Performance of partial cystectomy in the United States from 2001 to 2010: trends and comparative outcomes

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FAIENA I, DOMBROVSKIY V, KOPROWSKI C, SINGER EA, JANG TL, WEISS RE. Performance of partial cystectomy in the United States from 2001 to 2010: trends and comparative outcomes. *Can J Urol* 2014;21(6):7520-7527.

Introduction: *To investigate the trends in the performance of radical cystectomy (RC) versus partial cystectomy (PC) in the United States over the past 10 years and compare postoperative outcomes between two procedures.*

Materials and methods: *The data was captured from the Nationwide Inpatient Sample (NIS) 2001-2010 using the appropriate ICD-9-CM diagnosis and procedure codes. Patient sociodemographics, comorbidities and in-hospital complications after PC and RC were compared, taking into account some hospital characteristics. A chi-square analysis including a Cochran-Armitage trend test and a multivariable logistic regression analysis were employed.*

Results: *RC rate increased from 84.8% in 2001 to 90.3% in 2010, while PC decreased from 15.2% to 9.7% ($p < 0.0001$). PC patients were older than their RC counterparts (72.1 ± 11.3 versus 68.6 ± 10.1 years; $p < 0.0001$), had higher prevalence of major comorbidities, but decreased rate of postoperative complications overall (21.3% versus 38.6%; $p < 0.001$). The greatest rates of PC utilization were found in the Northeast and South (12.8% and 12.7%). The frequency of PC was 18.9% in non-teaching hospitals compared to 9.0% in teaching hospitals ($p < 0.0001$). In multivariate analysis, females, octogenarians, patients with hypertension and obesity, and patients in non-teaching and rural hospitals were more likely to receive PC.*

Conclusions: *Despite the potential advantages in cancer control offered by RC, PC is being performed more frequently on the elderly, female patients, patients with hypertension and obesity, in non-teaching and rural hospitals, and in certain United States geographic regions, which can be partially explained by disparities in access to high volume cancer centers.*

Key Words: partial cystectomy, radical cystectomy, comparative outcomes, bladder cancer

Introduction

Bladder cancer is estimated to account for 74,690 incident cases and 15,580 cancer related deaths in 2014.[1] Although radical cystectomy (RC) remains the gold standard of treatment for muscle-invasive bladder cancer and high risk non-muscle-invasive tumors, partial cystectomy (PC) continues to be performed for limited indications. Classically, these indications include solitary tumors located in easily resectable areas such as the bladder dome without associated carcinoma in situ.[2] PC, which involves full-thickness excision of the bladder tumor together with pelvic lymph node dissection, provides pathological staging of the primary tumor and lymph nodes. Moreover, compared with RC, PC may decrease surgical morbidity, particularly by avoiding the need for urinary diversion, and preserves urinary and sexual function.[3] However, PC is considered to be associated

Accepted for publication October 2014

Acknowledgement
This work is supported by a grant from the National Cancer Institute (P30CA072720).

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with a higher risk of tumor recurrence and the need for secondary therapies, and has therefore been regarded as an inferior treatment option. Indeed, there has been concern regarding the overuse of PC, particularly in older patients and in non-teaching hospitals.[4] We investigated PC utilization trends in patients with bladder cancer in the United States from 2001 to 2010 and compared some patient and hospital characteristics and postoperative outcomes between groups with PC and RC.

Materials and methods

Data source

The data for this analysis was captured from the United States Healthcare Cost and Utilization Project Nationwide Inpatient Sample (NIS) 2001-2010, sponsored by the Agency for Healthcare Research and Quality. The NIS is the largest publicly available all-payer database of inpatient stays in the United States community hospitals, containing data for approximately 20% of all hospitalizations in the nation and providing opportunity to calculate national estimates.[5]

Study cohort

Patients 40-year-old or older with bladder cancer as a principal diagnosis were selected with the ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification) diagnosis codes 188.0-188.6, 188.8-188.9 (Malignant neoplasm of bladder), and 233.7 (Carcinoma in situ – Bladder). To identify surgical procedures, we used ICD-9-CM procedure code 57.6 for PC and 57.71 for RC in any procedure position in the data. Patients' sociodemographic information included age, gender, race, insurance status, and year of hospitalization. Hospital-specific characteristics encompassed geographic region (based on United States census regions), hospital location (rural versus urban), and teaching status (teaching versus non-teaching).

