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Cerebrovascular Disease and Chronic Obstructive Pulmonary Disease Increase Risk of Complications with Robotic Partial Nephrectomy

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Abstract

Objective: To identify specific comorbidities within the Charlson Comorbidity Index (CCI) that are associated with increased complication rates after robot-assisted partial nephrectomy (RAPN).

Patients and Methods: After institutional review board approval, a consecutive series of 641 patients undergoing RAPN were retrospectively identified. Perioperative complications were defined and classified using the Clavien grading system. Fisher's exact test or chi-square test was performed to evaluate the association of individual comorbidities with perioperative complications. Logistic regression was used for multivariable analysis to adjust for other non-CCI comorbidities and tumor-specific and patient-specific characteristics.

Results: Of the 641 patients undergoing RAPN, complications occurred in 67 patients (10.5%), including 10 (14.9%), 28 (41.8%), 20 (29.9%), 5 (7.5%), and 4 (6.0%) patients with Clavien grade 1, 2, 3a, 3b, and 4 complications, respectively. Cerebrovascular disease [odds ratio 3.01 (95% confidence interval [CI] 1.10, 8.26) $p = 0.03$] and chronic obstructive pulmonary disease [COPD; 3.12 (1.24, 7.89) $p = 0.02$] predicted complications in multivariable analysis of clinicopathologic characteristics, including all CCI and non-CCI comorbidities. In additional modeling with only CCI comorbidities, similar results were observed, with cerebrovascular disease [2.93 (1.04, 7.56) $p = 0.04$] and COPD [2.69 (1.04, 6.28) $p = 0.04$] as the only two significant variables. No other variables reached statistical significance in either model, including nephrometry score or estimated blood loss ($p > 0.50$ for both). COPD predicted major complications (Clavien grade 3 or 4) in multivariable analysis [3.19 (1.07, 9.48) $p = 0.04$].

Conclusions: Cerebrovascular disease and COPD predict perioperative RAPN complications after RAPN. Identification of patients with these comorbidities preoperatively may afford improved counseling and risk stratification.

Introduction

Over 61,000 new cases of kidney cancer will be diagnosed in 2015, leading to over 14,000 cancer-specific deaths.[1] Increased utilization of abdominal imaging has resulted in increased incidental findings of localized renal masses,[2] and current guidelines by the American Urological Association (AUA) recommend nephron-sparing surgery as standard of care for patients presenting with small T1 renal masses consistent with renal-cell carcinoma (RCC).[3] Multiple options with comparable oncologic outcomes exist for management of localized RCC, including open, laparoscopic, and robotic partial nephrectomy (PN) and percutaneous ablation.[4–6]

To better predict complexity of PN and perioperative complications, tumor-specific characteristics are incorporated into scoring systems such as RENAL nephrometry score (RNS).[7] RNS incorporates tumor radius, exophytic/endophytic properties, proximity to collecting system, anterior/posterior locality, and location relative to the polar line. RNS has been associated with perioperative outcomes and complications in previous studies of small renal tumors and PN.[8–10] Despite the objectivity of RNS, this measure alone does not incorporate other patient-specific characteristics and comorbidities that may significantly complicate PN and surgical outcomes.

The Charlson Comorbidity Index (CCI) is a weighted scoring metric designed to account for patients with comorbid conditions,[11] and CCI has been incorporated into many analyses of kidney cancer surgical and oncologic outcomes.[12–15] All-encompassing indices such as CCI provide an advantage of risk stratification, but may not be the best predictor of outcomes; comorbidity profiles often differ based on population and disease state of interest, which can lower the predictive

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power of these indices.[16,17] Therefore, the purpose of this study was to identify specific comorbid conditions within the CCI that predict perioperative complications after robot-assisted partial nephrectomy (RAPN) at a high-volume tertiary care center.

Patients and Methods

After approval was obtained from the Washington University Institutional Review Board, retrospective review of a consented, deidentified, and prospectively maintained database was performed for patients that underwent RAPN between 2007 and 2014. All patients demonstrated renal masses suspicious for RCC upon CT or MRI.

Surgical technique

RAPN operations were performed through a retroperitoneal or transperitoneal approach using the da Vinci Surgical System. The techniques for these respective approaches have been previously described.[18,19] The operative approach was selected based on a composite of the following factors: patient habitus, history of previous intra-abdominal surgery, relative anterior–posterior location of the tumor, and surgeon preference.

