

Current Status of Laparoscopic Partial Nephrectomy

Taek Sang Kim

Department of Urology, College of Medicine, Kosin University, Busan, Korea

복강경신부분절제술의 최신지견

김택상

고신대학교 의과대학 비뇨기과학교실

Recently, nephron-sparing, minimally invasive surgery of small renal masses has become popular. The most typical surgery is laparoscopic partial nephrectomy (LPN). However, due to technical difficulties, the indications for LPN had been limited to small, exophytic, and peripheral tumors. This paper introduces current status of oncological outcomes and technical considerations.

Key Words: Kidney, Laparoscopy, Nephrectomy

Over the past two decades, incidentally detection of small renal masses (SRMs) have been increasing. For patients who are found to have SRMs, nephron-sparing surgery (NSS), or partial nephrectomy, is preferred because it offers the best residual renal function.^{1,2} The oncological outcome of partial nephrectomy (PN) is comparable to that of radical nephrectomy (RN), and some reports that the overall survival (OS) is better after a PN than after a RN.^{3,4} Additionally, minimally-invasive surgery (MIS) options for nephrectomy include laparoscopic radical nephrectomy (LRN), laparoscopic partial nephrectomy (LPN), and robot-assisted partial nephrectomy (RAPN). These MIS options have become popular due to the benefits of lower postoperative pain and better cosmetic outcomes, when compared to open surgical

resections. Recently, oncological outcomes of LPN have emerged as equal those of open approaches such as open radical (ORN) or open partial nephrectomy (OPN).⁵ Since the initial report on LPN,^{6,7} techniques for LPN has gradually improved. Despite these advances, LPN has not been universally adopted because of the technical difficulties associated. This paper is a review of recent updates to laparoscopic partial nephrectomy techniques.

1. Oncological Outcomes

In an early report, Allaf et al. reported that 95.8% of patients had no recurrence during the median 3 years follow-up study period after LPN. Gill et al. compared 771 cases of LPN to 1,028 cases of OPN in the management of solitary renal tumors. The

cancer specific survival (CSS) of LPN and OPN were 99.3% and 99.2%, respectively. LPN was associated with shorter operation time, smaller estimated blood loss, shorter hospital stay, and comparable surgical complications, when compared with OPN.⁸ Simmons et al. reported that partial nephrectomy of pT1b showed no differences from radical nephrectomy in overall survival (OS) as well as CSS.⁵ Thompson et al. reported that OS was longer for patients who underwent PN than for patients who underwent RN.⁴ Huang suggested that the benefit of OS in partial nephrectomy had resulted from cardiovascular outcome benefits, which are caused by minimal renal function loss in partial resection compared to radical resection.⁹ Weight et al. reported that CSS is correlated with pathologic stage and nuclear grade. However, this cardiac-specific survival is related with preoperative status of coronary artery disease and estimated GFR. This also suggests that the overall survival gain from partial nephrectomy results from cardiovascular outcomes.³ From these previous findings, we can conclude that no differences in oncological outcomes exist between LPN and OPN. Other perioperative outcomes such as operating time, estimated blood loss, hospital stay are better for LPN. In addition, OS is superior for LPN than for LRN due to cardiovascular outcomes, which are closely related with residual renal function.

2. Feasibility and renal mass scoring systems

In the developmental period of laparoscopic partial resection, the operation was usually performed for pT1a renal tumors. With development of hemostatic agents, laparoscopic instrument, and surgical experience, LPN is now frequently performed for pT1b

