Oncological outcomes of partial nephrectomy for tumours larger than 4 cm: A systematic review

Tarek H. El-Ghazaly, MD; Ross J. Mason, MD, BSc; Ricardo A. Rendon, MD, MSc, FRCSC

Department of Urology, Dalhousie University, Halifax, NS

Cite as: *Can Urol Assoc J* 2014;8(1-2):61-6. http://dx.doi.org/10.5489/cuaj.1682
Published online February 10, 2014.

Abstract

Introduction: Many medical associations recommend nephron-sparing surgery (NSS) for tumours larger than 4 cm amenable to partial nephrectomy (PN). These recommendations are, however, mostly based on isolated reports. We systematically review the oncological outcomes of partial nephrectomy procedures performed for tumours larger than 4-cm.

Methods: A PubMed search was carried out using keywords "partial nephrectomy" and "nephron sparing" for records dating back to 1995. In total, 2136 abstracts were analyzed; from these, 174 studies were scrutinized. We identified 32 manuscripts reporting size-specific cancer-specific survival rates for masses greater than 4 cm. From each of these studies, we recorded the number of PN, tumour diameter, follow-up duration, 5- and 10-year recurrence, overall and cancer-specific survival rates (OS, CSS). We also calculated weighted OS and CSS rates.

Results: This systematic review includes 2445 patients with renal tumours larger than 4 cm who underwent PN: 1858 patients with tumours between 4 to 7 cm, 410 patients with tumours larger than 7 cm and 177 patients with tumours greater than 4 cm (exact size unknown). Our analysis revealed weighted 5-year CSS rates of 95.4%, 86.2% and 93.9% for tumours 4 to 7 cm, >7 cm, and all tumours >4 cm, respectively. The respective 5-year OS rates were 84.7%, 76.4%, and 84.7%.

Conclusions: We found excellent 5-year CSS and OS rates for patients with tumours 4 to 7 cm treated with PN. These outcomes compare favourably to those reported in historical radical nephrectomy (RN) series for similarly sized tumours. Thus, PN is an acceptable and often preferred treatment for renal masses >4 cm which are amenable to nephron-sparing procedures.

Introduction

Well-established as the standard of care for renal tumours smaller than 4 cm, partial nephrectomy (PN) is less often considered for larger tumours. This 4-cm cutoff was initially set as a threshold for PN following individual studies that reported poorer cancer-specific survival (CSS) in larger tumours resected through nephron-sparing (NSS) procedures.[1-3] More recently, however, larger studies comparing overall survival (OS) and CSS after partial and radical nephrectomies for T1b tumours have established NSS as an option with equivalent oncological outcomes and a significantly lower incidence of postoperative chronic kidney disease.[4-11] Based on these isolated studies, many medical associations (American Urological Association, European Association of Urology and the National Comprehensive Cancer Network) now recommend NSS for tumours larger than 4 cm which are surgically amendable to this approach.

In light of this paradigm shift and our belief that practice-changing decisions should be based on aggregated data rather than isolated studies, we present a systematic review of the literature (from 1995 to 2011) for oncological outcomes of PN performed specifically for tumours larger than 4 cm. To the best of our knowledge, this is the only published systematic review reporting aggregated oncological outcomes of renal masses >4 cm.

Methods

Using the PubMed database in January 2012, we searched for "partial nephrectomy" and "nephron sparing." We wanted to identify the aggregated oncological outcomes of NSS performed for tumours larger than 4 cm in humans over the past 16 years. The reason for choosing this 16-year time period was to capture contemporary data with evolved PN techniques that reflected the use of elective rather than imperative partial nephrectomy. We also wanted our results to better reflect the understanding of renal anatomy and renal cell carcinoma (RCC) gained over the past 15 to 20 years. The search was limited to English-language human studies, published between January 1, 1995 and December 31, 2011. This search yielded 2250 and 979 articles containing the terms "partial nephrectomy" and "nephron sparing,"

respectively. We removed case reports (only 1 patient), editorial letters and review articles from the results; although we noted the review articles for subsequent citation review. This reduced the results to 1507 and 629 entries for both terms. After manually reviewing all 2136 abstracts and 28 review articles citations, we eliminated duplicate entries and irrelevant studies; in the end, 174 studies of interest were compiled. These articles were scrutinized for studies reporting 5-year oncological outcomes specific to NSS procedures performed for renal masses greater than 4 cm in diameter, without contamination of data pertinent to smaller masses. A total of 32 case series satisfying our aforementioned inclusion criteria were identified[1,3-5,10,12-38] (Fig. 1). Weighted average values were extracted from each case series, factoring in their respective sample sizes. Measured parameters included the number of PN procedures, tumour size, follow-up duration, local and distant recurrence rates and OS and CSS rates.

