Curr Urol Rep (2013) 14:1–4
DOI 10.1007/s11934-012-0297-2

Partial Nephrectomy: Is There Still a Need for Open Surgery?

Varun Sharma · Markus Margreiter

Published online: 12 December 2012

Abstract Long-term outcome data indicate that open partial nephrectomy has cancer-free survival rates comparable to those of radical surgery, with better preservation of renal function, decreased overall mortality and reduced frequency of cardiovascular events. Open partial nephrectomy is increasingly being challenged by laparoscopic and/or robot assisted partial nephrectomy, which in the hands of experts appears to achieve comparable oncological results, albeit at a higher complication rate. We report a review based on literature published over the past years, which may provide insight into the role of open partial nephrectomy in the present urological practice and in years to come.

Keywords Open partial nephrectomy · Nephron sparing surgery · Renal tumors · Renal cell carcinoma · Laparoscopy

Introduction

During no other period in the history of mankind have advances in the field of medicine occurred with as much speed and intensity as in the last two decades. Many things that are considered routine today were unimaginable barely 20 years ago. There has been a paradigm shift in the treatment of multiple disease conditions in almost all disciplines of surgery. Such drastic changes have occurred for two principal reasons. The first is the abundance of technological advances made in both diagnostics and therapeutics. The second is our improved understanding of the disease process, especially the etiology and natural course of diseases. Pertinent questions spring to mind: What does the future hold for surgery and surgeons? Have we reached a plateau in the growth spurt of the last 20 years, or will the future again redefine the reach and scope of the surgeon? In reference to minimally invasive surgery, it has been saidthat "a surgeon without a scope has no scope." Indications of what may come are already apparent.

In Urology, laparoscopic surgery has gained enormous popularity in management of various diseases, including the surgical treatment of renal cell carcinomas (RCC). This is due to the advances in technology, increasing expertise of surgeons, and demand from the patients. Initially, laparoscopic radical nephrectomy was used even for small renal tumors, employing over-treatment oncologically for the sake of minimizing invasiveness. At present, we are witnessing increasing reports of laparoscopic partial nephrectomy (LPN) and robotic assisted partial nephrectomy (RAPN). Patients that would have been candidates for an open partial nephrectomy (OPN) in the past can now be treated using these minimal invasive approaches. So, is there still a need for open surgeons in the treatment of RCC?

The Present

Partial nephrectomy (PN) for nephron sparing removal of renal masses in solitary kidneys, bilateral masses, or in patients with poor renal function has been the standard of care for years and has supplanted radical nephrectomy. More recently, PN has also acquired this status for the management of small renal masses, even in the absence of identifiable renal insufficiency or the threat thereof, as the oncological outcomes compare favorably with those of radical nephrectomy (RN) [1, 2].

V. Sharma
Department of Urology and Transplantation,
Institute of Kidney Diseases and Research Centre (IKDRC-ITS),
Ahmedabad, Gujarat, India

M. Margreiter (✉)
Department of Urology, Medical University of Vienna,
Waehringer Guertel 18-20,
1090 Vienna, Austria
e-mail: markus.margreiter@meduniwien.ac.at

In patients with T1a RCC, PN has proven to be associated with better overall survival (OS), better long-term preservation of renal function, and fewer patients requiring dialysis or renal transplantation than after RN [3, 4]. As a result, the use of PN is increasingly advocated for the treatment of larger renal cell carcinomas, particularly if the tumor´s shape and location permits preserving an adequate segment of the kidney [5•, 6, 7]. Since the introduction of minimally invasive NSS, more and more patients are becoming interested in an option with a shorter hospital stay and a better cosmetic outcome with similar oncological results [8, 9]. Patients selected for contemporary OPN have evolved into a more complex group, by virtue of having a greater incidence of central tumors and tumors in a solitary kidney.

In a large single-center series of PN for renal masses, Lane et al. compared the outcome of OPN in 169 solitary kidneys with LPN in 30 solitary kidneys [10]. Although tumors in the OPN group were larger (mean diameter 3.8 cm vs. 2.8 cm) and more frequently in a hilar/central location (62 % vs. 47 %) than they were in the LPN group, a complication rate of only 24 % was observed after OPN, as compared to 43 % after LPN. The postoperative need for dialysis was only 0.6 % after OPN, as compared to 10 % after LPN. The mean warm ischemia time during OPN was 21 min, compared to 29 min during LPN. In a multivariate analysis accounting for age, tumor size, and time of warm ischemia, the risk of postoperative complications following LPN was 2.54 times higher than that of OPN ($p<0.05$).

