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Research Article

Predictive Factors for Ureteral Stricture in Patients Undergoing Endoscopic Stone Surgery

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ABSTRACT

Objective: To evaluate predictive factors for ureteral stricture in patients undergoing ureterorenoscopy (URS) for ureteral stones and to identify radiological and demographic parameters that may influence surgical access.

Methods: This retrospective study analyzed data from 197 patients who underwent URS between 2023 and 2025. After applying inclusion and exclusion criteria, 141 patients with available abdomino-pelvic computed tomography (CT) scans were included. Group 1 comprised 30 patients with ureteral strictures requiring passive dilatation with double-J stenting, whereas Group 2 included 111 patients with successful ureteral access and stone fragmentation. Demographic data [age, sex, body mass index (BMI)] and CT-based measurements renal pelvis anteroposterior (AP) diameter, proximal, mid, and distal ureteral AP diameters, distal coronal AP diameter, and stone size) were compared between groups.

Results: Distal ureteral transverse AP diameter (2.25 ± 0.28 mm vs 3.17 ± 0.55 mm, $P < 0.001$), distal coronal AP diameter (2.83 ± 0.43 mm vs 3.56 ± 0.42 mm, $P < 0.001$), and stone size (6.19 ± 2.48 mm vs 7.48 ± 2.06 mm, $P = 0.031$) were significantly lower in Group 1 than in Group 2. In addition, BMI was significantly higher in Group 1. Other CT parameters showed no significant differences.

Conclusion: Narrow distal ureteral diameters and smaller stone sizes measured on preoperative CT, along with higher BMI, were associated with failure of ureteral access at the initial URS session. Identifying these predictors preoperatively may guide patient counseling and surgical planningand reduce intraoperative complications.

Keywords: Ureteral stricture, URS, ureter stone, endoscopy

INTRODUCTION

Urolithiasis is a prevalent urological condition, affecting between 1% and 20% of the population, with prevalence varying according to geographic region.[1] Over the past two decades, substantial advancements have been made in minimally invasive techniques for the management of this condition, including ureterorenoscopy (URS), shock wave lithotripsy (SWL), and percutaneous nephrolithotomy.[2] In recent decades, advances in laser technology and URS have established URS as the standard treatment for ureteral stones.[3] The utilization of URS has increased as the surgical management of upper urinary tract stone disease shifts from predominantly non-invasive methods, such as SWL, toward more invasive approaches, notably flexible URS.[3] Despite its minimally invasive nature, URS can present significant technical challenges, particularly in cases involving ureteral strictures or narrow ureteral anatomy, which may hinder access to the calculi.[4]

When ureteral access cannot be achieved during the initial procedure, active balloon dilatation, or more commonly passive dilatation via placement of a double-J (DJ) stent followed by URS, is indicated. However, in cases of severe ureteral stenosis accompanied by stone obstruction, placement of a DJ stent may be infeasible. Consequently, this situation not only elevates patient morbidity and healthcare costs but also prolongs the

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duration of stone-related symptoms.[5] Moreover, in obstructive pyelonephritis, urgent urinary drainage is critical to prevent renal deterioration. If endoscopic DJ stent placement cannot be achieved, percutaneous nephrostomy remains the only viable alternative.[6] Taken together, these factors underscore the importance of identifying reliable predictors of difficult ureteral access, as early recognition can enhance clinical decision-making and optimize patient outcomes. Furthermore, it can facilitate the timely preparation of both patients and surgeons for potential percutaneous nephrostomy placement. Interestingly, smaller stones have also been associated with ureteral stricture, which may be explained by their tendency to lodge in already narrowed or fibrotic segments, where chronic irritation and limited luminal expansion promote further fibrosis and stricture formation.

