Dokkyo Journal of Medical Sciences
48(2) : 57 ～ 64, 2021

Original

Impact of Retroperitoneoscopic Living Donor Nephrectomy at a Single Center

Tadahiko Tokumoto, Kiyoshi Setoguchi, Yoji Hyodo, Akiyoshi Osaka, Toshiyuki Iwahata, Yasuyuki Inoue, Hiroshi Okada, and Kazutaka Saito

Department of Urology, Dokkyo Medical University Saitama Medical Center, 2-1-50 Minamikoshigaya, Koshigaya, Saitama 353-8555, Japan

No funding was received for this work.

SUMMARY

Laparoscopic living donor nephrectomy (LDN) has become a standard procedure, and transperitoneal LDN is now performed at many centers. Since 2001, we have been developing a retroperitoneoscopic living donor nephrectomy (RPLDN) technique that allows LDN to be performed by a direct retroperitoneal approach that does not interfere with the abdominal organs. In this study, we examined the operating time, blood loss, total and warm ischemic times (TIT, WIT), length of stay, number and length of renal arteries and vessels, graft function, and complications in 54 kidney donors (19 men, 35 women ; mean age 57.1±11.8 years) who underwent living donor kidney transplantation with allografts obtained by RPLDN. Mean follow-up was 16.8 months. Donor nephrectomy was successful in all patients. Fifteen kidneys had ≥2 renal arteries. The complication rate was 5.6%. There were no serious complications. Ureteral complications occurred in four recipients, who were successfully treated by retrograde ureteral stent placement. Mean TIT was 87.7 min and mean WIT was 4.7 min. Mean serum creatinine levels in recipients were 3.5, l.5, and 1.4 mg/dL on postoperative days 1, 7, and 14, respectively. Slow graft function was noted in four cases (7.4%), which normalized within 2 weeks of surgery. One-year donor survival was 100% and 1-year graft survival was 98.1%. All RPLDNs were well tolerated and the impact on recipient graft function was excellent. RPLDN could be an option for LDN.

Key Words : laparoscopic living donor nephrectomy (LDN), living donor kidney transplantation, retroperitoneoscopic living donor nephrectomy (RPLDN)

INTRODUCTION

The first laparoscopic living donor nephrectomy (LDN) was reported by Ratner et al. in 1995[1]. Since then, LDN has been gaining acceptance in many countries. In Japan, although there has been no increase in the number of cadaveric kidneys available for transplantation, the number of living renal transplants being performed has been increasing year by year according to the Japanese Society for Clinical Renal

Received March 22, 2021 ; accepted April 8, 2021
Reprint requests to : Professor Tadahiko Tokumoto
Department of Urology, Dokkyo Medical University Saitama Medical Center, 2-1-50 Minamikoshigaya, Koshigaya, Saitama 353-8555, Japan

Transplantation[2]. Laparoscopic procurement is of benefit to living kidney donors, and the recent outcomes of LDN seem to be much better than in earlier reports ; however, the procedure remains challenging, even for the most experienced laparoscopists[3,4].

The transperitoneal route is the most common approach because it provides an adequate working space and allows easy dissection. Transperitoneal LDN is now used in many centers[3~7]. However, retroperitoneal access has the further advantage of approaching the kidney directly without interfering with other organs in the abdominal cavity. In 2001, we started development of a retroperitoneoscopic living donor nephrectomy (RPLDN) technique, and in 2004 and 2005 reported our initial experience with this procedure[8,9]. When the case numbers had increased further, we published another report on RPLDN[10]. In the present study, we retrospectively reviewed the experience of RPLDN at Dokkyo Medical University Saitama Medical Center to determine its efficacy and safety, in particular complication and graft survival rates.

MATERIALS AND METHODS

This study has been approved by the Bioethics Committee of Dokkyo Medical University Saitama Medical Center under approval number ; Koshigaya 29016.

