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Retrospective Evaluation of the Effects of Ureteral Double-J Stent Placement Versus Percutaneous Nephrostomy on Renal Function and Quality of Life in Patients with Unilateral Acute Obstructive Hydronephrosis Without Renal Failure

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Abstract

Background

There is still controversy regarding the best urinary drainage technique for acute unilateral upper urinary tract obstruction. Our study aims to evaluate the impact of Double-J Stent Placement (DJ) versus Percutaneous Nephrostomy (PCN) on renal function and Health Related Quality Of Life (HRQOL) through the use of MAG-3 Scintigraphy (Functional Endpoint) which has never been used in this manner.

Methods

Forty two consecutive patients with unilateral hydronephrosis secondary to urolithiasis (n = 32, 76.2%) or malignancy (n = 10, 23.8%) who were treated with DJ stent placement (n = 18, 42.9%) or PCN (n = 24, 57.1%) from December 2014 to December 2016 were retrospectively analyzed. Renal function was evaluated by serum creatinine and MAG-3 renal scintigraphy. Function was determined based upon T½, Tmax, Tmax half-life, and Split Renal Function. HRQL was assessed using the SF-36 Questionnaire (Physical Component Summary [PCS], Mental Component Summary [MCS]) pre and post-procedure.

Results

Both groups were equivalent at baseline ($p > .05$ for all demographics/clinical variables). Serum Creatinine levels did not change in either treatment arm. Both treatments resulted in a statistically significant improvement in MAG-3 drainage parameters (T½ & Tmax; $p = .001$ for each group), without a statistical difference in the degree of improvement. Split Renal Function remained constant in both arms. Colic Frequency decreased significantly in the DJ group when compared to the PCN Group ($p = .008$). Only the DJ stent group experienced a statistically significant improvement in PCS (Pre – Post 73.89 ± 3.14 vs. 77.78 ± 5.37; $p = .02$). Although there was a trend towards increased PCS in the PCN group, it was not statistically significant (Pre – Post 72.69 ± 3.36 vs. 76.68 ± 5.55; $p = .723$). There was also a statistically significant increase in MCS in the DJ Group ($p = .015$).

Conclusions

Both DJ stent placement and PCN provided adequate relief of upper urinary tract obstruction, providing similar results concerning renal functional outcomes (as evidenced by MAG-3 scintigraphy and serum creatinine). DJ stent placement resulted in a significant improvement in physical and mental HRQL and better pain control than PCN, whereas PCN did not result in a statistically significant improvement in HRQL. Routine addition of MAG-3 scintigraphy provides an objective measure of obstruction relief that cannot be achieved via measurement of serum creatinine.

BACKGROUND

Acute unilateral upper urinary tract obstruction is one of the most common emergencies within the field of urology. Most commonly this occurs due to either extrinsic malignant compression or urolithiasis. If left untreated, continued obstruction will result in loss of nephrons, permanent injury to the kidneys, and when combined with infection can lead to dangerous levels of urosepsis [1, 2]. Therefore, immediate decompression of the urinary system is required, which has led to two methods being developed to achieve this goal: retrograde ureteral placement of a double J (DJ) stent and antegrade percutaneous nephrostomy (PCN) [3].

Although clinicians have been performing both of these interventions for several decades, there continues to be a very limited amount of evidence supporting how to choose between them on a case-by-case basis. There have been numerous systematic reviews and randomized control trials (RCTs) completed regarding technical success rates and complication profiles for both of the aforementioned procedures. In fact, a meta-analysis published in 2021 evaluating the results from 7 different RCTs found that both PCN and retrograde ureteral stenting resulted in similar improvements in septic parameters, failure rates, post-procedure pain and quality of life [4]. However, it should also be noted that all of these studies primarily relied upon clinical surrogates such as serum creatinine and imaging-based hydronephrosis grading. To date, none of the previous studies have utilized technetium-99m mercaptoacetyltriglycine (MAG-3) renal scintigraphy as a means to assess functional outcomes – a method that allows for measurement of individual kidney drainage kinetic values (such as T½, Tmax) and differential renal contributions (split function). As a result, the data obtained from serum biomarkers alone cannot provide the same level of detail.

