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# Efficacy and Safety of Two Different Approaches in the Drainage of the Upper Urinary Tract in "Acute Obstructive Uropathy": A Critical Evaluation

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## Abstract

***Aim:*** To compare the results of retrograde ureteral stent (RUS) and percutaneous nephrostomy (PCN) procedures for decompression in patients with acute obstructive pyelonephritis.

***Patients and Methods:*** Medical records of patients undergoing PCN or RUS for emergency urinary diversion because of obstructive pyelonephritis were evaluated retrospectively. Patients with urinary tract obstruction and concurrent fever (≥38°C), pyuria, and costovertebral angle tenderness were included and divided into two groups based on the type of emergency urinary drainage applied (PCN in Group 1) and (RUS in Group 2). Apart from the demographic data and Charlson Comorbidity Index, laboratory and radiologic examination outcomes were well evaluated.

***Results:*** A total of 155 patients including 73 patients (47.1%) undergoing PCN (Group 1) and 82 patients (52.9%) undergoing RUS (Group 2). Although no significant difference was found regarding the demographic characteristics, the operation time, as well as fluoroscopy time, was significantly shorter in Group 1 cases when compared with those in Group 2 ($p < 0.0001$). The success rate was similar between the two groups, and there was also a significant difference regarding the complication rates in both groups of cases (5.5% *vs* 7.3%).

***Conclusions:*** Our findings showed that despite similar efficacy and success rates noted between PCN and RUS applications in the emergency drainage of cases presenting with obstructive pyelonephritis, PCN application was found to be advantageous because of shorter operation and fluoroscopy durations. More importantly, this approach was associated with a significantly less need for intensive care during the postoperative period.

**Keywords:** percutaneous nephrostomy, retrograde ureteral stent, obstructive pyelonephritis, sepsis

## Introduction

"Obstructive pyelonephritis" is one of the emergency conditions in urology practice, developing mainly in cases suffering from stone disease.[1] It has been well reported that untreated asymptomatic urinary stones may cause obstruction, and the clinical course may rapidly progress to urosepsis, a condition that is associated with high mortality rates.[2] Development of urosepsis has been reported in 10% of presenting cases with upper urinary tract obstruction and infection.[2]

In light of the possible severe complications associated with a higher risk of death, early diagnosis, culture/sensitivity test-based appropriate antibiotherapy, and elimination of the underlying risk factor(s) are the critical measures to be taken in such cases. Related to this issue, upper tract obstruction is the most important risk factor for infective complications, and it should be removed with appropriate drainage methods as early as possible. It has been well demonstrated that mortality rates are certainly higher (at least twofold) in cases persisting upper tract obstruction for a long period without effective drainage on time.[3]

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Retrograde ureteral Double-J stent (RUS) placement and percutaneous nephrostomy (PCN) tube placement are the two commonly applied methods for the emergency decompression of the obstructed upper urinary tract in clinical practice.[4] Reported data regarding the efficacy and the advantages/disadvantages of these two methods in the elimination of obstruction particularly in infected cases are limited, and their efficacy and safety profiles were found to be similar in a small randomized controlled study.[5] Regarding the safety profile of the two methods, in one study the authors have reported that RUS application in such cases could be associated with bacteremia where PCN application may be advantageous with relatively less infection risk.[6]

In this present study, we aimed to compare the efficacy and safety of two different approaches (PCN and RUS) in a homogeneous group of patients presenting with clinical findings of obstructive pyelonephritis.



## Patients and Methods

After obtaining local ethics committee approval (238-04.07.2023), between January 2020 and January 2022, patients presenting with obstructive pyelonephritis and undergoing PCN or RUS procedures for emergency urinary diversion were included in the study program. The medical records of these cases were evaluated retrospectively, and all patients had urinary tract obstruction, concurrent fever (≥38°C), pyuria, and costovertebral angle tenderness at first referral. Diagnosis of urosepsis and need for intensive care were made by using the criteria defined for the Sepsis-3.0 scoring system including an increase of 2 or more points in the Sequential (sepsis-related) Organ Failure Assessment score. In addition to the children (<18 years), patients with solitary kidney, pregnancy, pyonephrosis, anticoagulant use, significant coagulopathy, immunosuppressive drug use, and patients with missing data were all excluded. After the implementation of the exclusion criteria, six patients from Group 1 and five patients from Group 2 were excluded from the study program.

