Safety of retrograde pyelography for infected ureteral stones

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PALKA J, FAROOQ Z, ANDERSON BG. Safety of retrograde pyelography for infected ureteral stones. *Can J Urol* 2020;27(1):10130-10134.

Introduction: *Initial management of obstructing ureteral stones with concomitant urinary tract infection (UTI) includes prompt renal decompression and antibiotics. Some urologists theorize that performing retrograde pyelography (RGP) at the time of ureteral stent placement may cause pyelovenous backflow of bacteria thereby worsening clinical outcomes. We compared outcomes in patients with infected ureteral stones who underwent RGP versus no RGP prior to stent placement.*
Materials and methods: *A retrospective chart review was conducted involving patients who presented between 2015 and 2017 with an obstructing ureteral stone and associated UTI. Computed tomography scans were evaluated for stone size and location. Operative reports were reviewed to determine whether the patient underwent RGP at time of ureteral stent placement. Demographics, perioperative information, intensive care unit (ICU) admission rate, and length of stay (LOS) were compared.*
Results: *Seventy-two patients were identified and stratified by severity of condition at presentation, including UTI without sepsis (n = 18), sepsis (n = 32), severe sepsis (n = 11), and septic shock (n = 11). Forty-three patients underwent RGP at the time of stent placement, and 29 did not. Between both patient cohorts, statistical analysis revealed no significant difference in postoperative ICU admission rate (p = 0.35) or LOS for patients with UTI without sepsis (p = 0.17), sepsis (p = 0.45), severe sepsis (p = 0.66), and septic shock (p = 0.25).*
Conclusion: *The use of RGP prior to ureteral stent placement for an obstructing ureteral stone with concomitant UTI was not associated with unfavorable clinical outcomes in our retrospective series. While these findings support the safety of RGP in this setting, prospective trials are warranted.*

Key Words: retrograde pyelogram, sepsis, obstructing ureteral stone

Introduction

Approximately one in eleven patients in the United States was diagnosed with kidney stones in 2012, with the prevalence of kidney stones increasing among female patients.[1,2] The most acutely concerning sequelae of stone disease is associated sepsis, which may result from obstructing ureteral stones with concurrent urinary tract infection (UTI). Multiple studies have shown that optimal management includes appropriate antibiotics and emergent surgical decompression of the collecting system.[3-5]

While decompression by ureteral stenting is widely considered to be standard of care, there is a paucity of research evaluating the use of retrograde pyelography (RGP) during stent placement in patients with UTI. Performing RGP during cystoscopy allows urologists to visualize the upper urinary tract prior to stent placement. However, the injection of contrast into the ureter in a retrograde manner theoretically increases intrarenal pressure and may result in pyelovenous backflow.[6] Due to concern for potentiating systemic

Accepted for publication December 2019

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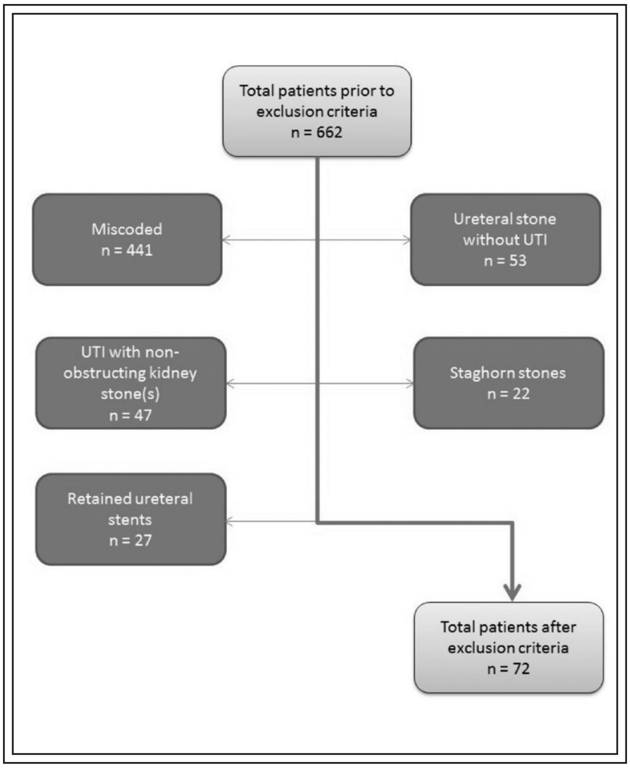

Figure 1. Exclusion criteria flowchart.

illness by retropulsion of bacterial pathogens via pyelovenous backflow, some urologists avoid performing RGP prior to placement of a ureteral stent when UTI is suspected. To our knowledge, no studies have evaluated outcomes in patients with obstructing stones who underwent RGP in this setting.