Several studies have reported that factors such as young age, female sex, small ureteral diameter, and high body mass index (BMI) may predispose patients to ureteral stenosis and increase the risk of ureteral injury.[7] In recent years, preoperative measurement of ureteral and renal pelvic diameters using non-contrast computed tomography (NCCT) has gained popularity for predicting ureteral stenosis and potential surgical complications.[8] Nevertheless, evidence remains limited regarding which specific radiological and demographic parameters constitute the most significant risk factors for ureteral stenosis requiring stent placement.

The present study aims to evaluate the risk of ureteral stenosis by assessing preoperative CT-based ureteral measurements alongside other clinical and demographic factors in patients undergoing URS. Identifying these risk factors may facilitate better preoperative counseling and surgical planning. Moreover, primary nephrostomy placement instead of URS in high-risk patients—particularly those with infection or renal obstruction—may reduce morbidity and improve clinical outcomes.

MATERIAL AND METHODS

This study was approved by the Mudanya University Health Sciences Ethics Committee (reference no: E-40839601-50.04-62, date: 03.12.2024) and conducted in accordance with the Declaration of Helsinki (1975, revised 2008). Patient data were recorded and analyzed retrospectively.

MAIN POINTS

- Preoperative computed tomography findings, specifically narrow distal ureteral diameters, are strong predictors of difficult ureteral access during ureterorenoscopy.
- Higher body mass index is associated with an increased risk of requiring passive dilatation with double-J stent placement before definitive stone treatment.
- Smaller ureteral stones are paradoxically associated with higher rates of ureteral strictures, possibly due to inadequate luminal dilation.

Patient Selection

A total of 197 patients who underwent URS between January 2023 and January 2025 were evaluated. Of these, 141 patients with available abdomino-pelvic NCCT were included. Exclusion criteria were:

- Age < 18 years (n=1),
- Absence of preoperative CT data (n=51),
- URS performed for diagnostic purposes (n=4).

Group Classification

- Group 1 (n=30): Patients in whom the distal ureter could not be accessed because of a stricture and who underwent passive dilatation with DJ stent placement.
- Group 2 (n=111): Patients with successful ureteral access and stone fragmentation during the first URS session.

Data Collection

Demographic parameters: age, sex, BMI.

Radiological measurements on NCCT (1 mm slice interval):

- Renal pelvis anteroposterior (AP) diameter (mm)
- Proximal, mid, distal ureteral AP diameters (mm)
- Distal ureteral coronal AP diameter (mm)
- Stone diameter (mm)

Measurement Method

Transverse measurements of the renal pelvis, proximal ureter, mid-ureter, and distal ureter were obtained in all patients using NCCT with a slice thickness of 1 mm. Additionally, measurements were taken at the level of the distal ureter in the coronal plane. For consistency, the ureter was defined at the same anatomical level in each case, and measurements were performed on the corresponding section images. All radiological measurements were independently performed by an experienced urologist (S.Y.).

Surgical Technique

All procedures were performed by a single experienced surgeon (SY) using a 7.5 Fr Storz semirigid ureteroscope. A guidewire was advanced through the ureteral orifice. In cases without strictures, stones were accessed and fragmented using laser lithotripsy. When a distal ureteral stricture was present, a DJ stent was placed and URS was postponed for one month to allow passive dilatation before definitive stone treatment.

Statistical Analysis

Statistical analyses were performed using MedCalc statistical software (Mariakerke, Belgium). The results were expressed as mean ± standard deviation. The normality of data distribution was evaluated using the Kolmogorov-Smirnov test. Since the data were normally distributed, comparisons between groups were performed using the Student's t-test. *P* values were considered statistically significant.

RESULTS

A total of 141 patients were included. Thirty patients (21.3%) required DJ stenting for ureteral stricture (Group 1), while 111 patients (78.7%) underwent successful primary URS (Group 2) (Table 1). No significant differences were observed between the groups in terms of age and gender. However, BMI was significantly higher in Group 1 patients than in those Group 2 ($P = 0.049$; Table 1).