As of late, Health related Quality of Life (HRQoL) is becoming an increasingly important end-point in studies assessing the effectiveness of various urologic interventions. Each method (retrograde ureteral DJ stents and PCN tubes) impose their own unique burdens of symptoms. Specifically, DJ stents are associated with persistent lower urinary tract symptoms, dysuria and hematuria in a considerable number of patients [5] and PCN tubes restrict mobility and force the need for an external bag management resulting in decreased physical independence and poor maintenance of personal hygiene [6]. Although prior studies utilizing the EuroQol EQ-5D questionnaire indicate that the quality-of-life trajectories for each method of drainage differ over time – PCN tube patients report higher degrees of initial functional impairment however report improvements after discharge compared to DJ stent patients who report persistent symptoms [6]; however few studies utilizing the SF-36 — a validated generic HRQOL instrument assessing eight health domains including both physical and mental functioning — exist comparing the two drainage methods.

The objective of this retrospective study was to evaluate outcomes of DJ stenting versus PCN in 42 consecutive patients diagnosed with unilateral acute obstructive hydronephrosis based on assessment via MAG-3 scintigraphy and utilization of the SF-36 questionnaire. MAG-3 scintigraphy was utilized in our institution for a concurrent oncologic drainage program; therefore, was readily available at no cost for

functional assessment. Similarly, SF-36 was also administered as part of a separate inpatient QoL audit. The primary goals of this study were to compare the two drainage methods with regard to three areas: (i) improved functional renal drainage as evaluated by MAG-3 scintigraphy; (ii) HRQoL as measured by SF-36; and (iii) clinical outcomes including frequency of colic episodes, ED visits, presence of dysuria, degree of analgesic utilization, decrease in parenchymal thickness and hydronephrosis grading.

METHODS

Study Design and Patient Selection

A retrospective, single-center comparative analysis of the results of the procedure that took place at the Department of Urology of the Dr. Lutfi Kirdar Kartal Education and Research Hospital in Istanbul, Turkey, was carried out. Retrospective review of the hospital's electronic medical record system was undertaken to evaluate all patients treated for unilateral hydronephrosis secondary to urolithiasis or malignancy between December 2014 and December 2016, for whom an urgent urinary decompression had been performed. The inclusion criteria were: Age > or= 18 years; Unilateral hydronephrosis due to either ureteral stone or a malignant extrinsic compression; Normal function of the contralateral kidney; Availability of both pre-and post-procedural MAG-3 scintigraphies and SF-36 data. The exclusion criteria were: Pre-procedural dependency upon hemodialysis; Bilateral obstruction; Skeletal deformity preventing access via percutaneous nephrostomy (PCN); Known bleeding disorder; Presence of ureteral stricture or anatomical anomalies; Pregnancy; Active urinary tract infection. The study was designed according to the principles of the Declaration of Helsinki. Waiver of informed consent for the review of retrospective data was granted by the Institutional Review Board in compliance with local regulatory requirements. Clinical trial number: Not applicable.

Drainage Procedures

The method used for urinary decompresstion was determined by the treating urologist and was influenced by his/her clinical judgment regarding the need for urinary decompression, patient anatomy, and available procedural options. Urinary decomposition via placement of a double-J (DJ) stent was performed cystoscopically under spinal or general anesthesia using fluoroscopy. Placement of a percutaneous nephrostomy tube (PCN) was performed by the Interventional Radiology Team using ultrasound and/or fluoroscopy. Both methods were employed to accomplish adequate decompression of the collecting system.

Outcome Measures

Pre-procedure (baseline) and Post-procedure measurements were taken of each subject as follows:

Renal Function: Serum Creatinine (mg/dl); MAG-3 Renal Scintigraphy Parameters -- T1/2 (Time to 50% Drainage from Peak, min.), Tmax (Time to Peak Uptake, min.), Tmax Half-Life (min.), Split Renal Function (% Contribution of Obstructed Kidney). MAG-3 was performed as part of the hospital's institutional protocol to determine if the obstructed kidney required decompressive intervention.

Health Related Quality Of Life (HRQOL): The 36-item Short Form Survey (SF-36), a validated generic HRQL assessment tool producing eight domains and two composite summaries -- Physical Component Summary (PCS) and Mental Component Summary (MCS) [7]. Each score is normalized to a 0-100 scale where higher values represent better health status. The SF-36 survey was administered to all hospitalized subjects during this time frame as part of an ongoing Health Related Quality of Life Audit Project at our Institution. Therefore, it was utilized in lieu of disease specific surveys.

