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Original article

The incidence of unsuccessful partial nephrectomy within the United States: A nationwide population-based analysis from 2003 to 2015

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Abstract

Purpose: Partial nephrectomy (PN) remains underutilized within the United States and few reports have attempted to explain this trend. The aim of this study is to evaluate the nationwide incidence of unsuccessful PN and factors that predict its occurrence.

Methods: Using the Premier Healthcare Database, we retrospectively analyzed a weighted sample of 66,432 patients undergoing curative surgery for renal mass between 2003 and 2015. PN intent was denoted by presence of insurance claims for the administration of mannitol. Unsuccessful PN was defined as an event in which patients were administered mannitol but received radical nephrectomy. A multivariate logistic regression model was generated to identify factors predicting unsuccessful PN.

Results: Overall rates of unsuccessful PN declined from 33.5% to 14.5% since 2003. Conversion to radical nephrectomy occurred most frequently during laparoscopic (34.7%) and least frequently during robotic approach (13.6%). There was significant difference in the rate of unsuccessful PN between very high and very low volume surgeons (open: 39.4% vs. 13.3%, laparoscopic: 51.2% vs. 32.2%, and robot assisted: 27.1% vs. 9.4%, all $P < 0.001$). After adjustment for patient- and hospital-related factors, surgical approach (laparoscopic vs. open, odds ratio = 1.74, 95% CI: 1.31–2.30, $P < 0.001$) and annual surgeon volume (very high vs. very low, odds ratio = 0.27, 95% CI: 0.21–0.34 $P < 0.001$) were associated with unsuccessful PN.

Conclusions: Although the rate of unsuccessful PN appears to be declining, it still remains common for low volume surgeons and with the laparoscopic surgical approach. Further evaluation of its effect on health care outcomes is necessary.

Keywords: Nephrectomy; Mannitol; Laparoscopy; Robotic surgical procedures; Conversion to open surgery

1. Introduction

Partial nephrectomy (PN), when technically feasible, has been touted as an option for management of small renal tumors [1]. The postoperative renal preservation of PN has been shown to reduce the risk of chronic renal insufficiency and related cardiovascular mortality in all patients regardless of contralateral renal function [2–5]. Current guidelines now recommend PN as a first-line treatment for small, localized renal masses [6,7]. Radical nephrectomy (RN) for small renal masses should only be reserved for patients with a high-complexity tumor that is not technically amenable to PN or for whom PN may result in unacceptable morbidity [1].

Still, there is some reluctance by smaller, nonacademic hospitals to adopt this technically challenging surgery.

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Low-volume hospitals and surgeons especially have been found to have lower rates of PN use compared to their counterparts, which may suggest a pattern of suboptimal care for certain patients [8–11]. One possible explanation for the underutilization of PN is the occurrence of undocumented intraoperative conversion from PN to RN. Surgeon inexperience in PN or minimally invasive surgery, or both, increased tumor complexity, and patient comorbidity such as poor baseline renal function may all be potential risk factors for unsuccessful PN [12,13].

Unfortunately, there has been a dearth of literature evaluating the trends and risk factors of unsuccessful PN using nationally representative data. The prevailing studies are mostly from single institutions that are susceptible to surgeon reporting bias and hospital clustering. Moreover, few studies have examined the effect of provider inexperience or selection of minimally invasive surgery (laparoscopic or robot-assisted surgery) on rates of unsuccessful PN. As low volume, rural treatment centers provide care for a large percentage of US patients, further investigation is needed to explain their relatively high rates of RN utilization [9,14,15]. We thus sought to compare rates of conversion from PN to RN by provider volume and surgical approach using intraoperative mannitol administration as an indicator for nephron sparing intent.

2. Methods

2.1. Data source

The Premier Healthcare Database (Premier Inc., Charlotte, NC), was utilized to identify patients undergoing curative surgery for renal mass between January 2003 and December 2015. Nearly, 20% of all-payer inpatient discharges (approximately 50 million in aggregate) within the United States are captured by this dataset, but hospital-specific projection weights for each discharge provided by Premier Inc. allow for nationally representative estimates to be inferred. These weights were created using a stratified comparison of the patients within Premier's database to discharge data from all US hospitals that responded to the American Hospital Association Annual Survey. Similarly, adjustment was also made for hospital clustering to account for similarities in practice patterns within each center such as surgical technique or supportive care practices. A prior landmark study similarly harvested the Premier Healthcare Database to evaluate surgical trends further validating our methodology [16,17]. All numbers reported in this study refer to projected estimates and all data accessed were deidentified, exempting our study from Institutional Review Board approval.

