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General Research

Trends in the Treatment of Adults with Ureteropelvic Junction Obstruction

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Abstract

Background and Purpose: Minimally invasive pyeloplasty is an effective treatment for patients with ureteropelvic junction obstruction that offers quicker convalescence than open pyeloplasty. Technical challenges, however, may have limited its dissemination. We examined population trends and determinants of surgical options for ureteropelvic junction obstruction.

Patients and Methods: Using the State Inpatient and Ambulatory Surgery Databases for Florida, we identified adults who underwent ureteropelvic junction obstruction repair between 2001 and 2009. After determining the surgical approach (minimally invasive pyeloplasty, open pyeloplasty, or endopyelotomy), we estimated annual utilization rates and the effects of patient, surgeon, and hospital predictors on surgery type, using multilevel multinomial logistic regression.

Results: Rates of minimally invasive pyeloplasty increased 360% (P for monotonic trend < 0.01), while rates of open pyeloplasty decreased 56% ($P < 0.01$). Rates of endopyelotomy were substantially higher and remained relatively stable ($P = 0.27$). Compared with open pyeloplasty, minimally invasive pyeloplasty was used more commonly among patients with private insurance (odds ratio [OR] 1.6; 95% confidence interval [CI], 1.2–2.3), those treated at teaching hospitals (OR 1.6; CI 1.0–2.6), and those treated by high-volume surgeons (OR 2.9; CI 2.0–4.2). Its use was less frequent among patients with multiple comorbidities (OR 0.53; CI 0.37–0.76). Similar associations were observed when comparing receipt of minimally invasive pyeloplasty with endopyelotomy; however, patients who underwent endopyelotomy were older.

Conclusions: The use of minimally invasive pyeloplasty has dramatically increased, largely replacing open pyeloplasty, while the use of endopyelotomy, albeit significantly more common than the other approaches, has remained stable. The surgical approach is influenced by several patient, surgeon, and hospital factors.

Introduction

Minimally invasive pyeloplasty is an effective treatment for patients with ureteropelvic junction obstruction that offers quicker convalescence,[1] decreased postoperative pain,[1,2] and improved cosmesis[3] compared with the conventional open pyeloplasty. With success rates greater than 90%, minimally invasive pyeloplasty has equivalent outcomes to those of open pyeloplasty[4] and superior outcomes to those of endopyelotomy.[5]

Despite these advantages, technical challenges may have limited the uniform dissemination of minimally invasive pyeloplasty. Laparoscopy has a steep learning curve, and intracorporeal suturing is difficult.[5,6] Formal laparoscopic training is less prevalent in the urologic community, which manifests as a lower utilization of minimally invasive pyeloplasties in this setting, compared with that in the academic setting.[6–8] Although the advent of robotic surgery has mitigated some of these challenges by reducing the learning curve,[5,9] its upfront expense (ie, capital investment of $1 million–$2.25 million[10]) impedes its widespread adoption. Previous studies demonstrate that minimally invasive techniques for upper urinary tract procedures are influenced not only by patient characteristics, but also by surgeon- and hospital-level factors.[11,12] The degree to which these factors have affected the adoption of minimally invasive pyeloplasty remains unclear, however.

For these reasons, we performed a study to characterize the use of various treatments for ureteropelvic junction obstruction and identify patient, surgeon, and hospital determinants

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of the surgical approach. In doing so, our analysis identifies possible targets for intervention to hasten minimally invasive pyeloplasty's uptake in the community.

Patients and Methods

Data source and study population

We used the Healthcare Cost and Utilization Project's State Inpatient and Ambulatory Surgery Databases for Florida to identify adults (18 years or older) who underwent ureteropelvic junction obstruction repair between 2001 and 2009. These two databases provide patient-level discharge data for 100% of the patients from facilities in the state.[13,14] Data from Florida were chosen for two reasons. First, Florida is the fourth most populous state[15] and is racially and ethnically diverse. Second, the Florida files capture the spectrum of practice settings.[16] Hospital characteristics were obtained by linking these databases to the American Hospital Association Survey, which contains an abundance of hospital-level data, including information about teaching status and control or ownership of the hospital (ie, hospital type).