Laparoscopy can duplicate the results of most open surgeries; however, the major challenges for the laparoscopic surgeon performing LPN are hemostasis and the avoidance of ischemic damage. Bleeding, one of the potential complications of LPN, can be overcome by the use of new agents and techniques [10, 11]. Prolonged warm ischemia time, which can have a negative functional impact, is another major concern. In a series of >500 LPNs, Haber and Gill reported a mean warm ischemia time of 32 min [12], which is longer than that for open NSS [13, 14]. Gill et al. retrospectively evaluated 771 LPNs and 1,029 OPNs performed at three high volume institutions during a 7-year period [8]. Patients who underwent LPN had less mean blood loss (300 ml vs. 376 ml), shorter surgery times (201 min vs. 266 min), and shorter hospitalizations (3.3 days vs. 5.8 days). Although the LPN group comprised patients with a significantly smaller mean tumor size (2.6 cm vs. 3.3 cm), more tumors in a peripheral/exophytic position (65.6 % vs. 46.7 %), and a better performance status, the mean warm ischemia time (30.7 min vs. 20.1 min), postoperative complications (18.6 % vs. 13.7 %), and the need for subsequent interventions (6.9 % vs. 3.5 %) were significantly higher than those in the OPN group ($p<0.0001$). In the series by Marszalek et al., who retrospectively compared 100 consecutive LPNs to 100 consecutive OPNs [9], the overall complication rate of 19 % in the LPN series appeared comparable to a rate of 14 % in the OPN series; however, intraoperative complications were significantly higher in the laparoscopic group (10 % vs. 3 %). When complications were stratified according to the Simmons grading system [10], more grade 3 complications (requiring re-intervention) were seen in the LPN group as compared to the OPN group (8 % vs. 3 %). Hemorrhagic and urine leak complications occurred in 6 % and 4 % after LPN, and in 1 % and 2 % after OPN, respectively. Positive margins were comparable in both groups (LPN 4.0 % vs. OPN 2.0 %; $p=0.5$).

The detrimental effects of warm ischemia on renal function have long been recognized, and recent data consider 20 min as the maximum warm ischemic time a normal kidney can be exposed to without permanent loss of function [15–17]. In OPN, this can be compensated in part by fairly simple slush ice cooling of the kidney. OPN techniques that avoid renal ischemia altogether are finding increasing interest [16, 18•]. A recent retrospective analysis of 104 OPNs was performed in solitary kidneys, avoiding clamping of the renal artery by a modified technique and securing hemostasis continuously during parenchymal dissection. This technique resulted in a significantly lower loss of renal function compared to that of OPN performed with a median cold ischemia time of 22 min [19]. Intraoperative blood loss was only marginally higher in the no-clamping group, and the overall complication rate and margin status were, in fact, lower.

For LPN, clamping of the renal pedicle is generally considered necessary for adequate vision during dissection of the parenchyma [20, 21]. Techniques developed for renal cooling during LPN include slush ice cooling [22] and hypothermic perfusion [23], but these procedures are complex and have not found general acceptance. The general trend in LPN is therefore to reduce renal ischemia as much as possible by limiting ischemia time to that of the actual tumor dissection, and performing renal reconstruction and hemostasis after declamping [24]. This procedure results in higher blood loss, but has fewer complications and less loss of renal function [25•]. However, limiting the ischemia time in this manner further raises the technical challenges of one of the most demanding laparoscopic operations in urology [26].