- Distal ureteral AP diameter was significantly lower in Group 1 (2.25 ± 0.28 mm) than in Group 2 (3.17 ± 0.55 mm; $P < 0.001$) (Table 2).
- Distal coronal AP diameter was also lower in Group 1 (2.83 ± 0.43 mm) than in Group 2 (3.56 ± 0.42 mm; $P < 0.001$) (Table 2).
- Stone size was smaller in Group 1 (6.19 ± 2.48 mm) than in Group 2 (7.48 ± 2.06 mm; $P = 0.031$).
- BMI was significantly higher in Group 1 ($P < 0.05$).
- Other parameters (renal pelvis AP, proximal-mid ureter AP, stone proximal location) showed no significant differences.

DISCUSSION

To date, no studies have addressed the measurement of ureteral diameters in patients undergoing prestenting for ureteral stenosis. Our findings suggest that narrower distal ureteral diameters on preoperative CT scans and higher BMI are associated with failure to obtain ureteral access during initial URS, necessitating DJ stenting. Additionally, small stones were associated with ureteral stenosis, suggesting that failure of these stones to pass may indicate ureteral stenosis. Interestingly, in our study, smaller stones were paradoxically associated with ureteral stenosis and failure of initial URS. This may be explained by the inability of even small stones to pass through a pre-existing narrow distal ureter. While some studies report that larger stones are more likely to cause obstruction and stricture formation, others have observed paradoxical findings, suggesting that stone size alone may not fully predict ureteral patency.[9,10] These discrepancies highlight the importance of considering ureteral anatomy and preexisting narrowing in addition to stone characteristics when planning an intervention. Furthermore, recent evidence indicates that increased ureteral wall thickness is associated with both decreased spontaneous passage of ureteral stones and a higher risk of ureteral stricture after URS.[11] These findings support our observation that ureteral anatomy, including distal ureteral narrowing, plays a critical role in predicting procedural success and long-term outcomes.

Table 1. Comparison of Demographic Characteristics Between Groups

	Group 1 (n=30)	Group 2 (n=111)	*P* value
Age	42.2 ± 6.2	39.9 ± 7.4	0.578
Male	29 (96.6%)	93 (83.9%)	0.145
Female	1 (3.4%)	18 (16.1%)	0.217
BMI	27.6±3.4	26.0±2.5	**0.049***

A Student's t-test was used. *P values < 0.05 > are considered statistically significant and are shown in bold.
BMI, body mass index.

Table 2. Comparison of Tomographic Measurement Data Between the Two Groups

	Group 1 (n=30)	Group 2 (n=111)	*P* value
Renal Pelvis AP	14.41 ± 5.54	14.90 ± 8.46	0.788
Proximal ureter AP	6.35 ± 2.34	6.70 ± 2.20	0.551
Mid ureter AP	3.99 ± 1.51	4.47 ± 1.79	0.260
Distal ureter AP	2.25 ± 0.28	3.17 ± 0.55	**< 0.001***
Distal ureter (Cor)	2.83 ± 0.43	3.56 ± 0.42	**< 0.001***
Stone size	6.19 ± 2.48	7.48 ± 2.06	**0.031***

Student's t-test was used. *P value 0.05 is considered statistically significant and is bolded.
AP, anteroposterior; Cor, coronal.

These findings are consistent with previous literature emphasizing the role of ureteral anatomy in determining URS outcomes. Narrow distal ureters have been consistently associated with an increased risk of stricture formation and technical difficulties during URS.[12,13] Similarly, higher BMI has been associated with more complex surgical rerouting and anatomic reorientation, potentially complicating surgical access.[13] This association may be explained by increased retroperitoneal fat and altered ureteral angulation, which can complicate endoscopic navigation. Additionally, obesity may affect patient positioning and limit the working space for instrumentation, potentially increasing operative difficulty. A meta-analysis has shown that older age and obesity are associated with a higher risk of ureteral stricture.[7] Our study expands on these observations by quantitatively linking the distal ureteral diameter to failure of initial URS, providing objective, imaging-based parameters that may predict procedural difficulty.

