23

Novel Renal Transplant-Related Surgical Approaches in the 21st Century

Shih-Chieh Jeff Chueh and Bashir R. Sankari
Glickman Urological and Kidney Institute, Cleveland Clinic, and Cleveland Clinic Lerner College of Medicine, OH USA

1. Introduction

The surgical procedures of implanting a kidney graft into the extraperitoneal iliac fossa has not changed much since its inception in 1950s; whereas the other renal transplant-related surgical approaches have been dramatically updated recently, especially with the commencement of urological laparoscopic surgery. The mile-stone advancement is the laparoscopic live donor nephrectomy (LDN). Conventional open LDN technique has been alleged as a hurdle for expanding live donor programs. Minimally invasive surgery approaches, like laparoscopic LDN, have been advocated to overcome this obstacle (Boulware et al., 2002). A variety of laproscopic LDN approaches will be detailed.

1.1 Pre-operative evaluation of live kidney donor

The eligibility as a living donor is subject to the regulations of the respective local Health Authorities. In the United States the United Network of Organ Sharing (UNOS) operates Organ Procurement and Transplantation Network (OPTN) under contract with the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services (HHS), which was established by the United States Congress under the National Organ Transplant Act (NOTA) of 1984 and provides policies of live kidney donors to be abided by. Under UNOS/OPTN policy, relatives, loved ones, friends, and even individuals who wish to remain anonymous may serve as live donors. Donating an organ is a personal decision that should only be made after fully informed about the possible risks and benefits. Live donors should be older than 18 years old, in good overall physical and mental health and free from uncontrolled high blood pressure, diabetes, cancer, HIV/AIDS, hepatitis, and organ diseases. Pre-operative assessments exclude incompatibility between the donor and the recipient and also confirm the proper functioning of the donor’s bilateral kidneys, and ensure that the risks of surgery and anesthesia are acceptable (OPTN, 2006; UNOS, 2009).

1.2 Which kidney to harvest?

Usually left kidney is preferred for live donation because the left renal vein is longer, which makes the implantation surgery easier and safer. In specific situations like: complex vascular or ureteral structures of the left kidney, significant inferiority of the right renal function relative to the left, right renal stone, etc., right kidney will be harvested for transplantation.

2. Laparoscopic live donor nephrectomy

2.1 History of laparoscopic live donor nephrectomy

Kavoussi and Clayman performed first laparoscopic nephrectomy for a cancerous kidney (Clayman et al., 1991). Ratner and Kavoussi first reported a successful laparoscopic live donor nephrectomy (LLDN, Ratner et al., 1995). Initially there were concerns about graft function and donor's safety with such procedure, and only limited centers routinely performed such procedure (Jacobs et al., 2004; Su et al., 2004). With more experience it revealed non-inferiority of the LLDN results, as compared with those of the open LDN. The benefits of the LLDN include smaller wounds, less pain, earlier resumption of oral intake, and faster recuperation and earlier return to previous life style and to work. Nowadays, LLDN has been the surgery of choice for harvesting a kidney from a live donor (Kercher et al.,2003; Troppmannet al., 2003; Tooher et al., 2004; Velidedeoglu et al., 2002).

2.2 Techniques of laparoscopic live donor nephrectomy

2.2.1 Hand-assisted laparoscopic live donor nephrectomy

2.2.1.1 Immediate preoperative preparation

The most important pre-operative conditioning of the live donor is vigorous hydration to combat the detrimental effect of pneumoperitoneum on the kidney function. Usually before the kidney is harvested 3~6 liters of fluid has been given to the donor to ensure good renal perfusion and diuresis. The operation is carried out under general anesthesia; an oro- or nasogastric tube is necessary to decompress the stomach, and a urethral catheter drains the bladder and helps monitoring urine output. Continuous or frequent blood pressure monitoring during the surgery to ensure mean arterial blood pressure about 100 mmHg, and a central line to ensure central line pressure around 10 mmHg help the kidneys well perfused. At the initiation of renal hilar dissection and right before the transection of the renal vessels, 12.5 grams of Mannitol are given to protect the kidneys and to induce diuresis.

2.2.1.2 Left hand-assisted LLDN (Chueh et al., 2002a; Hollenbeck et al., 2004)

The donor is positioned in an oblique flank position with the operating table flexed at the waist and all the pressure points are well padded. First, around the navel a 7-cm midline incision is made, or alternately a Pfannenstiel incision, if the donor's body size allows the intra-abdominal hand to reach the kidney. The incision is deepened layer by layer into the peritoneal cavity. A hand-assisted device (HAD) is set-up at this site. With one hand in the abdomen through the HAD, the insertion sites of the ports are tented up by the operator's fingers to ensure safe insertion of the trocars. The working port is located in the anterior axillary line about the level of the umbilicus, and the laparoscopic port can be at the left lower abdomen between the umbilicus and the anterior superior iliac crest (making sure to avoid injuring the inferior epigastric artery) or in the midline (epigastrium) above the HAD. The pneumoperitoneum of the abdominal cavity was then insufflated up to 10-12 mmHg, and a 30 degree laparoscope is used for the whole procedure.

The dissection begins by taking down the descending colon along the white line of Toldt to expose the kidney and ureter. Special attention must be exercised to the tissue planes between the structures: the Gerota fascia and soft tissues in front of the ureter needs to be preserved with the ureter, whereas the Gerota fascia in front of the kidney can be taken down with the colon, so the color of the kidney can be visualized during the dissection and abundant soft tissues around the ureter can be preserved to ensure good blood supply to the

ureter. Initial series showed higher rate of ureteral complications and urine leakage when no special attention to preserve the ureteral blood supply was exerted (figure 1; Bartlett, 2002).
The take-down of the descending colon extends from its distal junction with the sigmoid colon up to its splenic flexure, and it further extends cranially up to the lateral parietal attachment of the spleen; i.e.: the phrenicocolic and splenophrenic ligaments are divided. This extensive take-down facilitates the colon, spleen and the pancreatic tail to fall off the main operative field and helps to harvest a long ureter (figure 1b). The intra-abdominal hand is used freely for retracting the colon, spleen and pancreas away from the operative field, and for some blunt dissection between the kidney and the surrounding soft tissues. Pressure on the kidney or the renal vessels, either by the intra-abdominal fingers or by any instruments, is absolutely forbidden.
Further dissections aim at the tributaries of the left renal vein: namely, the gonadal, adrenal and lumbar veins. The gonadal vein is dissected along its medial side and off the underlying psoas muscle; whereas the majority of its lateral border is kept intact to preserve the blood supply to the ureter, except near its entrance into the left renal vein where it is dissected circumferentially and transected to expose a window for further dissection of the lumbar vein(s) and the left renal artery. The gonadal vein is controlled and transected again distally near the iliac vessels. The lumbar vein(s) usually drain into the posterior surface of the left renal vein. Its dissection is facilitated by elevating the gonadal vein stump or the lower margin of the renal vein. The lumbar vein is often quite short and might be multiple. The division of the lumbar vein(s) further opens up the window to dissect the renal artery. The dissection of the upper margin of the left renal vein leads to the insertion point of the left adrenal vein into the renal vein, which is usually more medial to that of the gonadal vein. The adrenal vein is controlled and divided. The adrenal gland was dissected off the upper pole of the kidney with special attention not to interfere with upper pole branch(es) of the renal artery if there is any extra-hilar early branching of the renal artery.
The left renal vein is dissected medially beyond its anterior crossing of the aorta. The renal artery is first partially dissected without any grasping or compression of the artery to avoid arterial spasm. Then the lateral, posterior and superior surfaces of the kidney were dissected off its surrounding attachments along the plane of the renal capsule, while leaving some soft tissues attached to the capsule for further traction. The adipose and soft tissues around the renal hilum and those in the triangle between the low pole of the kidney and the ureter (golden triangle, figure 1b*) are preserved to ensure adequate blood flow to the ureter.
The posterior and superior surfaces of the renal artery are then further freed when the kidney is flipped forward. The arterial dissection is carried out proximally to include its take-off from the aorta in order to facilitate retrieving longer artery.
The ureter is dissected medial to the gonadal vein to leave abundant tissues around it all the way down to its crossing at the iliac vessels, where it is transected immediately before the division of the renal pedicle to avoid torsion of the kidney (figure 1a and 1b). Only the distal ureter is clipped, and the proximal end of the ureter is left open to observe and ensure brisk urine output. The dissection of the upper pole and posterior-upper part of the kidney sometimes might be difficult because of the limited angles of the pivot function of the laparoscopic ports. Special care must be exerted not to put pressure on the renal parenchyma during this part of the dissection.
After making sure that the kidney is attached to the body only by the renal vessels the kidney is held up gently with the intra-abdominal hand, and the renal artery is first ligated at its origin from the aorta. Then the renal vein is controlled at the point of its crossing to the

aorta or even more medially if the dissection allows. This sequence of vessel ligations prevents congestive stasis of blood in the kidney. The control of the renal pedicles have been performed with either a standard laparoscopic vascular stapler (usually 3 rows of staplers on both sides of a dividing knife), Endo TA™ 30 stapler (only a triple staggered row of titanium staples, Covidien), polymer locking clips (Hem-o-lok, Weck, Teleflex), or laparoscopic metal clips (for artery only). The Endo TA stapler and the polymer locking clips provide the advantage of preserving maximal graft vascular length, which makes the implantation vascular anastomosis easier; whereas the use of conventional laparoscopic vascular stapler sacrifices 4 mm of the graft vascular length because 3 rows of staggered staplers at the end of the vessels need to be excised before anastomosis.

