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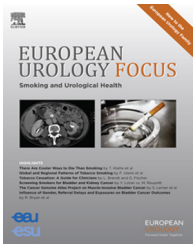

Priority Focus – Kidney Cancer

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Minimally Invasive Partial Nephrectomy Versus Laparoscopic Cryoablation for Patients Newly Diagnosed with a Single Small Renal Mass

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Abstract

Background: Minimally invasive partial nephrectomy (MIPN) and laparoscopic renal cryoablation (LRC) are two treatment options increasingly used for small renal masses.
Objective: To compare perioperative, oncologic, and functional outcomes after MIPN and LRC.
Design, setting, and participants: We included 372 consecutive patients newly diagnosed with a single small renal mass and treated with either MIPN or LRC at a single institution.
Intervention: MIPN and LRC.
Outcome measurements and statistical analysis: Regression models were used to evaluate the impact of surgical treatment (MIPN vs LRC) on perioperative, oncologic, and functional outcomes.
Results and limitations: Overall, 206 patients (55%) underwent MIPN and 166 (45%) were treated with LRC. In multivariate analysis, the rate of postoperative complications was significantly lower in the MIPN compared to the LRC group (20% vs 28%; adjusted difference −11%; $p = 0.02$) after adjusting for age at surgery, American Society of Anesthesiologists score (1 vs 2 vs 3), and tumor size. The median follow-up was similar in the two groups (43 and 39 mo for MIPN and LRC, respectively). In univariate Cox regression analysis, treatment type was not significantly associated with disease-free survival (hazard ratio 1.06, 95% confidence interval [CI] 0.45–2.52; $p = 0.9$). The disease-free survival rate at 5 yr was 92% in MIPN and 93% in LRC patients. In multivariate linear regression analysis, LRC was significantly associated with a higher estimated glomerular filtration rate (eGFR) at 6 mo compared to MIPN (coefficient 4.68, 95% CI 0.06–9.30; $p = 0.047$) after adjusting for age at surgery, tumor size, and preoperative eGFR. There was no significant association between surgical treatment and postoperative eGFR at 3 yr after surgery (coefficient −2.36, 95% CI −7.55 to 2.83; $p = 0.4$). Limitations include the retrospective study design and selection bias.
Conclusions: MIPN and LRC provided similar cancer control and comparable renal function at intermediate-term follow-up. Both surgical techniques emerged as viable treatment options for patient newly diagnosed with a single small renal mass. Further multi-institutional studies with longer follow-up and nephrometry scores are needed to corroborate our findings.
Patient summary: In patients newly diagnosed with a single small renal mass, minimally invasive partial nephrectomy and laparoscopic renal cryoablation provided similar cancer control and comparable renal function at intermediate-term follow-up.

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1. Introduction

The widespread use of routine abdominal imaging has led to an increase in the proportion of patients diagnosed with asymptomatic small renal masses (SRMs) [1]. According to National Comprehensive Cancer Network and European Association of Urology guidelines, partial nephrectomy represents the standard of care for these patients [2,3]. Minimally invasive partial nephrectomy (MIPN), including both laparoscopic and robot-assisted approaches, has emerged as an effective alternative to open surgery, offering comparable oncologic outcomes with reduced morbidity [4–7].

Several thermal ablation procedures have been developed to reduce the risk of complications. Thermal ablation has several potential benefits compared to partial nephrectomy, as there is no need to incise the renal parenchyma and to clamp vessels. Among alternative ablative strategies, laparoscopic renal cryoablation (LRC) has shown encouraging oncologic outcomes [8,9] and lower retreatment rates [10].

Several studies have compared partial nephrectomy to LRC for SRM treatment. Specifically, LRC was associated with lower complication rates, good functional outcomes, and higher recurrence rates compared to laparoscopic partial nephrectomy [11,12]. Similar results emerged from a comparison of LRC and robot-assisted partial nephrectomy [13]. These findings were substantially confirmed by two recent meta-analyses that highlighted worse oncologic outcomes and improved perioperative outcomes for LRC compared to laparoscopic partial nephrectomy [14,15].

However, these studies analyzed minimally invasive surgery and LRC in highly heterogeneous patient population, including cancer-naïve patients, single-kidney patients, and patients with previous surgery for kidney cancer. As previous history of renal cell carcinoma (RCC) is an important predictor of adverse oncologic outcomes [16], such studies are prone to selection bias [17]. Moreover, in patients previously treated with renal surgery, both MIPN and LRC might be more challenging, resulting in poorer surgical and functional outcomes.