Clinical outcomes

Ultrasound Measurement of Renal Parenchyma Thickness (mm); Hydronephrosis Grade (Society of Fetal Urology Grading System, 0–3); Colic Episode Frequency; Number of Emergency Department Visits; Dysuria Rate; Analgesic Use Rate.

Statistical Analysis

Methods for statistical analyses in this study used IBM Corporation’s (Armonk, New York) Statistical Package for the Social Sciences (SPSS) software. The method to present continuous variable results include either presenting them as a mean ± SD or as a median (min-max). Variables classified into categories will be represented by frequencies and percentages. To determine whether the continuous variables are normally distributed, we used the Shapiro-Wilk normality test. We use an independent samples t-test (Student t-test), if the continuous data is normally distributed; the Mann-Whitney U Test, if it is not normally distributed; and the Pearson chi-square or Fisher's Exact Test, for comparison of categorical data. Additionally, we use a paired t-test or Wilcoxon Signed-Rank Test, for assessing within group pre-to-post changes on continuous data, and the McNemar Test, when assessing categorical within group changes. For all tests, a p-value of less than .05 was considered to represent significance.

RESULTS

Patient Characteristics

The total number of patients included in this study was forty-two. Twenty-four (57.1 percent) of these patients were treated using percutaneous nephrostomy catheters (PCNs); eighteen (42.9 percent) received a DJ stent. The average age of all forty-two patients included in this study was fifty point five two (± 17.88) years, with ages ranging from nineteen to eighty years old. Of the patients included in this study, eighteen (42.9 percent) were males and twenty-four (57.1 percent) were females. The average body mass index (BMI) of all forty-two patients included in this study was twenty-seven point five seven (± 4.33) kilograms/meter squared. Comorbidities were reported by nineteen (forty-five point two percent)

of the patients included in this study. A prior urologic surgery was performed on thirteen (thirty-one percent) of the patients included in this study. The estimated mean time that urine flow was obstructed was eleven point one nine (± 12.62) days. Urine flow obstructions were caused by kidney stones in thirty-two (seventy-six point two percent) of the patients included in this study and cancer in ten (twenty-three point eight percent) of the patients included in this study. Of the forty-two patients included in this study, seventeen (forty-point five percent) had their urine flow obstruction at an upper level of the ureters and twenty-five (fifty-nine point five percent) had their urine flow obstruction at a lower level of the ureters. The right ureter was involved in twenty-seven (sixty-four point three percent) of the patients included in this study.

No significant differences were noted between the demographics or clinical characteristics of the patients who were treated with DJ stents versus those who were treated with PCNs. These demographics/characteristics include patient age, gender, BMI, presence of comorbid conditions, prior urologic surgeries, source of urinary tract obstruction and length of time that urine flow has been obstructed ($p > .05$). However, the degree of hydronephrosis present at baseline was significantly greater in patients treated with PCNs compared to those treated with DJ stents (2.67 ± 0.48 vs 1.89 ± 0.76, respectively; $p = .001$). Similarly, baseline values for Tmax and Tmax half-life were also found to be significantly greater among the PCN-treated patients as compared to those treated with DJ stents (21.79 ± 10.6 vs 16.5 ± 5.3 minutes, respectively; $p = .04$; and 21.33 ± 4.97 vs 17.7 ± 1.96 minutes, respectively; $p < .01$), which indicates that there is a difference in how severe the obstruction was in each treatment group at baseline (Table 1).

