Hand-assisted Retroperitoneoscopic Live Donor Nephrectomy: Reduced Perioperative Risk and Excellent Outcome – Experience from the first 110 Consecutive Cases

Aim/Background: Laparoscopic live donor nephrectomy is associated with two major life-threatening complications, sudden severe bleeding and intestinal injury. Hand-assisted and retroperitoneoscopic techniques reduce the risk of these life-threatening complications. In this study, we report on our experience from the first 110 consecutive live donor nephrectomies operated with a combined hand-assisted and retroperitoneoscopic technique (HARS).

Material/Methods: The first consecutive 110 donors operated with the HARS technique are included in the study. The data has been collected prospectively according to intention to treat. Body Mass Index (BMI), warm ischemia time (WIT), operating time and blood loss were recorded. Complications, and allograft outcome in the recipient were followed postoperatively with a mean follow-up of 870 (1868-40) days.

Results: The mean operating time was 142 (80-305) min and the mean WIT 172 (85-510) seconds. The operative time was significantly longer in male donors, 167 (110-305) min vs 126 (80-215) min, (p<0.001). BMI did not influence the operating time but kidneys with multiple arteries prolonged the operating time significantly, 137 (80-305) min vs. 182 (115-265) min (p<0.001). The mean bleeding was 185 (50-700) ml.

Major complications were one non-lethal pulmonary embolus and two donors required blood transfusion. One donor was reoperated due to suspicion of trocar hernia. Fourteen patients had minor complications (fever, n=4; urinary tract infection, n=6; chylous ascites, n=1; orchialgia, n=2; subcostal pain, n=1).

Two kidneys did not have immediate onset of function. Neither of these were attributed to the donor operation. Two recipients experienced urinary leakage and one a stenosis.

Overall recipient- and graft survival were 97% and 95%, respectively.

Conclusions: HARS enables short operating times and reduces the risks associated with endoscopic live donor nephrectomy.

Key words: hand assistance, hand-assisted retroperitoneoscopic nephrectomy (HARS), live donor nephrectomy, living donors, morbidity, safety
Abbreviations

BMI  Body mass index  
HARS  Hand-assisted retroperitoneoscopy  
LDN  Living donor nephrectomy  
WIT  Warm ischemia time

Introduction

Living donor nephrectomy (LDN) causes less morbidity with less pain and shorter recuperation period than conventional open nephrectomy (2,3,4,5). The safety of the procedure has, however, been questioned (6,7). The two major life threatening complications associated with the procedure is bleeding and intestinal complications. Severe sudden bleeding is the most common cause for emergency conversion (8,9). Intestinal injury and gastrointestinal complications such as nausea and vomiting, dehydration, ileus, or constipation are the most common cause for readmission after LDN (8,10).

Intestinal injuries are often not detected intraoperatively. The delayed diagnosis aggravates its severity. Intestinal lesions as well as bleeding have been the cause of death in connection with laparoscopic nephrectomy (9,11,12,13). In live donor nephrectomy the donor receives no direct therapeutic benefit and safety issues are therefore extremely important. To address the two mentioned complications we have developed a hand-assisted retroperitoneoscopic technique (HARS). The hand-assisted technique facilitates the operation and makes it safer (14,15,16,17). Perioperative bleedings can then immediately be controlled by manual compression. Often the bleeding source can subsequently be identified and ligated without conversion to open surgery. A massive bleeding is difficult to handle with a pure laparoscopic technique. The delayed diagnosis aggravates its severity. Intestinal lesions as well as bleeding have been the cause of death in connection with laparoscopic nephrectomy (9,11,12,13).

In live donor nephrectomy the donor receives no direct therapeutic benefit and safety issues are therefore extremely important. To address the two above-mentioned complications we have developed a hand-assisted retroperitoneoscopic technique (HARS). The hand-assisted technique facilitates the operation and makes it safer (14,15,16,17). Perioperative bleedings can then immediately be controlled by manual compression. Often the bleeding source can subsequently be identified and ligated with a clip without conversion to open surgery. A massive bleeding is difficult to handle with a pure laparoscopic technique. It takes longer to identify the bleeding source and achieve haemostasis, which puts the donor at risk (16,18,19,20,21,22,23,24,25,26,27,28). Conversion is also often necessary. The hand-assisted technique has also the benefit that it shortens operating times as well as warm ischemia time (WIT) (16,17,21,29,30).