We first identified inpatient procedures of interest (ie, open pyeloplasty and minimally invasive pyeloplasty) using *International Classification of Diseases,* 9th Revision, Clinical Modification (ICD-9) procedure codes. Patients who underwent a pyeloplasty during their hospital stay (ICD-9 55.87) were categorized as having an open pyeloplasty. To account for the lack of a specific procedure code for minimally invasive pyeloplasty, we applied a validated algorithm[17] to distinguish minimally invasive and open surgical approaches. In addition, we used the nonspecific ICD-9 code for laparoscopic robot-assisted procedure (17.42), which became available in 2008. There was only one minimally invasive pyeloplasty attributed to this ICD-9 code in 2008 and 26 in 2009, which alleviated concerns that this code detected a significant number of minimally invasive pyeloplasties that would have otherwise gone unreported. Next, we identified endopyelotomies in the State Ambulatory Surgery Database using the *Current Procedural Terminology,* 4th Edition codes 50575, 52342, 52345, and 52346. Using these criteria, our study population consisted of 565 minimally invasive pyeloplasties, 850 open pyeloplasties, and 1841 endopyelotomies.

Outcomes

Our primary outcome was the surgical approach used for ureteropelvic junction obstruction (ie, minimally invasive pyeloplasty, open pyeloplasty, or endopyelotomy). We assessed the associations between this outcome and several patient, surgeon, and hospital characteristics. A teaching hospital was defined as one that is a member of the Council of Teaching Hospitals, has an Accreditation Council for Graduate Medical Education approved residency program, or has a ratio of full-time equivalent interns and residents to beds of 0.25 or higher.[18] Hospital type was categorized as government, nongovernment nonprofit, or nongovernment for-profit. To determine surgeon volume for each patient, we identified the number of ureteropelvic junction obstruction procedures performed by the patient's surgeon in the year of the patient's surgery. Surgeon volume was categorized into three groups: Low (≤ 2), intermediate (3–4), and high (≥ 5).

Statistical analysis

We estimated the annual rate of each surgical approach and tested for monotonic trends using Poisson regression. Next, we examined differences among patients who received minimally invasive pyeloplasty *vs* those who received open pyeloplasty or endopyelotomy, using chi-square tests. Specifically, we compared a variety of demographic characteristics, urologist surgical volume, and properties of the hospital at which patients were treated. The adjusted effects of these characteristics were estimated using a multilevel multinomial logistic model,[19] which accounted for the three unordered categories (the surgical alternatives) as well as the nesting of patients within hospitals. The model included covariates for age, sex, race, primary payer, neighborhood socioeconomic status, comorbidity, hospital type, hospital teaching status, surgeon volume, and year of treatment.

Neighborhood socioeconomic status was derived from block-level census data on wealth, income, education, and occupation, using the method of Diez Roux and associates.[20] Comorbidity was measured by using the adaptation of the Charlson index by Deyo and colleagues[21] in which ICD-9 diagnosis and procedure codes were used to note the presence or absence of 16 comorbid conditions. All analyses were performed using SAS v9.2 (Cary, NC). The probability of a type I error was set at 0.05, and all testing was two-sided. The Institutional Review Board of the University of Michigan approved the study protocol.

Results

From 2001 to 2009, rates of minimally invasive pyeloplasty increased 360% (P for monotonic trend < 0.01), while those of open pyeloplasty decreased 56% ($P < 0.01$) (Fig. 1). By 2008, rates of minimally invasive pyeloplasty surpassed open pyeloplasty. Throughout the study, rates of endopyelotomy were substantially higher than those of both minimally invasive pyeloplasty and open pyeloplasty; however, they remained relatively stable ($P = 0.27$). Similarly, the rates of all three surgeries combined remained stable throughout the study period ($P = 0.54$).

There were significant case mix differences across the three surgical approaches (Table 1). Compared with those undergoing open pyeloplasty or endopyelotomy, patients undergoing minimally invasive pyeloplasty were more frequently younger, male, and nonwhite. Further, those treated with minimally invasive pyeloplasty more often had private insurance, lived in higher socioeconomic status neighborhoods, and had no comorbidities.

As with patient characteristics, hospital characteristics differed among the three surgical approaches (Table 2). Minimally invasive pyeloplasties were more frequently performed in nongovernment, for-profit hospitals and in teaching hospitals.

The frequency of procedure type by surgeon volume is illustrated in Figure 2. The proportion of surgeries performed by minimally invasive pyeloplasty was 43% for high-volume surgeons, 14% for intermediate-volume surgeons, and 10% for low-volume surgeons ($P < 0.01$). Among low- and intermediate-volume surgeons, endopyelotomy was the predominant procedure.