In this study, no significant differences were observed between the two groups in the diameters of the renal pelvis, proximal ureter, and mid-ureter as measured on CT scans. However, both AP and coronal measurements showed that distal ureteral diameters were significantly smaller in patients in Group 1 than in patients in Group 2. This suggests that distal ureteral narrowing plays a central role in determining initial ureteral accessibility. Distal ureteral stricture present in the majority of unsuccessful or non-accessible URS procedures. Our findings highlight the potential clinical utility of standardizing these measurements to provide patients with clearer preoperative information regarding the likelihood of ureteral stricture.

As the diameter of ureteral stones decreases, the incidence of ureteral stenosis and of failed URS increases.[9] The present results reinforce this observation, indicating that even small calculi may fail to pass through a narrowed ureter. Clinically, 2-4-mm stones causing significant obstructive uropathy often fail to pass despite 2-4 weeks of conservative management and medical expulsive therapy.[10] The decision to proceed with surgical intervention is based on a comprehensive evaluation of the stone's size, location, degree of hydronephrosis, as well as the patient's clinical symptoms. Our data suggest that in such cases the ureter is often too narrow to be accessed during the

initial URS attempt, requiring prior ureteral stenting to facilitate access.[14] Incorporating ureteral diameter measurements into the preoperative assessment may therefore enable earlier surgical planning, avoiding unnecessary delays in stone passage, relieving obstruction, and improving patient outcomes.

The standard treatment for ureteral obstruction caused by stones is URS combined with laser lithotripsy.[15] However, in patients presenting with infection secondary to renal obstruction, timely renal drainage is imperative due to the elevated risk of urosepsis.[16] In such cases, the most commonly employed interventions are DJ stent placement or percutaneous nephrostomy.[17] Based on our results, when managing patients with stone-related hydronephrosis and urosepsis, particularly those with a narrow ureteral diameter on CT, proceeding with percutaneous nephrostomy may be more appropriate to optimize both clinical outcomes and patient safety. This consideration is underscored by the increased technical challenges associated with DJ stent placement in the presence of ureteral obstruction and stenosis, factors that may elevate the risk of intraoperative complications.

From a clinical standpoint, our study emphasizes that preoperative identification of patients at higher risk of stricture allows for improved surgical planning. Surgeons may anticipate the need for staged procedures, prepare for DJ stenting, and provide patients with realistic expectations regarding outcomes.[18] Additionally, careful manipulation in patients predicted to have narrow ureters may reduce the risk of iatrogenic ureteral injury.[19]

Study Limitations

Limitations of this study include its retrospective design, single-center setting, and a relatively small number of stricture cases. Nonetheless, the prospective data collection and the standardized surgical approach by a single surgeon strengthen its validity. Our findings should therefore be interpreted as hypothesis-generating and should encourage larger multicenter studies to validate these predictors and to incorporate them into preoperative risk stratification models.

CONCLUSION

Preoperative CT parameters, specifically distal ureteral AP and coronal diameters, along with BMI and stone size, significantly predict the likelihood of failed ureteral access during URS. Surgeons should consider these factors in preoperative planning to minimize complications, improve patient counseling, and optimize treatment strategies. However, prospective multicenter validation studies are warranted to confirm these findings and enhance their generalizability.

Ethics

Ethics Committee Approval: This study was approved by the Mudanya University Health Sciences Ethics Committee (reference no.: E-40839601-50.04-62, date: 03.12.2024)

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Footnotes

Author Contributions

Concept Design – S.Y.; Data Collection or Processing – S.Y.; Analysis or Interpretation – S.Y., N.A.; Literature Review – S.Y.; Writing, Reviewing and Editing – S.Y., N.A.

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