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PERCUTANEOUS NEPHROSTOMY AS A PROCEDURE IN THE TREATMENT OF URINARY TRACT OBSTRUCTION – EXPERIENCES IN THE UNIVERSITY CLINIC OF UROLOGY IN SKOPJE

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ABSTRACT

Introduction: Obstructive uropathy encompasses various urinary tract obstructions, leading to changes in urine flow, kidney pressure, and impaired kidney function. Predicting renal recovery from obstructive uropathy, can be challenging and necessitates treatment, as in percutaneous nephrostomy (PNS) drainage. The choice of drainage method depends on patient-specific factors and local expertise. According to the data for the Republic of North Macedonia, in the register of the European Renal Association, in the last few years, there has been an increase in the percentage of patients with obstructive nephropathy from 7.6% to 8.9% who end up on a chronic hemodialysis program. Prompt relief from urinary tract obstruction is essential to preserve renal function and prevent complications.

The aim of this study is to present our initial data analysis of recent experience in the use of nephrostomies as a method for temporary or long-term resolution of obstructive nephropathy, in terms of safety and success in preserving kidney function and reducing the number of patients on hemodialysis.

Materials and methods: This study analyzed the medical records of 24 patients with obstructive uropathy who underwent PNS placement. Data were collected for the type and degree of obstruction from the ultrasonographic examination. A pig tail nephrostomy was used, with a dilator, guided under ultrasound and controlled with contrast and fluoroscope. Obstructive nephropathy was defined as an elevation of the serum creatinine > 109 μmol/L, before the intervention. Glomerular filtration rate (GFR) was calculated according to the formula CKD epi in ml/min. Each placement of the PNS was considered as an individual procedure and the data of 38 placed nephrostomies were analyzed. We compared the laboratory analyses from the day before (D0) PNS placement and on the seventh day (D7) after PNS placement. The reduction of values for red blood cells (RBC) and hemoglobin (Hb) baseline values from D0 to D7 and the need for transfusion after the procedure were defined as a complication-bleeding. The increase in total counts of the white blood cells (WBC) and C-reactive protein (CRP) from the baseline values from D0 to D7 were defined as a complication-infection. Standard statistical methods were used for data processing.

Results: Most patients, 17 (70%), had malignant disease as the cause of obstruction. Unilateral obstruction was more common, detected in 24 (63%) of procedures, with a high degree of hydronephrosis. Obstructive nephropathy, marked by elevated serum creatinine, was observed in 23 (60%) cases before PNS placement. Complications included bleeding and infection but did not result in any fatalities. When comparing the laboratory analysis before PNS placement (D0) and seven days later (D7), a statistically significant decrease in serum creatinine (225±161 vs. 162±145, p=0.005) and an increase in GFR (47±39 vs.59±34, p= 0.005) were observed.

Conclusion: Percutaneous nephrostomy is a safe and effective treatment option for urinary tract obstruction, especially in patients with malignancies. Continuous monitoring is essential to assess long-term compli-

cations and the longevity of PNS functionality. This procedure offers a significant benefit in preserving renal function and minimizing the need for hemodialysis in these patients.

Keywords: Urinary Tract Obstruction, Obstructive Nephropathy, Percutaneous Nephrostomy, Kidney Function

INTRODUCTION

Obstructive uropathy refers to the syndrome caused by urinary tract obstruction, either functional or anatomic from malignant or benign processes in the urinary system or surrounding organs and structures. It includes urinary tract dilatation, impedance and the resulting slowing of urine flow, change in the pressure inside the kidney tubular system and impaired kidney function.

Ultimately, however, the rate of irreversible obstructive injury is a multifactorial process influenced by the degree, level, and duration of the obstruction, as well as by the presence of infection [1]. In a clinical situation, it is difficult to predict how much renal function will be recoverable in an individual patient; thus, a therapeutic trial of nephrostomy drainage may be indicated before judging a kidney to be irreversibly damaged.

The type of drainage should be determined by local technical expertise and availability as well as patient-specific factors [2]. A morbidly obese or a patient with coagulopathy with a minimally dilated collecting system that is poorly visualized by ultrasound may be better served by retrograde ureteroscopic stent placement.

Essential in treatment is to relieve the urinary tract from obstruction, as quickly as possible, in order to preserve renal function and prevent the occurrence of further complications such as infections and the need for hemodialysis treatment.

One of the methods for treating obstructive nephropathy is percutaneous placement of nephrostomies. It can be performed with two methods: Seldinger technique and one-stab technique, either depending on the location of obstruction (unilateral or bilateral). Complications from the procedure, such as bleeding, infection, etc., sometimes may occur [3].

