Surgical aspects of renal transplantation
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Although the advent of (hand-assisted) laparoscopic donor nephrectomy has had a positive effect on the donor pool, there is still some concern about the increased morbidity and safety of the laparoscopic donor nephrectomy. The aim of this study was to compare the results of hand-assisted laparoscopic donor nephrectomy (HALD) with open donor nephrectomy (ODN). A single-center non-randomized analysis of 202 living donor kidney transplantations (44 ODN, 158 HALD) between January 1995 and April 2006 was conducted. The left kidney was harvested in 75% in the ODN group and 53% in the HALD group ($P = 0.009$). There was no conversion in the HALD group. Mean donor operative time for HALD (174 min) was longer than for ODN (124 min, $P < 0.001$). The mean donor hospital stay (4.9 days vs 9.6 days, $P < 0.001$) was significantly less for HALD. HALD had lower mean creatinine values at day 7 and 1 month ($P = 0.001$ and $P = 0.002$) and lower urological complication rates ($P = 0.02$) compared with ODN. The 1-year graft survival rates of the ODN and the HALD group were 84% and 95% ($P = 0.006$), respectively. Hand-assisted laparoscopic donor nephrectomy is a safe procedure for a donor nephrectomy with potential benefits compared with ODN.
INTRODUCTION

Living donor kidney transplantation is superior to postmortal kidney transplantation because of the better patient and graft survival rates, better cost-effectiveness and improved quality of life of the recipient. Open living donor nephrectomy is associated with disincentives including long hospital stay, prolonged postoperative pain, cosmetic problems and slow convalescence. Long-term side-effects include a denervated abdominal wall and less frequently, intractable pain. These disincentives are a drawback for possible donors to donate a kidney. With the advent of laparoscopic living donor nephrectomy, a reduction in hospital stay, fewer postoperative analgesic requirements, improved cosmetics, and an earlier return to normal daily activities have been reported. The advantages of hand-assisted laparoscopic donor nephrectomy above conventional laparoscopy include the ability to use tactile feedback, less kidney traction, rapid kidney removal and shorter warm ischemic periods. In addition, it has broadened the indications for laparoscopic living donor nephrectomy to include obese donors and donors with abnormal anatomy or previous abdominal surgery. However there are recent reports demonstrating increased morbidity of laparoscopic donor nephrectomy. Therefore, we compared our hand-assisted laparoscopic donor nephrectomy (HALD) with our open donor nephrectomy (ODN) at our institution during the last 11 years.

PATIENTS AND METHODS

Donors

Between January 1995 and April 2006 202 living donor nephrectomies were carried out (158 HALD and 44 ODN) at the Academic Medical Center, Amsterdam. Specific preoperative donor evaluation included blood and urine examination, angiography, pyelography and renal scintigraphy. From January 1995 to December 1999 ODN was carried out. From January 2000 HALD was introduced for living donor nephrectomy. After introduction of the HALD, ODN was no longer carried out. Data from HALD were collected prospectively and data from ODN were collected retrospectively. The presence of multiple renal arteries was no contraindication for donation if reconstruction was feasible ex vivo before transplantation.

Donor operative procedure

Open donor nephrectomy was carried out retroperitoneally through a lumbotomy incision below the 12th rib and included resection of a part of this rib. HALD was carried out transperitoneally. After open dissection of the distal ureter and gonadal vein through a 7–8-cm Pfannenstiel incision, the non-dominant operator’s hand was introduced through a
handport (Omniport, Advanced Surgical Concepts, Wicklow, Ireland) and two 10–12-mm trocars were placed. A maximum insufflation pressure of 12 mmHg was used. After full mobilization of the colon and the kidney, the hilar structures were dissected. Transsection of the artery was carried out with metal clips, while an endoscopic stapler (Endopath ETS Compact Linear Cutter, Johnson & Johnson, Dilbeek, Belgium) was used to transect the renal vein. The kidney was extracted through the Pfannenstiel incision and flushed and preserved with cold University of Wisconsin solution (UW).

**Recipients**

Implantation of the kidney was carried out directly after the donor nephrectomy via the extra peritoneal approach in the iliac fossa. After successful transplantation all patients were followed for at least 1 year. A urological complication was defined as any urinary fistula (leakage) and/or ureteral obstruction within 1 month.

Standard immunosuppression before 1999 consisted of prednisone and ciclosporin; thereafter it consisted of prednisolone, ciclosporin and mycophenolate mofetil. From 2002 on, with the increase of totally human leukocyte antigen (HLA) mismatched donors, anti-CD25 monoclonal antibody (basiliximab) was added as induction therapy. First episodes of acute rejection were treated with pulse doses of methylprednisolone. Second episodes were treated with anti-thymocyte globulin (ATG).

**Statistical analysis**

In the univariate comparison, donor and recipient details of both groups were compared using χ² test (discrete data) or Mann–Whitney U-test (continuous data) as indicated. The 1-year graft survival rate was calculated by the Kaplan-Meier technique and the log-rank test. P < 0.05 was considered statistically significant. For statistical analyses the SPSS software package (SPSS, Chicago, IL, USA) was used.