Comorbidities and postoperative complications

Among 29 Agency for Healthcare Research and Quality (AHRQ) comorbidity measures that are presented in the NIS database, we selected for analysis congestive heart failure, hypertension, chronic pulmonary disease, pulmonary circulation disease, diabetes with and without chronic complications, renal failure, and obesity. Postoperative complications (cardiac including myocardial infarction, respiratory and pneumonia, renal and acute renal failure, sepsis and bloodstream infection, surgical site infection, peritonitis and bleeding) were identified with the ICD-9-CM diagnosis codes in Table 1.

Statistical analysis

SAS 9.4 software (SAS Institute, Cary, NC, USA) was employed for data analysis and statistics. All parameters were estimated using the NIS weighting function. Differences between categorical variables in two groups were tested by the chi-square test with odds ratio (OR) and 95% confidence interval (95% CI) calculations. To exclude the potential effect of various confounders, a multivariable logistic regression analysis with forward stepwise selection was utilized with adjustment for patient's sociodemographic characteristics and comorbidities, hospital characteristics and the type and year of the surgical procedure. The Cochran-Armitage

TABLE 1. **ICD-9 codes for postoperative complications**

Complication	**Diagnostic codes**
Cardiac including myocardial infarction	997.1, 410.00-410.02, 410.10-410.12, 410.20-410.22, 410.30-410.32, 410.40-410.42, 410.50-410.52, 410.60-410.62, 410.70-410.72, 410.80-410.82, 410.90-410.92, and 427.5
Respiratory and pneumonia	997.3x, 480.x, 481, 482.0-482.2, 482.3x, 482.4x, 482.8x, 482.9, 483.x, 484.x, 485, 486, 507.0, 512.1, 518.4, 518.5, 518.81, and 518.82
Renal and acute renal failure	997.5, 584.x, and 593.81
Sepsis and bloodstream infection	038.0, 038.1x, 038.2, 038.3, 038.4x, 038.8, 038.9, 995.91, 995.92, 998.0, 785.52, 996.61, 996.62, and 999.3x
Surgical site infection (SSI)	998.5x, 998.30- 998.32, and 998.83
Peritonitis	567.1, 567.2x, 567.3x
Bleeding	285.1 and 998.11-998.12

trend test was used for trend-analysis over time. P < 0.05 was considered statistically significant. The study was approved by the Rutgers Robert Wood Johnson Medical School Institutional Review Board.

Results

We estimated 86,067 cystectomies performed for bladder cancer in the United States in 2001-2010. As Table 2 demonstrates, RC significantly predominated over PC (p < 0.0001). Patients with PC were significantly older than those with RC; the proportion of patients aged 80+ in this group was over twice that of the RC group. Females were significantly more likely to have PC than males (OR = 1.9; 95%CI 1.82-2.00). The majority of the patients in all race categories underwent RC. The proportion of Caucasians among patients with RC was significantly greater than among those with PC, Table 2. A similar difference for all other race groups was not found. However, the rate of PC utilization among Caucasians (11.8%) did not differ significantly rates in African-Americans (12.1%; p = 0.64) and Hispanics (12.9%; p = 0.13).