With the open approach the operation is performed retroperitoneally which reduces the risk of intra- and postoperative intestinal complications. Endo-
scopic nephrectomy can also be performed by a retroperitoneal approach (31,32,33,34,35). With the HARS operation we have combined the safety advantages of both the hand-assisted technique and retroperitoneoscopic approach (36,37). In the present study, we report on our experience of the first 110 consecutive cases of HARS live donor nephrectomy.

Materials and Methods

The study includes a consecutive series of 110 donors who underwent LDN with the HARS technique, from the first HARS operation and onwards. During the same period, no other endoscopic live donor nephrectomies have been performed. The waste majority of the operations involved the left kidney. Late in the series two right-sided operations have been performed. If the right kidney was chosen due to arterial anatomy or inferior function, they have otherwise been operated with an open anterior extraperitoneal approach. The left kidney has always been chosen for harvesting when both kidneys were equal. An angiogram and gamma camera with split function were obtained from all donors preoperatively. The operative time is from skin to skin. WIT is defined as the time from clamping the artery until the kidney was immersed in crushed ice and cold perfusion was established. Postoperative hospital stay is defined as the period from the first postoperative day until the day of discharge. Donors were allowed to stay on the ward as long as they wished. All donors received prophylactics with antibiotics and low-molecular-weight heparin as well as compression stockings.

Operative Procedure

The operative procedure has been described in detail elsewhere (38,39). The patient is placed in a 90° oblique position but the table is not broken in order to maximise the retroperitoneal space and not stretch the peritoneum. The operation starts with Pfannenstiel or inferior midline incision. The peritoneum is left intact and a pre-peritoneal space is created through blunt manual dissection. The dissection starts in a direction towards the iliac vessels and the peritoneum is then gradually loosened from the posterior and anterior abdominal wall in a cranial direction to above the upper pole of the kidney. A hand-assist device is placed in the wound. The surgeon’s left hand is placed between the abdominal wall and the peritoneum in order to shield the peritoneum and viscer. A blunt 12 mm working port is then placed immediately to the left of the hand port. Gas (CO₂) is insufflated into the pre/post-peritoneal space. Gas pressure is kept at a maximum of 12 mm Hg. A second 12 mm blunt port is introduced high on the subcostal margin which allows access for a 30°-video laparoscope, again with the surgeons hand shielding the peritoneum and viscer. A third 5 mm blunt port is placed in the flank below the costal margin. The position of the patient, surgeons and ports are depicted in figure 1. The operation is performed in essentially the same manner as the traditional technique. The renal vein is dissected from the hilum towards the vena cava proximal to the adrenal vein. The gonadal, lumbar and adrenal veins are divided between double clips. The artery is freed down to the aorta. The ureter is dissected, often together with the gonadal vein, down to the iliac vessels. The artery(ies), the vein and sometimes the ureter, are then divided with an endovascular stapler. A lot of tissue should be kept around the ureter in order not to compromise its circulation and can therefore not always be ligated with clips. As soon as the vein and artery is divided the kidney is taken out by hand in order to minimise WIT. The ports are removed under direct vision in order to detect any bleeding from the port sites. The wound is not drained. The 12 mm ports are closed, but the 5 mm port in the flank is left without closure and the abdominal wall is closed with a running suture. The extraperitoneal approach obviates mobilising the colon and the spleen. The splenocolic ligament is left intact. In some patients, we have experienced tears in the peritoneum. However, this has not created any difficulties, and gas entering the abdominal cavity does not reduce the retroperitoneal working space.

All complications are documented and a surgeon sees the donors at a 3-month follow-up visit. There is a complete and continuous follow-up of all recipients. Immediate onset of function is defined as perioperative urine production with lowering of serum creatinine at postoperative day 1 and no necessity for dialysis in the first week following renal transplantation.

Statistics

Unless otherwise stated, data are presented as a mean with (min-max) range given in parentheses. Analysis of variance (ANOVA) was used for compari-
son between groups, and simple regression was used to investigate the relationship between the variables of operative time and body mass index (BMI). Statistical software, StatView for Windows (SAS Institute Inc., Cary, NC, USA), was used to execute the statistical calculations. A p-value of <0.05 was considered to be statistically significant.

Results

Preoperative Characteristics

The mean age of the donors was 48 (25-72) years and the female/male ratio was 65/45. Seventy (64%) of the donors were related and 40 (36%) unrelated (mostly spousal, n=34). One donor was a non-directed donor. The mean BMI was 26 (17-35) kg/m². In ten cases, the recipient was incompatible – 2 positive cross-matches and 8 blood group incompatible – necessitating desensitisation.