Results

A total of 2445 patients with renal tumours larger than 4 cm in diameter who underwent PN were included in identified studies published between 1995 and 2011. This number includes 1858 patients (76%) with tumours between 4 to 7 cm, 410 patients (16.8%) with tumours larger than 7 cm, and 177 patients (7.2%) with tumours of non-specified diameters greater than 4 cm (Table 1). Information on surgical approach was available for 1564 patients from 15 studies and included 1311 open PN, 252 laparoscopic PN, and 1 robotic PN.[15,17-20,22,25,27,28,30,32-36]

The mean tumour diameter was 5 and 8.1 cm for masses 4 to 7 cm and >7 cm in diameter, respectively. The median follow-up duration was available for 1735 patients (71%) and was estimated at 4.5 years. The weighted mean follow-up duration was 3.8 years and was relevant for only 896 patients (36.6%). The 5-year local and distant recurrence rates for masses 4 to 7 cm in diameter were 3.3% and 7.3%, respectively. For masses greater than 7 cm in diameter, we found that local and distant recurrence rates were higher at 8.8% and 18.7%, respectively (Table 2).

The 5-year CSS and OS rates were 95.4% and 87.1% for masses between 4 to 7 cm in diameter, and 86.2% and 78% for masses greater than 7 cm in diameter, respectively (Table 3).

Discussion

PN has undergone a transition from being reserved for patients with compromised renal function to one electively offered to patients with two normal-functioning renal units; the use of PN has increased from 15.3% in 2002 to 24.7% in 2008 ($p < 0.001$).[39] Regarding T1b renal masses, the rate of PN utilization has reached 35% in European tertiary care centres.[40] This shift had initially begun to materialize with the emergence of studies examining the outcomes of PN procedures performed in the early 1990s demonstrating equivalent oncological and superior renal function outcomes of PN performed for smaller renal masses, when compared to RN.[7,8,41] These studies, coupled with others that showed significant improvement in OS, led to the expansion of the use of PN to include larger masses. Furthermore, it was found that the prognosis worsened as masses became larger, not only for patients treated with NSS procedures, but also for those treated with RN.[42-46] This outcome led many authorities to reconsider the role of tumour size when planning elective surgical management. Currently, the empirical consensus is that as long as safe resection can be achieved, then the oncological outcomes should be similar.

Challenging the 4-cm cutoff diameter, 3 studies in this review compared the oncological efficacy of PN for both T1a and T1b masses.[24,26,32] Having examined 839 elective PNs for malignant tumours, Patard and colleagues reported no significant differences in positive surgical margins, local or distant recurrence rates, and CSS between tumours less than or greater than 4 cm.[24] Similar findings were reported by Filipas and colleagues. In their study, 132 patients with tumours less than 4 cm had a 5-year OS rate of 91.6% and a CSS rate of 98.1%, compared to an OS rate of 92.6% and a CSS rate of 97.0% in 48 patients with a tumour diameter greater than 4 cm.[32] Antonelli and colleagues compared the outcomes of 313 T1a and T1b managed by either RN or PN, with a mean follow-up period between 54.3 and 78.8 months. There were no significant differences between the masses assigned to either procedure in regards to histologic type and the incidence of high nuclear grade (G3-4). Within both-sized groups, differences in disease progression and disease-free survival rates after either procedure were non-significant.[26]