After obtaining demographic data (age, gender, body mass index [BMI], and Charlson Comorbidity Indices), serum (creatinine, total blood count, C-reactive protein [CRP] values, and procalcitonin), and urine analyses along with urine culture-sensitivity tests were performed in all cases. Radiologic evaluation included urinary ultrasonography and noncontrast computed tomography (NCCT) examinations. Stone size was determined by measurement of the longest axis of the stone on NCCT. The degree of hydronephrosis was classified by using the Onen et al. classification.[7] Empirical antibiotherapy was immediately initiated after the consultation of the cases with the Infectious Diseases department. Based on the applied procedure for urgent urinary diversion, patients were divided into two groups, namely (Group 1): patients undergoing PCN and (Group 2): patients undergoing Double-J stent insertion (RUS).

All procedures were performed within the first 24 hours after admission by two experienced urologists with similar equipment and settings.

### *Surgical technique*

After obtaining written informed consent, procedures were performed in the day surgery management unit under local anesthesia in the lithotomy position. During the cystoscopy procedure, 500 mg paracetamol (as an IV infusion) and intraurethral lidocaine were administered initially to provide adequate analgesia. After achieving local anesthesia, the bladder was accessed through the urethra with a 21F cystoscope (Richard Wolf). A guidewire (0.035-inch polytetrafluoroethylene-coated sensor guidewire, Boston Scientific Inc., Marlborough, MA, USA) was inserted into the relevant ureter through the cystoscopy. After the position of the guidewire in the renal pelvis with fluoroscopic guidance, a 4.8F Double-J stent was inserted into the obstructed collecting system over the guidewire. The appropriate position of the catheter was also confirmed by fluoroscopy.

The operational duration was measured as the period between the entry of the cystoscope through the external meatus and the bringing of the patient back into the supine position.

In contrast, regarding the PCN procedure, after the evaluation of complete blood count findings and coagulation parameters, a thorough radiologic evaluation with NCCT was performed (perirenal colonic status, degree of hydronephrosis, and calyceal anatomy), and the percutaneous tube was placed. The procedure was performed under local anesthesia in sterile conditions in the prone position. The targeted calix was punctured with a Chiba needle under sonographic guidance. After the puncture, the internal sheath of the needle was removed, and urine outflow was assured. Then, opaque material was injected into the renal collecting system to outline and check the anatomy of the affected renal unit. A guidewire was inserted, and the tract was dilated with a 10F Amplatz dilator. A nephrostomy tube was placed, and its location was assured under fluoroscopic guidance. Our fluoroscopy settings were low dose and pulsed (1PPS) used for all procedures. The operation time was defined as the period elapsed between sterile draping and turning the patient to a supine position.

Although a Foley catheter was routinely placed in all patients undergoing Double-J stent placement, it was placed after the PCN procedures only in cases with infravesical obstruction signs. No catheter was placed in these cases on a routine basis.

### *Postoperative evaluation*

All cases were followed in a close manner, and the period for the normalization of infectious parameters after the urinary diversion procedure was carefully recorded. Complete blood count and CRP values were checked twice daily, and vital signs (temperature, pulse, blood pressure, and saturation) were recorded at least 4 times a day. Complications were noted and classified according to the Clavien–Dindo classification.[8]

### *Statistical analysis*

Normally distributed numerical data were expressed as mean ± standard deviation. Non-normally distributed numerical data were expressed as median (interquartile range). The normality test of numerical data was performed with the Kolmogorov–Smirnov test. Student's *t-test* was used to

compare normally distributed numerical data, and Mann–Whitney *U* test was used to compare non-normally distributed numerical data. Chi-square and Fisher's exact tests were used to compare categorical data. Statistical analyses were performed with IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). *p*-Value <0.05 was considered statistically significant.