Results from the multinomial logistic regression analysis (Table 3) demonstrate that, compared with open pyeloplasty, minimally invasive pyeloplasty was used more commonly among patients with private insurance (odds ratio [OR] 1.6;

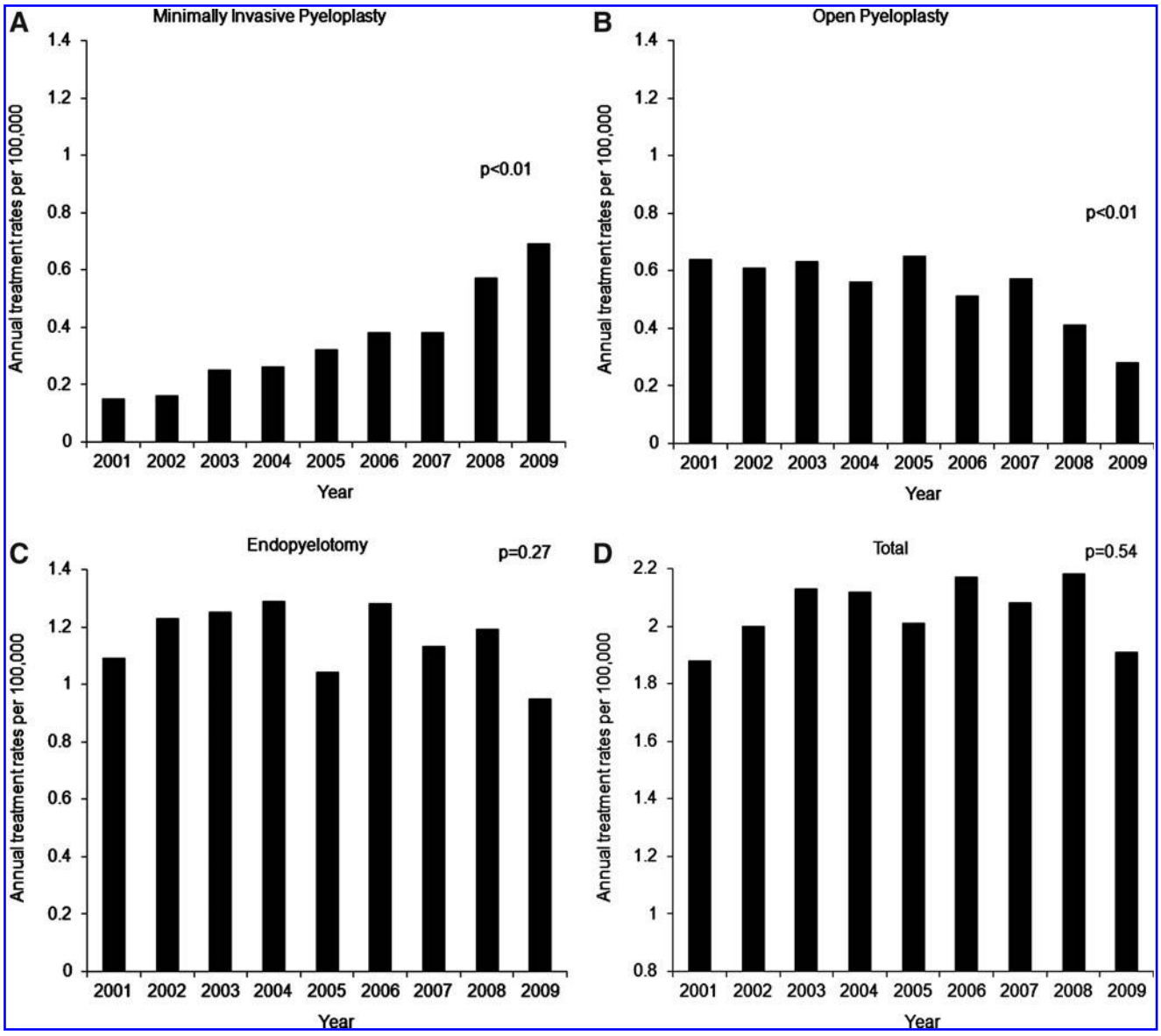

FIG. 1. Trends in the treatment of ureteropelvic Junction obstruction. **(A)** Minimally invasive pyeloplasty; **(B)** open pyeloplasty; **(C)** endopyelotomy; **(D)** total.