Operative Characteristics

The mean operative time was 142 (80-305) min. No effect of a learning curve on operative time was observed and there was no statistical difference in operative time between the first ten cases and the following hundred, 154 (120-225) min vs 142 (80-305) min, respectively (Figure 2). The operative time was significantly longer in male donors as compared to female, 167 (110-305) min vs 126 (80-215) min, (p<0.001). BMI was equal between female and male, 25.3 (20-35) (kg/m²) vs 25.8 (17-32) (kg/m²), and obesity, as such, did not have an influence on operative times (Figure 3). However, the subjective impression is that obese male donors with compact and firm fatty tissue around the kidney prolonged operative times and made the operation more difficult. The mean WIT was 173 (85-510) seconds. Fifteen donors had more than one artery, 12 had two and 3 had three arteries. Four of these had not been detected on the preoperative angiogram. Most of the multiple arteries could be divided in the same staple row. The operative time was significantly longer when multiple arteries were present, 137 (80-305) min vs. 182 (115-265) min (p<0.001). There was no difference in frequency of multiple arteries between male (n=9) and female (6). There was a relatively high frequency of venous anomalies. Five patients had a retroaortic vein and one had a leftsided inferior caval vein. These abnormalities did not influence the perioperative course. In 21 cases, there was a tear in the peritoneum, but this did not affect operative time or reduce the operative field. Tears tended to be more frequent early in the series. In four cases, it was not possible to create a retroperitoneal space due to scaring after previous operations. In these cases, the operation proceeded with a hand-assisted intraperitoneal technique. There were no major intraoperative complications and no conversions to open surgery. In three cases there was a larger bleeding. One from a lumbar vein that had been ligated with a LigaSure device (LigaSure™, Valleylab, Tyco Healthcare, Boulder, CO, USA). Another due to a clip that became dislodged from the stump of a lumbar branch and finally one after a clip had transected a suprarenal vein. All these bleedings could be handled with manual compression and positioning of a clip over the lesion. There were no lesions to the kidney or artery(ies). The mean estimated bleeding was 185 (50-700) ml. The donor that bleed 700 ml intraoperatively required 2 units of blood in the postoperative period.

Postoperative Characteristics

The mean postoperative hospital stay was 5.7 (4-15) days and the mean period of sick leave 6.2 (3-12) weeks. It should, however, be noted that the donors were allowed to stay as long as they wanted on the ward and that the Swedish health care system is generous with sick leave. One donor was reoperated on postoperative day 9 due to pain at one of the trocar sites and suspicion of a hernia. No hernia was found at the reoperation and
the pain disappeared. Two donors complained over orchialgia and one donor complained about prolonged pain subcostally and in the flank. A CT scan did not demonstrate any abnormalities and the pain has slowly vanished. One patient developed a pulmonary embolus 3 months postoperatively, in spite of perioperative thrombosis prophylactics and the absence of any coagulation disorders. The donor was treated with anticoagulation for 6 months. Minor complications were urinary tract infection in 6 donors and four developed fever of unknown origin. Finally, one donor who had to be operated using an intraperitoneal approach due to scaring after previous operations developed chylous ascites. The ascites had to be drained percutaneously for one week. Apart from this, there have been no other major or minor complications.

Recipient Graft Function and Complications

All kidneys except two had immediate onset of function. One of them had a complex venous anatomy and developed a venous thrombosis. The patient underwent reoperation and the thrombus was removed. The kidney developed acute tubular necrosis and the patient required four dialysis sessions in the postoperative period. One year after the transplant the patients serum creatinine was 120 μmol/l. The other patient had severe amylloidosis and hypotension. The systolic pressure was below 80 mmHg throughout the transplantation and not above 100 mmHg postoperatively. He subsequently developed urosepsis and acute tubular necrosis requiring 7 sessions of dialysis. The kidney recovered and creatinine three years after the transplant was 200 μmol/l. The reason for the primary non-onset of function could thus not be related to the harvesting technique in either of the two cases. There has been one ureteral stenosis due to twisting of the ureter and one case of urinary leakage due to distal ureteral necrosis requiring reoperation at the 7th day after the transplantation. Finally one patient had a urinary leakage from the bladder that was treated temporarily with bladder catheter drainage. Recipient- and graft survival are 97% and 95%, respectively, at a mean follow-up of 870 (1868-40) days. Three patients died with functioning graft. Two of a myocardial infarction, 6 weeks and 7 postoperatively. One due to suspected suicide 8 months postoperatively. One patient lost his graft after 3 months following multiple rejections. Another patient lost his graft due to recurrence of disease after 42 months and one woman lost her graft 6 months postoperatively due to intimal dissection during an attempt to dilate a renal artery stenosis.

