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The Impact of Endourological Procedures on Uroflowmetry Parameters: A Prospective Study

Faris Abushamma[1],[2], Amir Aghbar[1,2*], Ahmad Iqtait[1], Lyana Shtewi[1], Ekrema Qasim[1] Rola Abu Alwafa[1] & Hashim Hashim[3]

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Abstract: Introduction: Endourological procedures are integral to urology, utilizing advanced tools for diagnosis and treatment. These interventions impact uroflowmetry, a key diagnostic tool for lower urinary tract symptoms. Anesthesia type influences both pain perception and uroflowmetry. This study aims to explore the relationship between endourological procedures and uroflowmetry parameters. **Methods:** A prospective cohort study conducted at An-Najah National University Hospital included patients undergoing endourological procedures between May and December 2023. Uroflowmetry was performed before and after procedures, assessing peak flow rate (PFR), voided volume, time to maximum flow, flow time, and voiding time. Statistical analysis was performed using SPSS version 21. **Results:** 49 patients met our inclusion criteria, and the median age for study participants was 49 years, with a body mass index (BMI) range from 18.5 to ≥30. Comorbidities included diabetes mellitus (20.4%) and hypertension (26.5%). Anesthesia modalities included general anesthesia (71.4%), local anesthesia (18.4%), and spinal anesthesia (10.2%). Post-operative uroflowmetry revealed a slight increase in median PFR from 16.0 ml/s (pre-op) to 18.0 ml/s (post-op), with a mean difference of +2.3 ml/s. Voided volume decreased from a median of 240.0 ml to 226.0 ml, with a mean difference of -5.6 ml. Time to maximum flow reduced from 9.0 s to 8.0 s, with a mean difference of -3.2 s. Flow time decreased from 34.0 s to 30.0 s, with a mean difference of -13.3 s. Voiding time also decreased from 44.0 s to 37.4 s, with a mean difference of -20 s. Diabetes mellitus significantly influenced urinary flow dynamics, with diabetic patients exhibiting a notable difference in preoperative and post-operative median PFR compared to non-diabetic patients ($p = 0.023$). **Conclusion:** Endourological procedures impact uroflowmetry parameters, with notable changes observed post-procedure. Diabetes mellitus is a crucial factor influencing urinary flow dynamics, underscoring its importance in patient outcomes.

Keywords: Endourology, Uroflowmetry, Anesthesia, Diabetes Mellitus.

Introduction

Endourological procedures are commonly used in urology to diagnose and treat various urologic disorders. These procedures involve using endoscopes, lasers, and other specialized tools to access and manipulate the urinary tract [1].

Endourological procedures can significantly impact uroflowmetry, a non-invasive urodynamic test in which specific measurements are made of the rate of flow of urine and the volume voided. It is normally followed by an ultrasonically scanned measurement of post-void residual (PVR) urine volume and an interpretation of the flow pattern recorded by the machine throughout the void. It is utilized for patients who present with symptoms of lower urinary dysfunction. It should be recognized that uroflowmetry represents the compound effect of bladder and urethral function [2].

Limited studies have investigated the effect of endourological procedures on uroflowmetry, and the results have been mixed. Studies have shown that patients undergoing these procedures may experience a decrease in their maximum urinary flow rate and an increase in post-void residual volume. These changes can be temporary or long-lasting, depending on the procedure and the patient's response [3].

Pain assessment is also important in endourological procedures. Patients may experience pain during or after the procedure, affecting their overall experience and recovery. Studies have shown that different endourological procedures can result in varying pain levels. For example, one study found that percutaneous nephrolithotomy was associated with a higher level of pain than ureteroscopy. Another study found that patients undergoing laser lithotripsy experienced less pain than those undergoing pneumatic lithotripsy [4].

Various techniques can be used to manage pain during endourological procedures. These techniques include regional anesthesia, intravenous analgesia, and conscious sedation. Studies have shown that the use of regional anesthesia, such as epidural or spinal anesthesia, can result in lower levels of pain and better patient satisfaction compared to intravenous analgesia or conscious sedation alone [5].