## Results

A total of 155 patients were included in the study program; although PCN was performed in 73 of these cases (47.1%) (Group 1), 82 patients (52.9%) underwent RUS. The mean age values in both group cases were 55.9 ± 7.8 and 54.8 ± 15.2 years, respectively, with no significant difference on this aspect. Similarly, gender, BMI, American Society of Anesthesiologists (ASA) scores, Charlson Comorbidity Index scores, and incidence of comorbidities (diabetes mellitus) were not significantly different between the two groups (Table 1). There was also no significant difference between the groups regarding the preoperatively assessed vital sign values (temperature, systolic blood pressure, peak heart rate, and daily urine output). Preoperative laboratory findings (white blood cell [WBC], CRP, procalcitonin, and creatinine) were similar in both groups. Lastly, stone location, stone diameter, degree of hydronephrosis, and time to drainage were all similar between the two groups (Table 2).

The operation time was significantly shorter in the PCN group compared with the cases in Group 2 (20 ± 2 minutes *vs* 27 ± 8.4 minutes, respectively; $p < 0.0001$). Similarly, the fluoroscopy time was again shorter in Group 1 (4 ± 1.4 seconds) than Group 2 (6.3 ± 2 seconds; $p < 0.0001$).

Regarding the infective parameters, there was no significant difference between the two groups concerning bacterial growth in the urine culture examinations and the length of hospital stay (Table 3). The bacterial growth outcomes in blood and urine cultures are shown in Table 4. The success rate was similar between the two groups.

Although a PCN procedure was performed in 6 (7.3%) patients in whom the RUS application was not successful, RUS was performed in 1 (1.3%) case of Group 1 who could not tolerate the PCN procedure.

Last but not least, as an important parameter, a significantly higher rate of postoperative intensive care unit (ICU) requirement was noted in Group 2. Complications were recorded in four patients (5.5%) of Group 1 and six patients (7.3%) of Group 2, and the difference between the two groups on this aspect was again not statistically significant.

## Discussion

Obstructive uropathy induced particularly by urinary stones carries always the risk of uroseptic complications. It has been reported that the mortality rate is 2.5 times higher in urosepsis cases with urinary obstruction.[9] Prompt and effective decompression of the obstructed renal collecting system is one of the crucial steps in the prevention of severe infective conditions such as urosepsis and septic shock.[2]

Regarding the urgent decompression of the upper urinary tract in clinical practice, there are two different commonly applied methods, namely RUS and PCN.[4] Despite the commonly accepted consensus on the urgent decompression of the collecting system in obstructive pyelonephritis, there is insufficient evidence that may indicate the superiority of one method over the other with this aim. Reported data so far demonstrate that both PCN and RUS could show similar efficacy and safety in cases of postrenal acute renal failure.[10] Although RUS placement with this aim seems to be more tolerable and cosmetically acceptable, procedure failure, prolonged ureteral manipulation, and uncontrolled intrarenal pressure levels in complete obstruction situations are the main disadvantages of this approach.[4] In contrast, despite better drainage and no risk of intrarenal pressure rise, the lower rate of acceptance by the patients because of the disturbed life quality is the most important drawback of this modality.[4] In a study conducted by Wong et al., the data of 34,009 patients presenting with obstructive uropathy and sepsis clinic were retrospectively reviewed between 2006 and 2014. Although 28.9% of these patients were treated with PCN, in 71.1% of them RUS was performed. Comorbid cases carrying higher anesthesia risk were frequently treated with PCN, and therefore, mortality rates were higher. However, after propensity matching, the mortality rates of the two methods were found to be similar.[11] Similarly, in a mortal condition such as sepsis, where rapid initiation of treatment is critical,