In this review, we found that the aggregated 5-year local (3.3%) and distant (7.3%) recurrence rates for T1b tumours treated with PN is lower than those of tumours larger than 7 cm (7.3% and 18.7%, respectively). The 5- and 10-year CSS rates for masses larger than 7 cm in diameter were also inferior, at 86.2% and 74.9%, respectively. We hypothesize that this decrease in recurrence-free and CSS rates with tumours >7 cm might be due to a higher incidence of aggressive tumour biology in larger masses. This has been previously suggested by Turun and colleagues who found a significant increase in the odds ratio of high-grade disease by 1.46 with each 1-cm increase in tumour diameter.[47] The higher recurrence and mortality rates associated with masses greater than 7 cm treated with PN might initially suggest that a better outcome can be achieved with RN. However, in studies including a comparison of both procedures for masses greater than 7 cm, there was almost no difference

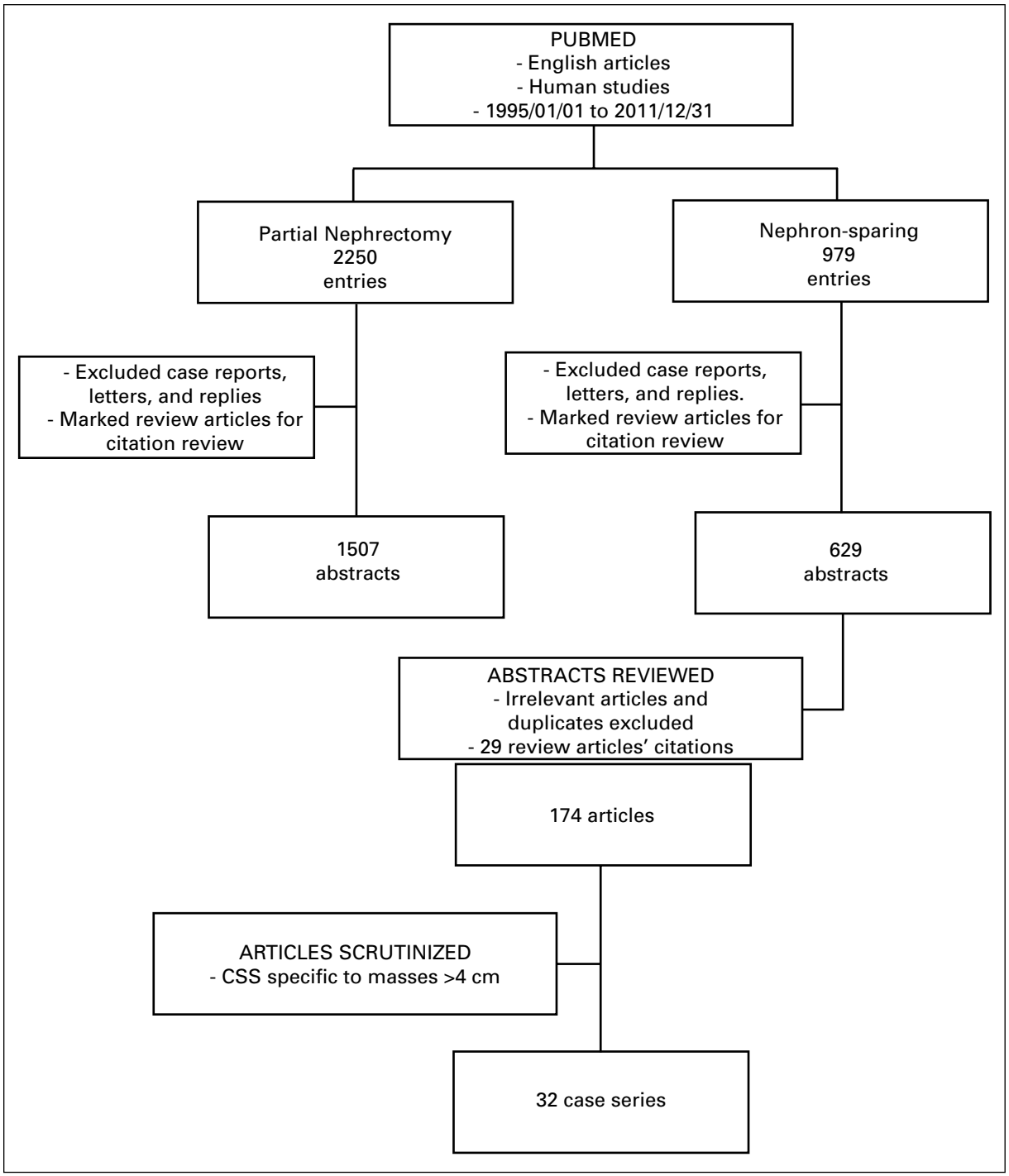

Fig. 1. Overview of search strategy and study selection.