Donors

This study retrospectively reviewed consecutive case of 54 of kidney donors (19 men, 35 women) from whom living donor kidney grafts were obtained by RPLDN between December 2017 to February 2021. The demographics and clinical and surgical characteristics of these donors are shown in Table 1. Left RPLDN is performed preferentially over right RPLDN because of the longer left renal vein which facilitates implantation. However, although the shorter right vein can cause problems, there are cases where right RPLDN is indicated for a variety of reasons, including renal cysts, a poorly functioning right kidney, and renal artery aneurysm. One donor (1.9%) underwent right nephrectomy because the right kidney was significantly smaller than the left kidney. The presence of multiple renal vessels or obesity did not preclude use of the retroperitoneoscopic approach. Mean donor age was 57.1 (range 32–79) years. Mean body mass index (calculated as kg/m^2) was 24.1 (range 15.5–32.0). Renal imaging studies were performed, including intravenous urography and three-dimensional computed tomography. Volumetry of the left and right kidneys was also examined on computed tomography scans (data not shown). All donors were relatives of the recipients and included spouses, siblings, parents, grandparents, and sons or daughters.

Recipients

The recipient characteristics are shown in Table 1. Mean recipient age was 50 (range 27–74) years. Nineteen recipients underwent ABO-incompatible renal transplantation. All recipients received a triple-drug immunosuppressive protocol (tacrolimus, mycophenolate mofetil, and methylprednisolone) starting 1 week before transplantation. Briefly, tacrolimus was administered at an initial dose of 0.15 mg/kg/day, and then adjusted to maintain a whole-blood trough level of 8–12 ng/mL for 1–2 months postoperatively and 7–9 ng/mL thereafter. Mycophenolate mofetil was administered at an initial dose of 2000 mg/day and then decreased to 1000–1500 mg/day 1 month postoperatively. Methylprednisolone was administered at an initial dose of 20 mg/day, which was increased to 500 mg/day on the day of surgery and then gradually decreased to 6–8 mg/day within 1–2 months of transplantation. Basiliximab (an anti-interleukin-2 receptor blocker) was administered at a dose of 20 mg/day at the time of transplantation and on postoperative day 4. A protocol that included double-filtration plasmapheresis and injection of low-dose rituximab (200 mg/body weight) before transplantation was implemented in all patients. The dosage of rituximab was 200 mg/body.

RPLDN technique

The patient was placed in the lateral decubitus position on a flat operating table. In most cases, three retroperitoneoscopic ports were inserted. However, four ports were sometimes used for a right-sided procedure. A retroperitoneal working space was developed with a balloon dilator (PDB 1000, Tyco Healthcare, Norwalk, CT, USA). The first 12-mm port

Table 1 Patient demographics and clinical and surgical characteristics

Variables	54
Donor age (years), mean ± SD (range)	57.1 ± 11.8 (32–78)
Donor sex (male/female)	19/35
Recipient age (years), mean ± SD (range)	50.0 ± 11.3 (27–74)
Recipient sex (male/female)	35/19
ABO incompatibility (yes/no)	19/35
Donor BMI, mean ± SD (range)	24.1 ± 3.8 (15.5–32.0)
Site of nephrectomy (left/right)	53/1
Donor abdominal surgical history	9 (16.7%)
Preemptive renal transplantation	34 (63.0%)
Blood relationship (yes/no)	26/28
Surgical data	
Renal arteries, n (%)	
1	39 (72.2)
2	14 (25.9)
3	1 (1.9)
Renal veins, n (%)	
1	52 (96.3)
2	1 (1.9)
3	1 (1.9)
Length of renal artery (mm), mean ± SD (range)	
First	25.4 ± 6.7 (12–47)
Second	26.5 ± 7.6 (20–43)
Third	30 (30)
Length of renal vein (mm), mean ± SD (range)	
First	25.9 ± 5.3 (14–39)
Second	14.0 ± 5.7 (10–18)
Third	15 (15)
Graft weight (g), mean ± SD (range)	195 ± 74 (122–552)
Operating time (min), mean ± SD (range)	215 ± 40 (154–354)
TIT (min), mean ± SD (range)	87.7 ± 27.8 (53–197)
WIT (min), mean ± SD (range)	4.7 ± 1.4 (2.2–8.1)
First urine (min), mean ± SD (range)	3.5 ± 2.9 (0.8–18.9)
Mean estimated blood loss (mL) (range)	20 (2–200)
CO_2 pressure (mmHg), mean ± SD (range)	8.2 ± 1.4 (6–12)
Hospital stay (days), mean ± SD (range)	7.6 ± 1.3 (5–12)

BMI, body mass index ; RPLDN, retroperitoneoscopic living donor nephrectomy ; SD, standard deviation ; TIT, total ischemic time ; WIT, warm ischemic time.