Table 1. Demographic Data

| *Parameters (mean ± SD)* | *Total* (n = *155*) | *Group PCN* n = *73 (47.1)* | *Group RUS* n = *82 (52.9)* | p |
|---|---|---|---|---|
| Age (year) | 55.3 ± 13.7 | 55.9 ± 7.8 | 54.8 ± 15.2 | 0.533 |
| Sex (*n*, %) | | | | 0.747 |
| Men | 73 (47.1) | 33 (45.2) | 40 (48.8) | |
| Women | 82 (52.9) | 40 (54.8) | 42 (51.2) | |
| BMI (kg/m$^2$) | 26.5 ± 2.4 | 26.7 ± 2.2 | 26.4 ± 2.6 | 0.448 |
| ASA (*n*, %) | | | | 0.579 |
| 1 | 15 (9.6) | 6 (8.2) | 9 (11) | |
| 2 | 119 (76.8) | 59 (80.8) | 60 (73.2) | |
| 3 | 21 (13.5) | 8 (11) | 13 (15.9) | |
| Charlson Comorbidity Index | 1 ± 0.1 | 1 ± 0.3 | 1 ± 0.1 | 0.533 |
| DM (*n*, %) | 84 (54.2) | 39 (53.4) | 45 (54.9) | 0.873 |

BMI = body mass index; DM = diabetes mellitus; PCN = percutaneous nephrostomy; RUS = retrograde ureteral stent.

Table 2. Preoperative Clinical, Laboratory, and Radiologic Findings

| *Parameters (mean ± SD)* | *Total* (n = *155)* | *Group PCN* n = *73 (47.1)* | *Group RUS* n = *82 (52.9)* | p |
|---|---|---|---|---|
| Preop. fever (C) | 38.3 ± 0.4 | 38.4 ± 0.3 | 38.2 ± 0.4 | 0.057 |
| Peak heart rate (number/min) | 105.6 ± 7.1 | 105.1 ± 5.7 | 106.1 ± 8 | 0.311 |
| Systolic blood pressure (mm Hg) | 120.8 ± 10.5 | 121.7 ± 9 | 120 ± 11.7 | 0.296 |
| Daily urine output (cc) | 1537.4 ± 237.4 | 1539.7 ± 245.3 | 1535.3 ± 231.6 | 0.910 |
| WBC (10*3 μL) | | | | |
| Preop. | 19.8 ± 3.5 | 20.4 ± 2.9 | 19.2 ± 3.7 | 0.132 |
| 12 hour | 17.6 ± 2.2 | 18.3 ± 2.5 | 17.2 ± 3 | 0.102 |
| 24 hours | 16.2 ± 3.2 | 17.1 ± 1.1 | 16 ± 1.3 | 0.097 |
| 36 hours | 15.1 ± 3 | 15.8 ± 2.2 | 14.9 ± 2 | 0.117 |
| Serum creatinine (mg/dL) | 0.8 ± 0.5 | 0.9 ± 0.3 | 0.8 ± 0.3 | 0.322 |
| CRP (mg/L) | | | | |
| Preop. | 225.2 ± 44.1 | 228.5 ± 33.6 | 222.1 ± 51.7 | 0.359 |
| 12 hours | 212.7 ± 45.4 | 214.8 ± 32.6 | 210.9 ± 54.5 | 0.584 |
| 24 hours | 188.9 ± 43.4 | 187.4 ± 29.8 | 190.3 ± 52.8 | 0.666 |
| 36 hours | | | | |
| Procalcitonin (ng/mL) | 0.1 ± 0.1 | 0.1 ± 0.1 | 0.1 ± 0.1 | 0.736 |
| Stone diameter | 9.8 ± 1.9 | 9.9 ± 1.7 | 9.6 ± 2.1 | 0.380 |
| Stone location | | | | 0.138 |
| Calix | 3 (1.9) | 3 (4.1) | 0 (0) | |
| Renal pelvis | 48 (31) | 19 (37) | 29 (60.4) | |
| Prox. ureter | 52 (33.5) | 27 (37) | 25 (30.5) | |
| Mid ureter | 27 (17.4) | 15 (20.5) | 12 (14.6) | |
| Distal ureter | 25 (16.1) | 9 (12.3) | 16 (19.5) | |
| Hydronephrosis | | | | 0.790 |
| Grade 1 | 19 (12.2) | 7 (9.5) | 12 (14.6) | |
| Grade 2 | 56 (36.1) | 30 (41) | 26 (31.7) | |
| Grade 3 | 57 (36.7) | 24 (32.8) | 33 (40.2) | |
| Grade 4 | 23 (14.8) | 2 (16.4) | 11 (13.4) | |
| Time to drainage (hours) | 7 ± 2.9 | 6.4 ± 1.7 | 7.5 ± 2.8 | 0.067 |

CRP = C-reactive protein; SD = standard deviation; WBC = white blood count.