**RESULTS**

**Donors**

The donor characteristics are presented in Table 1. The left kidney was harvested in 75% in the ODN group and 53% in the HALD group (P = 0.009). No conversions in the hand-assisted group were necessary. The mean operation time was longer in the HALD group (173.8 ± 43.7 min) compared with the ODN group (123.7 ± 31.9 min) (P < 0.001). The mean hospital stay for the HALD technique (4.9 ± 2.0 days) was shorter compared with the ODN group (9.6 ± 5.1 days) (P < 0.001).

There was no significant difference between both groups regarding multiple arteries, multiple veins and warm ischemic time. Although the laparoscopic group had a higher
preoperative and postoperative complication rate, especially minor complications, this difference was statistically not significant ($P = 0.35$ and $P = 0.28$) (Table 2).

**Recipients**

Recipient characteristics are presented in Table 3. The operation time was longer in both the left and the right group of the HALD group compared with the ODN group ($P = 0.04$ and $P = 0.01$). Direct renal transplant function (defined as no need for post-transplant dialysis) was higher in the HALD group compared with the ODN group ($P < 0.001$).

ODN had a significantly higher risk for urological complications compared with the HALD group ($P = 0.02$). The hospital stay was longer with the ODN technique in comparison with the HALD technique ($P = 0.001$). The mean creatinine values at day 7 and 1 month were better in the HALD group in comparison with the ODN group ($P = 0.001$) respectively ($P = 0.002$). However, this difference was not detectable at 1 year after transplantation. The 1-year renal graft survival rates of the ODN group and the HALD group were 83% and 96% ($P = 0.006$), respectively.

**DISCUSSION**

In the present study, HALD is associated with a shorter hospital stay for donors and recipients, a higher direct renal transplant function rate, lower acute rejection rate and lower post-transplant serum creatinine levels. These findings are in contrast to the reports of others who have raised the issue of suboptimal graft function, donor safety and increased
recipient morbidity after laparoscopic donor nephrectomy\textsuperscript{9,10}. The present study indicates equal donor and recipient morbidity for both groups. The complication rate in the HALD donor groups was slightly higher and these were all minor complications. The difference in numbers of preoperative and postoperative complications can be explained by the complications of the prospectively followed HALD group being more accurate. This bias can especially be more prominent in the minor complication group.

The fact that our laparoscopic technique seems not inferior to the open donor nephrectomy might be due to advantages of the hand-assisted technique over the conventional laparoscopic donor nephrectomy. HALD has the advantage of tactile feedback to dissection, retraction, exposure and controlling bleeding. In addition, the final stages of vascular stapling and kidney removal are safer and rapid\textsuperscript{5,6}. Several studies reported a shorter operative and warm ischemia times in the HALD group compared with the conventional laparoscopic group\textsuperscript{5,6}. Because of our hand modality no conversion was necessary. Laparoscopic vascular stapling devices

\begin{table}[h]
\centering
\caption{Number of preoperative and postoperative complications.}
\begin{tabular}{llll}
\hline
 & \textbf{Open} & \textbf{Laparoscopic} & \textbf{p} \\
\hline
\textbf{All Preoperative complications} & \multicolumn{2}{l}{2 (4.5)} & 8 (5) \text{ } 0.9 \\
\textbf{Minor complications} & \multicolumn{2}{l}{Renal vascular injury} & 3 \\
 & \text{Minor bowel injury} & 2 \\
 & \text{Spleenic capsular tear} & 1 \\
\textbf{All Postoperative complications} & \multicolumn{2}{l}{All} & 3 (6.8) \text{ } 17 (10.7) \text{ } 0.4 \\
\textbf{Minor complications} & \multicolumn{2}{l}{Wound infection} & 1 \\
 & \text{ILEUS} & 3 \\
 & \text{Testicular swelling} & 3 \\
 & \text{Hematoma} & 1 \text{ } 2 \\
 & \text{Urinary tract infection} & 2 \\
 & \text{Pneumonia} & 2 \\
 & \text{Pneumothorax} & 1 \\
 & \text{Phlebitis} & 1 \\
 & \text{Cardiac arrhythmias} & 1 \\
 & \text{Haematuria} & 1 \\
\textbf{Major complications} & \multicolumn{2}{l}{Re-exploration due to bleeding} & 1 \\
 & \text{Deep venous thrombosis} & 1 \\
\hline
\end{tabular}
\begin{flushright}
\textsuperscript{1} \chi^2 \text{ test; uPRBC = units of packed red blood cells}
\end{flushright}
\end{table}
resulted in shorter length of renal artery and veins. These aspects can explain the significant increased operation time in our study for the recipient operations in the HALD group.

Factors postulated to contribute to the slower recovery of renal function in recipients of laparoscopical donor nephrectomy reported to date include longer warm ischemic time and increased intra-abdominal pressure created by the pneumoperitoneum. Pneumoperitoneum has a significant effect on renal hemodynamics. Harmann et al. demonstrated that with an intra-abdominal pressure of 20 mmHg, renal blood flow and glomerular filtration rate decreased to less than 25% of normal\textsuperscript{11}. The use of a low insufflation pressure of 12 mmHg and shorter operating times might explain these differences.

