

Stent duration and increased pain in the hours after ureteral stent removal

Michael E. Rezaee, MD,¹ Annah J. Vollstedt, MD,¹ Tammer Yamany, MD,² Manoj Monga, MD,^{3,4} Amy Krambeck, MD,^{4,5} Ojas Shah, MD,^{4,6} Roger L. Sur, MD,^{3,4} Anna M. Zampini, MD,^{4,7} Kymora B. Scotland, MD,^{4,8} Ben H. Chew, MD,^{4,8} Brian H. Eisner, MD,^{2,4} Vernon M. Pais Jr, MD^{1,4}

¹Section of Urology, Department of Surgery, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire, USA; ²Department of Urology, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts, USA; ³Department of Urology, UC San Diego Health, San Diego, California, USA; ⁴Endourology Disease Group of Excellence; ⁵Indiana University Health Physicians Urology, Indianapolis, Indiana, USA; ⁶Columbia University Irving Medical Center, New York, New York, USA; ⁷Glickman Urological & Kidney Institute, The Cleveland Clinic, Cleveland, Ohio, USA; ⁸The University of British Columbia, Vancouver, British Columbia, Canada

REZAE ME, VOLLSTEDT AJ, YAMANY T, MONGA M, KRAMBECK A, SHAH O, SUR RL, ZAMPINI AM, SCOTLAND KB, CHEW BH, EISNER BH, PAIS JR VM. Stent duration and increased pain in the hours after ureteral stent removal. *Can J Urol* 2021;28(1):10516-10521.

Introduction: To assess the relationship between pain after ureteral stent removal and patient and procedural factors.

Materials and methods: A validated survey designed to assess the relationship between quality of life and treatment decisions in kidney stone disease was randomly distributed to patients with a history of a ureteral stent in seven medical centers across North America participating in an endourology research collaborative between July 2016 and June 2018. The primary outcome was increased pain after ureteral stent removal. Statistical analyses were performed using Chi-square and multiple logistic regression.

Results: A total of 327 surveys were analyzed. Twenty seven percent of patients reported increased pain in the

hours after ureteral stent removal. Patients with a stent ≤ 7 days were significantly more likely to experience pain after stent removal compared to those with a stent > 7 days (33.3% versus 22.8%, $p = 0.04$). Female gender (OR: 2.41, 95% CI: 1.42-4.10) was associated with increased pain after stent removal, while increasing age was inversely associated (OR: 0.52, 95% CI: 0.36-0.74). After adjustment, patients with a stent > 7 days were significantly less likely to report pain in the hours after removal (OR: 0.59, 95% CI: 0.35-0.99).

Conclusions: Approximately one in four patients will experience increased pain after ureteral stent removal. Female patients, younger patients, and patients with a stent ≤ 7 days were more likely to experience an increase in pain immediately following stent removal. Understanding factors associated with post-stent removal pain may be helpful in counseling patients at high risk stent removal morbidity.

Key Words: urolithiasis, ureteral stents, stent pain, healthcare utilization, renal colic

Introduction

The prevalence of urolithiasis is approximately 9% in the United States, with more men (10.6%) experiencing stone disease compared to women (7.1%).¹ Stones unlikely to pass spontaneously or with medical expulsive therapy can be managed with ureteral stent placement, ureteroscopy, shock wave lithotripsy,

percutaneous nephrolithotomy, or a combination of these therapies. The use of ureteral stents preoperatively for passive dilation of the ureter and following ureteroscopy is common amongst practicing urologists.^{2,3} Postoperative ureteral stents may in fact reduce unplanned hospital returns.⁴ Unfortunately, close to 80% of patients receiving a ureteral stent will experience significant stent-related morbidity after placement, including flank and suprapubic pain.⁵

Patients and providers often perceive that ureteral stent removal will resolve or decrease stent-related pain, or that stent removal will be painless. However, evidence suggests that 38%-57% of patients may experience substantial pain after ureteral stent removal.^{6,7} To-date, limited research has been conducted