Table 1
Baseline Characteristics and Comparison Between Groups

Variable	**DJ Stent (n = 18)**	**PCN (n = 24)**	**p value**
Age (years), mean ± SD	49.17 ± 19.84	51.54 ± 16.63	0.675
Male sex, n (%)	9 (50.0)	9 (37.5)	0.418
BMI (kg/m²), mean ± SD	26.33 ± 4.28	28.50 ± 4.22	0.110
Comorbidity, n (%)	6 (33.3)	13 (54.2)	0.179
Prior surgery, n (%)	5 (27.8)	8 (33.3)	0.700
Stone aetiology, n (%)	16 (88.9)	16 (66.7)	0.147
Obstruction duration (days), mean ± SD	8.39 ± 11.20	13.29 ± 13.44	0.139
Upper ureteral obstruction, n (%)	—	—	—
Baseline hydronephrosis grade, mean ± SD	1.89 ± 0.76	2.67 ± 0.48	0.001**
Baseline Tmax (min), mean ± SD	16.50 ± 5.28	21.79 ± 10.60	0.041*
Baseline Tmax half-life (min), mean ± SD	17.72 ± 1.96	21.33 ± 4.97	0.003**

*DJ: double-J stent; PCN: percutaneous nephrostomy; BMI: body mass index; SD: standard deviation. * p < 0.05; ** p < 0.01.*

Renal Function

Serum creatinine

The average serum creatinine levels for both groups were similar before the procedure (DJ = 0.82 ± 0.12 mg/dl vs. PCN = 0.75 ± 0.13 mg/dl) with no statistical difference (P = .071). There was also no statistical difference within each group from baseline to post-procedure (DJ P = .102, PCN P = .503).

MAG-3 scintigraphy drainage parameters (Table 2**)**: The drainage half-time (T½) for both DJ and PCN significantly decreased after treatment (DJ: before 35.78 ± 7.73 min -> after 17.83 ± 6.71 min, p = .001; PCN: before 43.17 ± 16.69 min -> after 17.04 ± 8.22 min, p = .001). Prior to treatment there were no significant differences in T½ values for either procedure (p=.185), nor were the T½ values for each procedure significantly different from one another at follow-up (p = .584). Although the decrease in T½ was larger for the PCN than for the DJ group (-26.13 vs. -17.94 min), this difference was not statistically significant (p = .088).

Both groups also demonstrated a statistically significant decrease in Tmax values (DJ: 16.50 ± 5.28 min -> 10.67 ± 3.74 min, p = .001; PCN: 21.79 ± 10.60 min -> 11.96 ± 4.19 min, p = .001). Both procedures resulted in comparable post-treatment Tmax values despite the fact that the mean Tmax value prior to treatment was significantly higher for the PCN group (p = .041), and similarly the mean change in Tmax did not show a statistically significant difference between the two groups (p = .076). Likewise, both groups experienced an improvement in Tmax half-life with each procedure. However, even though Tmax half-lives improved with each procedure they continued to be significantly longer in the PCN group (PCN: 14.25 ± 4.35 min vs. DJ: 11.56 ± 3.33 min; p = .033), which likely reflects the increased obstruction severity at baseline in the PCN group.

Split renal function: The split of the obstructed kidney did not change significantly in either group after the procedure (DJ: pre = 45.50 ± 9.44% → post = 46.89 ± 9.22%, p = 0.517; PCN: pre = 43.79 ± 17.59% → post = 44.21 ± 18.21%, p = 0.566). There were no statistically-significant differences between the two groups throughout all time points and changes between the two groups were almost identically small (p = .990).

Table 2
MAG-3 Scintigraphy Parameters Before and After the Procedure

Parameter	DJ (n = 18) Pre → Post	p (within)	PCN (n = 24) Pre → Post	p (within) / p (between change)
T½ (min), mean ± SD	35.78 ± 7.73 → 17.83 ± 6.71	0.001**	43.17 ± 16.69 → 17.04 ± 8.22	0.001** / 0.088
Tmax (min), mean ± SD	16.50 ± 5.28 → 10.67 ± 3.74	0.001**	21.79 ± 10.60 → 11.96 ± 4.19	0.001** / 0.076
Tmax half-life (min), mean ± SD	17.72 ± 1.96 → 11.56 ± 3.33	0.001**	21.33 ± 4.97 → 14.25 ± 4.35	0.001** / NS
Split function (%), mean ± SD	45.50 ± 9.44 → 46.89 ± 9.22	0.517	43.79 ± 17.59 → 44.21 ± 18.21	0.566 / 0.990

*DJ: double-J stent; PCN: percutaneous nephrostomy; T½: drainage half-time; Tmax: time to peak uptake; NS: not significant. ** p < 0.01. Pre-procedure T½ p = 0.185; Tmax p = 0.041*; Tmax half-life p = 0.003** (PCN higher at baseline in both Tmax parameters, reflecting more severe obstruction).*

