UDK: 616.61-008.6-083.98

PERCUTANEOUS NEPHROSTOMY IN THE DIAGNOSIS AND TREATMENT OF OBSTRUCTIVE UROPATHY − THE EXPERIENCE OF A SECONDARY HEALTH CARE CENTER

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This study was aimed to examine the efficacy, feasibility, frequency of complications, and outcome of emergency or elective renal unblocking in patients with benign or malignant pathology.

A prospective study, so far, included 158 patients, of which 94 (59.49%) female and 64 (40.50%) male, who underwent PCN at the Urology Department at "Aleksa Savić" General Hospital in Prokuplje from January 2018 to January 2020. The series included patients with both benign and malignant obstruction.

The success rate of the procedure was 97.47%. More than 40% of the PCN placement indications were calculosis. Incidence of complications in our study correlates with literature findings.

PCN is a safe and effective method. In addition to overcoming the learning curve, it is a sovereign method in prompt intervention on developed obstruction. Completely guided by ultrasound, it greatly reduces the cost of treatment, referring to reference centers and possible hemodialysis therapy. In addition, it will help relieve tertiary institutions and, more importantly, in the timely provision of adequate health care to our patients.

Key words: *Kidney, Hydronephrosis, Nephrostomy, Percutaneous*

PERKUTANA NEFROSTOMIJA U DIJAGNOSTICI I LEČENJU OPSTRUKTIVNE UROPATIJE − ISKUSTVO CENTRA NA SEKUNDARNOM NIVOU ZDRAVSTVENE ZAŠTITE

Cilj studije je bilo ispitati efikasnost, izvodljivost, učestalost komplikacija i ishod hitne ili elektivne deblokade bubrega kod pacijenata sa benignom ili malignom patologijom.

Prospektivna studija koja je do sada obuhvatila 158 pacijenata, od kojih 94 (59.49%) pacijenata ženskog i 64 (40.50%) pacijenta muškog pola kojima je plasiran perkutani nefrostomski kateter (PCN) na odeljenju urologije u OB „Aleksa Savić“ u Prokuplju od januara 2018. do januara 2020. godine. U studiju su obuhvaćeni kako pacijenti sa benignim tako i sa malignim patofiziološkim mehanizmom opstrukcije.

Perkutana nefrostomija je sprovedena kod nastale osptruktivne uropatije usled različitih benignih ili malignih stanja kod ukupno 158 pacijenata. Kod 97 (61,39%) pacijentata je PCN plasirana zbog benignih a kod 61 (38,60) pacijenta PCN je indikovana usled opstrukcije nastale na terenu malignih bolesti. Uspešnost plasmana je iznosila 97,47%. U preko 40% indikacija za plasman nefrostomskog katetera bila je kalkuloza. Učestalost komplikacija u naštoj studiji odgovara podacima iz literature.

Perkutana nefrostomija predstavlja bezbednu i efikasnu metodu. Uz savladavanje krive učenja, predstavlja suverenu metodu u promptnoj intervenciji kod nastale opstrukcije. Kompletno ultrazvučno vođena, umnogome smanjuje troškove lečenja, slanje pacijenata u referentne centre kao i eventualni hemodijalizni tretman. Dodatno, rasterećuje tercijalne institucije i što je još važnije, pomaže u pravovremenom pružanju zdravstvene zaštite našim pacijentima.

Ključne reči: *bubreg, hidronefroza, nefrostomija, perkutana*

Introduction

Obstructive uropathy is a pathological condition in which urine flow is blocked, resulting in increased pressure within the renal collecting system and possibly permanent kidney damage. The interruption and inability of urine to flow results in pain, infection, sepsis, and loss of renal function in its terminal stage (1). This condition is potentially life-threatening especially in a patients with a single functioning kidney due to progressive uremia. The very degree of developed hydronephrosis or the possibility of developing primary renal atrophy is individual patient's response that requires prompt renal decompression (2).

Various modalities allow unblocking the affected organ: retrograde stenting, open drainage, and percutaneous nephrostomy (PCN). Although very widespread as a procedure and favorite among both urologists and radiologists, there are still no European recommendations and guidelines that would include determined rates of complication (3). Our study included patients who underwent a PCN procedure in a secondary health care facility, in the urology department. We believe it should be all the more critical in terms of immediate treatment of acute conditions caused by renal obstruction and preparation for minimally invasive intervention in the pathology of calculosis. It is inevitable to mention the epidemiological aspect during the COVID-19 pandemic. Due to a drop in elective surgery rates worldwide, PCN is an opportunity to delay the intervention without consequences for patients health effectively (4).