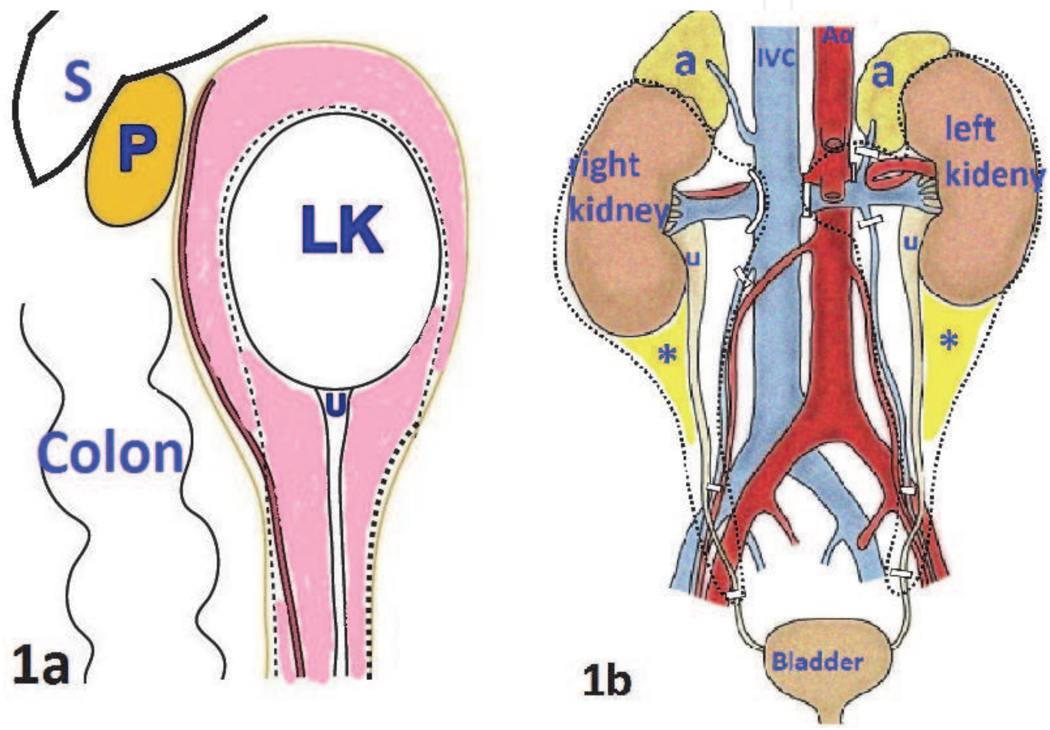


Fig. 1. Schematic planes of dissection during various nephrectomies. 1a. sagittal view. LK= left kidney, P= pancreatic tail, S= spleen, u= left ureter, painted pink area= perirenal soft tissues inside Gerota's fasia, dotted line= dissection plane during LDN, red line= anterior dissection plane during radical nephrectomy. 1b. coronal view. a= adrenal gland, Ao= aorta, IVC= inferior vena cava, u= ureter, *= Golden triangle, tubular structures painted in red= arteries, tubular structures painted in blue= veins, rectangle areas over vessels or ureter= sites of ligating vessels or ureter, dotted lines= planes of dissection during LDN.

Even though there have been several papers reporting successful applications of Hem-o-lok clips in controlling the pedicles during LLDN (Chueh et al., 2004; Ponsky et al., 2008), however, LLDN had been indicated by the manufacturer of the Hem-o-lok clip as a contraindication for the use of the polymer locking clips in 2006, and FDA announced a product recall, too (FDA, 2006), because Hem-o-lok clips may become dislodged following ligation of the renal artery after laparoscopic donor nephrectomy; and cases of delayed bleeding leading to severe morbidities or even mortality of the donor after using the Hem-o-lok clips. This issue has been further pointed out when UNOS first sent a notice to its members and FDA regarding the Hem-o-lok clip in 2008. More recently, UNOS and

American Society of Transplant Surgeon (ASTS) again sent a letter to their members to emphasize the importance of this issue, and urge the centers those perform live donor nephrectomy not use this clip for LLDN. Possible technical explanations for the complication might be related to that some harvesting surgeon just applied one Hem-o-lok clip over the artery in order to retrieve longer artery, and the Hem-o-lok clip slipped off an arterial stump that was left too short, or due to that the polymer clip(s) were weakened because of some thermal energy damage during the operation, and they fell apart in a couple days later. Hence, Endo TA™ 30 stapler is our current preference because of its ability of ensuring arterial seal and of harvesting longer vessels. Cold scissors cut of the renal pedicle vessels lateral (distal) to the stapler lines of the TA stapler completely frees the kidney, and the kidney is immediately retrieved out of the abdomen via the HAD wound to the back table for ex vivo perfusion and bench preparation in ice slush.

Once the kidney is delivered to the back table, the harvesting surgeon re-establishes the HAD and the pneumoperitoneum for meticulous hemostasis. Laparoscopic suction and irrigation are freely used to locate the bleeders. Attention is first focused on the transected ends of pedicles, and then the adrenal bed, lumbar vein stump, and lymphatic openings. The pneumoperitoneum is progressively decreased to 5 mmHg to ensure all minor bleeders are detected and securely controlled. Usually a drainage tube is not necessary.

The procedural sequences of LLDN are different from those of other types of laparoscopic nephrectomies because the renal pedicles are usually first ligated in the later circumstances, but in the former the pedicle vessels are initially dissected from the surrounding tissues, yet not ligated until the whole kidney is ready to be retrieved. This is to ensure a shortest warm ischemic time (WIT) of the harvested kidney for a better graft function after implantation.

A pinkish kidney with tense tone of the renal cortex and a well distended renal vein during the dissection indicate good perfusion of the kidney (and usually translated into immediate graft functioning after transplantation). But if the color is dusky or pale, or the tone of the kidney is floppy, or the renal vein is collapsed during the dissection, it indicates that the kidney is not adequately perfused and thus requires immediate attention and corrections of the donor's conditions by the surgeon and the anesthetic team must be executed. Maneuvers that might help include: more vigorous hydration, elevating the blood pressure and vasodilation of the renal artery with pharmaceutical agents, decrease the pressure of the pneumoperitoneum (5~8 mmHg), correction of any kinking or spasm of the renal artery, etc.

2.2.1.3 Right hand-assisted LLDN (Buell et al., 2004; Chueh et al., 2002a)

Only the procedural differences from the above-mentioned left hand-assisted LLDN are described below. The donor is placed similarly but with the right side up. The first camera port at the umbilicus is safely placed. After CO_2 insufflation to create pneumoperitoneum, a 7-cm subcostal oblique line corresponding to the level of right renal pedicle is marked on the skin. Three working ports, 2 at the ends of the marked line and 1 at the anterior axillary line between iliac bone and lower costal margin, are inserted. The ascending colon and the 2nd portion of the duodenum are taken down to expose the kidney and the inferior vena cava (IVC). After division of the right gonadal vein near its insertion into the IVC, and preliminary dissection of the renal pedicle and right ureter, the incision between the two working ports is connected to set-up the HAD and the surgeon's hand is inserted. The dissection of the right renal artery is done mainly when the kidney is flipped medially to expose its posterior surface. After all the dissections are completed, the ureter is transected. Then the hand is removed from the HAD, and the pneumoperitoneum is desufflated, while leaving the base wound retractor of the HAD still in place. This creates a window large enough for division of the vessels with traditional Satinsky vascular clamp to yield a full-length right renal vein with a partial IVC cuff. After the kidney is retrieved to the back table, the defect in the IVC is closed with 4-0 Prolene continuous sutures in 2 layers for meticulous hemostasis. Then the Satinsky vascular clamp is released. Some right renal donors might have longer renal vein, which can be measured from the Computed Tomography angiographic images preoperatively during the donor evaluation. In that case the HAD wound for the hand and for extracting the kidney can be moved down to a periumbilical, right Gibson, or Pfannenstiel incision. And the right kidney, after totally freed from the surrounding tissues, is pulled up laterally during the application of the Endo TA stapler, which is then pushed as medially as possible at the junction of right renal vein and the IVC to harvest a renal vein at its maximal length.

2.2.2 Pure laparoscopic live donor nephrectomy

The basic concept, planes of dissection, and the majority of the "pure laparoscopic" approach are very similar to those of the hand-assisted approach. The followings will only depict the differences:

2.2.2.1 Pure left LLDN

A working instrument, which usually enters into the operative field through a left subcostal port, substitutes all the functions of the intra-abdominal hand in the HAD approach. Without the HAD, the laparoscopic port can be at the umbilicus or left upper abdomen, depending on the body habitus of the donor. The port for the right-hand instrument is located at the same position. Another 15 mm port is created along the Pfannenstiel incision, which is later extended to 5-6 cm, with muscle split in the midline for the final extraction of the harvested kidney. An extra-large retrieving bag- EndoCatch II (Covidien, Mansfield, MA, USA) is employed through that port for helping traction during the dissection and for retrieving the kidney. Once all the dissections have been done and the ureter has been transected, the EndoCatch II is partially activated to "bag" the kidney and the ureter into the EndoCatch II bag while the edge of the bag and the string are still attached to its metallic ring; in this way, the renal pedicles can be tented up tight by elevating the Endocatch II ring (kidney) in the air. This tremendously facilitates the ligation of the renal pedicles and ensures long vessel length of the graft.

2.2.2.2 Pure right LLDN (Boorjian et al., 2004; Johnson et al., 2001)

Procedures are similar to those of pure left LLDN. The main differences are: 1. The ascending colon and the 2nd portion of duodenum, instead of the descending colon, pancreatic tail and the spleen, are taken down. 2. The right gonadal vein usually drains into the inferior vena cava (IVC), but it might also drain into the right renal vein directly. 3. There might be some small, thin-walled, innominate veins, which have higher chance to cause bleeding, draining into the right renal vein. 4. The wall of the right renal vein is thin, in comparison to that of the left renal vein, which is more prone to tear or bleeding during the procedures. 5. The length of the right renal vein is usually only 1-2 cm in length, which is much shorter than that of the left renal vein. 6. During the dissection of the upper pole of the right kidney, retraction of liver is usually necessary for better exposure. Once the kidney is completely dissected with only the renal vessels attached to the body, the kidney is bagged into the EndoCatch bag, and lifted high to tent up the renal pedicles. The right renal artery is stapled behind the IVC, and the renal vein is stapled at the IVC where it drains into, both with the Endo TA stapler, and then both vessels are transected immediately lateral (distal) to the staplers.

