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PERCUTANEOUS NEPHROSTOMY IN OBSTRUCTIVE UROPATHY: COMPLICATIONS AND FEASIBILITY ANALYSIS OF OUTPATIENT SURGERY UNDER LOCAL ANESTHESIA

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

A prospective study included 158 patients, of which 94 (59.49%) women and 64 (40.50%) men, who underwent PCN at the Urology Department of General Hospital "Aleksa Savić" in Prokuplje from January 2020 to January 2024. All the patients were admitted in an outpatient manner. The cohort included patients with both benign and malignant obstruction.

The operation success rate was 97.47%. More than 40% of percutaneous nephrostomy (PCN) placements were performed for calculosis. The frequency of issues in our study aligns with results from previous investigations. Regarding the hydronephrosis grade, there was a clear statistical significance in the complication rates among the groups with mild, moderate, and severe hydronephrosis. Every problem was categorized using the five modified C–D (Clavien–Dindo Classification System) grades. Most of the problems were low-grade C–D complications.

Percutaneous nephrostomy primarily gives us time in treatment planning, and in a certain number of patients, it represents the final urine derivation when there is no definitive surgical procedure. In addition to overcoming the learning curve, it is a sovereign method in prompt intervention on developed obstruction. Performing percutaneous nephrostomy in an outpatient manner represents a safe and feasible procedure.

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Key words: *kidney, hydronephrosis, nephrostomy, percutaneous*

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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 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 an 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 a 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. All patients included in this study underwent PCN in an outpatient surgery manner. It is inevitable to mention the epidemiological aspect during the COVID-19 pandemic. Due to a drop in elective surgery rates worldwide, PCN represented an opportunity to delay the final intervention without consequences for patients' health effectively (4).

Materials and Methods

The prospective study, included 158 patients, of which 94 (59.49%) women and 64 (40.50%) men who were placed percutaneous

nephrostomy catheter (PCN) unilaterally or bilaterally at the Department of Urology of General Hospital "Aleksa Savić" in Prokuplje from January 2020 to January 2024. All procedures were performed in our center by a urologist, under local anesthesia, and were entirely done under ultrasound guidance. Inclusion criteria: renal blockage in the urinary tract with or without infection, patient living close to the hospital.

The study included patients with benign and malignant pathophysiological mechanisms of obstruction. Patients were held for 2 to 4 hours for observation and continuously monitored for tension, pulse, body temperature and control blood count. Furthermore, blood count, biochemical analysis and ultrasound follow-up within 72 hours postoperatively were also performed. All patients received cefazolin or cefuroxime prophylaxis if there was no positive urine culture. Otherwise, adequate antibiotic was administered.

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 was determined, a local anesthetic was administered in the form of 20 ml of 1% lidocaine. After the incision of the skin and fascia under ultrasound vision, a channel was created using the previously fixed guide on the convex probe, following the modified Seldinger technique as described by Pedersen (5).

Postoperative complications were evaluated according to the standardized modified Clavien–Dindo classification system employed for grading complications (6). Patients were stratified by comorbidity status using the Charlson comorbidity index, within investigating the feasibility and complications rate among given groups. A 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 the 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 women 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 by 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 re-placement after failed probing attempts. Over 40% of the indications for placement were calculosis. All the patients included in the study were admitted in an outpatient manner.

The 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 was statistical significance between the mean operative time of procedure in Group I compared to the means of other given groups ($p < 0.5$). This gives us the proof of a relatively short learning curve of ultrasound guided percutaneous nephrostomy procedure (Figure 1).

The Charlson Comorbidity Index (CCI) score was as follows: 42 patients (26.6%) were classified as Group I with a score of 0; 55 patients (34.8%) were classified as Group II with a score of 1; and 61 patients (38.6%) were classified as Group III with a score of ≥ 2. High CCI score was not significantly related to higher medical complication rates after PCN in our study, enabling feasibility of the procedure in the 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). The 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 dislodgement/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. Concerning the hydronephrosis grade, the 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 1. Obstruction etiology and gender distribution