In addition to pain management, the use of non-pharmacological interventions, such as distraction techniques or relaxation therapy, can also be effective in reducing pain and anxiety during endourological procedures. One study found that music therapy during percutaneous nephrolithotomy resulted in lower levels of pain and anxiety compared to a control group [6].

The type of anesthesia used during endourological procedures can also affect uroflowmetry results. Studies have shown that general anesthesia can decrease the maximum urinary flow rate compared to spinal or epidural anesthesia. This may be due to the effects of general anesthesia on the smooth muscle tone of the urinary system [7-8].

This study investigates the impact of different endourological procedures on uroflowmetry parameters. Specifically, it seeks to understand how different surgeries affect urinary flow rates,

1 Department of Medicine, College of Medicine and Health Sciences, An-Najah National University, Nablus, Palestine.
2 Department of Urology, An-Najah National University Hospital, Nablus, Palestine.
* Corresponding author: amir.aghbar@najah.edu.
3 Bristol Urological Institute, North Bristol NHS Trust, Bristol, United Kingdom.

post-void residual volume, and lower urinary tract symptoms. By assessing these factors, the study aims to improve our understanding of the effects of endourological procedures on urinary function and optimize patient care.

Methods

Study design, setting and timing:

A prospective cohort study was conducted between May 2023 and December 2023 in Nablus- Palestine, at An-Najah National University Hospital "NNUH".

Study population

Male patients who underwent endourological procedures at NNUH during the period as mentioned above were included, including those under local and general anesthesia.

Inclusion and exclusion criteria

The inclusion criteria for this study included males aged 18 years and above who were scheduled to undergo endourological procedures between May 2023 and December 2023. Exclusion criteria comprised female patients, patients with previous medical conditions related to the urinary tract, documented or symptomatic urinary tract infections, inability to cooperate for objective assessment (Uroflow), pediatric age group, and patients unable to achieve a minimum voided amount of 100 ml.

Data collection instrument

The patient demographic questionnaire collected information related to the demographic characteristics of the participants. The uroflowmeter assessed the maximum flow rate (Qmax) and post-void residual volume.

Uroflowmetry procedure

Uroflowmetry was performed using a flowmeter (MMS/Laborie's), and the measurements were expressed in milliliters per second (ml/s) to assess peak flow rate. Participants who met our inclusion criteria were asked to void normally, either sitting or standing, with a comfortable full bladder, and they were provided the needed privacy and comfortable surroundings to remove the inhibitory effect of the test environment. The test was considered acceptable if the minimum voided volume, as measured by the device, was 100 ml, and if less than this amount, the participant was asked to re-urinate after refilling the bladder. Two sets of uroflowmetry for included participants were recorded, one prior to their endourological intervention and the other after the intervention, after the patient was deemed able to urinate immediately or a couple of hours later.

Ethical considerations

All aspects of the study protocol, including access to and use of the patient clinical information, were authorized by the Institutional Review Boards (IRB) and the local health authorities.

Confidentiality

We confirmed that the collected data were used for clinical research only. Information was confidential and used for research purposes only. An informed consent was given to all participants that confirm the privacy of data and all data will be secret and used only for research purposes.

Statistical analysis

Data were entered and analyzed using the Statistical Package for Social Sciences program (SPSS) version 21. Data were expressed as means ± standard deviation (SD) for continuous variables and as frequencies and percentages for categorical variables. Variables that were not normally distributed were expressed as medians (lower-upper quartiles). Variables were tested for normality using Kolmogorov-Smirnov test. Either the chi-square or the Fisher exact test, as appropriate, were used to test the significance between categorical variables. The Kruskal-Walli's Bonferroni-Dunn post hoc analysis or Mann-Whitney test was used to determine the differences in the means between categories. The significance level was set at p-value < 0.05.