(Blunt Tip Trocar, Tyco Healthcare, Norwalk, CT, USA) was inserted into the axillary line between the iliac crest and the 12th rib and used as a camera port. The second 12-mm port (Versaport™ V2 5–12 mm, Tyco Healthcare, Norwalk, CT, USA) was inserted at the angle of the 12th rib and the lateral margin of the muscle. The third port was inserted 3 cm above the anterior spine of the iliac bone. A 10-mm flexible fiberscope (Olympus, Tokyo, Japan) was used and held by an assistant during the procedure.

The retroperitoneal space was insufflated to a pressure of 5–10 mmHg. The kidney and ureter were dissected retroperitoneally. The renal artery was identified from the posterior aspect and freed carefully from the surrounding lymphatic and fatty tissues using an ultrasonic knife or vessel sealing system. The renal vein was also identified, and the gonadal and lumbar veins were dissected. A GIA vascular stapler (Tyco Healthcare, Norwalk, CT, USA) was used for gonadal or lumbar veins that were more than

7 mm in diameter. Next, the kidney was dissected between the perinephric fat and the fibrous capsule of the kidney. The fatty tissue of the renal hilum was dissected and severed using the ultrasonic knife or vessel sealing system ; however, the hilum was not completely freed to prevent renal lymphocele and thermal injury to the renal vessels. The ureter was dissected carefully to avoid damage to its feeding arteries and veins. The ureter was transected after clipping at the level around the bifurcation of the common iliac artery.

In all cases, just before transection of the renal arteries and veins, a 5-cm Pfannenstiel incision was made, and an anterior vesical space (Retzius cavity) was created by finger dissection. The Pfannenstiel incision is more cosmetically acceptable than the standard flank incision. The incision was closed using a Lapdisc® (Ethicon Endosurgery, Cincinnati, OH, USA) to maintain the pneumoretroperitoneum. The hand-assisted method was not used in any of the cases.

An Endocatch™ II (US Surgical, Norwalk, CT, USA) was inserted through the incision and was placed under the kidney. A vessel clip was placed temporarily at the renal artery before transection to avoid accidental bleeding, which could result from malfunction of a GIA vascular stapler. Next, the renal artery and vein were severed sequentially using the GIA vascular stapler. The kidney was then placed in the bag and extracted via the Pfannenstiel incision. The specimen was immediately placed on ice and perfused with Eurocollins solution KCC® (KYOWA Criti-Care Co.,Ltd. Tokyo, Japan) at 4℃. From the outset, we have not used an indwelling drain if possible when performing this procedure.

Recipient surgery

A standard renal transplant technique was used in all patients. The renal artery was anastomosed to the external iliac, internal iliac, common iliac, or hypogastric artery and the renal vein was anastomosed to the external or common iliac vein. In cases where the graft had ≥2 renal arteries, the arteries were reconstructed on the back table. The ureter was implanted into the bladder using the Lich-Gregoir technique[11].

Table 2 Complications in retroperitoneoscopic living donors

Complication	N = 54
Conversion to open procedure	0
Intraoperative hemorrhage (>500 g)	0
Adrenal bleeding	0
Renal capsular injury	1
Postoperative hemorrhage	0
Blood transfusion	0
Pulmonary embolism	0
Atelectasis	0
Pneumothorax	0
Subcutaneous emphysema	1
Mediastinal emphysema	0
Rhabdomyolysis	0
Bowel complications	0
Ureteral complications	1
Wound infection	0
Total, n (%)	3 (5.6)

RESULTS

Mean follow-up duration was 16.8 months. Donor nephrectomy was performed successfully in all cases. No donor procedure required conversion to open nephrectomy. Mean graft weight was 195 g. One donor (1.9%) underwent right nephrectomy. Mean operating time was 215 min with a mean estimated blood loss of 20 g. Mean warm ischemic times (WIT) was 4.7 min. Mean CO_2 gas pressure during the procedure was 8.2±1.4 mm Hg. The postoperative hospital stay was 7.6±1.3 days. The average length of first, second, and third renal arteries was 25.4 mm, 26.5 mm, and 30 mm, respectively ; the respective mean lengths for first, second, and third renal veins were 25.9 mm, 14.0 mm, and 15.0 mm (Table 1).

