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Original Article

The results of ultrasound-guided percutaneous nephrostomy tube placement for obstructive uropathy: A single-centre 10-year experience

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ABSTRACT

Objective: The aim of this study was to determine the results of ultrasound-guided percutaneous nephrostomy tube placement performed solely by urologists. We present our relevant one decade experience in a tertiary care hospital.

Material and methods: We evaluated technical success and complication rates of ultrasound-guided percutaneous nephrostomy tube placement for obstructive uropathy in our clinic, between December 2004 and January 2015. Data were retrieved retrospectively from patients' files. This procedure was performed by urologists and two different methods for renal access were employed: Seldinger technique and direct puncture technique. Percutaneous nephrostomy tube placement was considered successful if the tube was placed in the renal pelvis and drained urine spontaneously and adequately. Complications were classified according to the Guideline of Society of Interventional Radiology Guidelines for Percutaneous Nephrostomy.

Results: Four hundred and fifteen percutaneous nephrostomy tube placements were performed in 354 patients (165 men and 159 women) suffering from obstructive uropathy due to several benign (57.3%) or malign (42.7%) diseases. The mean age in this study group was 43.2 years (range 27 to 81). We were found that 228 procedures were performed by using the Seldinger technique and 187 using direct puncture technique. The overall technical success, major and minor complications rates were 96.1%, 11.1%, and 7.7%, respectively. The Seldinger technique and direct puncture technique were compared: technical success rate was 97.8% vs. 94.1% (p=0.052). There was no difference between the two techniques in terms of major and minor complication rates.

Conclusion: Ultrasound-guided percutaneous nephrostomy tube placement is a safe, easy and effective technique for providing temporary or permanent drainage of an obstructed renal pelvi-calyceal system. This procedure can be performed effectively and safely by an urologist.

Keywords: Achievement; obstructive uropathy; percutaneous nephrostomy; postoperative complications; urologists.

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Introduction

The term obstructive uropathy describes all structural and functional changes, manifesting as a restriction of normal urine flow which leads to progressive renal injury if left untreated dependent on the severity, duration, and presence of concomitant infection, renal functions are affected at various degrees.[1] As two valid treatment options, retrograde placement of ureteral catheter or nephrostomy tube is indicated temporarily till definitive treatment of potentially life-threatening obstruction is achieved, or permanently cases where treatment is not possible.[2]

In cases where advancement of ureteral catheter proximal to the obstruction is not technically feasible or not appropriate even if feasible, placement of a percutaneous nephros-

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tomy tube is an ideal urinary diversion method.[2] Probably in many countries, ultrasound-guided percutaneous placement of nephrostomy tube has been realized by radiologists, and nearly all studies demonstrating technical success, and complication rates have been performed by radiology clinics.[3] Though percutaneous interventions are well known by urologists, in very few publications outcomes of ultrasound-guided percutaneous nephrostomy tube placement performed by urologists are evaluated in the literature.[3-7] The aim of our study is to evaluate technical success, and complication rates in patients who underwent ultrasound-guided percutaneous placement of nephrostomy tube with the indication of obstructive uropathy during a 10 year period in a urology clinic of a university hospital.

Material and methods

For this study approval of Ethics Committee of Mersin University was obtained (11/23/2017; decision no. 2017/327). Demographic data, etiologies of obstruction, technical details of percutaneous nephrostomy, and complications of the patients who underwent ultrasound-guided percutaneous nephrostomy tube placement performed by urologists between December 2004, and January 2015 because of supravesical obstructive nephropathy developed secondary to benign, and malignant etiologies were retrospectively evaluated. Patients with abnormal coagulation parametres, renal position or fusion anomalies, previous renal surgery or those with a history of disease or medical treatment which would affect these parametres were not included in the evaluation.

Preparation before percutaneous nephrostomy

Coagulation parametres of all cases were evaluated before percutaneous nephrostomy tube placement, and one hour before the procedure a single dose of prophylactic antibiotic (ceftriaxone 1 g IV) was administered. The patients were placed in lateral decubitus position using a lumbar cushion with the diseased part facing upwards. Before the procedure, renal anatomies, and degrees of hydronephrosis of the patients were evaluated as described by Fernbach et al.[8] during ultrasonographic examination using a 3.5-MHz convex probe (Grade I-IV). For intrarenal access into collecting system, lower pole posterior calyceal access through a puncture made nearly 2 cm below the 12th rib on the posterior axillary line was selected. After preparing a sterile surgical site, local anesthesia was applied on the puncture line, and using an 11 G scalpel the anatomical layers from the skin down to fascia was punctured. Two different techniques were used for ultrasound-guided access into collecting system.

