

2014 BEST PAPERS IN ROBOTIC RENAL SURGERY

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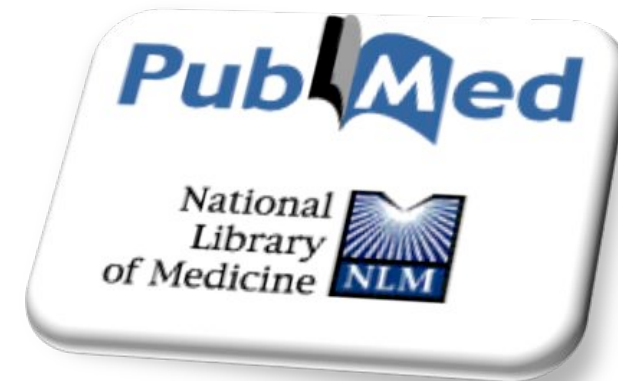
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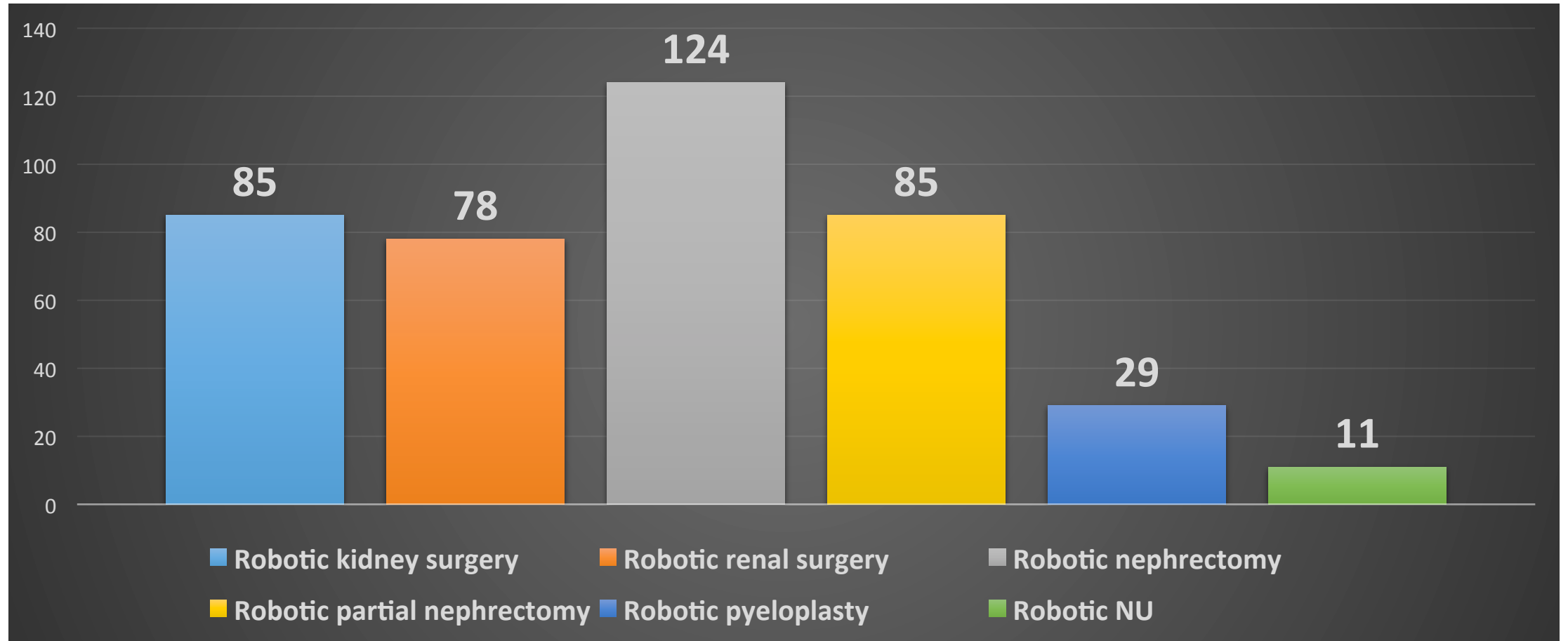


SEARCH METHODOLOGY

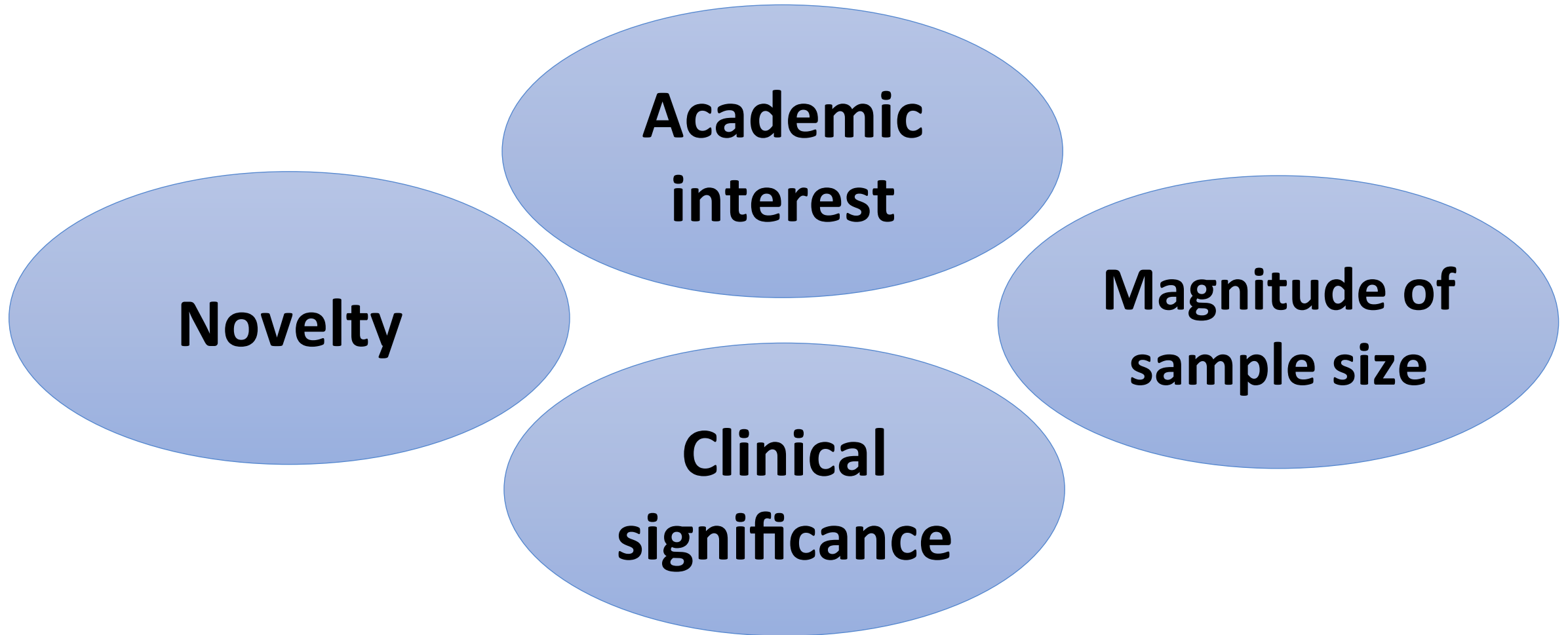
- PubMed search, Free text protocol
- Time limits: year 2014
- Exclusion criteria:
 - review, letters, comments
 - studies I co-authored
- Search terms:
 - *robotic kidney surgery*
 - *robotic renal surgery*
 - *robotic nephrectomy*
 - *robotic partial nephrectomy*
 - *robotic nephroureterectomy*
 - *robotic pyeloplasty*



PubMed hits



Selection criteria



RAPN: growing evidence

Practice Patterns and Outcomes of Open and Minimally Invasive Partial Nephrectomy Since the Introduction of Robotic Partial Nephrectomy: Results from the Nationwide Inpatient Sample

Khurshid R. Ghani,^{*,†} Shyam Sukumar,[†] Jesse D. Sammon, Craig G. Rogers,[‡] Quoc-Dien Trinh[‡] and Mani Menon

From the Department of Urology, University of Michigan (KRG), Ann Arbor and Vattikuti Urology Institute, Henry Ford Health System (JDS, CGR, MM), Detroit, Michigan, Department of Urology, University of Minnesota (SS), Minneapolis, Minnesota, and Department of Surgery, Division of Urology, Brigham and Women's Hospital/Dana-Farber Cancer Institute, Harvard Medical School (QDT), Boston, Massachusetts