Accepted for publication November 2020

Address correspondence to Dr. Vernon M. Pais Jr, Section of Urology, Department of Surgery, Dartmouth Hitchcock Medical Center, 5 Medical Center Drive, Lebanon, NH, 03756 USA

to understand risk factors for patient morbidity after stent removal. Although data suggests that shorter stent duration may negate the protective effects of preventing unplanned post-procedure returns to the hospital, the relationship between stent duration and patient-perceived pain after stent removal has not been well assessed.⁴ Stent duration may have a significant impact on pain after stent removal. Previous work has shown that a ureter stented for less than a week may dilate and accommodate a stent to a lesser degree compared to a ureter that is stented for a week or more.⁸

Obtaining a better understanding of pain after ureteral stent removal could have a significant impact on post-removal analgesia utilization, quality of life, and willingness to accept future stent placement. To identify patients who may experience pain and potentially benefit from pre-stent removal counseling or specialized management, factors associated with increased pain after ureteral stent removal must be elucidated. We hypothesized that several factors may have a significant impact on experiencing increased pain after stent removal. In this study, we examined the prevalence of pain after stent removal and assessed for factors associated with increased pain after ureteral stent removal.

Materials and methods

A validated survey designed to assess the relationship between quality of life and subsequent treatment decisions in stone disease was randomly distributed to urology patients ≥ 18 years of age with a history of a ureteral stent in seven academic medical centers across the U.S. and Canada participating in an endourology research collaborative between July 2016 and June 2018.⁹ Eight questions from this anonymous survey were analyzed with the goal of understanding the relationship between experiencing increased pain after ureteral stent removal and patient and clinical factors.⁹ Primary questions of interest included 'How long was your last stent left in place?', 'Did your pain increase in the hours after your stent was removed?', 'How was your last stent removed?' and 'When was your last stent?'. Additional questions examined patient demographics and prior history with urolithiasis and stents.⁹ Responses were encoded in duplicate and cross-referenced to ensure accuracy. The Committee for the Protection of Human Subjects at Dartmouth reviewed and approved this study for conduct (CPHS #29631) and each individual site obtained approval of their respective Institutional Research Ethics Boards.

Data were summarized with proportions. Pearson's Chi-square was used to evaluate self-reported patient

and clinical factors by the occurrence of increased pain in the hours after ureteral stent removal. Multiple logistic regression was then utilized to examine the relationship between increased pain after ureteral stent removal and patient and clinical factors. Our dependent variable was increased pain in the hours after stent removal. Independent variables included duration of time spent with a stent, age category, gender, health status, timing of last stent, and number of prior stents and stones. We included independent variables in our multivariate model that differed significantly by increased pain after stent removal in univariate analyses. Self-reported health status was included in models regardless of significance as a means to account for patient complexity/co-morbidities. Duration of time spent with a stent was defined as 7 days or less versus more than 7 days to account for the potential time required for a ureter to dilate and more successfully accommodate a stent.⁸ The p value used for statistical significance for all analyses was < 0.05 . All data were analyzed using STATA 11.2 (StataCorp, College Station, TX, USA).

Results

A total of 356 surveys were completed. Twenty-nine surveys were excluded from the analysis due to missing patient demographics and outcome data, leaving 327 (91.9%) for our final sample. The majority (71.5%) of patients had their most recent stent within 2 years of filling out the survey. Patients were more frequently over 50 years of age (71.2%) and reported their health to be good-to-excellent (84.2%). The majority of stents were removed via cystoscopy (59.7%) compared to pull strings (40.3%). Over 27% of patients reported increased pain in the hours after ureteral stent removal, Table 1.

Patients with a stent indwelling for 7 days or less were significantly more likely to experience pain after stent removal compared to those who had a stent for more than 7 days (33.3% versus 22.8%, $p = 0.04$, Figure 1). A greater proportion of women experienced pain after stent removal compared to men (36.1% versus 18.6%, $p < 0.001$). Younger patients had more pain after stent removal compared to older patients; increased pain was reported in 36.4% of patients 18-29 years compared to 11.1% of patients 70 years or older. Pain after stent removal did not differ by self-reported health status, number of prior stents or stones, method of stent removal, or timing of last stent, Table 2.

