Review Article

Laparoscopic live donor nephrectomy

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ABSTRACT

With the number of patients presently awaiting renal transplantation exceeding the number of cadaveric organs available, there is an increasing reliance on live renal donation. Of the 11,869 renal transplants performed in 2002 in the US, 52.6% were living donors (from the United Network for Organ Sharing Registry). Renal allografts from living donors provide: superior immediate long-term function; require less waiting time and are more cost-effective than those from cadaveric donors. However, anticipation of postoperative pain and temporary occupational disability may dissuade many potential donors. Additionally, some recipients hesitate to accept a living donor kidney due to suffering that would be endured by the donor. It is a unique medical situation when a young, completely healthy donor undergoes a major surgical procedure to provide an organ for transplantation. It is mandatory to offer a surgical technique, which is safe and with minimal complications. It is also obvious for any organ transplantation, that the integrity of the organ remain intact, thus, enabling its successful transplantation into the recipient. An acceptably short ischemia time and adequate lengths of ureter and renal vasculature are favored. Many centers are performing laparoscopic live donor nephrectomy in an effort to ease convalescence of renal donors. This may encourage the consideration of live donation by recipients and potential donors.

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Renal transplantation has had a major impact on the survival and quality of life for individuals suffering from end-stage renal disease (ESRD), and remains the only treatment offering patients an independent life-style, free from dialysis. By providing a less invasive alternative to renal donation, without compromising the safety and well-being of the donor, and the quality of the allografts, it is hoped that live renal donation may become a more appealing and persuasive option for friends and relatives of the individual suffering from ESRD. Live donor renal transplantation is associated with many advantages for the recipient, including improved graft survival, decreased recipient morbidity, and a decreased overall cost of therapy, compared with cadaver transplantation.[1] To be successful, live donor nephrectomy should involve: minimal donor morbidity; minimal renal warm ischemia time; atraumatic kidney removal; ureteral preservation with adequate ureteral length and vascularity; preservation of adequate renal artery and vein length, without damage to the vessel, and immediate renal graft function without complications.[1] Initially performed by Ratner et al,[2] laparoscopic live donor nephrectomy is on the increase in centers worldwide. Proposed benefits include decreased morbidity, shortened hospital stay and improved cosmesis for the donor with equivalent long-term survival for the recipient. Laparoscopic approaches to live donor nephrectomy have the potential of increasing the number of living renal donors, as it effectively reduces concerns regarding donor morbidity and time to recovery.

Significant controversy has surrounded the introduction of laparoscopic renal harvesting.[3,4] Laparoscopic donor nephrectomy is difficult technically. Considerable care and laparoscopic experience are needed by the surgeon, to ensure the safety of the donor and recipient. In some series, technical expertise does improve with the increase in case volume as expected.[5] With an increase in

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application of minimally invasive techniques in major surgical procedures, laparoscopic live donor nephrectomy has gained popularity. The procedure has now evolved to decrease the disincentives associated with live donation.

Patient selection. As a general rule, the larger or healthier kidney remains intact with the donor and the smaller of the 2 kidneys is used for donation. If the kidneys are essentially the same size, the organ with simpler vascular anatomy is donated. However, for women of childbearing age right renal donation is preferred due to higher incidence of complications during pregnancy.[6]

Preoperative imaging. Preoperative imaging is essential in making this decision. Computerized tomography (CT) with 3-dimensional (3-D) reconstruction is very useful in evaluating donor renal anatomy. Although the overall accuracy of arterial anatomy prediction is good, accuracy decreases when there are multiple arteries. Overall, an accuracy of 90-100% for predicting arterial anatomy by CT has been reported.[7-9] In a larger study, Del Pizzo et al[10] reported an accuracy rate of 93% in 175 patients undergoing laparoscopic nephrectomy. Out of 14 of the examined kidneys, 23% had more than one artery. Janoff et al[11] found that 3-D CT had 90.5% accuracy in 199 patients, where 27% of kidneys had multiple arteries. In kidneys with multiple arteries, he found that CT accuracy decreased to 60.3%. Nevertheless, the positive predicative value of CT remains high.