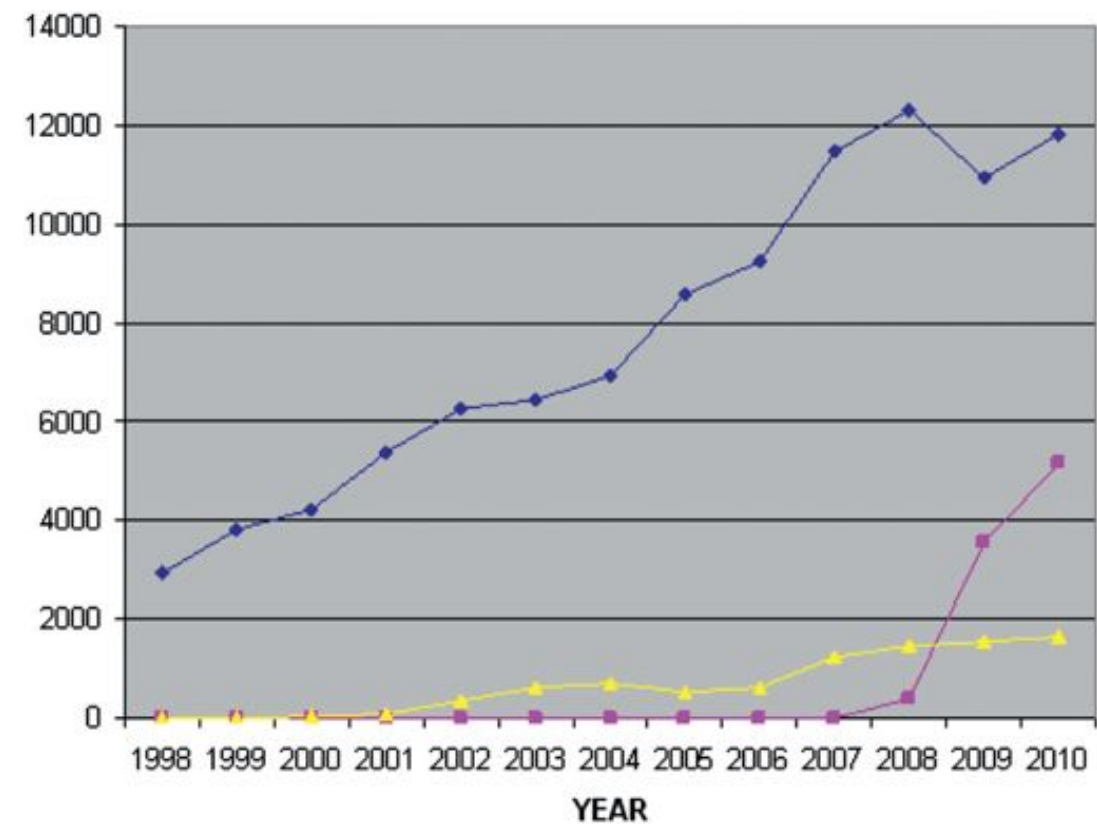
- **38,064 PNs from the Nationwide Inpatient Sample between 2008 and 2010**
 - 66.9% open
 - 23.9% robotic
 - 9.2% laparoscopic

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- **38,064 PNs from the Nationwide Inpatient Sample between 2008 and 2010**
 - 66.9% open
 - 23.9% robotic
 - 9.2% laparoscopic
- **Patients treated with MIPN less likely to receive blood transfusion, postop. complication, prolonged hospital stay**
- **RPN patients less likely to experience intraop. complication**
- **Excess hospital charges higher after RPN**



CONCLUSIONS

RPN has now overtaken LPN in the United States as the minimally invasive approach of choice for PN.

Association of type of renal surgery and access to robotic technology for kidney cancer: results from a population-based cohort

Steven V. Kardos, Cary P. Gross^{*†}, Nilay D. Shah[‡], Peter G. Schulam, Quoc-Dien Trinh[§], Marc C. Smaldone[¶], Maxine Sun^{* **††}, Christopher J. Weight^{††}, Jesse Sammon^{§§}, Leona C. Han[‡] and Simon P. Kim^{*}

*Department of Urology, *Cancer Outcomes, Public Policy and Effectiveness Research Center, †Department of Internal Medicine, Yale University, New Haven, CT, ‡Division of Health Care and Policy Research, Mayo Clinic, Rochester, ††Department of Urology, University of Minnesota, Minneapolis, MN, §Division of Urology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, ¶Department of Surgery, Fox Chase Cancer Center-Temple University Health System, Philadelphia, PA, §§Department of Urology, Henry Ford Health System, Detroit, MI, USA, **Cancer Prognostics and Health Outcomes and ††Department of Public Health, University of Montreal Health Center, Montreal, QC, Canada*

Methods

After merging the Nationwide Inpatient Sample (NIS) and the American Hospital Association survey from 2006 to 2008, we identified 21 179 patients who underwent either PN or radical nephrectomy (RN) for renal cell carcinoma (RCC). The primary outcome assessed was the type of nephrectomy performed. Multivariable logistic regression identified the patient and hospital characteristics associated with receipt of PN.

Association of type of renal surgery and access to robotic technology for kidney cancer: results from a population-based cohort

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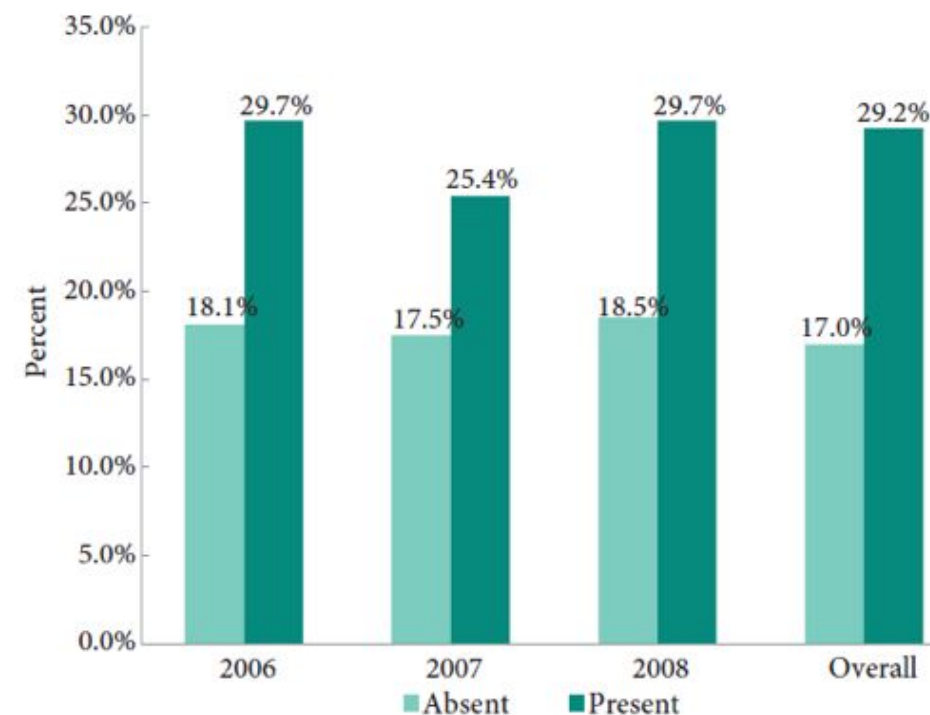
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Conclusions

Although academic and urban locations are established factors that affect the receipt of PN for RCC, the availability of robot-assisted surgery at a hospital was also independently associated with higher use of PN. Our results are informative

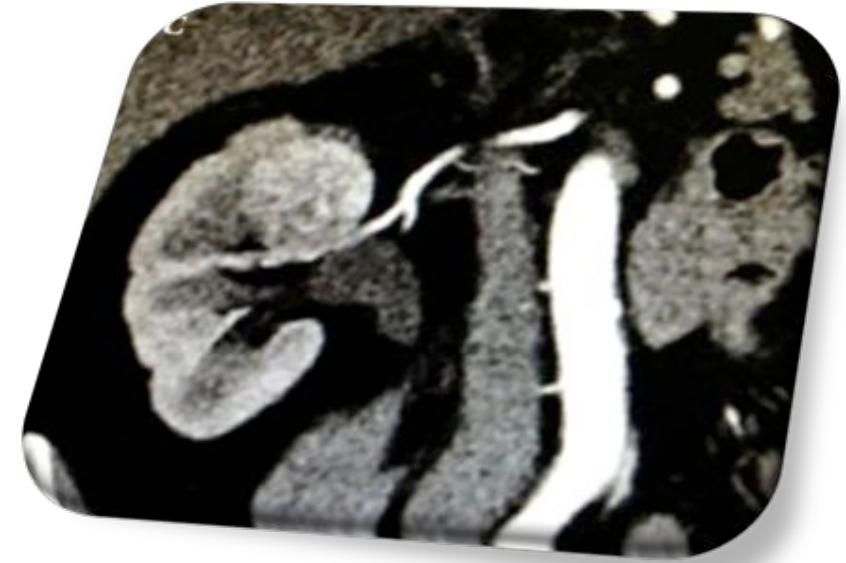
Fig. 1 Proportion of patients undergoing partial nephrectomy (PN), stratified by absence or presence of robotic technology for 2006–2008 and overall. $P < 0.001$ for the differences in percentage of patients receiving PN for each year and overall.