2.2. Study cohort

Patients undergoing elective PN (55.4) or RN (55.51) for the treatment of a renal mass were identified using International Classification of Disease, Ninth Revision codes. Indications such as infection, trauma, and donor nephrectomy were excluded. A nationally representative cohort of 127,891 patients receiving PN and 354,130 RN in the United States were retrieved from Premier Healthcare Database between 2003 and 2015. The use of intraoperative mannitol was documented using billing codes. Patients without receipt of the mannitol were subsequently excluded. Our final cohort was comprised of 66,432 patients of whom 53,526 received PN and 12,906 received RN at 374 US hospitals.

2.3. Covariates

Patients characteristics included age, sex, race (white, black, and others), comorbidities (Charlson comorbidity index of 0, 1, or ≥2), and insurance status of the patients. Hospital characteristics included academic status of the hospital (teaching vs. nonteaching), bed size (<300, 300–500, or >500), and location (rural vs. urban). Annual hospital and surgeon PN volumes were calculated and presented as quintiles. Volumes at or below the 20th percentile for each index year were considered to be very low (<6 cases per hospital and <2 cases per surgeon annually) and volumes above the 80th percentile were considered to be very high (>33 cases per hospital and >11 cases per surgeon annually). The middle 60 percentile were combined into an intermediate category. Indeed, the terms very high volume surgeon and hospital may have distinct implications depending on practice setting; however, the nationally representative nature of our data includes both rural and nonteaching institutions allowing for broad generalizability of our conclusions within the United States.

2.4. Indicator for conversion

Mannitol is used for renal preservation during PN as it has been suggested to minimize ischemic or reperfusion injury [18]. Consequently, mannitol prescriptions during cases that result in RN likely were intended to be a partial resection. The most likely time of mannitol administration was found to be immediately before renal artery clamping, further suggesting that surgeries ending in RN with mannitol receipt were likely converted intraoperatively [18]. The conversion of PN to RN in our cohort was defined as an event in which patients received mannitol—suggesting PN intent—but were billed for RN. The term "unsuccessful" was used to describe cases of intraoperative conversion from intended PN to RN, denoted by the use of mannitol during RN. It does not, however, comment on the validity of the decision, as in many cases conversion may have actually been clinically indicated by intraoperative findings such as deep sinus fat invasion, positive margins, or significant tumor progression.

2.5. Statistical analysis

Baseline characteristics of successful and unsuccessful PN were evaluated for each surgical approach (open, laparoscopic, and robot assisted). The demographics of our study cohort were presented categorically and Pearson's chi-square test was used for comparison between groups. There were no missing data. The proportions of conversion from open, laparoscopic, and robot-assisted PN to RN were calculated and compared among the 3 hospital and surgeon volume subgroups using Pearson's chi-square analysis. A multivariate logistic regression model was created to identify predictors of unsuccessful PN in all patients and results were further stratified by patients of very high volume surgeons, and patients receiving surgery between 2012 and 2015. Rates of unsuccessful PN were finally trended over time for each surgical approach and depicted graphically. The low usage rate of minimally invasive surgery for PN near the beginning of the study period precluded inclusion of the initial years for both laparoscopic and robotic surgery. Statistical analyses were completed using two-sided tests, a significance level of <0.05 and Stata 14 Statistical Software (College Station, TX).

3. Results

Overall, there was a significant difference in the rate of unsuccessful PN among patients treated via the different surgical approaches (22.8% for open, 34.7% for laparoscopic, and 13.6% for robot assisted; $P < 0.001$). The Fig. depicts the trend in rates of unsuccessful PN by surgical approach since 2003. The rate of unsuccessful PN significantly declined from 32.6% to 16.3% for the open approach ($P < 0.001$) and from 17.7% to 13.1% for the robotic approach ($P = 0.001$). The rate for the laparoscopic approach fluctuated greatly over the course of the study period ($P = 0.183$). Patient demographics and hospital characteristics based on success of PN were presented in Table 1. Older and more comorbid patients had higher rates of conversion to RN. Conversely, surgeries resulting in conversion from PN to RN had similar mean operating room times (289 vs. 325 min; $P = 0.144$) but shorter hospital length of stays (3.8 vs. 5.3 d; $P < 0.001$) compared to successful nephron sparing surgeries. Converted nephrectomies also had lower rates of major complications (defined by the Clavien-Dindo classification), (3.7% vs. 6.6%; $P < 0.001$) and lower blood transfusion rates (20.0% vs. 31.4%; $P < 0.001$), likely due to the decreased complexity of the RN operation.