Materials and methods

Following Institutional Review Board approval, we performed a retrospective cohort review of male and female patients who presented to our institution from 2015 to 2017 with an obstructing ureteral stone associated with UTI. Medical records were searched using ICD-10 codes for ureteral calculus (N20.1), renal calculus (N20.2), UTI (N39.0), sepsis (A41.9), severe sepsis without septic shock (R65.20), severe sepsis with septic shock (R65.21), bacteremia (R78.81), and hydronephrosis (N13.2).

Initially, 662 patients were identified, and all patients under 18 years of age were excluded. Chart review was then carried out identifying and excluding patients that were miscoded or had ureteral stones without UTI, UTI with non-obstructing kidney stones, staghorn stones, or retained ureteral stents, Figure 1. After these criteria were applied, a total of 72 patients remained. These patients were stratified into one of four categories: obstructing

TABLE 1. **Patient characteristics and outcomes**

	RGP performed (n = 43)	**RGP not performed (n = 29)**	**p value**
Age, years (SD)	60 (16)	51 (14)	0.02
Gender, (%)			0.03
Female	21 (49%)	22 (76%)	
Male	22 (51%)	7 (24%)	
Diabetic, (%)	12 (28%)	10 (35%)	0.61
Paraplegic/quadriplegic, (%)	10 (23%)	5 (17%)	0.77
Stone size, mm (SD)	9.8 (6.6)	8.0 (4.0)	0.20
Stone location, (%)			0.77
Proximal ureter	28 (65%)	18 (62%)	
Mid ureter	6 (14%)	3 (10%)	
Distal ureter	9 (21%)	8 (28%)	
Foley placed at end of procedure, (%)	24 (56%)	18 (62%)	0.63
Laterality			0.14
Left	23	21	
Right	20	8	

RGP = retrograde pyelography; SD = standard deviation; ICU = intensive care unit; LOS = length of stay

TABLE 2. **Primary outcomes**

	RGP performed (n = 43)	RGP not performed (n = 29)	p value
Infection without sepsis			
Mean LOS, days	5.5	4.0	0.17
Sepsis			
Mean LOS, days	6.1	5.7	0.45
Severe sepsis			
Mean LOS, days	5.8	6.8	0.66
Septic shock			
Mean LOS, days	7.2	8.0	0.25
Postoperative ICU admission (%)	6 (14%)	7 (24%)	0.35

RGP = retrograde pyelography; SD = standard deviation; ICU = intensive care unit; LOS = length of stay

stone with UTI without systemic inflammatory response syndrome (SIRS); obstructing stone with sepsis; obstructing stone with severe sepsis; and obstructing stone with septic shock. Sepsis category definitions from the "Surviving Sepsis" campaign guidelines were utilized to stratify patients.[6] UTI was defined by a positive urine culture, if available, or urinalysis suggestive of infection including positive nitrite, leukocyte esterase, pyuria, and/or bacteria found with associated symptoms consistent with criteria defined by the National Surgical Quality Improvement Program (NSQIP).[15]

Patient characteristics and perioperative data including gender, stone size and location, existing paraplegia or diabetes, and postoperative placement of a Foley catheter were compared, Table 1. Primary endpoints included intensive care unit (ICU) admission rates and postoperative length of stay (LOS) , Table 2. Mann-Whitney U, Pearson Chi-squared, and Fisher's exact tests were utilized for statistical evaluation of the data. Relationships were considered significant in circumstances of $p \leq 0.05$. All tests were performed using IBM SPSS Statistics version 19.0.

Results

Of the 72 patients identified, 43 underwent RGP at the time of ureteral stent placement, 51% of whom were men and 49% were women. In the non-RGP group (29 patients), 76% were women and 24% were men (p = 0.03). Comparable rates of diabetes (p = 0.61) and paraplegia (p = 0.77) existed between the groups. Rates of post-operative urethral Foley catheter placement were also similar (p = 0.63). RGP patients were significantly older (60 versus 51 years-old, p = 0.02).

The majority of stones were located in the proximal ureter in both groups (62% in non-RGP and 65% in RGP patients, p = 0.77). Average stone size was also similar (9.8 mm in non-RGP versus 8 mm in RGP; p = 0.20). There was no significant difference in stone laterality (p = 0.14). Patients were grouped by severity of clinical condition on presentation. Eighteen patients presented with UTI without sepsis, 32 with sepsis, 11 with severe sepsis, and 11 with septic shock. No significant differences were found in postoperative ICU admission rates between RGP and non-RGP groups (p = 0.35). LOS was also similar for patients who presented with UTI without sepsis (p = 0.17), sepsis (p = 0.45), severe sepsis (p = 0.66), and septic shock (p = 0.25). Additionally, there were no mortalities in either group. For patients with an available urine culture, Escherichia coli was the most commonly isolated organism in both RGP and non-RGP patients (41% and 26%, respectively). No cases of ureteral stent migration or need for reoperation for stent malposition were identified in either the retrograde or non-retrograde study groups. Lastly, of the 43 RGP patients reviewed, none of the operative reports described pyelovenous backflow.