Discussion

Live donor nephrectomy is a unique operation where an operation is performed on a healthy person who receives no direct therapeutic benefit. Every available means should therefore be employed to reduce major complications and the risk of mortality.

Laparoscopic nephrectomy has been shown to reduce the morbidity of live donor nephrectomy, but safety issues with the procedure are still of some concern. In this study, we report on the largest experience with a hand-assisted retroperitoneoscopic nephrectomy technique. The technique addresses the two major complications associated with laparoscopic nephrectomy, - large sudden bleeding and intestinal complications.

The technique increases the safety margin of the operation. Endoscopic donor nephrectomy is a surgically demanding procedure and the hand-assisted technique facilitates the procedure. It provides tactile feedback that compensates for the two-dimensional picture on the video screen (14, 16, 17, 20,22,24,26,30,40,41). It helps to identify surgical planes as well as making it easier for the surgeon to identify anatomical structures. This is especially important for surgeons in a learning phase or with limited experience, situations where complications are more likely to occur.

Bleeding is difficult to manage using laparoscopic instruments alone. It is the most common reason for conversion to open surgery, reoperation, and has led to donor mortality (8,9,10,11). Severe sudden bleeding can also occur with experienced surgeons, for instance, with malfunctioning of an endovascular stapler (8,11,12). In such a situation, the hand-assisted technique is claimed to be of clear advantage since it allows immediate compression to achieve hemothrosis (16,18,21,22,23,24,25,26). There are numerous reports where the hand-assisted technique has been helpful in such situations (9,26,27,28).

Long operative time is generally associated with a number of post-surgical complications. The hand-assisted technique shortens operative times (16,17,21,29,30). This can be of importance since the patients are positioned in an awkward position that can cause long-lasting discomfort and even lead to severe complications such as neurovascular injuries and rhabdomyolysis (10,42,43,44,45).

In the present series the operative time is shorter then most other series with a transperitoneal approach, both pure laparoscopic and hand-assisted techniques.

The retroperitoneal approach addresses the second major life-threatening complication associated with laparoscopic nephrectomy, namely the risk for visceral injury (46).

These injuries can be difficult to detect during surgery. The delayed diagnosis aggravates its severity and can progress into life-threatening complications (46,47,48). Gastrointestinal complications represent the major postoperative problem after laparoscopic live donor nephrectomy leading to prolonged ileus and readmission (8,10). The HARS technique obviates the need of mobilising the descending colon and dividing the splenocolic ligament, thus minimising the risk of internal herniation (49).

In this series, there were no visceral injuries and no donor experienced delayed bowel function except for the patient who underwent surgery with an intrabdominal approach and was readmitted due to chylous ascites. Many surgeons fear that the retroperitoneal route for endoscopic donor nephrectomy limits the working space. The relatively short operating time in the current series gives a good indication that working space is not limited and that the operation is in fact easier than the transperitoneal route, even when gas leaks into the abdominal cavity.

The HARS technique was developed to increase the safety of endoscopic donor nephrectomy. Low morbidity as well as preserving optimal function and integrity of the kidney are, however, also an important features of the operation. In this series, as well as in previous studies, we have demonstrated that morbidity is low and that kidney function and integrity is well preserved (36). All kidn-
nencies except two had immediate onset of function and WIT was acceptable in all cases. In the two cases where there was not an immediate onset of function, this could not be attributed to the donor operation. A hand-assisted technique yields shorter WIT compared to traditional laparoscopic technique (15-17, 22,26,30,33).

We conclude that, from a theoretical and empirical perspective, the HARS procedure has safety advantages when compared to traditional laparoscopic nephrectomy. In this series the morbidity has been low. Our experience gives the impression that the technique is comparably “easy” to perform, as the operating times are fairly short. The kidney function and integrity is well preserved, with excellent graft survival. The HARS technique can thus be recommended as an easy and safer operative technique for endoscopic live donor nephrectomy.

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References