renal tumors, and for cases such as renal tumors in a solitary kidney or in patients with chronic renal disease.^{5,10} To classify operative feasibility, several renal tumor scoring system, such as PADUA score, C-index, RENLA nephrometry score, had been developed and introduced.¹¹⁻¹³ Subsequent to this, many studies have assessed clinical applications of these renal mass scoring systems. RENAL nephrometry score (RNS), developed by Kutikov and Uzzo, consists of tumor size, exophytic morphology, nearness to the collecting system, and location with respect to the renal polar lines.¹¹ Canter et al. reported that the use of RNS influenced the decision making process in the management of renal tumors. In that study, patients who received radical nephrectomy not only had higher individual R, N, and L component scores but also had higher overall score.¹⁴ Thus, RNS effectively can make a plan for the surgical approach to renal masses. Rosevear et al. reported that renal tumors managed with RN had a higher RNS than PN, suggesting that this scoring system predicted the surgical preference of individual surgeons.¹⁵ Bruner et al. proposed that renal tumor patients with higher RNS experienced higher likelihood of (retroperitoneal?) urine leakage after partial nephrectomy.¹⁶ Mayer et al. found that RNS is predictive of warm ischemic time during laparoscopic or robot assisted laparoscopic partial nephrectomy.¹⁷ PADUA score is another frequently used scoring system and consists of anatomical features similar to RNS.¹² C-index is calculated by the measured distance between (the center of a) kidney and renal tumor, and is also applicable to prediction of feasibility and difficulty of partial nephrectomy.¹³ Samplaski et al. reported that renal tumors with C-index of over 2.5 were 2.2 times more likely to result in renal function decrease

greater than 30%.¹⁸

3. Residual renal function after LPN

Assuming equal oncological results, the advantage of LPN over LRN is the superiority of residual renal function. In the study by Zorn et al., patients who developed chronic renal insufficiency after LRN and LPN were 36.4% and 0%, respectively. The mean estimated GFR in LRN group was 64.2 mls/min, which represented a 36.4% decrease from pre-operative renal function. The same mean value in LPN group was 88.72 mls/min, which represented a 6% decrease.² In the previous study already mentioned,¹ we also evaluated postoperative renal function change in the Korean patients undergoing laparoscopic nephrectomy. Chronic renal insufficiency had developed in 6.3% of patients who underwent LPN, which contrasts with the, very high rate of 68.5% for patients who received LRN. The incidence of post-nephrectomy chronic renal insufficiency was higher than the data published for Western populations. The respective preoperative estimated GFR were 80.3 mls/min and 81.7 mls/min for the LRN and LPN groups, which are lower than those preoperative values of the Western counterparts. These preoperative differences most likely explains the postoperative differences observed after a nephrectomy in various populations. In our patients, the incidence of renal insufficiency normalized after 1 year of operation, at which point the incidences were 7% and 35% for LPN and LRN, respectively, which were similar to those reported for Western population. With the larger pT1b renal tumors, renal function loss is expected to be larger than the loss experienced after the resection of smaller renal masses. In addition, larger mass resection can prolong the warm ischemic time due to technical

difficulty. Deklaj et al. have reported the incidence of chronic renal insufficiency to be 55.7% and 30.4% in LRN and LPN, respectively, for pT1b renal tumors.¹⁹ There are several factors known to cause renal function deterioration after LPN. Shikanov et al. suggested that renal tumor size and diabetes mellitus can influence the residual renal function after LPN.²⁰ Thompson et al. reported that warm ischemia time, percent volume of kidney preserved, and preoperative GFR were important factors predicting residual renal function after LPN.²¹ Song et al. reported that the most important factors for residual renal function was renal volume reduction.²² In LPN, application of cold ischemia using ice slush is not as easy to perform as it is during open partial nephrectomy. Several methods have been reported for cold ischemia during laparoscopic nephrectomy: continuous cold saline irrigation through ureteral catheter, infusion of cold fluid through renal angio-catheter, and ice slush in endo-catch bag placed in the vicinity of the kidney.²³⁻²⁵ However, these methods are technically challenging to apply during LPN and, therefore, are not used widely. Generally, the cut-off value for warm ischemia time has been thought to be 30 minutes. However, there is a lack of evidence for this cut-off value for warm ischemia time. Choi et al. set cut-off value of warm ischemia time at 28 minutes because, beyond this cut-off time, the renal functions of the patients deteriorated continuously. In contrast, the renal functions recovered post-operatively for patients who had less than 28 minutes of warm ischemia.²⁶ Funahashi et al. reported the cut-off value of warm ischemia to 25 minutes during LPN. Using MAG3 renal scans, those authors found that MAG3 uptake was decreased in the patients with warm ischemia time over 25 minutes.²⁷