TABLE 2. **Sociodemographics of the study population**

Characteristics	**Cystectomy**			**Total**
	Partial	**Radical**	**p value**	
Age, years (mean ± SD)	72.1 ± 11.3	68.6 ± 10.1	< 0.0001	69.0 ± 10.3
Age groups				
40-59	1559 (15.0%)	14587 (19.3%)	< 0.0002	16146
60-69	2311 (22.3%)	22762 (30.1%)	< 0.0002	25073
70-79	3446 (33.2%)	27895 (36.8%)	< 0.0002	31341
80+	3053 (29.5%)	10454 (13.8%)	< 0.0002	13507
Gender				
Male	7574 (73.2%)	63496 (83.9%)	< 0.0002	71070
Female	2779 (26.8%)	12187 (16.1%)	< 0.0002	14966
Missing	16	15		31
Race				
Caucasian	6899 (66.5%)	51587 (68.2%)	0.0001	58486
African-American	358 (3.5%)	2605 (3.4%)	0.953	2963
Hispanics	281 (2.7%)	1905 (2.5%)	0.2404	2186
Other and missing	2831 (27.3%)	19601 (25.9%)		22432
Insurance status				
Medicare	7112 (68.6%)	46669 (61.7%)	< 0.0002	53781
Medicaid	282 (2.7%)	2912 (3.8%)	< 0.0002	3194
Private	2583 (24.9%)	23130 (30.6%)	< 0.0002	25713
Uninsured	190 (1.8%)	1608 (2.1%)	0.0513	1798
Other	202 (2.0%)	1379 (1.8%)		1581
Comorbidities				
CHF	607 (5.9%)	3436 (4.6%)	< 0.0001	4043
Hypertension	5504 (53.7%)	37502 (50.0%)	< 0.0001	43006
CPD	2197 (21.4%)	15249 (20.3%)	0.008	17446
Diabetes without CC	1755 (17.1%)	12325 (16.4%)	0.07	14080
Diabetes with CC	180 (1.8%)	1047 (1.4%)	0.0038	1227
Renal failure	520 (5.1%)	3986 (5.3%)	0.328	4506
Obesity	644 (6.3%)	3775 (5.0%)	< 0.0001	4419
Missing	125	653		778
Total	10369 (12.0%)	75698 (88.0%)		86067

SD = standard deviation; CHF = congestive heart failure; CPD = chronic pulmonary disease; CC = chronic complications

TABLE 3. **Likelihood of having postoperative complications**

Complication	Radical cystectomy versus partial cystectomy	
	Odds ratio (95% CI)	p value
Any complication	2.33 (2.08-2.59)	< 0.0001
Cardiac	1.67 (1.28-2.18)	0.0001
Respiratory and pneumonia	1.80 (1.50-2.15)	< 0.0001
Pulmonary embolism	2.69 (1.42-5.08)	0.0015
Renal	2.21 (1.79-2.71)	< 0.0001
Bleeding	2.32 (1.97-2.73)	< 0.0001
Any infection	1.86 (1.59-2.17)	0.0001
Urinary tract infection	1.20 (0.96-1.50)	0.1126
Sepsis	2.79 (2.11-3.69)	< 0.0001
C. diff pseudomembranous colitis	3.07 (1.67-5.63)	0.0001
Surgical site infection	3.14 (2.10-4.70)	< 0.0001
Peritonitis	2.19 (1.07-4.48)	0.0276
Disruption and non-healing surgical wound	4.19 (2.50-7.02)	< 0.0001

As shown in Table 2, the proportion of Medicare beneficiaries among patients with PC was significantly greater than those with RC. In contrast, the proportion of patients with Medicaid and private insurance were greater in the RC group. In analyzing the utilization of PC for patients of different insurance statuses, we found the greatest utilization rate (13.2%) in Medicare patients. It was significantly smaller among patients with Medicaid (8.8%; $p < 0.0002$), private insurance (10.1%; $p < 0.0002$) and uninsured patients (10.6%; $p = 0.001$).

Various comorbid diseases were shown to be more prevalent in patients with PC, Table 2. Patients who underwent PC had greater rates of congestive heart failure, hypertension, chronic pulmonary disease, diabetes, and obesity. Nevertheless, various postoperative complications developed more frequently after RC than after PC, Table 3. Patients with RC compared to those with PC were more likely to experience cardiac, respiratory and renal complications, postoperative infection and bleeding, and pulmonary embolism.