Percutaneous nephrostomy using Seldinger technique

Collecting system was entered using a sheathed 18 G needle, and urine flow was checked for the confirmation of correct access. The needle was removed, and 0.038" J-type guidewire was advanced through the sheath. Nephrostomy tract was dilated with Amplatz type dilators up to a diameter which exceeds the caliber of the nephrostomy tube (8-12 F) which was chosen based on patient's anatomical characteristics. Afterwards, nephrostomy tube was advanced over guidewire, and guidewire was withdrawn, and nephrostomy tube was fixed to the skin with 3/0 silk sutures.

Percutaneous nephrostomy using direct puncture technique

Trocar-tip needle placed in a nephrostomy tube (8-12 F) chosen based on patient's anatomical characteristics was inserted into collecting system, and then the needle was withdrawn. Urine flow was observed to confirm the correctness of access. The cannula of the needle was taken out, and nephrostomy tube was fixed to the skin with 3/0 silk sutures.

Patient follow-up after percutaneous nephrostomy

In all cases the first urine samples coming from the catheter were sent for urine culture/antibiogram. After the procedure, the patients were followed up for an average of 4 hours in a day care unit. Excluding the patients who manifested complications or those scheduled for maintenance antibiotherapy, all patients were discharged after follow-up period. Antibiotherapy that was initiated for patients with clinically suspect infection and/or infected urine flow coming from the catheter was empirically maintained on antibiotherapy (ceftriaxone IV 2 x 1 g). Antibiotherapy was adjusted based on the results of culture/antibiogram. Fluid-electrolyte balance, and renal function test results were monitored.

Engagement of nephrostomy tube in renal pelvis, and spontaneous urine flow was defined as procedural success.[9] In cases where the procedure failed, one day following parenteral hydration, percutaneous placement of nephrostomy tube was achieved using Seldinger technique under fluoroscopy/ultrasound guidance. Complications were classified according to the Percutaneous Nephrostomy Guideline of Society of Interventional Radiology (SIR). Complications which did not require treatment or those without significant outcomes which necessitated minimal treatment were accepted as minor complications, while complications which required treatment, hospitalization longer or shorter than 48 hours or those leading to unplanned increase in the treatment or resulting in permanent sequelae or death of the patient were considered as major complications.[9]

Statistical analysis

Descriptive statistics for continuous variables were expressed, and also tabulated as mean ± standard deviation, and for cat-

Table 1. Obstructive etiologies considered as indications for percutaneous nephrostomy

Benign diseases	n	%	Malignant diseases	n	%
Pyonephrosis	66	18.6	Cervical cancer	57	16.1
Stone disease	61	17.2	Prostate cancer	43	12.2
Ureteral injury	34	9.6	Bladder cancer	31	8.8
Ureteral obstruction	25	7.1	Rectal cancer	9	2.5
Pregnancy	11	3.1	Endometrial cancer	6	1.7
Neurogenic bladder	6	1.7	Ovarian cancer	5	1.4

Table 2. Grades of hydronephrosis of the patients, and success rates of access techniques used

	Seldinger technique (%-n/N)	Direct puncture (%-n/N)	p
Grade I	97.5% (39/40)	82.1% (32/39)	0.029
Grade II	97% (64/66)	94.2% (49/52)	0.653
Grade III	97.4% (76/78)	98.2% (55/56)	0.999
Grade IV	100% (44/44)	100% (40/40)	0.999
Overall	97.8% (223/228)	94.1% (176/187)	0.052

egorical variables as frequencies, and percentages (%) For the comparison of characteristics of the patients with success, and complication rates of Seldinger, and direct puncture techniques applied, Pearson Chi-Square, Likelihood Ratio or Fisher's Exact Tests were used dependent on the distribution of frequencies. For statistical analyses SPSS® (Statistical Package for the Social Sciences Inc, Chicago, ABD) version 17.0 package program was employed, and p values less than 0.05 were deemed to be statistically significant.