4. Approach to Kidney

Besides the normal LPN, several methods of minimally invasive partial nephrectomy exist, such as hand-assisted LPN, single-port LPN, and robot-assisted LPN. Hand-assisted LPN has the advantage of kidney compression during tumor resection. However, the hand port make it necessary to create an incision that is larger than that for a purely laparoscopic PN.²⁸ Robot-assisted LPN has the advantage of a shorter learning curve than a pure LPN. However, reducing complications or warm ischemia time is controversial for this approach.²⁹ Robot-assisted LPN allows accurate mass excision and renorrhaphy for complex renal tumors such as central, hilar tumor.³⁰ Single-port LPN is in the developmental period, and has been reported to be feasible by pioneers.³¹ During LPN, transperitoneal approach allows for a large working space with access to anterior or low pole renal mass. Though retroperitoneal approach provides a much smaller working space, it does provide direct access to renal vessels, early recovery of bowel motility, and access to posterior surface and upper pole renal masses.³² Either of these two anatomic approaches is dependent on surgical experience, and surgeon preference can be an important factor in optimizing outcomes.

5. Renal vascular control and warm ischemia

For the control of renal vessels, most urologic surgeons use the laparoscopic bulldog clamp, which has been the, traditional method in LPN. However, the laparoscopic bulldog clamps require that renal vessels be skeletonized to allow for accurate placement of vessel clamp and to prevent vascular injury. Laparoscopic Satinsky clamp is another instrument

used to control renal vessels. With this clamp, complete renal vessel skeletonization is not necessary, and arteries and veins can be bluntly clamped together. However, the laparoscopic Satinsky clamp can not go through typical trocars due to the curved shape of the working part of instrument and requires a flexible cannula. Without specialized laparoscopic instruments, vascular tourniquet methods from open surgery can be modified for use in laparoscopic nephrectomies. Hacker et al. reported a laparoscopic Rumel tourniquet method for renal vessel control. Though this method also requires complete renal vessel skeletonization, its benefit is that it is extremely inexpensive.³³ Shao et al. reported a segmental renal artery clamp technique during LPN for minimal ischemic injury.³⁴ Simon et al. designed a special instrument, the Simon renal pole clamp, which can clamp low or upper pole of kidney without renal vessel clamp during LPN.³⁵ Gill et al. introduced the 'Zero ischemia' technique by which the tumor-feeding arteries were controlled with micro-bulldog clamps after ultradissection of segmental renal arteries. The advantage of this technique is minimal-to-none post-operative renal function decrease with complications comparable to those established for traditional LPN.³⁶ Recently, some surgeons have reported LPN without renal artery clamp – the 'off-clamp' technique. This technique has difficulties in obtaining safe resection margin and hemostatic control during renal mass resection. Because it offers advantage of residual renal function, however, the technique has found applications in renal tumor patients with solitary kidney or chronic renal insufficiency. In the study by Rais-Bahrami, patients who underwent off-clamp LPN experienced slightly more estimated blood loss. However, these patients did not experience any

differences in hospital stay, perioperative transfusion rate, and positive surgical margin status, when compared to patients who received LPN with some form of renal vessel control and renal ischemia time. Residual renal function after postoperative 6 months in the off-clamp LPN group was better than that for the hilar controlled LPN group.³⁷ Wszolek et al. compared the cancer specific survival and overall survival of patients who had undergone off-clamp LPN and hilar controlled LPN, and did not find differences in either of these outcomes. However, residual renal function was better for the off-clamp LPN group than for the hilar controlled LPN group (eGFR: 50.8 vs 41.1 mls/min).³⁸ In the near future, randomized prospective clinical trials are needed to verify the safety, renal function results, and oncological outcomes of the off-clamp technique.