Haas et al. demonstrated the efficacy of a hospital-wide organized reception protocol.[12] In their study, the authors stated that in patients being admitted to the sepsis clinics because of obstructive uropathy, a preorganized system for PCN application for the quick relief of obstruction was higher, which allowed shorter hospital stays.[12] However, we believe that despite the data provided above, there may be situations where clinical applications should be customized on an individual patient basis. Related to the clinical practice pattern in our department on this aspect, based on the presentation time (outpatient clinic during the daytime or emergency department at night on call), degree of hydronephrosis, associated infection, patient factors for intervention and/or anesthesia, patient preference, and surgeon's experience, we evaluate the case in detail for an appropriate decision. Although, as a relatively lower invasive option, Double-J stent placement is our first option in these cases, we certainly place a nephrostomy tube in cases with a higher degree of hydronephrosis, infected cases, cases presenting urgently, complete obstruction and high stone burden, external compression, and in cases where Double-J stent placement seems to be unsuccessful. Although our study does not have this design, it should be kept in mind as a clinical practice.

Related to this issue, in their randomized controlled study, Pearle et al. in 1998 demonstrated no significant difference between these two approaches regarding the time to normalization of WBC values and fever clinic.[5] However, although Xu et al. were able to show that the rapid improvement in

Table 3. Perioperative and Postoperative Data

| *Parameters (mean ± SD)* | *Total* (n = *155)* | *Group PCN* n = *73 (47.1)* | *Group RUS* n = *82 (52.9)* | p |
|---|---|---|---|---|
| Operation time (min) | 24.1 ± 5.7 | 20 ± 4.2 | 27 ± 8.4 | <0.0001 |
| Fluoroscopy time (second) | 5.2 ± 2.9 | 4 ± 1.4 | 6.3 ± 2 | <0.0001 |
| Drainage (*n*, %) | 145 (93.5) | 72 (98.6) | 76 (92.7) | 0.087 |
| Hospitalization (days) | 8 ± 4.5 | 8.2 ± 4.5 | 7.8 ± 4.7 | 0.518 |
| ICU requirement (*n*, %) | 15 (9.7) | 2 (2.7) | 10 (12.1) | 0.021 |
| Presence of Complications (*n*, %) | 10 (6.5) | 4 (5.5) | 6 (7.3) | 0.750 |

ICU = intensive care unit.

Table 4. Microorganisms Isolated

| *Isolated microorganisms* | *(n, %)* |
|---|---|
| None | 42 (27) |
| Escherichia coli | 47 (30.3) |
| Proteus mirabilis | 16 (10.3) |
| Pseudomonas aeruginosa | 14 (9) |
| Enterococcus faecium | 10 (6.4) |
| Klebsiella pneumoniae | 7 (4.5) |
| Candida albicans | 4 (2.5) |
| Other | 15 (9.6) |

fever clinic and CRP values was significantly pronounced in the PCN group,[2] no significant difference was observed between the two modalities regarding the clinical recovery parameters in a more recently published study by Anıl et al.[4] In our study, in addition to the similar success rates obtained in both groups, there was no significant difference between the two groups in terms of postoperative CRP levels and length of hospital stay.

Concerning the efficacy of these two modalities in the effective drainage of obstructed collecting systems, although a 99% success rate has been reported in cases with a dilated collecting system, this rate is 2% to 96% in nondilated systems.[13–15] In contrast, although the general success rate for Double-J stenting was reported to be 98%, failure rates varying between 0% and 20% have also been reported particularly in cases with complete obstruction.[16–18] In our study, a Double-J stent could not be inserted in six patients (7.3%) because of ureteral obstruction. Although there was no statistically significant difference between the two groups, drainage was obtained in 98.6% of cases of the PCN group.