Materials and methods

The prospective study, so far, included 158 patients, of which 94 (59.49%) female and 64 (40.50%) male who were placed percutaneous nephrostomy catheter (PCN) unilaterally or bilaterally at the Department of Urology in GH "Aleksa Savić" in Prokuplje from January 2018. to January 2020. All procedures were performed in our center by a urologist, under local anesthesia or analgesic sedation, and were entirely done under ultrasound guidance. The study included patients with benign and malignant pathophysiological mechanism of obstruction.

Immediate preoperative preparation included complete blood count, urea, creatinine and coagulation status values. The reason for the delayed placement within 24 hours was the stabilization of coagulation status and previous antibiotic therapy in patients with more severe forms of urinary tract infections. Additional reason for the procedure delay was anemia with hemoglobin values below 70, which also undergone PCN procedure within 24 hours of admission to the urology department after urgent blood transfusion.

During the procedure, the posterior calyx of the lower calyx group of the pyelocaliceal system was most commonly used following the avascular line of Brodel for access to avoid vascular injuries. After the incision site is determined, a local anesthetic is administered in the form of 20 ml of 1% lidocaine. After the incision of the skin and fascia, under ultrasound vision, through the channel of the previously fixed guide on the convex probe, and according to modified Seldinger technique described by Pedersen (5).

After the procedure, all patients were continuously monitored within 24 hours for tension, pulse, body temperature and control blood count.

Postoperative complications were evaluated according to the standardized modified Clavien Dindo classification system which has being employed for grading of complications (6). Patients were stratified by comorbidity status using the Charlson comorbidity index within investigating feasibility and complications rate among given groups. Comparison between complications arising from benign and malignant etiology was made by using the Chi-square. A univariate analysis was performed in which the relationship between some independent variables and occurrence of complications was analyzed. Data were expressed as mean plus standard deviation and a p value < 0.05 was considered statistically significant. Patients were also categorized according to their BMI groups and investigated through univariate analysis for dependence.

Results

Percutaneous nephrostomy (PCN) was performed in obstructive uropathy due to various benign or malignant conditions in a total of 158 patients. The age structure of the patients was between 25 and 84 years. In men, the mean age was 54.32 years, while in female patients the mean age was 52.13 years. In 97 (61.39%) patients, PCN was placed due to benign, and 61 (38.61%) PCNs were indicated due to obstruction caused in the field of malignant diseases (Table 1).

The success rate was 97.47%, noting that after repeated unsuccessful procedures, that percentage was even higher. Placement failure was noted in 4 (2.53%) patients and was caused by intolerance to the pronation position, difficult anatomy or interposed abdominal organs. In 2 (1.27%) patients, PCN catheter blockage occurred within the first 24 hours, and they required replacement after failed probing attempts. Over

40% of the indications for placement were calculosis.

Average duration of the procedure in the observed series was 27 minutes with an SD of 7.24. Patients were divided into 8 groups for investigating the learning curve timeline. Within groups there is statistical significance between mean operative time of procedure in “group I” compared to means of other given groups ($p < 0.5$). This gives us the proof of relatively short learning curve of ultrasound guided percutaneous nephrostomy procedure (Figure 1).

Table 1. Obstruction etiology and gender distribution

	Indication/Cause	N	%	Men N	%	Women N	%
Benign N = 97	Calculosis	64	40.51	30	18.99	34	21.52
	UPJ obstruction	10	6.33	4	2.53	6	3.80
	Pyonpehrosis	5	3.16	3	1.90	2	1.27
	Ureteral stenosis	9	5.70	2	1.27	7	4.43
	Ureteral ligature	9	5.70	2	1.27	7	4.43
Malignant N = 61	Blader cancer	9	5.70	7	4.43	2	1.27
	Ureteral malignancy	9	5.70	5	3.16	4	2.53
	Cervical cancer	24	15.19			24	15.19
	Endometrial cancer	4	2.53			4	2.53
	Prostate cancer	11	6.96	11	6.96		
	Ovarian cancer	4	2.53			4	2.53
Total				**64**		**94**	

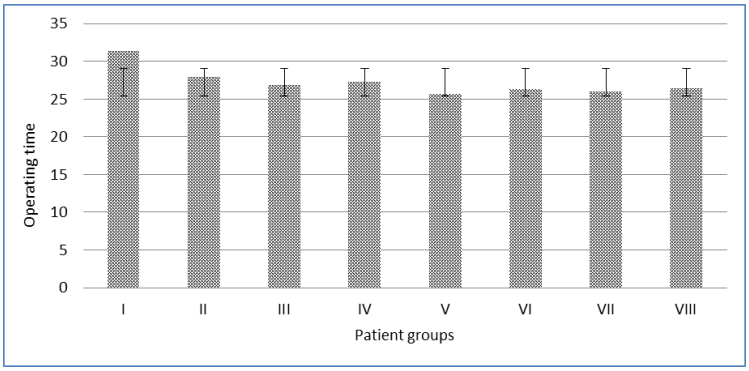

Figure 1. Timeline of procedure duration among groups. Significance in I vs VII $p < .005$ ($p = .034$); with no significance in comparison of operating time between other subsequent groups.