While considering patients for LPN, the location and size of the mass are defining parameters for the technical complexity and morbidity. Peripheral, exophytic tumors smaller than 4 cm in diameter, distant from the collecting system, and on the posterior lower convexity of the kidney are ideal for LPN [27]. A larger size and an endophytic, hilar location increase the technical challenge multifold. When factoring the need for considerable experience with this type of surgery, it becomes obvious that OPN continues to play a significant role in the management of more difficult lesions. However, with laparoscopic and robotic surgery being available in most hospitals, fewer but more complex lesions are referred for OPN. In a study at the Lahey Clinic, lesions managed with OPN were larger, more often hilar, more central, deeper, and usually involved the collecting system to a greater degree than in the past. This observation is consistent with experiences at other tertiary care centers. Similarly, when compared to the era before laparoscopy, tumors undergoing OPN in the laparoscopic era at the Cleveland Clinic were more often in a solitary kidney (40.0 % vs. 15.6 %), centrally located (55.6 % vs. 37.3 %), and of a higher grade (Fuhrman 3 or 4) (43.1 % vs. 27.8 %, each $p<0.01$) [28].

Careful case selection for elective patients with T1b RCC is of paramount importance. It has been proved that cancer-free survival significantly decreases in patients with tumors larger than 4 cm compared to those with smaller tumors [29]. The fact that nephron sparing is technically feasible does not automatically imply it is the treatment of choice. The use of a minimally invasive approach in patients with T1b RCC necessitates a surgeon highly skilled in minimally invasive surgery and a technically more sophisticated procedure for which the outcome is yet to be proved.

The Future

With broad availability of robots, PN has come to the attention of robotic surgeons. Complication rates and anesthesia/ischemia times of RAPN are promising and seem comparable to that of LPN [30]. However, data on oncologic outcomes after robotic PN are limited.

Conclusions

More than 100 years ago, the father of modern medicine, Sir William Osler, challenged surgeons to perpetually refine their craft, stating, “Diseases that harm require treatments that harm less.” In this era of minimally invasive surgery, OPN still remains the preferred treatment for complex renal masses; in particular, those found in solitary kidneys, bilaterally, and those tumors which do not qualify for LPN or RAPN.

Disclosure No potential conflicts of interest relevant to this article were reported.

References

Papers of particular interest, published recently, have been highlighted as:
• Of importance