We analyzed the use of PC in various census regions of the United States and in hospitals with different locations and teaching statuses. The greatest proportion of PC was in the Northeast (12.8%), closely followed by the South (12.7%; $p = 0.76$) and was significantly smaller in the Midwest (11.5%) and West (11.0%;$p < 0.0002$ for both). In bivariate analysis, the likelihood of having PC was greater in rural versus urban hospitals (OR = 1.9; 95%CI 1.80-2.09; $p < 0.0001$) and in non-teaching versus teaching facilities (OR = 2.3; 95%CI 2.25-2.44; $p < 0.0001$).

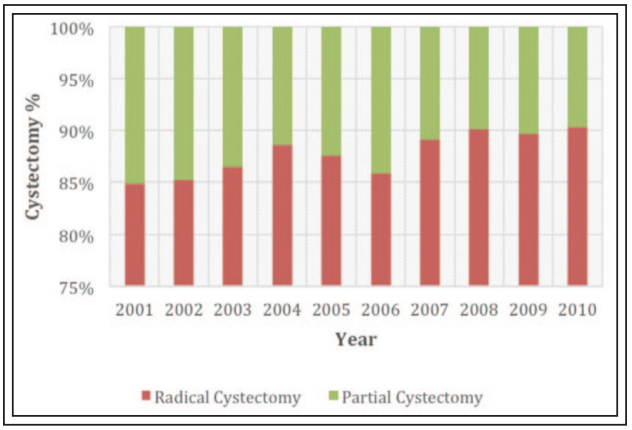

Figure 1a. Trends in radical and partial cystectomy, United States 2001-2010.

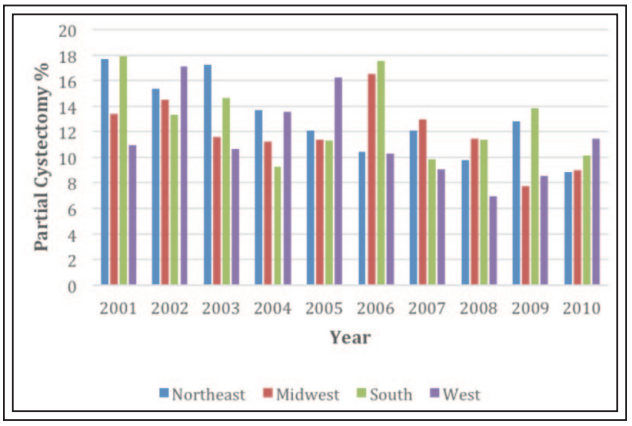

Figure 1b. Trends in partial cystectomy utilization in various United States census regions, 2001-2010.

TABLE 4. **Predictors of partial cystectomy utilization**

Characteristic	Odds ratio (95% CI)	p value
Year	0.96 (0.94-0.98)	< 0.0001
Age groups		
40-59	Reference	-
60-69	0.90 (0.77-1.05)	0.1755
70-79	1.04 (0.90-1.20)	0.6064
80+	2.43 (2.09-2.84)	< 0.0001
Gender		
Male	Reference	-
Female	1.73 (1.55-1.93)	< 0.0001
Comorbidity		
Hypertension	1.13 (1.03-1.25)	0.011
Obesity	1.57 (1.29-1.92)	< 0.0001
Hospital region		
West	Reference	-
Northeast	1.37 (1.18-1.60)	< 0.0001
Midwest	1.19 (1.03-1.38)	0.019
South	1.23 (1.08-1.50)	0.0023
Hospital location		
Urban	Reference	-
Rural	1.26 (1.06-1.50)	0.01
Hospital teaching status		
Teaching	Reference	-
Non-teaching	2.15 (1.95-2.38)	< 0.0001

Using trend-analysis, utilization of PC and RC for bladder cancer from 2001 to 2010 was evaluated. As seen in Figure 1a, the proportion of RC for bladder cancer increased from 84.8% in 2001 to 90.3% in 2010, while PC decreased from 15.2% to 9.7% (p = < 0.0001). For each procedure the trend is approximately linear, with the exception of 2 years – 2004 and 2006. Further stratifying PC trends by geographic regions illustrates a considerable amount of annual variation, Figure 1b. For example, the proportion of PC cases performed in the South varied from 17.5% in 2006 to 9.8% in 2007. Thus, it is important to understand that the aforementioned overall trend throughout this decade is a summation that at first masks significant variation both among and within geographical regions.

