Ureteral stenting after routine ureteroscopy: Is earlier stent removal feasible?

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Introduction: *Ureteroscopy and laser lithotripsy is a common treatment option for upper urinary tract calculi. Currently, ureteral stents are placed after uncomplicated ureteroscopy for up to 1 week, but the optimal length of placement is not well defined. Ureteral stents are associated with significant morbidity, particularly stent discomfort. This study aims to determine differences in postoperative unplanned clinic or ED visits based on duration of stent placement.*

Materials and methods: *This is a single-institution, IRB-approved, retrospective cohort study of 559 ureteroscopy cases with laser lithotripsy for urinary tract calculi performed from 2016 to 2018. The primary outcome was unplanned ED or clinic visits within 30 days following surgery and there. The patients were separated into three groups based on stent duration: 1 (0-3 days), 2 (4-6 days), and 3 (> 6 days).*

Results: *Fifty-eight (10.31%) patients experienced an unplanned visit within 30 days of the procedure. There was no significant difference in unplanned visits among groups for stent duration ($p = 0.45$). A Clavien grade analysis showed no difference in grades between groups ($p = 0.59$). A Cox regression model showed no difference in risk of unplanned visit comparing those in groups 2 and 3 to group 1 ($p = 0.157$ and 0.374, respectively). This also remains to be the case after adjusting for age, sex, and surgeon ($p = 0.166$ and 0.376, respectively).*

Conclusions: *We found no difference in unplanned visits in patients based on the duration of stent placement following routine ureteroscopy. Stent removal within 3 days of surgery appears to be sufficient to minimize morbidity after uncomplicated ureteroscopy.*

Key Words: stenting, ureteroscopy, ureter, endourology, urolithiasis

Introduction

Ureteral stents are commonly used in urologic surgery. Several studies have shown that stenting may not be necessary after routine ureteroscopy.[1-5] However, a recent international survey found that more than 63% of urologists report leaving a stent in all cases.[6] Though stenting after uncomplicated ureteroscopy is still prevalent, there is little data addressing the optimal duration for stent placement.

The main complications associated with stent placement include pain, bleeding, infection, migration, and encrustation.[2] Besides the potential harmful effects, ureteral stents are also associated with a decrease in quality of life, often due to stent discomfort/colic.[1,2]

Recent studies evaluating the outcomes of ureteral stenting compared to omission after ureteroscopy have shown delayed discharge (23% versus 10%)

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and increased narcotic pain requirements.[5,6] In contrast, other studies have shown that postoperative stent placement resulted in fewer postoperative complications ED visits.[9-11] A 2019 Cochrane review, Ordonez et al,[2] showed a moderate certainty of evidence for increased pain (POD 0) in stented patients. There was no change in UTI symptoms and cultures in stented patients (RR 0.94, 95% CI 0.59 to 1.51). The rest of the findings in the paper had a low or very low grade of certainty.[2] These publications show an unclear relationship between the placement or omission of ureteral stents after ureteroscopy.

Although there are conflicting findings on whether or not to use a stent after uncomplicated ureteroscopy, it is still an extremely common practice.[4,6,9] For this reason, and due to the lack of data surrounding optimal stent duration, our study aimed to clarify whether the risk of complications changed with varying stent durations. To characterize this association, we examined the difference in postoperative unplanned clinic or ED visits based on three categories of stent placement duration. We hypothesized that there would be no difference in complications among these three stent duration groups. Earlier removal following ureteroscopy may reduce adverse effects of stents, while still providing the benefits of ureteral stent placement in the postoperative period.

Materials and methods

This was an IRB-approved, retrospective cohort study of 559 patients who underwent uncomplicated ureteroscopy with laser lithotripsy for urinary tract calculi performed from January 2016 to December 2018 by multiple surgeons at a single tertiary care institution. In congruence with the study by Brooks et al, an uncomplicated ureteroscopy was defined as a unilateral or bilateral ureteroscopy for urolithiasis management in patients with two functional kidneys, and no anatomic abnormalities nor ureteral injuries as a result of ureteroscopy.[7,13] We chose to examine only those patients undergoing uncomplicated URS to minimize variability in our patient population and we recognize that recurrent UTI and prolonged operative time can affect the postoperative need for stenting.[14] Patients were excluded if they had impacted ureteral stones, second stage ureteroscopy, second stage PCNL, or absence of stent placement.