Results

Patient demographics and clinical characteristics

The study encompassed a cohort of 49 male patients, among whom the median age was 49 years, with a range spanning from 33 to 63 years. Body Mass Index (BMI) distributions revealed that the majority fell within the range of 18.5 to 29.9, with 36.7% having a BMI between 18.5 and 24.9, 42.9% between 25 and 29.9, and 20.4% with a BMI of 30 or higher. Regarding comorbidities, 20.4% of patients had diabetes mellitus (DM), while the majority (79.6%) did not. Additionally, 26.5% of participants had hypertension (HTN), with the remaining 73.5% being free from this condition. Anesthesia modalities varied, with the predominant choice being general anesthesia (71.4%), followed by local anesthesia (18.4%), and spinal anesthesia (10.2%). Regarding pre-procedure double J (DJ) stent placement, 26.5% have pre-procedure DJ stent placement, while 76.5% did not. (Table 1).

Table (1): Patient demographics and clinical characteristics.

Variable	Frequency (%) or Median (Q1-Q3) N=49
Age	49.0 (33.0-63.0)
BMI	
<18.5	0 (0.0)
18.5-24.9	18 (36.7)
25-29.9	21 (42.9)
≥30	10 (20.4)
DM	
Yes	10 (20.4)
No	39 (79.6)
HTN	
Yes	13 (26.5)
No	36 (73.5)
Type of anesthesia	
General anesthesia	35 (71.4)
Local anesthesia	9 (18.4)
Spinal anesthesia	5 (10.2)
Pre-procedure DJ stent	
Yes	13 (26.5)
No	36 (73.5)

BMI: body mass index, DM: Diabetes Miletus, HTN: Hypertension.

Uroflowmetry results before and after endourological intervention

The uroflowmetry results before and after endourological procedures were analyzed to assess changes in urinary flow parameters as evident in Table 2. Post-operative median peak flow rate showed a slight increase from 16.0 ml/s (Q1-Q3: 10.6-20.7) to 18.0 ml/s (Q1-Q3: 11.5-23.0), with a mean difference of +2.3 ml/s. Voided volume exhibited a decrease from a median of 240.0 ml (Q1-Q3: 158.5-367.0) to 226.0 ml (Q1-Q3: 167.7-329.1), with a mean difference of -5.6 ml, whereas time to maximum flow showed a reduction from 9.0 s (Q1-Q3: 5.5-14.5) to 8.0 s (Q1-Q3: 5.0-15.0), with a mean difference of -3.2 s. Flow time decreased from 34.0 s (Q1-Q3: 22.7-58.0) to 30.0 s (Q1-Q3: 20.0-42.0), with a mean difference of -13.3 s. Voiding time also decreased from 44.0 s (Q1-Q3: 28.8-72.3) to 37.4 s (Q1-Q3: 22.1-49.0), with a mean difference of -20 s. These results collectively suggest an improvement in urinary flow dynamics post-endourological procedures, reflected by increased peak flow rates and decreased voiding and flow times.

Table (2): Results of uroflowmetry before and after endourological procedures.

Variable	Preoperative Median (Q1-Q3)	Post-operative Median (Q1-Q3)	Difference (After Vs Before)
Peak flow rate (ml/s)			
Median (Q1-Q3)	16.0 (10.6-20.7)	18.0 (11.5-23.0)	+2
Mean	16.3	18.9	+2.3
Range	4.0-38.0	4.0-42.0	-
Voided volume (ml)			
Median (Q1-Q3)	240.0 (158.5-367.0)	226.0 (167.7-329.1)	-14
Mean	263.4	257.8	-5.6
Range	103.4-488.0	100.0-566.0	-
Time to maximum flow (s)			
Median (Q1-Q3)	9.0 (5.5-14.5)	8.0 (5.0-15.0)	-1
Mean	15.4	12.2	-3.2
Range	2.0-117.2	2.0-137.0	-
Flow time (s)			
Median (Q1-Q3)	34.0 (22.7-58.0)	30.0 (20.0-42.0)	-4
Mean	47.0	33.7	-13.3
Range	14.6-372.5	10.6-87.0	-
Voiding time (s)			
Median (Q1-Q3)	44.0(28.8-72.3)	37.4 (22.1-49.0)	-6.6
Mean	60.0	40.0	-20
Range	19.3-477.9	11.6-94.0	-