We hypothesized that MIPN and LRC would lead to similar outcomes in a more homogeneous group of patients less susceptible to selection bias, specifically, patients newly diagnosed with a single SRM. We used our single-institution database to compare intraoperative, perioperative, oncologic, and functional outcomes of MIPN and LRC in this study population.

2. Patients and methods

2.1. Patient population

After institutional review board approval, we identified 412 consecutive patients diagnosed with an SRM (≤4 cm) and treated with either MIPN or LRC at our institution between 2000 and 2013. We excluded patients with a previous history of RCC ($n = 16$), patients with a solitary kidney ($n = 11$), and patients diagnosed with synchronous lesions ($n = 13$). These selection criteria yielded 372 assessable individuals newly diagnosed with a single SRM. Treatment choice was left to the discretion of the surgeon. MIPN was typically proposed for healthy young patients who elected for nephron-sparing surgery. Conversely, LRC was offered to patients with comorbidities and baseline renal dysfunction, who were at higher surgical risk. Three different surgeons, who started their surgical experience at our institution, treated all the cases. Patients were treated during the surgeons' learning curve, and the three surgeons performed MIPN and LRC during the same period. Overall, 166 patients (45%) were treated by surgeon #1, 140 (37%) by surgeon #2, and 66 (18%) by surgeon #3. Surgeons #1, #2, and #3 performed 101 (49%), 84 (41%), and 21 (10%) procedures in the MIPN group, and 65 (39%), 56 (34%) and 45 (27%) procedures in the LRC group, respectively.

2.2. Surgical techniques

Minimally invasive surgery consisted of either laparoscopic or robot-assisted partial nephrectomy performed using previously described surgical techniques [18,19]. Specifically, intraoperative ultrasonography was carried out in all patients to guide tumor excision, the renal vessels were clamped, and partial nephrectomy was completed under warm ischemia.

LRC consisted of transperitoneal or retroperitoneal access to the renal cavity, kidney mobilization, laparoscopic ultrasound evaluation, ultrasound-guided biopsy of the lesion, puncture of the SRM with cryoprobes, and a double freeze-thaw cycle with extension of the ice ball approximately 1 cm beyond the tumor edge [20].

2.3. Patient variables

We collected data for the following variables: age at diagnosis, gender, American Society of Anesthesiologists (ASA) score, body mass index (BMI), preoperative serum creatinine, preoperative estimated glomerular filtration rate (eGFR), chronic kidney disease stage, tumor size, and tumor location (side, pole, and face). eGFR was calculated using the equation from the Modification of Diet in Renal Disease Study Group [21]. Chronic kidney disease stage was defined according to the National Kidney Foundation clinical practice guidelines [22].

2.4. Outcomes and statistical analysis

The aim of the study was to compare MIPN and LRC in patients newly diagnosed with a single SRM. We hypothesized that MIPN and LRC provided similar results regarding the following outcomes.

2.4.1. Intraoperative and perioperative outcomes

We evaluated estimated blood loss, total operative time, intraoperative complications, blood transfusion rate, in-hospital complications, Clavien-Dindo complication grade [23], and length of hospital stay. Linear and logistic regressions were used to evaluate the impact of surgical treatment (MIPN vs LRC) on continuous and binary outcomes, respectively. Data were adjusted for patient age, ASA score (1 vs 2 vs 3), and tumor size. For the endpoints of intraoperative complications, blood transfusion rate, and Clavien-Dindo complication grade, event numbers were low, so we adjusted only for ASA score.

2.4.2. Oncologic outcomes

We evaluated the local recurrence rate, metachronous SRM rate, distant metastasis rate, and disease-free survival rate. Local recurrence was defined as an enlarging or persistently enhanced treatment site on follow-up imaging, according to Working Group on Image-guided Tumour Ablation criteria [24]. Metachronous SRM was defined as a new contrast-enhancing lesion located at a site other than the treated area in the ipsilateral kidney or in the contralateral kidney. Distant metastasis was defined as the presence of RCC anywhere else apart from the ipsilateral or contralateral kidney. Disease-free survival was defined as the simultaneous absence of local recurrence, metachronous SRM, and