The primary outcome was time to unplanned ED or clinic visit, in days, within 30 days following uncomplicated ureteroscopy with laser lithotripsy, after which observations were administratively censored. All patients were followed for this 30 day period, with no patients lost to follow up. For each unplanned visit, the reason for visit, associated Clavien grade, and whether the visit occurred before or after stent removal were recorded.

The ureteroscopy technique at our institution typically involved using a 0.038-inch Bentson wire [working wire and safety wire], 5-French needle tip semirigid ureteroscope, and/or Storz flexible digital ureteroscope. When needed, 12-14 French ureteral access sheaths were used and the ureter was dilated to improve access. Our general practice is to use access sheaths only when doing flexible ureteroscopy and not for rigid ureteroscopy. Access sheaths were used for stones in the kidney or the proximal ureter. Either 200 or 365 micron Holmium laser fiber was used for lithotripsy at both dusting and fragmentation settings. Stents were either left on a string (secured to the inner thigh or penis), or the string was removed. Stents were removed 2-14 days postoperatively by a urologist in the clinic via pulling on the string attached to the stent or flexible cystoscopy with a stent grasper if the string was removed.

The primary exposure was duration of stent placement, in days, following uncomplicated ureteroscopy with laser lithotripsy. Stent placement duration was categorized into three groups: Group 1 (0-3 days), Group 2 (4-6 days), and Group 3 (> 6 days). Stent placement duration was based on surgeon preference. Stone management information was collected including the attending surgeon, use of ureteral access sheath, need for dilation to access the ureter, leaving the stent on a string, number of stones, size, location, and laterality. The type of ureteroscope used (semirigid and/or flexible) was not recorded, as the risk of trauma with either type of ureteroscope is low, and the literature shows no difference in complications when using either.[16] Additional baseline patient information was collected on age, sex, BMI, and ASA score.

Study participants contributed person-time from the day of stent placement until unplanned visit or study conclusion. Cox proportional hazards models were used to estimate hazard ratios [HR] for having an unplanned visit, using time to visit as the time scale. Stent duration was considered as a categorical variable (0-3 days, 4-6 days, > 6 days) and was assessed as the primary predictor of interest in crude and adjusted models. The decision to separate dwell time into three groups was to compare "early" removal to "late" removal with relatively large sample sizes and compare the complication rates. The additional covariates included in the adjusted model were chosen based on finding a significant difference in the

covariate among exposure groups in tabular analysis, Table 1. These covariates included ASA score, stone location, largest stone diameter, use of ureteral access sheath, and attending surgeon to account for potential confounding by these covariates. Subsequently, stent string attachment was added to the adjusted model to assess whether it was a significant predictor of unplanned visits.

Two-sided p values were calculated with statistical significance set at $p < 0.05$ for measures of association. The proportional hazards assumption was tested by comparing models with and without interaction terms between each covariate and time to visit using log-likelihood tests. The assumption was met for all outcomes ($p > 0.05$). Analyses were performed using Stata, release 15 (StataCorp LLC. 2017, College Station, TX, USA)