Both crude (OR: 0.59, 95% CI: 0.36-0.97) and adjusted (OR: 0.59, 95% CI: 0.35-0.99) logistic regression models demonstrated that patients with a stent for more than 7 days were significantly less likely to report pain in

TABLE 1. Self-reported patient characteristics

Total, % (n)	100 (327)
Female, % (n)	49.5 (162)
Age groups, % (n)	
18-29 years	3.7 (12)
30-49 years	25.1 (82)
50-69 years	54.4 (178)
70 years or older	16.8 (55)
Health status, % (n)	
Excellent	11.9 (39)
Very good	33.7 (110)
Good	38.6 (126)
Fair	13.5 (44)
Poor	2.2 (7)
Number of prior stones, % (n)	
1	18.5 (58)
2-5	43.5 (136)
More than 5	38.0 (119)
Number of prior stents, % (n)	
1	50.8 (161)
2-5	42.6 (135)
More than 5	6.6 (21)
Timing of last stent within the last, % (n)	
Month	14.4 (39)
6 months	27.4 (74)
Year	13.3 (36)
2 years	16.3 (44)
> 2 years	28.5 (77)
Duration of time spent with last stent, % (n)	
7 days or less	42.5 (139)
More than 7 days	57.5 (188)
Pain increased after stent removal, % (n)	27.3 (87)
Method of stent removal	
Scope procedure	59.7 (178)
Removed by pulling string	40.3 (120)

the hours after stent removal. A greater proportion of women experienced pain after stent removal compared to men (36.1% versus 18.6%, $p < 0.001$). Women were significantly more likely to experience increased pain after ureteral stent removal in both the crude (OR: 2.46, 95% CI: 1.48-4.11) and adjusted model (OR: 2.41, 95% CI: 1.42-4.10). After adjustment, increasing patient age was associated with less pain after stent removal (OR: 0.52, 95% CI: 0.36-0.74; Table 3).

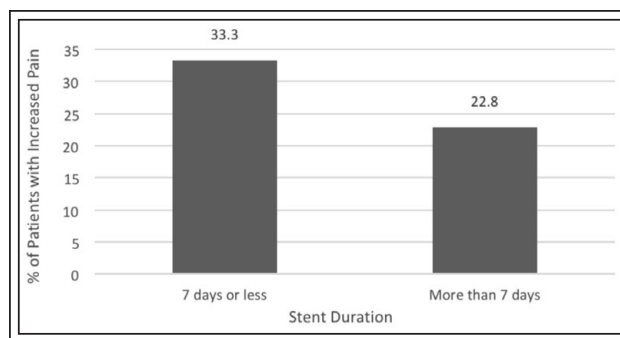


Figure 1. Percentage of patients with increased pain after ureteral stent removal by stent duration.

Discussion

In this study of kidney stone patients with a history of a ureteral stent, more than one-fourth of patients (27.3%) experienced an increase in pain in the hours after stent removal. Shorter duration of ureteral stent placement, female gender and younger age were found to be associated with increased in pain in the hours after removing a ureteral stent. The occurrence of increased pain did not differ by method of stent removal, self-reported health status or number of prior stents and stones.

Ureteral stents are commonly used in urology and have a well-documented history of patient morbidity.^{7,10} Up to 80% of patients receiving a ureteral stent may experience lower urinary tract symptoms, suprapubic pain, flank pain, incontinence, or hematuria.¹⁰ More recently patient morbidity after ureteral stent removal has been identified as an area of interest in stent management. In a retrospective, phone-based survey of 104 patients with a recent history of ureteral stent removal, Theckumparampil et al found that 38% of patients experienced pain after ureteral stent removal.⁵ Similarly, using an international, web-based, anonymous survey of 571 visitors to www.kidneystoners.org, Loh-Doyle et al found that 57% of respondents reported moderate-to-severe pain levels after ureteral stent removal, with an average self-reported pain score of 4.8 on a scale from 1-10.⁶ We found a lower proportion of patients (27.3%) experiencing pain after stent removal compared to the above referenced studies. This may be explained by our more specific focus on increased or additional pain above a patient's baseline pain rather than the presence of pain after stent removal. In addition, with over 80% of our study population self-reporting good-to-excellent health, we may have captured a higher proportion of patients who are

