VIDEO ARTICLE
Urooncology

Doi: 10.4274/jus.galenos.2024.2024-10-4
J Urol Surg 2025;12(1):49-51

Laparoscopic Partial Nephrectomy Tips and Tricks

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Abstract

This video article presents tips and techniques for laparoscopic partial nephrectomy (LPN), emphasizing the importance of preoperative assessment with advanced imaging techniques like 3-dimensional reconstruction. The transperitoneal approach, precise trocar placement, and intraoperative ultrasound guidance are highlighted for optimal surgical outcomes. The role of renorrhaphy, with considerations for suturing techniques and materials, is discussed, particularly focusing on nephron-sparing strategies. The benefits of minimizing warm ischemia time are reviewed alongside the value of zero ischemia techniques. LPN remains a highly effective nephron-preserving procedure for managing small renal masses.

Keywords: Endourology, general urology, urooncology

Introduction

Partial nephrectomy (PN) should be recommended for clinically stage T1 or "resectable" T2 tumors rather than radical nephrectomy if technically feasible. Technical preference for PN depends on the expertise of the surgeon (1). Laparoscopic and robotic PN have shown comparable surgical margin status and oncological outcomes relative to open surgery in appropriately selected patients (2). Current data indicate that the advantages of minimally invasive surgery are evident in the short-term perioperative period and are comparable to open surgery during intermediate and long-term assessments (3). In experienced hands, laparoscopic partial nephrectomy (LPN) indeed works as an effective nephron-preserving platform despite a more difficult learning curve (4). In this video article, we aim to present LPN's technical details and tips on all steps.

Preoperative Assessment

Comprehensive preoperative evaluation is essential for optimizing outcomes and minimizing complications in patients undergoing PN. High-resolution multiphasic contrast-enhanced tomography or magnetic resonance imaging assesses the tumor's location, size, and relationship to surrounding structures. The tumor's proximity to the renal vasculature and collecting system is crucial for surgical planning. 3D reconstruction techniques enable patients to grasp organ structures' spatial and anatomical relationships more effectively than conventional images.

Scoring systems such as the RENAL nephrometry score (5) aid in assessing tumor complexity and assist surgeons in refining nephron-sparing strategies during surgery and in preoperative discussions with patients. The RENAL score also has significant correlations with clinical outcomes, including longer warm ischemia times, increased complications, more aggressive pathological features, and higher tumor grades (6).

Positioning and Trocar Placement

We prefer the transperitoneal approach, which offers a larger operative field and facilitates easier anatomical orientation. A modified lateral decubitus position aids colon medialization, allowing the intestines to naturally fall away from the kidney. The pneumoperitoneum is established using a closed technique, with the optical trocar typically inserted at the pararectal line or umbilicus, depending on the patient's anatomical characteristics. The remaining trocars are placed in a triangular configuration based on the tumor's location, whether polar or central, and at the upper or lower pole of the kidney.

Vascular and Perirenal Dissection

Following the medialization of the colon, duodenum, and spleen, Gerota's fascia is incised next to the gonadal vein.

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Received: 07.10.2024 **Accepted:** 21.10.2024 **Publication Date:** 21.02.2025

Cite this article as: Gülşen M, Köse E, Özden E. Laparoscopic partial nephrectomy tips and tricks. J Urol Surg. 2025;12(1):49-51.

After the ureter is identified and suspended, the fascia is carefully dissected to the inferior margin of the renal vein. The inferior pole is subsequently elevated to enhance visibility. Mobilization is enhanced by liberating the plane between the kidney and the adrenal gland. The renal vein and artery are separately dissected and secured with silicone tapes. Dissection is conducted cautiously due to vascular abnormalities and the risk of perforating branches. We employ ultrasonic energy devices, such as Thunderbeat®, for vascular and perirenal fat dissection. Intraoperative ultrasonography is essential for directing accurate parenchymal dissection, particularly in cases with adherent perirenal fat (7), avoiding tumor capsule rupture, and defining margins. Tumor margin scoring is performed using hook cautery. The application of intraoperative ultrasound is especially vital for executing PN in endophytic tumors.

Resection and Renorraphy

Recent literature demonstrates that the most important determinant of functional outcomes after PN is the preservation of vascularized renal parenchyma (8). Efforts to optimize this parameter during tumor excision and reconstruction should be prioritized as long as oncological outcomes are not compromised. In short, preserving nephron mass is crucial for maintaining kidney function. Resection, enucleoresection, and enucleation are the three main resection techniques. The choice of technique depends on the tumor's location, shape, relationship to the collecting system and vessels, and the surgeon's experience. The tumor's relationship with these anatomical structures plays a critical role in selecting the surgical strategy and can directly impact the surgical outcomes.