Perioperative and renal functional outcomes of elective robot-assisted partial nephrectomy (RAPN) for renal tumours with high surgical complexity

Alessandro Volpe^{*†}, Diletta Garrou^{*‡}, Daniele Amparore^{*‡}, Geert De Naeyer^{*}, Francesco Porpiglia[‡], Vincenzo Ficarra^{*§} and Alexandre Mottrie^{*}

**Division of Urology, O.L.V. Vattikuti Robotic Surgery Institute, Aalst, Belgium, †Division of Urology, University of Eastern Piedmont, Maggiore della Carità Hospital, Novara, ‡Division of Urology, University of Torino, San Luigi Hospital, Orbassano, and §Division of Urology, University of Udine, Udine, Italy*

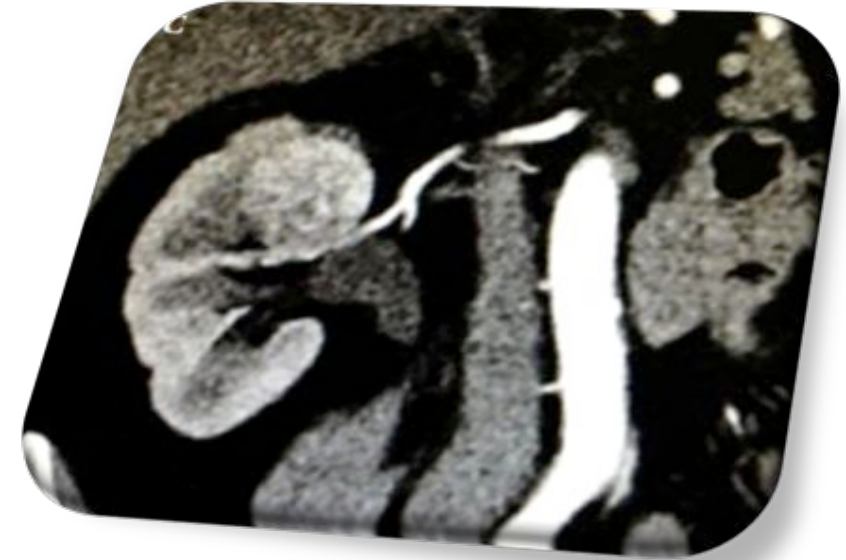


44 RAPNs for renal tumours PADUA scores ≥ 10

Perioperative and renal functional outcomes of elective robot-assisted partial nephrectomy (RAPN) for renal tumours with high surgical complexity

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44 RAPNs for renal tumours PADUA scores ≥ 10

- Median EBL: 150 ml
- Median WIT: 16 min
- Postop. complication rate: 22.7%
 - 9.1% high grade
- Two (4.5%) PSMs
- No significant decline in eGFR at 6 months

Conclusion

In experienced hands RAPN for renal tumours with a PADUA score of ≥ 10 is feasible with short WIT, acceptable major complication rate and good long-term renal functional outcomes. A slightly higher risk of PSMs can be expected due to the high surgical complexity of these lesions. The robotic technology allows a safe expansion of the indications of minimally invasive PN to anatomically very challenging renal lesions in referral centres.

A multicentre matched-pair analysis comparing robot-assisted versus open partial nephrectomy

Vincenzo Ficarra¹, Andrea Minervini², Alessandro Antonelli³, Sam Bhayani⁴,
Giorgio Guazzoni⁵, Nicola Longo⁶, Giuseppe Martorana⁷, Giuseppe Morgia⁸,
Alexander Mottrie⁹, James Porter¹⁰, Claudio Simeone³, Gianni Vittori², Filiberto Zattoni¹¹
and Marco Carini²

¹Department of Urology, University of Udine, Udine, ²Department of Urology, University of Florence, Florence,
³Department of Urology, University of Brescia, Brescia, Italy, ⁴Washington University School of Medicine, Saint Louis, MO,
USA, ⁵Department of Urology, Vita-Salute University, San Raffaele-Turro Hospital, Milan, ⁶Department of Urology, University
Federico II, Naples, ⁷Department of Urology, University of Bologna, Bologna, Italy, ⁸Luna Foundation, ⁹OLV Robotic
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Variables	RAPN N = 200	OPN N = 200	P
Median (IQR) length of stay (including day of surgery), days	6 (5–6)	7 (6–8)	0.014
n/N (%):			
Postoperative overall complications	28/200 (14)	43/200 (21.5)	0.027
Clavien severity grade:			
1–2	19 (9.5)	34 (17)	0.030
3	8 (4)	7 (3.5)	0.34
4	1 (0.5)	2 (1)	–
Transfusion rate	21/200 (10.5)	20/200 (10)	0.78

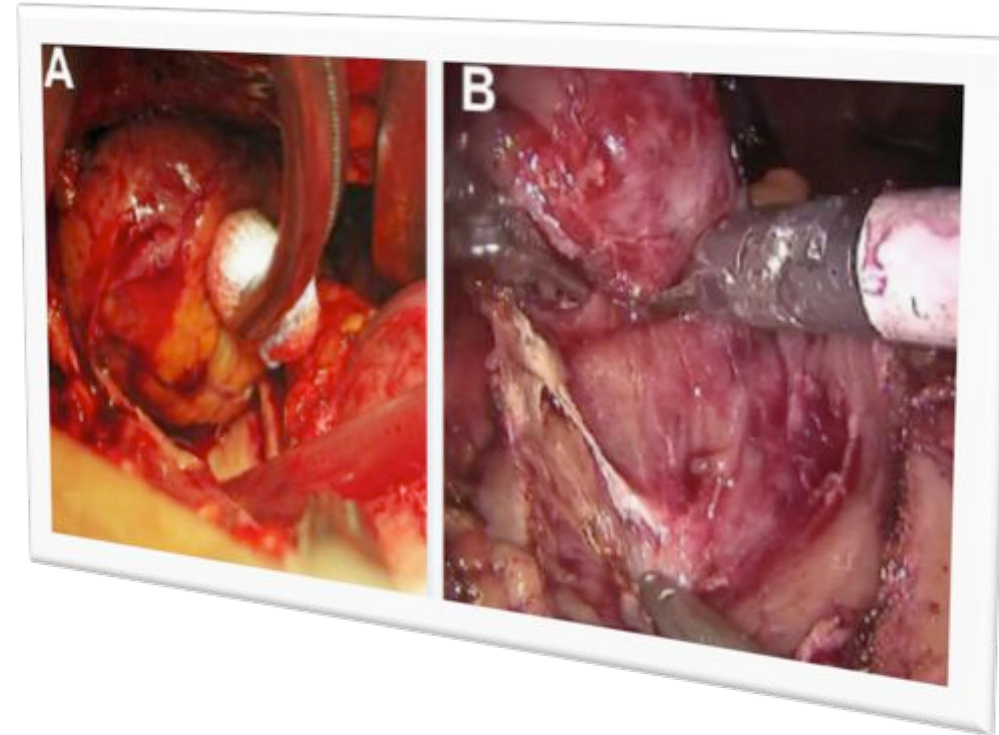
Conclusion

RAPN can achieve equivalent perioperative, early oncological and functional outcomes as OPN. Moreover, RAPN is a less invasive approach, offering a lower risk of bleeding and postoperative complications than OPN.