95% confidence interval [CI], 1.2–2.3), those treated at teaching hospitals (OR 1.6; 95% CI, 1.0–2.6), and those treated by high-volume surgeons (OR 2.9; 95% CI, 2.0–4.2). Its use was less frequent among patients with multiple comorbidities (OR 0.53; 95% CI, 0.37–0.76). Similar associations were observed when comparing receipt of minimally invasive pyeloplasty to endopyelotomy; however, patients who underwent endopyelotomy tended to be older. By 2005, the odds of receiving a minimally invasive pyeloplasty, relative to either an open pyeloplasty or endopyelotomy, was at least twofold higher than in 2001 and continued to increase substantially throughout the study period.

Discussion

Over the past decade, the use of minimally invasive pyeloplasty has dramatically increased, largely replacing open pyeloplasty, while the use of endopyelotomy, albeit significantly more common than the other two approaches, has remained relatively stable. The total rate of surgery for ureteropelvic junction obstruction has remained stable during this time. The surgical approach is influenced by several patient, provider, and hospital factors. We found that patients with private insurance, patients treated by high-volume surgeons, and patients treated at teaching hospitals receive minimally invasive pyeloplasties more frequently than either open pyeloplasties or endopyelotomies.

Although the rate of minimally invasive pyeloplasty has substantially increased, its dissemination varies, depending on patient, surgeon, and hospital factors. Adjusting for other covariates, patients undergoing minimally invasive pyeloplasty tended to be younger than patients undergoing endopyelotomy. Although not as effective,[5] endopyelotomy is an attractive option for older patients who may benefit from the least invasive approach.[22] A more concerning finding, however, is that patients with private insurance are more

Table 1. Frequency Distributions (%) of Selected Characteristics in Adult Patients, by Type of Treatment for Ureteropelvic Junction Obstruction

Characteristic	*Minimally invasive pyeloplasty N = 565*	*Open pyeloplasty N = 850*	*Endopyelotomy N = 1841*	P *value*
Patient age, years				< 0.01
18–44	57	50	30	
45–64	29	30	34	
65 +	14	20	36	
Sex				0.02
Female	55	61	61	
Race[a]				< 0.01
White	76	80	83	
Nonwhite	24	20	17	
Primary payer[b]				< 0.01
Nonprivate	27	41	47	
Private	73	59	53	
Socioeconomic status[c]				< 0.01
Low	33	38	32	
Medium	29	32	35	
High	38	30	33	
Comorbidity				< 0.01
0	86	74	80	
1 +	14	26	20	

[a]35 patients with missing race.
[b]5 patients with missing primary payer.
[c]104 patients with missing socioeconomic status.

likely than patients without private insurance to receive minimally invasive pyeloplasties relative to open pyeloplasties or endopyelotomies. This finding may stem from the increasing number of robotic platforms in recent years[23] and the subsequent increase in the use of robot-assisted laparoscopic pyeloplasties.[24] Robotic equipment requires a substantial initial investment.[10] To recoup those costs, hospitals may preferentially treat patients who have a favorable payer-mix with this expensive technology. For instance, a single-institutional study found that robot-assisted laparoscopic prostatectomy was a money-losing proposition across all payers, but it incurred the least debt when performed on patients with private insurance.[25] Alternatively, payer status may relate to patient access to hospitals that provide new technologies. In light of the advantages of minimally invasive pyeloplasty, this disparity in utilization based on payer status has quality-of-care implications for patients without private insurance.

Along these same lines, the disproportionate use of minimally invasive pyeloplasty by teaching hospitals has implications for patients as well. Our study supports previous findings that physicians in academic settings are more likely to perform minimally invasive pyeloplasties.[6–8] In part, this reflects the higher proportion of surgeons at academic centers who are laparoscopically trained and the types of hospitals investing in new, expensive technologies.[8] The estimated effect of teaching *vs* a nonteaching hospital does not appear to be explained by differences in surgeon volume.