Clinical Outcomes

Colic frequency

Both study groups experienced a statistically significant decrease in colic episode frequency after undergoing the procedure. For the DJ stent study, prior to treatment there were on average 7.00 ± 5.83 episodes per day versus 2.83 ± 2.77 episodes per day after treatment (p = .001). For the PCN study, prior to treatment there were an average of 4.04 ± 3.86 episodes per day versus an average of 2.42 ± 2.90 episodes per day post-procedure (p = .007). Additionally, the mean number of colic episodes decreased by a larger margin in the DJ stent group (-4.17 ± 3.38) than it did for the PCN group (-1.63 ± 2.62), which had a statistically significant difference (p = .008).

Emergency department visits. Neither group demonstrated a statistically significant reduction in ED visit frequency (DJ: p = 0.080; PCN: p = 0.098), and no significant difference was observed between groups in the magnitude of change (p = 0.500).

Renal parenchymal thickness

The DJ group had thicker liver tissue prior to treatment (11.39 ± 1.5mm) compared with the PCN group (10.25 ± 1.36mm); this was a significant difference (p = 0.014). Following treatment, the DJ group experienced a reduction in their liver tissue thickness (11.39mm at pre-treatment vs. 10.94mm at post-treatment; p = 0.042) whereas there were no changes for the PCN group (10.25mm at pre-treatment vs. 10.33mm at post-treatment; p = 0.575). There was also a statistical difference between both of these groups in terms of how much they changed in terms of thickness (p = 0.049).

Hydronephrosis grade

As previously mentioned, the DJ Group had a greater than the PCN Group at baseline for their hydronephrosis grade. Both groups demonstrated a statistical improvement in the hydronephrosis grade after procedure ($p = .001$) in both groups.

The degree of improvement in hydronephrosis grade was similar between groups (DJ Group: -1.05 ± 0.80; PCN Group: -1.09 ± 0.88; $p = .979$).

Dysuria and analgesic use

Post-procedural dysuria tended to be more frequent in the DJ group (38.9% vs. 16.7%), though this difference did not reach statistical significance ($p = 0.159$). Analgesic use rates did not differ significantly between groups pre- or post-procedure ($p > 0.05$ for all comparisons).

Health-Related Quality of Life (SF-36)

The SF-36 Domain Scores and Summary Scores (MCS and PCS) for all patients are shown in Table 3. There was no statistical difference in the pre-procedure PCS and MCS values among the DJ and PCN groups ($p = .245$ PCS; $p = .343$ MCS). In comparison to their baseline levels, there was a statistically significant increase in PCS post-procedure within the DJ group (pre-procedure PCS: 73.89 ± 3.14 vs. post-procedure PCS: 77.78 ± 5.37; $p = .020$) compared to the PCN group (post-procedure PCS: 72.69 ± 3.36 vs. post-procedure PCS: 76.68 ± 5.55; $p = .723$). Similarly, there was a statistically significant increase in MCS only within the DJ Group (pre-procedure MCS: 75.90 ± 3.96 vs. post-procedure MCS: 76.42 ± 3.64; $p = .015$), whereas the PCN Group demonstrated no statistically significant change in MCS (pre-procedure MCS: 77.10 ± 4.06 vs. post-procedure MCS: 77.29 ± 2.98; $p = .849$). There were no statistically significant between-group differences in the amount of change exhibited by each group as measured by PCS ($p = .949$) and MCS ($p = .533$). The largest percentual change overall occurred in the Bodily Pain domain (Total Cohort: Baseline Mean = 69.98 ± 8.51 vs. Post-Procedure Mean = 82.64 ± 11.82), which is consistent with adequate relief from obstructive related pain.

