Spontaneous passage of ureteral stones in patients with indwelling ureteral stents

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Introduction: *To determine rates of spontaneous ureteral stone passage in patients with indwelling ureteral stents, and to identify factors associated with the spontaneous passage of stones while a ureteral stent is in place.*
Materials and methods: *From our institutional database, we identified patients who underwent ureteroscopic procedures for stone disease between January 1, 2013 and March 1, 2015. We compared the rates of spontaneous stone passage between patients who had previously undergone ureteral stent placement and those who had not. In patients with indwelling stents, multivariate logistic regression was performed to identify factors associated with spontaneous stone passage.*
Results: *A total of 194 patients met inclusion criteria. Spontaneous stone passage rates were similar in the stented (17/119, 14%) and non-stented (15/75, 20%) groups (p = 0.30). In bivariate analysis of stented patients, smaller stone size (p < 0.001) and distal stone location (p = 0.01) were significantly associated with spontaneous stone passage. Multivariate logistic regression analysis of stented patients showed that only small stone size was significantly associated with the likelihood of stone passage (p = 0.01), whereas stent duration, stone location, and stone laterality were not.*
Conclusions: *A small, but clinically significant percentage of ureteral stones pass spontaneously with a ureteral stent in place. Small stone size is associated with an increased likelihood of spontaneous passage in patients with indwelling stents. These findings may help to identify patients who can potentially avoid additional surgical procedures for definitive stone removal after ureteral stent placement.*

Key Words: ureteral stent, ureteral obstruction, ureteral stone, ureteroscopy, urolithiasis

Introduction

Urolithiasis is an increasingly common cause of patient morbidity. With an aging, obese population with poor dietary habits and higher rates of metabolic syndrome, the lifetime prevalence of urolithiasis is approaching 10%.[1]

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Ureteral stents are often used to alleviate renal obstruction and its sequelae. For patients with urolithiasis, stent placement is typically a temporizing measure to alleviate renal obstruction until the stone can be definitively removed. In addition to diverting urine to bypass the stone and relieve obstruction, ureteral catheterization causes passive ureteral dilation and aperistalsis.[2,3] This aperistalsis is thought to prevent the spontaneous passage of ureteral stones after stent placement.[4,5] Therefore, in order to definitively remove the stones, most patients are subjected to an additional surgical procedure with the associated risk of perioperative complications.

The likelihood of spontaneous stone passage in patients with non-stented ureters has been well studied and the factors associated with the spontaneous passage of ureteral stones are generally accepted. Smaller, distal ureteral stones are more likely to pass spontaneously and often can be managed expectantly.[6-11] However, the impact of ureteral stent placement on the likelihood of spontaneous stone passage is unclear, as are the factors predictive of stone passage in patients with an indwelling ureteral stent.

We hypothesized that a clinically significant percentage of ureteral stones pass spontaneously despite the presence of an indwelling ureteral stent. In the current study, we compared rates of spontaneous stone passage in stented to non-stented ureters. Furthermore, we aimed to identify factors associated with the spontaneous passage of ureteral stones in patients with indwelling ureteral stents. Identification of such factors may enable clinicians to identify patients likely to pass stones after stent placement, thereby avoiding unnecessary surgical procedures.

Materials and methods

Likelihood of stone passage in stented versus non-stented ureters

We performed a retrospective analysis of all ureteroscopic procedures performed for the treatment of ureteral or renal calculi at Temple University Hospital between January 1, 2013 and March 1, 2015. We included patients with an indwelling ureteral stent, as well as patients who had not been previously stented. Patients undergoing repeat procedures due to incomplete stone removal at the time of initial endoscopy and patients with encrusted stents due to a failure to follow up or excessive indwelling stent time were excluded. This study was approved by our institutional internal review board.

Indications for initial ureteral stent placement were determined through review of the electronic medical record. 6Fr double-J ureteral stents were placed, and stent length varied based on provider preference.