Nonetheless, regardless of the setting, minimally invasive pyeloplasties are performed primarily by high-volume surgeons. Forty-three percent of high-volume surgeons used the minimally invasive approach, compared with only 14% and 10% of intermediate- and low-volume surgeons. This finding underscores the technical demands and learning curve associated with minimally invasive pyeloplasty.[5,6] Further, pyeloplasties are not common procedures, and surgeons who do not see a large volume of these patients may be less inclined to learn new and challenging techniques.[26] At the same time, the ability of robotic surgery to reduce the learning curve[9] may help the diffusion of minimally invasive pyeloplasties by attracting lower-volume surgeons. Conversely, endopyelotomies represent the predominant procedure performed by lower volume surgeons, largely because they are technically easier and less morbid compared with pyeloplasties.[22]

These findings, along with endopyelotomy's inferior success rates to both open and minimally invasive pyeloplasty,[22] suggest that endopyelotomy may be overused. Although there is a definite role for endopyelotomies among a specific patient population and for secondary repairs,[27] 64% of patients in our study were younger than 65 years, 80% had no comorbidities, and the rates of endopyelotomy were often twice as high as those for either of the pyeloplasty approaches. Similarly, even though the rate of minimally invasive pyeloplasty has increased over the past 10 years, its utilization compared with other treatments for ureteropelvic junction obstruction appears to be affected by the patient's primary payer, the teaching status of the hospital, and the annual number of cases performed by the surgeon.

These findings should be interpreted in the context of several limitations. First, for the study period, patient information was available only at the discharge level. Thus, we could not follow patients over time and assess long-term outcomes. Further, the context of the procedure (eg, a primary or secondary repair)

Table 2. Frequency Distribution (%) of Selected Hospital Characteristics for Adult Patients, by Type of Treatment for Ureteropelvic Junction Obstruction

Characteristics	*Minimally invasive pyeloplasty N = 565*	*Open pyeloplasty N = 850*	*Endopyelotomy N = 1841*	P *value*
Hospital type[a]				0.01
Government	17	14	13	
Nongovernment, nonprofit	43	59	53	
Nongovernment, for-profit	40	27	34	
Teaching *vs* nonteaching hospital[a]	75	54	42	0.01

[a]In all, 200 cases with missing hospital type and teaching status.

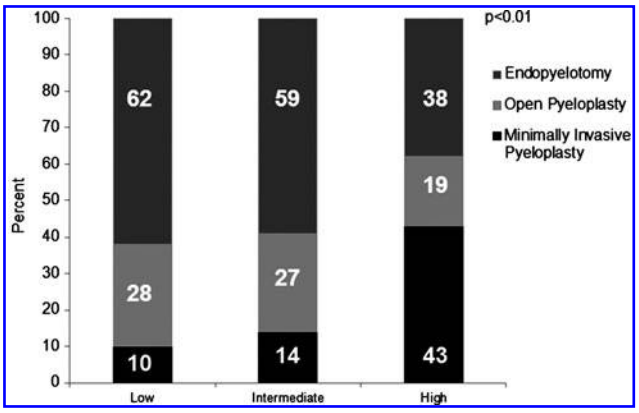

FIG. 2. Frequency distribution (%) of treatment for ureteropelvic junction obstruction, by the surgeon's annual volume of ureteropelvic junction obstruction procedures (low, ≤2; inermediate, 3–4; and high, ≥5).

could not be determined. Given the high success rates of both minimally invasive[5] and open pyeloplasties,[28] however, the number of secondary repairs (eg, endopyelotomies) will be relatively low. Despite the inability to track patients longitudinally, this study provides a population-based assessment of the trends in treatment of ureteropelvic junction obstruction repair and factors associated with surgical approach. Second, our study is limited by the lack of a specific procedure code for minimally invasive pyeloplasty. Given the advent of the robot-assisted laparoscopic pyeloplasty at the turn of the century, however, the simultaneous decline in the rate of open pyeloplasties, and the relative stability in the total number of procedures, we believe our results accurately depict a substantial, yet uneven, dissemination of minimally invasive pyeloplasty. Third, we do not know the extent to which our findings from Florida can be generalized to other states or the entire country. Although Florida has a large, diverse population and numerous hospitals and ambulatory surgery centers, our findings will need to be replicated in other populations.

Over the past decade, the rates of minimally invasive pyeloplasty have risen dramatically, surpassing the rates of open pyeloplasty. Reasons for this may include the improved technical feasibility with robot-assisted surgery compared with laparoscopy, the greater comfort in performing minimally invasive pyeloplasties among the younger generation of urologists, or the conviction that minimally invasive pyeloplasties produce better outcomes. Regardless of the reasons, its dissemination is not occurring uniformly in the general population; minimally invasive pyeloplasties are performed more frequently among patients with private insurance, those treated at teaching hospitals, and those cared for by high-volume surgeons. Future studies are warranted to evaluate how the expense of robotic technology, in particular, influences the treatment pattern of minimally invasive pyeloplasty.