in 5-year CSS between either procedure, weighted at averages of 74% versus 75% for PN and RN, respectively.[14,25] Similarly, PN compared favourably to RN for T1b renal masses in studies that included a comparison of both procedures with a trend towards higher CSS and OS in patients undergoing PN (weighted averages of 97% vs. 88.4% and 94.5% vs. 82.6%, respectively, Table 4).[4,5,17,21]

When deciding optimal surgical procedure (PN vs. RN), some authors have demonstrated a higher chance of tumour multifocality in patients with larger renal masses suggesting a potential benefit to RN.[48,49] However, Gupta and colleagues, in their study of 58 patients with multifocal RCC, found that multifocality did not affect oncological outcomes of PN, and that PN can be safely offered to patients presenting with

Table 1. Overview of partial nephrectomy procedures

	All >4 cm	4.1–7 cm	>7 cm
No. procedures	2445	1858	410
Mean tumour size (cm)	5.6 (n = 1498, 61.3%)	5 (n = 916, 49.3%)	8.1 (n = 192, 46.8%)
Median follow-up (years)	4.5 (n = 1735, 71%)	5.1 (n = 1004, 54.4%)	3.8 (n = 215, 52.4%)
Mean follow-up (years)	3.8 (n = 896, 36.6%)	4 (n = 361, 19.4%)	4.4 (n = 88, 21.5%)

multifocal tumours greater than 4 cm.[14] Furthermore, many studies have demonstrated that, in T1 and T2 masses, multifocality of RCC occurs independently from primary tumour size.[50,51]

Urologists contemplating elective PN for larger renal masses are often concerned with the increased incidence of postoperative complications (higher in comparison with RN[34]). However, when analyzing the risk for complications in 507 LPN procedures, Tuma and colleagues found that if PN is performed by experienced surgeons, then increasing mass size, patient age or ASA score do not significantly affect complication rate.[52]

Another important question is regarding the role of PN in elderly patients with larger renal masses. Roos and colleagues compared the functional and oncological outcomes in young patients undergoing PN or RN for renal tumours larger than 4 cm to those of elderly patients. They wanted to assess the impact of age and the choice of surgery on oncological control and residual renal function following either procedure.[34] In both age groups, patients who underwent RN had a much lower estimated glomerular filtration rate at the last available follow-up than patients who underwent PN. New onset of chronic kidney disease for patients treated with NSS or RN was 15.5% and 31.1% of young and in 24.2% and 50.9% of elderly patients, respectively. Differences in OS and CSS rates between the two procedures were not significant within the same age groups.[34]

Table 2. Recurrence rates according to tumour size

	All >4 cm	4.1–7 cm	>7 cm
Total	11.6% (n = 1564, 64%)*	10.9% (n = 944, 50.8%)*	23.1% (n = 126, 30.7%)*
Local	3.8% (n = 1400, 57.3%)*	3.3% (n = 839, 45.2%)*	8.8% (n = 126, 30.7%)*
Distant	9.8% (n = 1476, 60.4%)*	7.3% (n = 884, 47.6%)*	18.7% (n = 126, 30.7%)*

*No. patients with the parameter described, and their representation in respect to their size group.

There are several limitations in this systematic review. We've included a relatively small number of studies and we did not identify any randomized controlled trials. Also, we found that 7 out of the 32 reviewed studies did not differentiate between the survival rates of PN for T1b masses and those performed for masses greater than 7 cm in diameter. Furthermore, most studies did not report survival rates according to pathological stage or histological subtype for tumours >4 cm; therefore, pathological information was not included in this study. Different papers described either the mean or median follow-up durations; few papers reported both. Moreover, the weighted mean and median follow-ups were relatively short. This review is also exposed to publication bias towards studies with better outcomes, or those produced from large volume centres, or performed by experienced surgeons. Finally, this review only included English-language studies from the PubMed database and may have missed reports from other languages and databases, as well as from non-refereed journals and conference proceedings.