Data collection

Staff physicians and data managers prospectively collected tumor characteristics, perioperative outcomes, and patient demographics, including the following comorbidities that contribute to CCI: acquired immunodeficiency, chronic obstructive pulmonary disease (COPD), congestive heart failure, cerebrovascular disease, connective tissue disease, dementia, diabetes mellitus, hemiplegia, leukemia, lymphoma, liver disease, renal disease, myocardial infarction, peripheral vascular disease (PVD), solid tumor within the last 5 years, and metastases of solid tumor, as outlined previously.[11]

Cerebrovascular disease was defined as history of cerebrovascular accident or transient ischemic attack. Of note, the kidney tumor for which the patient was undergoing surgery was not included in the CCI calculation. Other comorbidities not included in CCI but analyzed in this study include abdominal aortic aneurysm, arrhythmia, asthma, coronary artery disease, history of deep vein thrombosis, history of renal stones, hyperlipidemia, hypertension, and spinal cord injury.

Perioperative complications were recorded prospectively and defined by the Clavien grading system.[20] Major complications were defined as Clavien grade 3 or 4. Hemorrhage was defined as bleeding sufficient to warrant perioperative blood transfusion or other therapeutic intervention, or symptomatic hematoma. Urine leakage was defined either by radiographic demonstration of extra-pyelocaliceal urine or increased drain fluid creatinine. Ileus was defined as the necessary placement of a nasogastric tube due to prolonged return of normal bowel function.

Statistical analyses

Baseline characteristics between patients with and without complications were compared using either the Student's *t*-test or chi-square analysis. To evaluate the association of individual comorbidities with perioperative complications, Fisher's exact test was performed. Multivariable analysis was performed using logistic regression to determine the relationship of individual comorbidities with perioperative complications while adjusting for other comorbidities and tumor-specific and patient-specific characteristics, including the following: body mass index (BMI), gender, age, need for pelvicaliceal repair, off-clamp technique, operative time, estimated blood loss, RNS, and the absence of any significant comorbidity. All data analyses were performed using R software v3.1.3, and a two-tailed p-value <0.05 was defined as significant in all analyses.

Results

A total of 641 patients were identified that underwent RAPN for renal masses at the Washington University (Table 1). Complications occurred in 67 patients (10.5%) after surgery, including 10 (14.9%), 28 (41.8%), 20 (29.9%), 5 (7.5%), and 4 (6.0%) patients with Clavien grade 1, 2, 3a, 3b, and 4 complications, respectively (Table 2). A total of 64 of 67 complications occurred before 30 days after surgery. We evaluated baseline characteristics between patients with and without complications using either the Student's *t*-test or chi-square analysis.

Patients with complications had significantly longer operative times (153.8 ± 48.1 minutes *vs* 175.6 ± 63.5 minutes, $p = 0.001$), higher blood loss (180.7 ± 235.5 mL *vs* 226.5 ± 219.8 mL, $p = 0.004$), and were more likely to need pelvicaliceal repair (13.0% *vs* 6.9%; $p = 0.01$) than patients without complications. Other demographics were similar between patients with and without perioperative complications. There

Table 1. Characteristics and Demographics of Patients Undergoing RAPN

	Complications		
Characteristics	*No* (n = *574*)	*Yes* (n = *67*)	p
BMI, mean (±SD)	30.7 (±6.7)	32.1 (±7.1)	0.17
Age, mean (±SD)	57.4 (±11.8)	59.8 (±11.5)	0.08
Operative time, mean (±SD)	153.8 (±48.1)	175.6 (±63.5)	**0.001**
Estimated blood loss, mean (±SD)	180.7 (±235.5)	226.5 (±219.8)	**0.004**
Nephrometry, mean (±SD)	7.5 (±1.9)	8.1 (±1.8)	0.05
Gender, *N* (%)			0.98
Male	333 (89.5)	39 (10.5)	
Female	232 (89.6)	27 (10.4)	
Off-clamp, *N* (%)			0.10
No	428 (88.4)	56 (11.6)	
Yes	146 (93.0)	11 (7.0)	
Pelvicaliceal repair, *N* (%)			**0.01**
No	243 (93.1)	18 (6.9)	
Yes	329 (87.0)	49 (13.0)	
CCI, *N* (%)			0.06
CCI = 0	314 (92.1)	27 (7.9)	
CCI = 1	126 (89.4)	15 (10.6)	
CCI = 2	72 (85.7)	12 (14.3)	
CCI ≥3	62 (82.7)	13 (17.3)	

Bold = $p < 0.05$ and therefore considered significant.
BMI = body mass index; CCI = Charlson Comorbidity Index; RAPN = robot-assisted partial nephrectomy.