Robotic vs Open Simple Enucleation for the Treatment of T1a-T1b Renal Cell Carcinoma: A Single Center Matched-pair Comparison

Sergio Serni, Gianni Vittori, Lorenzo Masieri, Mauro Gacci, Alberto Lapini,
Giampaolo Siena, Graziano Vignolini, Andrea Mari, Marco Carini, and Andrea Minervini

T1a-T1b renal tumors – 160 OSE vs 80 ERASE

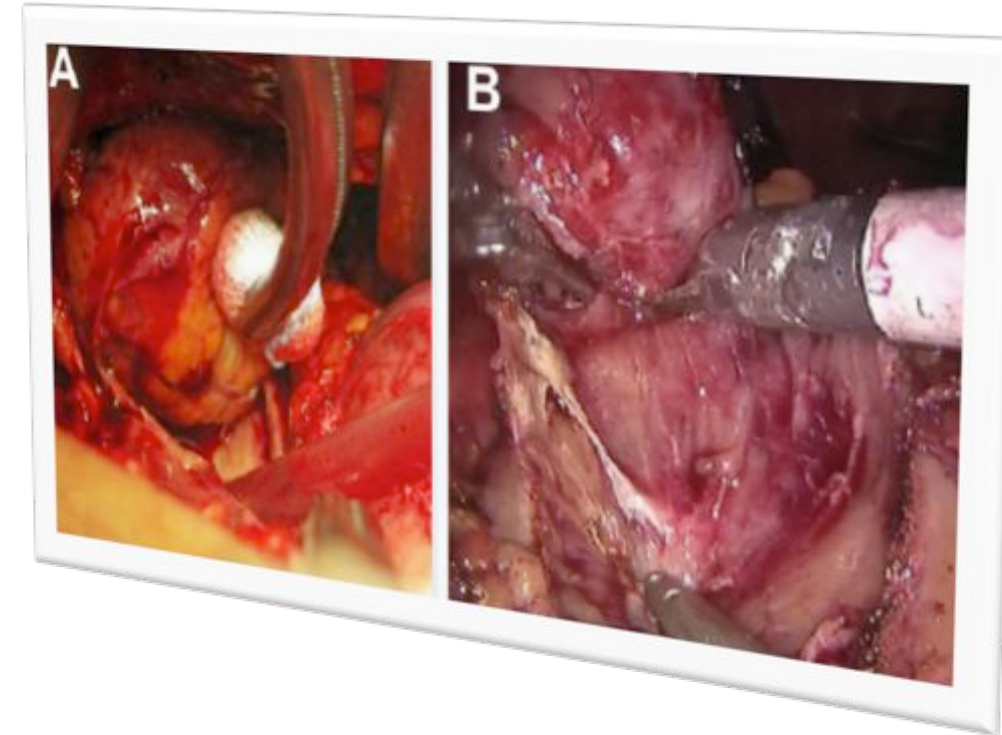


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T1a-T1b renal tumors – 160 OSE vs 80 ERASE

- No significant differences in WIT, complications, transfusion rate, reoperation rate, PSM
- In the ERASE group, lower EBL, longer operative time, and a 1-day shorter hospitalization
- On the multivariate analysis, the surgical approach was NOT independently associated with WIT >25 minutes, postoperative complications, and AKD.



CONCLUSION

ERASE is feasible and is associated with a PSM rate and perioperative outcomes, namely with WIT, complications, and early functional results, similar to those reported after OSE.

New pathways to expedite postoperative recovery

One- vs 4-week stent placement after laparoscopic and robot-assisted pyeloplasty: results of a prospective randomised single-centre study

H. Danuser, C. Germann, N. Pelzer, A. Rühle, P. Stucki and A. Mattei

Klinik für Urologie, Luzerner Kantonsspital, Lucerne, Switzerland

Patients and Methods

A total of 100 patients with pelvi-ureteric junction obstruction were treated by Anderson-Hynes pyeloplasty and the anastomosis was stented using a 6-F JJ catheter for either 1 week (1W series) or 4 weeks (4W series), based on a randomisation protocol. Postoperative follow-up was

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Stenting time	Success rate, %	Residual symptoms, %	Complications, %	Synchronous pyelolithotomy, %	Median renal function treated side, % (range)	Median renal function improvement, % (range)	Median surgery time, min (range)	Median hospitalisation, days (range)
1 week: $n = 50$	98	10	4	4	47 (14–70)	1 (-16 ± 28)	201 (103–410)	5 (3–12)
4 weeks: $n = 50$	100	6	6	8	45 (5–57)	0 (-18 ± 19)	192 (106–430)	6 (4–12)
P	0.006*	0.48 [‡]	0.65 [‡]	0.47 [‡]	0.25 [†]	0.59 [†]	0.87 [†]	0.01 [†]

Conclusions

Stenting of the pelvi-ureteric anastomosis after laparoscopic or robot-assisted pyeloplasty for 1 week is as effective as stenting for 4 weeks. Both procedures, laparoscopic or robot-assisted pyeloplasty have an excellent success rate.

Clinical Pathway After Robotic Nephroureterectomy: Omission of Pelvic Drain With Next-day Catheter Removal and Discharge

Tariq A. Khemees, Samiha M. Nasser, and Ronney Abaza



RNU was performed in 29 patients with mean age and body mass index of 69 years (50-90 years) and 30 kg/m² (19-41 kg/m²), respectively. No patient required a pelvic drain, and 2 were discharged with a catheter. All but 2 patients (93%) were discharged on POD#1. Overall, successful pathway application was achieved in 26 of 29 patients (90%) including no drain, catheter removal on the morning after surgery, and discharge on POD#1. No patient developed urine leak or other complications related to early catheter removal.

Early discharge after laparoscopic or robotic partial nephrectomy: care pathway evaluation

Amit Patel, Shay Golan*, Aria Razmaria*, Sandip Prasad†, Scott Eggener* and Arie Shalhav*

Department of Urology, DuPage Medical Group, Downers Grove and *Section of Urology, University of Chicago, Chicago, IL, and †Department of Urology, Medical University of South Carolina, Charleston, SC, USA

Table 1 Minimally invasive PN care pathway.

Preoperative

Care plan is thoroughly described to the patient by a physician or physician-extender during clinic visit and again at the day of surgery.

s.c. heparin (5000 units) is given prior to incision.

Postoperative (day 0)

CBC and BMP.

If stable, patient is transferred to a regular nursing unit.

Acetaminophen (650 mg every 6 h) and ibuprofen (400 mg every 6 h) or i.v. ketorolac. If GFR <60 mL/min/1.73 m², intermittent doses of i.v. opioids were used instead.

Ambulation and alimentation (liquids and soft diet).

Postoperative (day 1)

CBC and BMP

Removal of urethral catheter (at 0600 h)

Continues ambulation (for 15 min every 2 h)

Removal of drain (if <80 mL per 8-h shift)

Discharge with analgesics regimen (ibuprofen and acetaminophen ± tramadol)

New tools to aid in clinical decision making

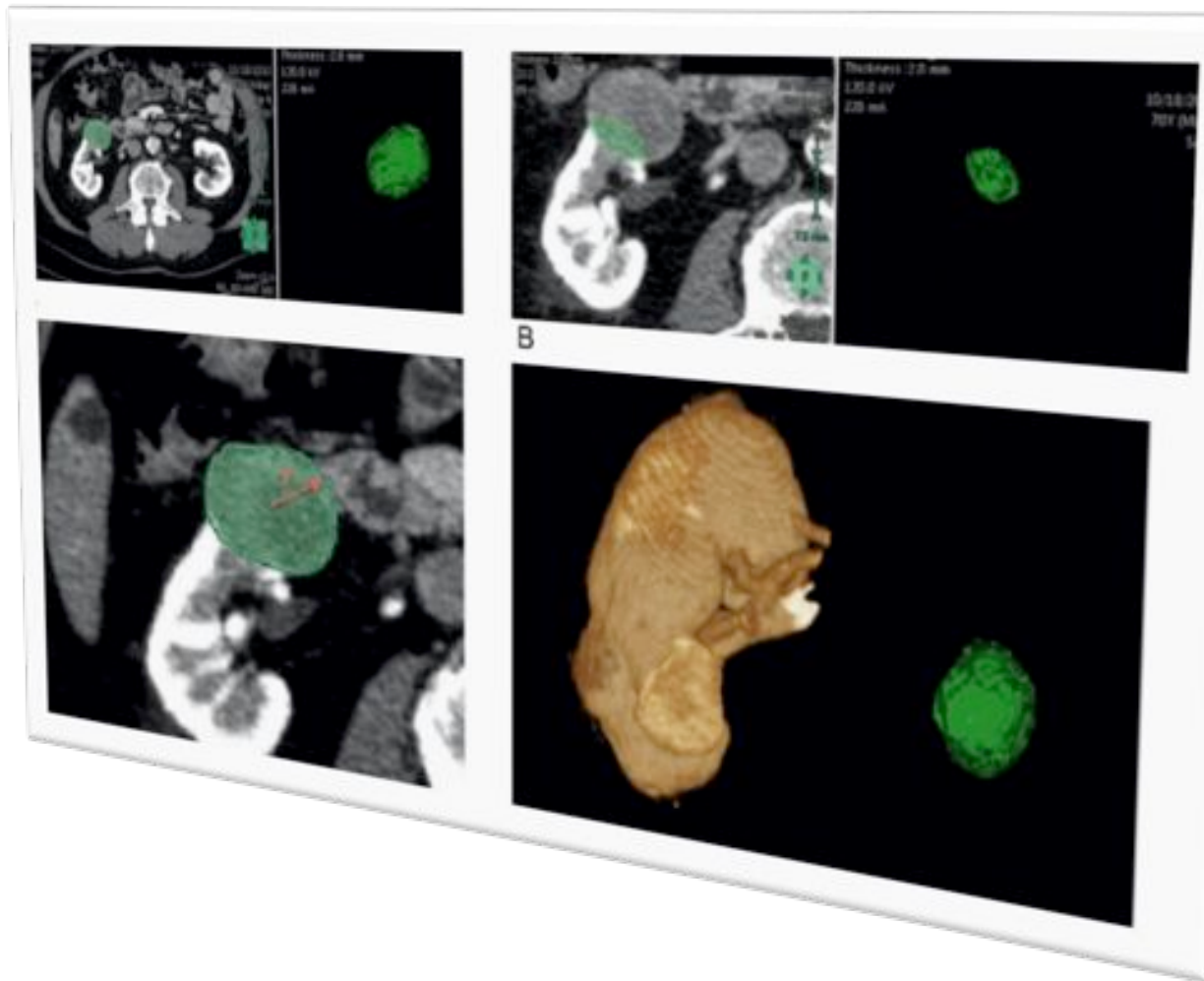
Platinum Priority – Kidney Cancer
Editorial by XXX on pp. x–y of this issue