6. Surgical resection margin

During excision, cold scissors are ideal for pathological examination of resection margin. Bipolar or ultrasonic scalpel scissors can minimize bleeding from the resection margin, but there is a concern about thermal violation of the resection margin in using these high-energy devices. Phillips et al. studied the resection margin status of LPN with bipolar or ultrasonic scalpel, and reported that these devices did not influence the histological evaluation of resection margin even though they did cause fragmentation, or extravascular blood clotting.³⁹ The prevalence of positive surgical margin after partial nephrectomy varies widely, from 1.8 to 10 percent. Song et al. suggested that the most important factor for residual renal function is the degree of renal volume reduction.²² On one hand, too large of a much safety margin can unnecessarily trade off renal function for small-

probability gains in complete resection. On the other hand, the converse of this trade off is true for a too small of a safety margin – an incomplete resection to protecting the renal function. Timsit et al. reported that the central deeper margin has a higher risk of positive surgical margin, when compared to a peripheral parenchymal margin. They suggested that a taking few millimeters of normal tissue around the tumor at the surface, tend to approach closer to the lesion, going deeper and often enucleating the inner pole of the tumor.⁴⁰ There is no definitive consensus for safety margin during partial nephrectomy. For localized renal cell carcinoma, Sutherland et al. had proposed that a minimal margin of normal renal parenchyma of less than 5 mm must be removed during partial nephrectomy.⁴¹ Recently, there is trend to decrease the extent of safety margin. Castilla et al. suggested that the extent of the resection margin after NSS for RCC does not correlate with long-term disease progression.⁴² Minervini et al. reported equivalent long term oncological outcomes for both enucleation of small renal masses and partial nephrectomy.⁴³ In a match cohort study, Bensalah et al. even reported that the cancer specific survival was not influenced by negative and positive surgical margins for patients who underwent partial nephrectomy.⁴⁴ There are some controversies regarding surgical margin after partial nephrectomy. To-date, the extent of safety margin and the use of energy devices do not appear to influence oncological outcomes.

7. Hemostasis and renorrhaphy

Hemostasis of resected surfaces of kidney and renorrhaphy can usually be performed quickly by a skilled surgeon. If hemostasis cannot be achieved

quickly, however, these processes can increase the amount of bleeding and warm ischemia time, and increase the chance of pseudoaneurysm. Hemostasis can be achieved with monopolar cautery, argon beam coagulator, parenchymal suture, and biologic hemostatic agents. For reducing parenchymal suture time, Lapra-Ty and Hem-O-lok clips en-loading technique are using widely.^{45,46} Benway et al. compared the closing tension of LapraTy, sliding Hem-O-lok clips, and tied suture, and reported the closing tension of sliding Hem-O-lok clips to be superior to others.⁴⁶ Sammon et al. reported that renorrhaphy using barbed suture (V-Loc suture, Covidien) could reduce warm ischemia time. The advantages of barbed suture are lack of without suture slippage and parenchymal tearing.⁴⁷ There are several available biologic hemostatics. Bak et al. reported that human thrombin and bovine gelatin (FloSeal, Baxter) could reduce estimated blood loss and warm ischemia time during LPN.⁴⁸ Other useful known biologic hemostatics are fibrin sealant (Tissel, Baxter), polyethylen glycol (Coseal, Baxter), albumin-gluteraldehyde-based sealant (Bioglue, Cryolife). These agents were more effective when applied with a Surgicel bolster.⁴⁹

8. Conclusions

Partial nephrectomy has benefits of preserved residual renal function and overall survival (especially cardiovascular outcomes) for small renal mass. However, LPN is technical challenging, and clinically, LPN applicable patients have performed open partial nephrectomy or radical nephrectomy. Recent advancements of LPN techniques, such as reduced warm ischemia time, hemostatic agents, and renorrhaphy techniques, can make more widely performed in treatment of small renal masses.