The correlation between results of uroflowmetry before and after endourological procedures with patients' demographics

The key findings from Table 3 indicate that diabetes mellitus (DM) status significantly influences urinary flow dynamics before and after endourological procedures, with patients diagnosed with DM showing a notable difference in preoperative and post-operative median peak flow rates (PFR) compared to those without DM (p = 0.023). Conversely, while variations in preoperative and post-operative median PFR are observed across different BMI categories, these differences do not reach statistical significance (p > 0.05). However, there is a trend suggesting higher post-operative PFR in patients with a BMI of ≥30 compared to those with lower BMIs. These findings underscore the significance of DM status in post-procedural urinary flow dynamics, suggesting its potential as a crucial factor in patient outcomes following endourological interventions.

Table (3): The correlation between results of uroflowmetry before and after endourological procedures with patients' demographics.

Variable	PFR pre-op Median (Q1-Q3)	PFR post op Median (Q1-Q3)
BMI		
18.5-24.9	16.0(9.0-23.5)	20.4(14.5-27.4)
25-29.9	13.0(9.6-18.5)	14.7(10.0-19.5)
≥30	19.2(16.0-26.2)	21.3(17.7-30.0)
P value	0.438b	0.063b
DM		
Yes	12.0(11.5-21.2)	11.5(9.5-16.8)
No	17.0(10.1-21.0)	20.0(14.7-27.2)
P value	0.616a	0.023a
HTN		
Yes	13.0(12.0-17.8)	15.0(10.0-23.0)
No	17.5(10.1-21.7)	18.45(12.0-26.0)
P value	0.411a	0.725a
Type of anesthesia		
General anesthesia	17.0(12.0-21.0)	17.6(11.0-23.0)
Local anesthesia	13.0(7.4-23.5)	17.0(10.5-23.6)
Spinal anesthesia	12.0(6.0-20.0)	27.0(13.2-32.9)
P value	0.458b	0.405b
Pre-procedure DJ stent		
Yes	12.0 (5.9-17.7)	20.0 (14.8-26.0)
No	17.8 (12.0-21.7)	17.3 (10.0-23.0)
P value	0.07a	0.282a

BMI: body mass index, DM: Diabetes Miletus, HTN: Hypertension
The bold values indicate p<0.05
a Statistical significance values calculated using Mann–Whitney U-test.
statistical significance values calculated using kruskal wallis test

Uroflowmetry parameters based on the type of intervention.

The study encompassed a cohort of 49 patients (36 of them were cystoscopy and 13 ureteroscopy) The uroflowmetry results before and after endourological procedures (Cystoscopy and Ureteroscopy) were analyzed to assess changes in urinary flow parameters as evident in Table 4. Post-operative median peak flow rate of ureteroscopy showed a slight increase from 17.0ml/s (Q1-Q3: 10.6-21.2) to 20.0 ml/s (Q1-Q3: 15.1-25.8), where as in cystoscopy the pre and post operative peak flow rate remain the same of pre-16.0ml/s (Q1-Q3: 10.4 -20.8) and post 16 ml/s (Q1-Q3: 11.0-23.0). In ureteroscopy voided volume exhibited an increase from a median of 164.0 ml (Q1-Q3: 136.5-305.4) to