Conclusions

During the study period, the use of minimally invasive pyeloplasty has dramatically increased, largely replacing open pyeloplasty, while the use of endopyelotomy, albeit significantly more common than the other two approaches, has remained relatively stable. The total rate of surgery for ureteropelvic junction obstruction has remained stable during this time. The surgical approach is influenced by several patient, provider, and hospital factors.

Table 3. Estimated Effect (Adjusted Odds Ratio* and 95% Confidence Interval) of Each Predictor on the Use of Minimally Invasive Pyeloplasty *vs* Open Pyeloplasty or Endopyelotomy: Results of a Multilevel, Multinomial Logistic Regression Analysis

Predictor	*Minimally invasive pyeloplasty* vs *open pyeloplasty*	*Minimally invasive pyeloplasty* vs *endopyelotomy*
Patient age, years		
18–44	1	1
45–64	0.93 (0.68–1.3)	0.45 (0.34–0.61)
65+	1.2 (0.77–1.9)	0.35 (0.23–0.53)
Sex		
Female	1	1
Male	1.3 (0.98–1.7)	1.2 (0.94–1.6)
Race		
White	1	1
Nonwhite	0.76 (0.54–1.1)	0.83 (0.60–1.2)
Primary payer		
Nonprivate	1	1
Private	1.6 (1.2–2.3)	1.5 (1.1–2.1)
Socioeconomic status		
Low	1	1
Medium	1.1 (0.78–1.5)	0.87 (0.64–1.2)
High	1.1 (0.77–1.5)	0.85 (0.62–1.2)
Comorbidity		
0	1	1
1+	0.53 (0.37–0.76)	0.99 (0.70–1.4)
Hospital type		
Government	1	1
Nongovernment, nonprofit	0.54 (0.27–1.1)	0.66 (0.31–1.4)
Nongovernment, for-profit	0.86 (0.42–1.8)	0.93 (0.43–2.0)
Teaching hospital		
No	1	1
Yes	1.6 (1.0–2.6)	2.9 (1.7–4.8)
Surgeon volume		
Low	1	1
Intermediate	1.6 (1.1–2.2)	1.6 (1.2–2.2)
High	2.9 (2.0–4.2)	2.5 (1.7–3.6)
Year		
2001	1	1
2002	0.83 (0.39–1.7)	0.82 (0.39–1.7)
2003	1.1 (0.56–2.3)	0.93 (0.47–1.9)
2004	1.6 (0.81–3.2)	1.4 (0.70–2.7)
2005	2.3 (1.2–4.6)	2.6 (1.4–5.0)
2006	3.7 (1.9–7.1)	2.9 (1.5–5.3)
2007	3.0 (1.6–5.9)	2.9 (1.5–5.3)
2008	7.1 (3.7–14)	4.6 (2.5–8.3)
2009	14 (7.1–25)	9.1 (4.8–17)

*The effect of each predictor was adjusted for all other predictors in the model.

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Disclosure Statement

No competing financial interests exist.