Renal Tumor Contact Surface Area: A Novel Parameter for Predicting Complexity and Outcomes of Partial Nephrectomy

Scott Leslie^a, Inderbir S. Gill^a, Andre Luis de Castro Abreu^a, Syed Rahmanuddin^b,
Karanvir S. Gill^a, Mike Nguyen^a, Andre K. Berger^a, Alvin C. Goh^a, Jie Cai^a,
Vinay A. Duddalwar^b, Monish Aron^a, Mihir M. Desai^{a,*}

5. Conclusions

CSA is a novel, readily measurable CT-based imaging parameter that quantifies renal tumor complexity. This initial validation study suggests that CSA may predict perioperative events after PN. Specifically, CSA correlates with operative time, EBL, LOS, complications, and renal function. CSA may also be a clinical predictor of renal mass pathology. If validated externally in a larger cohort of patients, CSA may be incorporated into future versions of current nephrometry scoring systems.



Synapse 3D software:

- 5 min per patient
- High interobserver correlation

Internal Validation of the Renal Pelvic Score: A Novel Marker of Renal Pelvic Anatomy That Predicts Urine Leak After Partial Nephrectomy

Jeffrey J. Tomaszewski, Marc C. Smaldone, Bic Cung, Tianyu Li, Reza Mehrazin, Alexander Kutikov, Daniel J. Canter, Rosalia Viterbo, David Y. T. Chen, Richard E. Greenberg, and Robert G. Uzzo

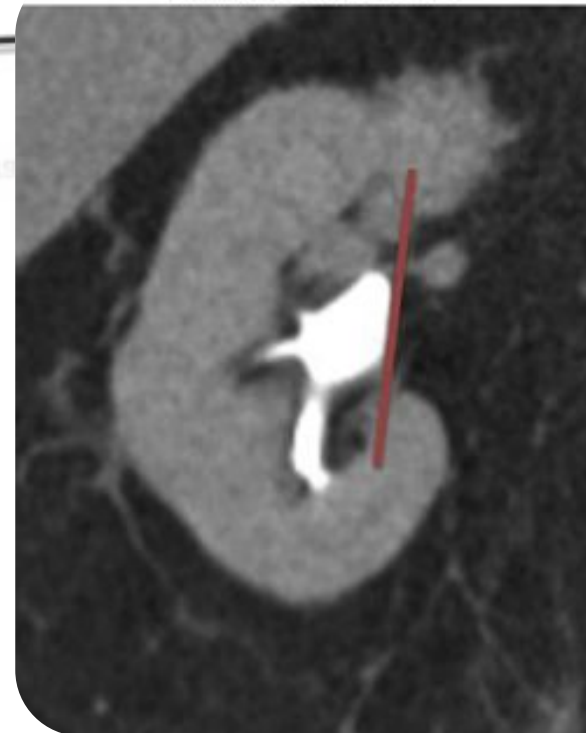
CONCLUSIONS

Herein, we identify a single anatomic feature, the RPS, which most reliably predicts the occurrence of a urinary leak after open or minimally invasive NSS and the efficiency of interventions to correct the leak. Elevated

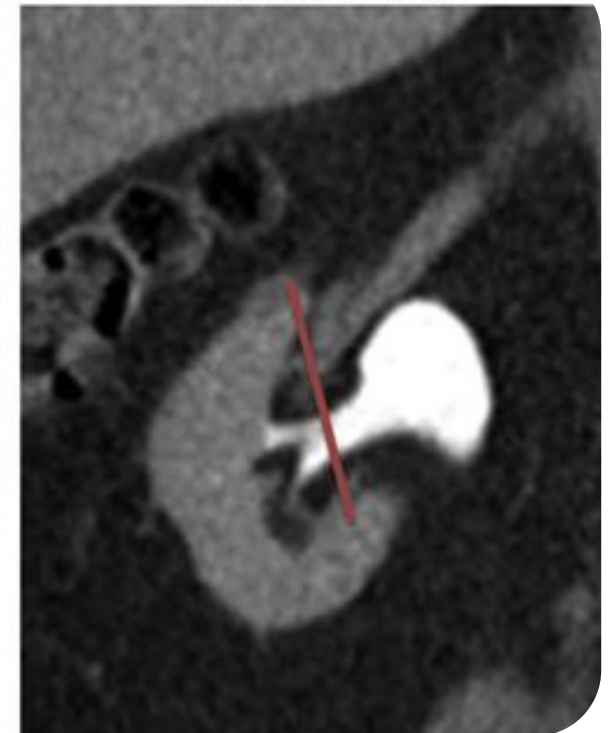
Table 3. Multivariate analysis demonstrating associations between patient characteristics and urine leak*

Variable	OR	95% CI	P Value
Intrarenal pelvis	24.8	13.2-169.4	<.001
"E"xophytic/endophytic score, 3 (vs 1)	4.5	1.3-15.5	.0182
Collecting system entry	6.1	2.5-14.9	<.001

Intrarenal renal pelvis



Extrarenal renal pelvis

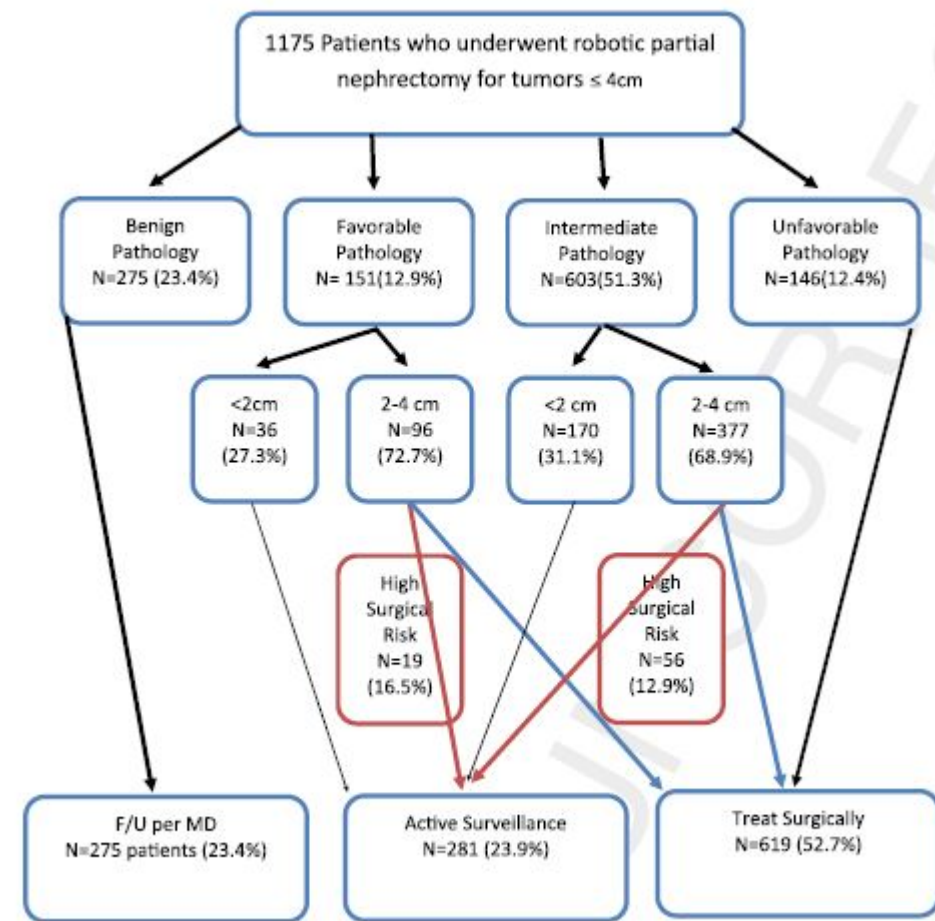


Evaluation of Renal Mass Biopsy Risk Stratification Algorithm for Robotic Partial Nephrectomy—Could a Biopsy Have Guided Management?

