Short Communication

BIOMEDICAL Journal of Scientific & Technical Research

ISSN: 2574 -1241

DOI: 10.26717/BJSTR.2025.63.009844

Minimally Invasive Laparoscopic Partial Nephrectomy - A Novel Technique

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ARTICLE INFO

Received: August 19, 2025

Published: September 02, 2025

Citation: D Balan, AP Fényes, Vartolomei, T Kozma-Bognár and Á Pytel. Minimally Invasive Laparoscopic Partial Nephrectomy - A Novel Technique. Biomed J Sci & Tech Res 63(1)-2025. BJSTR. MS.ID.009844.

BACKGROUND

Objectives: Surgical options for management of renal cell carcinoma (RCC) have been evolving, as evidenced by the introduction of a new laparoscopic partial nephrectomy technique, which is described in this article. RCC accounts for roughly 3% of all cancers and is increasingly common, particularly in the developed world, with small renal masses (SRM) increasing in frequency. The goal of our study was to introduce a novel surgical technique for laparoscopic partial nephrectomy, were we have invented a new modified Klammer clamp. Between 2019-2023 119 patients were operated with the new technique, and data gained in this population was analysed, showing benefits such as reduced ischemic time, hospital stay, and tumor management.

Methods: The retrospective analysis involved a diverse group of patients, median age 62 years, and the surgical endpoints assessed were duration of surgery, conversion to open, and pathological results.

Results: Remarkably, the median procedure time measured at 120 minutes, the conversion rate to open surgery was only 9.2%, and no reoperation was needed, suggesting low complication rates. Pathological findings showed that most of the excised tumors were clear cell renal carcinoma. Renal function was tracked following surgery, revealing a median GFR of 71.5 mL/min/1.73 m^2 at three to six months following the operation, indicating a recoverable impairment of renal function yet an overall intact renal status

Conclusions: In conclusion, the authors claim that the new laparoscopic approach using the modified Klammer clamp instrument is a safe and effective means to treat renal tumors, allowing for a less invasive approach while maintaining renal function. The authors call for continued long-term follow-up and the role of advanced imaging and robotic assistance to further improve urologic surgery.

Keywords: Laparoscopic Partial Nephrectomy; Novel Technique; Renal Function

Abbreviations: RCC: Renal Cell Carcinoma; SRM: Small Renal Masses; BMI: Body Mass Index; GFR: Glomerular Filtration Rate; PN: Partial Nephrectomy; RCT: Randomized Control Trials; IQR: Interquartile Range

Introduction

In the era of robotic surgery it is pretty difficult to highlight the advantages of open and laparoscopic surgeries for renal cell carcinoma, however it is necessary. Several articles on laparoscopic/robotic partial nephrectomies still debate the advantages and disadvantages of clamping the renal hilum, in this article we describe the advantages of totally by-passing of this theme, leaving the renal hilum intact [1-3]. Renal cell carcinoma accounts for around 3% of all cancers with increasing incidence in more developed countries [4,5]. In Europe, due to the accessibility to quality healthcare the incidence of small renal masses (SRM) has risen considerably, representing around 30% globally [6]. Risk factors include smoking, obesity, increased body mass index (BMI), hypertension and diabetes, according to some of the emerging studies [7,8]. Protective agents are mentioned in the literature like moderate alcohol consumption and physical activity [9-13]. The development of surgical techniques is the most import-

ant progress in the field of urology that has an impact on improving patient outcomes, especially for renal tumor therapy. Of these advanced modalities, laparoscopic partial nephrectomy has emerged as a front-runner with several advantages over techniques performed via the open approach. In this article, we describe a new technique of laparoscopic partial nephrectomy that we performed at our department, with highlights of its low ischemic time, shorter hospital stay, and absence of renal hilum preparation.

We observed a high rate of kidney function preservation and safe tumoral resection percentage, comparable with data in the literature [14,15]. We observed previously and studying the literature that most of the laparoscopic partial nephrectomy complications occur when the hilum is dissected and the Bulldog clamps applied. We aimed at developing a new type of local ischemia that only affects the tumoral site, thus performing the highly recommended nephron sparing surgery, without the need for hilum dissection. After using the Klammer clamp on multiple occasion during radical cystectomy the idea emerged that a special clamp should be developed that can be placed surrounding the renal tumor. In collaboration with hospital staff the previously mentioned Klammer clamp has been sent for modification: obtaining a more convex surface perfectly appliable for renal use. The objective of the study was to highlight the clear benefits of a novel laparoscopic technique performed in our department.

