UROpedia CANADA

ORIGINAL RESEARCH

Ureteral stent in ureteroneocystostomy for vesicoureteral reflux

Analysis of data from the National Surgical Quality Improvement Program-Pediatrics

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ABSTRACT

INTRODUCTION: We aimed to assess the association between stent placement during ureteral reimplantation for vesicoureteral reflux (VUR) and short-term postoperative outcomes.

METHODS: We conducted a retrospective analysis of National Surgical Quality Improvement Program-Pediatrics (NSQIP-P). Independent variables included stent placement, age, sex, urologic comorbidity, prior VUR procedures, severity of reflux, preoperative urinary tract infections (UTIs), American Society of Anesthesiologists (ASA) classification, and operative approach. Outcomes of interest were emergency department (ED) visits, operative time, readmissions, unplanned operations, length of hospital stay (LOS), and postoperative UTIs. Descriptive statistics were performed, and Chi-squared and Mann-Whitney U tests were used for univariate analysis. For multivariate analyses, logistic regression, linear regression, and negative binomial models were applied.

RESULTS: A total of 4550 patients were identified (median age 47.36 months, 68.7% female, 48.8% stented). In multivariate analyses, ureteral stenting was significantly associated with higher rates of ED visits ($p=0.0019$), related readmissions ($p<0.0001$), and postoperative UTIs ($p<0.0001$). The expected length of hospitalization for the stent group was 37% longer than for the non-stent group ($p<0.0001$), and the operative time was, on average, 31 minutes longer ($p<0.0001$).

CONCLUSIONS: This study reveals an association between ureteral stenting and short-term adverse postoperative outcomes following ureteral reimplantation for VUR. Consideration should be given to the selective use of stents at the time of ureteral reimplantation for VUR. There are limitations to the study due to the absence of some surgical data in the database, such as type of reimplant, long-term success rate, and type of stent used.

INTRODUCTION

Despite the increased popularity of endoscopic treatment, ureteroneocystostomy remains the gold standard for anti-reflux procedures. Its established success rate of over 90% makes it a favored option for treating vesicoureteral reflux (VUR).[1] The goal of surgical management is to preserve renal function, reduce the occurrence of pyelonephritis, and decrease the reliance on antibiotic prophylaxis.[2] There is significant variability in surgical techniques, including open vs. laparoscopic approaches, and intravesical (open/pneumovesicoscopic) vs. extravesical methods. Another variable aspect of the procedure is the use and type of ureteral stent.[3]

This study aimed to compare the short-term outcomes of ureteroneocystostomy for VUR between stented and non-stented pediatric patients using data from the American College of Surgeons National Surgical Quality Improvement Program-Pediatric (ACS NSQIP-P). Additionally, it examined the associations between patient characteristics, procedural factors, and clinical outcomes.

METHODS

Patient selection

The 2020–2022 NSQIP-P database was queried to identify cases of ureteroneocystostomy for VUR in patients aged 0–17 years across all participating sites. The procedure was identified using ureteroneocystostomy current procedural terminology (CPT) codes (50780, 50782, 50783, 50947, 50948), and the pre-

KEY MESSAGES

- The use of stents after ureteral reimplantation for VUR remains a subject of debate.
- Decisions regarding stenting are influenced by anatomical variations, surgical techniques, and surgeon preferences.
- The impact of stenting on short-term outcomes is not fully understood, further complicating this decision-making process.
- This large study aims to address this controversy using a substantial sample size and validated data.

operative diagnosis of VUR was captured using specific ICD-9 (593.70) and ICD-10 codes (N13.70, N13.71, N13.72, N13.731, N13.732, N13.739, N11.0, Z87.448).

Data collection

We extracted data on patient characteristics (age, sex assigned at birth), disease characteristics (severity and laterality of reflux, urologic comorbidities, history of VUR procedures, preoperative urinary tract infection [UTI]), procedural factors (stenting, American Society of Anesthesiologists [ASA] classification, surgical approach, operative time), and short-term surgical outcomes (length of hospital stay [LOS], emergency department [ED] visits, unplanned admissions, unplanned surgeries, and postoperative UTIs) from the NSQIP-P database. NSQIP coding for UTI is based on strict criteria, compatible with the Center for Disease Control recommendations.