The overall donor complication rate was 5.6% (Table 2). No serious complications, such as massive bleeding or bowel injury, were encountered. No patient experienced postoperative hemorrhage. No donor required blood transfusion after RPLDN. A ureteral injury occurred in one patient (1.9%), who was managed successfully without any sequelae. None of the donors required readmission. Fifteen donors (27.8 %) had ≥2renal arteries and renal artery aneurysm that needed arterial reconstruction on the back table (Table 1).

Table 3 Transplanted graft function

Variable	N=54
1-year recipient survival, n (%)	54 (100)
1-year graft survival, n (%)	53 (98.1)
Slow graft function, n (%)	4 (7.4)
Delayed graft function, n (%)	2 (3.7)
Acute rejection, n (%)	4 (7.4)
Postoperative mean serum creatinine (mg/dL)	
1 day	3.5±1.5
4 days	1.5±0.8
7 days	1.4±0.6
14 days	1.4±0.5
1 month	1.4±0.5
12 months	1.4±0.5

Slow graft function : serum creatinine level>3.0 mg/dL at 4 days after transplantation.
Delayed graft function : hemodialysis required after transplantation owing to tubular necrosis.

The postoperative donor survival rate was 100% at 1 year, 100% at 2 years, and 100% at 3 years (Table 3). Mean post-transplant serum creatinine levels in the recipients was 3.5 mg/dL, 1.5 mg/dL, 1.4 mg/dL, and 1.4 mg/dL on days 1, 4, 7, and 14 after transplantation, respectively. Graft function was good and stable after 1 month. Four patients (7.4%) showed relatively slow graft function, defined as a serum creatinine level>3.0 mg/dL on day 4 after surgery but there were no rejection episodes. One patient (1.9 %) required hemodialysis for acute tubular necrosis after transplantation. Thus far, one graft has been lost because of acute rejection. The graft survival rate was 98.1% at 1 year.

DISCUSSION

Recent advances in surgical techniques, immunosuppressive therapy, and post-transplant monitoring have led to an impressive increase in patient and allograft survival[12,13]. There has been considerable improvement in the surgical techniques used to perform LDN since the first procedure was reported, with many further refinements made to improve the safety outcomes for donors and recipients[14,15]. Many authors have shown that laparoscopic nephrectomy results in less postoperative pain, a shorter hospital stay, a more rapid return to work, and higher donation rates when compared with conventional open nephrectomy[14,16]. According to these reports, LDN has become a new standard for kidney harvesting.

In 2004 and 2005, we reported our initial experience of RPLDN at a single center[8,9]. The present study retrospectively reviews the single-center experience of RPLDN at a different institution, Dokkyo Medical University Saitama Medical Center, and evaluates its efficacy and safety, particularly with regard to complications and graft survival.

In a study that included 1200 patients, Leventhal et al.[17] reported an overall complication rate of 4.2%, including 7 conversions to laparotomy and a readmission rate of 1.2% for management of complications. In our present study, the complication rate was 5.6%. However, no donor required readmission, and there were no serious complications, such as massive bleeding or intestinal injury. Furthermore, no patient had postoperative bleeding, no donor required a blood transfusion after RPLDN, no case required conversion to open donor nephrectomy during RPLDN, and no donor had a blood transfusion after RPLDN because of a mean estimated blood loss of 20 g. These results indicate that RPLDN is performed safely in our department.

In this study, 15 (27.8%) of the grafts had ≥2 renal arteries and required arterial revascularization on the back table. Fortunately, all anastomotic techniques for arterial reconstruction used in our department resulted in good renal transplant function perioperatively. Kohei et al.[11] similarly reported that 25.4% of 425 RPLDN procedures involved grafts that contained ≥2 renal arteries. This high incidence of multiple renal arteries is thought to be a consequence of using the retroperitoneal approach, which allows small arteries to be identified easily at the time of surgery. Furthermore, recent advances in vascular surgery and techniques used for anastomosis in kidney transplantation have made it possible to revascularize such kidneys for living donor kidney transplantation[18]. However, our experience is that revascularization of ≥2 renal arteries contribute to a prolonged operating time and an increased total ischemic time (TIT).

In this study, the average length of the main renal vein in the graft was 2.5 cm, and there were no cases with a length<1.0 cm. In our department, we harvest the longest possible renal vein to ensure safe donor

retroperitoneoscopic renal harvesting. Han et al.[19] reported that donor kidneys with unusually short renal veins, which may result in unavoidable tension during renal vein anastomosis, may be modified by renal vein extension, thereby facilitating a secure anastomosis and reducing postoperative complications.