Trans-peritoneal approach. Classically, for left side donor nephrectomy, 4 trocars are placed. Dissection begins by reflection of the colon medially. Subsequently, Gerota´s fascia is entered anteriorly and the superior pole is dissected. During laparoscopy, lateral renal attachments are left in place to prevent rotation of the kidney. Dissection is performed anterior and medial to the lower pole, for identification of the gonadal vessels. The gonadal vein is dissected and traced superiorly to the renal vein. The tissue between the lower pole and ureter is left intact to prevent devascularization of the ureter. Then, the gonadal vein is transected, and dissection is performed inferior to the renal vein. Any lumbar veins in this area are carefully isolated and transected, followed by dissection and transection of the adrenal vein. Next, complete dissection of the hilum, thereby freeing the renal artery from its origin, from the aorta. The adrenal gland is separated from the upper pole of the kidney, and the remainder of the upper pole is dissected. The ureter is dissected down to the pelvis and divided. Before transecting the renal vessels, posterior attachments are taken down. The renal artery is divided first, followed by the renal vein. The kidney is extracted manually through a muscle splitting Pfannenstiel or Gibson incision.[12]

Retroperitoneal approach. This side proves to be more technically difficult because the liver must be retracted cephalad to allow dissection of the upper pole. Also, the application of the endoscopic gastrointestinal automatic (endo-GIA) stapler on the right renal vein results in a loss of 1-1.5 cm of length. Balloon dilation facilitates the retroperitoneal working space. Utilizing 3 ports, the kidney is retracted anteriorly and the renal artery is mobilized circumferentially. Once the proximal renal vein is mobilized and a segment of the adjacent IVC is exposed, the ureter, with sufficient periureteral tissue, is dissected distally enabling the upper pole to be separated from the adrenal gland. The anterior kidney surface is slightly mobilized to prevent the kidney from falling posteriorly. The renal artery is clipped using 2 clips, and is then divided. An endo-GIA stapler is used to transect the renal vein. The retroperitoneum is entered through the extraction incision, and the kidney is manually extracted. The port sites are closed with the Carter-Thomason needle.[13]

Donor. Jacobs et al[14] reviewed 738 consecutive laparoscopic living donor nephrectomies at the University of Maryland, and reported a total of 12 donors who underwent open conversion for vascular injury or obesity and failure to progress laparoscopically. Of the vascular injuries, 6 out of 10 occurred during the use of a vascular stapler. A further 2 of these 738 cases were aborted, and the nephrectomy was not performed. In one case, the donor suffered a colonic injury, which was repaired laparoscopically and underwent laparoscopic donor nephrectomy later. Major complications including vascular and bowel injuries, present a significant risk to the donor. Minor complications included splenic lacerations, liver laceration, pneumothorax, diaphragm injuries, conversions for obesity, stapler misfired controlled with clips or sutures, controllable vascular injuries of the adrenal or lumbar vessels, entrapment bag malfunction, difficult manual extractions, and mesenteric laceration. The average hospital stay was 64.4 hours. Hospitalization length did not correlate with the donor age, gender, weight, or race.

In terms of recovery, donors had bowel sounds recorded at 32.1 hours, and bowel movements at 63.5 hours after surgery. Bowel function return was not affected by age, gender, race, morphine, weight or surgical date. There were 12 patients who had prolonged ileus or required hospital readmission. Postoperative creatinine was 1.5 times preoperative creatinine regardless of donor gender, race or age. Major postoperative complications included atrial fibrillation, pancreatitis, small bowel obstructions requiring laparotomy, pneumonia, retroperitoneal hematomas and splenic laceration requiring splenorrhaphy.

