Available online at www.sciencedirect.com
ScienceDirect
journal homepage: www.JournalofSurgicalResearch.com

Trends of ureteral stent usage in surgery for diverticulitis

Alexander S. Chiu, MD,[a] *Raymond A. Jean, MD,*[a,b] *Jolanta Gorecka, MD,*[a] *Kimberly A. Davis, MD MBA,*[c] *and Kevin Y. Pei, MD*[c,*]

[a] *Department of Surgery, Yale School of Medicine, New Haven, Connecticut*
[b] *National Clinician Scholars Program, Department of Internal Medicine, Yale School of Medicine, New Haven, Connecticut*
[c] *Section of General Surgery, Trauma and Surgical Critical Care, Department of Surgery, Yale School of Medicine, New Haven, Connecticut*

ARTICLE INFO

Article history:
Received 1 August 2017
Received in revised form
8 September 2017
Accepted 29 September 2017
Available online xxx

Keywords:
Diverticulitis
Ureteral stent
Colorectal surgery

ABSTRACT

Background: Many believe that the use of ureteral stents in colorectal surgery for diverticulitis aids prevention and easier identification of ureteral injuries; others argue that the added time, cost, and risks of stent placement negate potential benefits. Even among providers who use stents, selective use is common. Among unclear consensus, it remains unknown if the use of stents is growing.
Materials: Patients in the National Inpatient Sample who underwent a partial colectomy or anterior rectal excision for diverticulitis between 2000 and 2013 were included ($n = 811,071$). Trends in ureteral stent use, multivariate logistic regression of factors influencing stent placement, and linear regression of length of stay (LOS) and costs associated with stent use were examined.
Results: Usage of ureteral stents increased from 6.66% in 2000 to 16.30% in 2013 ($P < 0.0001$). Rates of stent usage were higher with laparoscopic surgery (19.31% *versus* 12.31% open, $P < 0.0001$). Regression demonstrated patients in the Northeast (Midwest odds ratio (OR) 0.49 [0.37-0.66] $P < 0.0001$, South OR 0.60 [0.45-0.80] $P = 0.0004$, West OR 0.30 [0.22-0.41], $P < 0.0001$), and those whose admission was elective (OR 2.37 [2.08-2.69], $P < 0.0001$) were more likely to receive stents. Stent use was associated with an increased LOS (0.55 days, $P < 0.0001$) and cost ($1,983, $P < 0.0001$).
Conclusions: The use of ureteral stents in surgery for diverticulitis has steadily increased since 2000, despite the lack of consensus of their overall benefit. Stent usage is associated with laparoscopic surgery and varies widely among regions of the country. Further studies are required to truly understand the risk-benefit ratio of ureteral stenting and to determine if its increased use is warranted.

Introduction

Diverticulitis represents one of the most common conditions treated by general surgeons, accounting for approximately 300,000 surgical admissions annually.[1] The incidence of diverticulitis continues to rise and is the most common indication for colonic resection for benign disease.[2,3]

Diverticulitis is also a known risk factor for ureteral injury during colorectal surgery.[4,5] Owing to the significant inflammation and scarring associated with diverticulitis, ureteral

* *Corresponding author*. 330 Cedar Street, PO Box 208062, New Haven, CT 06520-8062. Tel.: +203 785-2572; fax: +203 785-3950.
E-mail address: kevin.pei@yale.edu (K.Y. Pei).

https://doi.org/10.1016/j.jss.2017.09.050

anatomy may be distorted, predisposing the ureter to injury. While ureteral injury is rare, recent data have shown the incidence to be less than 1%,[6-9] and as operations for diverticulitis have increased over time, many surgeons have begun using ureteral stents in both laparoscopic and open surgery.[9]

Data regarding the efficacy of ureteral stents in colorectal surgery are mixed and limited in scope. Although standard approach to colectomies involves identification of the ureters based on anatomic landmarks, some believe that stenting may aid in identifying the ureters intraoperatively, both visually and tactilely.[5,10,11] However, there is no definitive evidence of the benefits of stent placement on patient outcomes, and to date, there have been no randomized controlled trials examining this question. Furthermore, some have argued that the associated additional costs and increased operative time outweigh the potential benefits.[4,12] Among this controversy, ureteral stenting is generally left to the discretion of the surgeon, often differing from clinician to clinician. Significant variability in practice patterns can occur even within a single institution. In this study, we sought to characterize trends in ureteral stenting for colorectal surgery at a national level, as well as to identify the relation of ureteral stenting to length of stay (LOS) and cost in partial colectomies for diverticulitis.