The operating time in this study was longer than that in recent reports[20~22]. There are several possible explanations for this finding. Most of the recent cases were performed by young doctors under the direct supervision of experienced laparoscopic surgeons. However, in difficult cases, such as those involving severe adhesions or complex vessels, the supervising laparoscopic surgeon took over from the surgical trainee and performed the procedure. The United Network of Organ Sharing (UNOS) requires the surgeon or assistant to have performed 15 living donor nephrectomies to be certified as the primary surgeon. Raque et al.[23] examined the relevant literature and reported the learning curve for living donor nephrectomy to be approximately 35 cases, which is more than twice the number recommended by UNOS. Thus, the RPLDN technique requires a long learning period. Therefore, academic institutions should provide intraoperative education so that junior surgeons have the opportunity to learn this technique.

In our study, mean TIT was 87.7 min, mean WIT was 4.7 min, and graft function was 98.1% at 1 year. Mean post-transplant serum creatinine levels in recipients were respectively 3.5 mg/dL, 1.5 mg/dL, 1.4 mg/dL, and 1.4 mg/dL on days 1, 4, 7, and 14 after transplantation. Graft function was good and stable after 1 month (Table 3). Canes et al.[24] found a positive correlation between the WIT and the post-transplant serum creatinine level on days 2 and 3 post-transplant, but this effect was not seen on days 7 and 14. Our results similarly suggest that graft function after day 7 seems to be influenced by various factors, including graft weight, donor renal function, and nephrotoxic substances. At 1 year, the postoperative donor survival rate was 100% and the graft survival rate was 98.1%. These results are comparable with those reported for other facilities[5,9,10,24].

RPLDN does not need high pressures to expand the retroperitoneal space. In our study, mean CO_2 pressure was 8.2 mmHg. Recently, we have been using 6–7 mmHg, which is a much lower pressure than the 15 mmHg reported for the transperitoneal approach[25,26]. High pressure pneumoperitoneum can cause subcapsular cortical damage[26].

In this study, the postoperative hospital stay was 7.6±1.3 days, which seems to be longer than that reported in the US[3,4,21]. However, this finding may reflect the fact that patients in Japan tend to stay in hospital until they have fully recovered because medical care is essentially free. Furthermore, the present era of SARS-CoV-2 (COVID-19) infection requires hospitalization for 4 days before transplantation.

Based on our experience, we believe that RPLDN is the safest and most beneficial surgical method for kidney donors because it allows easy and careful access to the renal surface and reduces the risk of injury to intra-abdominal organs, such as the intestines.

In conclusion, we have found that RPLDN procedures are well tolerated with minimal complication rates and have an excellent impact on recipient graft function. The findings of this study suggest that RPLDN could be a feasible option for LDN.

Disclosure Statement

None declared.

Author Contributions

TT wrote the final design of the study and manuscript. TT, KS, YH, AO, TI and YI collected patients' data. TT, KS, YH, HO and KS were involved in study design and data interpretation. TT, KS, YH, HO and KS were involved in the data analysis. All authors critically revised the manuscript, approved the manuscript to be published, and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part the work are appropriately investigated and resolved.

REFERENCES

1) Ratner LE, Ciseck LJ, Moore RG, et al : Laparoscopic live donor nephrectomy. Transplantation **60** : 1047–1049, 1995.

2) Yagisawa T, Mieno Y, Ichimaru N, et al : Annual Progress Report from the Japanese Renal Transplant Registry : Number of Renal Transplantations in 2018 and Follow-up Survey. Journal of Japanese Society