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

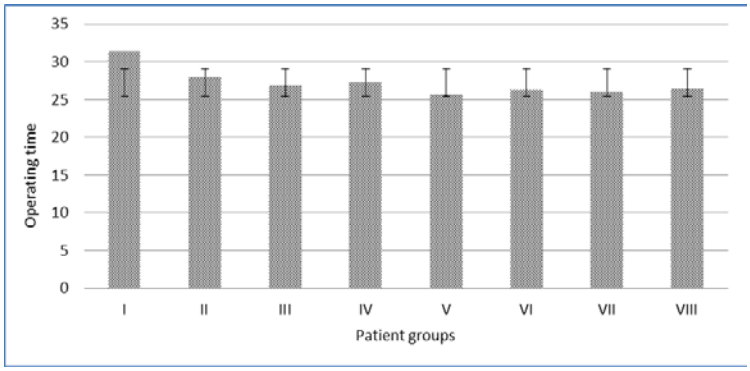

Figure 1. Timeline of procedure duration among groups. Significance in I vs. VII p < .005 (p = .034); with no significance in comparison of operating time between other subsequent groups

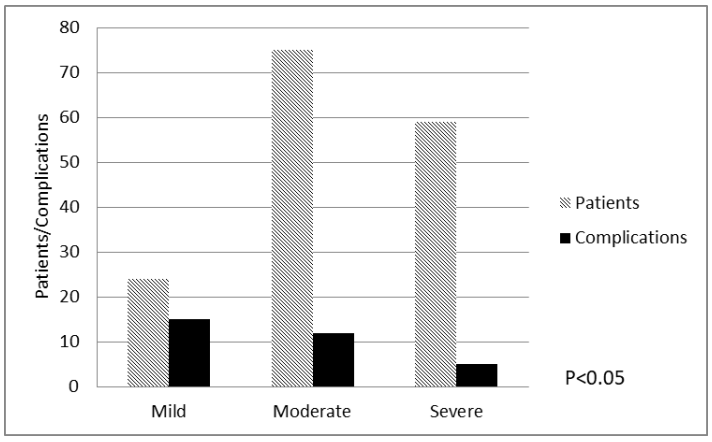

Figure 2. The presence of strong statistical significance concerning hydronephrosis grade and frequency of complications, X^2 (2, N = 158) = 17.31, p = .000174

Table 2. The Clavien–Dindo classification of the 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/reinsertio n	10 (6.33%)
IIIa	Subcapsular haemathoma	Prolonged hospital stay (> 72 h)	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

The difference in the complication rates between the patients' benign and malignant disease groups 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 in the occurrence of complications between the examined groups ($\chi^2 = 0.3033$, $p < .05$).

As mentioned, CCI score was used to compare the "weight" of the comorbidity score, incidence of complications, and feasibility of procedure among weighted groups. Group I included 42 patients (26.6%) with a score of 0, Group II included 55 patients (34.8%) with a score of 1 and Group III included 61 patients (38.6%) with a score of ≥ 2. There was no statistical significance between groups when observing the incidence of complications. Additionally, there was no significance in the feasibility of percutaneous nephrostomy procedure within different comorbidity groups, as indicated by χ^2 (2, N 158) = 0.0546, p = .973082 (Figure 3).

No statistical significance was found when analyzing complications across BMI groups. For the underweight group (BMI < 18.5 kg/m², N = 10, 6.3%), there were 3 complications (1.9%); for the normal weight group (BMI 18.5–24.9 kg/m², N = 74, 46.8%), there were 14 complications (8.86%); for the overweight group (BMI 25–29.9 kg/m², N = 51, 32.3%), there were 10 complications (6.30%); and for the obese group (BMI > 30 kg/m², N = 23, 14.6%), there were 5 complications (3.16%). This was supported by $\chi 2$ (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 without 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).

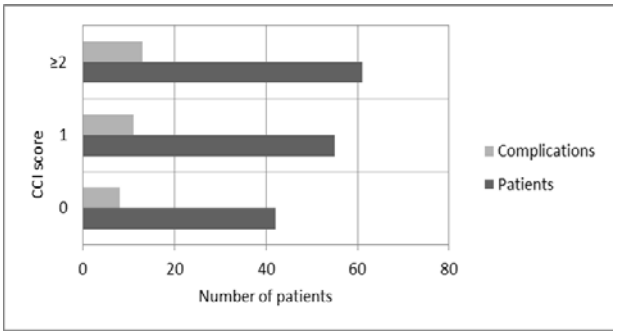

Figure 3. Complications incidence among Charlson Comorbidity Index (CCI) score groups, $\chi 2$ (2, N = 158) = 0.0546, p = .973082

Discussion

In our study, in 4 years, 158 procedures were performed by placing PCN catheters under complete ultrasound guidance as an outpatient surgical procedure. The study is of prospective design. 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 CCI, Clavien–Dindo classification of complications, BMI observance and "shredded" timeline groups for learning curve observation.

