem	2 4.3%				0 0.0%				
	Fluconazole	2 4.3%				0 0.0%				
	Vancomicin+Imipenem	2 4.3%				0 0.0%				
	Gentamicin	0 0.0%				1 3.2%				
	Ceftazidime	0 0.0%				1 3.2%				
	Meropenem	1 2.2%				0 0.0%				
	Meropenem+Tazocin	1 2.2%				0 0.0%				
	Cilanem	0 0.0%				1 3.2%				
	Imipenem	1 2.2%				0 0.0%				
	Ceftriazon+Metronidazole	0 0.0%				1 3.2%				

Discussion

It has been determined that both methods are successful and safe in treating obstructive pyelonephritis before treatment directed to removal of the stone.

Upper urinary tract (UUT) stones commonly lead to pain and drug-resistant pain pyelonephritis, potentially resulting in kidney unit loss and life-threatening situations in case of severe infections (6).

The *European Association of Urology* (EAU) guidelines for lithiasis suggest to delay definitive stone treatment after the resolution of infection or sepsis (7). In our clinical practice, stone treatment was not performed in association with decompression therapy.

PCN was initially described by the urologist *Dr. Willard Goodwin* in 1955 as a minimally invasive, X-ray-guided procedure, either temporary or permanent, offering an alternative to traditional surgery for patients with hydronephrosis (8). Since then, there has been an increase in the use of fluoroscopy and ultrasonography in PCN among urologists and interventional radiologists. A survey study involving urologists and radiologists assessing pelvic system decompression concluded that preferences for PCN or DJ stent placement are generally based on personalized treatment according to the degree of hydronephrosis in the obstruction (9). In our study, the PCN procedure was commonly performed by interventional radiologists (87% of cases). However, in determining the treatment approach, aside from the degree of hydronephrosis, we aimed to a comprhensive evaluation focusing on the identification of the patient's clinical factors and to subsequent administration of antibiotic treatment until primary stone therapy.

Retrograde DJ stent placement offers the advantage of being a feasible option, which is preferred in routine practice by urologists. Compared to PCN, DJ stent placement is considered more cosmetically favorable for patients. However, many patients undergoing DJ stent placement experience *lower urinary tract symptoms* (LUTS), including post-operative pain, polyuria, and dysuria. Consequently, because of the resulting reduction in quality of life, some patients may not prefer this procedure (10).

According to the European Guideline, it is recommended that upon the patient's initial presentation, a urinary culture analysis is promptly conducted, with a subsequent reanalysis of the urinary culture following urological intervention. Following this general principle, in our study, we conducted two separate urine culture analyses before and after drainage treatment. Our results indicated that 40% of these cultures were positive, with culture positivity detected in 21 patients with nephrostomy and 10 patients with DJ stent placement. In the study conducted by *Anil H et al.*, a culture positivity rate of 66.7% was observed, and the most frequently isolated pathogen in urinary tract infections was Escherichia coli (11). Similarly, in our study, Escherichia coli was the most frequently observed organism at 24.6%. Additionally, Pseudomonas aeruginosa and Klebsiella pneumoniae were among the other common pathogens, while Candida infection, which is also described in the literature, was also frequently observed (12, 13).

The relatively low rate of positive urine cultures (40.3%) and blood cultures (11.7%) in our study can be attributed to several factors. First, obstructive pyelonephritis often triggers an inflammatory response, which may not always lead to detectable bacteriuria or bacteremia by the time cultures are taken. This can happen due to the intermittent shedding of bacteria into the urine or bloodstream, resulting in negative culture results despite the presence of infection. Additionally, many patients might have received empirical antibiotic treatment prior to hospital admission or sample collection, which could suppress bacterial growth and lead to false-negative cultures. Furthermore, the obstruction itself may limit the dispersion of bacteria into the bloodstream or urinary tract, reducing the likelihood of positive cultures. Moreover, variations in the timing and quality of sample collection can also play a role. In some cases, cultures may have been taken after the initiation of antibiotic therapy or during phases of fluctuating bacteremia, reducing culture sensitivity. It is also possible that some cases involved non-bacterial causes of infection, such as fungal infections, which were detected in a subset of patients. These factors, along with the complex nature of obstructive urolithiasis and pyelonephritis, likely contributed to the relatively low culture positivity rates observed in our study.

Patients were administered broad-spectrum antibiotic treatment in accordance with European guidelines before the culture results are available (14).

In our clinical practice, the obstructive pyelonephritis patients which apply to the emergency room or outpatient clinic, are immediately started with the broad-spectrum antibiotic Ceftriaxone (1 g IV). However, following the results of the urinary culture antibiogram, the appropriate treatment is then prescribed from the infectious diseases department. The most common treatments were Ceftriaxone and Ertapenem. In a study conducted by *Subramanian et al.*, antibiotic sensitivity was evaluated after initial empirical treatment in patients with urosepsis, and it was concluded that 41 of 63 patients (65%) were sensitive to beta-lactam antibiotics according to urine culture (13). We have observed that sensitivity to intial empirical broad spectrum Ceftriaxone treatment has been confirmed in 46.75% of cases, so we administered this treatment regimen in our clinic.

Urinary Candida species are a common clinical finding, especially among hospitalized patients. In fact, some reports indicate that 90% of Candida *urinary tract infection* (UTI) cases occur in hospitalized patients with a urinary catheter (15). According to urine and blood culture results, we observed Candida positivity in 12 patients (38.7%). Half of these patients had *diabetes* (DM) and 8 patients were either hospitalized or had a urinary catheter installed. Only 2 patients were recommended fluconazole treatment as antifungal therapy by the infectious diseases department after confirmation by new urine or blood culture tests. In addition, recommendations were made for regulating blood sugar level and changing the catheter.

There are some limitations in our study. The small number of patients may be related to the fact that the study coincided with the Covid-19 pandemic period. Moreover, patients may be also treated in other centers so limiting our access to accurate information. In addition, the results of urine and blood cultures may be affected by regional and geographical factors. Therefore, it is important to highlight that the spectrum of pathogens and sen-

sitivity to antibiotic that we have observed are specific for patients from our region.

Conclusions

PCN and DJ stent techniques show comparable effectiveness in the treatment of cases of sepsis resulting from obstructive uropathy. Although the PCN technique is more invasive, it helps to quickly obtain an urine sample from the upper urinary tract in order to diagnose the causative microorganism, facilitating the rapid and accurate implementation of treatment protocols. Empiric antibiotic therapy with ceftriaxone shows sensitivity to pathogens in almost half of patients. Finally, PCN can accelerate timing of stone treatment and be used as a guide for subsequent surgeries.

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