2.2.3 Retroperitoneoscopic live donor nephrectomy

Several teams (Bachmann et al., 2008; Sundqvist et al., 2004; Tanabe et al., 2005; Kohei et al., 2010) published successful series of retroperitoneoscopic LDN. Tanabe's revised technique usually employs a 3-port dissection technique combined with a Pfannenstiel 5-cm retrieving wound to accomplish the surgery.

The donor is in a lateral flank position, but the table is not bent. It requires a flexible laparoscope inserted through a mid-axillary port between the lower costal margin and the iliac crest, and a very experienced and skillful assistant as the telescope holder to collaborate with the operator. The surgeon develops the retroperitoneal working space, and dissects the kidney off the surrounding tissues with a pure retroperitoneoscopic dissection technique under a low 5-10 mmHg pressure of pneumo-retroperitoneum. After the kidney is totally freed (except the vascular pedicles), that Pfannestiel wound is deepened to the extraperitoneal space to connect to the previously dissected retroperitoneal space, then a Lapdisc (Hakko Medical, Tokyo, Japan) is setup at that incision and an Endocatch II retrieving device is inserted through the Lapdisc to harvest the kidney. Laparoscopic EndoGIA Stapler (Covidien, Mansfield, MA, USA) is used to control the renal artery and renal vein, or even larger gonadal vein or lumbar vein during the dissection.

The benefits of such an approach are early and direct dissection of the renal artery, no violation of the intraperitoneal organs, bowels, etc., and theoretically might lead to less post-operative ileus or bowel injury. The risks and challenges are that the retroperitoneal working space is much smaller and it is more technically demanding to operate in such circumstance without exerting unnecessary pressure on the kidney.

Summarizing their experiences with a total of more than 600 live donors operated via such approach shows that the chance of open conversion was low, and the complication rates were 4.9~ 7.7 %. Mean warm ischemia time was 2.2- 4.8 minutes. And the recipients' allograft function recovered smoothly. Thus, in experienced hands retroperitoneoscopic LDN seems provide similar outcome as compared with those of laparoscopic LDN.

2.3 Comments and summary of laparoscopic LDN

Evidences showed that the post-operative pain and quality of life of the donors, either operated by the hand assisted approach or the pure laparoscopic approach are similar, and both are significantly better that those of the traditional open approach (Velidedeoglu et al., 2002; Kercher et al., 2003; Troppmann et al., 2003; Mjøen et al., 2010; Leventhal et al., 2010). Laparoscopic LDN has evolved to be the surgery of choice for live kidney donors. Yet the bottom line issues are still the donor's safety and the functional integrity of the kidney graft. The donor surgeons should work in the way that they are most confident with and have very low threshold of converting to an approach with bigger incision to ensure the ultimate basic principles. For beginners it might be easier and safer to start with the hand-assisted approach, but this approach is ergonomically not friendly; and also poses some difficulty in fine handling and traction of the tissues by the left hand (fingers). Even though with the most experienced LLDN surgeon, there should always be a set of open exploration instruments immediately available in the operation suite during the LDN surgery; and the threshold of converting to a safer procedure should always be low.

3. Laparoendoscopic Single Site (LESS) live donor nephrectomy

Through the last 2 decades of developing minimally invasive surgery, urological laparoscopic surgery has gained more acceptance as a standard of care in various intra-abdominal procedures. Novel endeavors to advance this field are aimed at further mitigating morbidity and improving cosmetic outcomes. This trend has led to the development of multi-channel single-access ports, articulating instruments, and surgical techniques that could allow the laparoscopic procedures to be performed through a single small skin incision (laparoendoscopic single-site [LESS] surgery). The majority of such reports often hide the incision within the umbilicus, and transperitoneal route is typically employed. There have been reports of LESS live donor nephrectomy (LDN) in some elite transplant centers (Gill et al., 2008; Gimenez etal., 2010., Andonian et al., 2010a). We recently also successfully completed 4 cases of LESS LDN with speedy convalescence of the donors, and smooth recovery of the recipients' graft function.

3.1 Technique of LESS LDN

3.1.1 Belly-Button LESS LDN (Chueh and Sankari, submitted, 2011)

We will depict our technique of LESS LDN performed through a small incision at the belly-button. The donor is placed in a 60 degree flank position as in the pure laparoscopic LDN. A first layer transparent adhesive drape is applied over the whole abdomen after it has been prepped and draped. A 4.5 ~5-cm vertical midline incision is made around the umbilicus, and the wound is deepened layer by layer until the peritoneum cavity is entered. A GelPort® hand-assisted device (HAD) is setup at this wound. A second layer transparent adhesive drape is then applied over the abdomen, which also covers the whole GelPort and obliterates intra-operative gas leakage from the central pre-made entry/exit hole of the gel-cap. Thus the GelPort is used as the access platform for the following LESS LDN.

A 12-mm port is inserted through the gel-cap portion of the GelPort at its periphery part, but not right at the margin of its rigid ring. Pneumoperitoneal insufflation is started and a 30-degree 5 or 10-mm laparoscope is used to examine the peritoneal cavity. Another 2 laparoscopic ports, one 5-mm and one 12-mm in size, are inserted through the gel-cap portion of the GelPort under direct vision; again at the periphery of the gel-cap, forming a triangular relationship with the first port, and each port stays away from the others as far as possible. Then with a grasper in the non-dominant hand, and a cutting device in the dominant hand, the colon is taken down to expose the kidney. Most of the time two straight instruments can be used at the same time, or a grasper with a flexible angled tip and a straight cutting instrument might work better at some situations.

Then the other following procedures are very similar to those of the pure laparoscopic LDN described above. In case of difficulty dissections (e.g.: distended colon obscuring clear visualization of the renal hilum, or some bleeding requiring efficient suction to localize the bleeder), a third 5-mm working port can be inserted through the Gel-cap at a point away from the other ports for a 3rd instrument to provide effective traction or suction. The dilemma of adding the 3rd or more instruments is that although it might provide better operative field, the sword-fighting limited angles of the crowded instruments through the LESS incision might also make smooth progression of the procedures difficult. Hence the decision of how many ports necessary should be evaluated individually.

When the kidney is only attached to the body by the renal pedicles, and the ureter has been transected at its crossing of the iliac vessels, an extra-large EndoCatch II (Covidien) is separately inserted through the gel-cap either directly or through a 15-mm port for retrieving the kidney. The EndoCatch II is opened to "bag" the kidney and its proximal ureter into the retrieval bag while the edge of the bag and the string are still attached to its metallic ring. Thus, the renal pedicles can be tightly tented up by elevating the Endocatch II ring in the air. This significantly opens up the space of the renal vessels with their body attachments (aorta and IVC) and facilitates the ligation of the renal pedicles and ensures long vessel length of the graft. The ligation of the renal artery and the renal vein is performed by applying the laparascopic Endo TA stapler (Covidien), and then the vessels are transected distal to the staple lines with scissors. If there are 2 or more renal arteries, they can be controlled separately by Endo TA staplers, or the smaller artery can ligated with Hem-o-lok or metal clips (at least 2 to 3 clips are necessary). The smaller artery is ligated first to shorten the warm ischemic time of the major portion of the kidney.

At this point, the kidney is totally freed, and the string of the EndoCatch is pulled to detach the retrieval bag from the metallic ring to keep the kidney in the bag, the 2nd layer of the transparent adhesive drape is cut around the external ring of the GelPort, and the gel-cap is released from its base fascial retractor to harvest the kidney easily without squeezing it.

Then the GelPort device is quickly assembled again, and the pneumoperitoneum is re-insufflated for meticulous hemostasis. The pressure of pneumoperitoneum is decreased to 5 mmHg to detect even mild venous or lymphatic oozing. Usually no drain tube is necessary. The GelPort devise is removed, and the wound is closed in a standard fashion.

3.1.2 Pfannenstiel LESS Live Donor Nephrectomy (Andonian et al., 2010a)

This technique is pioneered by Kavoussi et al. Their main benefit is to hide the skin incision line low in the supra-pubic area, instead of via the belly-button. Through a 5-cm Pfannenstiel incision, three 5-mm ports are placed in a triangular manner (2 at the midline [5 cm apart], and 1 at the ipsilateral rectus mucle 5 cm from the inferior port in the midline). A 5 mm flexible-tip laparoscope (EndoEye, Olympus, Japan), along with other long bariatric laparoscopic instruments, is used to perform laparoscopic donor nephrectomy in the fashion similar to the pure laparoscopic LDN. Before ligating the renal hilum, the superior midline trocar is exchanged for a 12-mm trocar to allow for an Endo-GIA stapler. After the kidney is placed in the entrapment sac, the anterior rectus fascia between the 2 midline ports is incised and the kidney is removed. After closure of the fascial defects, the Pfannenstiel incision is closed in a subcuticular manner.

Its initial outcomes are successfully in 6 patients without standard laparoscopic or open conversion; and no additional needlescopic instruments used. The median operative time, median warm ischemia time (5 minutes), and median hospital stay are similar to those of the case-matched standard laparoscopic (SL) approach. Although VAS (visual analog pain scale) scores were lower in the LESS versus SL group at each of post-operative day (POD) #2 (1.5 vs. 4) and discharge (0 vs. 2), this did not reach statistical significance (Andonian et al., 2010b).