Statistical analysis

To describe the demographic and clinical characteristics of the patients, procedural factors, and outcomes, we calculated frequencies, proportions, means, and standard deviations (SDs), or medians and interquartile ranges (IQRs). The unadjusted association between stenting status and different outcomes was assessed using the Chi-squared test for categorical variables, and either the T-test or Mann-Whitney U test for continuous variables.

Logistic regression was used to evaluate the adjusted associations between ureteral stent placement and 30-day outcomes or complications (e.g., ED visits, readmissions, unplanned reflux-related procedures, and postoperative UTIs). Negative binomial regression was employed to assess the adjusted association between stenting status and LOS, while linear regression was used to analyze its association with operative time. A common set of potential confounders was included in each adjusted model based on their clinical relevance and performance in univariable analyses.

Two sets of analyses were performed: a complete case analysis (primary analysis) and a full model with multiple imputations for missing values (sensitivity analysis) to assess the effect of missing data. All independent and dependent variables were included in the imputation models. Multiple imputation using the fully conditional specification (FCS) algorithm was performed, where the regression method was applied for continuous variables, and the discriminant function method was used for categorical variables. A log transformation was applied for the imputed count variable. Forty imputed datasets were created, and the convergence of imputation models was assessed.

The level of significance was set at $p \leq 0.05$. All analyses were performed using SPSS (version 26) and SAS 9.4 (SAS Institute Inc, Cary, NC, U.S.).

RESULTS

A total of 4550 cases were identified in the 2020–2022 NSQIP-P database. Ureteral stent placement was performed in 2221 cases (48.8%). The demographic and baseline characteristics of the patients with and without stents are compared in Table 1.

Among the stented children, stent removal occurred in the operating room (OR) for 434 patients and outside the OR for 1053 patients within 30 days post-surgery. In 734 patients (16%), the stents remained in place beyond 30 days postoperatively.

Stented patients were younger, more frequently male, had a history of urologic procedures and comorbidities (neurogenic, non-neurogenic, or both), exhibited more severe VUR, had higher ASA classifications, were more likely to have preoperative or intraoperative UTIs, and were more likely to undergo open ureteroneocystostomy.

Within the cohort, there were 508 (11.2%) ED visits, 152 (3.3%) related readmissions, 101 (2.2%) unplanned procedures, and 142 (3.1%) postoperative UTIs (Table 2). Other outcomes included progressive renal insufficiency (0.3%), acute renal failure (0%), surgical site infections (0.5%), and sepsis (0.8%). The median (IQR) operation time and LOS were 158 (120–206) minutes and 1 (1–2) days, respectively.

Univariate analysis indicated that adverse outcomes — including ED visits, related readmissions, unplanned procedures, and UTIs — were more common among stented patients compared to non-stented patients (Table 2). Furthermore, stented patients experienced longer OR times and extended LOS compared to unstented patients.

Table 3 presents the results of multivariate complete case analyses, comparing the outcomes of ureteroneocystostomy with and without stent placement. All models were adjusted for the same set of patient- and procedure-related confounders: age, sex (assigned at birth), urologic comorbidities, VUR severity, prior VUR procedures, ASA classification, preoperative UTI, and the type of procedure (open, minimally invasive, or both).

After adjustments, stenting remained significantly associated with higher rates of ED visits (odds ratio [OR] 1.47, 95% confidence interval [CI] 1.15–1.87, p=0.0019), related readmissions (OR 2.52, 95% CI 1.61–3.95, p<0.0001), and postoperative UTIs (OR 2.73, 95% CI 1.72–4.34, p<0.0001). The adjusted expected LOS for the stent group was 37% longer than for the non-stent group (relative risk [RR] 1.37, 95% CI 1.29–1.47, p<0.0001), and operation time was extended by an average of 31 minutes (mean difference: 30.89 minutes, 95% CI 25.31–36.47, p<0.0001). Detailed, complete model outputs are provided in the online Appendix (available at *cuaj.ca*)

The association between stenting and various outcomes was comparable between the complete case analyses and the full models with multiple imputations.