Recipient. Theoretical concerns that the pneumoperitoneum required for laparoscopy leads to decreased renal blood flow, transient renal ischemia with acute tubular necrosis, and altered function, have remained unfounded. Overall, recipient and graft survival rates were similar for the laparoscopic and open groups. Derweesh et al[15] reviewed 101 laparoscopic, and 35 open living donor nephrectomies. Only patients with data available on renal scintigraphy Tc mercatoacetyltriglycine(Tc-MAG3 renogram), performed on postoperative day one and 5, were reviewed. Four renographic criteria were reviewed to investigate delayed renal function recovery in recipients: T-max and T1/2 at postoperative day one and 5. The donor and recipient age, donor gender, body mass index (BMI) and number of human leukocyte antigen (HLA) mismatches did not differ statistically in the 2 groups. Average renal warm ischemia time was 4.3 minutes in the laparoscopic live donor nephrectomy (LDN) group. Cold ischemia, revascularization time and total ischemia times were not significantly different between the groups. The incidence of rejection and graft survival did not differ significantly between recipients from the groups. Kidneys procured laparoscopically performed as well as those procured openly. Serum creatinine did not differ statistically between the 2 groups at postoperative days one and 5, and one, 3, 6, and 12 months. Only one out of the 4 renographic criteria investigated, T-max at day one was different between the 2 groups, and this did not reflect negatively with respect to long term renal function.

Delayed graft function. Abreu and colleagues[16] at the Cleveland Clinic reviewed donor and recipient from 100 consecutive laparoscopic live donor nephrectomies. Four criteria were used to classify delayed graft function: 1.- requirement of dialysis in postoperative week one; 2.- creatinine level 2.5 mg/dl or greater at postoperative day 5; 3.- time taken to half- peak activity (mercaptoacetyltriglycine renal scan) at postoperative day 5, greater than 12.2 minutes (normal range one to 12.2) and 4.- time to reach peak activity (mercaptoacetyltriglycine renal scan) at day 5 greater than 6.5 minutes (normal range 2.1 to 6.5).

The number of patients in the delayed graft function categories was 5 with outcome one, 14 with outcome 2, 39 with outcome 3 and 24 with outcome 4. There were 23 patients represented in more than one category, and 59 patients were classified as having normal function. Recipient age, donor/recipient gender relationship, unrelated highly mismatched donors and cold/total preservation times were identified as risk factors related to impaired early renal function recovery. None of the variables related to the laparoscopic technique itself represented risk factors for delayed graft function.

Laparoscopic versus open living donor nephrectomy. Laparoscopic donor nephrectomy has the potential to minimize the burden placed on live kidney donors. Waller et al[17] compared donor morbidity and recovery following 34 open donor nephrectomies and 20 laparoscopic donor nephrectomies; where, postoperatively, donors were managed with a patient-controlled analgesia system. They found laparoscopic donor nephrectomy to be associated with a shorter hospital stay (6 versus 4 days) and less narcotic requirements. Laparoscopic donors returned to work quicker than the open nephrectomy donors (5 versus 12 weeks). There were no differences in recipient serum creatinine levels at 3 months post-transplant, but 2 recipients of transplant kidneys retrieved laparoscopically developed ureteral obstruction. The laparoscopic donor group was associated with less postoperative pain and a substantial improvement in donor recovery times.

Brown et al[18] reviewed 50 consecutive laparoscopic nephrectomies, and compared them with 50 consecutive open donor nephrectomies in which donor age, gender and number of HLA mismatches did not differ statistically between the 2 groups. In the laparoscopic groups, mean follow-up was 109 days; mean operative time was 234 minutes; mean estimated blood loss was 114 ml, and mean hospital stay was 3.5 days. In the open nephrectomy groups, mean follow-up was 331 days; mean operative time was 208 minutes; mean estimated blood loss was 193 ml; and mean hospital stay was 4.7 days. The average renal warm ischemia time was 2.8 minutes in the laparoscopic nephrectomy group. Serum creatinine did not differ statistically between the 2 groups preoperatively or postoperatively at days one, 5, and one month. The recipients' ureteral complications in the laparoscopic groups were 2% and in the open nephrectomy groups 6%.

In conclusion, laparoscopic donor nephrectomy is a promising, yet still developmental approach and a fair amount of further evaluation is considered necessary to define the limitations and efficacy of this technique. It is clear from the initial data that this operation is technically difficult and involves a steep learning curve. Presently, laparoscopic donor nephrectomy should belong to centers with renal transplant and advanced laparoscopic surgical teams that are not only integrated, but sufficiently experienced too.

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