Charlson comorbidity index (CCI) score was calculated as “0” for 42 patients (26.6%, called group I), “1” for 55 patients (34.8%, called group II) and “≥ 2” for 61 patients (38.6%, called group III). High CCI score was not significantly related to higher medical complication rates after PCN in our study enabling feasibility of the procedure in widest possible pathological states.

In order to achieve data standardization, all complications were classified according to the five grades of modified C-D (Clavien-Dindo Classification system). Majority of complications were low grade C-D complications out of which 19 patients (12.03%) had fever, pain or transient hematuria (hematuria lasting < 24 h) classified as C-D I. In 2 patients (1.27%), subcapsular hematoma (C-D IIa) was recorded, verified and monitored by ultrasound. Urine leaks and urinoma formation (C-D IIb) were not noted as complications in our series. PCN tube dislodgment/ blockage/failure was recorded in 10 patients (6.33%) as C-D III. One patient (0.63%) developed sepsis (C-D IVb) after PCN placement, while 1 patient (0.63%) was referred to the ICU of

a tertiary reference center after placement of a nephrostomy catheter (in a single kidney), where he was successfully treated, with previously diagnosed preprocedural septic shock. There were no complications with a fatal outcome or other major complications (C-D V) (Table 2).

Patients included in the study had mild 24 (15.19%), moderate 75 (47.47%) or severe 59 (37.34%) grade of hydronephrosis. In relation to the hydronephrosis grade, incidence of complications was also observed. Out of the total number of procedures, among mild, moderate and severe hydronephrosis groups there was clear statistical significance in complication rates. ($p = .00017420$), ($p < .05$) (Figure 2).

Table 2. Clavien Dindo classification of resulted complications

Class	Definition	Management	Complication N (%)
I	Fever, pain, vomiting, transient hematuria (hematuria lasting < 24 h)	Analgesic,antipyretic,antiemetic, conservative	19 (12.03)
II	Severe hematuria, urinary tract infection, pyelonephritis		0
III	PCN tube dislodgment/blockage/failure	Reposition/change/reinsertion	10 (6.3)
IIIa	Subcapsular haemathoma	Prolonged hospital stay (> 72 hrs)	2 (1.27)
IIIb	Urinoma / Perirenal abscess		0
IV	Bowel perforation		0
IVa	Hemorrhage not controlled by conservative/minimal invasive procedure		0
IVb	Sepsis, multiorgan dysfunction	ICU care	1 (0.63)
V	Death		0

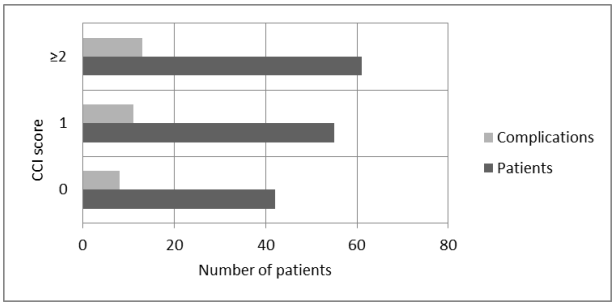

Figure 3. Complications incidence among Charlson comorbidity index (CCI) score groups.
χ^2 (2, N = 158) = 0.0546, p = .973082

The difference in the complication rates between the benign and malignant disease groups of patients was not statistically significant. In the group of patients with benign obstruction, a total of 21 complications occurred in our series, while 11 complications occurred in the group with obstruction based on malignant pathology. The χ^2 test was used to compare the rates of complications that occurred in the observed groups, which showed that there was no statistical significance of the occurrence of complications between the examined groups ($\chi^2 = 0.3033$), ($p < .05$).

As mentioned, Charlson comorbidity (CCI) score was used to compare "weight" of comorbidity score and incidence of complications and feasibility of procedure among weighted groups. Group calculated as "0" for 42 patients

(26.6%, called group I), “1” for 55 patients (34.8%, called group II) and “≥ 2” for 61 patients (38.6%, called group III). There was no statistical significance between groups when observing incidence of complication. Also, there was no significance in feasibility of percutaneous nephrostomy procedure within differed comorbidity groups, χ^2 (2, N = 158) = 0.0546, p = .973082 (Figure 3).