We also evaluated the association of the secondary covariates with the outcomes (Appendix; available at *cuaj.ca*). Concomitant urologic comorbidities are associated with an increased likelihood of ED visits (OR 1.40, 95% CI 1.09–1.82, p=0.0099), readmissions (OR 1.69, 95% CI 1.10–2.59, p=0.0164), postoperative UTIs (OR 1.99, 95% CI 1.29–3.08, p=0.0019), as well as longer LOS and operation times. A history of any prior VUR procedure is also linked to a higher frequency of readmissions (OR 1.96, 95% CI 1.13–3.40, p=0.0171) and prolonged LOS and operation times.

Voiding cystourethrogram (VCUG) grades 2 or 3, or radionuclide cystography (RNC) grade 2, were associated with shorter operation times and LOS compared to VCUG grade 1 or RNC grade 1. Additionally, VCUG grades 4 or 5, or RNC grade 3, were linked to shorter LOS compared to VCUG grade 1 or RNC grade 1.

Children with ASA class 2 or 3 had longer operation times compared to those with ASA class 1. Moreover, ASA classes 2–4 were associated with longer LOS compared to ASA class 1. Patients who underwent combined minimally invasive/laparoscopic surgery and open surgery had longer operation times and LOS compared to those who had only minimally invasive/laparoscopic surgery. Preoperative or intraop-

Table 1. Demographic, clinical, and procedural characteristics of patients undergoing reimplantation for vesicoureteral reflux disease based on stenting status (NSQIP-P database, 2020–2022)

Characteristic	Stenting status		p
	Stented (n=2221)	Non-stented (n=2329)	
Age in months, median [Q1-Q3[a]]	42.63 [20.90–75.23]	51.63 [25.73–81.13]	<0.001
Sex (assigned at birth), n (%)			
Male	809 (36.4)	617 (26.5)	<0.001
Urological comorbidity, n (%)			<0.001
Yes	606 (27.2)	463 (19.9)	
Neurogenic[b]	113 (5.1)	71 (3.0)	
Non-neurogenic[c]	473 (21.3)	383 (16.4)	
Both	20 (0.9)	9 (0.4)	
Prior VUR procedure, n (%)			
Yes[d]	292 (13.1)	138 (5.9)	<0.001
Reflux disease severity, n (%)			<0.001
VCUG grade 1–2/RNC grade 1	61 (2.7)	41 (1.8)	
VCUG grade 2–3/RNC grade 2	562 (25.5)	889 (38.2)	
VCUG grade 4–5/RNC grade 3	1374 (61.8)	1272 (54.6)	
Unknown	224 (10.1)	127 (5.4)	
Laterality, n (%)			0.77
Unilateral	1033 (46.5)	1097 (47.1)	
Bilateral	1180 (53.1)	1226 (52.6)	
Unknown	8 (0.4)	6 (0.3)	
Type of procedure, n (%)			<0.001
Open	1752 (78.9)	1679 (72.1)	
Minimally invasive surgery[e]	249 (11.2)	427 (18.3)	
Both	220 (9.9)	223 (9.6)	
ASA classification, n (%)			<0.001
Class 1	318 (14.3)	382 (16.4)	
Class 2	1563 (70.4)	1726 (74.1)	
Class 3	328 (14.8)	213 (9.1)	
Class 4	11(0.5)	7 (0.3)	
Unknown	1 (0.0)	1(0.0)	
Preoperative/intraoperative UTI			0.026
Yes	146 (6.7)	112 (4.8)	
Unknown	742 (33.4)	819 (35.1)	

[a]25th and 75th percentiles. [b]Neurogenic comorbidity includes neurogenic bladder, neurogenic bowel, spina bifida/myelomeningocoele, tethered cord, spinal cord injury, and imperforate anus. [c]Non-neurogenic comorbidity includes posterior urethral valve, Eagle-Barrett or prune-belly syndrome, bladder exstrophy, cloacal exstrophy, ectopic ureter, ureterocoele, and duplex kidney. [d]Including endoscopic subureteric injection (n=84), reimplant (n=218) and both (n=28). [e]Current procedural terminology (CPT) coding does not distinguish between laparoscopic reimplant and robot-assisted laparoscopic reimplant, thus they are classified together as 'minimally invasive.' ASA: American Society of Anesthesiologists; RNC: radionuclide cystography; UTI: urinary tract infection; VCUG: voiding cystourethrogram; VUR: vesicoureteral reflux.