Table 3. Overall and cancer-specific survival rates according to tumour size

	All >4 cm	4.1–7 cm	>7 cm
OS			
5-year	86.1% (n = 1835, 75%)*	87.1% (n = 1061, 57%)*	78% (n = 278, 68%)*
10-year	58.8% (n = 543, 22%)*	56.8% (n = 215, 12%)*	54% (n = 186, 45%)*
CSS			
5-year	93.9% (n = 2445, 100%)*	95.4% (n = 1491, 80%)*	86.2% (n = 367, 90%)*
10-year	86.8% (n = 868, 36%)*	84.7% (n = 363, 20%)*	74.9% (n = 270, 66%)*

OS: overall survival; CSS: cancer-specific survival. *No. patients with the parameter described, and their representation in respect to their size group.

Conclusion

This systematic review reveals excellent OS and CSS for patients with renal tumours >4 cm in diameter treated with PN. These outcomes compare favourably to those reported in comparative RN series for similarly sized tumours. PN is therefore an acceptable and often preferred first-line treatment modality for renal masses >4 cm.

Table 4. Aggregated partial and radical nephrectomy survival rates

	PN	RN
4.1–7 cm (follow-up duration: 4.9 years)[4,5,17,21]		
No. procedures	607	2419
5-year OS	94.5%	82.6%
5-year CSS	97%	88.4%
>7 cm (follow-up duration: 5.2 years)[14,25]		
No. procedures	47	612
5-year CSS	74%	75%

PN: partial nephrectomy; RN: radical nephrectomy; OS: overall survival; CSS: cancer-specific survival.

Competing interests: Dr. El-Ghazaly and Dr. Mason declare no competing financial or personal interests. Dr. Rendon has received honoraria from Amgen, Astellas, Ferring and Janssen for participation in Advisory Boards and their Speaker's bureau. Dr. Fleshner is a member of the Advisory Board for Amgen, Janssen, Astellas, and Eli Lily and has received honoraria for his roles. He has also participated in clinical trials for Amgen, Janssen, Medivation, the Ontario Institute for Cancer Research, and Prostate Cancer Canada.

This paper has been peer-reviewed.