226.0 ml (Q1-Q3: 164.0-279.0), where as in cystoscopy voided volume exhibited a decrease from a median of 276.4 ml (Q1-Q3: 165.5-388.2) to 225.5 ml (Q1-Q3: 167.0-342.1). In ureteroscopy there was decrease in time to maximum flow from 11.0 s (Q1-Q3: 5.1-23.5) to 6.0 s (Q1-Q3: 4.35-15.0) where as in cystoscopy there is a slight reduction from 8.5 s (Q1-Q3: 5.25-12.7) to 8.0 s (Q1-Q3: 5.5-14.2). regarding to flow time, there is increase in ureteroscopy from 24.1 s (Q1-Q3: 16-66.7) to 30.0 s (Q1-Q3: 21.5-39.4), where as in cystoscopy there is reduction in flow time from 36.5 s (Q1-Q3: 25.0-57.2) to 32.2 s (Q1-Q3: 20.0-46.5). In addition, the voiding time shows a greater decrease in time in ureteroscopy from 44.6 s (Q1-Q3: 35.5-88.0) to 37.0 s (Q1-Q3: 24-43.7) compare to that of cystoscopy which shows reduction from 41.0s (Q1-Q3: 26.8-63.2) to 37.7s (Q1-Q3: 21.6-55.5)

Table (4): The difference between uroflowmetry parameter based on type of surgery.

Uroflow parameter Median (Q1-Q3)	Cystoscopy n= 36	Ureteroscopy n= 13	P-Value
PFR pre-op	16 (10.4 -20.8)	17(10.6-21.2)	0.874a
PFR post op	16(11.0-23.0)	20 (15.1-25.8)	0.415a
Voided volume Pre-op	276.4(165.5-388.2)	164(136.5-305.4)	0.075
Voided volume post-op	225.5(167.0-342.1)	226(164.0-279.0)	0.618
Time to maximum flow Pre	8.5 (5.25-12.7)	11 (5.1-23.5)	0.618
Time to maximum flow Post	8(5.5-14.2)	6 (4.35-15.0)	0.447
Flow time Pre	36.5(25.0-57.2)	24.1(16-66.7)	0.389
Flow time Post	32.2 (20.0-46.5)	30 (21.5-39.4)	0.659
Voiding time Pre	41.0(26.8-63.2)	44.6(35.5-88.0)	0.421
Voiding time Post	37.7(21.6-55.5)	37.0(24-43.7)	0.595

The bold values indicate $p<0.05$
a Statistical significance values calculated using Mann–Whitney U-test.

Discussion

This research delves into the intricate interplay between endourological procedures and uroflowmetry in the context of urology. These procedures, utilizing advanced tools and techniques, are vital for diagnosing and treating various urologic conditions. Understanding their impact on urinary flow dynamics and pain perception is crucial for enhancing patient care. Moreover, the choice of anesthesia modalities significantly influences patient comfort and satisfaction during these interventions. This study aims to elucidate these relationships, offering valuable insights to optimize clinical practice and improve outcomes for patients undergoing endourological procedures.

Uroflowmetry have been used as an assessment tool for managing lower urinary tract symptoms [9- 10], which have been variably studied in our community [11, 18]. Limited previous research have been conducted relating the effect of endourological procedures on urine flow, but one study have shown that urethral catheterization adversely impact urine flow in a specific set of cohort of patients [19]. Other studies evaluated the examined the effect of bladder sensitivity on uroflowmetry parameters [20]. These studies signify the importance of uroflowmetry as an important assessment tool in management urology patients.

Several factors have been implicated to affect voiding. Sitting position was found to have a better PFR than standing position in patients with benign prostate hyperplasia [21], while other study showed a contrary findings with voiding standing position better than sitting position [22]. The impact of voiding position on uroflowmetry parameters remains a debated topic [23]. In this study, patients voided in their accustomed and preferred position to ensure natural behavior. To control for this factor, future studies should standardize the voiding position and maintain a consistent height or distance between the external urethral meatus and the uroflowmetry device.

Bladder sensation was also found to affect uroflowmetry results and PFR, and strong recommendations to do uroflowmetry evaluation to be made after developing strong desire to void [24]. Ethnicity have also been found as a factor influencing uroflowmetry parameters, with nomograms developed for some populations [25, 27].