Complications within BMI groups showed no statistical significance. BMI < 18.5 kg/m^2 underweight group (N = 10 6.3%) had 3 (1.9%), 18.5 - 24.9 kg/m^2 normal group (N = 74, 46.8%) had 14 (8.86%), 25 - 29.9 kg/m^2 overweight group (N = 51 32.3%) had 10 (6.30%) and > 30 kg/m^2 obese group (N = 23 14.6%) had 5 (3.16%) complications, χ^2 (2, N = 158) = 0.4449, p = .930823.

Percutaneous nephrostomy catheter placement was performed under local anesthesia in 142 (89.87%) patients and analgesic sedation in 16 (10.13%) patients. We believe that it is important to note that in patients who had no problems or contraindications for the PCN procedure under local anesthesia, a better and more precise placement was achieved in our series. This was achieved thanks to better communication with the patient suggesting rhythm of respiration and reduction of respiration-caused changes in the position of the targeted calyx (respiratory amplitude of the kidney).

Discussion

In our study, in a period of 2 years, 158 procedures were performed by placing percutaneous nephrostomy (PCN) catheters under complete ultrasound guidance. The study is of prospective design. Data is used from medical records, medical history and operative protocols. All relevant parameters were evaluated to obtain clear statistical factors on the frequency of complications after this procedure. In order to standardize our cohort we used Charleson comorbidity index, Clavien Dindo classification of complications, BMI observance and “shredded” timeline groups for learning curve observation.

Most previously published studies have shown successful PCN placement without complications in more than 90 percent of cases. Namely, many studies have shown high efficiency of nephrostomy catheter placement in renal obstruction, while in a certain number of them, when patients without obstruction changes were included in the series, the percentage of complications was slightly higher. When we take into account all the above factors that may to some extent affect the success of PCN catheters placement under exclusive ultrasonic guidance, we come to the range from 83.1% to 92% (3, 7).

Pedersen was the first to perform a percutaneous nephrostomy completely under ultrasound guidance with a placement success rate of 70%. Today, it is one of the most common interventions performed by urologists in the centers worldwide performing this procedure (5). The AUA guidelines suggests an upper limit of 4% while guidelines in Europe are still under preparation. Even studies with CT enhanced PCN procedures are showing relatively similar complications incidence, although designed for more complex cases (8).

There were no patients in our study that required the need for transfusion resulting from bleeding after PCN. Also, there were no injuries of intra-abdominal organs (spleen, liver, colon, and pleura) which are described in the literature as major complications (9, 10). Modified Clavien Dindo classification of complications that Kumar used in their study showed similar results compared to our cohort (11). As noted in the study results, 1 (0.63%) patient developed a septic condition after PCN placement, which brings the rate of major complications to levels below 1% (0.63%) and correlates with data from the literature. The criteria for defining a specific condition during consideration were set on the basis of the Third International Consensus on the definition of sepsis and septic shock (12). Comparatively, in the literature, with respect to this definition, the incidence of sepsis as a complication is up to 3.6% (13, 14).

In terms of considering minor complications, it is challenging to classify and standardize some of them concerning primarily technical problems such as "slippage" of the catheter outside the pyelocalyceal (PC) system due to large respiratory amplitude and renal movement within its physiological limits (15). There were 4 (2.53%) slips in our series, while 2 (1.27%) patients had a catheter blockage that required replacement within 24 hours of initial placement, which correlates with data from the literature (10, 11, 15). Transient hematuria after the procedure is a common condition that is difficult to quantify. However, all patients who had hematuria in the urine after PCN placement were classified into minor complications 19 (12.03%) for the purpose of clearer statistical processing. It should be noted that these patients did not require therapeutic protocol adjustment except for the extension of hospitalization to a maximum of 48 hours. In all of the patients, haematuria was lost spontaneously or after mild nephrostomy catheter rinsing with saline (< 24 hrs).

Percutaneous nephrostomy at a secondary health care institution primarily gives us time in treatment planning, multidisciplinary consideration of pathological conditions arising in the field of kidney and ureter blockage, diagnosis and

preparation for their definitive surgical solutions. Also, in a certain number of patients, it represents the final urine derivation when there is no alternative operation to perform another type of derivation or unblocking of the natural urine pathway.

Conclusion

Ultrasound-guided percutaneous nephrostomy is safe and effective procedure in terms of both therapeutic and diagnostic treatment in secondary level centers. Performed under local anesthesia reduces the costs of treatment, referring to reference centers and possible hemodialysis therapy. Epidemiological aspect should be emphasized during the pandemic of COVID-19 as PCN isn't aerosol-generating procedure. It enables the functioning and preservation of renal function in the case when the definitive solution should be waited in a limited timeframe.

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