We primarily prefer enucleation, when technically feasible, to maximize the preservation of normal renal parenchyma. The concept of tumor enucleation (blunt excision of the tumor with minimal margin during nephron-sparing surgery) was originally developed in familial renal cell carcinoma (RCC) patients who require multiple surgeries throughout their lifetime due to multiple tumors to preserve as much renal parenchyma as possible (9). This technique maximizes renal tissue preservation, making it a suitable strategy for repeat surgeries. It was later evaluated in the sporadic RCC population, and several studies reported similar oncological outcomes compared to traditional PN (10). In traditional PN, a deliberate margin of normal renal parenchyma surrounding the tumor is excised, while enucleation minimizes this margin. However, most studies comparing enucleation and traditional PN have been retrospective, with no standard pathological review applied. Additionally, the selection of enucleation is often based on favorable imaging characteristics such as homogeneity and encapsulation (11). Enucleation involves blunt dissection along the tumor pseudo capsule, a structure in many but not all renal cancers. When present, the pseudo capsule may contain invasive cancer in up to one-third of cases, with its impact on prognosis being unclear (12). Given these concerns, careful evaluation of tumor growth patterns and its interface with normal parenchyma through preoperative radiological imaging is necessary to assess the feasibility of successful enucleation.

In PN, safe resection should be followed by quality reconstruction. Renorrhaphy techniques during minimally invasive PN have evolved for several reasons. In the early LPN series, renorrhaphy focused on minimizing complications through proper hemostasis and closure of the collecting system. Today, "nephron-sparing renorrhaphy" aims to maximize the volume of vascularized parenchyma preserved, thus ensuring better long-term renal function. This approach prioritizes bleeding control and preservation of the kidney's functional tissue (13).

Renorrhaphy can be performed in two layers (medullary and cortical) or in a single layer. A systematic review evaluating suturing techniques found no difference in complications between single- and double-layer renorrhaphy but emphasized that single-layer closure was more advantageous for preserving kidney function (14). The same review found no significant difference in complications between interrupted and continuous suturing but reported that the duration of surgery was longer in the interrupted suture group (14). We prefer a double-layer running fashion; in medullar renorraphy, we prefer monofilament sutures with a Hem-o-lok™ clip at the end. In the cortical renorraphy, we use a 2/0 absorbable, braided suture with a sliding clip technique (15).

In terms of suture material, both barbed and monofilament sutures can be used for medullary renorrhaphy. While barbed sutures shorten the duration of renorrhaphy, we prefer monofilament sutures in complex masses to prevent tension and tearing in the tissue. Monofilament sutures offer an advantage in wide-based cases as they can be tightened from both ends.

The European Association of Urology guidelines recommend limiting warm ischemia time to 20-25 minutes (1). Although warm ischemia time is important, as previously mentioned, complete tumor resection and renorrhaphy should be prioritized. Zero ischemia (off-clamp) techniques may improve functional outcomes, but they are not always feasible and may reduce the surgical field visibility during PN (16).

In patients undergoing off-clamp PN, the long-term estimated glomerular filtration rate was higher (mean difference =7 mL/min/1.73 m^2) than those undergoing on-clamp PN. Meta-analyses comparing ischemia techniques have shown that zero ischemia is associated with higher positive surgical margin rates (5.6% *versus* 3.8%, $p<0.01$) and local recurrence (3.1% *versus* 1.8%, $p=0.13$) compared to warm ischemia (17).

Conclusion

Minimally invasive PN has proven to be a safe and effective procedure for managing renal masses, offering similar oncological outcomes to open surgery while preserving renal function. Advances in laparoscopic and robotic techniques and intraoperative imaging tools have further enhanced surgical precision and outcomes. Preserving vascularized renal parenchyma remains a critical factor in maintaining long-term renal function. Continued focus on optimizing surgical techniques, such as nephron-sparing renorrhaphy and enucleation, will ensure that PN remains the gold standard in nephron-sparing surgery for appropriate cases.

Video 1.

Ethics

Informed Consent: Written informed consent was obtained from the patient.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.G., E.Ö., Concept: M.G., E.Ö., Design: M.G., E.Ö., Data Collection or Processing: M.G., E.K., Analysis or Interpretation: M.G., E.K., Literature Search: M.G., E.K., Writing: M.G.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declare that they received no financial support for this study.

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