Improved closure techniques for laparoscopic partial nephrectomy in moderately complex renal cell carcinoma

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Laparoscopic partial nephrectomy (LPN) as a minimally invasive nephron-sparing surgery is gradually becoming the preferred surgical treatment for T1a renal carcinoma since it yields faster post-operative recovery and equivalent oncological outcomes to radical nephrectomy.[1] However, it is difficult to perform LPN for complex renal tumors, resulting in a longer warm ischemic time (WIT), which consequently affects the recovery of post-operative renal function.[2] With the development of laparoscopic instruments and techniques and the accumulating experience of surgeons, the WIT during LPN may be shortened using anatomy-based early unclamping (EUC)[1] after the placement of one or two running sutures on the tumor bed. In this study, we improved the closure techniques for LPN using EUC in patients with complex renal tumors and assessed their effectiveness.

Between February 2012 and June 2016, the clinical data of 130 patients who underwent LPN at The Third Affiliated Hospital of the Naval Military Medical University and Changzheng Hospital were retrospectively analyzed. All included patients were diagnosed with moderately complex RCC (R.E.N.A.L. score)[3] [radius, exophytic/endophytic, nearness to collecting system or sinus, anterior/posterior, and location relative to polar lines] of 7–9). The exclusion criteria were as follows: (1) no informed consent and (2) lost patient consent forms. The authors certify that they have obtained all appropriate patient consent forms.

In the improved-EUC (I-EUC) group, when renal cancer and peripheral renal parenchyma were exposed, the renal artery was dissociated and clamped using an artery clip. Along the surface of the tumor or pseudocapsule, complete cold scissor tumor resection was performed, including excision of the adjacent normal tissues 0.5 cm away from the tumor edge [Figure 1A]. A 3-0 absorbable barbed suture was used to suture the deep wound of the renal parenchyma and collective system continuously [Figure 1B]. The intra-operative photographs are displayed in Supplementary Figure 1, http://links.lww.com/CM9/A288. The tail of the 2-0 absorbable barbed suture was clamped using Hem-o-lock clips and was used to perform rapid continuous sutures with relatively large intervals in the full length of the outer layer of the wound, which could guarantee the apposition of the wound margin and shorten the WIT. At the last withdrawal of the needle, the suture was tightened and clamped using Hem-o-lock clips close to the surface of the kidney, that is, the knotting effect [Figure 1C]. After suturing the second layer of the renal wound, the artery clip was unclamped, and the renal blood flow was restored [Figure 1D]. The 2-0 absorbable barbed suture was used to suture the final layer, making the orientation assume an “S”-shaped direction [crisscross of the two layers] [Figure 1E]. The function of this layer was to ensure that the hemorrhagic spots were closed and the wound edges were consolidated. Careful observation of the wound bed ensured a firm suture and no obvious hemorrhage [Figure 1F]. In the standard unclamping (SUC) group, we followed the procedures of SUC, in which the artery clip was unclamped when the three suture layers were completed. Statistical data analysis was performed using SPSS 19.0 software (SPSS, Chicago, IL, USA). Categorical
variables were evaluated using the Chi-square test, and continuous variables were evaluated using Student’s t test or the Wilcoxon rank-sum test. P values of <0.05 were considered statistically significant.