According to the data for the Republic of North Macedonia, in the register of the European Renal Association, in the last few years, there has been an increase in the percentage of patients with obstructive nephropathy from 7.6% to 8.9% who end up on a chronic hemodialysis program [4, 5, 6]. This is one of the reasons that brought forth a recent need to start placing NS at the University Clinic of Urology, as is done at the University Clinic of Nephrology. This initiative should contribute to reduction of the total number of patients on dialysis, not only as a number from an economic aspect, but also from the aspect of better quality of life, especially for patients with malignant disease.

The aim of this study is to present our initial data analysis of recent experience in the use of nephrostomies as a method for temporary or long-term resolution of obstructive nephropathy, in terms of safety and success in preserving kidney function and reducing the number of patients on hemodialysis.

MATERIALS AND METHODS

In this study we analyzed the data from the medical history of 24 patients over a one year period, with obstructive uropathy. These patients had a percutaneous nephrostomy placed at the University Clinic of Urology. From the ultrasonographic examination of the urinary tract before PNS placement, data were processed for: the type of obstruction (unilateral or bilateral) as well as the degree of obstruction (graduated as hydronephrosis of I, II, III and IV grade). In all cases normal coagulation status was obtained before the procedure. A pig tail nephrostomy was used, with a dilator, guided under ultrasound and controlled with contrast and fluoroscope. Obstructive nephropathy was defined as an elevation of the serum creatinine > 109 μmol/L, before the intervention. Glomerular filtration rate (GFR) was calculated according to the formula CKD epi in ml/min. Each placement of the

PNS was considered as an individual procedure and data of 38 placed nephrostomies were analyzed. We compared the laboratory analyses from the day before (D0) PNS placement and on the seventh day (D7) after PNS placement. The reduction of values for red blood cells (RBC) and hemoglobin (Hb) baseline values from D0 to D7 and the need for transfusion after the procedure were defined as a complication-bleeding. The increase in total counts of the white blood cells (WBC) and C-reactive protein (CRP) from the baseline values from D0 to D7 were defined as a complication-infection. All patients received antibiotics in prophylactic doses. Standard statistical methods were used for data processing. Continuous variables were presented with mean and standard deviation, and nominal variables with numbers and percentages. A t-t test was used for comparison, and values for $p < 0.05$ were taken as statistically significant.

RESULTS

The patients' median age was 63.5 (28-89) years, 13 males and 11 females. In 16 patients, the obstruction induced nephropathy with elevated creatinine. In 15 (62%) of the patients, previous treatment of the obstruction was done surgically, with the placement of a J-J ureteral stent, and/or there was a need for treatment with hemodialysis. Out of the total number of 24 patients, 16 had PNS placed only on one occasion, while 8 of them needed PNS on more than on one occasion (5 patients on two occasions, two on three occasions and one had as many as 6 PNS placed). (Table 1)

Malignant disease was the cause of the obstruction in 17 (70%) of the patients, and in most of them these were from the urinary tract or surrounding organs. (Table 2)

Table 1. *Baseline characteristics of patients*

Total number of pts, n=24		**mean(rang) No (%)**
Age (years)		63.5 (28-89)
gender	**male**	**13 (55%)**
	female	11 (45%)
Serum creatinine (µmol/L)	**<109**	8 (33%)
	>109	**16 (67%)**
Previous treatment, n=15		
surgical **hemodialysis** **J-J ureteral stent**		6 (25%) 3 (12%) 6 (25%)
Number of procedures (nephrostomy)/ patient		
one		**16 (16%)**
> one		**8 (33%)**

Table 2. *Etiology of obstruction*

Etiology, n=24	**No (%)**	**Percentage (%)**
A. **Malignant process**	**(17)**	**70 %**
1. Uterine cancer/ Uterine Cervical Cancer	2 6	
2. Urinary bladder cancer	3	
3. Prostate cancer	2	
4. Ureter cancer		
5. Distant metastasis:		
- lung	1	
- breasts	1	
- rectum	1	
- colon	1	
B. **Nonmalignant process**	**(7)**	30%
- nephrolithiasis	6	
- pyonephrosis	1	

Unilateral obstruction was present in 63% of cases. The higher degree of hydronephrosis (II and III degrees) before PNS placement was present in 15 patients. In more than half of the cases, the patients had already developed obstructive nephropathy with serum creatinine higher than 109 μmoll/L. Bleeding was present in five, and blood transfusion was required in three patients due to per procedural bleeding, occurring mostly as part of an underlying malignant disease.