We then determined rate of spontaneous ureteral stone passage by reviewing operative reports from subsequent ureteroscopic procedures performed for definitive stone removal. Stones were concluded to have passed spontaneously if no residual stone was seen on a thorough endoscopic examination of the renal pelvis, associated calices, and the entire length of the ureter. Using chi-squared analysis, we compared rates of spontaneous stone passage in patients with indwelling ureteral stents (stented group) versus those who had not undergone stent placement (non-stented group).

Factors associated with stone passage in stented ureters

We assessed factors associated with the likelihood of spontaneous stone passage in patients with indwelling ureteral stents. For each patient, we recorded the following variables: patient age and sex, stone size, stone laterality, stone number, stone location, and duration of time between ureteral stent placement and subsequent ureteroscopy.

Radiology reports of abdominopelvic computed tomography (CT) scans performed prior to ureteral stent placement were reviewed to determine stone size and laterality, as well as the stone number. Stone size was measured in the axial, coronal, and sagittal planes and the largest size was recorded. Stone location was also determined by pre-stent CT images, and was categorized as: renal pelvis, proximal ureter (ureteropelvic junction and ureter cranial to bony pelvis), mid-ureter (ureter overlying bony pelvis), and distal ureter (ureter caudal to bony pelvis and ureterovesical junction). Stone number was evaluated by assessing the number of ipsilateral ureteral stones observed on pre-stent CT images. Additional non-obstructing renal stones were not included in this value. Stent duration was calculated as the number of days between ureteral stent placement and the definitive ureteroscopic procedure.

Bivariate chi-squared analysis and multivariable logistic regression were then used to identify variables associated with spontaneous stone passage in patients with indwelling ureteral stents. Covariates in the multivariate logistic regression model included: stone size, location, laterality, and duration of time since stent placement. For patients with multiple ureteral stones, only the largest stone was used in this analysis.

Factors associated with stone passage in non-stented ureters

The factors associated with spontaneous stone passage in patients without ureteral stents have been well characterized in the literature.[6-11] As the objective of our study was to assess the likelihood of predictors of stone passage after ureteral stent placement, we did not assess factors associated with stone passage in non-stented ureters.

Results

Data were collected for 212 ureteroscopic procedures performed for stone disease during the time period of interest. Eighteen patients were excluded: 14 were repeat procedures due to incomplete stone removal at the time of initial endoscopy and 4 patients had prolonged stent duration and stent encrustation. Of the remaining 194 procedures, 119 (61%) were performed on patients with indwelling ureteral stents and 75 (39%) on patients who had not been previously stented. Table 1 compares patient demographics and stone parameters between the stented and non-

TABLE 1. **Patient demographics, stone characteristics, and indications for stent placement**

Variable	Stented n (%)	Non-stented n (%)	p value
Age			0.65
< 30	15 (13)	10 (13)	
30-40	23 (19)	13 (17)	
40-50	30 (25)	14 (19)	
> 50	51 (43)	38 (51)	
Gender			0.12
Male	50 (42)	40 (53)	
Female	69 (58)	35 (47)	
Stone laterality			0.92
Left	58 (48)	36 (48)	
Right	61 (52)	39 (52)	
Number of stones			0.52
0-1	108 (91)	70 (93)	
> 1	11 (9)	5 (7)	
Stone size (cm)			0.05
< 0.4	13 (11)	3 (4)	
0.4-0.8	63 (53)	36 (48)	
> 0.8	37 (31)	35 (47)	
Unknown	6 (5)	1 (1)	
Stone location			0.03
Renal pelvis	22 (18)	27 (36)	
Proximal ureter	42 (35)	17 (23)	
Mid ureter	19 (16)	10 (13)	
Distal ureter	32 (27)	21 (28)	
Unknown	4 (3)	0 (0)	
Time from diagnosis to ureteroscopy (days)			0.09
≤ 30	18 (15)	20 (27)	
31-60	41 (34)	26 (35)	
61-100	34 (29)	10 (13)	
> 100	22 (18)	16 (21)	
Unknown	4 (3)	3 (4)	
Stent duration (days)			
≤ 30	26 (22)		
31-60	38 (32)		
61-100	32 (37)		
> 100	17 (14)		
Unknown	6 (5)		
Indications for stent placement			
Pain	55 (46)		
Obstructive pyelonephritis	35 (29)		
Pain and acute renal insufficiency	4 (3)		
Other/unknown	25 (21)		
Total	**119 (61)**	**75 (38)**	