References

1. Hafez KS, Fergany AF, Novick AC. Nephron sparing surgery for localized renal cell carcinoma: Impact of tumor size on patient survival, tumor recurrence and TNM staging. *J Urol* 1999;162:1930-3. http://dx.doi.org/10.1016/S0022-5347(05)68071-8
2. Lerner SE, Hawkins CA, Blute ML, et al. Disease outcome in patients with low stage renal cell carcinoma treated with nephron sparing or radical surgery. *J Urol* 1996;155:1868-73. http://dx.doi.org/10.1016/S0022-5347(01)66032-4
3. Belldegrun A, Tsui KH, deKernion JB, et al. Efficacy of nephron-sparing surgery for renal cell carcinoma: Analysis based on the new 1997 tumor-node-metastasis staging system. *J Clin Oncol* 1999;17:2868-75.
4. Patard JJ, Shvarts O, Lam JS, et al. Safety and efficacy of partial nephrectomy for all T1 tumors based on an international multicenter experience. *J Urol* 2004;171:2181-5. http://dx.doi.org/10.1097/01.ju.0000124846.37299.5e
5. Leibovich BC, Blute ML, Cheville JC, et al. Nephronsparing surgery for appropriately selected renal cell carcinoma between 4 and 7 cm results in outcome similar to radical nephrectomy. *J Urol* 2004;171:1066-70. http://dx.doi.org/10.1097/01.ju.0000113274.40885.db
6. Shvarts O, Alemozaffar M, Kim et al. Nephron-sparing surgery as the new gold standard for T1 (< 7 cm) renal cell carcinoma: results of a contemporary UCLA series. *J Urol* 2004;171:1774.
7. Lau WK, Blute ML, Weaver AL, et al. Matched comparison of radical nephrectomy vs nephron-sparing surgery in patients with unilateral renal cell carcinoma and a normal contralateral kidney. *Mayo Clin Proc* 2000;75:1236-42. http://dx.doi.org/10.4065/75.12.1236
8. McKiernan J, Simmons R, Katz J, et al. Natural history of chronic renal insufficiency after partial and radical nephrectomy. *Urology* 2002;59:816-20. http://dx.doi.org/10.1016/S0090-4295(02)01501-7
9. Huang WC, Levey AS, Serio AM, et al. Chronic kidney disease after nephrectomy in patients with renal cortical tumours: A retrospective cohort study. *Lancet Oncol* 2006;7:735-40. http://dx.doi.org/10.1016/S1470-2045(06)70803-8
10. Mitchell RE, Gilbert SM, Murphy AM, et al. Partial nephrectomy and radical nephrectomy offer similar cancer outcomes in renal cortical tumors 4 cm or larger. *Urology* 2006;67:260-4. http://dx.doi.org/10.1016/j.urology.2005.08.057
11. Medina-Polo J, Romero-Otero J, Rodríguez-Antolín A, et al. Can partial nephrectomy preserve renal function and modify survival in comparison with radical nephrectomy? *Scand J Urol Nephrol* 2011;45:143-50.
12. Jeldres C, Pantuck A, Belldegrun A. Nephron-sparing surgery vs. radical nephrectomy in patients with renal cell carcinoma >7 cm with no evidence of nodal or distant metastasis. *J Urol* 2008;179:417-8. http://dx.doi.org/10.1016/S0022-5347(08)61224-0
13. Simmons MN, Brandina R, Hernandez AF, et al. Surgical management of bilateral synchronous kidney tumors: functional and oncological outcomes. *J Urol* 2010;184:865-72. http://dx.doi.org/10.1016/j.juro.2010.05.042
14. Gupta GN, Peterson J, Thakore KN, et al. Oncological outcomes of partial nephrectomy for multifocal renal cell carcinoma greater than 4 cm. *J Urol* 2010;184:59-63. http://dx.doi.org/10.1016/j.juro.2010.03.035
15. Weight CJ, Larson BT, Gao T, et al. Elective partial nephrectomy in patients with clinical T1b renal tumors is associated with improved overall survival. *Urology* 2010;76:631-7. http://dx.doi.org/10.1016/j.urology.2009.11.087
16. Pahernik S, Roos F, Röhrig B, et al. Elective nephron sparing surgery for renal cell carcinoma larger than 4 cm. *J Urol* 2008;179:71-4. http://dx.doi.org/10.1016/j.juro.2007.08.165
17. Lane BR, Gill IS. 7-year oncological outcomes after laparoscopic and open partial nephrectomy. *J Urol* 2010;183:473-9. http://dx.doi.org/10.1016/j.juro.2009.10.023
18. Zheng JH, Xu YF, Peng B, et al. Retroperitoneal laparoscopic partial nephrectomy for renal-cell carcinoma in a solitary kidney: Report of 56 cases. *J Endourol* 2009;23:1971-4. http://dx.doi.org/10.1089/end.2008.0653
19. Thompson RH, Siddiqui S, Lohse CM, et al. Partial versus radical nephrectomy for 4 to 7 cm renal cortical tumors. *J Urol* 2009;182:2601-6. http://dx.doi.org/10.1016/j.juro.2009.08.087
20. Simmons MN, Weight CJ, Gill IS. Laparoscopic radical versus partial nephrectomy for tumors >4 cm: Intermediate-term oncologic and functional outcomes. *Urology* 2009;73:1077-82. http://dx.doi.org/10.1016/j.urology.2008.11.059
21. Crispen PL, Boorjian SA, Lohse CM, et al. Outcomes following partial nephrectomy by tumor size. *J Urol* 2008;180:1912-7. http://dx.doi.org/10.1016/j.juro.2008.07.047
22. Kolla SB, Ercole C, Spiess PE, et al. Nephron-sparing surgery for pathological stage T3b renal cell carcinoma confined to the renal vein. *BJU Int* 2010;106:1494-8. http://dx.doi.org/10.1111/j.1464-410X.2010.09293.x