Because of the significant impact of some patient and hospital characteristics on the utilization of PC as well as changes in the use of procedure over time, we ran a multivariable logistic regression analysis model that adjusted PC use for patient age, race, gender, insurance status and comorbidities as well as for hospital region, location, teaching status and year of surgery. As demonstrated in Table 4, the results of this analysis confirm our main previous findings with chi-square statistics on an unadjusted basis. PC utilization decreased during the study period by 4% annually. The oldest patients were more likely to have PC than their youngest counterparts and the likelihood of PC in women was greater than in men. Simultaneously, patient race and insurance status have become invalid as predictors of PC. Among comorbidities, hypertension and obesity were the main contributors to PC option. Furthermore, compared to the West, there seems to be regional predilection for PC in the Northeast, Midwest, and South. Finally, patients in rural or non-teaching hospitals were more likely to undergo PC than those in urban and teaching facilities.

Discussion

Rates of PC have been steadily declining over the past 30 years. Among candidates for bladder extirpation, estimates suggest approximately 6%-10% meet the criteria for PC.[6,7] Despite this, rates of up to 24% in the late 1980s were reported.[4] This raised concerns regarding the potential overuse of a procedure with limited indications. Potential mechanisms that drive PC use include better

functional outcomes due to bladder preservation (e.g. bladder function, potency), lesser technical challenge (revealing an avoidance pattern among some physicians) and lesser physiological demands on the patient compared with RC. However, Knoedler et al recently found a 38% intravesical recurrence rate in those who underwent PC and 19% went on to have RC.[8]

Numerous studies have emphasized choosing the right patient population for PC in order to avoid potential misuse of treatment. In a population-based matched analysis of the Surveillance, Epidemiology, and End Results – 9 (SEER-9) data, Capitanio et al identified 7243 patients treated with PC (1573) or RC (5670) and matched for age, race, pT stage, pN stage, tumor grade, year of surgery, and number of removed lymph nodes. With this matching criteria, the 5 year overall (OS) and cause-specific survival (CSS) in patients treated with PC versus RC were 57.2% and 70.3% for PC patients and 54.6% and 69.2%, respectively, for RC patients ($p = 0.3$, $p = 0.5$).[9] With no statistically significant differences in OS and CSS between PC and RC, they concluded that PC does not undermine cancer control in appropriately selected patients. When the number of lymph nodes removed was excluded from their match criteria, there was a statistically significant difference in OS and CSS. Other studies have noted the value of lymphadenectomy with PC and suggest it may be underutilized.[9-11] The key is patient selection; one would not expect to have better oncologic outcome with PC compared to RC, however with proper patient selection, acceptable cancer control can be achieved with PC.[12]

There has been an overall decrease in the rate of PC; our most recent data found about 10% overall use of PC. Previous studies, however, have shown that there is a discrepancy in PC rates among the elderly and in non-teaching hospitals, with rates as high as 40% and 25% respectively.[4] Furthermore, this discrepancy cannot be accounted for with regards to disease severity or comorbidities. We again note these same discrepancies, albeit at lower rates (23%, 19%). Presumably, rates would be higher in elderly patients because of the associated morbidity of RC coupled with patient risk factors. In the patient population undergoing PC, our analysis did reveal higher a prevalence of every abstracted comorbidity, with one exception (diabetes without chronic complications), which may lend credence to the theory of patient selection based on risk when considering RC in this patient population. Despite these concerns, it has been shown that RC can be safe in the elderly population. As Roghmann et al discussed in a recent study that examined RC trends from NIS data (1998-2007), the increased risks of RC in octogenarians - namely blood transfusions, postoperative complications, adverse discharge disposition, and in-hospital mortality - should not be prohibitive. Instead, they argue that candidates for surgery should be referred to high-volume specialized centers of care, where better outcomes were observed for this vulnerable patient population.[13] In another study, Trulson et al studied stage T2 bladder cancer in octogenarians in the SEER-17 registry database and found that compared to other treatment modalities (TURBT, radiation therapy, PC), RC offered the best overall survival and cancer-specific survival.[14] The apparent age bias may unfairly exclude older patients from getting RC, which may have negative impacts on their survival. In addition, we note gender disparities on multivariate analysis. Women were more likely to undergo PC compared to men (OR 1.73, 95% CI, 1.55-1.93; $p = < 0.0001$), which is surprising given that more men underwent PC compared to women in our cohort. This gender disparity was noted in older reports using this dataset (OR 1.4, 95% CI, 1.3-1.5).[4] A possible explanation is that some women may undergo PC for gynecologic malignancy. However, in our analysis we only included patients with bladder malignancy therefore, patients with gynecologic malignancies should be excluded. The lack of tumor-specific data may account for these findings as well as possibility of a coding error in the dataset that may skew the rates of PC in women, and further detailed analysis is warranted.