References

1. Bansal P, Gupta A, Mongha R, et al. Laparoscopic versus open pyeloplasty: Comparison of two surgical approaches—a single centre experience of three years. J Minim Access Surg 2008;4:76–79.
2. Bonnard A, Fouquet V, Carricaburu E, et al. Retroperitoneal laparoscopic versus open pyeloplasty in children. J Urol 2005;173:1710–1713.
3. Klingler HC, Remzi M, Janetschek G, et al. Comparison of open versus laparoscopic pyeloplasty techniques in treatment of uretero-pelvic junction obstruction. Eur Urol 2003; 44:340–345.
4. Siqueira TM Jr, Nadu A, Kuo RL, et al. Laparoscopic treatment for ureteropelvic junction obstruction. Urology 2002; 60:973–978.
5. Yanke BV, Lallas CD, Pagnani C, et al. The minimally invasive treatment of ureteropelvic junction obstruction: A review of our experience during the last decade. J Urol 2008; 180:1397–1402.
6. Marcovich R, Jacobson AI, Aldana JP, et al. Practice trends in contemporary management of adult ureteropelvic junction obstruction. Urology 2003;62:22–26.
7. Kim HL, Hollowell CM, Patel RV, et al. Use of new technology in endourology and laparoscopy by american urologists: Internet and postal survey. Urology 2000;56:760–765.
8. Tan BJ, Rastinehad AR, Marcovich R, et al. Trends in ureteropelvic junction obstruction management among urologists in the United States. Urology 2005;65:260–264.
9. Passerotti CC, Passerotti AM, Dall'Oglio MF, et al. Comparing the quality of the suture anastomosis and the learning curves associated with performing open, freehand, and robotic-assisted laparoscopic pyeloplasty in a swine animal model. J Am Coll Surg 2009;208:576–586.
10. Makarov DV, Yu JB, Desai RA, et al. The association between diffusion of the surgical robot and radical prostatectomy rates. Med Care 2011;49:333–339.
11. Hollingsworth JM, Krein SL, Dunn RL, et al. Understanding variation in the adoption of a new technology in surgery. Med Care 2008;46:366–371.
12. Miller DC, Saigal CS, Banerjee M, et al. Diffusion of surgical innovation among patients with kidney cancer. Cancer 2008; 112:1708–1717.
13. HCUP State Inpatient Databases (SID). Healthcare Cost and Utilization Project (HCUP). 2001–2009. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/sidoverview.jsp. Accessed October 9, 2012.
14. HCUP State Ambulatory Surgery Databases (SASD). Healthcare Cost and Utilization Project (HCUP). 2001–2009. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/sasdoverview.jsp. Accessed October 9, 2012.
15. Table 1. Intercensal Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2010 (ST-EST00INT-01). U.S. Census Bureau, 2011. http://www.census.gov/popest/data/intercensal/state/state2010.html. Accessed December 20, 2011.
16. Strope SA, Ye Z, Hollingsworth JM, et al. Weekend admission and treatment of patients with renal colic: A case of avoidable variation? Urology 2009;73:720–724.
17. Miller DC, Wei JT, Dunn RL, Hollenbeck BK. Trends in the diffusion of laparoscopic nephrectomy. JAMA 2006;295: 2480–2482.
18. Trinh QD, Bianchi M, Sun M, et al. Discharge patterns after radical prostatectomy in the United States of America. Urol Oncol 2011 Nov 17. Epub ahead of print.
19. Allison PD. Logistic Regression Using SAS: Theory and Application. Cary, NC: SAS Institute Inc, 1999.
20. Diez Roux AV, Merkin SS, Arnett D, et al. Neighborhood of residence and incidence of coronary heart disease. N Engl J Med 2001;345:99–106.
21. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992;45:613–619.
22. Brooks JD, Kavoussi LR, Preminger GM, et al. Comparison of open and endourologic approaches to the obstructed ureteropelvic junction. Urology 1995;46:791–795.
23. Duchene DA, Moinzadeh A, Gill IS, et al. Survey of residency training in laparoscopic and robotic surgery. J Urol 2006;176:2158–2167.
24. Braga LH, Pace K, DeMaria J, Lorenzo AJ. Systematic review and meta-analysis of robotic-assisted versus conventional laparoscopic pyeloplasty for patients with ureteropelvic junction obstruction: Effect on operative time, length of hospital stay, postoperative complications, and success rate. Eur Urol 2009;56:848–857.
25. Lotan Y, Bolenz C, Gupta A, et al. The effect of the approach to radical prostatectomy on the profitability of hospitals and surgeons. BJU Int 2010;105:1531–1535.
26. Richstone L, Kavoussi LR. Barriers to the diffusion of advanced surgical techniques. Cancer 2008;112:1646–1649.
27. Tan HJ, Ye Z, Roberts WW, Wolf JS. Failure after laparoscopic pyeloplasty: Prevention and management. J Endourol 2011;25:1457–1462.
28. Gögüs C, Karamürsel T, Tokatli Z, et al. Long-term results of Anderson-Hynes pyeloplasty in 180 adults in the era of endourologic procedures. Urol Int 2004;73:11–14.

