SURGICAL TECHNIQUE

Combined approach of laparoscopic and open surgery for complex renal lesions

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Abstract

Objective: To develop a combined surgical approach (laparoscopic and open) that allows an increased vascular control and decreased ischemia time, maintaining the advantages of pure laparoscopic partial nephrectomy (LPN).

Material and methods: During the laparoscopic phase, dissection of the kidney and its pedicle is achieved. Then, an open approach is initiated through a mini-laparotomy, with the kidney being brought to the incision, improving the identification and exposition of the tumors. Following tumor identification by ultrasound, exeresis of the lesion is performed with or without vascular clamping.

Results: Through this approach we performed the excision of complex lesions in 6 patients. Mean surgical time was 192 min (range 180–210) and mean warm ischemia time was 13 min (0–22), with a mean blood loss of 267 ml (100–500). Average pre and postoperative glomerular filtration rate was 51.5 (28–90) and 48.8 ml/min/1.73 m² (19–90), respectively. In one patient, suture repair of the pelvicaliceal system was needed, with no other perioperative morbidities being reported.

Conclusions: This combined approach is a minimally invasive surgical alternative, reproducible and safe which preserves the virtues of pure LPN. It allows a better control of the vascular pedicle, reducing the risk of hemorrhage and the warm ischemia time. This technique may be either considered in the treatment of renal masses with indication for partial nephrectomy but of complex laparoscopic approach or as a surgical approach in the early learning curve of the LPN.

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PALABRAS CLAVE

Laparoscopia; Nefréctomía; Cirugía conservadora de nefronas

Abordaje combinado para la nefrectomía parcial en lesiones renales complejas

Resumen

Objetivo: Desarrollar un abordaje quirúrgico combinado (laparoscópico y abierto) que permita un mayor control vascular y un menor tiempo de isquemia, conservando las ventajas de la nefrectomía parcial laparoscópica pura (NPL).
Introduction

In the last 2 decades, the spread of imaging techniques has resulted in an increase in the detection of renal masses ≤4 cm. Currently, renal or nephron sparing surgery (NSS) is the standard treatment of small renal masses. It is important to conduct a NSS whenever it is possible, to minimize the deterioration of the renal function secondary to radical nephrectomy (RN), whether it is laparoscopic or open.

The literature has shown that NSS is a safe technique, with oncological outcomes and perioperative morbidity comparable to the RN. Rates of disease-free survival in the long term after open partial nephrectomy similar to those observed after the RN have been described.

In recent years, laparoscopic partial nephrectomy (LPN) has been standardized as a surgical technique in the management of renal masses under 4 cm. Despite the technical difficulty of the LPN, different centers have recently published series with both oncological and morbidity results, comparable to those of the open approach. However, although the LPN reduces the surgical time, it shows a lower intraoperative blood loss and allows for a shorter hospital stay, it is associated to a longer warm ischemia time (WIT), as well as an increased risk of postoperative complications.

In spite of the proven benefits of the NSS, a U.S. multicenter study found an underuse of partial nephrectomy, especially in centers with low surgical volume.

We present our experience with a technique developed to enable us to conduct partial nephrectomy in the treatment of complex renal masses, combining a first laparoscopic approach that allows for a meticulous dissection of the renal hilum and the perirenal space, and then fast tumor resection through a minimal subcostal incision.

Material and methods

Between October 2008 and January 2012, 109 LPNs were performed transperitoneally in our center. In 6 patients with complex renal masses, and after titration with computed tomography (CT), we opted for the combined laparoscopic and open approach that is presented in the oncology session. The characteristics of the patients, the preoperative, surgical, and postoperative data are summarized in Table 1.

Three patients had 2 homolateral synchronous intrarenal lesions, and in the remaining cases, they were single lesions, whose surgical approach was considered complex for having an intrarenal location and/or being related to the excretory pathway or renal vessels (Figs. 1 and 2).

The most common indication for nephron-sparing surgery was chronic kidney disease (50%, 3 cases): one case was a single kidney patient (history of contralateral renal neoplasm), another had a history of contralateral partial nephrectomy, and the last one contralateral kidney stones. Three patients had normal renal function, one with a history of contralateral kidney stones being treated and 2 without relevant medical or nephro-urology history.

Figure 1  CT scan: 26-mm intraparenchymal isodense mass that captures contrast in the middle area of the anterior renal side is observed.
Table 1  Characteristics of the patients, surgical data, and results.

