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SURGICAL ENDOSCOPY
and Other Interventional Techniques

Hand-assisted laparoscopic surgery (HALS) for live donor nephrectomy is more time- and cost-effective than standard laparoscopic nephrectomy

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Abstract
Background: Hand-assisted laparoscopy (HALS) was introduced to increase the safety of living donor nephrectomies. Herein we evaluate the first HALS living donor nephrectomies performed at our center.
Methods: Traditional laparoscopic nephrectomies (TLS) ($n = 11$) and HALS nephrectomies ($n = 11$) were included in the study. One patient from the TLS group was excluded because the operation was converted to open nephrectomy. We compared the operating times (OT) and warm ischemia times (WIT) for the two procedures and calculated the operating costs.
Results: Mean OT was 270 min in the TLS group and 197 min in the HALS group; thus, there was, a significant reduction of 27% with HALS. WIT was 297 sec for the TLS group and 214 sec for the HALS group, for a reduction of 28%. Costs were also lowered for HALS.
Conclusion: In addition to shortening both OT and WIT, HALS enhances the safety margin of the procedure, especially during trocar placement. It is further helpful in preventing torsion of the kidney and controlling potential bleedings, as well as during vascular stapling and kidney removal.

Key words: Living donors — Hand-assisted laparoscopic nephrectomy — Laparoscopic nephrectomy — Kidney — Hand port

During nephrectomies for kidney transplantation, it is critical to keep the morbidity of live kidney donors as low as possible. This is the motive for applying the laparoscopic technique to live donor nephrectomies, even though the technique lengthens operating time, adds additional costs, and sets high demands for experienced and skilled laparoscopic surgeons [2, 3, 6, 8, 12]. The advantages of laparoscopic nephrectomy are less surgical trauma, shorter hospitalization and reduced convalescence time [2, 3, 9]. Several authors, however, have argued that the technique has not yet been proven safe enough [5, 7, 10]; moreover, it has a long learning curve for each surgeon and a higher incidence of complications than the open approach. With the twin goals of improving the safety of the technique and making use of the same incision created for harvest of the kidney, hand-assisted laparoscopic surgery (HALS) was first applied to nephrectomy in the late 1990s [13]. HALS enhances the confidence of the operating surgeon and increases the margin of safety, as the surgeon's hand is in the abdominal cavity throughout the entire procedure [11]. The tactile feedback gained with HALS facilitates the operation and makes it easier to procure the kidney.

The aim of this study was to evaluate the HALS technique in living donor nephrectomies in comparison with standard laparoscopic nephrectomies.

Materials and methods

The first 11 HALS at our center were followed prospectively and compared retrospectively to living donor nephrectomies performed with traditional laparoscopic surgery (TLS). To obviate the effect of the learning curve for the laparoscopic technique, the early series of TLS was excluded from the study; only the last 11 cases prior to changing to the HALS technique served as control. In the HALS group, we could no longer discern a learning curve (Fig. 1). One of the TLS donors was excluded from the study because the operation was converted to open nephrectomy due to bleeding. Two surgeons (J.W., M.H.) took turns performing the operations. All donors donated their left kidney. The demographic parameters studied were age, gender and body mass index (BMI). The intraoperative parameters were operating time (OT), warm ischemia time (WIT), bleeding and complications. We also compared the costs for the two techniques. Postoperative inpatient care time was also followed. Recipient parameters were time for onset of renal function and serum creatinine at 3 months.

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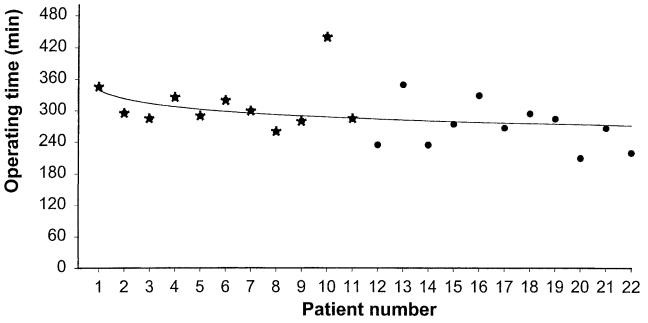

Fig. 1. Operating times for the first 22 living donor laparoscopic nephrectomies performed at our center. Stars represent the early laparoscopic nephrectomies that were excluded from the study, solid black circles represent the laparoscopic nephrectomies constituting the TLS group.