TABLE 2. Self-reported patient characteristics by pain after stent removal

	Increased pain	No increased pain	p value
Gender, % (n)			< 0.001
Men	18.6 (30)	81.4 (131)	
Women	36.1 (57)	63.9 (101)	
Age groups, % (n)			0.002
18-29 years	36.4 (4)	63.6 (7)	
30-49 years	40.7 (33)	59.3 (48)	
50-69 years	25.4 (44)	74.6 (129)	
70 years or older	11.1 (6)	88.9 (48)	
Health status, % (n)			0.35
Excellent	25.6 (10)	74.4 (29)	
Very good	23.2 (25)	76.9 (83)	
Good	32.8 (40)	67.2 (82)	
Fair	21.4 (9)	78.6 (33)	
Poor	42.9 (3)	57.1 (4)	
Number of prior stones, % (n)			0.52
1	24.6 (14)	75.4 (43)	
2-5	25.0 (33)	75.0 (99)	
More than 5	31.3 (36)	68.7 (81)	
Number of prior stents, % (n)			0.71
1	27.7 (44)	72.3 (115)	
2-5	25.2 (33)	74.8 (98)	
More than 5	33.3 (7)	66.7 (14)	
Timing of last stent within the last, % (n)			0.62
Month	35.0 (14)	65.0 (26)	
6 months	22.7 (20)	77.3 (68)	
Year	29.8 (14)	70.2 (33)	
2 years	30.6 (15)	69.4 (34)	
> 2 years	25.8 (24)	74.2 (69)	
Duration of time spent with last stent, % (n)			0.04
7 days or less	33.3 (45)	66.7 (90)	
More than 7 days	22.8 (42)	77.2 (142)	
Stent removed with scope procedure, % (n)	28.8 (34)	40.4 (84)	0.95

TABLE 3. Crude and adjusted relationship between pain after stent removal and duration of time spent with a stent, gender, age and health status

	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Stent for more than 7 days	0.59 (0.36-0.97)	0.59 (0.35-0.99)
Female sex	2.46 (1.48-4.11)	2.41 (1.42-4.10)
Increased age	0.52 (0.37-0.74)	0.52 (0.36-0.74)
Health status	1.14 (0.86-1.53)	1.03 (0.78-1.37)

generally healthier and experience less pain in general or inversely a population that may overrate health and underrate pain. Our findings may also better reflect the true prevalence of pain after ureteral stent removal as our survey was administered directly to patients in medical centers, unlike Loh-Doyle et al who looked at patients seeking online information regarding stone disease.⁶

The etiology of pain after ureteral stent removal has not been well elucidated. However, we can hypothesize that symptoms similar to ureteral or renal colic may be due to temporary obstruction of the ureter after stent removal.⁸ For example, obstruction may be secondary to ureteral edema, transient aperistalsis of the ureter, clot, or residual stone fragments. A better understanding of the mechanism of pain after ureteral stent removal may allow urologists to circumvent patient morbidity associated with this procedure. In the meantime, understanding factors associated with increased pain is important to allow urologists to provide patients with realistic expectations for post-stent removal morbidity.

We are not the first to report an association between stent duration and pain after stent removal.¹² Paul et al found that patients with a post ureteroscopy stent for 3 days had significantly more patient phone calls, clinic visits, and emergency room visits for renal colic compared to patients with a stent in for 7 days (23% versus 3%, $p = 0.03$).¹² Similarly, in our multivariable model, we found that patients with a ureteral stent for more than 7 days had significantly decreased odds of experiencing increased pain in the hours after stent removal compared to those with a stent 7 days or less, Figure 1. Theckumparampil et al also examined stent duration and pain after removal between 4 and 6 days, but found no difference in the average number of days with a stent among patients who did and did not experience pain after removal ($p = 0.09$).⁵ Failure to reach statistical significance in their study may be explained by a smaller sample size. The inverse relationship between decreased pain after stent removal and increased duration of stent placement is likely explained by the resolution of ureteral edema and inflammatory changes as the ureter dilates and better accommodates a stent over time. Maintenance of indwelling stents between 5 and 8 days has been recommended to allow for these changes to subside and to prevent transient ureteral obstruction.⁸ However, stenting after uncomplicated ureteroscopy has become controversial with recent studies demonstrating similar patient morbidity between patients who do and do not receive ureteral stents.^{11,13} With over 27% of patients experiencing

increased pain after stent removal, our study may also provide additional evidence to forgo stent placement after uncomplicated ureteroscopy.