Results

Mean age of the patient population that consisted of 159 (44.9%) women, and 203 (57.3%) men was 43.17±16.59 years, A total of 415 nephrostomy tubes were placed (unilateral, n= 293, and bilateral, n=61) due to development of obstructive uropathy secondary to benign (n=203; 57.3%) or malignant (n=151; 42.7%) etiologies (Table 1). Overall technical success rate was calculated as 96.1% (399/415) in percutaneous nephrostomy tube placement using Seldinger (n=228; 54.9%) or direct puncture (n=187; 45.1%) techniques. Grades of hydronephrosis, success rates of the techniques applied are presented in Table 2. Minor,

Table 3. Complications (%) detected in percutaneous nephrostomy interventions

Complications	n	%
Minor		
Temporary (<72 hours) macroscopic hematuria	17	4.1
Fever	14	3.4
Colicky pain	9	2.2
Vazovagal symptoms	4	1
Urinary extravasation not requiring any intervention / urinoma	2	0.5
Major		
Recurrent placement of percutaneous nephrostomy tube due to occlusion of the tube with clots secondary to macroscopic hematuria	10	2.4
Macroscopic hematuria requiring blood transfusion	7	1.7
Recurrent placement of percutaneous nephrostomy tube due to displacement /malposition of the nephrostomy tube	6	1.4
Urosepsis	5	1.2
Retroperitoneal hematoma requiring blood transfusion	2	0.5
Urinoma requiring percutaneous intervention	1	0.2
Injury to a neighbouring organ or vessel	1	0.2

and major procedural complication rates were 11.1% (46/415), and 7.7% (32/415), respectively. Any correlation between grades of hydronephrosis, access technique applied, and complication rates was not detected. Minor, and major complication rates for Seldinger, and direct puncture techniques were 12.3% 9.6%, and 6.6% vs. 9.1%, respectively (p values were 0.391, and 0.340, respectively). Minor, vs. and major complication rates in patients with Grades I, II, II, and IV hydronephrosis were detected as 12.7% vs. 10.1%; 11% vs. 8.5%; 11.9% vs. 6%; 8.3% vs. 7.1% and 8.3%, respectively (p=0.815, and 0.717, respectively). Complications, and their frequencies observed in patients whose median hospital stay was 2(1-7) days are summarized in Table 3.

Discussion

Firstly, in the year 1865 Thomas Hillier described percutaneous nephrostomy catheter placement for therapeutic purposes. The article in which Goodwin et al.[11] reported in the year 1955,

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technique, and outcomes of percutaneous nephrostomy tube placement in 15 cases with hydronephrosis was the turning point.[10] Firstly, in the year 1974, Pedersen[12] described ultrasound-guided placement of percutaneous nephrostomy tube. Pedersen[12], implanted 8 nephrostomy tubes via percutaneous route under ultrasound guidance in 6 patients, and reported technical success rate as 75 percent.[12] Success rates have increased dependent on the improved quality of the equipment used, and accumulation of experience within years, and in the current literature technical success rates ranging between 90, and 100% have been reported for ultrasound-guided percutaneous nephrostomy tube placement.[6]

In the literature among the factors which are thought to be effective on technical success rates mostly dilation of collecting system, access technique used, and experience of the surgeon have been stressed. Success rates decrease in cases with non-dilated collecting system. In the SIR guideline, overall success rate ranging between 84-99% was indicated irrespective of the imaging modality used, while success rates for procedures realized for cases with non-dilated, and dilated collecting systems were reported as 82-96%, and 96-100%, respectively.[9] In another publication, overall technical success rate was reported as 94.6%, while for non-dilated, and dilated collecting systems technical rates were detected as 82.7%, and 96.4%, respectively.[6]

Basically two techniques have been used for intrarenal access into collecting system namely Seldinger, and direct puncture techniques. In the literature, very scarce number of prospective studies have evaluated technical success rates of these two techniques. Wah et al.[13] evaluated 276 attempts at ultrasound-guided percutaneous nephrostomy tube placements performed using Seldinger access (n=190) or direct puncture (n=62) techniques (n=62), and reported technical success rates of 98.2%, and 93.5%, respectively (p=0.075). Although success rates did not differ between both techniques, the authors recommended use of direct puncture technique for nephrostomy tube placement for temporary urinary diversion in patients with moderate, and advanced grade pelvicalyceal hydronephrosis, while in another prospective study published in our country, Cangüven et al.[5] reported procedural times, and technical success rates for Seldinger, and direct puncture techniques as 9 vs. 5 minutes, and 97.7% vs. 97.3%, respectively. In subgroup analyses performed based on grades of hydronephrosis (Grades 1-4) any difference was not detected between these two access techniques with respect to technical success rates. However authors declared that they felt themselves more secure when they performed this procedure in cases with dilated collecting systems. Apart form these subjective data, in our study we detected statistically significantly higher success rates in cases with Grade 1 hydronephrosis when Seldinger access technique was used (97.5% vs. 82.1%, for direct puncture technique, p=0.029).

