RIGHT RETROPERITONEAL VERSUS LEFT TRANSPERITONEAL LAPAROSCOPIC LIVE DONOR NEPHRECTOMY

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ABSTRACT

Objectives. To describe our preferred method of right laparoscopic live donor nephrectomy (LDN) using a retroperitoneoscopic approach to determine the indications for, and overall rate of, right LDN and to compare the donor and recipient early outcomes of right retroperitoneal LDN to those of left transperitoneal LDN in a consecutive single-institution series.

Methods. At our institution, LDN for allotransplantation was performed in 143 consecutive patients. The indications for right LDN (n = 29) included multiple left renal vessels (n = 18), early branching of the left renal artery (n = 1), left renal vein anomaly (n = 2), right renal arterial fibromuscular dysplasia (n = 2), right renal cyst (n = 3), mild right hydronephrosis with delay on renal scan (n = 1), or right nephrolithiasis (n = 2).

Results. Right LDN was performed in 29 (20.3%) of 143 patients using a retroperitoneal approach in all but the first case. Right retroperitoneal LDN was associated with decreased blood loss and operative time compared with left transperitoneal LDN. The hospital stay, analgesic use, and donor serum creatinine at discharge were similar in both groups. Despite a statistically significantly increased warm ischemia time and decreased renal vein length, right retroperitoneal LDN was associated with recipient functional outcomes at 5 and 30 days after transplant that were no different from those after left transperitoneal LDN.

Conclusions. Right retroperitoneal laparoscopic LDN provides similar donor and recipient outcomes when compared with the left transperitoneal approach and obviates most of the technical challenges encountered with a right transperitoneal approach.


Laparoscopic live donor nephrectomy (LDN) is becoming an accepted standard of care, providing decreased morbidity to the donor without compromising recipient outcomes.1–3 Furthermore, there has been a perceived increase in the rates of kidney donation associated with LDN.4,5 However, one prevailing controversy regarding the minimally invasive approach has been the virtual lack of the use of the right kidney. In contemporary series of open donor nephrectomy, the right kidney was removed in 24% to 35% of cases, and the decision was based on the tenet of selecting the kidney with the lowest anticipated risk of technical failure, yet always leaving the donor with the “better” kidney.6–8 In contrast, the rate of right LDN at most large centers ranges from 11.8% to as low as 3.5%.9–11 This is a reflection of the increased level of technical difficulty with right transperitoneal LDN and the high rate of vascular complications in early series.10

Despite modifications in the technique of right transperitoneal LDN with a reduction in the rate of graft loss to less than 7%, reluctance persists in selecting the right kidney for LDN.9,12–14 It appears that either candidates for right donor nephrectomy are undergoing open surgery or open-assisted techniques, or a fundamental change has occurred in the patient selection criteria favoring the left kidney, regardless of its status. Therefore, in this study, we sought to describe our preferred method of right LDN using a retroperitoneoscopic approach to determine the indications for, and our overall rate of, right LDN and to compare the do-
MATERIAL AND METHODS

In this study, we evaluated 143 consecutive patients undergoing laparoscopic LDN for allotransplantation at our institution. All patients underwent routine preoperative evaluation, including three-dimensional volume-rendered triphasic computed tomography scan and/or renal angiography. The rationale for donor kidney selection for LDN was identical to the standard principles used for open donor nephrectomy. In the setting of “all things being equal,” the left kidney was selected because of the longer left renal vein. However, if the left renal vascular anatomy was unfavorable compared with that of the right or if a right renal parenchymal lesion was identified, the right kidney was selected. In our series, the specific indications for right LDN included multiple left renal vessels (n = 18), early branching of the left renal artery (n = 1), left renal vein anomaly (n = 2), right renal artery fibromuscular dysplasia (n = 2), right renal cyst (n = 3), mild right hydronephrosis with delay on renal scan (n = 1), or right nephrolithiasis (n = 2).

The choice of laparoscopic approach was at the discretion of the surgeon. In general, the transperitoneal approach was used for left LDN. However, left retroperitoneal LDN was performed in the setting of a retroaortic left renal vein (n = 1) or multiple bilateral renal vessels (n = 1). In another patient, the left kidney was procured retroperitoneoscopically because of morbid obesity (body mass index 54 kg/m²). The first right LDN in our series was performed transperitoneally. All subsequent right LDNs were performed retroperitoneoscopically.

All patients received our standard preoperative management, which included bowel preparation with two bottles of magnesium citrate the evening before surgery and vigorous intravenous hydration on arrival. Intraoperative and postoperative data were recorded prospectively in our computerized database. Statistical analyses were performed using Student’s t-test for continuous variables and Fisher’s exact test for categorical data.