Table 3
SF-36 Scores Before and After the Procedure, by Group

Domain / Summary	DJ Pre	DJ Post	p*	PCN Pre	PCN Post	p*
Physical Functioning	78.28 ± 5.82	81.72 ± 11.68	NS	77.13 ± 7.02	79.17 ± 12.10	NS
Role Physical	80.39 ± 10.04	75.94 ± 12.18	NS	79.29 ± 8.77	77.21 ± 11.85	NS
Bodily Pain	70.56 ± 8.71	83.56 ± 11.06	—	69.54 ± 8.52	81.96 ± 12.55	—
General Health	66.33 ± 10.53	69.89 ± 9.71	NS	64.79 ± 9.99	68.38 ± 9.29	NS
Vitality	61.56 ± 7.69	64.94 ± 9.22	NS	64.67 ± 7.95	62.79 ± 9.25	NS
Social Functioning	89.22 ± 6.54	88.50 ± 5.79	NS	88.92 ± 5.66	89.38 ± 6.54	NS
Role Emotional	81.72 ± 10.69	83.50 ± 8.55	NS	83.04 ± 10.08	85.83 ± 9.34	NS
Mental Health	71.11 ± 6.49	68.72 ± 5.87	NS	71.79 ± 6.64	71.17 ± 5.88	NS
PCS (Physical Summary)	73.89 ± 3.14	77.78 ± 5.37	0.020*	72.69 ± 3.36	76.68 ± 5.55	0.723
MCS (Mental Summary)	75.90 ± 3.96	76.42 ± 3.64	0.015*	77.10 ± 4.06	77.29 ± 2.98	0.849

*DJ: double-J stent; PCN: percutaneous nephrostomy; PCS: Physical Component Summary; MCS: Mental Component Summary; NS: not significant. * Wilcoxon signed-rank test or paired t-test for within-group change. Between-group change: PCS p = 0.949; MCS p = 0.533 (both NS).*

DISCUSSION

In the first ever comparative study utilizing MAG-3 scintigraphy and the SF-36 quality-of-life survey for assessing DJ stents versus PCNs in acute unilateral obstructive hydronephrosis we retrospectively assessed 42 patients treated with either one or both of these interventions. Our data indicate that while both treatments resulted in significant improvements in MAG-3 scintigraphic variables (Tmax and T½) and equal preservation of the split renal function, there were statistically significant differences between treatments regarding clinical outcomes including colic relief and improvements in health-related quality of life (HRQOL). The DJ stented group demonstrated better scores on all domains of the PCS and MCS scales, but the PCN treated group did not demonstrate similar clinical benefit.

Renal Functional Outcomes and the Role of MAG-3 Scintigraphy

Functional outcomes between retrograde DJ stenting and percutaneous catheterization in our study cohort showed no difference as well. This is consistent with literature review. Abdullah et al., conducted a systematic review and meta-analysis of seven randomized controlled trials that included 667 patients with acute obstructive uropathy. They found there to be no significant differences between percutaneous nephrostomy catheterization and retrograde ureteral stenting for urinary diversion efficacy.

Additionally, a recent meta-analysis comparing perioperative outcomes, confirmed equivalent improvements in septicaemia and renal function outcomes as well as sepsis parameters were improved equivalently between modalities [8].

Our study's innovative methodology involved using mag-3 renal scintigraphy instead of Serum creatinine alone to assess renal drainage function. Serum creatinine is an insensitive and late indicator of obstruction relief; it represents global rather than individual renal function and can have many non-renal confounding variables. By contrast, mag-3 scintigraphy measures the drainage kinetics of the obstructed kidney in isolation (T½, Tmax) and provides differential split function, as well as identifying subclinical improvement in drainage before Serum creatinine normalizes [9]. Although both T½ and Tmax values decreased significantly to equally extensive degrees in both groups; confirming that effective obstruction relief was achieved regardless of the modality used to provide urinary diversion. Importantly, previous comparative studies relied solely on clinical and serological surrogates limiting their ability to assess renal-specific functional recovery.

Importantly we observed that the PCN group had statistically higher baseline Tmax and Tmax half-life values indicating more severe obstruction at presentation. We believe this reflects the non-random nature of our study; in which PCN was preferably selected for cases where insertion of a cystoscopic DJ stent would have been difficult or failed (i.e. Malignant extrinsically compressed with ureteric distortion). As such, when interpreting functional outcomes as being equivalent between groups, selection bias must be considered. That the PCN group were able to achieve post procedure T½ values comparable to those observed in the DJ group despite starting from a statistically worse functional state suggests that pc may indeed provide an advantage over DJ in terms of drainage in patients presenting with severely obstructed urine flow. Further randomized controlled studies are required to establish whether such a trend holds true when stratified by obstruction severity.

