Impact of Curative Effect of Laparoscopic and Open Partial Nephrectomy for Complex Renal Tumours on Renal Function

Hong-mei Li, Peng Sun, Wen-zeng Yang and Zhen-yu Cui

1Department of Urology, Affiliated Hospital of Hebei University, Baoding, Hebei, P. R. China
2Department of Cardiovascular Medicine, Affiliated Hospital of Hebei University, Baoding, Hebei, P. R. China

ABSTRACT
Objective: To explore the effect and safety of laparoscopic partial nephrectomy (LPN) and open partial nephrectomy (OPN) in the treatment of complex renal tumours and to compare renal function in the perioperative period.
Study Design: Comparative study.
Place and Duration of Study: Departments of Urology and Cardiovascular Medicine, Affiliated Hospital of Hebei University, from July 2016 to June 2018.
Methodology: A total of 168 complex renal tumour patients with renal tumour scoring system scores (R.E.N.A.L) \( \leq 7 \) and tumour stages of T1aN0M0~T1bN0M0 (diameter of tumour \( \leq 7 \) cm without metastasis) were chosen. The patients were classified into the retroperitoneal laparoscopic partial nephrectomy (RLPN) group and open partial nephrectomy (OPN) group, comprising 84 patients in each group. Intraoperative and postoperative characteristics of both groups were compared. Statistical analysis of the occurrence rate of postoperative complications was conducted. Renal function indicators, including serum urea (UREA), creatinine (Cr), uric acid (UA) and glomerular filtration rate (GFR), were evaluated one day before the operation and one week after the operation.

Results: The differences between the two groups in intraoperative renal warm ischaemia time (WIT) and postoperative drainage time were not statistically significant. Compared with OPN group, RLPN group had shorter recovery time of gastrointestinal function, less use of analgesics and longer hospital stay. The difference in the recent occurrence rate of complications was not statistically significant. The differences between the two groups in UREA, Cr, UA and GFR one day before the operation and one week after the operation were not statistically significant (\( p>0.05 \)). The Cr and UA levels of both groups improved significantly after the operation, and the GFR level declined significantly. The differences were statistically significant compared with preoperation levels (\( p<0.05 \)).

Conclusion: The effect and safety of RLPN in the treatment of complex renal tumours are equal to those of open operations. Laparoscopic surgery involves a small operative wound and contributes to renal function recovery, allowing patients to recover quickly; however, laparoscopic surgery has high technical requirements for its operators.

Key Words: Laparoscopic partial nephrectomy, Open partial nephrectomy, Complex renal tumour, Curative effect, Renal function.

In this study, the objective was to determine the effect of RLPN and OPN in the treatment of complex renal tumours and on renal function.

**METHODOLOGY**

The study was approved by the Institutional Ethics Committee and written informed consents were obtained from all participants. A total of 168 patients who were diagnosed by Urology and Cardiovascular Medicine at Affiliated Hospital of University and received NSS treatment of complex renal tumours from July 2016 to June 2018 were chosen. The patients were classified into RLPN group (84 cases) and OPN group (84 cases), as per random number table. Inclusion criteria were definitively diagnosed through a combination of clinical symptoms, chest X-ray films, abdominal ultrasound/CT/MRI examinations, R. E. N. A. L. ≥7, tumour stage T1aN0M0-TibN0M0 (diameter of tumour ≤7 cm, without metastasis), no relevant surgical contraindications, and signed informed consent form. Exclusion criteria were severe organic lesions such as those on the heart, liver and lung or other malignant tumours; coagulation function and immune deficiency; comorbidities of hypertension and diabetes; presence of regional lymphatic metastases and distant metastases.

For the RLPN group, patients were placed in a lateral position; after general anaesthesia and cannula insertion, a 3 cm incision was made 2 cm upward of and along the midaxillary line and crista iliaca. Blunt dissection of the lumbodorsal fascia was performed, and the balloon was inflated to expand the retroperitoneal gap. The operation incisions were made along the posterior auxiliary line under the 12th rib and anterior auxiliary line of the rib margin, and the trocar and laparoscope were placed. Artificial pneumoperitoneum (CO₂ pressure 15 mmHg) was established. Extra peritoneal fat was cleared, and the Gerota fascia was cut open lengthwise. Loose tissue between the renal fatty capsule and renal anaemia capsule was separated. Renal parenchyma and the tumour were then exposed, and the renal pedicle and blood vessels were separated. A bulldog vascular clamp was used to interdict the renal artery. WIT was recorded. The tumour and surrounding renal parenchyma were cut along the tumour edge 0.5–1 cm. The renal collection system and renal parenchyma wound surface were sutured. A drainage tube was placed at the renal artery, and the operation incisions were closed.