Haider Rahbar, Sam Bhayani, Michael Stifelman,* Jihad Kaouk, Mohamad Allaf, Susan Marshall, Homayoun Zargar, Mark Ball, Jeffrey Larson and Craig Rogerst,‡

From the Vattikuti Urology Institute, Henry Ford Hospital, Detroit, Michigan (HR, CR), Division of Urologic Surgery, Washington University School of Medicine, Saint Louis, Missouri (SB, JL), Department of Urology, New York University Langone Medical Center, New York, New York (MS, SM), The Glickman Urological Institute, Cleveland Clinic, Cleveland, Ohio (JK, HZ), and the James Buchanan Brady Urological Institute, The Johns Hopkins Medical Institutions, Baltimore, Maryland (MA, MB)

- Simplified algorithm of biopsy directed SRM management previously reported using risk stratified biopsies was applied to 1,175 robotic partial nephrectomy cases from 5 academic centers.
- A theoretical assumption was made of perfect biopsies that were feasible for all patients and had 100% concordance to final pathology.



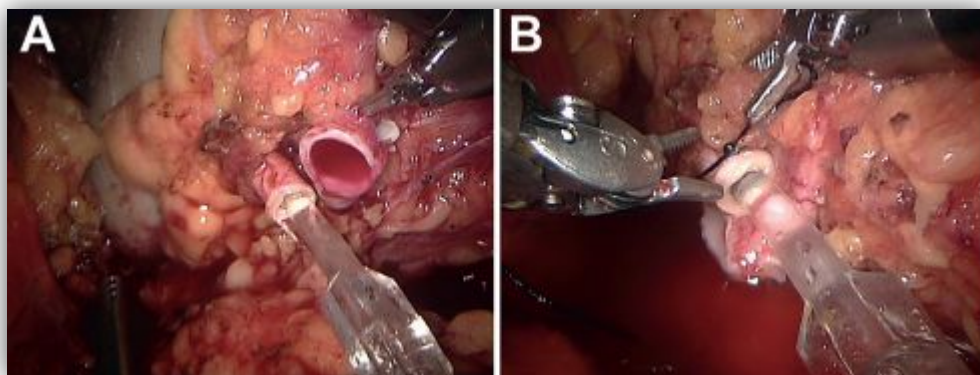
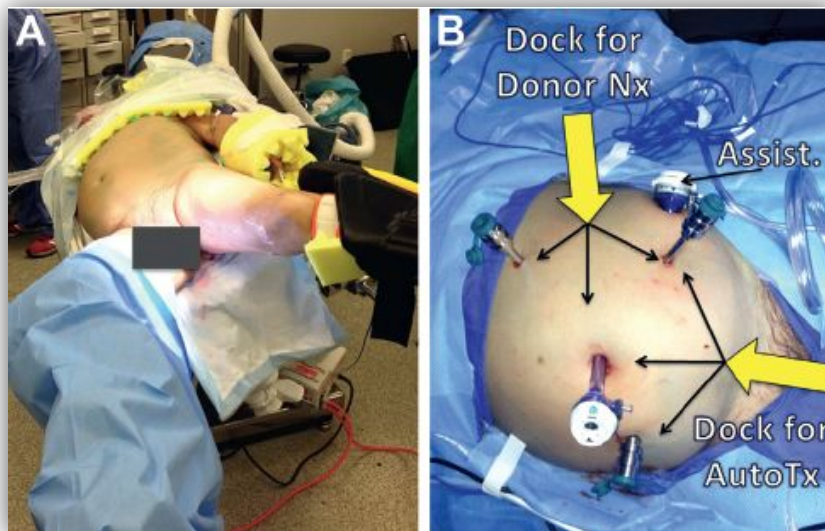
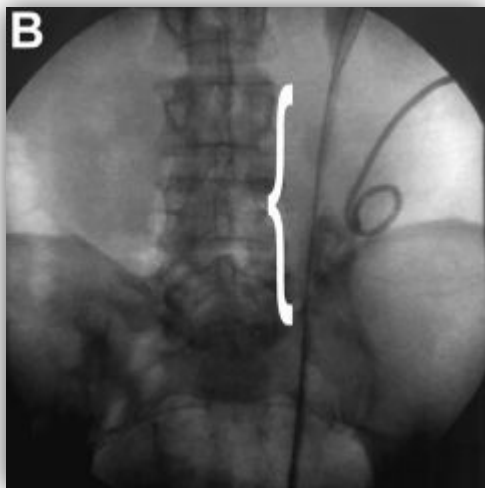
Conclusions: The theoretical application of a biopsy driven, risk stratified small renal mass management algorithm to a large robotic partial nephrectomy database suggests that about half of the patients might have avoided surgery. Despite the obvious limitations of a theoretical assumption of all patients receiving a perfect biopsy, the data support the emerging role of renal mass biopsies to guide management, particularly in high risk surgical patients.

New techniques & technologies

Completely Intracorporeal Robotic Renal Autotransplantation

Zachary N. Gordon,* Jordan Angell and Ronney Abaza†

Department of Urology, Ohio State University Wexner Medical Center and James Cancer Hospital, Columbus, Ohio



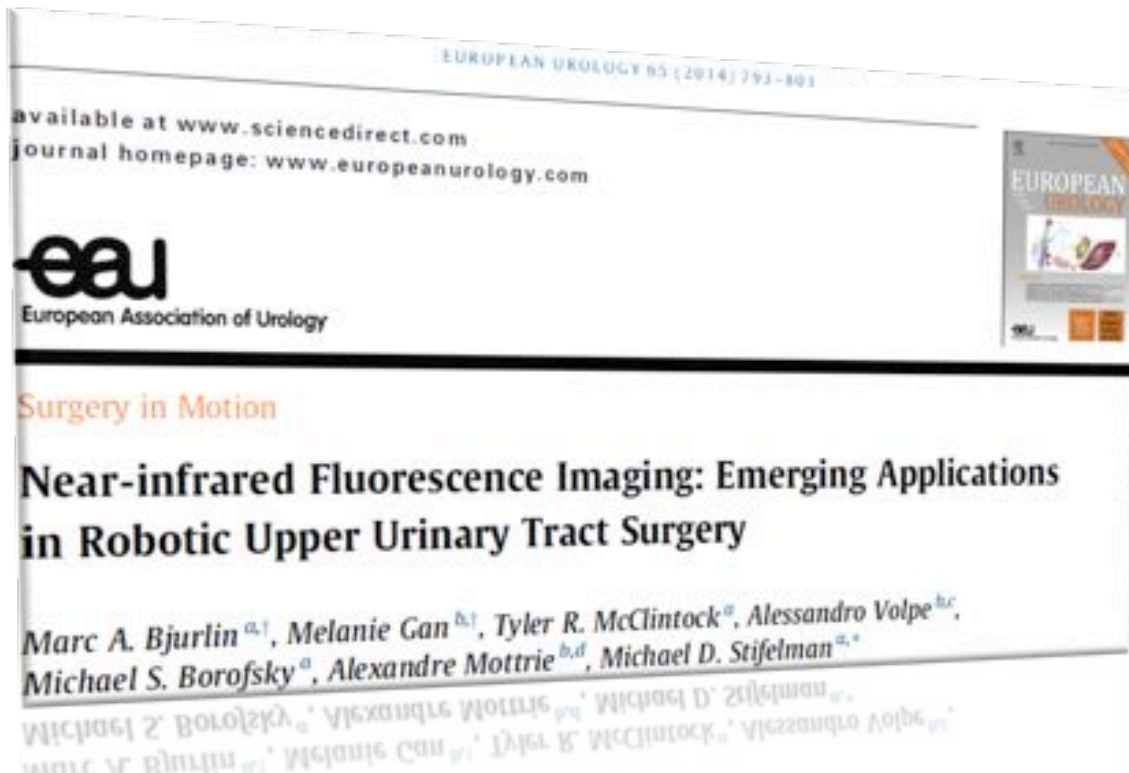
CONCLUSIONS

Although technically challenging, completely intracorporeal robot-assisted nephrectomy with RATx is a feasible approach to renal preservation after major ureteral injury. This operation may be considered in select patients in the hands of experienced robotic surgeons. However, further refinement is required as this novel procedure is cautiously reproduced and adopted by others.