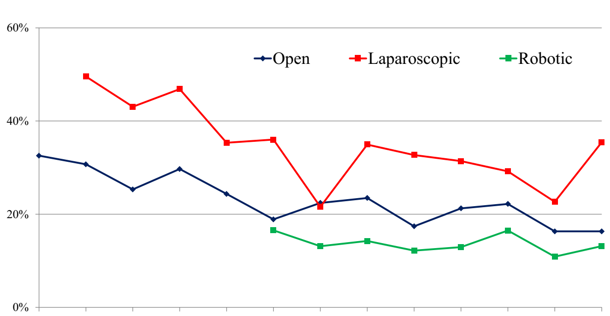

Fig. Trend in rates of unsuccessful partial nephrectomy by surgical approach between 2003 and 2015. (Color version of figure is available online.)

Table 2 describes the rate of conversion from open, laparoscopic, and robot-assisted PN to RN by provider volume. The median annual surgeon and hospital PN volumes were 5 (interquartile range: 2–10; range: 0–63), and 18 (interquartile range: 8–33; range: 0–114) cases, respectively. For all surgical approaches, the rate of unsuccessful PNs dropped significantly when patients were treated by very high volume hospitals and surgeons compared to their very low volume counterparts. This trend was most apparent for open surgery (35.6% vs. 18.9% for very low and very high volume hospitals and 39.4% vs. 13.3% for very low and very high volume surgeons, respectively).

In the multivariate analysis, independent factors associated with unsuccessful PN were old age, 2 or more comorbidities, hospitals with more than 500 beds, and the selection of laparoscopic over open surgery (laparoscopic vs. open, odds ratio [OR] = 1.74; 95% CI: 1.31–2.30; $P < 0.001$; Table 3). Surgeries conducted at hospitals with intermediate annual PN volume had 28% lower odds of resulting in conversion compared to very low volume hospitals (OR = 0.72; CI: 0.57–0.92; $P < 0.001$). Similarly, intermediate (OR = 0.33; CI: 0.28–0.39; $P < 0.001$) and very high volume surgeons (OR = 0.27; CI: 0.21–0.34; $P < 0.001$) had lower odds of conversion, respectively, compared to very low volume surgeons. These trends remained when only the years 2012 to 2015 were considered. Among just very high volume surgeons, those operating at teaching hospitals had lower odds of conversion while surgeons in rural centers had higher odds of unsuccessful PN. Even for very high volume surgeons, laparoscopic surgery was associated with significantly higher odds of conversion compared to open surgery (OR = 3.16; CI: 1.28–7.82; $P = 0.013$).

4. Discussion

The rate of unsuccessful PN appeared to decline for the open and robot-assisted surgical approaches between 2003 and 2015. Since its inception, robot-assisted PN has consistently required the lowest percentage of conversion to RN. As expected, older patients that suffered from more comorbidities had higher odds of unsuccessful PN. Conversely, higher annual volume hospitals and surgeons appeared to have lower odds. However, after adjustment for patient and hospital characteristics, surgeon volume appeared to be correlated more closely with success of

Table 1
Baseline characteristics of partial nephrectomies by surgical approach and occurrence of conversion to radical nephrectomy