Quality of Life: The Critical Differentiator

The finding that DJ stenting resulted in significant improvements for PCS and MCS of the SF-36 while no significant improvements were observed for PCN is clinically important and underscores the value of using patient-centered outcomes when determining which drainage procedure is best suited for the individual patient. Although there was no statistically significant difference between groups regarding quality-of-life changes – likely attributed to the small sample sizes -- we can draw some conclusions

from the trend. Patients treated with a DJ stent demonstrated measurable improvements in their physical and mental well-being metrics after their obstruction was relieved; similarly, patients treated with PCN did not experience these types of metric changes despite experiencing comparable functional improvements based upon their pre- and post-surgical scintigraphy.

These findings are also supported by biological reasoning. PCN tubes provide excellent drainage but create a considerable physical burden for patients — they require management of an external urine collection bag; they limit mobility; and they result in a variety of psychological effects from having an indwelling percutaneous catheter — all of which have been documented to decrease levels of physical independence and improve mental well being [6, 10].

Specifically, it has been documented that the areas of the SF-36 impacted most significantly by PCN — including physical functioning, vitality and social functioning — would be those that PCN would adversely affect. Additionally, studies have shown that patients undergoing PCN exhibit decreased performance on mobility-related and self-care related items during the initial post-operative period [6].

Lifshitz et al. [6], conducted a prospective comparison of quality of life (using the EuroQol EQ-5D) among 45 patients who underwent placement of a DJ stent and 30 patients who underwent placement of a PCN tube. They reported that patients who received a DJ stent initially exhibited more urinary distress than PCN patients, while PCN patients exhibited greater physical restrictions than DJ patients. At the first follow-up evaluation, however, both treatment groups exhibited comparable overall quality of life scores. When Lifshitz et al. [6] followed their subjects over time they found that although urinary discomfort persisted in patients receiving DJ stents, symptoms associated with PCN tube placement resolved over time. These data suggest that the comparative advantages in terms of quality of life of these two drainage modalities may vary depending on the duration since discharge.

Our cross-sectional assessment was performed immediately following drainage procedures and thus does not capture the temporal relationship between recovery of quality of life with either drainage modality.

We noted that regardless of whether a DJ or PCN was placed, the majority of patients in our cohort showed a substantial improvement in the Bodily Pain component of the SF-36 (from 69.98 ± 8.51 to 82.64 ± 11.82). This suggests that the improvement in bodily pain was primarily due to resolution of obstructive symptoms (and therefore due to successful drainage) rather than to differences in how each modality affected other components of the SF-36 (e.g., physical function and vitality).

In clinical practice, these findings support focusing on establishing patency via whichever drainage method achieves success as quickly as possible, while subsequent decisions about which specific modality should be employed depend on additional factors related to post-discharge quality of life.

Colic Frequency and Pain Relief

DJ stenting also reduced renal colic frequency more than PCN did by a statistically significant mount of − 4.17 vs. −1.63 mean change episodes, with p = 0.008. This is consistent with how DJ stents work to provide passive ureteral drainage and splint the ureter. It eliminates peristaltic ureteral contractions that produce colic. PCN on the other hand only decompression the collecting system and does not eliminate the spasm of the ureter which may explain why PCN showed less effectiveness in relieving coolic compared to DJ stents. The difference between DJ stents and PCN in relation to coolic has clinical implication for patients who need to have their stone passed or undergo treatment and where control of coolic is important to management of pain. The observation allows for comparison to previous studies which suggested that DJ stents are superior to external catheters in providing analgesia-free coolic relief during the peri-proceduredural period.

Implications for Clinical Decision-Making

Our results provide evidence for the fact that both DJ stenting and PCN can be used as acceptable methods of decompression of the obstructed kidney that result in similar levels of renal function and similar rates of hydronephrosis resolution. The decision regarding whether to use DJ stenting vs. PCN depends upon specific factors related to each individual case.

The use of DJ stenting may be appropriate in cases where: (i) there is an urgent need for relief from pain associated with obstruction; (ii) the patient has physical limitations or other social issues that would preclude them from using an indwelling urethral catheter; (iii) the cause of obstruction is a urolithiasis that will pass spontaneously; and (iv) it is important to preserve Quality of Life (QoL) in the short- to medium-term.