General, spinal, and local anesthesia were not found have a significant effect on uroflowmetry parameters. Although previous studies showed general and spinal anesthesia reduce urinary flow and risks the development of urinary retention [7- 8]. Intraurethral lidocaine administration was not found to have any effect on voiding parameters during urodynamic study [28]. The variability in anesthesia regimens presents a potential confounding factor in this study. While we standardized the timing of uroflowmetry assessments post-procedure, future studies should focus on employing a more homogeneous anesthesia regimen to better control this variable.

The results of our research demonstrate notable changes in urinary flow parameters following endourological procedures. Postoperatively, there was a slight increase in median PFR and a decrease in voided volume, with reductions observed in time to maximum flow, flow time, and voiding time. These findings collectively suggest an improvement in urinary flow dynamics post-procedure, characterized by increased peak flow rates and decreased voiding and flow times. Although limited available evidence to compare our results to, a previous study evaluated the impact of long-term ureteral catheter on urinary symptoms and urine flow, and found that the peak flow rate, voided volume, and postvoid residual urine volume were not significantly changed [29]. Another study showed that urethral catheter has a significant effect on uroflowmetry parameters [30]. Flexible cystoscopy was also found to have negatively affect the PFR [31]. Other study showed a statistical improvement in urine flow after rigid cystoscopy [32]. The timing of voiding post-procedure was flexible to reflect real-world conditions. While this approach ensures patient comfort, future studies should standardize the timing of uroflowmetry assessments to more effectively control for the influence of voiding time.

Our study found that DM as a significant factor affecting urinary flow dynamics before and after endourological procedures. DM patients exhibited notable differences in PFR compared to non-DM patients, emphasizing its crucial role in post-procedural urinary flow dynamics. This contrary to previous studies noting that patients with DM have a wide range of bladder dysfunction, and voiding dysfunction is one of these spectra [33]. Several factors have been attributed to diabetic bladder dysfunction, including detrusor muscle dysfunction, urothelial dysfunction, autonomic nervous system impairment, and systemic factors like inflammation, oxidative stress, and microvascular damage [34]. Reduced PFR, and increased voiding time and time to maximum flow were observed among diabetics [35]. Other studies have evaluated the uroflow in diabetics and non-diabetics, non-diabetics were found to have longer average flow and smaller post-voiding residual, but no difference was found between the two groups concerning PFR, voided volume, voiding time, and average flow time [36]. These results stress the importance of considering DM status in predicting patient outcomes post-endourological interventions.

While variations in PFR across different BMI categories were noted, statistical significance was not reached, except for a trend showing higher post-operative PFR in patients with a BMI of ≥30. Studies have shown that BMI has no effect on urine flow as demonstrated by a urodynamic study comparing those with a BMI of more and less than 30, although overactive bladder symptoms increased with age [37].

Conclusion

Our study highlights the impact of endourological procedures on uroflowmetry parameters. We observed slight improvements in post-procedural uroflowmetry parameters through a prospective cohort design, including increased peak flow rates and decreased voiding and flow times. Importantly, DM emerged as a critical factor influencing urinary flow dynamics, emphasizing the need to consider this comorbidity in patient outcomes following endourological interventions.

Strengths and Limitations

Our study's strengths are its prospective cohort design, comprehensive endourological procedures' impact assessment, and rigorous statistical analysis. However, limitations include a relatively small sample size, single-center nature, male gender inclusion only, a short follow-up period, and the lack of blinding, which may affect the generalizability and validity of our findings. Additionally, our dataset did not include detailed patient histories, including information on urologic conditions such as benign prostatic hyperplasia (BPH) and relevant medications. Despite these limitations, our study provides valuable insights into optimizing clinical practice and improving outcomes for patients undergoing endourological procedures in urology.

Disclosure Statement

- **Availability of data and materials:** The data and materials utilized in this research are available upon request from the corresponding author.
- **Author contributions:** All authors contributed significantly to the research, with each playing an essential role in the study's design, data collection, analysis, and manuscript preparation. The contributions were nearly equal across the team, ensuring a collaborative effort throughout the project.
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