The effect of surgeon's experience on technical success rates is a controversial issue. Some literature data have indicated increase in success rates in parallel with the surgeon's experience, while in some publications, authors have argued that surgeon's experience does not effect success rates.[3,6,13] In their prospective study, Lee et al.[14] evaluated surgeon's experience on technical success rates, and reported that radiologists should perform ≥10 percutaneous nephrostomy tube placements to complete their learning curve, while technical success rates between surgeons performing ≥10 percutaneous nephrostomy tube placements did not differ. They also indicated that surgeons need to achieve at least 10 percutaneous nephrostomy tube placements to maintain their optimal success rates. Although most of the success rates reported belong to radiologists, according to small number of publications urologists also have achieved similar success rates.[3,6] Highest (96.1%) technical success rate in our case series which was accomplished only by urologists support this argument.

Placement of percutaneous nephrostomy tube for therapeutic purposes is a life-saving procedure when used as a complementary procedure to antibiotherapy mainly in cases with pyonephrosis.[15] Despite its superiority, generally in nearly 10% of the patients complications are observed after an invasive method of nephrostomy tube placement.[9] Major, and minor complications have been reported in the literature after ultrasound-guided percutaneous nephrostomy tube placements in 5-21%, and 3.1-6.7% of the cases.[3] Değirmenci et al.[6] evaluated, and classified complication rates according to SIR guideline, and reported minor, and major complication rates as 9.9%, and 9.6%, respectively. We think that higher major complication rate in our series (7.7%) when compared with other relatively similar series stems from the definition of major complication rate. Indeed, in many series, nephrostomy tube-related complications have not been evaluated as major complications, but in a separate category or as minor complications.[6] However since these complications required additional treatment, in compliance with definitions in SIR guideline, they were evaluated as major complications.

Some factors are effective on the development of complications seen following ultrasound-guided percutaneous nephrostomy tube placement. Değirmenci et al.[6] evaluated complication rates using multivariate analysis, and reported presence of

non-dilated collecting system increased complication rates statistically significantly (p=0.001, OR=6.1; 95% CI=2-18.4). All of our cases had various degrees of hydronephrosis (Grade I-IV), and any correlation between grade of the hydronephrosis, and development of complication was not detected. However, Skolarikos et al.[3] reported that most of the major complications developed as a result of interventions realized out of the working hours. In our series where data were retrospectively evaluated, we couldn't evaluate the impact of procedures performed out of working hours on complication rates. In a SIR guideline, placement of percutaneous nephrostomy tube was described as clean or clean-contaminated procedure, and development of increased risk of sepsis was reported in patients who did not receive prophylactic antibiotherapy.[9] In many studies, a 3% incidence of sepsis has been reported, while in our series thanks to application of prophylactic antibiotherapy with 3. generation cephalosporin our risk of sepsis was much lower (1.2%).

Adequate literature data are not found regarding the impact of complications on access technique. Wah et al.[13] reported minor, major, and catheter-related complications observed after Seldinger, and direct puncture techniques as 5% vs. 13%; 4.1% vs. 3.2%, and 24.3 vs. 11.3%, respectively (*p* values 0.043, 0.999, and 0.027, respectively). However in our study we detected similar complication rates for both techniques. Despite contrary publications, as a generally accepted corollary, experience of surgeons decreases complication rates.[3,13,16] Besides, as is the case with technical success rates, any difference between urologists, and radiologists regarding complication rates was not found.[3,4] In order to decrease complication rates the procedure should be performed without delay, and if possible within working hours In additon, coagulation parametres should be evaluated, and prophylactic antibiotherapy should be used preoperatively. Intrarenal access, and dilatations should be performed attentively, also medial access, extreme dilatations, and manipulations should be avoided.[3,16]

Our study has some limitations. In our retrospective study, timing, and duration of procedure (within or out of working hours, emergency or elective) could not be evaluated, and compared because of missing patient records. Another limitation is that, since this procedure was performed by urologists experienced in percutaneous renal surgery, we couldn't evaluate the impact of experience on technical success, and complication rates.

In conclusion, placement of nephrostomy tube via percutaneous route under the guidance of ultrasound for therapeutic purposes may be applied effectively, and safely by urologists. In patients with low-grade hydronephrosis, it is appropriate to use Seldinger access technique. However it should not be forgotten that this method takes longer time when compared with the direct puncture technique, and it has higher equipment costs.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Mersin University School of Medicine (Date: 23.11.2017; No: 2017/327).

Informed Consent: This article is based on a retrospective study. All data were collected from the patient files.

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