TABLE 1. **Patient, management, and stone characteristics**

	Total n = 559 (%)	**Group 1 n = 147 (%)**	**Group 2 n = 189 (%)**	**Group 3 n = 223 (%)**	**p value**
Age, years (SE)	50.82 (0.64)	52.09 (1.30)	49.18 (1.16)	51.38 (0.93)	0.118
Gender					0.738
Female	267 (47.76)	73 (49.66)	85 (44.97)	109 (48.88)	
Male	289 (51.70)	74 (53.74)	102 (53.97)	113 (50.67)	
Male-to-Female	3 (0.54)	0 (0)	2 (1.06)	1 (0.45)	
BMI, kg/m^2 (SE)	29.26 (0.29)	29.30 (0.52)	29.22 (0.56)	29.26 (0.44)	0.994
ASA score		*			0.042
1	43 (7.71)	17 (11.64)	9 (4.76)	17 (7.62)	
2	341 (61.11)	81 (55.48)	122 (64.55)	138 (61.88)	
3	165 (29.57)	48 (32.88)	56 (29.63)	61 (27.35)	
4	9 (1.61)	0 (0)	2 (1.06)	7 (3.14)	
Surgeon		*	*	*	< 0.001
A	280 (50.1)	114 (77.6)	85 (45.0)	81 (36.3)	
B	80 (14.3)	2 (1.4)	41 (21.7)	37 (16.6)	
C	61 (10.9)	8 (5.4)	28 (14.8)	25 (11.2)	
D	110 (19.7)	18 (12.2)	21 (11.1)	71 (31.8)	
E	28 (5.0)	5 (3.4)	14 (7.4)	9 (4.0)	
Access sheath used	462 (82.6)	130 (88.4)*	158 (83.6)	174 (78.0)	0.047
Dilated	14 (2.5)	2 (1.4)	4 (2.1)	8 (3.6)	0.363
Stent string	336 (60.22)	130 (88.44)	138 (73.40)	68 (30.49)*	< 0.001
Number of stones					0.832
Single	260 (46.51)	66 (44.90)	91 (48.15)	103 (46.19)	
Multiple	299 (53.49)	81 (55.10)	98 (51.85)	120 (53.81)	
Stone location		*			0.041
Kidney	307 (54.92)	94 (63.95)	93 (49.21)	120 (53.81)	
Ureter	167 (29.87)	38 (25.85)	58 (30.69)	71 (31.84)	
Both	85 (15.21)	15 (10.20)	38 (20.11)	32 (14.35)	
Largest stone diameter, mm (SE)	7.65 (0.14)	6.97 (0.20)	7.48 (0.27)	8.24 (0.23)*	0.001
Unplanned visits	58 (10.31)	19 (12.93)	16 (8.47)	23 (10.31)	0.413

*statistically significant difference in group
Group 1 = stent duration 0-3 days; Group 2 = stent duration 4-6 days; Group 3 = stent duration > 6 days; SE = standard error; BMI = body mass index; ASA = American Society of Anesthesiologists physical status classification score. All p values for continuous variables calculated with one-way ANOVA test. All p values for categorical variables calculated with chi-squared test if fewer than 20% of cells had values < 5; otherwise Fisher's exact test was used.

TABLE 2. **Characteristics of unplanned visits to the ED or clinic per stent group**

	Total (n = 58)	Group 1 (n = 19)	Group 2 (n = 16)	Group 3 (n = 23)	p value
Reason for visit (%)					0.267
Pain	22 (37.93)	11 (57.89)	4 (25.00)	7 (30.43)	
Fever	8 (13.79)	1 (5.26)	3 (18.75)	4 (17.39)	
Hematuria	2 (3.45	0 (0)	0 (0)	2 (8.70)	
LUTS	1 (1.72)	0 (0)	1 (6.25)	0 (0)	
Multiple	25 (43.10)	7 (36.84)	8 (50.00)	10 (43.48)	
Clavien grade (%)					0.589
I	8 (13.79)	2 (10.53)	4 (25.00)	2 (8.70)	
II	36 (62.07)	10 (52.63)	9 (56.25)	17 (73.91)	
IIIa	11 (18.97)	5 (26.32)	3 (18.75)	3 (13.04)	
IIIb	2 (3.45)	1 (5.26)	0 (0)	1 (4.35)	
IVa	1 (1.72)	1 (5.26)	0 (0)	0 (0)	
Visits after stent removal (%)	30 (51.72)	12 (63.16)	14 (87.50)	4 (17.39)	< 0.001

Group 1 = stent duration 0-3 days; Group 2 = stent duration 4-6 days; Group 3 = stent duration > 6 days; LUTS = lower urinary tract symptoms; Multiple = having more than one primary reason for visit (including pain, fever, hematuria, LUTS, urinary retention, dizziness, persistent hydronephrosis, sepsis, altered mental status, tachycardia, syncope, and constipation).

Results

A total of 559 patients met the inclusion criteria of the study, see Table 1. Of these, there were 147 in Group 1 (26.3%), 189 in Group 2 (33.8%), and 223 in Group 3 (39.9%). There were no significant differences with respect to age, gender, BMI, need for ureteral dilation, number of stones, or total unplanned visits amongst these groups. Patients in Group 1 had a wider distribution of ASA scores and stones that were more commonly located in the kidney than the other groups. Patients who were operated on by surgeon A were more prevalent in Group 1, whereas those who were operated on by surgeon D were more prevalent in Group 3. Access sheath use was more prevalent in Group 1 than in the other groups. Patients in Group 3 had larger average stone diameter and were less likely to have stents left on strings than the other groups.