23. Margulis V, Tamboli P, Jacobsohn KM, et al. Oncological efficacy and safety of nephron-sparing surgery for selected patients with locally advanced renal cell carcinoma. *BJU Int* 2007;100:1235-9. http://dx.doi.org/10.1111/j.1464-410X.2007.07225.x
24. Patard JJ, Pantuck AJ, Crepel M, et al. Morbidity and clinical outcome of nephron-sparing surgery in relation to tumour size and indication. *Eur Urol* 2007;52:148-54. http://dx.doi.org/10.1016/j.eururo.2007.01.039
25. Dash A, Vickers AJ, Schachter LR, et al. Comparison of outcomes in elective partial vs radical nephrectomy for clear cell renal cell carcinoma of 4-7 cm. *BJU Int* 2006;97:939-45. http://dx.doi.org/10.1111/j.1464-410X.2006.06060.x
26. Antonelli A, Cozzoli A, Nicolai M, et al. Nephron sparing surgery versus radical nephrectomy in the treatment of intracapsular renal cell carcinoma up to 7 cm. *Eur Urol* 2008;53:803-9. http://dx.doi.org/10.1016/j.eururo.2007.11.007
27. Becker F, Siemer S, Hack M, et al. Excellent long-term cancer control with elective nephronsparing surgery for selected renal cell carcinomas measuring more than 4 cm. *Eur Urol* 2006;49:1058-63. http://dx.doi.org/10.1016/j.eururo.2006.03.003
28. Carini M, Minervini A, Lapini A, et al. Simple enucleation for the treatment of renal cell carcinoma between 4 and 7 cm in greatest dimension: Progression and long-term survival. *J Urol* 2006;175:2022-6. http://dx.doi.org/10.1016/S0022-5347(06)00275-8
29. Van Poppel H, Bamelis B, Oyen R, et al. Partial nephrectomy for renal cell carcinoma can achieve long-term tumor control. *J Urol* 1998;160:674-8. http://dx.doi.org/10.1016/S0022-5347(01)62751-4
30. Moinzadeh A, Gill IS, Finelli A, et al. Laparoscopic partial nephrectomy: 3-year followup. *J Urol* 2006;175:459-62. http://dx.doi.org/10.1016/S0022-5347(05)00147-3
31. Fergany AF, Hafez KS, Novick AC. Long-term results of nephron sparing surgery for localized renal cell carcinoma: 10-year follow-up. *J Urol* 2000;163:442-5. http://dx.doi.org/10.1016/S0022-5347(05)67896-2
32. Filipas D, Fichtner J, Spix C, et al. Nephron-sparing surgery of renal cell carcinoma with a normal opposite kidney: Long-term outcome in 180 patients. *Urology* 2000;56:387-92. http://dx.doi.org/10.1016/S0090-4295(00)00656-7
33. Black P, Filipas D, Fichtner J, et al. Nephron sparing surgery for central renal tumors: experience with 33 cases. *J Urol* 2000;163:737-43. http://dx.doi.org/10.1016/S0022-5347(05)67794-4
34. Roos FC, Brenner W, Jäger W, et al. Perioperative morbidity and renal function in young and elderly patients undergoing elective nephron-sparing surgery or radical nephrectomy for renal tumours larger than 4 cm. *BJU Int* 2011;107:554-61. http://dx.doi.org/10.1111/j.1464-410X.2010.09516.x
35. Roos FC, Brenner W, Müller M, et al. Oncologic long-term outcome of elective nephron-sparing surgery versus radical nephrectomy in patients with renal cell carcinoma stage pT1b or greater in a matched-pair cohort. *Urology* 2011;77:803-8. http://dx.doi.org/10.1016/j.urology.2010.09.020
36. Becker F, Roos FC, Janssen M, et al. Short-term functional and oncologic outcomes of nephron-sparing surgery for renal tumours ≥7 cm. *Eur Urol* 2011;59:931-7. http://dx.doi.org/10.1016/j.eururo.2011.02.017
37. Breau RH, Crispen PL, Jimenez RE, et al. Outcome of stage T2 or greater renal cell cancer treated with partial nephrectomy. *J Urol* 2010;183:903-8. http://dx.doi.org/10.1016/j.juro.2009.11.037
38. Jeldres C, Patard JJ, Capitanio U, et al. Partial versus radical nephrectomy in patients with adverse clinical or pathologic characteristics. *Urology* 2009;73:1300-5. http://dx.doi.org/10.1016/j.urology.2008.08.492
39. Patel SG, Penson DF, Pabla B, et al. National trends in the use of partial nephrectomy: A rising tide that has not lifted all boats. *J Urol* 2012;187:816-21. http://dx.doi.org/10.1016/j.juro.2011.10.173
40. Zini L, Patard JJ, Capitanio U, et al. The use of partial nephrectomy in European tertiary care centers. *Eur J Surg Oncol* 2009;35:636-42. http://dx.doi.org/10.1016/j.ejso.2008.07.008
41. Lee CT, Katz J, Shi W, et al. Surgical management of renal tumors 4 cm or less in a contemporary cohort. *J Urol* 2000;163:730-6. http://dx.doi.org/10.1016/S0022-5347(05)67793-2
42. Kletscher BA, Qian J, Bostwick DG, et al. Prospective analysis of multifocality in renal cell carcinoma: Influence of histological pattern, grade, number, size, volume and deoxyribonucleic acid ploidy. *J Urol* 1995;153:904-6. http://dx.doi.org/10.1016/S0022-5347(01)67600-6
43. Li Q, Guan H, Zhang Q, et al. Multi-centricity and its associated factors in renal cell carcinoma in Chinese patients. *Chin Med J* 2002;115:1341-4.