One hundred and thirty patients met the inclusion criteria (72 patients in the SUC group and 58 patients in the I-EUC group), and the baseline demographics and tumor characteristics are summarized in Supplementary Table 1, http://links.lww.com/CM9/A289. There were no significant differences between the SUC and I-EUC groups with respect to sex allocation, age, body mass index, Eastern Cooperative Oncology Group performance status, smoking history, hypertension, diabetes, serum creatinine, blood urea nitrogen, American Society of Anesthesiologists (ASA) score, or R.E.N.A.L. score. The operative outcomes are shown in Supplementary Table 2, http://links.lww.com/CM9/A289. The mean WIT was distinctly shorter in the I-EUC group than in the SUC group (P < 0.001). No patients received blood transfusions intra-operatively or delayed transfusions post-operatively, and no significant difference was found between the two groups with respect to the mean EBL, the mean operative duration, post-operative complications, the positive margin or the mean length of post-operative hospital stay. As shown in the follow-up data, the pre-operative estimated glomerular filtration rate (eGFR) and reduction in eGFR 3 and 6 months after LPN between the two groups were not significantly different [Supplementary Table 3, http://links.lww.com/CM9/A289]. Twelve months after LPN, the SUC group had a significantly slower serum eGFR recovery than the I-EUC group (P = 0.013). In the final analysis, the SUC group had a significantly greater eGFR decline than the I-EUC group 12 months after LPN (P = 0.004). No local recurrence or distant metastasis was observed in the follow-up studies.

With the development of laparoscopes, some investigations have revealed that renal function is reduced proportional to a prolonged ischemic time (warm and cold ischemic times), and there are a growing number of methods to reduce the WIT.[4] Some urologists have advocated earlier arterial unclamping, selective arterial clamping, “zero ischemia,” selective segmental arterial clamping, and off-clamp techniques.[5] However, these techniques have been mainly used in uncomplicated small RCCs and are always performed by well-experienced and skilled surgeons.[5] In complex RCCs, the repeatability of these techniques is limited.[5] Some studies have reported that the WIT will be reduced by 40% during laparoscopic EUC compared with that during SUC.[4] However, in the practical application of EUC, we found the following limitations: (1) when the renal wound bed is sutured, unclamping of the renal artery often leads to further blood oozing, making the surgical field unclear; (2) the recovery of renal blood supply leads to excessive kidney tension, which often causes poor apposition of the outer layer of the renal wound margin and a greater risk of post-operative hemorrhage; and (3) the excessive usage of hemostatic materials will increase the operative cost. I-EUC could reduce these operative risks depending on the unclamping of the artery clips after fast and continuous suturing of the renal parenchyma, which guarantees less errhysis and better wound apposition; the “1” method will continuously suture the point of errhysis with better hemostasis when the renal artery is unclamped. The I-EUC method provided sufficient time for tumor excision and wound bed suturing; this makes it possible for experienced surgeons to master this method and yields better repeatability among LPN learners. Moreover, we found that suturing the points of errhysis after unclamping the artery clips made the effect of hemostasis more efficient.

Figure 1: The procedure of improved closure techniques for laparoscopic partial nephrectomy. (A) Cold scissors and aspirators were used for the excision of the RCC tumors and adjacent normal tissues (0.5 cm) in the LPN treatment for moderately complex renal carcinoma. (B) The 3-0 QUIL SRS suture was used for the continuous suture to close the collective system and achieve hemostasis in the suturing of the first layer. (C) The 1-0 QUIL SRS suture was used for the running suture to close the entire edge of the wound, tightened using Hem-o-look clips. (D) The artery clip was removed, and the WIT was recorded. (E) The final layer was sutured in a direction across the inner layer to close the errhysis parts. (F) The wound bed was carefully observed to guarantee successful hemostasis. LPN: Laparoscopic partial nephrectomy; RCC: Renal cell carcinoma; WIT: Warm ischemic time.
Compared with the SUC method, the I-EUC suturing method significantly reduced the WIT and minimized the eGFR decline 12 months post-operatively when we improved the unclamping of the artery clips. Therefore, the “2 + 1” suturing method provides a more sufficient suture time, more accurate and firm suture effects, clearer vision, more adequate hemostasis, and a shorter learning curve.

In conclusion, I-EUC effectively reduced the WIT and minimized the eGFR decline by improving the suturing method and employing EUC in the laparoscopic treatment of moderately complex RCCs; this consequently improved the patients’ quality of life, expanded the applicability of LPN, and improved its safety. Thus, this method deserves clinical promotion.

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Conflicts of interest
None.

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