Table 2. Postoperative outcomes of the patients undergoing reimplantation for vesicoureteral reflux disease, stratified for stenting status

Outcome	Stented (n=2221)	Non-stented (n=2329)	p
Emergency department visits, n (%)	298 (13.4)	210 (9.0)	<0.001*
Related readmissions, n (%)	107 (4.8)	45 (1.9)	<0.001*
Unplanned procedures (related to anti-reflux treatment), n (%)	64 (2.9)	37 (1.6)	0.003*
Urinary tract infections, n (%)	99 (4.5)	43 (1.8)	<0.001*
Operation time (min)			<0.001**
Median [IQR]	179 [135–235]	142 [110–181]	
Mean (SD)	193.29 (86.97)	152.81 (65.68)	
Length of hospital stay† (days)			<0.001***
Median [IQR]	2 [1,3]	1 [1,2]	
Mean (SD)	2.33 (3.27)	1.57 (2.10)	

*Chi-squared test. **T test. ***Mann-Whitney U test. †Total N=4537, stented: (n=2212); non-stented (n=2325). IQR: interquartile range; SD; standard deviation.

Table 3. Multivariate analysis: Association of ureteral stenting and postoperative outcomes (N=2772)

Outcome	Adjusted OR* (95% CI)	p
Emergency department visits	1.47 (1.15–1.87)	0.0019
Related readmissions	2.52 (1.61–3.95)	<0.0001
Unplanned procedures (related to anti-reflux treatment)	1.60 (0.97–2.66)	0.0671
Urinary tract infections	2.73 (1.72–4.34)	<0.0001

*Logistic regression model, odds ratios (OR) were adjusted for patient-related confounders (age, sex, urologic comorbidity, vesicoureteral reflux [VUR] severity, prior VUR procedure, American Society of Anesthesiologists score, preoperative urinary tract infection), and procedural factors (type of procedure: open, minimally invasive, or both). CI: confidence interval.

erative UTIs were associated with a higher likelihood of unplanned procedures related to anti-reflux treatment (OR 2.15, 95% CI 1.13–4.09, p=0.0193), as well as extended operation times and LOS

DISCUSSION

There is considerable variability in the use of ureteral stents during ureteroneocystostomy, with decisions largely based on expert opinions and surgeon preferences. The most common reasons for placing a stent include concerns about obstruction at the reimplantation site due to early postoperative edema (1–6%) and a narrow neo-hiatus.[4] Some surgeons routinely use stents to prevent postoperative anastomotic urinary leakage, while others argue that lower-grade reflux and the absence of dilatation may predispose patients to postoperative obstruction, especially in the presence of significant bladder inflammation, making ureteral stenting a prudent choice.[5] Other reasons for stent use include a solitary kidney, renal impairment, repeat reimplant, tapering procedures, and significant comorbid conditions.[4]

Despite its presumed benefits, ureteral stenting has its drawbacks. Some patients may experience bladder irritability, spasms, hematuria, and flank pain, which can be difficult to tolerate. Neglected stents may result in complicated UTIs and encrustations. Additionally, there are significant costs associated with the stent itself and the resources required for its removal, which may introduce further anesthetic and surgical risks.[6]

Several observational studies have shown comparable outcomes and complication rates in stented vs. non-stented reimplantation procedures, regardless of whether an open or minimally invasive approach is used;[4,5,7] however, these studies are often limited by small sample sizes and confounding factors. Mahalingan's study[4] included a comprehensive review of other studies[8-13] examining stenting in pneumovesicoscopic reimplantation for VUR, including 442 patients and 751 non-stented ureters. Only six patients experienced early postoperative obstruction, and two experienced late obstruction.[4]