SURGICAL TECHNIQUES

Left Transperitoneal LDN. After Veress needle insufflation, two 12-mm ports, one 5-mm port, and one 2-mm port were placed. A low Pfannenstiel extraction site was prepared, leaving the peritoneum intact to maintain the pneumoperitoneum. This allowed for placement of an additional port through the extraction site, which was used for retraction or as an alternate site for the stapler. The ureter was clipped on the kidney side. The main renal vein was divided with an articulating stapler positioned parallel to, and flush with, the vena cava. The kidney was placed on gentle lateral traction at this time to tent up the vena cava, optimizing the right renal vein length. The remaining anteromedial attachments of the kidney were now released from the peritoneum, and the kidney was removed manually through the extraction site without a bag and with the ureter intact. The ureter was further retracted through the extraction site, clipped distally, and transected with Metzenbaum scissors.

Right Retroperitoneal LDN. Our three-port retroperitoneal approach has been previously described. A muscle-splitting Gibson extraction incision was prepared, leaving the transversalis fascia intact to maintain the pneumoretroperitoneum. The anteromedial attachments of the kidney to the peritoneum were maintained until kidney extraction to hold the kidney anteriorly and keep it from flopping down posteriorly, facilitating division of the renal hulm. The ureter was left intact. The main renal artery was controlled using two Hemolock clips placed proximally as possible, usually retrocaval. The artery was transected with scissors without any clips on the kidney side. The main renal vein was divided with an articulating stapler positioned parallel to, and flush with, the vena cava. The kidney was placed on gentle lateral traction at this time to tent up the vena cava, optimizing the right renal vein length. The remaining anteromedial attachments of the kidney were now released from the peritoneum, and the kidney was removed manually through the extraction site without a bag and with the ureter intact. The ureter was further retracted through the extraction site, clipped distally, and transected with Metzenbaum scissors.

TABLE I. Distribution of 143 patients who underwent laparoscopic live donor nephrectomy at our institution

<table>
<thead>
<tr>
<th>Approach</th>
<th>Left</th>
<th>Right</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transperitoneal</td>
<td>106</td>
<td>1</td>
<td>107</td>
</tr>
<tr>
<td>Retroperitoneal</td>
<td>8</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td>Total (%)</td>
<td>114</td>
<td>(79.7)</td>
<td>29 (20.3)</td>
</tr>
</tbody>
</table>

RESULTS

All 143 patients underwent LDN successfully without open conversion. Right LDN was performed in 29 (20.3%) of 143 patients. The distribution of all 143 patients by side and laparoscopic approach is shown in Table I. The demographic, intraoperative, and postoperative data for patients undergoing transperitoneal or retroperitoneal LDN are compared in Table II. The allograft artery, vein, and ureteral lengths were measured on the bench table by the transplant surgeon. The comparisons of vessel and ureteral lengths shown in Table II represent left transperitoneal LDN versus right retroperitoneal LDN only.

The recipient serum creatinine levels after live renal transplantation were similar after transperitoneal and retroperitoneal LDN on day 5 (2.04 versus 2.30 mg/dL; \( P = 0.51 \)) and day 30 (1.52 versus 1.51; \( P = 0.95 \)), respectively (normal 0.7 to 1.4 mg/dL).

Four donors undergoing transperitoneal left LDN had an intraoperative complication, including a splenic capsular tear by a trocar controlled by argon beam coagulation with an estimated total blood loss of 500 mL, renal arterial/aortic bleeding owing to clip malfunction controlled by laparoscopic suture repair with an estimated total blood loss of 300 mL, dislodged adrenal vein clip associated with 100 mL of the estimated total blood loss of 200 mL, and faulty video equipment—each occurring in 1 patient.

One donor who underwent left transperitoneal LDN developed postoperative rhabdomyolysis associated with acute renal failure requiring temporary dialysis. This was a 32-year-old healthy muscular African-American man with a body mass...
index of 30.3 kg/m² who was in a modified left flank position with an elevated kidney bridge for 3.7 hours with all pressure points well-padded. He had no identifiable risk factors other than having a muscular build. He eventually regained normal renal function off dialysis. He was not excluded from this study.

Two donors undergoing right retroperitoneal LDN had an intraoperative complication, including a renal parenchymal tear injury with subcapsular hematoma and a renal capsular tear. Both were repaired on the bench table and successfully transplanted. Three recipients experienced delayed graft function requiring dialysis within the first week after transplantation. The warm ischemia time in each case was 242, 260, and 360 seconds (range 150 to 500 for all right LDNs). Despite early functional impairment, each allograft fully recovered, with a mean serum creatinine level at 1 year of 1.5 mg/dL (range 1.3 to 1.7). The mean estimated blood loss for patients who underwent right retroperitoneal LDN was 121 mL (range 50 to 400).