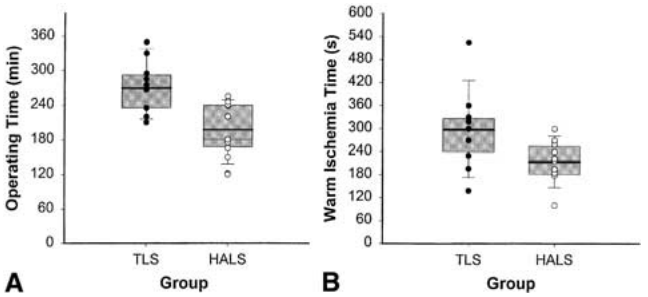

Fig. 2. **A** Operating time (min) for donors undergoing TLS ($n = 11$) (black dots) and HALS ($n = 11$) (white dots). **B** Warm ischemia time (sec) for donors undergoing TLS ($n = 11$), (black dots) and HALS ($n = 11$) (white dots).

Operative technique

TLS donor nephrectomy was essentially performed as previously reported [4]. During the HALS donor nephrectomy, the donor was tilted with pillows in a 45° oblique position, right side down, carefully padded, and secured to the surgical table. The HandPort system (Smith & Nephew, Andover, MA, USA) was used in accordance with the instructions manual in all cases. This system allows the surgeon to commence the procedure with an infraumbilical midline laparotomy. Once free access to the peritoneal cavity is established, the surgeons left hand is placed in the abdomen and a working port is placed immediately to the left of the hand port. Pneumoperitoneum is established and an additional port is introduced high on the subcostal margin. This port allows access for a 30° video laparoscope. The surgeon and the assistant are comfortably seated throughout the procedure (Fig. 2).

The operation is performed in essentially the same manner as the TLS technique. The descending colon is dissected and moved medially, and the lateral attachments of the spleen are dissected. The medioanterial portion of Gerota's fascia is opened, leaving most of the perirenal fatty tissue and Gerota's fascia along with the kidney. The upper pole of the kidney is dissected free. The vascular pedicle is dissected starting with the vein. The gonadal, lumbar, and adrenal veins are cut between double clips. The artery is freed down to the aorta. The ureter is then dissected together with the gonadal vein down to the iliac vessels. Finally, the lateral attachments of the kidney are divided. In most of the operations, an additional port was placed in the flank to facilitate a safe dissection of the renal vessels and its branches. This allows the introduction of a Babcock clamp, which can be used to grasp the peritoneal fat and pull the kidney in a lateral direction to stretch the vessels. After stapling of the vessels, the kidney was harvested using a laparoscopic retrieval bag (Endocatch, AutoSuture, US Surgical Corp., Norwalk, CT, USA) in the TLS group and by hand in the HALS group.

Statistics

All data are presented as means (range) minima. The Mann-Whitney U-test was applied. A p-value of < 0.05 was considered significant.

Results

Demographic data

The mean age of the TLS group was 52.7 years (range, 33–68); for the HALS group, it was 48.2 years (range, 39–57). Nine of 11 patients in the TLS group and four of 11 patients in the HALS group were women. The mean donor BMI was 25.8 (range, 20.6–30.7) in the TLS group and 25.4 (range, 22.1–29.8) in the HALS group.