<table>
<thead>
<tr>
<th>Data</th>
<th>Patient 1</th>
<th>Patient 2</th>
<th>Patient 3</th>
<th>Patient 4</th>
<th>Patient 5</th>
<th>Patient 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), sex</td>
<td>71, male</td>
<td>46, male</td>
<td>74, male</td>
<td>61, male</td>
<td>65, male</td>
<td>67, female</td>
</tr>
<tr>
<td>Nephro-urological history</td>
<td>Left LPN due to 35-mm oncocytoma</td>
<td>Contralateral kidney stones</td>
<td>CKD</td>
<td>Contralateral kidney stones</td>
<td>Right nephrectomy (clear cell</td>
<td>CKD</td>
</tr>
<tr>
<td></td>
<td>CKD</td>
<td></td>
<td></td>
<td></td>
<td>carcinoma pT3a Fuhrman II</td>
<td>CKD</td>
</tr>
<tr>
<td>Pre/post-operative GFR (ml/min/1.73 m²)</td>
<td>24/23</td>
<td>&gt;90/&gt;90</td>
<td>28/19</td>
<td>86/77</td>
<td>30/30</td>
<td>51/54</td>
</tr>
<tr>
<td>Kidney</td>
<td>Right</td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
<td>Left</td>
</tr>
<tr>
<td>CT-number of lesions (mm)</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CT-size of the lesions (mm)</td>
<td>28 and 22</td>
<td>26 and 9</td>
<td>50</td>
<td>19</td>
<td>42</td>
<td>35 and 8</td>
</tr>
<tr>
<td>CT-location</td>
<td>Intrarenal, in the upper pole</td>
<td>Intrarenal, anterior middle third</td>
<td>Intrarenal (adjacent to the urinary</td>
<td>Intrarenal Middle third</td>
<td>Exophytic (adjacent to the urinary</td>
<td>Intrarenal (adjacent to the urinary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The lowest exophytic in the middle</td>
<td>tract), in the upper third posterior</td>
<td></td>
<td>tract), in the middle-upper third</td>
<td>tract), in the upper pole</td>
</tr>
<tr>
<td></td>
<td></td>
<td>third</td>
<td>valve</td>
<td></td>
<td>third lateral side</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical time (min) (laparoscopic/open)</td>
<td>210 (130/80)</td>
<td>190 (100/90)</td>
<td>180 (80/100)</td>
<td>180 (90/90)</td>
<td>200 (120/80)</td>
<td></td>
</tr>
<tr>
<td>Vascular anatomy</td>
<td>1 vein, 2 arteries</td>
<td>1 vein, 2 arteries</td>
<td>1 vein, 2 arteries</td>
<td>1 vein, 1 arteries</td>
<td>1 vein, 2 arteries</td>
<td></td>
</tr>
<tr>
<td>WIT (min)/clamping</td>
<td>22/vein and artery 200</td>
<td>18/arterial 1200</td>
<td>4/arterial 200</td>
<td>0</td>
<td>22/arterial 500</td>
<td></td>
</tr>
<tr>
<td>Intraoperative bleeding (ml)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>5</td>
<td>6</td>
<td>9</td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Drainage days</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Pathological anatomy</td>
<td>2 oncocytomas (30 and 22 mm)</td>
<td>pT1a 26 and 14-mm Fuhrman II clear cell renal carcinomas</td>
<td>pT1a 35-mm Fuhrman III clear cell renal carcinoma</td>
<td>pT1a 19-mm Fuhrman II clear cell renal carcinoma</td>
<td>pT1a 50-mm Fuhrman II clear cell renal cystic carcinoma</td>
<td>pT1a 40 and 8-mm Fuhrman II clear cell renal carcinomas</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical margins</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>Subcostal incision (cm)</td>
<td>10</td>
<td>11</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

CKD: chronic kidney disease; LPN: laparoscopic partial nephrectomy; GFR: glomerular filtration rate (ml/min); CT: computed tomography; WIT: warm ischemia time.
Surgical technique

Under antibiotic prophylaxis, and after anesthetic induction, we proceed to bladder catheterization and nasogastric tube placement, the latter being removed immediately after surgery. Ureteral catheterization is not routinely performed. The patient is placed in lateral decubitus position, with pneumatic compression stockings in the lower extremities.

Laparoscopic phase

The main characteristics of this surgical technique have been described by Rosales et al. A 12-mm trocar is placed at the outer edge of the rectus abdominis muscle, at the umbilical level, and then, 3 assistance trocars are placed. In right-side tumors, a fifth 5-mm trocar is added to separate the liver. We proceed to the medial mobilization of the colon. The renal hilum was dissected and opening of Gerota’s fascia was carried out to release the renal surface, preserving the perirenal fat overlying the tumor. It is essential to obtain a thorough and individualized dissection of the renal vessels and release of the remaining perirenal fat, with the aim to achieve a complete mobilization of the kidney, essential step for the completion of the combined approach.