3.2 Comments and summary of LESS LDN

The benefit of using the GelPort® as the access platform for the LESS LDN in our series is its feasibility of conversion to a standard multiple-port laparoscopic LDN or even a hand-assisted LDN in case any difficult dissections or significant bleeding occur during the procedure of LESS LDN. This offers an immediate 'exit strategy', because considerable and difficult-to-control bleedings might suddenly happen anytime during the procedure, and endangers the safety of the donor or the function of the graft. No matter what approach of

LDN is performed, cannot the bottom-line principles of ensuring the safety of the live donor and good quality of the kidney harvested be over-emphasized. Only when these 2 basic important principles can be strictly upheld, can we pursue the smaller incision and smoother recovery of the live donors. Thus, during the procedure of LESS LDN the threshold of conversion to a conventional laparoscopic LDN (either pure-laparoscopic or hand-assisted approach) should be kept low to protect the donor and the kidney. In case of a significant bleeding that cannot be adequately secured or a situation that endangers function of the kidney (e.g.: prolonged warm ischemic time), instead of continuing struggles with the LESS approach it is recommended to compress or grasp the bleeder with a grasper, and then add one or more ports outside the LESS platform, or even insert a hand into the operating field to control the situation. Use of a GelPort™ as the LESS platform during LDN gives the flexibility of different degrees of speedy conversions.

Even though there have been multiple reports demonstrating the feasibility of LESS LDN, one important basic question not well-answered so far is how many benefits or disadvantages to the live donors this technique provides in comparison to the conventional laparoscopic LDN. The answer to this question can only be achieved by an adequately powered multi-center prospective randomized comparison using tools designed to detect subtle differences in morbidity and to assess cosmetic satisfaction. The other issue is regarding the cost of the surgery. A recent report by Lunsford et al concludes that Single-site laparoscopic living donor nephrectomy offers comparable perioperative outcomes to conventional laparoscopic living donor nephrectomy at a higher cost. (Lunsford et al., 2011) More reports with detailed economic analyses are required to answer this question.

4. Other renal transplant-related laparoscopic procedures

Besides laparoscopic donor nephrectomy there are other laparoscopic or novel procedures feasible among ESRD patients with a transplant kidney (Fornara et al., 1997). These procedures aim at either problems related to the transplanted kidneys (e.g.: lymphocele, tumor in transplant kidney); or problems related to the native kidneys (e.g.: polycystic kidneys, renal cell carcinomas). Their respective details are described as follows:

4.1 Laparoscopic marsupialization of lymphoceles

Lymphocele development after renal transplantation is a well-recognized possible complication that occurs with the incidence of 0.6-26%. Lymphoceles may originate either from the lymphatic system of the recipient or the transplanted kidney. Before the laparoscopic era, the standard treatment of symptomatic lymphoceles is first puncture aspiration to differentiate between urinoma/lymphocele and to test for bacterial infection; then percutaneous drainage, with or without the injection of sclerosing solution; and finally, open marsupialization if initial approaches fail. With the advent of laparoscopic surgery, laparoscopic approaches to remove an ellipse of peritoneal wall along with the adjacent lymphocele wall, to lyse all internal lymphocele loculations, and even tuck in a piece of omentum by laparoscopic suture allow for the free flow of lymph into the peritoneal cavity and remove the pressure effect of the lymphocele on the transplant kidney, graft ureter, and even venous drainage can be achieved (Parra et al., 1992; Khauli et al., 1992).

There are many caveats in performing such procedure. Several cases of graft ureter transaction have been reported. Thus, pre-operative stenting the graft ureter should be performed whenever possible. (Abou-Elela et al., 2006; Shokeir et al., 1994). Multiple septa and loculations of the lymphoceles might lead to early recurrence or failure of the surgery. Tricks to deal with this circumstance includes transcutaneous staining of the lymphocele lining with methylene blue, and use of intraoperative ultrasonography (Schilling et al., 1995; Matin & Gill, 2001). Other tips for anatomically difficult lymphoceles lateral or inferior to the transplant kidney, which without a common wall between the lymphocele and peritoneal cavities has been reported by placing a cable of 2 internalized peritoneal dialysis catheters between the lymphoceles and the peritoneal cavity for maintaining permanent lymphoperitoneal drainage (Matin & Gill, 2000). Other potential problems associated with laparoscopic marsupialization of lymphoceles consist of injury to other organs (6%), and open conversion (6%) (Atray et al., 2004; Gruessner et al.,1995).

4.2 Laparoscopic nephrectomy for renal cell carcinoma or polycystic kidneys in native kidneys

Laparoscopic nephrectomy has been shown effective in removing diseased kidneys with tumors, even tumors larger than 7-cm in diameter. (Berger et al., 2008; Steinberg et al., 2004) Long-term oncologic outcomes (overall, cancer-specific, and recurrence-free survivals) of laparoscopic radical nephrectomy, either with pure laparoscopic or HAD technique, or with trans-peritoneal or trans-retroperitoneal approach, for renal cell carcinoma (RCC) are comparable to those of its open counterpart, with the obvious benefits of less pain, less blood loss and earlier recuperation (Colombo et al., 2008; Chung et al., 2007; Venkatesh et al., 2007; Desai et al., 2005; Nambirajan et al., 2004).

Patients with ESRD are known to have higher surgical risks (higher American Society of Anesthiologists score, higher comorbidity index, higher incidence of previous abdominal surgery, and higher incidence of hypertension), and yet they also have higher incidence of renal tumors and which does not decrease even after renal transplantation because of maintenance immunosuppression (Chueh SC et al., 2011a; Melchior et al., 2011; Navarro et al., 2008; Tollefson et al., 2010). Laparoscopic radical nephrectomy among this special patient group, even though more challenging and might be associated with slightly longer admission and higher perioperative risks, is well recognized as feasible and safe (Bird et al., 2010). Recently, there was even report of successful LESS radical nephrectomy among these patient groups (Greco et al., 2010; Chueh et al., 2011b).

Technically, laparoscopic radical nephrectomy is similar to that of the previously mentioned LDN, with their main differences depicted are as follows: 1). The sequence/ timing of pedicle ligation: during LDN in order to shorten the warm ischemic time the renal artery and renal vein are ligated right before retrieving the kidney; whereas during radical nephrectomy in order to decrease the chance of tumor cell seeding along the vessels, renal artery and vein are controlled as early as possible and before further mobilization of the whole kidney. 2). The plane of dissection (figure 1a): during LDN peri-renal fat and soft tissues are not necessary and Gerota's fascia is opened to reveal the color and tone of the kidney during the dissection; whereas during radical nephrectomy dissection is made along outside the Gerota's fascia to encompass all the soft tissues around the kidney to ensure enbloc resection. Adrenal gland is spared during LDN but it is excised during radical nephrectomy if the tumor is in the upper pole or no clear plane between the tumor and adrenal gland discerned on the images (Siemer et al., 2004). Abundant soft tissues around the ureter are mandatory during LDN; whereas ureter can be stripped during radical nephrectomy unless urothelial carcinoma is suspected preoperatively. 3). Method of specimen extraction: Some urologists morcellate the kidneys for cancerous renal specimen of radical nephrectomy to achieve key-hole wounds, whereas at least a 5-cm incision needs to be made to harvest the LDN kidney. 4). Laparoscopic setting: during LDN the pressure of the pneumoperitoneum is kept as low as possible (usually around 10-12 mmHg or less) to avoid interfering the renal perfusion and subsequent graft function; whereas during radical nephrectomy a pneumoperitoneum of 15 mmHg is usually employed.

Polycystic kidney disease (PCKD) might lead to ESRD, and renal transplant is a well-known therapy for those patients. Indications for native nephrectomies among those PCKD patients include severe fullness and early satiety, abdominal pain, recurrent urinary tract infections, recurrent hematuria, poorly controlled hypertension, need space for future transplant; and suspicion of malignancy in the enlarged kidneys. Laparoscopic nephrectomy for PCKD kidneys has been shown as a viable alternative of its open counter-part. Either transperitoneal or retroperitoneoscopic approach is feasible. Retroperitoneoscopic approach provides quicker and direct access to the renal hilum, but requires separate port wounds on each side of the body. And many papers reported the use of HAD facilitate the dissection and excision of the diseased PCKD kidneys. When compared to open surgery, the laparoscopic approach results in significantly shorter hospital stay, decreased morbidity and quicker recovery (Rehman et al., 2001; Gill et al., 2001). The use of Vacuum Curettage System (Berkeley VC-10, ACMI, Southborough, MA) to morcellate and aspirate the kidney was reported to provide a significant decrease in the overall size and allow easy extraction through the midline incision (Whitten et al., 2006).

As to when is the best timing to do the surgery, and whether simultaneous bilateral or staged surgery is safer for the patients are still in dispute. Some articles reported 60% complication rate if performed simultaneously, and thus recommend staged operation. Another report mentioned renal transplantation and ipsilateral native PCKD nephrectomy carry no significant additional morbidity compared to that of renal transplantation alone (Ismail et al., 2005; Lucas et al., 2010).

4.3 Laparoscopic nephroureterectomy and bladder cuff eecision for localized urothelial carcinomas in native upper urinary tract

Standard treatment for localized urothelial carcinoma (UC) of the upper urinary tract (UUT) is nephroureterectomy with resection of the ipsilateral distal ureter and bladder cuff. Since Clayman et al. reported in 1991 the initial case of laparoscopic nephroureterectomy (LNU), there have been reports demonstrating that LNU decreases pain and accelerates convalescence of patients (Jarrett et al., 2001). It can be done either with pure laparoscopic approach or with the help of a hand-assisted device (McNeill et al., 2000; Gill et al., 2000; Shalhav et al., 2000; Chen et al., 2001).

Operative technique of a hand-assisted nephroureterectomy (HALNU; Chen et al., 2001): The patient is placed in a 60º oblique position with no change in posture during the entire procedure. The operating table can be rotated from side to side to facilitate exposure during different parts of the surgery. Via a 7-cm lower abdominal Gibson incision, distal ureterectomy with bladder cuff resection was done according to the classic open maneuver. If this is on the side of the transplant kidney cautions need to be exerted to prevent interfering with the transplant ureter. The bladder is closed so that it is watertight with 2-0 absorbable sutures. The end of the distal ureter was double ligated, wrapped with a 4 x 4 gauze, tied up, and left in the retroperitoneum. Then a hand-assisted device (HAD) is set up at this incision, and pneumoperitoneum is insufflated. Two laparoscopic ports are inserted, under the guidance of the intraperitoneal hand and telescope. A 30º telescope is used.