An increase in CRP and fever was registered in four cases, indicating the occurrence of infection as a procedural complication. There was no mortality after PNS placement. (Table 3)

When the laboratory data from D0 and D7 were compared, a significant decrease in the total counts of WBC and values for CRP were found. A significant improvement in renal function was also noted with a statistically significant decrease in serum creatinine and an increase in eGFR at D7. Total counts for RBC and hemoglobin values, before and after the interventions, remained without significant changes. (Table 4)

The median duration of PNS was 3.3 months with a range of (0.25–12) months. In that period, three of the patients underwent surgical treatment as a permanent resolution of the obstruction, and 5 patients died from a cause not related to the procedure.

Table 3. *Description of the type, degree of obstruction and presence of obstructive nephropathy before PNS and complications occurrence after the procedures*

Number of procedures, n= 38		**No (%)**
Hydronephrosis	unilateral	**24 (63%)**
	bilateral	14 (37%)
Degree of hydronephrosis	I	1 (3%)
	II	20 (53%)
	III	14 (37%)
	IV	1 (3%)
Serum creatinine (μmol/L)	<109	17 (40%)
	>109	23 (60%)
complications	bleeding transfusion	5 (13%) 3 (8%)
	infection	4 (10%)

Table 4. *Comparison of laboratory values before (D0) and after (D7) PNS placement*

values	**D0** **Mean (±SD)**	**D7** **Mean (±SD)**	**p**
RBC (10^12/L)	4.2 (± 0.99)	4.2 (±0.81)	0.43
Hb (g/L)	108 (±11.12)	114 (±21.12)	0.10
WBC (10^9/L)	11 (±5.45)	9.9 (±4.2)	**0.002**
Urea (mmol/L)	9.2 (±5.81)	6.6 (± 5.14)	**0.003**
Creatinine (μmol/L)	225 (±161.44)	162 (±145.79)	**0.005**
eGFR (ml/min)	47(±39)	59(±34)	**0.005**
CRP (mg/L)	76 (± 64.88)	45 (± 41)	**0.017**

*Red blood cells (RBC), White blood cells (WBC), hemoglobin (Hb), Glomerular filtration rate (GFR), c-reactive protein (CRP)

DISCUSSION

Percutaneous nephrostomy (PCN) placement was first described in 1955 by Goodwin et al. as a minimally invasive treatment for urinary obstruction, causing marked hydronephrosis [7].

Relief of urinary obstruction represents the most common indication for PCN placement representing 85 to 90% of patients in several large series [8]. The three most common causes of renal obstruction in adults are urinary stones, malignancy, and iatrogenic benign stricture. In one large series, 39% of all nephrostomy tubes were placed due to of calculus disease and 61% due to malignancy [6, 9]. These findings are consistent with the etiology of obstruction in this series, where 17 (70%) had a malignant disease as a cause of the obstruction. According to Quality Improvement Guidelines for Percutaneous Nephrostomy in 2016, more than fifty percent of obstructions are caused by stones [10].

Ultrasound is usually the first diagnostic tool due to relative availability, minimal risk, and high sensitivity for detecting a dilated collecting system in terms of description of the type (unilateral or bilateral) and degree (I-IV). However, compared with other imaging methods it is not as effective in determining the etiology and location of obstruction [11]. Unilateral hydronephrosis was detected more often, as much as 63% and a higher degree of hydronephrosis of II degree in 20 cases and III degree in 14 cases (53% and 37%), respectively.

Clinical data suggests that complete recovery of the glomerular filtration rate (GFR) can be expected within one week of complete obstruction with minimal improvement seen after 12 weeks of complete obstruction. (12, 13) Complete or partial obstruction of urine flow leads to elevated urinary pressure with associated afferent arteriolar vasoconstriction causing a marked reduction in glomerular blood flow. Over time, chronic obstruction leads to permanent progressive functional loss through a combination of ischemic or disuse-induced tubular injury as well as inflammation and interstitial renal fibrosis [14].

In 23 (60%) of the procedures an increase in serum creatinine, and a drop in GFR were registered, before PNS placement, as a result of the obstruction and the development of obstructive nephropathy. Three patients were treated with hemodialysis. Seven days after PNS placement, the results showed a statistically significant decrease in serum creatinine, as well as an increase in GFR. It also points to the success of the procedure in resolving not only the uropathy but also the nephropathy as a result of the obstruction.