Prior research has reported that male gender is associated with increased morbidity from indwelling ureteral stents.^{14,15} In contrast, we found that female gender was associated with increased pain after stent removal. It is unclear why female patients would experience more pain compared to males. Possible reasons may include decreased utilization of opiate pain medications or more accurate reporting of symptoms. Unlike other studies,^{5,6} we found that younger age was associated with increased pain in the hours after stent removal. Younger patients may be more sensitive to and less tolerant of pain.¹⁶ However, younger patients may also be more likely to experience a first-time kidney stone or ureteral stent compared to older patients and therefore may endorse higher pain due to the unexpected pain compared to a repeat episode of discomfort.

Loh-Doyle et al found that patients who used strings to remove ureteral stents experienced significantly less pain compared to those undergoing cystoscopy for removal.⁶ However, in a prospective randomized controlled trial of patients undergoing ureteral stent placement for urolithiasis, Barnes et al found no difference in patient morbidity by stent removal method.¹⁷ We also did not observe a relationship between experiencing increased pain after stent removal and method of removal. Ureteral stent removal by pulling a string may reduce overall indwelling stent time and duration of known stent-related morbidity, but may be less important in predicting who will experience increased pain after stent removal.¹⁸

Two small randomized controlled trials have examined prophylactic treatment for pain after ureteral stent removal. In a 2013 study by Tadros et al, patients receiving a 50 mg dose of the non-steroidal anti-inflammatory medication (NSAID), rofecoxib, prior to stent removal were significantly less likely to experience severe pain after stent removal.¹⁹ However, this finding has not been reproduced since. In a 2016 study, prophylactic administration of 440 mg of Naproxen had no impact on the occurrence of severe pain after stent removal.²⁰ We did not evaluate the use of analgesics, but there is a need to understand appropriate prescribing of NSAIDs and opioids for post-stent removal pain. Counseling patients about indwelling ureteral stent morbidity is essential to help patients understand and cope with their post-operative course.²¹ We would argue that counseling patients and setting expectations for post-stent removal pain is also

important and could have significant implications for post removal NSAID/opioid use, quality of life, patient satisfaction and willingness to accept a future stent. However, future research is needed to investigate these concepts.

The primary strengths of our study include a moderate sample size of patients with a history of a ureteral stent and a wide geographic survey distribution. Our retrospective survey design is a limiting factor, particularly as it relates to recall bias. However, we observed no difference in increased pain after stent removal based on how long ago a patient had their last stent. The blinded distribution of surveys prevents determining the response rate as denominator is not available. Selection bias is also a concern as patients who voluntarily completed the survey may have experienced more morbidity from a ureteral stent compared to those who did not participate. Because of the anonymity required by our institutional review board, we were unable to discern additional demographic and clinical granularity including the potential modifying effect of NSAID, opioid, alpha-1 blocker, and anticholinergics use on the occurrence of pain after stent removal. Additionally, we did not specify location of pain (e.g. urethral, abdominal, or flank) after ureteral stent removal, which may also be related to method of removal (e.g. string versus cystoscopy). Finally, we were not able to assess study outcomes by specific time cut offs (e.g. 4 versus 5 days) given how the survey questions were constructed. Therefore, we are unable to comment on an exact number of days with a ureteral that may be associated with less pain after stent removal.