TABLE 2. **Rates of spontaneous stone passage in patients with and without indwelling ureteral stent**

	Stented n (%)	Non-stented n (%)	p value
Stone passed	17 (14)	15 (20)	0.30
Stone present	102 (86)	60 (80)	

stented groups. This Table also describes indications for ureteral stent placement, the most common of which was refractory pain, followed by obstructive pyelonephritis.

Table 2 shows the rates of spontaneous stone passage in stented versus non-stented patients. There was no significant difference in the rate of spontaneous stone passage between groups (p = 0.30).

In the stented group, 17 of 119 (14%) patients had stones pass spontaneously prior to ureteroscopy. Table 3 shows the bivariate associations of number of ureteral stones, stone size, stone location, stone laterality, and stent duration with the likelihood of spontaneous stone passage among these patients. Both small stone size (p < 0.01) and distal location (p = 0.01) were significantly associated with stone passage in stented patients.

Table 4 shows the result of the multivariate logistic regression model assessing factors associated with spontaneous stone passage in stented patients. In this model, only small stone size (p = 0.01) was significantly associated with the likelihood of stone passage. No associations were observed between stent duration, stone location, or stone laterality and the rate of stone passage.

Discussion

It is well known that a significant percentage of obstructing ureteral stones will pass spontaneously with conservative management.[6-11] However, it is unclear how ureteral stent placement affects the likelihood of spontaneous stone passage. In the

TABLE 3. **Univariate associations of factors associated with spontaneous stone passage in patient with indwelling ureteral stents**

	Spontaneous passage n (%)	No spontaneous passage n (%)	Total	p value
# of ureteral stones				0.20
1	14 (12)	94 (88)	108	
> 1	3 (27)	8 (63)	11	
Stone size (cm)				< 0.01
< 0.4	6 (46)	7 (54)	13	
0.4-0.8	8 (13)	55 (87)	63	
> 0.8	1 (3)	36 (97)	37	
Unknown	2	4	6	
Stone location				0.01
Renal pelvis	0 (0)	22 (100)	22	
Proximal ureter	3 (7)	39 (93)	42	
Mid ureter	3 (16)	16 (84)	19	
Distal ureter	10 (31)	22 (69)	32	
Unknown	1	3	4	
Stone laterality				0.52
Right	10 (16)	52 (84)	61	
Left	7 (12)	51 (88)	58	
Stent duration (days)				0.40
≤ 30	2 (8)	24 (92)	26	
31-60	7 (18)	31 (82)	38	
61-100	6 (19)	26 (81)	32	
> 100	1 (6)	16 (94)	17	
Unknown	1	5	6	

TABLE 4. **Multivariable logistic regression model of variables associated with spontaneous stone passage in patients with indwelling ureteral stents**

Variable	Odds ratio	p value	95% confidence interval
Stone size (cm)	0.006	0.01	0.0001-0.30
Stent duration (days)	1.00	0.97	0.98-1.02
Stone location*			
Proximal ureter	Reference	Reference	Reference
Mid ureter	0.97	0.98	0.11-8.40
Distal ureter	3.78	0.13	0.66-21.56
Stone laterality			
Right	Reference	Reference	Reference
Left	1.09	0.90	0.29-4.14

*renal pelvic stones excluded as no stones passed spontaneously

current study, we found that a clinically significant percentage of ureteral stones passed spontaneously despite the presence of an indwelling ureteral stent. In fact, the likelihood of spontaneous stone passage after ureteral stenting was similar to the spontaneous passage rate in non-stented ureters. Furthermore, we found that small stone size and distal ureteral location increased the likelihood of stone passage after ureteral stent placement. These variables are similar to those that have been proven in the literature to predict for spontaneous stone passage in non-stented ureters.[6-11]