Minilaparotomy open phase

After administration of mannitol, we proceed to extend the uppermost and external assistance trocar incision, in order to make a small subcostal incision of approximately 8 cm. Through this minilaparotomy, and after the placement of self-retractable separator Bookwalter, we proceeded to dislocation and approximation of the kidney to the incision, which is supported by a gauze. The tumor lesions are identified and exposed. Having identified the tumor lesion, sometimes with intraoperative ultrasound, we proceed to marking the peritumoral renal capsule with electric scalpel and then to arterial clamping by introducing a Satinsky clamp through the optical port.

With or without vascular clamping, we proceed to the resection and removal of the entire tumor mass with Metzenbaum scissors. After resection of the tumor, the surgical bed is sutured with 3/0 resorbable thread, and a hemostatic agent (FloSeal®) is applied on the bed, in order to ensure hemostasis. The renal parenchyma is repaired with 2/0 continuous resorbable suture with Hem-o-lok®. After the closing of the renal parenchyma, the vascular clamp is removed and the hemostasis is checked. We proceed to the abdominal drain placement and surgical wound closure. The abdominal drain is removed in the first 24–48 h.

Results

Six patients (mean age: 64 years; range 46–74) underwent partial nephrectomy using combined laparoscopic and open approach (Table 1). The mean operative time was 192 min (180–210), the average duration of the laparoscopic and open times being 107 (80–130) and 85 min (70–100), respectively.

The mean WIT was 13 min (0–22), as in the penultimate case, the operation was carried out without need for vascular clamping. In a patient with intrarenal lesion adjacent to the urinary tract (no. 6), a small laceration thereof was sutured, with unremarkable postoperative course.

The mean intraoperative blood loss was 267 ml (100–500). No transfusion was necessary in any case and no other complications were observed in the perioperative period. On average, the drainage was maintained for 2.5 days (0–5) and the mean hospital stay was 5.7 days (4–9). The mean length of the surgical incision for the open approach was 7.7 cm (5–11). The mean preoperative glomerular filtration rate was 51.5 ml/min/1.73 m² (28–90), and the postoperative one was 48.8 ml/min/1.73 m² (19–90).

The result of the pathological anatomy was oncocytoma in one case and renal cell carcinoma in the rest, 3 with clear cell variant, and 2 type II papillary. The surgical margins were free of tumor in all cases. With a mean follow-up of 22.4 months (range: 3–42), the patients had no incidences, and they have no signs of recurrence.

Discussion

With the advances in the imaging techniques, the incidental detection of small renal masses has increased in the last decade, partial nephrectomy being currently the gold standard in its treatment, which presents medium-term oncologic outcomes similar to radical nephrectomy.

Specifically, according to the European guidelines of urology, the elective indications for partial nephrectomy include stage T1a tumors with functioning contralateral kidney, and those relating to the patients with hereditary renal tumor, or at risk of kidney failure if radical nephrectomy is carried out, there being absolute indication for patients with solitary kidney or bilateral tumor. In addition, partial nephrectomy is also a valid option in selected patients with larger tumors (T1b).

With the implementation of laparoscopic urologic surgery in recent years, its advantages over open surgery have been recognized, including a larger work area and better direct

Figure 2 CT scan: solid lesion is observed in the upper third of the kidney that captures contrast.
vision, as well as less postoperative pain, shorter hospital stay, and faster recovery. In the specific case of the LPN, shorter operative time and lower intraoperative blood loss are added to these advantages. However, this technique has a longer learning curve\textsuperscript{19} and it is associated to a higher WIT and risk of postoperative complications, including bleeding requiring transfusion.\textsuperscript{10,12,19} Thus, and although it is a valid option in expert hands and in selected patients, open partial nephrectomy remains the standard recommendation.\textsuperscript{17} In fact, it has been suggested that being a technically demanding procedure, LPN should only be performed by experienced laparoscopic surgeons.\textsuperscript{20}

Because the LPN has been qualified as a very difficult technique and with a complexity comparable to laparoscopic retroperitoneal lymphadenectomy,\textsuperscript{7} underuse of partial nephrectomy (open or laparoscopic) has been reported in centers with moderate experience in favor of radical nephrectomy, whose laparoscopic approach has become popular.\textsuperscript{13} However, it is noteworthy that the use of radical nephrectomy in patients with small renal masses is associated with increased cardiovascular events and mortality during their follow-up when compared to partial nephrectomy,\textsuperscript{21} one argument more in favor of conducting NSS whenever possible, either by open or laparoscopic pathway.