Nephroureterectomy is then performed similarly to those described. The surgeon and the assistant, both facing the patient's abdomen, stand side by side. For a left HALNU, if the surgeon is ambidextrous, he/she inserts his/her right hand intraperitoneally, and operates the laparoscopic instrument with his/her left hand. If he/she is right-handed, the operator's left hand is placed intraperitoneally. For a right HALNU, the surgeon inserts his/her left hand into the HAD. After the colon is taken down, the renal vessels are first identified, dissects, then ligated and transected. An adrenalectomy is performed only when the tumor involved the upper pole parenchyma of the kidney in image studies. Then the kidney and the entire length of the ureter with the surrounding tissues are excised and removed en-bloc from the lower abdomen incision made for the HAD.

4.4 Simultaneous laparoscopic bilateral nephroureterectomy (nephrectomy) without changing body position

The incidence of UC is higher in patients with ESRD, especially in some Asian countries and countries with Balkan Nephropathy and the carcinomas are often multifocal (Liao et al., 2004). When there is UC in either one or both sides of the upper urinary tract in ESRD patients, the treatment of choice usually is simultaneous bilateral nephroureterectomy. Traditionally, open simultaneous bilateral nephroureterectomy is usually done via a long midline incision extending from the xyphoid to the symphysis pubis. To perform unilateral LNU smoothly, the patient has to be positioned at 60º oblique to a full lateral flank position for better exposure and easier dissection because the surrounding organs are displaced downward by gravity (Jarrett et al., 2001; McNeill et al., 2000; Gill et al., 2000; Shalhav et al., 2000). For laparoscopic bilateral nephroureterectomy (LBNU) to be completed in one session with the above-mentioned approach, one needs to do additional position changes to perform the nephroureterectomy on the contralateral side. This is cumbersome and prolongs operation time, and patients need to be re-sterilized and re-draped. The following is an easy and convenient maneuver to facilitate and speed up the operation.

Operative technique (Chueh et al., 2002): Two 6-inch-wide inflatable cuffs (an air tourniquet device originally used for damping blood flow during orthopedic surgery on extremities), one on each side of the back, are placed underneath the patient. The patient is placed in a supine position with his/her chest, shoulders, and thighs loosely secured by straps to the operation table, so that there is some room for the air cuff to lift the patient upwards when it is inflated. And thus the patient would not slide off the table when the table is maximally rotated to its side. Possible pressure-bearing areas (when the table is rotated and the cuff is inflated) like both sides of the thighs, hips, axillae, and shoulders and other bony prominences were well padded with soft gel pads (Action Product, Hagertown, MD, USA) to avoid neuromuscular injuries.

To begin the operation, a 7 cm infra-umbilical midline incision is made for the HAD, and a telescopic port is created immediately supra-umbilically to hide this scar. The operator and the assistant stand on the contra-lateral side of the kidney to be operated first. Then the air cuff on the ipsilateral side of the target kidney is inflated (up to 400 mmHg), and the operation table is rotated completely to the contra-lateral side (facing the operator). This brought the patients into a ~60º oblique position which make dissection of the ipsilateral kidney, ureter, and especially the renal pedicles much easier because the surrounding organs will slide down due to gravity after they are taken down from their original attachments. A 12-mm port was inserted in the ipsilateral abdomen at the midclavicular line slightly higher than the level of the umbilicus. If there is difficulty during dissection, another 5-mm port (optional) can be inserted at the sub-xyphoid midline. For hand-assisted laparoscopic nephroureterectomy (HALNU) on the left side, the surgeon inserts his/her left hand into the HAD, stands caudal to the assistant, and operates the laparoscopic instruments with his/her right hand.

For a right HALNU, if the surgeon is ambidextrous, he/she inserts his/her right hand intraperitoneally, stands caudal to the assistant and operates the laparoscopic instrument with his/her left hand. If he/she is right-handed, the assistant stands caudal to him/her, and the surgeon's left hand is placed intraperitoneally (the main 12-mm working port is moved to the right upper quadrant in this circumstance). The middle to lower ureter is first dissected and ligated (without cutting) with clips distal to the tumor to avoid squeezing tumor cells into the bladder during dissection. Then the hand-assisted laparoscopic nephrectomy is performed similarly to those described. The adrenal gland is not excised unless preoperative studies strongly suggested invasion of the tumor into the upper-pole parenchyma of the kidney. After transecting the renal pedicles and freeing the kidney and upper ureter, the specimen could be placed down to the ipsilateral pelvic cavity for later en bloc removal at the final stage of the surgery.

After completing the first side, the 12-mm working port wound on that side is closed in an air-tight manner, and the table is tilted completely to the other side. The air cuff on the first side is deflated, and insufflation of the cuff underneath the other side of the patient proceeds. The surgical team moves to the other side of the table (the side on which the kidney has been excised), inserts a new 12-mm port, and the nephroureterectomy on the second side is performed similarly. In patients with a functional renal graft, a 5-Fr. ureteral catheter was inserted into the graft ureter cystoscopically before the entire laparoscopic procedure to assist identification and protection of the graft kidney and ureter during later dissection.

After the above-mentioned procedures are done, in order to ensure complete resection of the distal ureter and bladder cuff, the operative table is brought back to a neutral position and both air cuffs are deflated. Traditional bladder cuff resection and bladder closure on both sides are performed in an open fashion through the lower midline wound originally made for the HAD. When a transplant kidney is present, dissection of the native lower ureter stays just medial to the lateral border of the native ureter on that specific side. If difficult dissection is encountered (e.g.: a heavy patient with a deep pelvic cavity and/or a patient with a stage T2-T3 lower ureteral tumor), the wound can be extended further towards the symphysis pubis to provide a clearer operative field, and two complete sets of nephroureterectomy specimens are subsequently brought out of the wound.

An intermediate term (median 35 months) follow-up of a total of 40 patients who were identified to have pathologically confirmed urothelial carcinoma of upper urinary tract, either operated by HALBNU (n=25) or by its open counterpart (OBNU, n=15) revealed that the HALBNU group was associated with less blood loss, earlier bowel recovery, less narcotic use, shorter hospital stay, and earlier convalescence. The operative time and complication rate were comparable between the two groups. There was no open conversion in the HALBNU group. The overall, cancer-specific, and bladder-recurrence-free survival were all equivalent between the HALBNU and OBNU group (Tai et al., 2009).

5. Partial nephrectomy for transplanted kidneys

Development of tumors in renal allograft represents a challenging opportunity to both urologists and transplant surgeons. We report our experience with a recent case and present our innovative approach to this problem.

5.1 Case presentation (Sankari and Chueh, submitted, 2011)

The patient has a simultaneous tumor in the native right kidney and a tumor in the transplanted kidney located in the right lower quadrant. The native right kidney was removed with a transperitoneal laparoscopic approach through an incision over the right lower quadrant. Then transplanted kidney was dissected intraperitoneally via the same incision. This allowed us to reflect the colon and avoid any intraperitoneal injury. The iliac artery above and below the kidney was encircled with vessel loops in case we needed to temporarily occlude the blood inflow. The tumor was located over the lateral mid aspect of the kidney and was intrarenal. Following dissection and exposure of the kidney, the tumor could not be palpated or visually identified. Intraoperative ultrasound was used to locate the tumor and markers was made 1 cm above and below the tumor margin. We believe a zero warm ischemia time is more favorable for kidney function outcome, particularly in solitary kidneys. Resection then proceeded quickly with circumferential resection of the tumor all the way down to the underlying renal sinus. Suturing of the deeper collecting system tissue was performed with 3:0 chromic running suture. Floseal hemastatic agent was used to control the exposed small renal vessels. And cupsular sutures with 2:0 chromic interrupted sutures were done. Blood loss was 300 ml. Resection time was 25 minutes without any warm ischemia time. Kidney function remained unchanged post operatively.

5.2 Comments on partial nephrectomy for transplanted kidneys

Kidney transplant recipients are at increased risk for malignancies (Chueh SC et al., 2011a; Navarro et al., 2008; Tollefson et al., 2010). Development of cancer depends on the duration and type of immunosuppression or association with viral infection. Renal cell carcinoma (RCC) in renal transplant recipients is the most common urologic cancer in both native kidneys and transplanted kidneys (Melchior, et al., 2011). The development of tumors in the renal allograft represents a very challenging task for the urologist and transplant surgeon to treat these malignancies, especially when the allograft kidney is still functioning. The overall incidence of de novo malignancies after renal transplant is 4-5 times higher than that of the general population (Penn I, 1998). Malignancy can arise from unnoticed transmission of tumor cells or metastasis within the graft, or they can originate from the recipient.

Transplanted and native kidneys should be screened for tumors by yearly ultrasound after transplant (Kalble T, et al., 2005). Thus tumors can be diagnosed at an early stage. If a tumor is detected in a functionless native kidney, radical nephrectomy is the treatment of choice. RCC within the renal allograft itself is a less frequent event and accounts for approximately 10% of the cases (Kalble T, et al., 2005; Melchior, et al., 2011; Penn I, 1998). Once RCC in the transplanted kidney is diagnosed, it is crucial to determine the genetic origin of the tumor by means of DNA analysis. Thus the potential transmission of tumor cells to other recipients from the same donor can be assessed (Boix, et al., 2009).

There is no consensus on treatment of RCC in the transplanted kidney. Available treatment options include ablative techniques, nephron sparing surgery and allograft nephrectomy. Nephron sparing surgery in the allograft can be a challenging procedure even for experienced urological surgeons (Chambade, et al., 2008). We applied the same surgical principles for partial nephrectomy in the non-transplant patient.

Modification of the immunosuppressive regimen for renal transplant recipients in whom the tumor developed is a matter of debate. But most centers would recommend adjustment of the medications. The mammalian target of Rapamycin (mTOR) inhibitor which is used to prevent acute rejection after renal transplant does not increase the risk of malignancy

(Campistol, 2009). This is in contrast to calcineurin inhibitors (CNI; tacrolimus and cyclosporine) and antimetabolites (mycophenolic acid and azathioprine). Consideration should be given to switch transplant recipients with RCC to mTOR inhibitor (sirolimus or everolimus) and discontinue CNIs and antimetabolites. Prednisone has no effect on tumor progress and can be continued to provide prophylaxis against renal allograft rejection. mTOR inhibitor is a growth factor inhibitor and will affect wound healing and its use should be delayed till after surgical wounds have healed.