Operative parameters, mean (SD) [range]	Robotic KT (n = 25)
Operative time: Incision to closure, min	214.1 (39.8) [156–293]
Console time: Console start to finish, min	135.4 (31.2) [94–201]
Vessel bed preparation time, min	15.8 (5.9) [9–32]
Ischemia times	
Warm ischemia time, min	2.4 (1.1) [1.5–6.0]
Rewarming time (with ice slush), min	46.6 (9.3) [27–66]
Total, min	75.3 (19.2) [50.7–142.5]
Vascular anastomoses times	
Arterial anastomosis, min	12.0 (2.6) [7–17]
Venous anastomosis, min	13.4 (3.4) [8–21]
Ureterovesical anastomosis time, min	17.4 (5.8) [11–33]
Intracorporeal kidney cooling	
Surface temperature (before unclamping), °C	20.3 (2.9) [14.5–27.8]
Amount of ice slush used, ml	334.6 (87.6) [240–480]
Blood loss, ml	151.7 (103.5) [50–450]
Intraoperative vascular injuries, yes:no, No. (%) [*]	0 (0)
Incision length, cm	6.1 (0.5) [5.4–7.1]
Need for anastomotic revision (vascular or ureterovesical) [*]	0 (0)
Conversion to open surgery, no. (%) [*]	0 (0)

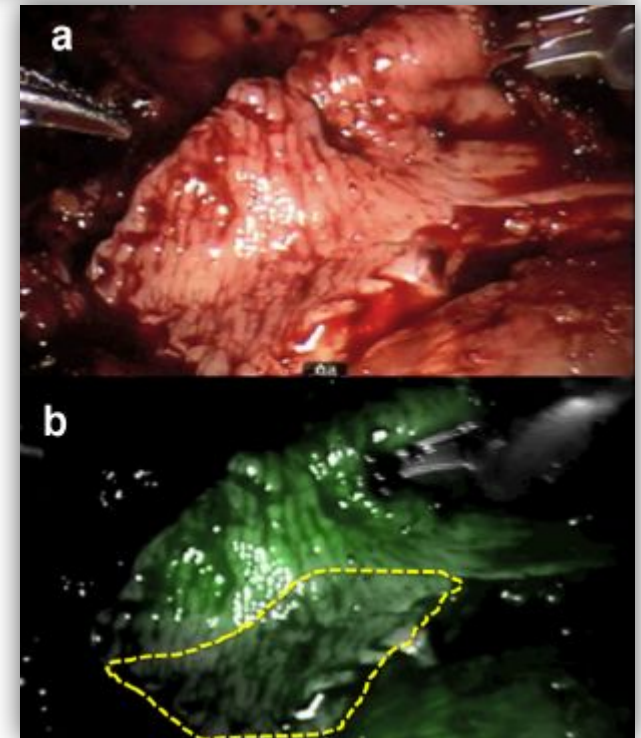
- All grafts functioned immediately post-transplant
- Postop complication rate: 16%
 - no patient developed anastomotic leaks, wound complications, or wound infections.
 - no patient had developed a lymphocele detected on CT scanning.
 - 2 patients underwent re-exploration
 - 1 patient died of CHF

Conclusions: RKT with regional hypothermia is safe and reproducible when performed by a team skilled in robotic surgery.



- 48 RPN: EBL 200 ml, WIT 17 min, PSM 3.8%, CR 12.5%
- 42 reconstructive procedures: pyeloplasty (n=20), ureteral reimplant (n=13), ureterolysis (n = 7), and ureteroureterostomy (n = 2): overall success rate 95.2%.

Conclusions: Our technique of RPN with selective arterial clamping and robotic upper urinary tract reconstruction utilizing NIRF imaging is presented. This technology provides real-time intraoperative angiogram to confirm selective ischemia and may be an adjunct technology to confirm well-perfused tissue within a reconstruction anastomosis.





Surgery in Motion

Robot-assisted, Single-site, Dismembered Pyeloplasty for Ureteropelvic Junction Obstruction with the New da Vinci Platform: A Stage 2a Study

Nicolò Maria Buffi^{a,*}, Giovanni Lughezzani^a, Nicola Fossati^a, Massimo Lazzeri^a,
Giorgio Guazzoni^a, Giuliana Lista^a, Alessandro Larcher^a, Alberto Abrate^a, Cristian Flori^b,
Andrea Cestari^c, Francesco Porpiglia^b

Andrea Cestari^c, Francesco Porpiglia^b,
Giorgio Guazzoni^a, Giuliana Lista^a, Alessandro Larcher^a, Alberto Abrate^a, Cristian Flori^b,
Nicolò Maria Buffi^{a,*}

- Median OT: 160 min; median hospital stay: 5 days
- Two conversions; no intraoperative complications; in three cases, additional 5-mm trocar needed
- Postoperative complications rate 26% (n = 8), mostly grade 1-2
- Overall success rate: 93.3% (n = 28) at a median follow-up of 13 mo

Conclusions: Single-site robotic pyeloplasty is a feasible technique in selected patients, with good cosmetic results and excellent short-term clinical outcomes. Prospective studies are needed to further assess its role for the treatment of UPJO.

- Pilot study of 30 consecutive cases of R-LESS pyeloplasty performed at two participating institutions

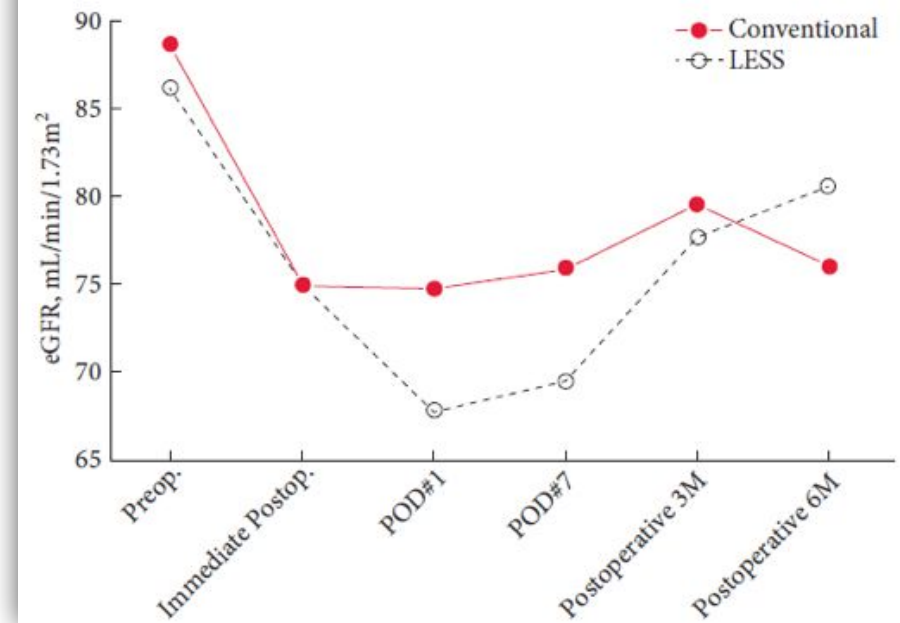
Laparoendoscopic single-site (LESS) robot-assisted partial nephrectomy (RAPN) reduces postoperative wound pain without a rise in complication rates

Tae Young Shin[†], Sey Kiat Lim[‡], Christos Komninos[§], Dong Wook Kim[¶], Woong Kyu Han^{*}, Sung Jun Hong^{*}, Byung Ha Jung^{*} and Koon Ho Rha^{*}

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Variable	C-RAPN	LESS-RAPN	P
Patients' demographics			
No. of patients	80	79	
Mean (SD) age, years	52.0 (13.2)	52.4 (12.9)	0.840
Gender: male; female, n (%)	47 (58.8); 33 (41.2)	51 (63.8); 29 (36.2)	0.519
Mean (SD) body mass index, kg/m ²	24.6 (3.2)	24.0 (3.0)	0.277
ASA score, n (%)			0.325
I, II	78 (97.5)	75 (95.0)	
III, IV	2 (2.5)	4 (5.0)	
Perioperative outcomes			
Mean (SD) TOT, min	183.1 (76.1)	210.3 (83.4)	0.033
Mean (SD) WIT, min	19.8 (13.1)	26.5 (10.5)	0.001
Mean (range) estimated blood loss, mL	313.0 (30–1600)	334.9 (30–1550)	0.669
Mean (SD) hospital stay, days	4.8 (2.2)	4.6 (2.1)	0.645
Mean (SD) VAPS	2.1 (1.3)	1.7 (1.0)	0.048

Fig. 1 Comparison of postoperative recovery of renal function between C-RAPN and LESS-RAPN. POD, postoperative day; 3M, 3 months; 6M, 6 months.