REFERENCES

1. Kang SH, Rhew HY, Kim TS. Changes in renal function after laparoscopic partial nephrectomy: comparison with laparoscopic radical nephrectomy. *Korean J Urol* 2013;54:22-5.
2. Zorn KC, Gong EM, Orvieto MA, Gofrit ON, Mikhail AA, Msezane LP, et al. Comparison of laparoscopic radical and partial nephrectomy: effects on long-term serum creatinine. *Urology* 2007;69:1035-40.
3. Weight CJ, Lieser G, Larson BT, Gao T, Lane BR, Campbell SC et al. Partial nephrectomy is associated with improved overall survival compared to radical nephrectomy in patients with unanticipated benign renal tumours. *Eur Urol* 2010;58:293-8.
4. Thompson RH, Boorjian SA, Lohse CM, Leibovich BC, Kwon ED, Chevillie 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.
5. 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.
6. Winfield HN, Donovan JF, Godet AS, Clayman RV. Laparoscopic partial nephrectomy: initial case report for benign disease. *J Endourol* 1993;7:521-6.
7. McDougall EM, Clayman RV, Anderson K. Laparoscopic wedge resection of a renal tumor: initial experience. *J Laparoendosc Surg* 1993;3:577-81.
8. Allaf ME, Bhayani SB, Rogers C, Varkarakis I, Link RE, Inagaki T, et al. Laparoscopic partial nephrectomy: evaluation of long-term oncological outcome. *J Urol* 2004;172:871-3.
9. Huang WC, Elkin EB, Levey AS, Jang TL, Russo P. Partial nephrectomy versus radical nephrectomy in patients with small renal tumors--is there a difference in mortality and cardiovascular outcomes? *J Urol* 2009;181:55-61.
10. Crépel M, Jeldres C, Perrotte P, Capitanio U, Isbarn H, Shariat SF, et al. Nephron-sparing surgery is equally effective to radical nephrectomy for T1BN0M0 renal cell carcinoma: a population-based assessment. *Urology* 2010;75:271-5.
11. 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.
12. Ficarra V, Novara G, Secco S, Macchi V, Porzionato A, De Caro R, et al. Preoperative aspects and dimensions used for an anatomical (PADUA) classification of renal tumours in patients who are candidates for nephron-sparing surgery. *Eur*