In most cases partial nephrectomy requires temporary occlusion of the renal artery to allow for tumor resection and renal reconstruction in a relatively bloodless field (Uzzo and Novick, 2001). This is supplemented with surface cooling if warm ischemia time is expected to exceed more than 30 minutes. The risk of vascular injury though uncommon remains a potential risk of vascular occlusion (Thompson,et al., 2007). Renal artery occlusion can be avoided during open surgery in selected peripheral renal masses based on the rapidity with which hemostasis and renorraphy is possible. Vascular clamping has the potential to lead to renal ischemia and reperfusion injury which are associated with adverse outcome. Vascular clamping during open partial nephrectomy in patients with solitary kidney was associated with greater risk of renal failure and temporary dialysis than partial nephrectomy without ischemia (Wszolek et al., 2010). Duration of ischemia is found to be the strongest modifiable risk factor for decrease renal function after partial nephrectomy (Lane, et al., 2011).

Libertino described his technique for partial nephrectomy without vascular occlusion essentially achieving a 0-ischemia time (Smith, et al., 2010). The renal vessels are dissected all the way to the level of the intrarenal branches. Both renal arteries and renal veins are secured with vessel loops but not occluded. Hemostasis of the resected parenchyma is achieved with electrocautary for small vessels and suture ligation for large vessel. Pediatric clamps are used to occlude the larger vessels prior to ligation with a figure of eight 4:0 vicryl sutures. Opening in the collecting system is closed with absorbable sutures, and a JJ stent is inserted antegradely as needed. Renal parenchyma is then approximated with absorbable sutures. Throughout the procedure an assistant provides exposure with a Frazier suction tip and a Penfield neurosurgical spatula. The percentage change in estimated GFR was higher in the clamped group; yet, the transfusion rate was higher for the unclamped group.

Partial nephrectomy in transplanted kidney represents a unique opportunity to apply techniques developed in partial nephrectomies for solitary kidneys. Modification of the operation is necessary. Anatomically, the transplanted kidney is encased in a bed of scar tissues. Dissection of the renal hilum is tedious and risks injury to the renal vasculature. The dissection of the kidney is aided by performing the operation intraperitoneally. This will allow avoiding inadvertent injury to the intraabdominal organs. Proximal and distal control of the iliac artery above and below the level of the renal artery anastomosis will allow for temporary occlusion in the event of excessive bleeding. We recommend performing the operation without vascular occlusion if possible to avoid any ischemic injury to the transplant kidney.

6. Conclusions

Implantation of a kidney graft into the extraperotineal iliac fossa has not changed much surgically since its inception from 1950s; whereas the other renal transplant-related surgical approaches have dramatically been updated for the past ten more years, especially with the commencement of urological laparoscopic surgery.

The most important mile-stone advancement is the laparoscopic live donor nephrectomy. Since its original report in 1995, in spite of the initial concerns regarding the quality of the graft function and the safety issue for the live donor, laparoscopic live donor nephrectomy has been recently well recognized academically and practically as the surgery of choice for harvesting live donor kidney; which in fact was driven both by the donors' preference and by the surgeons' competence in performing this surgery. It can be performed either via a pure laparoscopic approach, in which a wound is extended at the end of the procedure to harvest the kidney; or it can also be performed via a hand-assisted approach, in which the graft is harvested from the hand-assisted incision.

More recently a newer variant of the laparoscopic surgery—laparoendoscopic single site (LESS) surgery has been evolved to the field of live donor nephrectomy in certain elite transplant centers. This technique creates a smaller and single incision to accomplish the procedure under the same surgical principles with a much steeper learning curve, and some special equipments are necessary to facilitate such operation. The ultimate value of LESS live donor nephrectomy still warrants further proof with prospective randomized data even though it is surgically feasible.

Besides the donor nephrectomy, laparoscopic surgery has also been applied to a variety of procedures related to the renal transplant recipients. Recurrent lymphoceles resistant to repeated aspiration and drainage can be managed with laparoscopic marsupilization (internal drainage into the peritoneal cavity). Incidence of renal cell carcinomas (RCC) in the native kidneys has been shown higher in the transplant recipients than that of the general population. If the RCC is still localized at diagnosis, it can be treated with laparoscopic radical nephrectomy. In certain areas around the world the incidence of urothelial carcinoma in the native upper urinary tract (ureters, renal pelvis and calyses) has also been reported much higher in the transplant recipients. With proper equipment laparoscopic bilateral nephroureterectomy with bladder cuff resection can be performed in one session through several small incisions without changing the patient's position.

Very rarely, tumor in the transplant kidneys might be found during follow-up. If the graft is still functioning, and the tumor is localized, partial nephrectomy of the transplant kidney can be used to excise the tumor while preserve the graft function.

The surgical procedures of each mentioned above have been detailed in this chapter.

7. References

Abou-Elela, A.; Reyad, I.; Torky, M.; Meshref, A. & Morsi, A. (2006) Laparoscopic marsupialization of postrenal transplantation lymphoceles. *J Endourol.* Vol. 20, No. 11, pp. 904-909.

Andonian, S.; Herati, AS.; Atalla, MA.; Rais-Bahrami, S.; Richstone, L. & Kavoussi, LR. (2010a) Laparoendoscopic single-site pfannenstiel donor nephrectomy. *Urology.* Vol. 75, No. 1, pp. 9-12.

Andonian, S.; Rais-Bahrami, S.; Atalla, MA.; Herati, AS.; Richstone, L. & Kavoussi, LR. (2010b) Laparoendoscopic single-site Pfannenstiel versus standard laparoscopic donor nephrectomy. *J Endourol.* Vol. 24, No. 3, pp. 429-432.

Atray, NK.; Moore, F.; Zaman, F.; Caldito, G.; Abreo, K.; Maley, W.& Zibari, GB. (2004) Post-transplant lymphocele: a single centre experience. *Clin Transplant.* Vol. 18, Suppl. 12, pp. 46-49.

Bachmann, A.; Wyler, S.; Wolff, T.; Gürke, L.; Steiger, J.; Kettelhack, C.; Gasser, TC. & Ruszat, R. (2008) Complications of retroperitoneoscopic living donor nephrectomy: single center experience after 164 cases. *World J Urol.* Vol. 26, No. 6, pp. 549-554.

Bartlett, ST. (2002) Laparoscopic donor nephrectomy after seven years. *Am J Transplant.* Vol. 2, No. 10, pp. 896-897.

Berger, AD.; Kanofsky, JA.; O'Malley, RL.; Hyams, ES.; Chang, C.; Taneja, SS. & Stifelman, MD. (2008) Transperitoneal laparoscopic radical nephrectomy for large (more than 7 cm) renal masses. *Urology.* Vol.71, No. 3, pp. 421-424.

Bird, VG.; Shields, JM.; Aziz, M.; De Los Santos, R.; Ayyathurai, R. & Ciancio, G. (2010) Transperitoneal laparoscopic radical nephrectomy for patients with dialysis-dependent end-stage renal disease: an analysis and comparison of perioperative outcome. *Urology.* Vol. 75, No. 6, pp. 1335-1342.

Boix, R.; Sanz, C.; Mora, M.; Quer, A.; Beyer, K.; Musulen, E.; González, C., Bayona, S.; Saladié, JM. & Ariza, A. (2009) Primary renal cell carcinoma in a transplanted kidney: genetic evidence of recipient origin. *Transplantation* Vol. 87, No. 7, pp. 1057-1061.

Boorjian, S.; Munver, R.; Sosa, RE. & Del Pizzo, JJ. (2004) Right laparoscopic live donor nephrectomy: a single institution experience. *Transplantation.* Vol. 77, No. 3, pp. 437-440.

Boulware, LE.; Ratner, LE.; Sosa, JA.; Tu, AH.; Nagula, S.; Simpkins, CE.; Durant, RW. & Powe, NR. (2002) The general public's concerns about clinical risk in live kidney donation. *Am J Transplant.* Vol. 2, No. 2, pp. 186-193.

Buell, JF.; Abreu, SC.; Hanaway, MJ.; Ng, CS.; Kaouk, JH.; Clippard, M.; Zaki, S.; Goldfarb, DA.; Woodle, ES. & Gill, IS. (2004) Right donor nephrectomy: a comparison of hand-assisted transperitoneal and retroperitoneal laparoscopic approaches. *Transplantation.* Vol. 77, No. 4, pp. 521-525.

Campistol, JM. (2009) Minimizing the risk of posttransplant malignancy. *Transplantation.* Vol. 87, Suppl. 8, S19-22.

Chen, J.; Chueh, SC.; Hsu, WT.; Lai, MK. & Chen, SC. (2001) Modified approach of hand-assisted laparoscopic nephroureterectomy for transitional cell carcinoma of the upper urinary tract. *Urology.* Vol. 58, No. 6, pp. 930-934.

Chueh, S.; Sankari, B.; Chung, SD. & Jones, JS. (2011a) Retroperitoneoscopic laparoendoscopic single site nephrectomy. *Br J Urol Intl* [Epub, in press]

Chueh, SC.; Chen, J.; Hsu, WT.; Hsieh, MH. & Lai, MK. (2002b) Hand assisted laparoscopic bilateral nephroureterectomy in 1 session without repositioning patients is facilitated by alternating inflation cuffs. *J Urol.* Vol. 167, No.1, pp.44-47.

Chueh, SC.; Flechner, S.; Goldfarb, D.; Sankari, B. & Campbell, S. (2011b) Re: Tollefson et al.: Surgical treatment of renal cell carcinoma in the immunocompromised transplant patient (Urology 2010;75:1373-1377). *Urology.* Vol. 77, No. 1, pp. 254-255.