Conclusions

Despite a significantly longer WIT and TOT, the functional outcomes of LESS-RAPN were comparable to those of C-RAPN for tumours of similar mean sizes and complexities, without any detriments in oncological and complications outcomes. On discharge, patients who underwent LESS-RAPN also reported lower pain levels as one of the advantages of minimally invasive surgery. With the development of

The cost issue: focus on RN

Does Robotic Assistance Confer an Economic Benefit during Laparoscopic Radical Nephrectomy?

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Department of Urology, Indiana University School of Medicine, Indianapolis, Indiana

- National Inpatient Sample database from 2009 to 2011
- 24,312 RN - 32% robotically done

Table 2. Multivariable linear regression of average hospital costs and charges associated with radical nephrectomy hospitalization

	Costs		Charges	
	\$ Coefficient (95% CI)	p Value	\$ Coefficient (95% CI)	p Value
RARN (vs LARN)	4,565 (4,141–4,988)	<0.001	11,267 (9,447–13,088)	<0.001
CCI	587 (335–839)	<0.001	2,813 (1,465–4,161)	<0.001
Complication	1,192 (316–2,069)	0.008	5,682 (1,586–9,778)	0.007
LOS 10 days or less	1,705 (1,550–1,860)	<0.001	6,609 (5,938–7,279)	<0.001
Constant	6,459 (5,973–6,946)	<0.001	21,441 (19,388–23,495)	<0.001

Conclusions: Robotic assisted radical nephrectomy results in increased medical expense without improving patient morbidity. Assuming surgeon proficiency with pure laparoscopy, robotic technology should be reserved primarily for complex surgeries requiring reconstruction. Traditional laparoscopic techniques should continue to be used for routine radical nephrectomy.

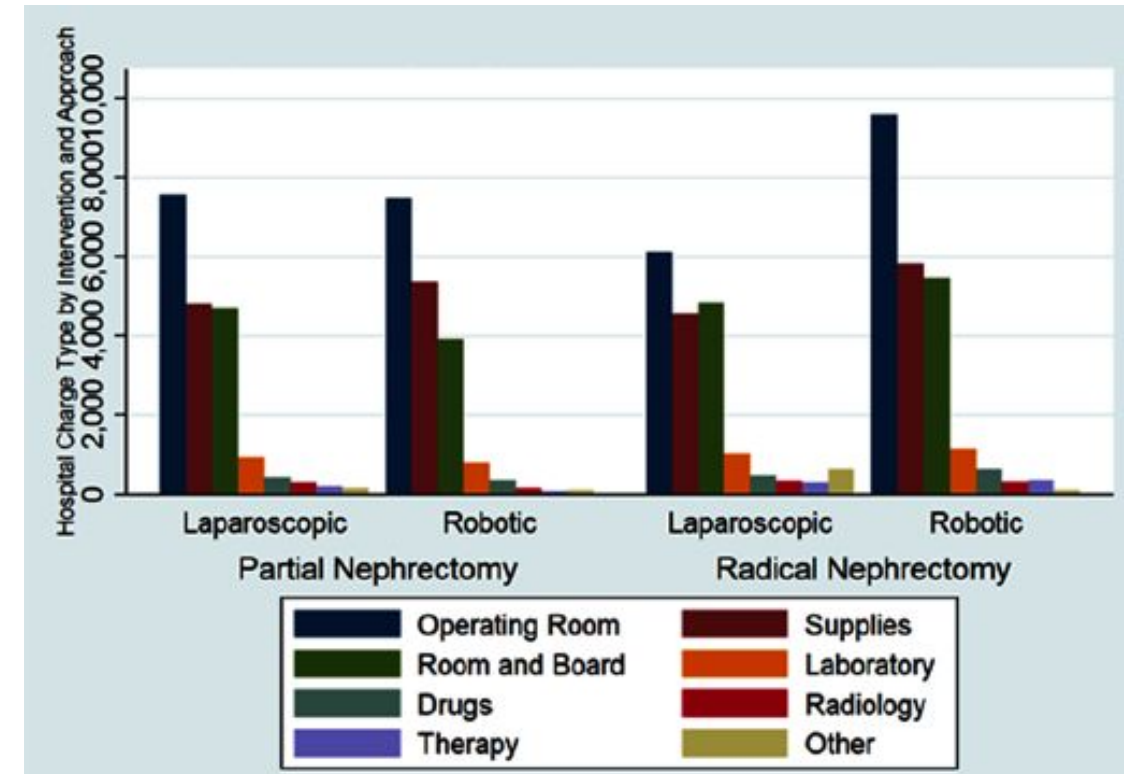
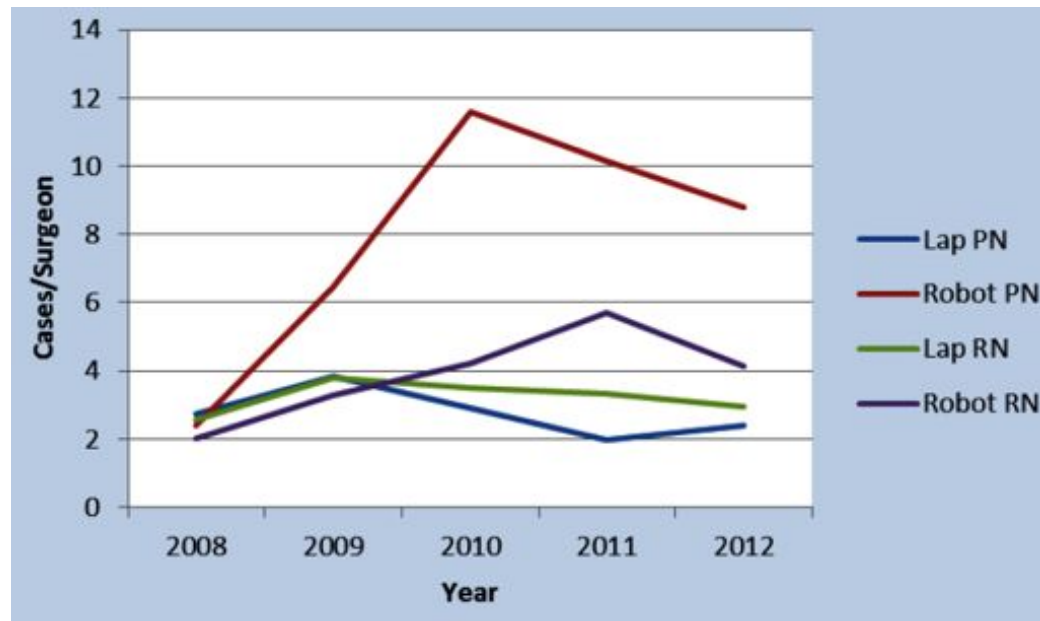
The Financial Impact of Robotic Technology for Partial and Radical Nephrectomy

Max Kates MD Mark W. Ball MD, Hiten D Patel MD, Michael A. Gorin MD, Phillip M. Pierorazio MD, Mohamad E. Allaf MD.

Running Title: Finances of Robotic Kidney Surgery

The James Buchanan Brady Urological Institute and Department of Urology, The Johns Hopkins School of Medicine, Baltimore, MD

Methods: The Maryland Health Services Cost Review Commission (HSCRC) documents all acute care hospital charges data. This database was queried for patients who underwent laparoscopic or robotic RN and PN from 2008-2012. Total hospital charge, sub-charge and length of stay (LOS) were analyzed separately for RN and PN.



2014 BEST ROBOTIC RENAL SURGERY LITERATURE: TAKE HOME MESSAGES

- **Evidence supporting RPN is steadily growing**
 - *rapidly becoming the new standard for MIPN*
 - *associated with higher rates of PN*
 - *as good as OPN*
- **New tools (ie CSA, RPS) available to aid in clinical decision making**
 - *role & clinical usefulness remain to be determined*
- **Care pathways for expedite postoperative recovery**
 - *external validation needed*
- **Novel robotic kidney procedures & technologies are available**
 - *within the realm of referring centers with high robotic skills*
 - *“IDEAL” assessment as key for their safe implementation*
- **Cost associated with robotics remains under scrutiny**
 - *LRN still more cost-effective than RRN*

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Renal surgery represents one of the most active and exciting area of research & investigation in urologic robotic surgery

- *LRN*

- Cost associated

- *LRN still more cost-effective*



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