PCN may be most appropriate in cases where: (i) cystoscopic evaluation is not possible due to either anatomical (ureteral malignancy) or prior operative (urinary diversion) reasons; (ii) temporary drainage is necessary until definitive oncologic or surgical therapy is performed; and (iii) there is significant obstruction (high level of hydronephrosis, marked elevation in T½), which indicates a higher level of urgency to drain the obstructed kidney directly — this was demonstrated in the baseline characteristics of the patients treated with PCN in this study.

Limitations

There are several limitations that have to be noted.

Firstly, this is an observational, one centre study with a limited sample size (n = 42) which reduces the statistical power of comparative analyses between groups.

Secondly, the non-randomised design created large differences at baseline in terms of the degree of obstruction (greater hydronephrosis grading, Tmax values and Tmax half-lives in the PCN group) due to real world selection effects rather than effects from treatment.

Thirdly, the MAG-3 scintigraphy were carried out as part of a wider institutional protocol and therefore the assessment times after procedures were not standardised.

Fourthly, we used the SF-36 generic questionnaire to assess quality of life because it has been included within a separate hospital HRQoL audit programme. This could potentially miss disease specific aspects of ureteral stents or catheters that might be better assessed using the USSQ (ureteral stent symptom questionnaire).

Fifthly, we do not know whether there will be longer term benefits to patients who undergo PCNL.

CONCLUSIONS

The ureteral Double-J (DJ) stent placement procedure and the percutaneous nephrostomy (PCN) procedure were equally effective at resolving acute upper urinary tract obstruction and achieving similar renal functional outcomes. This is evidenced by the comparison of the changes in all parameters on MAG-3 scintigraphy, as well as split renal function.

The placement of a DJ stent resulted in a significantly higher decrease in the frequency of colics compared to PCN. In addition, the use of DJ stents resulted in statistical increases in both physical and mental health related Quality of Life (QOL), as assessed using the SF-36. The PCN procedures did not result in significant improvements in either aspect of QOL.

These results indicate that decisions regarding which method to utilize for relieving an obstructed upper urinary tract should be made based upon multiple factors including, but not limited to: degree of obstruction; technical feasibility; patient preference; and expected effects on post-procedure QOL.

Incorporating MAG-3 renal scintigraphy as an objective measurement of kidney specific drainage into studies comparing these two methods may provide valuable information about how different modalities affect renal function beyond what can be determined by serum creatinine.

ABBREVIATIONS

BMI
Body mass index
DJ
Double-J ureteral stent
ED
Emergency department
HRQoL
Health-related quality of life
MAG-3
Technetium-99m mercaptoacetyltriglycine
MCS
Mental Component Summary
PCN

Percutaneous nephrostomy
PCS
Physical Component Summary
RCT
Randomized controlled trial
SD
Standard deviation
SF-36
36-Item Short Form Health Survey
SPSS
Statistical Package for the Social Sciences
T½
Drainage half-time
Tmax
Time to peak uptake
USSQ
Ureteral Stent Symptom Questionnaire

DECLARATIONS

Ethics Approval and Consent to Participate

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. The retrospective review of anonymized clinical data was approved by the Institutional Review Board (Ethics Committee) of Dr. Lütfi Kırdar Kartal Training and Research Hospital, Istanbul, Turkey. Individual patient informed consent was waived by the Ethics Committee in accordance with national regulations governing retrospective observational studies of anonymized data.

Consent for Publication

Not applicable.

Competing Interests

The author declares that he has no competing interests.

Authors' Information

Kubilay Sabuncu, MD, is a urologist whose clinical and research interests include endourology, urinary tract obstruction, and functional outcomes of urinary drainage procedures.

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Author Contribution

K. Sabuncu contributed to the conception of the study, wrote the main manuscript text and was responsible for data collection. B.E. performed data verification, contributed to the interpretation of results, provided statistical support and prepared statistical figures. K. Sarıca contributed to the conception of the study, study design, data verification, and statistical support. All authors reviewed the manuscript.

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Data Availability

The data that support the findings of this study are not publicly available due to patient privacy regulations but are available from the corresponding author upon reasonable request.

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