In our center, the LPN is now a routine treatment with a considerable volume, used whenever possible in patients with stage T1 renal masses. Despite our experience, and with the goal of preservation of nephrons, in 6 selected patients with complex intrarenal lesions and in contact with the urinary tract or renal pedicle vessels, whose pure laparoscopic excision was considered too difficult and associated to an extended WIT and major possible operative complications (extensive or vascular urinary tract injury), in a multidisciplinary oncology meeting, we opted for the realization of a combined surgical approach to retain the advantages of open surgery and the laparoscopic contributions.

In the present series, the excellent view obtained by laparoscopy allowed for meticulous dissection of the renal pedicle vessels, completing the partial nephrectomy through an incision with a mean length lower than 8 cm, an intermediate value between the 15 cm of the incision in open conventional nephrectomy, and 3–5 cm in laparoscopic partial nephrectomy.\textsuperscript{22} This saving gave the patients a significant improvement in their quality of life after surgery, with reduced pain and functional limitation, with a faster recovery.

On the other hand, it is known that of the various risk factors that predict a reduction in laparoscopic partial nephrectomy GFT, and that include a low preoperative GFT, advanced age, male gender, solitary kidney, large tumor size, upper pole tumor, percentage of resected parenchyma, and extended WIT, the latter is the most important modifiable risk factor.\textsuperscript{23,24} In fact, a WIT longer than 20 min has been correlated during partial nephrectomy to increased incidence of acute or chronic renal failure postoperatively that may even require dialysis.\textsuperscript{25,26} Furthermore, in a series of patients undergoing laparoscopic and open partial nephrectomy, it was observed that the patients undergoing laparoscopic surgery had a higher WIT, nearly half of them above 30 min, as well as a higher incidence of intraoperative complications.\textsuperscript{25} In our series, this disadvantage of the LPN was controlled by performing the exeretic phase and respective hemostatic suture via open surgery, reaching a mean WIT of 13 min and allowing for a very slight reduction in the GFT (5.2%), lower than that reported in LPN series.\textsuperscript{25}

We believe that the limited involvement of the renal function in our series is probably due to the low WIT along with the lower exeresis of the healthy renal parenchyma by enucleation practice in all cases.\textsuperscript{27}

Thus, by means of this technique whose initial experience we present, we successfully performed complete resection of renal tumors in 6 patients presenting a short WIT, poor intraoperative bleeding, and keeping the GFT, these data being also described in the other 2 published series\textsuperscript{22,28} (Tables 2 and 3). It should be noted that in the series by Lu et al.,\textsuperscript{25} the technique was implemented in tumors on the posterior renal side, and in addition to the retroperitoneoscopic approach, the WIT being higher (23 min).\textsuperscript{22} On the other hand, in the series by Pahernik et al.,\textsuperscript{28} who used the transperitoneal approach, no ischemia was used in 3 cases, which could explain the observed major bleeding, with an average of 500 ml. In our series, although with few cases, the clamping time has progressively decreased, the penultimate case being carried out without clamping, and with an average bleeding volume of less than 300 ml. In our series, compared with the others, the patients had greater difficulty intrarenal tumors, often multiple and with

![Table 2](http://www.elsevier.es)
higher degrees of involvement of the renal function at baseline.

In the laparoscopic approach of renal masses, apart from the tumor size, it is important to consider other factors: the renal anatomy and location of the tumor mass must be known. Intrarenal tumors, posteromedial located tumors, tumors adjacent to the renal hilum or a multiple vascular pedicle make surgical access difficult even in highly experienced surgeons in laparoscopic surgery, and they may be associated to prolonged ischemia time and increased risk of bleeding, so the most complex cases could benefit from the technique presented. 19,30

Although these are early results, we believe that the technique presented by combining initial laparoscopic access allowing for adequate vascular dissection and performing in a second time an open approach through a mini-laparotomy is a safe and reproducible technique, making it possible to obtain results comparable to open partial nephrectomy, simultaneously offering the advantages of the laparoscopic approach, such as a better view, careful vascular dissection, and less bleeding.

In our opinion, and although the LPN is currently a standardized technique that presents excellent results, it is a technically demanding procedure that requires a surgeon with extensive experience in laparoscopy, so that the technique presented might be indicated in selected cases in which the pure laparoscopic approach risks are unacceptable.

This method could also be considered as a surgical approach at the beginning of the learning curve of the LPN, or as a reproducible stock resource to use in difficult intraoperative situations to complete the LPN, allowing for a decrease in the rate of radical nephrectomies, especially in centers with lower surgical volume.

Conflict of interest

The authors declare that they have no conflict of interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.juro.2012.06.004.

References