For the OPN group, patients were placed in a lateral position. A diagonal incision was made in the 11th rib or under the 12th rib. The incision was cut open layer by layer to enter the retroperitoneal gap. The other steps are similar to the steps of RLPN.

Intraoperative indicators included intraoperative WIT, operation duration and intraoperative blood loss volume. Postoperative indicators include the following: postoperative drainage time, postoperative drainage volume, gastrointestinal function recovery time, amount of postoperative analgesic use and total length of hospital stay. Recent complications included bleeding, urine leakage, perirenal haematoma, infection of incisional wound, pleural injury and hypercapnia; renal function indicators including serum urea (UREA), creatinine (Cr), uric acid (UA) and glomerular filtration rate (GFR) were determined one day before the operation and one week after the operation.

SPSS Version 22.0 statistical software was used for data analysis. Enumeration data were expressed as the rate (%) and tested with the χ² test. Measurement data were expressed as x±s. Independent sample t-tests were used for inter-group comparisons, and paired sample t-tests were used for intra-group comparisons. P<0.05 indicates that the difference was statistically significant.

**RESULTS**

The comparison differences in age, gender, BMI, tumour diameter, tumour position and TNM stage were not statistically significant (p>0.05), as shown in Table I. The difference between the two groups in postoperative drainage time was not statistically significant (p=1.000). The postoperative drainage volume, gastrointestinal function recovery time, amount of postoperative analgesic drug use and length of hospital stay of the RLPN group were significantly lower than those of the OPN group, and the differences were statistically significant (p<0.001).

The differences between the two groups in UREA, Cr, UA and GFR one day before the operation were not statistically significant (p=0.611, 0.598, 0.996, and 0.962, respectively). The Cr and UA levels of both groups improved significantly after the operation, and the GFR level declined significantly. The differences were statistically significant compared with preoperatiopn (p<0.001) levels. The difference in the UREA levels of the two groups before the operation was not statistically significant (p=0.611). The differences in the two groups in UA and GFR one week after the operation were not statistically significant (p=0.513 and p=0.093, respectively), as shown in Table II.

**DISCUSSION**

With rapid developments in medical imaging and minimally invasive surgery technology, surgical method selection is changing from traditional open operations to minimally invasive surgeries. LPN is expected to replace OPN and become the standard operation to treat renal tumours. In 1993, Winfield reported the first LPN. In 1994, Gill reported the first RLPN. In 2003, Gill was the first to compare the advantages and disadvantages of LPN and OPN in the treatment of renal tumours, and
to discuss the differences between the two operations in terms of WIT, operation duration and intraoperative blood loss. LPN was used to treat renal tumours with a tumour diameter of 4~7 cm. There are still questions about the effectiveness and safety of the two operations, and there is little long-term, large sample and multi-centre data support. These questions were explored in this study.

RLPN is a minimally invasive surgery. With the great progress made in endoscope technology, the indications for operation, such as diameter, position and stage of tumours, can be gradually broadened; in contrast, the operation difficulty progressively increases. The therapeutic effect of RLPN is close to that of OPN. This study found that the intraoperative blood loss, postoperative drainage volume, gastrointestinal function recovery time, amount of postoperative analgesic drug use and length of hospital stay of the RLPN group obviously decreased and shortened compared with that of the OPN group. This finding may be because RLPN offers a clearer surgical view, which helps avoid blood vessel damage. Meanwhile, pneumoperitoneum establishment can reduce the amount of venous bleeding and gastrointestinal tissue traction, with little impact on abdominal wall tissues. In addition, the exposure time of the intestinal canal is short. Thus, RLPN contributes to postoperative intestinal canal function recovery and minimises patient exhaustion. In addition, the wound is small, heals fast and only causes slight pain. Thus, the length of the hospital stay obviously shortens. Bowlin et al. also considered that RLPN could better promote postoperative recovery. The length of hospital stay for Chinese patients is notably longer than that reported in foreign literature, which may be because China requires patients who had a partial nephrectomy to be hospitalised until the drainage tube is removed. In contrast, foreign patients will receive rehabilitation treatment in community hospitals. With OPNs, doctors can locate the tumour edge through touch. RLPN operators lack touch feedback and need to carefully examine the tumour. The factors of WIT, operation duration, and postoperative drainage time were almost the same for the two groups. Generally, RLPN is characterised as minimally invasive, with a fast recovery time, but has high technical requirements for its operators.