Table 2. Perioperative Complications After RAPN

Clavien grade	*Organ system*	*Complications (No.)*
1 (10 patients)	Cardiovascular	Hypotension (1)
	Genitourinary	Urinary retention (3), acute renal insufficiency (1)
	Gastrointestinal	Ileus (3)
	Other	Fever (1), pain (1)
2 (28 patients)	Cardiovascular	Postoperative hemorrhage (1), NSTEMI (1), hypotension (1), DVT (3), aortic thrombus (1), atrial fibrillation (3), hypertension crisis (1), BT (4), MI (1), PE (2), blood loss/anemia (1)
	Genitourinary	Dysuria (1), acute renal failure (1), urinary retention (2), prostate infection (1), rectus hematoma (1)
	Gastrointestinal	Ileus (1)
	Respiratory	Shortness of breath (1)
	Other	Dehydration (1), fever (2), wound infection (2), flank pain (1)
3a (20 patients)	Cardiovascular	Pseudoaneurysm (12), BT (2), AV fistula (1)
	Genitourinary	Urine leak (2)
	Respiratory	Reintubation in PACU (1), hydropneumothorax (1), pneumonia (1), shortness of breath/hypoxia (2), pneumothorax (1)
	Lymphatic	Lymphocele (1)
3b (5 patients)	Cardiovascular	Hemorrhage (1), pseudoaneurysm (1)
	Genitourinary	Incisional hernia (3)
	Respiratory	Shortness of breath/hypoxia (1)
4 (4 patients)	Cardiovascular	MI (2), BT (1)
	Genitourinary	Chronic renal insufficiency (1)
	Respiratory	Acute respiratory failure (1)
	Gastrointestinal	Ileus (1)
	Other	Persistent nausea (1)

AV = arteriovenous; BT = blood transfusion; DVT = deep vein thrombosis; MI = myocardial infarction; NSTEMI = non-ST segment elevation myocardial infarction; PACU = postanesthesia care unit; PE = pulmonary embolism.

was no statistically significant difference in CCI between patients with and without complications ($p = 0.06$).

The association of perioperative complications with individual comorbidities was evaluated using Fisher's exact test. Within the CCI, we identified the following factors as significantly associated with increased rates of complications: cerebrovascular disease ($p < 0.001$), COPD ($p = 0.003$), diabetes mellitus ($p = 0.05$), and renal disease ($p = 0.03$) (Table 3). We also evaluated comorbidities not included in the CCI and found no association with risk of complications (Table 4).

A multivariable model was constructed to evaluate the relationship of comorbid conditions and complications while controlling for other characteristics (Table 5). In the first model, all comorbid conditions were incorporated, including those conditions not found in the CCI. Cerebrovascular disease [odds ratio 3.01 (95% confidence interval [CI] 1.10, 8.26) $p = 0.03$] and COPD [3.12 (1.24, 7.89) $p = 0.02$] independently predicted perioperative complications after RAPN. In a second multivariable model that excluded comorbidities not found in CCI, similar results were yielded, with cerebrovascular disease [2.93 (1.04, 7.56) $p = 0.04$] and COPD [2.69 (1.04, 6.28) $p = 0.04$] as the only two significant variables. No other variables reached statistical significance in either model, including nephrometry score or estimated blood loss ($p > 0.50$ for both).

The association of individual comorbidities with major complications (Clavien grade 3 or 4; $n = 30$ patients) was then investigated. COPD was the only comorbidity within the CCI associated with increased rates of major complications ($p = 0.04$). Hyperlipidemia also predicted major complications during RAPN in univariable analysis ($p = 0.03$). These two comorbidities were incorporated into a multivariable model while controlling for nephrometry score, age, BMI, and operative time. Only COPD [3.19 (1.07, 9.48) $p = 0.04$] retained statistical significance in multivariable analysis.