Overall, 501 (89.6%) patients were event free and 58 (10.4 %) patients had an unplanned visit during the 30-day postoperative period, Table 2. Of the 58 patients with an event, 19 were from Group 1 (12.9% of total patients in Group 1), 16 were from Group 2 (8.5% of total patients in Group 2), and 23 were from Group 3 (10.3% of total patients Group 3). Of patients who had an unplanned visit, 12 (63.2%) in Group 1, and 14 (87.5%) in Group 2, and 4 (17.4%) in Group 3 had a visit after the stent was removed ($p < 0.001$).

The reasons for an unplanned visit to the ED or clinic included pain (22), fever (8), hematuria (2), lower urinary tract symptoms (1), and multiple symptoms (25). There was no difference in primary reason for

TABLE 3. **Unplanned visit-free survival**

	Unadjusted model			Model 1			Model 2		
Stent group	**HR**	**CI**	**p value**	**HR**	**CI**	**p value**	**HR**	**CI**	**p value**
Group 1	ref.	-	-	ref.	-	-	ref.	-	-
Group 2	0.62	0.32-1.20	0.157	0.65	0.33-1.28	0.214	0.64	0.32-1.26	0.196
Group 3	0.76	0.41-1.39	0.374	0.79	0.42-1.49	0.468	0.73	0.35-1.49	0.384

HR = hazard ratio; CI = 95% confidence interval; Group 1 = stent duration 0-3 days; Group 2 = stent duration 4-6 days; Group 3 = stent duration > 6 days; Model 1 = adjusted for ASA score, stone location, largest stone diameter, use of ureteral access sheath, and attending surgeon; Model 2 = adjusted for ASA score, stone location, largest stone diameter, use of ureteral access sheath, attending surgeon, and presence of string on stent.

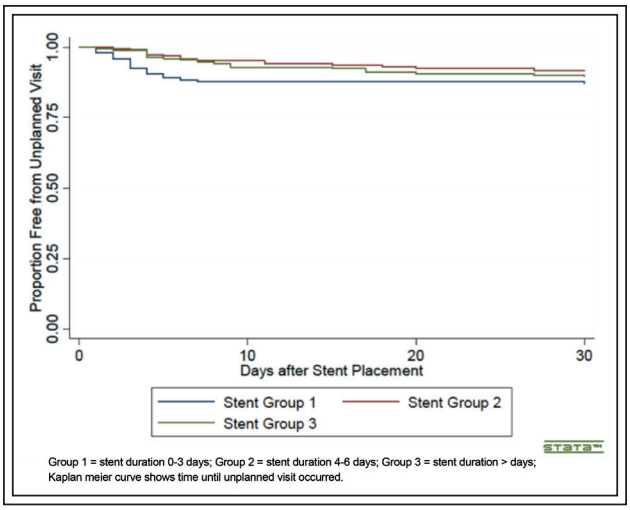

Figure 1. Kaplan Meier Curve.

unplanned visit (p = 0.267). There was also no difference in Clavien grade among groups (p = 0.589), Table 3.

The unadjusted Cox regression model demonstrated that there was no significant difference in the risk of unplanned visit comparing those in Groups 2 and 3 to Group 1 (p = 0.157 and 0.374, respectively). This also remains to be the case after adjusting for significant covariates (p = 0.214 and 0.468, respectively). Model 3, which additionally adjusted for stent string attachment, showed that still there was no increased risk of unplanned visits in the groups with longer stent duration (p = 0.196 and 0.384, respectively). Additionally, stent string attachment was not a significant predictor of unplanned visit (HR 0.80, 95% CI 0.40-1.62, p = 0.541), Figure 1.

Discussion

Our study found no difference in risk of unplanned clinic or ED visit based on the duration of stent placement following routine ureteroscopy in an adjusted cox regression model, suggesting that a longer stent duration is not more "optimal" than a shorter one. Furthermore, we found no significant association between stent string attachment and unplanned visits. Few studies addressing optimal stent duration exist currently. Paul *et al*[16] performed a tabular analysis in a cohort of 247 patients who underwent unilateral ureteroscopy with lithotripsy and had stents in place for either 3 or 7 days. Similar to our study, they found that there was no significant difference in postoperative adverse events in the 30 days following procedure (p = 0.11). Our study supports their findings with a more robust analysis that adjusts for potential confounders.