One challenge of LPN is to shorten intraoperative WIT as much as possible, to ensure that postoperative residual kidneys maintain good renal function and to reduce the risk of postoperative acute and chronic renal failure. The consensus in the field is that a WIT of 25 minutes is the most appropriate inflection point for short-term or long-term renal function damage. This study found that if the tumour volume was large, the difficulty for excision and suture techniques will increase. However, the average WIT of both groups was approximately 25 minutes. In addition, the blood flow in the renal artery was completely interrupted, but irreversible kidney damage did not occur. In this study, renal function indicators before and after the operation were measured, and it was found that the Cr and US levels improved significantly, while GFR levels declined significantly, indicating that the two operations can cause low-range impacts on renal functions. With RLPNs, the time of temporary blood flow interruption to the renal pedicle vessels can be optimised to a certain degree. Meanwhile, pneumoperitoneum establishment can protect renal parenchyma to a certain degree, which makes up for the insufficient blood flow during the vessel blockage time.

Although the two operations have similar indications and effectiveness, RLPN has a certain degree of difficulty because it is conducted through the endoscope. RLPN requires operators to remove the tumour and any suspicious tissue, retain as much normal tissue as possible, and completely suture the renal organs, as thoroughly and as soon as possible. Hence, the operators should have extensive operation experience. Becker et al. statistically analysed the occurrence rate of complications in T1 patients who were treated by the two operations and found that the occurrence rate of

### Table I: Statistics of the clinical data (X±S).

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Gender (male/female)</th>
<th>Age (year)</th>
<th>BMI (kg / m²)</th>
<th>Maximum diameter of tumour (cm)</th>
<th>Tumour stage (T1a / T1b)</th>
<th>Tumour position (left/right)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLPN group</td>
<td>84</td>
<td>54/30</td>
<td>53.9 ±8.4</td>
<td>23.1 ±4.5</td>
<td>4.0 ±1.1</td>
<td>62/22</td>
<td>48/36</td>
</tr>
<tr>
<td>OPN group</td>
<td>84</td>
<td>60/24</td>
<td>54.3 ±8.5</td>
<td>23.7 ±5.2</td>
<td>4.0 ±1.2</td>
<td>58/26</td>
<td>56/28</td>
</tr>
</tbody>
</table>

### Table II: Comparison of renal function indicators (X±S).

<table>
<thead>
<tr>
<th>Group</th>
<th>UREA (µmol·L⁻¹)</th>
<th>Cr (µmol·L⁻¹)</th>
<th>UA (µmol·L⁻¹)</th>
<th>GFR [mL/(min·1.73 m²)]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before operation</td>
<td>After operation</td>
<td>Before operation</td>
<td>After operation</td>
</tr>
<tr>
<td>RLPN group</td>
<td>4.07 ±1.07</td>
<td>4.57 ±0.76</td>
<td>124.65 ±16.74</td>
<td>174.65 ±14.75*</td>
</tr>
<tr>
<td>OPN group</td>
<td>3.99 ±0.96</td>
<td>4.11 ±0.85</td>
<td>125.42 ±13.23</td>
<td>179.61 ±13.09*</td>
</tr>
<tr>
<td>t</td>
<td>0.510</td>
<td>3.698</td>
<td>0.528</td>
<td>-2.305</td>
</tr>
<tr>
<td>P</td>
<td>0.611</td>
<td>&lt;0.001</td>
<td>0.598</td>
<td>0.022</td>
</tr>
</tbody>
</table>
complications was almost the same.\textsuperscript{19} The patients in the laparoscope group recovered more quickly after the operation. Some studies also maintain that while RLPN may reduce trauma and effectively shorten recovery time, it may increase the risk of postoperative complications.\textsuperscript{20,21} In this study, the occurrence rate of postoperative complications in the RLPN group was slightly higher than that in the OPN group, but the patients improved after symptomatic treatment.

**CONCLUSION**

The effect and safety of RLPN in the treatment of complex renal tumours are equal to those of open operations. Laparoscopic surgery involves a small operative wound and contributes to renal function recovery, allowing patients to recover quickly; however, laparoscopic surgery has high technical requirements for its operators.

**ETHICAL APPROVAL:**
The study was approved by the Institutional Ethics Committee of Affiliated Hospital of Hebei University, and ethical approvals were obtained prior to initiation of the research work.

**PATIENTS’ CONSENT:**
The informed consents were obtained from patients to publish the data concerning this case.

**CONFLICT OF INTEREST:**
Authors declared no conflict of interest.

**AUTHORS’ CONTRIBUTION:**
HML, ZYC: Designed this study and drafted this manuscript.
PS: Collected and analysed clinical data.
WZY: Significantly revised this manuscript.

**REFERENCES**
18. Patel AR, Eggener SE. Warm ischemia less than 30 minutes is not necessarily safe during partial nephrectomy every minute matters. *Urol Oncol* 2011; **29**:826-8.