Materials and methods

Data source

The Healthcare Cost and Utilization Project's (HCUP) Nationwide Inpatient Sample (NIS) data set represents the largest publicly available all-payer data set in the United States, comprising several million discharges across the country.[13] Data between the years of 2000 and 2013 were used for this study. Before 2012, the NIS was composed of a 20% stratified sample of US nonfederal short-term and other specialty hospitals, which can be used to make nationally representative estimates of health care utilization trends and outcomes.[14] In 2012, the sampling format was changed to a stratified sample of all discharges across NIS hospitals. All investigators with access to the data have a signed data-user agreement with HCUP.

Data selection

The NIS includes information at the level of individual hospital discharges, including up to 25 *International Classification of Disease, ninth Revision, Clinical Modification* (ICD-9-CM) diagnosis codes and 15 ICD-9-CM procedure codes. Discharges of interest were identified by searching for ICD-9-CM diagnosis codes for diverticulitis (ICD-9-CM 562.11 or 562.13), with concomitant procedure codes for open partial colectomy (ICD-9-CM procedure code 45.7 without laparoscopic code 54.21), laparoscopic partial colectomy (ICD-9-CM procedure code 17.3 or 45.7 with laparoscopic code 54.21), or anterior rectal excision (ICD-9-CM procedure codes 486.2, 486.3, or 486.9). Discharges were separated into cohorts of stenting and nonstenting based on the presence of a procedural code for ureteral catheterization (ICD-9-CM procedure code 59.8). Before 2009, ICD-9 CM procedure coding did not consistently distinguish between open and laparoscopic partial colectomies. For this reason, we excluded data in years before 2009 from our analysis of surgical approach.

To facilitate the manipulation of multiple ICD-9-CM diagnosis or procedure codes simultaneously, HCUP designed Clinical Classification Software (CCS) codes, which categorize multiple codes into a single diagnosis group. These are used to identify exclusion diagnosis or procedure-based exclusion criteria. Discharges were excluded if the patient had a diagnostic code for nephrolithiasis (CCS code 160) or a diagnostic code for a gastrointestinal malignancy (CCS codes 12-18). Other exclusion criteria were age less than 18 years or greater than 90 years; missing information for the variables of gender, discharge disposition, and in-hospital mortality; evidence of multiple colectomies in a single hospitalization; or evidence that the colectomy or ureteral stenting occurred before the current hospitalization.

Patient age was organized into categorical variables to facilitate analysis. Age was grouped as 18-40 years, 41-60 years, 61-80 years, and 81-90 years. Race was grouped using collapsed Agency for Healthcare Research and Quality (AHRQ) classifications of "white," "black," "Hispanic," "Asian/Pacific Islander," "other," or "missing." Given the high percentage of missing race data in the NIS (18.5%), this variable was not used as a predictor in any regression models. The Deyo adaptation of the Charlson Comorbidity Index (CCI) was used to capture overall comorbidity[15] and was grouped as 0, 1, or 2+. Given the range of severity in the presentation of acute diverticulitis and its impact on perioperative decision-making, we used the HCUP admission modifiers to classify discharges as either emergent or elective.

Hospital volume determination

To examine the impact of hospital volume on ureteral stenting for colonic excision and outcomes, we separated hospitals into cohorts of low, medium, and high volume. Hospital volume was calculated by first identifying the number of colectomies performed over the period studied, then calculating the unweighted average frequency of procedures performed by each hospital over the number of years the hospital was sampled. We next calculated terciles of hospital volume by average annual case volume and assigned volume designation of low volume (<20 cases/year), medium volume (20-40 cases/year), and high volume (>40 cases/year). Due to changes in the hospital sampling methodology after the 2012 NIS dataset, these years were excluded from regression analysis that included hospital volume.

Statistical analysis

Primary outcomes were LOS and total hospitalization costs. LOS was determined as the entire hospitalization, including time spent in the hospital preoperatively. Hospital costs were generated using cost-to-charge ratio files, provided by HCUP.[16] Costs were adjusted to 2013 United States dollars (USD) using National Bureau of Labor Statistics inflation calculators.[17]

All final analyses utilized stratified cluster sampling methods, consistent with the survey design of the NIS and as detailed in the NIS documentation.[13] Differences between groups were compared using chi-squared test for categorical