- Urol 2009;56:786-93.
13. Simmons MN, Ching CB, Samplaski MK, Park CH, Gill IS. Kidney tumor location measurement using the C index method. *J Urol* 2010;183:1708-13.
 14. Canter D, Kutikov A, Manley B, Egleston B, Simhan J, Smaldone M, et al. Utility of the R.E.N.A.L. nephrometry scoring system in objectifying treatment decision-making of the enhancing renal mass. *Urology* 2011;78:1089-94.
 15. Rosevear HM, Gellhaus PT, Lightfoot AJ, Kresowik TP, Joudi FN, Tracy CR. Utility of the RENAL nephrometry scoring system in the real world: predicting surgeon operative preference and complication risk. *BJU Int* 2012;109:700-5.
 16. Bruner B, Breau RH, Lohse CM, Leibovich BC, Blute ML. Renal nephrometry score is associated with urine leak after partial nephrectomy. *BJU Int* 2011;108:67-72.
 17. Mayer WA, Godoy G, Choi JM, Goh AC, Bian SX, Link RE. Higher RENAL Nephrometry Score is predictive of longer warm ischemia time and collecting system entry during laparoscopic and robotic-assisted partial nephrectomy. *Urology* 2012;79:1052-6.
 18. Samplaski MK, Hernandez A, Gill IS, Simmons MN. C-index is associated with functional outcomes after laparoscopic partial nephrectomy. *J Urol* 2010;184:2259-63.
 19. Deklaj T, Lifshitz DA, Shikanov SA, Katz MH, Zorn KC, Shalhav AL. Laparoscopic radical versus laparoscopic partial nephrectomy for clinical T1bN0M0 renal tumors: comparison of perioperative, pathological, and functional outcomes. *J Endourol* 2010;24:1603-7.
 20. 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.
 21. Thompson RH, Lane BR, Lohse CM, Leibovich BC, Fergany A, Frank I, et al. Renal function after partial nephrectomy: effect of warm ischemia relative to quantity and quality of preserved kidney. *Urology* 2012;79:356-60.
 22. Song C, Bang JK, Park HK, Ahn H. Factors influencing renal function reduction after partial nephrectomy. *J Urol* 2009;181:48-53.
 23. 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.
 24. Landman J, Venkatesh R, Lee D, Vanlangendonck R, Morissey K, Andriole GL, et al. Renal hypothermia achieved by retrograde endoscopic cold saline perfusion: technique and initial clinical application. *Urology* 2003;61:1023-5.
 25. Beri A, Lattouf JB, Deambros O, Grull M, Gschwendtner M, Ziegerhofer J, et al. Partial nephrectomy using renal artery perfusion for cold ischemia: functional and oncologic outcomes. *J Endourol* 2008;22:1285-90.
 26. Choi JD, Park JW, Lee SY, Jeong BC, Jeon SS, Lee HM, et al. Does prolonged warm ischemia after partial nephrectomy under pneumoperitoneum cause irreversible damage to the affected kidney? *J Urol* 2012;187:802-6.
 27. Funahashi Y, Hattori R, Yamamoto T, Sassa N, Fujita T, Gotoh M. Effect of warm ischemia on renal function during partial nephrectomy: assessment with new ^{99m}Tc-mercaptoacetyl triglycine scintigraphy parameter. *Urology* 2012;79:160-4.
 28. Strup S, Garrett J, Gomella L, Rowland R. Laparoscopic partial nephrectomy: hand-assisted technique. *J Endourol* 2005;19:456-9.
 29. Pierorazio PM, Patel HD, Feng T, Yohannan J, Hyams ES, Allaf ME. Robotic-assisted versus traditional laparoscopic partial nephrectomy: comparison of outcomes and evaluation of learning curve. *Urology* 2011;78:813-9.
 30. Benway BM, Bhayani SB, Rogers CG, Dulabon LM, Patel MN, Lipkin M, et al. Robot assisted partial nephrectomy versus laparoscopic partial nephrectomy for renal tumors: a multi-institutional analysis of perioperative outcomes. *J Urol* 2009;182:866-72.
 31. Desai MM, Berger AK, Brandina R, Aron M, Irwin BH, Canes D, et al. Laparoendoscopic single-site surgery: initial hundred patients. *Urology* 2009;74:805-12.
 32. Ng CS, Gill IS, Ramani AP, Steinberg AP, Spaliviero M, Abreu SC, et al. Transperitoneal versus retroperitoneal laparoscopic partial nephrectomy: patient selection and perioperative outcomes. *J Urol* 2005;174:846-9.
 33. Häcker A, Albadour A, Jauker W, Ziegerhofer J, Albquami N, Jeschke S, et al. Nephron-sparing surgery for renal tumours: acceleration and facilitation of the laparoscopic technique. *Eur Urol* 2007;51:358-65.
 34. Shao P, Qin C, Yin C, Meng X, Ju X, Li J, et al. Laparoscopic partial nephrectomy with segmental renal artery clamping: technique and clinical outcomes. *Eur Urol* 2011;59:849-55.
 35. Simon J, Bartsch G, Finter F, Hautmann R, de Petriconi R. Laparoscopic partial nephrectomy with selective control of the renal parenchyma: initial experience with a novel laparoscopic clamp. *BJU Int* 2009;103:805-8.
 36. Gill IS, Eisenberg MS, Aron M, Berger A, Ukimura O, Patil MB, et al. "Zero ischemia" partial nephrectomy: novel