Most papers previously published have shown successful PCN placement without complications in more than 90 percent of cases. However, most of them have not shown the results within the outpatient procedure cohorts. The success rates for nephrostomy catheter placement under exclusive ultrasonic guidance 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 suggest an upper limit of 4% of PCN complications. Guidelines in Europe are still under preparation. Even studies with CT-enhanced PCN procedures are showing relatively similar incidence of complications, although designed for more complex cases (8).

Our study found that none of the patients required a transfusion due to bleeding following PCN. Additionally, there were no reported injuries to intra-abdominal organs such as the spleen, liver, colon, or 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 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 based on the Third International Consensus on the definition of sepsis and septic shock (12). Comparatively, in the literature, concerning 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 (15, 10, 11). Transient hematuria after the procedure is a common condition that is difficult to quantify. However, 19 patients (12.03%) who had hematuria in the urine after PCN placement were classified into minor complications for 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 patients, haematuria was lost spontaneously or after mild nephrostomy catheter rinsing with saline (< 24 h).

Percutaneous nephrostomy primarily provides time for treatment planning and allows for a multidisciplinary approach to address pathological conditions associated with kidney and ureter blockage, diagnosis and preparation for their definitive surgical solutions. Further, in a certain number of patients, it serves as the final means of urine derivation when no alternative surgical options are available for restoring the natural urine pathway.

Conclusion

Ultrasound-guided percutaneous nephrostomy as an outpatient procedure is a safe and effective procedure in terms of both therapeutic and diagnostic treatment. Studies have highlighted the importance of patient selection criteria to ensure the safety and effectiveness of nephrostomy as one-day surgery. Epidemiological aspect should be emphasized during the pandemic of COVID-19 as PCN is not an aerosol-generating procedure. It enables the functioning and preservation of renal function when the definitive solution should be waited in a limited timeframe.

Performing percutaneous nephrostomy in an outpatient manner represents a safe and feasible procedure.

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PERKUTANA NEFROSTOMIJA U OPSTRUKTIVNOJ UROPATIJI: ANALIZA IZVODLJIVOSTI OPERACIJE I KOMPLIKACIJA U JEDNODNEVNOJ HIRURGIJI I LOKALNOJ ANESTEZIJI

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Opstruktivna uropatija predstavlja patološko stanje u kojem je blokiran prirodni tok urina. Opstruktivna uropatija dovodi do povećanja pritiska unutar kolektornog sistema bubrega i mogućeg trajnog oštećenja funkcije bubrega. Cilj ovog rada bio je da se ispitaju efikasnost i izvodljivost perkutane nefrosmotije, učestalost komplikacija, kao i ishodi hitne ili elektivne deblokade bubrega kao jednodnevne hirurške procedure u lokalnoj anesteziji kod bolesnika sa benignom ili malignom patologijom. Prospektivna studija je do sada obuhvatila 158 bolesnika − 94 žene (59,49%) i 64 (40,50%) muškarca − koji su podvrgnuti proceduri perkutanog plasmana nefrostomskog katetera na Odeljenju urologije u Opštoj bolnici „Aleksa Savić" u Prokuplju između januara 2020. godine i januara 2024. godine. Uspešnost procedure iznosila je 97,47%. Kod više od 40% bolesnika indikacija za plasman nefrostomskog katetera bila je kalkuloza. Incidencija komplikacija u našoj studiji korelira sa incidencijom prikazanoj u literaturi. Kada je reč o gradusu hidronefroze, između blage, izražene i teške hidronefroze postojala je očigledna statistička razlika u učestalosti pojave komplikacija između ispitanih grupa. Sve komplikacije su klasifikovane prema pet gradusa modifikovanog Clavien–Dindo klasifikacionog (C–D) sistema. Većina komplikacija bila je niskog gradusa prema C–D sistemu: 19 bolesnika (12,03%) sa drhtavicom, bolom ili prolaznom hematurijom (klasifikovani kao C–D gradus I). Mada perkutana nefrostomija prvenstveno daje više vremena za planiranje lečenja, kod određenog broja bolesnika predstavlja definitivnu urinarnu derivaciju kada ne postoji mogućnost daljeg operativnog lečenja. Iako postoji proces savladavanja krive učenja, perkutana nefrostomija predstavlja suverenu metodu brze intervencije kod razvijene opstrukcije. Plasman perkutanog nefrostomskog katetera kao jednodnevna hirurška procedura u lokalnoj anesteziji sigurna je i isplativa metoda kod odabranih bolesnika.

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