Chueh, SC.; Lai, MK.; Lee, PH. & Chen, J. (2002a) Technical considerations in hand-assisted laparoscopic live donor nephrectomy: initial Taiwan experience from National Taiwan University Hospital. *J Formos Med Assoc.* Vol. 101, No. 1, pp. 76-79.

Chueh, SC.; Wang, SM. & Lai, MK. (2004) Use of Hem-o-lok clips effectively lengthens renal vein during laparoscopic live donor nephrectomy *Transplant Proc.* Vol. 36, No. 9, pp. 2623-2624.

Chung, SD.; Huang, KH.; Lai, MK.; Huang, CY.; Pu, YS.; Yu, HJ. & Chueh, SC. (2007) Long-term follow-up of hand-assisted laparoscopic radical nephrectomy for organ-confined renal cell carcinoma. *Urology.* Vol. 69, No. 4, pp. 652-655.

Clayman, RV.; Kavoussi, LR.; Soper, NJ.; Dierks, SM.; Merety, KS.; Darcy, MD.; Long, SR.; Roemer, FD.; Pingleton, ED. & Thomson PG. (1991) Laparoscopic nephrectomy. *N Engl J Med.* Vol. 324, No. 19, pp. 1370-1371.

Colombo, JR. Jr.; Haber, GP.; Jelovsek, JE.; Lane, B.; Novick, AC. & Gill, IS. (2008) Seven years after laparoscopic radical nephrectomy: oncologic and renal functional outcomes. *Urology.* Vol. 71, No. 6, pp. 1149-1154.

Desai, MM.; Strzempkowski, B.; Matin, SF.; Steinberg, AP.; Ng, C.; Meraney, AM.; Kaouk; JH. & Gill, IS. (2005) Prospective randomized comparison of transperitoneal versus retroperitoneal laparoscopic radical nephrectomy. *J Urol.* Vol. 173, No. 1, pp.38-41.

FDA, 2006 http://www.fda.gov/Safety/Recalls/EnforcementReports/2006/ucm120409.htm

Fornara, P.; Doehn, C.; Fricke, L.; Hoyer, J. & Jocham, D. (1997) Laparoscopy in renal transplant patients. *Urology.* Vol. 49, No. 4, pp. 521-527.

Gill, IS.; Canes, D.; Aron, M.; Haber, GP.; Goldfarb, DA.; Flechner, S.; Desai, MR., Kaouk, JH. & Desai, MM. Single port transumbilical (E-NOTES) donor nephrectomy. *J Urol.* Vol. 180, No. 2, pp. 637-641.

Gill, IS.; Kaouk, JH.; Hobart MG.; Sung, GT.; Schweizer, DK. & Braun, WE. (2001) Laparoscopic bilateral synchronous nephrectomy for autosomal dominant polycystic kidney disease: the initial experience. *J Urol.* Vol. 165, No. 4, pp. 1093-1098.

Gill, IS.; Sung, GT., Hobart, MG.; Savage, SJ.; Meraney, AM.; Schweizer, DK.; Klein, EA. & Novick, AC. (2000) Laparoscopic radical nephroureterectomy for upper tract transitional cell carcinoma: the Cleveland Clinic experience. *J Urol.* Vol. 164, No. 5, pp. 1513-1522.

Gimenez, E.; Leeser, DB.; Wysock, JS.; Charlton, M.; Kapur, S.; Del Pizzo, JJ. (2010) Laparoendoscopic single site live donor nephrectomy: initial experience. *J Urol.* Vol. 184, No. 5, pp. 2049-2053.

Greco, F.; Wagner, S.; Hoda, MR.; Weigand, K.; Inferrera, A. & Fornara, P. (2010) Single-Portal Access Laparoscopic Radical Nephrectomy for Renal Cell Carcinoma in Transplant Patients: The First Experience. *Eur Urol.* 2010 Oct 15. [Epub]

Gruessner, RW.; Fasola, C.; Benedetti, E.; Foshager, MC.; Gruessner, AC.; Matas, AJ.; Najarian, JS. & Goodale, RL. (1995) Laparoscopic drainage of lymphoceles after kidney transplantation: indications and limitations. *Surgery.* ;Vol. 117, No. 3, pp. 288-295.

Hollenbeck, BK.; Seifman, BD. & Wolf, JS. Jr. (2004) Clinical skills acquisition for hand-assisted laparoscopic donor nephrectomy. *J Urol.* Vol. 171, No. 1, pp. 35-39.

Ismai;, HR.; Flechner, SM.; Kaouk, JH.; Derweesh, IH.; Gill, IS.; Modlin, C.; Goldfarb, D. & Novick, AC. (2005) Simultaneous vs. sequential laparoscopic bilateral native nephrectomy and renal transplantation. *Transplantation.* Vol. 80, No. 8, pp. 1124-1127.

Jacobs, SC.; Cho, E.; Foster, C.; Liao, P. & Bartlett, ST. (2004) Laparoscopic donor nephrectomy: the University of Maryland 6-year experience. *J Urol.* Vol. 171, No. 1, pp. 47-51.

Jarrett, TW.; Chan, DY.; Cadeddu, JA. & Kavoussi, LR. (2001) Laparoscopic nephroureterectomy for the treatment of transitional cell carcinoma of the upper urinary tract. *Urology.* Vol. 57, No. 3, pp. 448-453.

Johnson, MW.; Andreoni, K.; McCoy, L.; Scott, L.; Rodegast, B.; Friedman, E.; Thomas, S.; Salm, J.; Gerber, DA. & Fair JH. (2001) Technique of right laparoscopic donor nephrectomy: a single center experience. *Am J Transplant.* Vol. 1, No. 3, pp. 293-295.

Kälble, T; Lucan, M.; Nicita, G.; Sells, R.; Burgos Revilla, FJ.; Wiesel, M. & European Association of Urology. (2005) EAU guidelines on renal transplantation. *Eur Urol.* Vol. 47, No. 2, pp. 156-166.

Kerche, KW.; Heniford, BT.; Matthews, BD.; Smith, TI.; Lincourt, AE.; Hayes, DH.; Eskind, LB.; Irby, PB. & Teigland, CM. (2003) Laparoscopic versus open nephrectomy in 210 consecutive patients: outcomes, cost, and changes in practice patterns. *Surg Endosc.* Vol. 17, No. 12, pp. 1889-1895.

Khauli, RB.; Mosenthal, AC. & Caushaj, PF. (1992) Treatment of lymphocele and lymphatic fistula following renal transplantation by laparoscopic peritoneal window. *J Urol.* Vol. 147, No. 5, pp. 1353-1355.

Kohei, N.; Kazuya, O.; Hirai, T.; Miyauchi, Y.; Iida, S.; Shirakawa, H.; Shimizu, T.; Ishida, H. & Tanabe, K. (2010) Retroperitoneoscopic living donor nephrectomy: experience of 425 cases at a single center. *J Endourol.* Vol. 24, No. 11, pp. 1783-1787.

Lane, BR.; Russo, P.; Uzzo, RG.; Hernandez, AV.; Boorjian, SA.; Thompson, RH.; Fergany, AF.; Love, TE. & Campbell, SC. (2011) Comparision of cold and warm ischemia during partial nephrectomy in 660 solitary kidneys reveals predominant role of nonmodifiable factors in determining ultimate renal function. *J Urol.* Vol. 185, No. 2, pp. 421-427.

Leventhal, JR.; Kocak, B.; Salvalaggio, PR.; Koffron, AJ.; Baker, TB.; Kaufman, DB.; Fryer, JP.; Abecassis, MM. & Stuart, FP. (2004) Laparoscopic donor nephrectomy 1997 to 2003: lessons learned with 500 cases at a single institution. *Surgery.* Vol. 136, No. 4, pp. 881-890.

Leventhal, JR.; Paunescu, S.; Baker, TB.; Caciedo, JC.; Kocak, B.; Gallon, L.; Friedewald, J.; Luo, X.; Kaufman, DB.; Fryer, JP. & Abecassis, MM. (2010) A decade of minimally invasive donation: experience with more than 1200 laparoscopic donor nephrectomies at a single institution. *Clin Transplant.* Vol. 24, No. 2, pp. 169-174.

Liao, CH.; Chueh, SC.; Lai, MK. & Chen, J. (2004) Transitional cell carcinoma in renal transplant recipients. *Transplant Proc.* Vol. 36, No. 7, pp. 2152-2153.

Lucas, SM.; Mofunanya, TC.; Goggins, WC. & Sundaram, CP. (2010) Staged nephrectomy versus bilateral laparoscopic nephrectomy in patients with autosomal dominant polycystic kidney disease. *J Urol.* Vol. 184, No. 5, pp. 2054-2059.

Lunsford, KE.; Harris, MT.; Nicoll, KN.; Collins, BH.; Sudan, DL.; Kuo, PC. & Vikraman, D. (2011) Single-Site Laparoscopic Living Donor Nephrectomy Offers Comparable Perioperative Outcomes to Conventional Laparoscopic Living Donor Nephrectomy at a Higher Cost. *Transplantation.* Vol. 91, No. 2, pp. e16-17.

Matin, SF. & Gill, IS. (2000) Laparoscopic marsupialization of the difficult lymphocele using internalized peritoneal dialysis catheter. *J Urol.* Vol. 163, No. 5, pp. 1498-1500.

Matin, SF. & Gill, IS. (2001) Laparoscopic ultrasonography. *J Endourol.* Vol. 15, No. 1, pp. 87-92.

McNeill, SA.; Chrisofos, M. & Tolley, DA. (2000) The long-term outcome after laparoscopic nephroureterectomy: a comparison with open nephroureterectomy. *Br J Urol Intl.* Vol. 86, No. 6, pp. 619-623.

Melchior, S.; Franzaring, L.; Shardan, A.; Schwenke, C.; Plümpe, A.; Schnell, R. & Dreikorn, K. (2011) Urological de novo malignancy after kidney transplantation: a case for the urologist. *J Urol.* Vol. 185, No. 2, pp. 428-432.