Complications for patients with COPD include the following: urine leak ($n = 2$), wound infection ($n = 1$), urinary retention ($n = 1$), fluid overload ($n = 1$), postoperative blood transfusion ($n = 1$), acute respiratory failure or hypoxia requiring reintubation ($n = 2$), fever ($n = 1$), hemorrhage ($n = 1$), readmission for flank pain ($n = 1$), and non-ST segment elevation myocardial infarction ($n = 1$). Complications for patients with a history of cerebrovascular disease include the following: urinary retention ($n = 2$), hydropneumothorax ($n = 1$), anemia requiring blood transfusion ($n = 2$), atrial fibrillation ($n = 1$), aortic thrombus ($n = 1$), hypoxia requiring reintubation ($n = 1$), urine leak ($n = 1$), fluid overload ($n = 1$), non-ST segment elevation myocardial infarction ($n = 1$), and pulmonary embolism ($n = 1$).

Discussion

The management of renal masses with RAPN has become increasingly common,[21,22] and RAPN results in similar oncologic outcomes as open and laparoscopic PN while decreasing blood loss, operative time, and length of hospital stay.[4,5,23,24] Further advantages of RAPN include three-dimensional viewing *vs* two dimensions in laparoscopy and increased dexterity.[25] Complications during RAPN are not uncommon, with reported complication rates between 15% and 33%,[13,14] leading to significant morbidity. Discovering patient- and tumor-specific factors associated with complication rates during RAPN is paramount to improving standard of care in management of renal masses. To our

Table 3. Relationship of Specific Charlson Comorbidities with Perioperative RAPN Complications

Characteristics		N	*No complications,* n *(%)*	*Complications,* n *(%)*	p
AIDS	No	641	574 (89.5)	67 (10.5)	—
	Yes	0	—	—	
CVA or TIA	No	611	553 (90.5)	58 (9.5)	**<0.001**
	Yes	30	21 (70.0)	9 (30.0)	
COPD	No	599	542 (90.5)	57 (9.5)	**0.003**
	Yes	42	32 (76.2)	10 (23.8)	
Chronic heart failure	No	628	562 (89.5)	66 (10.5)	1.00
	Yes	13	12 (92.3)	1 (7.7)	
Connective tissue disease	No	631	565 (89.6)	66 (10.4)	1.00
	Yes	9	8 (88.9)	1 (11.1)	
Dementia	No	639	572 (89.5)	67 (10.5)	1.00
	Yes	2	2 (100.0)	0 (0.0)	
DM	No	509	462 (90.8)	47 (9.2)	**0.05**
	Yes	132	112 (84.8)	20 (15.2)	
DM with complications	No	631	566 (89.7)	65 (10.3)	0.28
	Yes	10	8 (80.0)	2 (20.0)	
Hemiplegia	No	640	573 (89.5)	67 (10.5)	1.00
	Yes	1	1 (100.0)	0 (0.0)	
Leukemia	No	637	572 (89.8)	65 (10.2)	0.06
	Yes	4	2 (50.0)	2 (50.0)	
Lymphoma	No	636	569 (89.5)	67 (10.5)	1.00
	Yes	5	5 (100.0)	0 (0.0)	
Metastatic tumor	No	637	570 (89.5)	67 (10.5)	1.00
	Yes	4	4 (100.0)	0 (0.0)	
Mild liver disease	No	629	562 (89.3)	67 (10.7)	0.63
	Yes	12	12 (100.0)	0 (0.0)	
Moderate to severe liver disease	No	638	572 (89.7)	66 (10.3)	0.28
	Yes	3	2 (66.7)	1 (33.3)	
Renal disease	No	597	539 (90.3)	58 (9.7)	**0.03**
	Yes	44	35 (79.5)	9 (20.5)	
MI	No	611	551 (90.2)	60 (9.8)	**0.02**
	Yes	30	23 (76.7)	7 (23.3)	
Peptic ulcer disease	No	622	555 (89.2)	67 (10.8)	0.25
	Yes	19	19 (100.0)	0 (0.0)	
PVD	No	627	564 (90.0)	63 (10.0)	**0.05**
	Yes	14	10 (71.4)	4 (28.6)	
Solid tumor (within last 5 years)	No	564	503 (89.2)	61 (10.8)	0.42
	Yes	77	71 (92.2)	6 (7.8)	

Bold = $p < 0.05$ and therefore considered significant.
AIDS = acquired immune deficiency syndrome; COPD = chronic obstructive pulmonary disease; CVA = cerebrovascular accident; DM = diabetes mellitus; PVD = peripheral vascular disease; TIA = transient ischemic attack.

knowledge, this is the first report on the relationship of specific comorbidities with RAPN complications.