Most series reports combined major and minor complication rates of PCN placement of 10% with a mortality rate of 0.05 to 0.3% [8, 15]. The major complications can be divided into three types, injury to adjacent structures, severe bleeding, and severe infection/sepsis.

The Society of Interventional Radiology (SIR) guidelines for the periprocedural management of coagulation categorizes nephrostomy placement as a procedure with ‘‘significant bleeding risk, which is difficult to detect or control” [16]. Farrell and Hicks noted that bleeding complications requiring transfusion occurred in 2% of patients with normal coagulation parameters and 4% of patients with a coagulopathy [9]. These measures to prevent procedural bleeding were applied in all 38 procedures.

Transient minor bleeding after nephrostomy tube placement is very common, occurring in up to 95% of cases. Severe post procedure bleeding requiring transfusion or other intervention is reported to occur in 1- 4% of patients [1]. This can take the form of hematuria or retroperitoneal bleeding. Small retroperitoneal hematomas not requiring treatment have been reported in up to 13% of patients imaged with computed tomography after nephrostomy placement [8].

Bleeding as a complication of the procedure was observed in 5 (13%) cases. All of these cases were mild and the bleeding stopped spontaneously. Three required blood transfusions, but this was consistent with the overall clinical condition of malignancy present, and no significant difference was found when comparing the total number of RBCs and Hb values before and after PNS placement.

A transient low-grade fever is common after PCN placement, with one study reporting a 100% incidence in 160 patients receiving emergency PCN placement [17]. A second study consisting of patients receiving nonemergent PCN placement as an outpatient procedure noted fevers and chills without hypotension to occur in 21% of patients. Whether this always represents a microbial response or is sometimes a response to inflammatory mediators released by the procedure is debated [18]. Progression to septic shock, with

fevers, chills and hypotension, is less common and reported to occur in 1 to 3% of all patients and 7 to 9% of patients with pyonephrosis [19]. Because urosepsis has a high mortality risk, prevention is the key. It is always better to schedule the intervention, when possible. The timing of percutaneous nephrostomy (PCN) procedures can have a significant impact on patient outcomes, with a clear difference observed between those performed during working hours and non-working hours. A recent study demonstrated that complications were notably more common when PCNs were carried out outside regular working hours, with a striking 71.4% of cases experiencing complications in this context. By contrast, when performed within working hours, the incidence of complications significantly decreased to 17.3%. This disparity underscores the importance of scheduling PCN procedures during regular working hours, as it not only minimizes the risk of complications but also ensures a safer procedure and better outcome for the patients in establishing a satisfactory preservation of renal function [20]. In our study, an increase in the absolute number of WBC and values in CRP were observed after the placement of PNS in 4 (10%) of the patients indicating the development of infection. Even though each PCN was performed during working hours, due to the urgency, in 3 of them there was a previous attempt of placing a ureteral stent without microbiological examination of urine due to the urgency.

In patients with a high risk of developing gram-negative sepsis, urgent or emergent percutaneous nephrostomy is recommended. Percutaneous nephrostomy timing should be determined by the clinical condition of each individual patient [10].

In the setting of dilated, obstructed collecting systems, successful PCN placement is achieved in 98 to 99% of patients. As might be expected, a lower success rate of 85 to 90% has been reported for PCN placement in nondilated systems or for complex stone disease [19]. After PCN placement in patients with azotemia secondary to obstruction, renal function has been noted to normalize in two-thirds of patients within 15 days, with a mean of 7.7 days [21]. After PCN placement in patients with pyonephrosis, fever and flank pain usually improve within 24 to 48 hours [22].

There was a successful PNS placement, with proper urine derivation in the study. The first assessment of patients on D7 indicated a state of stability in relation to the occurrence of further bleeding and infection, as well as recovery with a significant drop in serum creatinine. The average duration of the nephrostomy was 3.3 months. The high percentage of success might be explained with the high degree of hydronephrosis.

STUDY LIMITATIONS

Small Sample Size

The study's sample size is relatively small (24 patients), which may limit the generalizability of the findings and could be prone to selection bias.

Retrospective Design

The study is retrospective, which means it relies on historical patient data. This type of design can introduce various biases, including recall bias and the inability to control for all potential confounding variables.

Single-Center Study

The study is conducted at a single center, which might limit the applicability of the findings to a broader population. Different medical centers may have variations in patient demographics, procedures, and outcomes.

Lack of a Control Group

The absence of a control group makes it challenging to determine the efficacy of percutaneous nephrostomy compared to other treatment methods or the natural course of the condition.