Mjøen, G.; Holdaas, H.; Pfeffer, P.; Line, PD. & Øyen, O. (2010) Minimally invasive living donor nephrectomy - introduction of hand-assistance. *Transpl Int.* Vol. 23, No. 10, pp. 1008-1014.

Nambirajan, T.; Jeschke, S.; Al-Zahrani, H.; Vrabec, G.; Leeb, K. & Janetschek, G. (2004) Prospective, randomized controlled study: transperitoneal laparoscopic versus retroperitoneoscopic radical nephrectomy. *Urology.* Vol. 64, No. 5, pp. 919-924.

Navarro, MD.; Lopez-Andreu, M.; Rodriguez-Benot, A.; Agüera, ML.; Del Castillo, D. & Aljama, P. (2008) Cancer incidence and survival in kidney transplant patients. *Transplant Proc.* Vol. 40, No. 9, 2936-2940.

OPTN, (2006) http://optn.transplant.hrsa.gov/ContentDocuments/Guidance_ProgramSpecificLivingKidneyDonorMedEvalProtocols.pdf

Parra, RO.; Jones, JP. & Hagood, PG. (1992) Laparoscopic intraperitoneal marsupialization: report on a new treatment for lymphoceles. *Surg Laparosc Endosc.* Vol. 2, No. 4, pp. 306-311.

Penn, I. (1998) Occurrence of cancers in immunosuppressed organ transplant recipients. *Clin Transpl*. 147-158.

Ponsky, L.; Cherullo, E.; Moinzadeh, A.; Desai, M.; Kaouk, J.; Haber, GP.; Chen, D.; Ng, C.; Fuchs, G.; Singh, D.; Finelli, A.; Frank, I. & Matin, S. (2008) The Hem-o-lok clip is safe for laparoscopic nephrectomy: a multi-institutional review. *Urology.* Vol. 71, No. 4, pp. 593-596.

Ratner, LE.; Ciseck, LJ.; Moore, RG.; Cigarroa, FG.; Kaufman, HS. & Kavoussi, LR. (1995) Laparoscopic live donor nephrectomy. *Transplantation.* Vol. 60, No. 9, pp. 1047-1049.

Rehman, J.; Landman, J.; Andreoni, C.; McDougall, EM. & Clayman, RV. (2001) Laparoscopic bilateral hand assisted nephrectomy for autosomal dominant polycystic kidney disease: initial experience. *J Urol.* Vol. 166, No. 1, pp. 42-47.

Schilling, M.; Abendroth, D. & Kunz, R. (1995) Treatment of lymphocele in renal transplant recipients by laparoscopic fenestration after transcutaneous staining. *Br J Surg.* Vol. 82, No. 2, pp. 246-248.

Shalhav, AL.; Dunn, MD.; Portis, AJ.; Elbahnasy, AM; McDougall, EM. & Clayman, RV. (2000) Laparoscopic nephroureterectomy for upper tract transitional cell cancer: the Washington University experience. *J Urol.* Vol. 163, No. 4, pp. 1100-1104.

Shokeir, AA.; Eraky, I.; el-Kappany, H. & Ghoneim, MA. (1994) Accidental division of the transplanted ureter during laparoscopic drainage of lymphocele. *J Urol.* Vol. 151, No. 6, pp. 1623-1625.

Siemer, S.; Lehmann, J.; Kamradt, J.; Loch, T.; Remberger, K.; Humke, U.; Ziegler, M. & Stockle, M. (2004) Adrenal metastases in 1635 patients with renal cell carcinoma: outcome and indication for adrenalectomy. *J Urol.* Vol. 171, (6 Pt 1), pp. 2155-2159, discussion 2159.

Smith, GL.; Kenney, PA.; Lee, Y. & Libertino, JA. (2010) Non-clamped partial nephrectomy: techniques and surgical outcomes. *Br J Urol. Intl.* online publication Oct 29, 2010. doi:10.1111/j.1464-410X.2010.09798.x[Epub ahead of print]

Steinberg, AP.; Finelli, A.; Desai, MM.; Abreu, SC.; Ramani, AP.; Spaliviero, M; Rybicki, L.; Kaouk, J.; Novick, AC. & Gill, IS. (2004) Laparoscopic radical nephrectomy for large (greater than 7 cm, t2) renal tumors. *J Urol.* Vol. 172, (6 Pt 1), pp. 2172-2176.

Su, LM.; Ratner, LE, Montgomery, RA.; Jarrett, TW.; Trock, BJ.; Sinkov, V.; Bluebond-Langner, R. & Kavoussi, LR. (2004) Laparoscopic live donor nephrectomy: trends in donor and recipient morbidity following 381 consecutive cases. *Ann Surg.* Vol. 240, No. 2, pp. 358-363.

Sundqvist, P.; Feuk, U.; Haggman, M.; Persson, AE.; Stridsberg, M. & Wadstrom, J. (2004) Hand-assisted retroperitoneoscopic live donor nephrectomy in comparison to open and laparoscopic procedures: a prospective study on donor morbidity and kidney function. *Transplantation.* Vol. 78, No. 1, pp. 147-153.

Tai, HC.; Lai, MK.; Chung, SD.; Huang, KH.; Chueh, SC. & Yu, HJ. (2009) Intermediate-term oncological outcomes of hand-assisted laparoscopic versus open bilateral nephroureterectomy for dialysis and kidney transplant patients with upper urinary tract urothelial carcinoma. *J Endourol.* Vol. 23, No. 7, pp.1139-1144.

Tanabe, K.; Miyamoto, N.; Tokumoto, T.; Yamamoto, H.; Ishida, H.; Kondo, T.; Okuda, H.; Shinmmura, H.; Shirakawa, H.; Shimizu, T.; Ishikawa, N. & Toma, H. (2005) Retroperitoneoscopic live donor nephrectomy: extended experience in a single center. *Am J Transplant.* Vol. 5, (4 Pt 1), pp. 739-745.

Thompson, RH.; Frank, I.; Lohse, CM.; Saad, IR.; Fergany, A.; Zincke, H.; Leibovich, BC.; Blute, ML. & Novick, AC. (2007) The impact of ischemia time during open nephron sparing surgery on solitary kidneys: a multi-institutional study. *J Urol*. Vol. 177, No. 2, 471-476.

Tollefson, MK.; Krambeck, AE.; Leibovich, BC.; Blute, ML. & Chow, GK. (2010) Surgical treatment of renal cell carcinoma in the immunocompromised transplant patient *Urology* Vol. 75, No. 6, pp. 1373-1377.

Tooher, RL.; Rao, MM.; Scott, DF.; Wall, DR.; Francis, DM; Bridgewater, FH. & Maddern, GJ. (2004) A systematic review of laparoscopic live-donor nephrectomy. *Transplantation.* Vol. 78, No. 3, pp. 404-414.

Troppmann, C.; Ormond, DB. & Perez, RV. (2003) Laparoscopic (vs open) live donor nephrectomy: a UNOS database analysis of early graft function and survival. *Am J Transplant.* Vol. 3, No. 10, pp. 1295-1301.

UNOS, 2009, http://www.unos.org/docs/Living_Donation.pdf

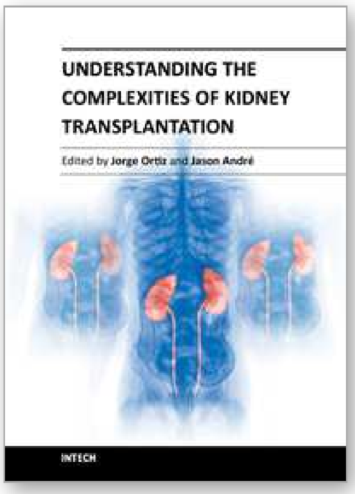
Uzzo, R. & Novick, AC. (2001) Nephron-sparing surgery for renal tumors. Indications, techniques and outcomes. *J Urol*. Vol. 166, No. 1, pp. 6-18.

Velidedeoglu, E.; Williams, N.; Brayman, KL.; Desai, NM.; Campos, L.; Palanjian, M.; Wocjik, M.; Bloom, R.; Grossman, RA.; Mange, K.; Barker, CF.; Naji, A. & Markmann, JF. (2002) Comparison of open, laparoscopic, and hand-assisted approaches to live-donor nephrectomy. *Transplantation.* Vol. 74, No. 2, pp. 169-72.

Venkatesh, R.; Belani, JS.; Chen, C.; Sundaram, CP.; Bhayani, SB.; Figenshau, RS. & Landman, J. (2007) Prospective randomized comparison of laparoscopic and hand-assisted laparoscopic radical nephrectomy. *Urology.* Vol. 70, No. 5, pp. 873-877.

Whitten, MG.; Van der Werf, W. & Belnap, L. (2006) A novel approach to bilateral hand-assisted laparoscopic nephrectomy for autosomal dominant polycystic kidney disease. *Surg Endosc.* Vol. 20, No. 4, pp. 679-684.

Wszolek, MF.; Kenney, PA.; Lee, Y. & Libertino, JA. (2010) Comparison of hilar clamping and non-hilar clamping partial nephrectomy for tumours involving a solitary kidney. *Br. J Urol. Intl.* 2010 Nov 11. doi: 10.1111/j.1464-410X.2010.09713.x. [Epub ahead of print]



Understanding the Complexities of Kidney Transplantation

Edited by Prof. Jorge Ortiz

ISBN 978-953-307-819-9

Hard cover, 564 pages

Publisher InTech

Published online 06, September, 2011

Published in print edition September, 2011

Kidney transplantation is a complex field that incorporates several different specialties to manage the transplant patient. This book was created because of the importance of kidney transplantation. This volume focuses on the complexities of the transplant patient. In particular, there is a focus on the comorbidities and special considerations for a transplant patient and how they affect kidney transplant outcomes. Contributors to this book are from all over the world and are experts in their individual fields. They were all individually approached to add a chapter to this book and with their efforts this book was formed. Understanding the Complexities of Kidney Transplantation gives the reader an excellent foundation to build upon to truly understand kidney transplantation.