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Abbreviations Used

CI = confidence interval
ICD-9 = *International Classification of Diseases*, 9th Revision, Clinical Modification
OR = odds ratio

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1. Mohamed Ismail, Hash Hashim. Pelvi-ureteric Junction Reconstruction 57-65. [Crossref]
2. Lai Weil R., Stewart Carrie A., Thomas Raju. 2017. Technology Based Treatment for UreteroPelvic Junction Obstruction. *Journal of Endourology* **31**:S1, S-59-S-63. [Abstract] [Full Text HTML] [Full Text PDF] [Full Text PDF with Links]
3. Jacobs Bruce L., Lai Julie C., Seelam Rachana, Hanley Janet M., Wolf J. Stuart Jr., Hollenbeck Brent K., Hollingsworth John M., Dick Andrew W., Setodji Claude M., Saigal Christopher S., for the Urologic Diseases in America Project. 2017. Variation in the Use of Open Pyeloplasty, Minimally Invasive Pyeloplasty, and Endopyelotomy for the Treatment of Ureteropelvic Junction Obstruction in Adults. *Journal of Endourology* **31**:2, 210-215. [Abstract] [Full Text HTML] [Full Text PDF] [Full Text PDF with Links]
4. Jacobs Bruce L., Seelam Rachana, Lai Julie C., Hanley Janet M., Wolf J. Stuart Jr., Hollenbeck Brent K., Hollingsworth John M., Dick Andrew W., Setodji Claude M., Saigal Christopher S., for the Urologic Diseases in America Project. 2017. Cost Analysis of Treatments for Ureteropelvic Junction Obstruction. *Journal of Endourology* **31**:2, 204-209. [Abstract] [Full Text HTML] [Full Text PDF] [Full Text PDF with Links]
5. Marshall C. Strother, Phillip Mucksavage. 2016. Minimally Invasive Techniques for the Management of Adult UPJ Obstruction. *Current Urology Reports* **17**:5. . [Crossref]
6. Hilary Zetlen, Kenn B. Daratha, Jonathan D. Harper, Hunter Wessells, Kenneth P. Roberts, John L. Gore. 2016. Hospital-level Variation in the Quality of Benign Inpatient Urologic Surgery. *Urology* **87**, 82-87. [Crossref]
7. Julian Hanske, Alejandro Sanchez, Marianne Schmid, Christian P. Meyer, Firas Abdollah, Florian Roghmann, Adam S. Feldman, Adam S. Kibel, Jesse D. Sammon, Joachim Noldus, Quoc-Dien Trinh, Jairam R. Eswara. 2015. Comparison of 30-day perioperative outcomes in adults undergoing open versus minimally invasive pyeloplasty for ureteropelvic junction obstruction: analysis of 593 patients in a prospective national database. *World Journal of Urology* **33**:12, 2107-2113. [Crossref]
8. Asim Ozayar, Justin I. Friedlander, Nabeel A. Shakir, Jeffrey C. Gahan, Jeffrey A. Cadeddu, Monica S.C. Morgan. 2015. Equivocal Ureteropelvic Junction Obstruction on Diuretic Renogram—Should Minimally Invasive Pyeloplasty be Offered to Symptomatic Patients?. *The Journal of Urology* **193**:4, 1278-1282. [Crossref]
9. Asim Ozayar, Monica S.C. Morgan, Justin I. Friedlander, Meghan Saumur, Govind Krishan, Jeffrey C. Gahan, Jeffrey A. Cadeddu. 2014. Prompt Management of Anastomotic Leak or Acute Obstruction after Minimally Invasive Pyeloplasty with Percutaneous Nephrostomy Preserves Outcomes. *The Journal of Urology* **192**:6, 1716-1719. [Crossref]
10. Riccardo Autorino, Christopher Eden, Alaa El-Ghoneimi, Giorgio Guazzoni, Nicolòmaria Buffi, Craig A. Peters, Robert J. Stein, Matthew Gettman. 2014. Robot-assisted and Laparoscopic Repair of Ureteropelvic Junction Obstruction: A Systematic Review and Meta-analysis. *European Urology* **65**:2, 430-452. [Crossref]
11. Paolo Fedelini, Paolo Verze, Clemente Meccariello, Davide Arcaniolo, Domenico Taglialatela, Vincenzo G. Mirone. 2013. Intraoperative and Postoperative Complications of Laparoscopic Pyeloplasty: A Single Surgical Team Experience with 236 Cases. *Journal of Endourology* **27**:10, 1224-1229. [Abstract] [Full Text HTML] [Full Text PDF] [Full Text PDF with Links]