Materials and Methods

Retrospective observational study with multiparametric evaluation of 119 cases of specific technique partial nephrectomy performed in our department during a 5 year period between January 2019 and December 2023. The preparation of the methodology has been performed according to STROBE checklist standards. Inclusion criteria were as follows: all patients with renal tumors scheduled for laparoscopic partial nephrectomy at initial evaluation, pre- and postoperative renal function assessment, written consent to the intervention and data analysis, information on blood-transfusion, and available histological evaluation. Exclusion criteria: patients with renal tumors that were not suitable for laparoscopic partial nephrectomy at initial evaluation, lack of data on renal function, histology and blood transfusion, those who did not give consent to data analysis. The kidney and the tumor preparation is carried out according to the usual routine laparoscopic procedures, but no hilus preparation nor hilus clamping is performed. The fatty capsule is opened, the kidney is mobilized and the tumoral lesion is prepared, maintaining the fat around the tumor. A mini laparotomy is applied and a specially designed soft Klammer intestinal clamp is placed under the tumor, a partial exclusion is performed for about 20 minutes and the tumor is resected and/or enucleated. With macroscopical negative surgical margins the resection edges are sutured with running vicryl suture with heam-o-lock thread fixation After releasing the staple, the stabile hemostasis is to be convinced.

The closure is as usual. The unique technique represents the application of a specific Klammer intestinal clamp-derived instrument that is applied on the kidney obtaining ischemia during enucleation/resection. Using this technique the necessity of preparing the renal hilum and application of Bulldog instruments is avoided, reducing the duration of intervention and a considerable number of complications. An excel database has been created analyzing key and clinically significant parameters such as: age, gender, type of partial nephrectomy, duration of surgery, reintervention, conversion rate, transfusion rate, histological grading, margin, size of tumor, preop GFR, preop creatinine levels, postop GFR and creatinine at 3-6 months.

Results

Study Population

For this study, the analysis included 119 interventions taking place in our department in a five-year period from January 2019 to December 2023. Patient demographics included: Median Age: 62 years (IQR> 33-83 years), Gender: 67 (56,3%) men and 52(43,7%) women.

Surgical Outcomes

Among the 119 interventions, results were: Laparoscopic Approach: 94 (79%) procedures were performed laparoscopically with a mini-laparotomy, 18 (15%) interventions performed as open surgeries. Conversion from laparoscopic to open surgery was required in 11 (9,2%) cases. Tumor-Free Status Nephrectomies: Based on local status, nephrectomy was performed to achieve a tumor-free status in 7 (5,8%) cases.

Duration and Complications

The median duration of the interventions was 120 minutes (IQR: 60 to 210 minutes). Notably, no reoperations were required during this time period, suggesting a low complication rate and a strong surgical technique.

Histological Analysis

The pathological examination of the resected tumors demonstrated a diversity of renal neoplasms: (Table 1)

Table 1: Histological analysis.

Renal Neoplasm Type	Number of Cases	Percentage (%)
Clear Cell Renal Carcinoma	76	63.8
Papillary Renal Cell Carcinoma	25	21.0
Oncocytoma	9	7.5
Chromophobe Carcinoma	4	3.3
Angiomyolipoma	4	3.3
Multilocular Cyst with Low Malignant Potential	1	0.84

Tumor Staging

Tumor staging is summarized in Table 2. In 5 cases (4,2%), positive margins of tumor resection were also observed, demonstrating that a meticulous surgical technique in practice should be crucial to obtain complete tumor resection.

Table 2: Tumor staging.

Stage	Number of Cases	Percentage (%)
pT1	101	84.8
pT2	1	0.8
pT3	2	1.7
pT4	1	0.8

Tumor Size and Preoperative Evaluations

The median size of the tumors was 2.9 cm (IQR> 1–9 cm). The preoperative assessments were as follows:

- Glomerular Filtration Rate (GFR): Preoperative GFR, median 80 (IQR:55–90) mL/min/1.73 m^2

- Serum Creatinine: The preoperative median creatinine levels were found at 107 (IQR: 88–138) μmol/L

Postoperative Outcomes

Renal function post-surgery is an important measure of how well nephron-sparring technique has been performed. Glomerular filtration rate (GFR) and serum creatinine were monitored to assess the patients' renal function in our study.

- Postoperative GFR: The median GFR at 3-6 months post-surgical intervention was 71.5 mL/min/1.73 m^2. This decrease from the preoperative median GFR of 80 mL/min/1.73 m^2 represents a recoverable reduction in renal function that is an expected complication of nephrectomy, yet remains within a clinically accepted range.

- Postoperative Level of Creatinine: The median values of serum creatinine on the postoperative day were 88.25 μmol/L, which was lower than the preoperative median creatinine value of 105 μmol/L, indicating that, although there may have been some decrease in GFR, the overall renal function was maintained and signs of improvement were observed.