The mini-incision muscle splitting ODN has been introduced as another minimal-invasion alternative for conventional laparoscopic donor nephrectomy\textsuperscript{12,13}. However two recent studies demonstrated that mini incision donor nephrectomy is inferior to laparoscopic donor nephrectomy\textsuperscript{12,13}.

The advantages of the Pfannenstiel incision used in our HALD are the cosmetically superior location of the incisions and the lower incidence of incisional hernia than a midline laparotomy\textsuperscript{14,15}.

The lower rejection rate and better 1-year graft survival in the recipients of our HALD group is most likely due to a difference in immunosuppressive drug regimen. Up to 2002,

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### Table 3. Characteristics of the renal transplant recipients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Open (44)</th>
<th>Laparoscopic (158)</th>
<th>(p^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>39.3 ± 14.4</td>
<td>41.0 ± 15.8</td>
<td>0.48</td>
</tr>
<tr>
<td>Female sex (%)</td>
<td>23 (53)</td>
<td>58 (37)</td>
<td>0.06</td>
</tr>
<tr>
<td>Second kidney transplantation (%)</td>
<td>1 (2)</td>
<td>12 (8)</td>
<td>0.20</td>
</tr>
<tr>
<td>Third or fourth kidney transplantation (%)</td>
<td>1 (2)</td>
<td>4 (3)</td>
<td>0.92</td>
</tr>
<tr>
<td>Preemptive transplants (%)</td>
<td>9 (23)</td>
<td>35 (23)</td>
<td>0.93</td>
</tr>
<tr>
<td>Operation time (mean ± SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left donor kidney</td>
<td>180.6 ± 31.7</td>
<td>197 ± 43.9</td>
<td>0.04</td>
</tr>
<tr>
<td>Right donor kidney</td>
<td>172.6 ± 27.7</td>
<td>209.6 ± 51.5</td>
<td>0.01</td>
</tr>
<tr>
<td>Peroperative complications (%)</td>
<td>6 (14)</td>
<td>16 (10)</td>
<td>0.51</td>
</tr>
<tr>
<td>Direct function\textsuperscript{1} (%)</td>
<td>34 (77)</td>
<td>148 (94)</td>
<td>0.001</td>
</tr>
<tr>
<td>Acute rejection (%)</td>
<td>16 (36)</td>
<td>33 (21)</td>
<td>0.03</td>
</tr>
<tr>
<td>Urological complications (%)</td>
<td>10 (23)</td>
<td>15 (10)</td>
<td>0.02</td>
</tr>
<tr>
<td>Hospital stay (mean ± SD)</td>
<td>18.0 ± 13.6</td>
<td>12.7 ± 13.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean serum creatinine (μmol/L ± SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median day 7 (range)</td>
<td>168 (33-1120)</td>
<td>113 (19-1381)</td>
<td>0.001</td>
</tr>
<tr>
<td>Median 1 month (range)</td>
<td>146 (22-1280)</td>
<td>117 (22-1020)</td>
<td>0.002</td>
</tr>
<tr>
<td>Median 1 year (range)</td>
<td>121 (61-816)</td>
<td>122 (43-1537)</td>
<td>0.44</td>
</tr>
<tr>
<td>One year graft survival (%)</td>
<td>37 (83)</td>
<td>150 (94)</td>
<td>0.006*</td>
</tr>
</tbody>
</table>

\(¹\) χ\textsuperscript{2} test or Mann-Whitney \textit{U} Test; * log-rank test; \(¹\) no need for post-transplant dialysis,
patients did not receive prophylaxis with anti-CD25 monoclonal antibodies. In addition, from that time point we applied a calcineurin dosage regimen based on a flexible Bayesian forecasting technique, resulting in a more optimal therapeutic index\textsuperscript{16}. The early laparoscopic donor nephrectomy series reported much higher rates of ureteric complications\textsuperscript{17}. With technical modifications by which the ureter and the gonadal vessels are dissected together and by careful protection of the ‘golden triangle’, this complication has reduced significantly. In the randomized trial by Simforoosh \textit{et al}. the ureteric complication rate for ODN was 2\%, compared with 0\% for laparoscopic donor nephrectomy\textsuperscript{2}. In our series the ureteric complication rate for ODN was 23\%, compared with 10\% for HALD. The increased visualization of the distal half of the ureter with the HALD technique compared with the ODN technique can explain the difference in the urological complication rate in our study.

Because of the temporal difference between the HALD and ODN group, other non-surgical factors such as changing immunosuppression regime, and improving clinical management can also influence the results. Therefore, it is not certain that HALD alone causes better results (e.g. hospital stay, renal function, graft survival) in this study.

However the results of HALD were at least as effective as the ODN and it did not lead to reduced early graft function and graft survival rates. The increased complication rate, although not significant, needs attention and is the subject for further studies.

In conclusion, hand-assisted laparoscopic donor nephrectomy is a safe procedure and our first choice in living donor nephrectomy.

\textbf{REFERENCES}