**COMMENT**

Although laparoscopic LDN is rapidly becoming accepted in renal transplantation, controversy remains regarding LDN for the right kidney. Mandal and colleagues reported the Johns Hopkins experience with right transperitoneal LDN, noting vascular complications in 3 of the first 8 cases—a rate of 38%. Subsequently, only donors with right renal lesions underwent right LDN. Left renal vascular anomalies did not preclude left LDN. A modification by the Johns Hopkins group is to perform right renal artery and vein division through an open upper abdominal incision, which subsequently serves as the extraction site, along with liberal use of saphenous vein graft for right renal vein extension.

Subsequent reviews from other centers reported improved success with right transperitoneal LDN using various techniques, with graft loss ranging from 0% to 6%. Turk and associates recently described the use of a laparoscopic Satinsky clamp for side clamping of the vena cava to obtain a caval cuff at right renal vein transection, followed by laparoscopic suturing of the vena cava in 4 patients. However, aside from a series from The Netherlands reporting an unusually high rate of 73%, right transperitoneal LDN has typically been performed in less than 12% of cases. This is less than one half of the reported rate of right donor nephrectomy during open surgery.

Technical difficulties with right transperitoneal LDN stem primarily from the markedly different right-sided intra-abdominal and renal anatomy.

**TABLE II. Patient characteristics (n = 143)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Transperitoneal LDN</th>
<th>Retroperitoneal LDN</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients (% of total)</td>
<td>107 (74.8)</td>
<td>36 (25.2)</td>
<td>NA</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>40.9</td>
<td>43.6</td>
<td>0.22</td>
</tr>
<tr>
<td>Females (n)</td>
<td>61 (57)</td>
<td>23 (64)</td>
<td>NS</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>26.1</td>
<td>26.2</td>
<td>0.94</td>
</tr>
<tr>
<td>Patients with ≥2 arteries (n)</td>
<td>18</td>
<td>5</td>
<td>0.52*</td>
</tr>
<tr>
<td><strong>Intraoperative data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated blood loss (mL)</td>
<td>166.2</td>
<td>107.8</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Warm ischemia time (s)</td>
<td>240.2</td>
<td>302.1</td>
<td>&lt;0.01†</td>
</tr>
<tr>
<td>Operative time (min)</td>
<td>220.5</td>
<td>190.4</td>
<td>0.002†</td>
</tr>
<tr>
<td>Artery length (cm)</td>
<td>3.2</td>
<td>3.2</td>
<td>0.76</td>
</tr>
<tr>
<td>Vein length (cm)</td>
<td>3.9</td>
<td>2.3</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Ureteral length (cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>15</td>
<td>13</td>
<td>0.004†</td>
</tr>
<tr>
<td>25th–75th percentile</td>
<td>13–15</td>
<td>10–15</td>
<td></td>
</tr>
<tr>
<td>Open conversions</td>
<td>0</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Postoperative data</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>2.57</td>
<td>2.60</td>
<td>0.97</td>
</tr>
<tr>
<td>Analgesic use (mg morphine)</td>
<td>31.7</td>
<td>30.9</td>
<td>0.86</td>
</tr>
<tr>
<td>Donor serum creatinine at discharge (mg/dL)</td>
<td>1.29</td>
<td>1.35</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Key: LDN = live donor nephrectomy; NA = not available; NS = not significant.

Data presented as mean values, unless otherwise noted; data in parentheses are percentages.

* Pearson chi-square test.
† Statistically significant.
‡ Left transperitoneal LDN (n = 106) vs. right retroperitoneal LDN (n = 28).
§ Wilcoxon rank sum test.
compared with that on the left side. A dedicated port is required for anterior retraction of the liver. The duodenum must be recognized and mobilized to expose the inferior vena cava adequately. Most importantly, the short right renal vein usually covers the renal artery, which lies directly posterior to it. As such, dissection of the right renal artery typically entails considerable traction on both the vein and the artery, causing technical difficulty and the potential for vasospasm. Some investigators have described the necessity to "flip" the right kidney medially to establish a "posterior approach" to the renal artery—a maneuver that could cause vasospasm and potentially trauma as well. Others have used an interaortocaval approach to the right renal artery, which is fraught with its own inherent technical dangers.17