Within the current literature, predictors of complications during RAPN are still debated. Some studies have found an association of RNS with complications,[10,13] while other studies did not find a significant association.[14,26] Similarly, the association of the CCI with RAPN complications and hospital readmission rates is still debated.[14,27] Interestingly, one large multicenter study on RAPN found no association between age-adjusted CCI and perioperative complications in multivariable analysis.[13] Given the etiologic heterogeneity of conditions within the CCI,[11] it seemed reasonable to propose that only specific comorbidities within the CCI predict perioperative complications. Indeed, only cerebrovascular disease and COPD were associated with adverse perioperative outcomes, while all other comorbid conditions in the CCI were not significantly associated with surgical complications.

The relationship of cardiovascular disease with adverse oncologic outcomes after surgery for renal masses has recently been demonstrated.[28] An independent relationship was observed between overall survival for T1aN0M0 RCC and specific comorbidities, including congestive heart failure, chronic kidney disease, PVD, COPD, diabetes, and cerebrovascular disease.[28] The relationship between these comorbidities and perioperative complications was not investigated, however. The data herein build on the current literature and suggest that patients with cerebrovascular disease and COPD are at a higher risk for complications after or during RAPN.

The association of CCI with perioperative complications has been studied in other surgical procedures. In patients undergoing surgery for spinal cord injuries, a higher CCI is associated with increased complication rates.[29] The CCI is a strong predictor of surgical complications in patients with intracranial meningiomas.[30] Interestingly, age-adjusted CCI

Table 4. Relationship of Other Non-Charlson Comorbidities with Perioperative RAPN Complications

Characteristics		N	*No complications,* n *(%)*	*Complications,* n *(%)*	p
AAA	No	618	553 (89.4)	65 (10.5)	1.00
	Yes	23	21 (91.3)	2 (8.7)	
Arrhythmia	No	603	542 (89.9)	61 (10.1)	0.27
	Yes	38	32 (84.2)	6 (15.8)	
Asthma	No	581	519 (89.3)	62 (10.7)	0.57
	Yes	60	55 (91.7)	5 (8.3)	
Benign prostatic hyperplasia	No	614	548 (89.3)	66 (10.7)	0.35
	Yes	27	26 (96.3)	1 (3.7)	
CAD	No	587	528 (89.9)	59 (10.1)	0.27
	Yes	54	46 (85.2)	8 (14.8)	
History of DVT	No	609	548 (90.0)	61 (10.0)	0.12
	Yes	32	26 (81.3)	6 (18.8)	
History of stones	No	529	471 (89.0)	58 (11.0)	0.40
	Yes	112	103 (92.0)	9 (8.0)	
Hyperlipidemia	No	417	378 (90.6)	39 (9.4)	0.21
	Yes	224	196 (87.5)	28 (12.5)	
Hypertension	No	243	223 (91.8)	20 (8.2)	0.15
	Yes	398	351 (88.2)	47 (11.8)	
Spinal cord injury	No	641	574 (89.5)	67 (10.5)	—
	Yes	0	—	—	

AAA = abdominal aortic aneurism; CAD = coronary artery disease.

is not a predictor of perioperative complications in patients with advanced epithelial ovarian cancer.[31] It is important to note that while the utility of CCI was investigated in these studies, some suggest that procedure-specific modifications may provide more predictive power than the current index alone.[29] As such, recent studies have investigated the relationship of individual CCI comorbidities with surgical outcomes, yielding mixed results regarding the relative predictive power of individual conditions *vs* CCI index.[32–34]

Table 5. Multivariable Analysis of Tumor- and Patient-Specific Characteristics with Perioperative RAPN Complications