	Open PN Conversion to RN		*P*	Laparoscopic PN Conversion to RN		*P*	Robot-assisted PN Conversion to RN		*P*
	No	Yes		No	Yes		No	Yes	
No. of patients	20,439	6,019		4,504	2,397		28,583	4,490	
Age (%)									
<55	6,642 (81.0)	1,559 (19.0)	<0.001	1,651 (75.3)	541 (24.7)	<0.001	9,065 (87.1)	1,342 (12.9)	0.015
55–64	6,102 (78.4)	1,679 (21.6)		1,366 (66.0)	705 (34.0)		8,782 (87.6)	1,246 (12.4)	
65–74	5,553 (75.4)	1,812 (24.6)		1,095 (65.0)	590 (35.0)		7,847 (86.2)	1,260 (13.8)	
>74	2,142 (68.9)	969 (31.1)		392 (41.1)	561 (58.9)		2,889 (81.8)	642 (18.2)	
Sex (%)									
Male	12,079 (76.7)	3,671 (23.3)	0.338	2,433 (62.8)	1,442 (37.2)	0.065	16,114 (84.7)	2,905 (15.3)	<0.001
Female	8,360 (78.1)	2,348 (21.9)		2,071 (68.5)	955 (31.5)		12,469 (88.7)	1,585 (11.3)	
Race (%)									
White	15,216 (77.3)	4,465 (22.7)	0.426	3,236 (64.7)	1,764 (35.3)	0.657	20,949 (86.8)	3,196 (13.2)	0.500
Black	2,094 (80.3)	514 (19.7)		364 (63.1)	213 (36.9)		2,505 (84.8)	450 (15.2)	
Others	3,129 (75.0)	1,040 (25.0)		904 (68.3)	420 (31.7)		5,129 (85.9)	844 (14.1)	
CCI (%)									
0	10,949 (79.7)	2,796 (20.3)	<0.001	2,494 (67.8)	1,186 (32.2)	0.009	16,192 (87.2)	2,386 (12.8)	0.012
1	4,731 (75.7)	1,523 (24.3)		1,145 (68.6)	524 (31.4)		7,426 (87.6)	1,054 (12.4)	
≥2	4,759 (73.7)	1,700 (26.3)		865 (55.7)	687 (44.3)		4,965 (82.5)	1,050 (17.5)	
Insurance status (%)									
Medicare	7,844 (72.9)	2,920 (27.1)	<0.001	1,484 (55.7)	1,180 (44.3)	<0.001	11,163 (85.7)	1,859 (14.3)	0.764
Medicaid	1,192 (84.4)	221 (15.6)		184 (66.8)	91 (33.3)		1,524 (86.5)	238 (13.5)	
Private	10,422 (80.5)	2,519 (19.5)		2,633 (73.0)	975 (27.0)		14,243 (87.0)	2,131 (13.0)	
Others	981 (73.2)	359 (26.8)		203 (57.4)	151 (42.6)		1,653 (86.3)	262 (13.7)	
Hospital type (%)									
Nonteaching	12,807 (75.9)	4,063 (24.1)	0.187	3,194 (65.1)	1,711 (34.9)	0.933	19,521 (86.7)	3,000 (13.3)	0.628
Teaching	7,632 (79.7)	1,946 (20.3)		1,310 (65.6)	686 (34.4)		9,062 (85.9)	1,490 (14.1)	
Hospital bed size (%)									
<300	4,274 (79.2)	1,123 (20.8)	0.082	995 (59.8)	669 (40.2)	0.548	6,600 (88.1)	894 (11.9)	0.206
300–500	8,271 (74.0)	2,907 (26.0)		1,853 (68.1)	869 (31.9)		12,432 (86.9)	1,877 (13.1)	
>500	7,894 (79.9)	1,989 (20.1)		1,656 (65.9)	859 (34.1)		9,551 (84.7)	1,719 (15.3)	
Hospital location (%)									
Rural	341 (79.1)	97 (20.9)	0.662	288 (86.0)	47 (14.0)	<0.001	560 (89.8)	63 (10.2)	0.190
Urban	20,098 (77.2)	5,922 (22.8)		4,216 (64.2)	2,350 (35.8)		28,023 (86.4)	4,427 (13.6)	

CCI = Charlson comorbidity index.

nephron sparing surgery than hospital volume. The selection of laparoscopic surgery, regardless of annual surgeon volume, resulted in higher odds of conversion to RN compared to open surgery. Furthermore, the index year of attempted PN did not significantly affect conversion probability despite hospitals and surgeons presumably becoming more comfortable with PN over time.

Our findings suggest that the rate of failed PN attempts across the United States was higher than previously described. A recent study from a very high volume, academic medical center reported that 32 of 1,023 (3.1%) robot-assisted PN attempts required conversion to RN between 2010 and 2015, lower than the 12.4% failure rate found among very high volume hospitals in our cohort [19]. However, a direct comparison of rates between these 2 studies may not be meaningful. Certainly, our definition of very high annual hospital volume is not relevant to a center of care that performs more than 170 PN cases per year on average. We feel that our conservative estimates are better representative of national rates within the United States, but the latter study's extremely low conversion rate further demonstrates the positive effect that hospital volume may have on PN success [11,14,15].