44. Baltaci S, Orhan D, Soyupek S, et al. Influence of tumor stage, size, grade, vascular involvement, histological cell type and histological pattern on multifocality of renal cell carcinoma. *J Urol* 2000;164:36-9. http://dx.doi.org/10.1016/S0022-5347(05)67443-5
45. Gohji K, Hara I, Gotoh A, et al. Multifocal renal cell carcinoma in Japanese patients with tumors with maximal diameter of 50 mm or less. *J Urol* 1998;159:1144-7. http://dx.doi.org/10.1016/S0022-5347(01)63532-8
46. DiMarco DS, Lohse CM, Zincke H, et al. Sporadic multifocal renal cell carcinoma according to histologic subtype compared with patients with solitary tumors after radical nephrectomy. *Urology* 2004;64:462-7. http://dx.doi.org/10.1016/j.urology.2004.04.016
47. Turun S, Banghua L, Zheng S, et al. Is tumor size a reliable predictor of histopathological characteristics of renal cell carcinoma? *Urol Ann* 2012;4:24-8. http://dx.doi.org/10.4103/0974-7796.91617
48. Mukamel E, Konichezky M, Engelstein D, et al. Incidental small renal tumors accompanying clinically overt renal cell carcinoma. *J Urol* 1988;140:22-4.
49. Miller J, Fischer C, Freese R, et al. Nephron sparing surgery for renal cell carcinoma: Is tumor size a suitable parameter for indication? *Urology* 1999;54:988-93. http://dx.doi.org/10.1016/S0090-4295(99)00347-7
50. Whang M, O'Toole K, Bixon R, et al. The incidence of multifocal renal cell carcinoma in patients who are candidates for partial nephrectomy. *J Urol* 1995;154:968-70. http://dx.doi.org/10.1016/S0022-5347(01)66945-3
51. Schlichter A, Wunderlich H, Junker K, et al. Where are the limits of elective nephron-sparing surgery in renal cell carcinoma? *Eur Urol* 2000;37:517-20. http://dx.doi.org/10.1159/000020187
52. Tuma B, Frota R, Kamoi K, et al. Risk factor analysis of postoperative complications in laparoscopic partial nephrectomy. *J Urol* 2008;179:1289-94. http://dx.doi.org/10.1016/j.juro.2007.11.070

Correspondence: Dr. Ricardo A. Rendon, Associate Professor, Department of Urology, Dalhousie University and Queen Elizabeth II Health Sciences Centre, Room 295, 1276 South Park St., Halifax, NS B3H 2Y9; fax: 902-492-2437; rrendon@dal.ca