Our practice of routinely performing ureteroscopy for definitive stone removal after initial stent placement resulted in high rate of negative ureteroscopic procedures. The 14% negative ureteroscopy rate in the current study is higher than the 6.3% rate recently reported in a statewide database.[12] This suggests that a meaningful number of patients may be able to avoid a definitive procedure for stone removal after ureteral stent placement, and identifies those patients who may be able to avoid further intervention. On bivariate analysis, we found that spontaneous stone passage is more common after ureteral stent placement in patients with smaller, more-distal stones. Potentially these patients could be reimaged to assess for stone passage after ureteral stent placement, but prior to subsequent ureteroscopic procedures. Alternatively, select patients may be able to have their stents removed via in-office cystoscopy, and then undergo subsequent imaging to confirm stone passage. These strategies may be able to avoid the potential surgical and anesthetic morbidity associated with endoscopic stone removal. Further investigation is clearly needed to better identify patients likely to pass stones after ureteral stent placement and to determine the optimal management of these patients.

In bivariate analysis, a smaller stone size and distal stone location were associated with an increased likelihood of spontaneous stone passage in patients with indwelling stents. However, in a multivariable logistic regression model, only small stone size was significantly associated with spontaneous stone passage. There was a trend towards an increased likelihood of stone passage in patients with distal ureteral stones, although this did not reach statistical significance. This is potentially due to the limited number of patients in the model, resulting in wide confidence intervals and a lack of statistical power to identify potential associations.

Prior animal studies suggest that ureteral stents disrupt normal peristalsis and thereby inhibit stone migration.[3,4,13] Kinn et al used a porcine model to compare peristalsis in stented and non-stented ureters during diuresis. Frequency and velocity of peristaltic contractions were decreased in stented ureters, and retrograde peristalsis, aberrant waves, and incomplete contractions were common. These data suggest that impaired ureteral peristalsis may inhibit the spontaneous passage of ureteral stones following ureteral stent placement.[4] Our data, however, contradict this hypothesis and show a clinically significant rate of spontaneous passage in patients despite the presence of an indwelling ureteral stent.

In humans, spontaneous passage of ureteral stones after stent placement has been suggested in the literature.[2] At least two prior studies have previously reported successful spontaneous passage of stones in selected patients with solitary, distal stones less than 10 mm in size.[14,15] These patients had a ureteral stent placed for 2 weeks and were followed for an additional 2 weeks after stent removal to evaluate for spontaneous stone passage. The authors reported a spontaneous stone passage rate of 83%-85%, however no patients passed their stone during the 2 week stent period. Our findings, in contrast, show that a number of ureteral stones will pass while the indwelling stent is in place.

There are several strengths of the current analysis. To our knowledge, this is the first study that has attempted to examine the rate of spontaneous passage of ureteral stones for patients with indwelling ureteral stents. Furthermore, stone passage was confirmed in all patients with a thorough negative endoscopic examination of the ureter, renal pelvis, and associated calices.

Several limitations of this study deserve mention. Our results do not speak to the optimal management strategy for patients after ureteral stent placement. Although some patients may benefit from repeat CT scan to assess for stone passage prior to ureteroscopy, there are potential harms from the additional radiation dosage from repeat imaging that must be considered. Furthermore, additional study is needed to determine whether some patients can safely have their stent removed via in-office cystoscopy, or if this practice would result in unacceptably high rates of recurrent obstruction and need for subsequent intervention.

Additional limitations of this study include the relatively small sample size, resulting in statistical limitations. In bivariate analysis, distal stone location was associated with an increased likelihood of stone passage. However, stone location did not reach statistical significance in our multivariable model, potentially due to an inadequate sample size to demonstrate this association.

Conclusion

In conclusion, this study shows that a small but clinically significant percentage of patients will experience spontaneous passage of ureteral stones despite the presence of an indwelling ureteral stent. Our data suggest that among patients with indwelling stents, small and distal ureteral stones are more likely to pass spontaneously, with a passage rate up to 46% for stones less than 4 mm. These findings may help to identify patients who can potentially avoid additional surgical procedures after initial ureteral stent placement. □

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