for Clinical Renal Transplantation **54** : 61–80, 2019.
3) Su LM, Ratner LE, Montgomery RA, et al : Laparoscopic live donor nephrectomy : Trends in donor and recipient morbidity following 381 consecutive cases. Ann Surg **240** : 358–363, 2004.
4) Rawlins MC, Hefty TL, Brown SL, et al : Learning laparoscopic donor nephrectomy safely. A report on 100 cases. Arch Surg **137** : 531–535, 2002.
5) Hirose T, Hotta K, Iwami D, et al : Safety and Efficacy of Retroperitoneoscopic Living Donor Nephrectomy : Comparison of Early Complication, Donor and Recipient Outcome with Hand-Assisted Laparoscopic Living Donor Nephrectomy. J Endourol **32** : 1120–1124, 2018.
6) Xiao Q, Fu B, Song K, et al : Comparison of Surgical Techniques in Living Donor Nephrectomy : A Systematic Review and Bayesian Network Meta-Analysis. Ann Transplant **25** : e926677, 2020.
7) Shokcor NM, Sultan S, Alvarez-Casas J, et al : Minimally invasive donor nephrectomy : current state of the art. Langenbecks Arch Surg **403** : 681–691, 2018.
8) Tanabe K, Miyamoto N, Tokumoto T, et al : Retroperitoneoscopic live donor nephrectomy : extended experience in a single center. Transplant Proc **36** : 1917–1919, 2004.
9) Tanabe K, Miyamoto N, Ishida H, et al : Retroperitoneoscopic live donor nephrectomy (RPLDN) : Establishment and initial experience of RPLDN at a single center. Am J Transplant **5** : 739–745, 2005.
10) Naoki K, Omoto K, Toshihito H, et al : Retroperitoneoscopic live donor nephrectomy : Experience of 425 cases at a single center. J Endourol **24** : 1783–1787, 2010.
11) Schwentner C, Oswald J, Lunacek A, et al : Lich-Gregoir reimplantation causes less discomfort than Politano-Leadbetter technique : results of a prospective, randomized, pain scale-oriented study in a pediatric population. Eur Urol **49** : 388–395, 2006.
12) Pascual M, Thernvath T, Kawai T, et al : Strategies to improve long-term outcomes after renal transplantation. N Engl J Med **346** : 580–590, 2002.
13) Shokeir AA : Open versus laparoscopic live donor nephrectomy : A focus on the safety of donors and the need for a donor registry. J Urol **178** : 1860–1866, 2007.
14) Melcher ML, Carter JT, Posselt A, et al : More than 500 consecutive laparoscopic donor nephrectomies without conversion or repeated surgery. Arch Surg **140** : 835–840, 2005.
15) Fettouh HA, Raouf HA, Shenoufy A, et al : Laparoscopic donor nephrectomy : Single-center experience in Egypt with 400 consecutive cases. Transplant Proc **39** : 807–810, 2007.
16) Derweesh IH, Goldfarb DA, Abreu SC, et al : Laparoscopic live donor nephrectomy has equivalent early and late renal function outcomes compared with open donor nephrectomy. Urology **65** : 862–866, 2005.
17) Leventhal JR, Paunescu S, Baker TB, et al : A decade of minimally invasive donation : Experience with more than 1200 laparoscopic donor nephrectomies at a single institution. Clin Transplant **24** : 169–174, 2010.
18) Saidi R, Kawai T, Kennealey P, et al : Living donor kidney transplantation with multiple arteries : recent increase in modern era of laparoscopic donor nephrectomy. Arch Surg **144** : 472–475, 2009.
19) Han DJ, Han Y, Kim YH, et al : Renal vein extension during living-donor kidney transplantation in the era of hand-assisted laparoscopic living-donor nephrectomy. Transplantation **99** : 786–790, 2015.
20) Kokkinos C, Nanidis T, Antcliffe D, et al : Comparison of laparoscopic versus hand-assisted live donor nephrectomy. Transplantation **83** : 41–47, 2007.
21) Potter SR : Single-surgeon laparoscopic donor nephrectomy and renal transplantation. Urology **68** : 947–951, 2006.
22) Bachmann A, Dickenmann M, Gürke L, et al : Retroperitoneoscopic living donor nephrectomy : A retrospective comparison to the open approach. Transplantation **78** : 168–171, 2004.
23) Raque J, Billeter AT, Lucich E, et al : Training techniques in laparoscopic donor nephrectomy : a systematic review. Clin Transplant **29** : 893–903, 2015.
24) Canes D, Mandeville JA, Taylor RJ, et al : Pure laparoscopic donor nephrectomy : 3-year experience and analysis of a refined technique to maximize graft function. J Endourol **22** : 2275–2283, 2008.
25) London ET, Ho HS, Neuhans AMC, et al : Effect of intravascular volume expansion on renal function during prolonged CO_2 pneumoperitoneum. Ann Surg **231** : 195–201, 2000.
26) Shimizu T, Tanabe K, Miyamoto N, et al : Early and

late histopathological changes in renal allografts procured by laparoscopic donor nephrectomy. Clin Transplant 20 Suppl **15** : 11–15, 2006.