1. Ljungberg B, Cowan NC, Hanbury DC, Hora M, Kuczyk MA, Merseburger AS, et al. EAU guidelines on renal cell carcinoma: the 2010 update. Eur Urol. 2010;58:398–406.
2. Campbell SC, Novick AC, Belldegrun A, Blute ML, Chow GK, Derweesh IH, et al. Guideline for management of the clinical T1 renal mass. J Urol. 2009;182:9.
3. Thompson RH, Boorjian SA, Lohse CM, Leibovich BC, Kwon ED, Cheville JC, et al. Radical nephrectomy for pT1a renal masses may be associated with decreased overall survival compared with partial nephrectomy. J Urol. 2008;179:468–71. discussion 72–3.
4. Miller DC, Schonlau M, Litwin MS, Lai J, Saigal CS. Renal and cardiovascular morbidity after partial or radical nephrectomy. Cancer. 2008;112:511–20.
5. • Joniau S, Vander Eeckt K, Srirangam SJ, Van Poppel H. Outcome of nephron-sparing surgery for T1b renal cell carcinoma. BJU Int. 2009;103:1344–8. *This study demonstrated the feasibility and good oncological results of NSS in T1b RCC.*
6. Touijer K, Jacqmin D, Kavoussi LR, Montorsi F, Patard JJ, Rogers CG, et al. The expanding role of partial nephrectomy: a critical analysis of indications, results, and complications. Eur Urol. 2010;57:214–22.
7. Pahernik S, Roos F, Rohrig B, Wiesner C, Thuroff JW. Elective nephron sparing surgery for renal cell carcinoma larger than 4 cm. J Urol. 2008;179:71–4.
8. Gill IS, Kavoussi LR, Lane BR, Blute ML, Babineau D, Colombo Jr JR, et al. Comparison of 1,800 laparoscopic and open partial nephrectomies for single renal tumors. J Urol. 2007;178:41–6.
9. Marszalek M, Meixl H, Polajnar M, Rauchenwald M, Jeschke K, Madersbacher S. Laparoscopic and open partial nephrectomy: a matched-pair comparison of 200 patients. Eur Urol. 2009;55:1171–8.
10. Simmons MN, Gill IS. Decreased complications of contemporary laparoscopic partial nephrectomy: use of a standardized reporting system. J Urol. 2007;177:2067–73.
11. Wille AH, Tullmann M, Roigas J, Loening SA, Deger S. Laparoscopic partial nephrectomy in renal cell cancer–results and reproducibility by different surgeons in a high volume laparoscopic center. Eur Urol. 2006;49:337–42.
12. Haber GP, Gill IS. Laparoscopic partial nephrectomy: contemporary technique and outcomes. Eur Urol. 2006;49:660–5.
13. Gill IS, Matin SF, Desai MM, Kaouk JH, Steinberg A, Mascha E, et al. Comparative analysis of laparoscopic versus open partial nephrectomy for renal tumors in 200 patients. J Urol. 2003;170:64–8.
14. Fergany AF, Saad IR, Woo L, Novick AC. Open partial nephrectomy for tumor in a solitary kidney: experience with 400 cases. J Urol. 2006;175:1630–3.
15. Marberger M. Renal ischaemia: not a problem in laparoscopic partial nephrectomy? BJU Int. 2007;99:3–4.
16. Thompson RH, Frank I, Lohse CM, Saad IR, Fergany A, Zincke H, et al. The impact of ischemia time during open nephron sparing surgery on solitary kidneys: a multi-institutional study. J Urol. 2007;177:471–6.
17. Shikanov S, Lifshitz D, Chan AA, Okhunov Z, Ordonez MA, Wheat JC, et al. Impact of ischemia on renal function after laparoscopic partial nephrectomy: a multicenter study. J Urol. 2010;183:1714–8.
18. • La Rochelle J, Shuch B, Riggs S, Liang LJ, Saadat A, Kabbinavar F, et al. Functional and oncological outcomes of partial nephrectomy of solitary kidneys. J Urol. 2009;181:2037–42. *This study evaluated the outcome of partial nephrectomy in solitary kidneys and demonstrated the detrimental effect of ischemia on renal function.*
19. Wszolek MF, Kenney PA, Lee Y, Libertino JA. Comparison of hilar clamping and non-hilar clamping partial nephrectomy for tumours involving a solitary kidney. BJU Int. 2011;107:1886–92.
20. Janetschek G. Laparoscopic partial nephrectomy for RCC: how can we avoid ischemic damage of the renal parenchyma? Eur Urol. 2007;52:1303–5.
21. Gill IS, Desai MM, Kaouk JH, Meraney AM, Murphy DP, Sung GT, et al. Laparoscopic partial nephrectomy for renal tumor:

duplicating open surgical techniques. J Urol. 2002;167(2 Pt 1):469–76.
22. Gill IS, Abreu SC, Desai MM, Steinberg AP, Ramani AP, Ng C, et al. Laparoscopic ice slush renal hypothermia for partial nephrectomy: the initial experience. J Urol. 2003;170:52–6.
23. Janetschek G, Abdelmaksoud A, Bagheri F, Al-Zahrani H, Leeb K, Gschwendtner M. Laparoscopic partial nephrectomy in cold ischemia: renal artery perfusion. J Urol. 2004;171:68–71.
24. Nguyen MM, Gill IS. Halving ischemia time during laparoscopic partial nephrectomy. J Urol. 2008;179:627–32.
25. • Gill IS, Kamoi K, Aron M, Desai MM. 800 Laparoscopic partial nephrectomies: a single surgeon series. J Urol. 2010;183(1):34–41. *This study demonstrates the evolvement of laparoscopic partial nephrectomie and surgical outcomes over the decade*.
26. Breda A, Finelli A, Janetschek G, Porpiglia F, Montorsi F. Complications of laparoscopic surgery for renal masses: prevention, management, and comparison with the open experience. Eur Urol. 2009;55:836–50.
27. Kutikov A, Uzzo RG. The R.E.N.A.L. nephrometry score: a comprehensive standardized system for quantitating renal tumor size, location and depth. J Urol. 2009;182:844–53.
28. Weight CJ, Fergany AF, Gunn PW, Lane BR, Novick AC. The impact of minimally invasive techniques on open partial nephrectomy: a 10-year single institutional experience. J Urol. 2008;180:84–8.
29. 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.
30. Shapiro E, Benway BM, Wang AJ, Bhayani SB. The role of nephron-sparing robotic surgery in the management of renal malignancy. Curr Opin Urol. 2009;19:76–80.