Conclusion

Approximately one in four patients will experience increased pain after ureteral stent removal. Patients with a shorter duration of ureteral stent placement and patients younger and of female gender were more likely to experience increased pain after stent removal. Patients who had stents indwelling for more than 7 days reported less pain after stent removal. These findings may help inform intended duration of stent placement when deemed clinically necessary and may also assist in periprocedural counseling. Additional research is warranted to confirm the most appropriate duration of stent placement. In addition, studying the underlying mechanisms that are responsible for these changes in ureteral stent symptoms will help identify new potential therapeutic targets to assist with all stent patients. □

References

1. Scales CD, Smith AC, Hanley JM et al. Prevalence of kidney stones in the United States. *Eur Urol* 2012;62(1):160-165.
2. Hughes B, Wiseman OJ, Thomspon T et al. The dilemma of post-ureteroscopy stenting. *BJU Int* 2014;113(2):184-185.
3. Auge BK, Sarvis JA, L'esperance JO et al. Practice patterns of ureteral stenting after routine ureteroscopic stone surgery: a survey of practicing urologist. *J Endourol* 2007;21(11):1287-1291.
4. Pais VM Jr, Smith RE, Stedine EA, Rissman CM. Does omission of ureteral stents increase risk of unplanned return visit? A systematic review and meta-analysis. *J Urol* 2016;196(5):1458-1466.
5. Theckumpampil N, Elsamra SE, Carons A et al. Symptoms after removal of ureteral stents. *J Endourol* 2015;29(2):246-252.
6. Loh-Doyle JC, Low RK, Monga M et al. Patient experiences and preferences with ureteral stent removal. *J Endourol* 2015;29(1):35-40.
7. Ordon M, Andonian S, Blew B et al. CUA guideline: management of ureteral calculi. *Can Urol Assoc J* 2015;(11-12):E837-E851.
8. Levine RS, Pollack HM, Banner MP. Transient ureteral obstruction after ureteral stenting. *AJR Am J Roentgenol* 1982;138(2):323-327.
9. Vollstedt AJ, Rezaee ME, Monga M et al. The use of outpatient opioid medication for acute renal colic and ureteral stents: insights from a multi-institutional patient survey. *Clin Nephrol* 2020;93(6):269-274.
10. Miyaoka R, Monga M. Ureteral stent discomfort: Etiology and management. *Indian J Urol* 2009;25(4):455-460.
11. Chen YT, Chen J, Wong WY et al. Is ureteral stenting necessary after uncomplicated ureteroscopic lithotripsy? A prospective, randomized controlled trial. *J Urol* 2002;167(5):1977-1980.
12. Paul C, Brooks N, Ghareeb G et al. PD16-07. Determining optimal stent duration following ureteroscopy: 3 vs. 7 days. *J Urol* 2017;197(4S):e350.
13. Byrne RR, Auge BK, Kourambas J et al. Routine ureteral stenting is not necessary after ureteroscopy and ureteropyeloscopy: randomized trial. *J Endourol* 2002;16(1):9-13.
14. Giannarini G, Keeley FX, Valent F et al. Predictors of morbidity in patients with indwelling ureteric stents: results of a prospective study using validated ureteric stent symptoms questionnaire. *BJU Int* 2011;107(4):648-654.
15. Irani J, Siquier J, Pires C et al. Symptom characteristics and the development of tolerance with time in patients with indwelling double-pigtail ureteric stents. *BJU Int* 1999;84(3):276-279.
16. Wandner LD, Scipio CD, Hirsh AT et al. The perception of pain in others: How gender, race, and age influence pain expectations. *J Pain* 2012;13(3):220-227.
17. Barnes KT, Bing MT, Tracy OR. Do ureteric stent extraction strings affect stent-related quality of life or complications after ureteroscopy for urolithiasis: a prospective randomized control trial. *BJU Int* 2014;113(4):605-609.
18. Oliver R, Wells H, Traxer O et al. Ureteric stents on extraction strings: a systematic review of the literature. *Urolithiasis* 2018;46(2):129-136.
19. Tadros NN, Bland L, Legg E et al. A single dose of a non-steroidal anti-inflammatory drug (NSAID) prevents severe pain after ureteric stent removal: a prospective, randomized, double-blind, placebo-controlled trial. *BJU Int* 2013;111(1):101-105.
20. Belanger G, Beaulieu L. PD31-05: Pain following ureteral stent removal: prevalence and treatment. *J Urol* 2016;195(4):e718-e719.
21. Joshi HB, Stainthorpe A, Macdonagh RP et al. The development and validation of a patient-information booklet on ureteric stents. *BJU Int* 2001;88(4):329-334.