With regards to PC outcomes and the institution where surgery is performed, Kates et al supported referral to high volume centers for PC. The authors noted that PC carries significant risks of hospital-acquired infections, and perioperative mortality rates of RC (about 1 in 50) closely compared to PC, despite being perceived as less technically challenging. Having surgery in higher-volume centers significantly lowered the risks associated with PC; there was a 30% decreased risk of death for each additional procedure a hospital performed annually.[15] This observation is of particular interest, since our most recent data reflected a greater tendency to perform PC in non-teaching hospitals than in teaching hospitals (18.9% versus 9.0%), and in rural hospitals over urban hospitals (20.2% versus 11.6%). Thus, PC is being performed more in rural and non-teaching hospitals, while current data supports doing this procedure in high-volume institutions.

Many possibilities may explain this observation. Two prominent ideas include selective referral (where non-teaching hospitals are diagnosing and treating candidates for PC while referring RC candidates to tertiary care centers) and less stringent selection criteria used by these centers, leading to potentially

inappropriate overuse of PC.[4] Additionally, because PC was performed more often in octogenarians (22.6%) when compared to other age groups, this may be a key population to study when attempting to explain why PC is performed more often in rural and non-teaching hospitals. Access to care could possibly explain the higher rates of PC in rural, non-teaching hospitals, as an octogenarian might have difficulty traveling to be treated at a tertiary medical center. In fact, regional variations in transportation have been shown to affect medical access, particularly in older adults (65+),[16] as some patients may even forego necessary treatment because of long distances to their treatment center.[17] All of these reasons may contribute to the relatively higher volume of PC in rural and non-teaching hospitals.

Our analysis has some limitations. To start, the retrospective design of the study and its reliance on administratively coded data should be taken into consideration, since there may be errors in coding or inconsistencies among different institutions.[18,19] Also, the NIS database does not provide information on cancer severity and pathology, which would be useful in measuring the indications for surgery, structural elements case mix and disease attributes, which, when analyzed together, will accurately characterize the misuse of PC and identify targets for quality improvement. The NIS also lacks longitudinal analysis on patient-level outcomes, which may result in an underestimation of postoperative complication rates, since complications may develop after discharge. Other possible confounding variables (not available in this dataset) include smoking status and neoadjuvant/adjuvant chemotherapy that patients may have received. Finally, the association with cancer control outcomes could not be assessed.

Conclusions

Despite the advantages of RC in disease control, PC is being performed frequently in the United States, although at a lower rate than previously reported. Surgical techniques have made RC safer and continent diversion has made the procedure more acceptable to patients. Despite this, many urologists are still performing PC, mainly in the elderly and in non-teaching and rural hospitals. Certainly, with the right patient populations, there are benefits to performing PC in lieu of RC, as evidenced by fewer postoperative complications, lessened physiologic burden, and bladder preservation/maintenance of continence. The concern remains, however, that current trends still reflect a selection based on age, comorbidities, region, and treatment center that illustrate underlying inconsistencies with when to perform PC over RC, potentially putting patients at higher risk of developing recurrent intravesicle disease. Further studies should be performed to more clearly define ideal patients for PC in an effort to remove some of the current treatment disparities and to better characterize why these selection biases have persisted. □

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