Operative parameters

Two donors in the TLS group and one in the HALS group had two left renal arteries; all of the other donors had one artery. In the TLS group, the mean OT was 270 min (range, 210–350) vs a significantly reduced 197 min (range, 120–255) for the HALS group ($p = 0.001$). This represents a reduction of 27% (Fig. 3A). WIT was 297 min (range, 138–525) in the TLS group and 213 sec

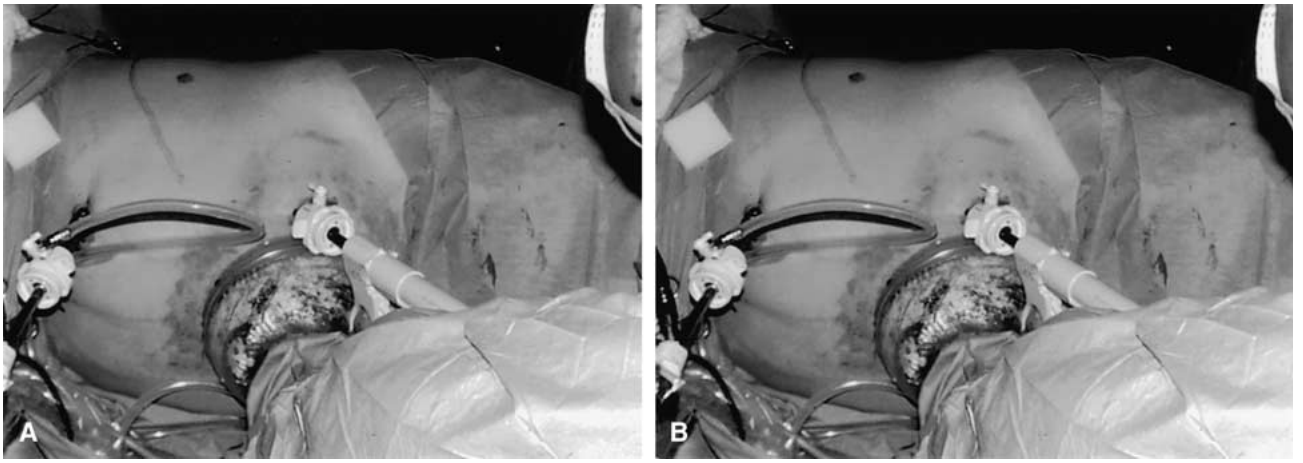

Fig. 3. **A**, **B** Photograph showing the working position of the surgeon vis-a-vis the patient's abdomen.

Table 1. Complications for 11 donors undergoing traditional laparoscopic nephrectomy (TLS) and 11 donors undergoing hand-assisted laparoscopic nephrectomy (HALS)

Group/patient no.	Complications
TLS/1	Small subcutaneous emphysema in the left flank
TSL/2	Minor wound infection
TSL/3	Hyperethesia in the scar of one of the trocars
TSL/5	Renal torsion intraoperatively
TSL/6	Renal torsion intraoperatively Difficulties with the Endocatch, which could not be used
TSL/8	Thrombosis in vv jugularis interna et communis 4 wk postoperatively
HALS/4	Loop diuretics initially needed postoperatively
HALS/5	Postoperative nausea

(ranges, 100–300) in the HALS group, a significant reduction of 28% ($p = 0.02$) (Fig. 3B). There was no difference between the two operating surgeons in OT or WIT. Estimated blood loss was 240 ml (range, 100–400) and 272 ml (range, 50–600) in the TLS and HALS groups, respectively; this was not a significant difference.

One laparoscopic retrieval bag did not manage to trap the kidney, so the surgeon had to insert his hand into the abdominal cavity to retrieve the organ. On two occasions during TLS, the kidney was rotated around its own vessels. In one case, it was quickly rotated back into place; but in the other it was accidentally turned another 180° before finally being untwisted. Both kidneys had immediate onset of function.

Postoperative parameters

There was no difference in postoperative care. After the operation, the TLS group stayed in hospital 6.5 days (range, 3–10) and the HALS group stayed for 6.2 days (range, 5–7). There were no major complications in the postoperative period; minor complications and subjective symptoms are listed in Table 1.

At our center, the operating room costs represent set prices per minute. Shorter anesthesia and operating times with the hand-assisted method thus lower the average cost. With HALS, the cost of one trocar is saved, and there is no need for the Endocatch. The endoretractor is unnecessary as well. On the other hand, a hand port is needed. The total amount saved is US $1100 (11,615 Swedish Kronor) per nephrectomy.