Discussion

As the prevalence of urolithiasis increases, so, too, will the prevalence of its associated sequelae. Multiple studies support prompt decompression in the setting of an obstructing ureteral stone with UTI with either percutaneous nephrostomy tube or retrograde ureteral stent placement. Failure to do so in a timely manner risks undue morbidity and even mortality.[3] Accordingly, the American Urological Association guidelines recommend urgent decompression.[5] Pearle et al reported equivalent outcomes comparing upfront percutaneous nephrostomy tube versus ureteral stent placement.[8] At our institution, the majority of patients undergo ureteral stent placement initially in the acute setting. Percutaneous nephrostomy tube placement is often reserved for cases in which a retrograde ureteral stent is unable to be placed due to anatomical limitations.

Previous studies have identified risks factors such as elderly age, poor ECOG status, and paralysis for progression to septic shock in the setting of infected ureteral stones.[9] Despite anecdotal recommendations against the use of RGP in the setting of infected ureteral stones, no studies to our knowledge have assessed the use of RGP as a precipitating factor toward septic shock.[14] Recommendations for RGP include using a dilute solution of less than 50% contrast in sterile fluid in order to minimize obscuring ureteral and renal filling defects. Historically, only 5 to 8 milliliters of fluid is required to outline the collecting system. Additionally, contrast should be administered slowly with enough volume to opacify the entire collecting system but over distention should be avoided to ameliorate the risk of pyelovenous backflow or extravasation.[14] As a matter of technical consideration, RGP allows for delineation of the ureteral course and anatomy prior to stent placement and affords the urologist reassurance of proper stent position. Advancing an open-ended ureteral catheter over a wire into the renal pelvis, proximal to the obstruction, then removing the wire and aspirating any contents to utilize as culture prior to RGPG may afford the safest maneuver to reduce intra-renal pressure prior to RGP.

A malpositioned ureteral stent may not extend proximal to the level of ureteral obstruction, or—especially in cases of stone impaction—may even perforate the ureter. Either situation results in the lack of collecting system drainage and defeats the purpose of the stent. Scenarios in which the proximal portion of the stent does not coil in an appropriate position within the collecting system may lead to stent migration. Migration is estimated to occur in 3.7%-9.5% of ureteral stent placements, and this is commonly due to poor selection of stent length.[10-12] While patient height is frequently used to estimate ureteral length, Jeon et al found that ureteral stent length selected by patient height more often resulted in stent migration. Furthermore, patient height was found to poorly correlate with exact ureteral length measurements performed using a guidewire intraoperatively.[13] Retrograde pyelography provides increased certainty with respect to ureteral stent length and position following placement.

In addition to its retrospective design, there are several limitations in our study. Time from initial patient presentation to procedure could not be evaluated. Moreover, the determination of a culture-proven UTI can be challenging due to timing of intervention and administration of antibiotics. In cases of complete ureteral occlusion, obtaining a voided urine culture can result in a negative preoperative result despite bacteria residing proximal to the offending stone.

Despite relatively homogenous patient populations for retrograde and non-retrograde groups, there may be an inherent patient selection bias for surgeons preferring stent placement either with or without retrograde pyelography. Patients that physically appeared more debilitated at the time of consultation or had worsening vital signs, instead of stable or improving vitals, may have selectively undergone stent placement without retrograde imaging or with a modified imaging approach. Individual surgeon preferences can account for selection biases, particularly between our suburban and urban hospitals, and operative technique (e.g. the amount of radiopaque contrast utilized, ureteral catheter size and position, etc.) is subject to variability among surgeons. These biases are naturally difficult to quantify given the retrospective nature of this study. Consequently, while the use of RGP may provide demonstrable technical advantages during ureteral stent placement, we concede that larger, prospective trials are warranted to further support the notion that it is safe to perform routinely in all cases.

Conclusion

The use of RGP prior to ureteral stent placement for an obstructing ureteral stone and concomitant UTI was not associated with an increased LOS or ICU admission rate, which implies minimal impact on the severity of clinical condition. Further prospective trials should be completed to validate these findings and to confer recommendations for the role of RGP in patients presenting with infected, obstructing ureteral stones. □

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