There was no significant difference in unplanned visits. The unadjusted Cox regression model demonstrated that there was no significant difference in the risk of unplanned visit comparing those in Groups 2 and 3 to Group 1 (p = 0.157 and 0.374, respectively). We also found no difference in the reason for unplanned visit (p = 0.267). The Paul et al study also looked at reasons for visit, particularly in the first 3 days following stent removal, and found a nearly significant increase in flank pain in the 3-day stent group compared to the 7-day group(p = 0.075). Our findings also show an increased trend in number of patients with pain-related visits over the 30-day follow up period in Group 1 (57.9%) compared the other groups (25.0% and 30.4%), over the 30-day follow up period.

Although there was no statistically significant difference between groups, there was a 50% higher rate of unplanned visits in Group 1 (12.9%) versus Group 2 (8.5%), despite Group 2 having a higher rate of both ureteral and kidney stones. This raises the possibility that a larger sample size or a randomized trial would show a significant difference. Group also 3 had patients with larger stones and some higher ASA scores, which may have placed these patients at higher risk for complications. They did not experience more complications, possibly supporting longer dwell times for higher risk patients.

Of the patients that did have an unplanned event, Groups 1 and 2 had a statistically higher (p < 0.0001) event rate after the stent was removed. This is likely because most complications occur in the first few days following stent placement, regardless of stent dwell time. This finding supports the idea that unplanned visits might be related to stent symptoms, rather than a complication of stent removal.

There is a recognized relationship in the literature between prolonged stent placement and patient morbidity.[2,13] Unnecessarily long stent placement is associated with decreased patient satisfaction and well-known stent-related symptoms.[1,7,13,16] Recent literature suggests ureteral stenting can be omitted after routine ureteroscopy.[2-5] A 2019 Cochrane systematic review, stenting may decrease unplanned return visits, readmissions, narcotic use, and stricture development, but may also cause increased pain and reduced quality of life.[2] The certainty of evidence from this review when discussing stent placement versus omission to be low or very low in eight separate outcomes.[2] However, this is not to say that stenting should be omitted altogether. In fact, stenting has

several benefits[9-11] and is recommended to decrease the risk of certain complications.[12]

Postoperative ureteral stents have been shown to have several benefits. A 2017 prospective multicenter study found that postoperative stent placement resulted in significantly fewer postoperative complications ($p < 0.001$) compared to those who did not receive a stent.[9] Two previous studies have shown than unstented patients presented to the emergency room more than stented patients.[10,11] Stent placement also reduces the risk of invasive, emergent stent placement in cases of Steinstrasse, which can be associated with significant morbidity.[10] Ultimately, the surgeon decides whether to stent and for how long by considering the pros and cons on a case-by-case basis,[3] with 55.4% of surgeons placing a stent in > 75% of cases.[4]

Our study was strengthened by the large sample size of our cohort, which likely limited the amount of random error in our effect estimates. Additionally, all patients completed follow up to the point of administrative censoring, which eliminated any concern for informative censoring. We recognize there is surgeon variability in the length of dwell time and may be due to a variety of factors unrelated to case complexity (surgeon preference, scheduling, etc.). One of the goals of our research was to highlight this variability and standardize optimal stent duration.

One limitation of our study was the lack of randomization typically seen in observational study, so our findings were susceptible to bias by unmeasured confounders. Also, our study may have selected for adverse outcomes and unplanned visits in patients reporting to our hospital or affiliated sites, resulting in selection bias. Migration to other hospital systems, however, was likely minimal given that our institution is the only safety-net hospital in the area. We also recognize that patients may have been symptomatic, yet unable or unwilling to seek care outside of a scheduled visit.

To our knowledge this is one of the largest studies to date which attempts to find an association between stent placement duration and adverse events. Before this study, there have been very few attempts to identify a relationship. However, further prospective randomized studies will need to be carried out to better understand an association between adverse events and stent duration.

Conclusions

Unplanned visits after uncomplicated ureteroscopy and stent placement occur in more than 10% of patients. We found no significant difference in total unplanned visits based on stent duration. However, there were significant differences in patient characteristics between groups, most notably stone size. For these reasons it is reasonable to believe that longer placement time (i.e., > 6 days) would benefit patients at higher risk for complications. □

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