Discussion

Our study concludes the benefits of the new laparoscopic partial nephrectomy technique in a minimally invasive manner with regard to ischemic time, hospital stays, and postoperative outcomes. No randomized control trials (RCT) have evaluated the oncological outcomes of open versus laparoscopic partial nephrectomies (PN), although some cohort studies exist that present similar oncological outcomes, even for higher stage tumors [16-19]. Regarding hospital stay, re-admission rate and 30 to 90 day mortality rate laparoscopic surgery provides better results [20]. Pain-management and the necessity of analgesic medication is significantly lower in laparoscopic approach versus open [21-23]. Same can be pronounced for convalescence [21]. Blood transfusion rate is similar for both types of approach, but perioperative bleeding seems to be less in laparoscopic surgery [18,21,24]. As far as operation time goes, open nephrectomy provides shorter durations [22]. Postoperative quality of life scores showed no statistical difference between the two approaches [22]. A comprehensive study focused on 3 year recurrence free survival rates showed no difference between open and laparoscopic nephrectomies [25]. A retrospective studies describing surgical techniques of laparoscopic adrenalectomy highlighted the importance of intraoperative imaging methods during surgery, especially intraoperative ultrasound, thus achieving better results [26,27].

One of the most important advantages of this novel surgical method is the low ischemic time due to effective segmentation of the tumor without a wide preparation of the renal hilum. In traditional approaches, the renal hilum is liberally manipulated, resulting in prolonged ischemic periods and higher chances of complications [28,29]. The modified Klammer clamp instrument allows the isolation of the tumor, with preservation of vascular supply to the remaining kidney parenchyma and reduction of the risk of ischemic damage. Most patients (94 of 119, 79%) received laparoscopic procedures, which were associated with shorter recovery times than open surgery. This shortening of inpatient duration not only helps patients recover faster and return to their lives sooner, but also eases the strain on healthcare resources [30]. Tumors were excised at renal surgery, and their pathological characterizations showed the majority of them to be primary renal cell carcinoma, with the most common subtype as clear cell renal carcinoma. [31,32]. This broad approach to surgical procedures, coupled with increased visualization afforded by laparoscopic techniques, allowed for near-complete tumor clearance with negative margins in most cases. Although five cases showed positive margins, the overall rate of achieving a tumor-free status suggests that the utilized surgical technique is effective.

Also, note the very low conversion rate to open surgery (11 out of 119), which shows the efficiency and security of the laparoscopic technique. The postoperative renal function data showed decreased GFR, which is an expected outcome of nephrectomy [33,34]. Nevertheless, the median GFR of 71.5 mL/min/1.73 m^2 at the three to six-month follow-up suggests that patients had good renal function and good stability after three to six months postoperatively. This improvement also indicates the effectiveness of the surgical technique used in preserving renal health.

Conclusion

The novel minimally invasive laparoscopic partial nephrectomy technique performed in our department clearly highlighted the benefits of this type of surgery: low complication rate, short ischemic time, low transfusion rate, decreased hospitalization, and efficacy in isolat-

ing tumors with the modified Klammer clamp instrument. This method represents a safe, efficient surgical approach. Our study, which included 119 interventions over a 5-year period, showcases this approach to provide our patients with the best possible outcomes, maintaining renal function and maximal tumor control. Our dedication to enhancing patient care will not change as we work to refine our methods and acquire new tools.

Future Directions

We hope to continue long-term follow-up of patients to ensure how long these results can be seen with this recent technique. Moreover, the use of advanced imaging modalities together with robotic assistance offers a promising avenue to improve the accuracy of laparoscopic nephrectomy, which will help the urologic surgeon take even better care of their patients. Overall, laparoscopic partial nephrectomy in the minimally invasive approach is a classic example of how we have progressively advanced in urological surgery, and our department has the motivation to keep exploring new frontiers. We are continuously raising the standard of care in the treatment of renal tumors by focusing on patient safety, complication minimization, and optimal results as presented in the study. Hopefully our technique could gain worldwide recognition with it's simplistic approach, low complication rates and high tumor-free results.

Author Contributions

Conceptualization, B.D. and KBT; Methodology, FAP; Software, B.D.; Validation, B.B. and KBT; Formal Analysis, B.D.; investigation, B.D and FAP.; resources, KBT.; data curation, B.D and FAP.; writing—original draft preparation, B.D.; writing—review and editing, B.D.; visualization, VMD.; supervision, KBT and VMD. P.A reiew and editAll authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Institutional Review Board Statement

Institutional Review Board Statement. The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Zala County Hospital, nr.1/2025.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

All data regarding to the study can be contacted at https://www.zmkorhaz.hu/.

Acknowledgments

The study was created with contributions of all authors who went beyond their normal call of duty and helped with the achievement of this article.

Conflicts of Interest

The authors declare no conflicts of interest.

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ISSN: 2574-1241

DOI: 10.26717/BJSTR.2025.63.009844

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