CONCLUSION

PNS is the method of choice for treating urinary tract obstruction in patients in whom the use of J-J stent and/or surgical intervention are not feasible. PNS is safe and ensures satisfactory preservation of renal function. It is especially significant for patients with malignant diseases who are not burdened by additional treatments such as hemodialysis. Continuous monitoring of patients with PNS is required in terms of long-term complications and survival of PNS itself.

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Резиме

ПЕРКУТАНАТА НЕФРОСТОМА КАКО ПРОЦЕДУРА ВО ТРЕТМАН НА ОПСТРУКЦИЈА НА УРИНАРНИОТ ТРАКТ – ИСКУСТВА ВО УНИВЕРЗИТЕТСКАТА КЛИНИКА ЗА УРОЛОГИЈА ВО СКОПЈЕ

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Вовед: Опструктивната уропатија е резултат на повеќе причини, кои доведуваат до промени во уринарниот тек, застој на урината, зголемен притисок во бубрезите и нарушена бубрежна функција. Предиктивноста за опоравување на бубрежната функција од опструктивната нефропатија претставува голем предизвик и тоа наметнува потреба од примена на перкутана нефростома како метода за дренажа. Изборот на методата зависи од специфичните фактори поврзани со пациентот и од самата експертиза. Според податоците во регистарот на Европската бубрежна асоцијација за Република Северна Македонија, во последните години има зголемување на процентот на пациенти со опструктивна нефропатија од 7,6 % на 8,9 % што завршуваат на програмата за хронична хемодијализа. Брзата дезопструкција на уринарниот систем е од суштинско значење за зачувување на бубрежната функција и спречување на компликациите.

Цел на оваа студија е да ја прикаже нашата првична анализа на податоци од неодамнешните искуства во поставувањето на нефростоми, како метод за привремено или долгорочно решавање на опструктивна нефропатија, од аспект на безбедност и успешност, зачувување на бубрежната функција, а со тоа и намалување на бројот на пациенти на хемодијализа.

Материјал и методи: Анализирани беа медицинските досиеја на 24 пациенти со опструктивна уропатија, на кои им била поставена ПНС. Податоци за видот и степенот на опструкцијата беа добиени од ултрасонографски преглед. Нефростома од видот на “pig tail” беше поставена со претходно пласирање дилататор, водена под ултразвук, а направена е контрола со вбризгување на контраст под флуороскоп. Опструктивната нефропатија беше дефинирана како покачување на серумскиот креатинин > 109 μmol/L, пред интервенцијата. Стапката на гломеруларна филтрација (ГФР) беше пресметана според формулата CKD epi во ml/min. Секое поставување на ПНС се сметаше како индивидуална процедура и беа анализирани податоците од 38 поставени нефростомии. Ги споредивме лабораториските анализи од денот пред поставување на ПНС (Д0) и седмиот ден (Д7) по поставувањето на ПНС. Намалувањето на апсолутниот број еритроцити (Ер) и хемоглобинот (Hb) од Д0 до Д7, како и потребата за трансфузија на декантирани еритроцити по процедурата беше дефинирано како компликација – крвавење. Зголемувањата на вкупниот број леукоцити (Ле) и С-реактивен протеин (ЦРП) од основните вредности на D0 до D7 беа дефинирани како компликација – инфекција. За обработка на податоците беа користени стандардни статистички методи.

Резултати: Поголемиот дел од пациентите 17 (70 %) имаа малигно заболување како причина за опструкцијата. Едностраната опструкција беше почеста, присутна кај 24 (63 %) од процедурите, со висок степен на хидронефроза. Опструктивна нефропатија беше забележана кај 23 (60 %) од

случаите пред поставување на ПНС. Нотирани беа компликации како крвaнење и инфекција, но тие не претставуваа причина за фатален исход. При споредба на лабораториските анализи пред поставување на PNS (D0) и седум дена подоцна (D7), забележавме статистички значајно намалување на серумскиот креатинин (225±161 v.s 162±145, p=0.005) и зголемување на GFR (47±39 v.s 59 ±34, p= 0,005).

Заклучок: Поставувањето на ПНС е безбедна и ефикасна опција за третман на опструкцијата на уринарните патишта, особено кај пациентите каде што причинител на опструкцијата е малигно заболување. Континуираното следење е од суштинско значење за да се проценат долгорочните компликации, траењето и функционалноста на ПНС. Оваа процедура нуди значителна корист за зачувување на бубрежната функција и минимизирање на потребата за хемодијализа кај овие пациенти.

Клучни зборови: опструкција на уринарните патишта, опструктивна нефропатија, перкутана нефростомска, бубрежна функција