Unsurprisingly, nearly all literature evaluating success of PN is from high volume academic hospitals while little is known about most urologic practice across the country. The low conversion rates touted by the existing peer-reviewed studies may be masking the true nationwide prevalence of intraoperatively converted PN [12,20–23]. Our study includes outcomes of patients and hospitals from a nationally representative sample thus allowing for greater generalizability.

Despite the decreasing temporal trend of unsuccessful PN, possibly owing to improved residency training in nephron sparing technique, we found that very low volume hospitals and surgeons had unacceptably high rates of conversion to RN. In contrast, Kara and colleagues reported no association between surgeon robot-assisted PN volume and conversion, although their study utilized cumulative experience and also only evaluated surgeons within a single hospital that were highly skilled in PN [19]. The use of annual volume is better suited for this type of analysis as

Table 2
The number and percentage of unsuccessful partial nephrectomies for open, laparoscopic, and robot-assisted surgery by annual hospital and surgeon volume

	Open PN to RN	Laparoscopic PN to RN	Robot-assisted PN to RN
Annual hospital volume			
Very low (<6)	2,603 (35.6%)	1,080 (43.8%)	754 (21.4%)
Intermediate (6–33)	2,594 (17.5%)	1,075 (28.3%)	2,820 (13.0%)
Very high (>33)	822 (18.9%)	242 (38.0%)	916 (11.6%)
Total	6,019 (22.8%)	2,397 (34.7%)	4,490 (13.6%)
P	<0.001	0.026	<0.001
Annual surgeon volume			
Very low (<2)	3,541 (39.4%)	1,454 (51.2%)	1,239 (27.1%)
Intermediate (2–11)	2,086 (14.4%)	795 (22.1%)	2,347 (12.4%)
Very high (>11)	392 (13.3%)	148 (32.2%)	904 (9.4%)
Total	6,019 (22.8%)	2,397 (34.7%)	4,490 (13.6%)
P	<0.001	<0.001	<0.001

comparisons can be maximally standardized; for example, it may be difficult to differentiate between a young, high volume surgeon and an older surgeon who has not performed a PN in several years. Also, our study accounted for hospital clustering which potentially biases single institute studies [24]. Thus, the large, nationally representative nature of our dataset is better suited to uncover the association between surgeon volume and rate of conversion.

If disparity in the access to standard of care for renal masses truly exists among patients treated by varying levels of surgeon experience, there may be a need to investigate the effect on health care outcomes at the patient level. In addition to the loss of renal function and cardiovascular benefits afforded by the selection of PN, conversion to RN may be associated with longer operating times, increased blood loss, and worse postoperative renal function compared to nonconverted RN [12,19]. Hypertension was also found to be more common in patients requiring conversion from laparoscopic PN to laparoscopic RN [13]. Prospective, controlled trials would allow for a better understanding of the true risks of intraoperative conversion to RN, although it is already apparent that the underutilization of PN in itself may be a public health concern [2,8,25].

Still, it appears that regionalization of medical care to high volume centers and surgeons would not benefit all patients equally. In fact, among high volume surgeons, odds of conversion to RN when utilizing the laparoscopic approach were significantly higher than for the open approach. Ostensibly, patients receiving laparoscopic PN

Table 3
Multivariate logistic model identifying factors related with unsuccessful partial nephrectomy