Some suggest that stents may be especially helpful in bilateral reimplantation to prevent postoperative oliguria, but others challenge this notion, stating that stents are unnecessary as long as free efflux of urine is observed intraoperatively.[14-16] Levy et al evaluated the safety of the same-day discharge after pyeloplasty and ureteral reimplantation using NSQIP data.[17] They were not able to comment on the effect of stenting on the outcome of interest. Packiam et al also used NSQIP data to compare the 30 outcomes in adults who underwent ureteral reimplant, comparing laparoscopic and open approaches. They did not present any data regarding the effect of stenting on the outcomes.[18] There is no recent study comparing adverse events in stented vs. non-stented patients on a large scale for those undergoing ureteroneocystostomy.

We used the ACS NSQIP-P database, which provides large population data that is high-quality, well-validated, risk-adjusted, and prospectively collected for various surgical operations, including complications and risk factors. Data is sourced from over 150 hospitals and is compliant with HIPAA regulations. Surgical clinical reviewers, trained and certified by ACS, collect the data.[19] To our knowledge, this is the first study to assess the association between stent placement during ureteral reimplantation and surgical outcomes using the NSQIP-P data.

The current study included over 4500 cases for analysis. We observed that stenting is not as routinely practiced as expected, with 51.2% of patients leaving the OR without a stent. Short-term postoperative complications were significantly higher in stented patients, both statistically and clinically. We employed robust statistical methods to isolate the effect of stenting on postoperative adverse events, adjusting for known variables available in the database. Our findings showed a 47% increase in the likelihood of ED visits and a 60% increase in unplanned procedures among stented patients. The probability of related admissions and UTIs more than doubled in stented children. Additionally, there were significant differences in both the LOS and operation time.

Other observations can also be drawn from the current NSQIP-P analysis. Despite the growing popularity of minimally invasive surgeries, contemporary practice patterns still show that open ureteral reimplantation is performed more frequently than laparoscopic or robotic techniques; however, there is a gradual upward trend in the use of minimally invasive ureteral reimplantation: 6.3% in 2012, 8.4% in 2018, and 14.9% in the current study.

We also observed shorter operative times and LOS for patients with higher-grade VUR in the univariate analysis. While we do not have a clear explanation for this finding, it is possible that the association between lower-grade VUR and other perioperative factors may be confounding the results. We encountered a relatively significant amount of missing data for some variables. To address this, we performed multiple imputation modeling to assess its potential impact on the results. The imputed models produced results similar to those of the complete case analysis for the effect of stenting on the outcomes of interest.

Limitations

As previous studies have pointed out,[1] the NSQIP-P database has limitations due to the relatively low rates of short-term complications and the lack of long-term data. Another limitation of our analysis is the absence of specific data on certain surgical complications (e.g., urinoma, leakage, stricture, progressive renal insufficiency, acute renal failure) and long-term followup. The database does not include information on operative success or failure (e.g., persistent VUR or stricture formation), as confirmed by appropriate imaging, nor data on type of stent (external vs. internal). Moreover, the NSQIP-P database does not document the various techniques used for ureteral reimplantation (e.g., Cohen cross-trigonal, Politano-Leadbetter, Glenn-Anderson, Hutch) or other aspects of the surgical procedure (intravesical vs. extravesical, tapered vs. non-tapered). It also does not differentiate between internalized double-J stents and externalized tubes.

These confounders suggest that stent use may be a proxy for more complex cases. Nevertheless, understanding the adverse events associated with stent placement remains valuable for urologists.

CONCLUSIONS

The current study demonstrated an association between stenting during ureteroneocystostomy for VUR and adverse postoperative outcomes, indicating that routine stenting may not be beneficial. Therefore, consideration should be given to the selective use of stents at the time of ureteral reimplantation for VUR.

COMPETING INTERESTS: The authors do not report any competing personal or financial interests related to this work.

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