- laparoscopic and robotic technique. *Eur Urol* 2011;59:128-34.
37. Rais-Bahrami S, George AK, Herati AS, Srinivasan AK, Richstone L, Kavoussi LR. Off-clamp versus complete hilar control laparoscopic partial nephrectomy: comparison by clinical stage. *BJU Int* 2012;109:1376-81.
 38. 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.
 39. Phillips JM, Narula N, Deane LA, Box GN, Lee HJ, Ornstein DK, et al. Histological evaluation of cold versus hot cutting: clinical impact on margin status for laparoscopic partial nephrectomy. *J Urol* 2008;180:2348-52.
 40. Timsit MO, Bazin JP, Thiounn N, Fontaine E, Chrétien Y, Dufour B, et al. Prospective study of safety margins in partial nephrectomy: intraoperative assessment and contribution of frozen section analysis. *Urology* 2006;67:923-6.
 41. Sutherland SE, Resnick MI, MacLennan GT, Goldman HB. Does the size of the surgical margin in partial nephrectomy for renal cell cancer really matter? *J Urol* 2002;167:61-4.
 42. Castilla EA, Liou LS, Abrahams NA, Fergany A, Rybicki LA, Myles J, et al. Prognostic importance of resection margin width after nephron-sparing surgery for renal cell carcinoma. *Urology* 2002;60:993-7.
 43. Minervini A, Ficarra V, Rocco F, Antonelli A, Bertini R, Carmignani G, et al. Simple enucleation is equivalent to traditional partial nephrectomy for renal cell carcinoma: results of a nonrandomized, retrospective, comparative study. *J Urol* 2011;185:1604-10.
 44. Bensalah K, Pantuck AJ, Rioux-Leclercq N, Thuret R, Montorsi F, Karakiewicz PI, et al. Positive surgical margin appears to have negligible impact on survival of renal cell carcinomas treated by nephron-sparing surgery. *Eur Urol* 2010;57:466-71.
 45. Orvieto MA, Chien GW, Laven B, Rapp DE, Sokoloff MH, Shalhav AL. Eliminating knot tying during warm ischemia time for laparoscopic partial nephrectomy. *J Urol* 2004;172:2292-5.
 46. Benway BM, Cabello JM, Figenshau RS, Bhayani SB. Sliding-clip renorrhaphy provides superior closing tension during robot-assisted partial nephrectomy. *J Endourol* 2010;24:605-8.
 47. Sammon J, Petros F, Sukumar S, Bhandari A, Kaul S, Menon M, et al. Barbed suture for renorrhaphy during robot-assisted partial nephrectomy. *J Endourol* 2011;25:529-33.
 48. Bak JB, Singh A, Shekarriz B. Use of gelatin matrix thrombin tissue sealant as an effective hemostatic agent during laparoscopic partial nephrectomy. *J Urol* 2004;171:780-2.
 49. Gill IS, Ramani AP, Spaliviero M, Xu M, Finelli A, Kaouk JH, et al. Improved hemostasis during laparoscopic partial nephrectomy using gelatin matrix thrombin sealant. *Urology* 2005;65:463-6.

Peer Reviewers' Commentary

Recently, laparoscopic partial nephrectomy is performed frequently in Korea. The major concern of minimally invasive nephron sparing surgery including laparoscopic partial nephrectomy is equal oncological outcome and minimal surgical complications to radical nephrectomy. The author described that the oncological outcome – especially overall survival – is superior to radical nephrectomy by several studies. This benefit is due to better residual renal function after surgery. The superior renal function can result in reducing cardiovascular events. I also agree and insist that the best efforts for the preservation of renal function should be continued for less cardiovascular events and better overall survival.

(Comment: Editorial Committee)