	All comorbidities		*Charlson comorbidities only*	
Characteristics	*Odds ratio [95% CI]*	p	*Odds ratio [95% CI]*	p
BMI	1.03 [0.99, 1.08]	0.16	1.03 [0.98, 1.07]	0.24
Age	1.01 [0.98, 1.05]	0.34	1.01 [0.98, 1.04]	0.35
Gender	0.95 [0.50, 1.81]	0.89	0.91 [0.48, 1.68]	0.77
Off-clamp	0.46 [0.19, 1.09]	0.08	0.50 [0.22, 1.15]	0.10
Pelvicaliceal repair	1.17 [0.56, 2.44]	0.68	1.12 [0.54, 2.34]	0.77
Operation time	1.01 [1.00, 1.01]	0.054	1.01 [1.00, 1.01]	0.07
Estimated blood loss	1.00 [1.00, 1.00]	0.99	1.00 [1.00, 1.00]	0.93
Nephrometry score	1.05 [0.87, 1.26]	0.61	1.06 [0.88, 1.27]	0.55
No comorbidity	0.38 [0.11, 1.37]	0.14	1.04 [0.14, 1.66]	0.93
AAA	0.41 [0.07, 2.33]	0.31	—	—
Arrhythmia	1.45 [0.43, 4.94]	0.55	—	—
CAD	0.83 [0.26, 2.63]	0.75	—	—
CVA or TIA	3.01 [1.10, 8.26]	**0.03**	2.93 [1.04, 7.56]	**0.04**
COPD	3.12 [1.24, 7.89]	**0.02**	2.69 [1.04, 6.28]	**0.04**
DM	1.27 [0.64, 2.49]	0.49	1.31 [0.64, 2.39]	0.49
DVT history	2.05 [0.65, 6.50]	0.22	—	—
Stones	0.83 [0.37, 1.89]	0.66	—	—
Hyperlipidemia	0.70 [0.35, 1.38]	0.30	—	—
Hypertension	0.73 [0.36, 1.48]	0.38	—	—
Renal disease	1.76 [0.67, 4.65]	0.25	1.77 [0.66, 4.26]	0.25
MI	2.36 [0.68, 8.25]	0.18	1.94 [0.66, 5.28]	0.22
PVD	1.89 [0.44, 8.08]	0.39	1.51 [0.37, 5.97]	0.57
Solid tumor	0.43 [0.15, 1.26]	0.12	0.54 [0.19, 1.43]	0.26

Bold = $p < 0.05$ and therefore considered significant.
CI = confidence interval.

All-encompassing indices such as the RNS and CCI are advantageous in that they compress multiple measures into a single variable; a significant disadvantage is that these scoring systems are often developed in one disease type or operation and may not translate well to other anatomic systems or procedures. Due to differences in type of procedure or disease pathogenesis, different comorbidities may differentially affect perioperative or surgical outcomes. Considering how diverse the conditions are within the CCI, it is not surprising that previous studies found that the CCI as an entire measure was not significantly associated with complication rates after RAPN.[13,14] The broad applicability of indices like RNS and CCI cannot be debated, but the data herein suggest that close examination of each patient's previous medical history and the relationship to the current illness is warranted.

Management options in the AUA guidelines for small renal masses include active surveillance,[3] and election for surveillance includes both performance status and patient preference at our institution. Patients with COPD or cerebrovascular disease may benefit from improved preoperative counseling regarding their risk of surgery *vs* other alternative management options.

Limitations of this study include the retrospective nature of analysis and low prevalence of some types of comorbidities. Future prospective multi-institutional studies are required for validation of the significance of these comorbidities. We were unable to evaluate other measures of patient function such as Eastern Cooperative Oncology Group performance status or Karnofsky performance status, as collection of these measures in this patient population was not standard for our institution until recently. Furthermore, it is unclear whether our results translate to other methods for nephron-sparing surgery for renal masses, or to patients with RCC in general. Studies are needed on a series of laparoscopic or open PN patients to evaluate the relationship of specific CCI comorbidities with complication rates.

Conclusions

Cerebrovascular disease and COPD are predictors of perioperative complications in patients undergoing RAPN, and COPD specifically predicts major complications. Preoperative identification of these patients may afford improved counseling and risk stratification.

Author Disclosure Statement

No competing financial interests exist.

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Abbreviations Used

AAA = abdominal aortic aneurysm
AUA = American Urological Association
BMI = body mass index
CAD = coronary artery disease
CCI = Charlson Comorbidity Index
COPD = chronic obstructive pulmonary disease
CT = computed tomography
CVA = cerebrovascular accident
DVT = deep vein thrombosis
MRI = magnetic resonance imaging
PN = partial nephrectomy
PVD = peripheral vascular disease
RAPN = robot-assisted partial nephrectomy
RCC = renal-cell carcinoma
RNS = RENAL nephrometry score
TIA = transient ischemic attack