The procedural duration and the extent of radiation exposure during these procedures are also important parameters to be concerned with in the emerging consideration cases. In the abovementioned study performed by Pearle M et al., although the operational duration values for Double-J catheter placement and PCN were 32.7 and 49.2 minutes, total fluoroscopy time values were reported for 5.1 minutes and 7.7 minutes for Double-J catheter placement and PCN, respectively.[5] They stated that both procedural and fluoroscopy times were significantly shorter in RUS.[5] In the study by Anıl et al., the median operational duration values in PCN and Double-J stenting groups were 15 and 7 minutes, respectively. Similarly, fluoroscopy time was reported to be higher in the PCN group (0.44 minutes) when compared with the Double-J stenting group (3 minutes).[4] The authors in this original study quoted that improvements in operation time and fluoroscopy times could be obtained in the light of increasing experience.[4] In our study, both operational duration and fluoroscopy time were significantly shorter in cases undergoing procedures for effective drainage of the upper urinary tract.

Regarding the complications related to these two methods, similar to the findings of the previously published studies, there was no difference in complication rates between the two groups in our current study.[5] However, in their original study, Anıl H. et al. observed a higher rate of complications in the Double-J stenting group, and hematuria was the most common one.[4] In another randomized controlled study conducted by Hajjaj et al. in obstructive uropathy cases, PCN procedure was found to be associated with higher success rates and lower complication rates compared with Double-J ureteral stenting.[19] Similarly based on their findings, Xu et al. stated that PCN should be preferred particularly in cases of obstructive urosepsis with high fever and severe inflammation because of the higher success rates obtained as well as faster recovery.[2] As stated above, despite the relatively higher rate of success and lower complication rates of the PCN option, Double-J stent insertion seems to be preferable by the patients because of its more cosmetic nature without any incision/tube on the body.[2] However, unlike the common belief accepted by urologists, in a prospective study, a higher rate of deterioration in the quality of life scores was noted in patients undergoing Double-J stenting compared with PCN.[20]

As a critical measure to be taken into account, saline instillation during the Double-J stent insertion procedure should be minimized to prevent intrarenal and intravascular reflux of pyrogenic agents.[2] In our study, the need for ICU follow-up was significantly higher in the RUS group. Slower decompression in RUS application compared with PCN, possible urethral and ureteral trauma during Double-J stent placement, and intrarenal and intravascular reflux because of working with saline during Double-J catheter placement may be the reason for this issue.

Our study is not free of limitations. First, the retrospective nature of the study protocol is a major concern, which may make our findings susceptible to bias. In addition, the small number of patients may constitute another limitation. However, obtaining a homogeneous patient group with well-defined inclusion and exclusion criteria is one of the important advantages of our study. Finally, taking the limited number of studies performed so far into account, we believe that our current findings will be contributive enough to the existing information in the literature. Further randomized controlled studies are certainly needed in this regard.

## Conclusions

In light of the published data and our current findings, we may state that although both PCN and Double-J stent insertion procedures seem to have similar efficacy and success rates in patients with obstructive pyelonephritis, the PCN approach was found to be more advantageous because of shorter operation and fluoroscopy times along with the significantly lower need for intensive care during postoperative early period.

## Ethics Committee Approval

Ethics committee approval was received for this study from the ethics committee of Health Science University, Umraniye Training and Research Hospital.

## Authors' Contributions

Conceptualization: F.Y.S., M.B., S.G., and K.S. Methodology: F.Y.S, S.G., and M.B. Writing: F.Y.S., H.K., and E.V.K. Editing: F.Y.S., H.K., and E.V.K. Supervision: E.V.K. and K.S.

## Data Availability

Not available because of local restrictions.

### Author Disclosure Statement

No conflict of interest was declared by the authors.

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**Abbrevations Used**

BMI = body mass index
CRP = C-reactive protein
DM = diabetes mellitus
ICU = intensive care unit
NCCT = noncontrast computed tomography
PCN = percutaneous nephrostomy tube placement
RUS = retrograde ureteral stenting
SD = standard deviation
WBC = white blood cell