All recipients had immediate function of their grafts. Mean serum creatinine 3 months after transplantion was 163 mmol/L (range, 102–270) in the group of patients receiving kidneys from the TLS group and 154 mmol/L (range, 90–265) for the recipients whose kidneys came from the HALS group. This is not a significant difference.

Discussion

In this study, we compared laparoscopic living donor nephrectomies with and without hand assistance. The hand-assisted operations were followed prospectively and were compared with retrospectively studied standard laparoscopic nephrectomies. A total of 24 pure laparoscopic living donor nephrectomies have been performed at our center. In two cases, the operations had to be converted due to bleeding. Neither of these donors was included in this study.

The most important advantage gained with hand assistance is an increase in safety, but we have also been able to reduce both the operating time and the warm ischemia time. This is not only cost-beneficial but also ensures the rapid and safe retrieval of the kidney with a shorter warm ischemia time. Although Slakey et al. and Wolf et al. [11, 12], also reported on the advantages of the hand-assisted method, they did not use the HandPort system, which allows the surgeon to commence the procedure with a laparotomy. This obviates the use of a Veress needle and allows safe placement of the ports. It further obviates the use of a wound retractor to prevent carbon dioxide dissection into the soft tissue of the abdominal wall, as described by Buell et al. in their case report [1]. Buell et al. recommend that the assistant surgeon place his or her hand into the abdomen, enabling the operating surgeon to proceed with two-handed laparoscopy. However, we think that it is preferable for the operating surgeon to have his or her hand in the abdomen, to maximize safety and provide the surgeon with fuller tactile sensation. In our experience, this measure proved especially helpful in preventing torsion of the kidney. Although none of the HALS procedures had any events of renal torsion, two cases of torsion occurred in the TLS group.

The postoperative stay was similar in both groups. In Sweden, there are no outpatient clinics, and patients return directly to their homes. Many of the donors have a long way to travel. They often want to stay on because the recipient is still in need of in-hospital care. We have a liberal attitude toward postoperative hospital care of the living donors to a great extent, the donors can decide for themselves when to be discharged.

One TLS operation was converted to open nephrectomy due to bleeding caused by a Veress needle. The needle damaged the liver, which was adherent to the ventral abdominal wall. We believe that this complication could have been avoided if the hand port had been used. With the hand-assisted technique, it is no longer necessary to introduce instruments blindly into the peritoneal cavity. The procedure is started with a midline incision, and the other trocars can be placed with the surgeon's hand already inside the abdomen.

Hand assistance also has some advantages during stapling of the vessels. The stapler can be put in place rapidly and securely, even when the vessels are complex. Our experience of patients with several renal arteries is still limited (only three cases), but undoubtedly a greater number of donors with several arteries will be offered laparoscopic surgery as we develop more experience. The dissection and stapling of the vessels is the most hazardous part of the operation and can carry a risk of massive bleeding. In our early experience with laparoscopic nephrectomy (prior to the donors in the TLS group), one donor bled profusely when an ovarian vein

was torn off. Bleeding is in fact the most frequent intraoperative complication [4]. At one transplant center in the US Midwest, bleeding in one donor led to ischemic encephalopathy and a chronic vegetative state (L. Ratner, personal communication). Indeed, though we have also been able to demonstrate a shorter operating time, a shorter warm ischemia time, and lower costs with HALS, we think that its strongest argument is the increased margin of safety it provides. To further reduce morbidity in living donor nephrectomy, one would like to see the development of a retroperitoneal approach. To this end, we have recently conducted successful hand-assisted retroperitoneal laparoscopic and lomboscopic living donor nephrectomies.

In conclusion, hand-assisted laparoscopic nephrectomy in living donor kidney transplantation can be recommended as a technique that increases the confidence of the operating surgeon and the safety margin of the procedure In addition to its shorter operating time and warm ischemia time, HALS offers particular advantages during trocar placement, for the prevention of torsion of the kidney and control of potential bleedings, and in the final hazardous stages of vascular stapling and kidney removal.

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