We believe that the aforementioned technical difficulties during right LDN may be eliminated by using a retroperitoneoscopic approach. The intraperitoneal viscera do not compromise exposure. More importantly, rapid and direct access to the renal hilum is routine, allowing for exposure and control of the right renal artery in a retrocaval location, thus ensuring adequate arterial length. The right renal vein is mobilized along with the adjacent vena cava. Use of an articulating stapler positioned parallel to, and flush with, the vena cava allows procurement of the entire length of the right renal vein. Nevertheless, the length of the right renal vein is shorter than left renal vein. However, the retroperitoneal working space is smaller, and prior expertise with this approach is necessary before attempting retroperitoneal LDN. Several other technical considerations are paramount to successful outcomes with right retroperitoneal LDN. First, retraction of the kidney should be performed with a reusable 10-mm three-pronged fan retractor rather than a 5-mm bowel clamp to prevent renal parenchymal laceration, which occurred in 1 case. Second, the anteromedial peritoneal attachments to the kidney must be left undisturbed until after the hilum has been transected to keep the kidney from flopping posteriorly and obscuring the hilum. Third, kidney extraction for right retroperitoneal LDN should be made through a modified muscle-splitting low Gibson incision.18 Use of the "standard" Pfannenstiel incision for specimen extraction after right LDN may have been responsible for the development of the subcapsular hematoma. Finally, as with any donor nephrectomy, care should be taken to maintain as much periureteral fatty tissue as possible during ureteral dissection. Although we have not noted ureteral complications after right LDN, it has been our impression that the periureteral package is less generous during right retroperitoneal LDN than during left transperitoneal LDN. Moreover, it has also been our impression that the periureteral package of left kidneys procured laparoscopically is somewhat more generous than the one from left kidneys procured in open surgery, resembling the abundant periureteral package of cadaveric kidneys.

We have previously reported the initial experience with right retroperitoneoscopic donor nephrectomy for autotransplantation in 4 patients and allotransplantation in 1, all of which were technically successful.15 Others have used a laparoscope to assist in open retroperitoneal donor nephrectomy.19 Hoznek and colleagues20 recently reported successful left retroperitoneal LDN in 3 patients.

We report the largest experience with retroperitoneal laparoscopic LDN and the only series comparing right retroperitoneal with left transperitoneal LDN in a consecutive single-institutional experience. Both groups were similar in age, sex, and body mass index. Blood loss and operative times were significantly less with the retroperitoneal approach. The hospital stay, analgesic use, and donor serum creatinine at discharge were similar in both groups. Furthermore, despite a statistically significantly longer warm ischemia time, right retroperitoneal LDN demonstrated 5 and 30-day recipient allograft functional outcomes comparable to those after left transperitoneal LDN in our study and also similar to those reported in a large series from the University of Maryland—for 544 cases of left transperitoneal LDN, the mean recipient serum creatinine at 1 month was 1.70 mg/dL.9

The longer warm ischemia time associated with the retroperitoneal approach is primarily due to the time needed for additional dissection required to mobilize the kidney from the peritoneum anteromedially after hilar transection and to then gain length and transect the ureter after kidney extraction. Furthermore, the significantly shorter right renal vein has not been associated with vascular complications or graft loss to date.

Of our 29 cases of right LDN, only the first case was done transperitoneally. All subsequent right LDN have been performed retroperitoneoscopically. Since then, the retroperitoneal approach has also been applied to 8 cases of left LDN in the specific circumstances of a retroaortic left renal vein or bilateral multiple renal arteries, for which improved left renal hilar access was required. Left retroperitoneal LDN has also been used for obese donors.

Certain shortcomings and technical caveats are inherent to right donor nephrectomy. Extension vein grafts were required in 3 cases in which the donor renal vein lengths were 1.0, 1.5, and 1.8 cm—these were third-party ABO-compatible iliac
vein grafts from recent cadaveric donors preserved in cold University of Wisconsin solution. In addition, complete mobilization of the recipient iliac vessels with or without internal iliac vessel ligation has become routine during transplantation of any right laparoscopic donor kidney. Additional comparison of the long-term recipient outcomes between groups is necessary to determine any adverse effects of right retroperitoneal LDN.

CONCLUSIONS

The retroperitoneal approach to laparoscopic right donor nephrectomy provides similar donor and recipient outcomes compared with the transperitoneal laparoscopic approach for the left kidney and obviates most of the technical challenges encountered with a transperitoneal approach to right LDN. The availability and use of an established laparoscopic technique that facilitates procurement of the right kidney allows transplant centers to maintain the benefits of the laparoscopic era while adhering to the fundamental principles of patient selection established in the open era.

REFERENCES