	All patients		Very high volume surgeons		2012–2015	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Age (continuous)	1.01 (1.01–1.02)	<0.001	1.01 (1.00–1.02)	0.171	1.01 (1.01–1.02)	0.002
Sex (female vs. male)	0.84 (0.74–0.94)	0.004	0.81 (0.59–1.10)	0.174	0.78 (0.65–.94)	0.008
Race						
Black vs. white	1.02 (0.81–1.28)	0.889	1.35 (0.88–2.08)	0.165	1.16 (0.86–1.55)	0.327
Others vs. white	1.07 (0.85–1.36)	0.554	1.18 (0.78–1.78)	0.434	1.19 (0.80–1.77)	0.391
Charlson comorbidity index						
1 vs. 0	1.06 (0.94–1.20)	0.356	1.02 (0.74–1.39)	0.920	1.03 (0.84–1.27)	0.751
≥2 vs. 0	1.24 (1.05–1.45)	0.009	1.25 (0.82–1.91)	0.294	1.20 (0.80–1.78)	0.391
Insurance status						
Medicaid vs. Medicare	0.89 (0.63–1.26)	0.522	0.45 (0.23–0.90)	0.025	0.93 (0.59–1.46)	0.737
Private vs. Medicare	0.90 (0.77–1.06)	0.207	0.99 (0.73–1.34)	0.963	0.97 (0.78–1.21)	0.790
Others vs. Medicare	1.19 (0.91–1.57)	0.210	0.72 (0.37–1.39)	0.324	1.05 (0.74–1.51)	0.769
Hospital type						
Teaching vs. nonteaching	1.00 (0.78–1.29)	0.991	0.65 (0.44–0.97)	0.036	0.93 (0.72–1.19)	0.565
Hospital bed size						
300–500 vs. <300	1.22 (0.95–1.56)	0.118	0.89 (0.52–1.54)	0.684	1.20 (0.89–1.60)	0.239
>500 vs. <300	1.42 (1.07–1.90)	0.016	1.57 (0.97–2.56)	0.068	1.35 (0.99–1.86)	0.061
Hospital location						
Rural vs. urban	1.47 (0.96–2.25)	0.078	1.77 (1.01–3.08)	0.044	0.95 (0.62–1.46)	0.808
Surgery year (continuous)	0.96 (0.93–0.99)	0.006	1.01 (0.95–1.08)	0.669	0.93 (0.85–1.02)	0.139
Hospital volume						
Intermediate vs. very low	0.72 (0.57–0.92)	0.009	n/a[a]		0.72 (0.51–1.02)	0.065
Very high vs. very low	0.88 (0.59–1.29)	0.506	n/a[a]		0.88 (0.56–1.39)	0.579
Surgeon volume						
Intermediate vs. very low	0.33 (0.28–0.39)	<0.001			0.44 (0.34–0.56)	<0.001
Very high vs. very low	0.27 (0.21–0.34)	<0.001			0.33 (0.24–0.46)	<0.001
Surgical approach						
Laparoscopic vs. open	1.74 (1.31–2.30)	<0.001	3.16 (1.28–7.82)	0.013	1.71 (1.06–2.76)	0.029
Robotic vs. open	0.85 (0.67–1.10)	0.215	0.66 (0.41–1.04)	0.072	0.82 (0.56–1.18)	0.278

[a]No very high volume surgeons were associated with very low volume hospitals.

have fewer comorbidities and less tumor complexity making this finding even more surprising [26]. The intricacy of PN surgery and the limited maneuverability and ergonomics of the laparoscopic technique may be contributing to higher rates of conversion. Patients at risk for unsuccessful PN ought to be informed preoperatively especially when considering use of the laparoscopic approach. It is possible that the universal implementation of robotic PN may mitigate rates of "unsuccessful" PN while still offering a minimally invasive approach, as robotic PN conversion rates were lowest amongst all three groups analyzed.

There are several important limitations of our study that require consideration. Although the use of the Premier Healthcare Database allows for a large sample size, the retrospective nature of the dataset subjects our study to all biases associated with this methodology. Also, the lack of available tumor characteristics restrict our analysis to a comprehensive characterization rather than a comparison of outcomes between the treatment and control groups. The effect of tumor characteristics on our conclusions, though, is likely minimal as surgeons with very low annual volume or those selecting the laparoscopic approach are usually treating tumors with less complexity compared to high volume surgeons or surgeons utilizing the open or robot-assisted approach. Our novel use of mannitol for the identification of PN intent might also be imperfect. Patients who did not receive intraoperative mannitol were excluded from our analysis potentially limiting the representativeness of our findings. Nonetheless, there is no evidence to suggest that patients undergoing PN receive mannitol selectively. There still remains debate on the true utility of mannitol use during nephron sparing surgery, though it is administered in a substantial number of PNs each year [27,28]. We compared rates of mannitol administration in our cohort with those in the literature and found little difference [12,27]. Although other markers for conversion exist, such as cystoscopic insertion of ureteral catheter, intraoperative fluoroscopy, and intraoperative ultrasonography, these procedures had low sensitivity in identifying PN intent ($<2\%$ of all patients receiving PN) (Table S1). Mannitol administration remained the best indicator to identify intended PN among all cases analyzed.

5. Conclusions

The rate of intraoperative PN to RN conversion appears to be declining, but it remains prevalent for low volume hospitals and surgeons and for the laparoscopic surgical approach. Further evaluation of the effect of unsuccessful PN is required to determine if regionalization of care for patients with small renal masses is warranted.

Appendix A. Supporting Information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.urolonc.2017.08.014.

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