Abstract

Objectives: To evaluate the technique of laparoscopic kidney transplant and demonstrate the feasibility of this procedure by an extraperitoneal approach.

Materials and Methods: The procedure was performed on 2 human cadavers. Retroperitoneal endoscopic left nephrectomy was performed. An extraperitoneal space was established by inflation of a balloon dilator. The external iliac artery and vein were exposed. A Pfannenstiel incision (6 cm) was made and a hand-access device was used. The renal artery was anastomosed to the external iliac artery (end-to-side anastomosis); the renal vein was anastomosed to the external iliac vein (end-to-side anastomosis). The ureter was anastomosed to the bladder with an extravesical tunnelling technique.

Results: The donor kidney grafts were obtained successfully. The preparation of the external iliac artery and vein was satisfactory. The entire procedure for the renal artery, renal vein, and ureteral anastomoses was performed with laparoscopic technique without any difficulty.

Conclusions: The present model on human cadavers may provide a feasible approach for training surgeons to perform human laparoscopic kidney transplant. The present technique may be applied to clinical human kidney transplant.

Key words: End-stage renal failure, Laparoscopy, Medical education, Surgery

Introduction

Laparoscopic surgery is preferred over open surgery for treatment of varied surgical problems and has multiple benefits. Laparoscopic donor nephrectomy is performed in many kidney transplant units.1-10 The advantages of kidney transplant by laparoscopic surgery may include a smaller incision, less pain, faster recovery, and shorter hospital stay compared with open surgery. Smaller incisions may heal quickly, and this may enable earlier administration of drugs such as sirolimus that may prevent graft rejection.

Laparoscopic kidney transplant has been developed with a transperitoneal approach to dissect the iliac vessels, perform vessel anastomosis, and place the kidney graft in the extraperitoneal space by closing the peritoneum.11-13 The application of this technique in human clinical kidney transplant is limited because it is technically demanding. In addition, improvements in the technique are anticipated. Therefore, establishing training models may facilitate clinical application of laparoscopic kidney transplant.

The purpose of this study was to evaluate the technique of laparoscopic kidney transplant and demonstrate the feasibility of this procedure by an extraperitoneal approach. In addition, we developed a training model on human cadavers to improve training for surgeons who were learning this procedure.

Materials and Methods

Specimens

The training model was established using 2 fresh frozen whole body cadavers with no history of
previous kidney surgery that were processed by gelatin infusion. The procedure was performed once only, on each cadaver. Approval for the study was obtained from the research ethics committee of the institute.

**Technique**

The cadaver was positioned in the right lateral decubitus position. A retroperitoneal endoscopic left nephrectomy was performed, similar to typical live donor nephrectomy. After the nephrectomy, the incision and port sites were closed with polyglactin suture (2-0 Vicryl, Ethicon Inc., Somerville, NJ). The kidney graft was prepared on the back table. Marking sutures were placed at the superior edge of the renal artery and renal vein (5-0 Surgipro, Covidien, Mansfield, MA) and the upper pole of the kidney (2-0 Vicryl, Ethicon Inc., Somerville, NJ).

The cadaver was repositioned supine with the right side tilted 20 degrees upward. A small incision (1.5 cm) was made cranial and lateral to the umbilicus, and a balloon dilator (PDB 10 mm Autosuture, Covidien, Mansfield, MA) was inserted into the extraperitoneal space. The dilator was inflated under direct vision to create an extraperitoneal space and facilitate exposure of the iliac vessels. The balloon dilator was replaced by a balloon access port (Hasson type, BTT 10 mm Autosuture, Covidien, Mansfield, MA) (Figure 1). The extraperitoneal working space was established by inflation of carbon dioxide (pressure, 12 mm Hg). The second port (5 mm) was inserted at caudal and lateral to umbilicus under direct vision. The third port (10 mm) was placed at superior and lateral to the first port (Figure 1). The peritoneum was pushed medially to extend the working space. The external iliac artery and vein were identified and dissected for preparation of the renal artery and vein anastomoses.

A 6-cm Pfannenstiel incision was made 5 cm superior to the pubis, and a Lap Disc was used through this incision (Lap Disc, Applied Medical, Rancho Santa Margarita, CA) (Figure 1). The kidney graft was placed into the iliac fossa of the extraperitoneal space through the Lap Disc. An arteriotomy was made on the external iliac artery and the renal artery was connected to it with an end-to-side anastomosis with 2 separate (posterior and anterior) sutures (5-0 Surgipro, Covidien, Mansfield, MA) (Figure 2). Heparin saline (1000 IU in 100 mL normal saline) was flushed into the anastomosis before completion of the last suture. The renal vein was anastomosed to the external iliac vein in the same fashion (end-to-side anastomosis) (Figure 3). During the vessel anastomosis, the kidney graft was flushed regularly every 5 minutes with cold normal saline (4°C) using a suction-irrigation set.

The bladder was identified by instilling 200 mL normal saline into the bladder. A ureteroneocystostomy was performed by a laparoscopic approach using Lich-Gregoir method with polydioxanone suture (5-0 PDS, Ethicon Inc., Somerville, NJ) (Figure 4).

**Results**

The laparoscopic left donor nephrectomy was performed successfully and the kidney graft was obtained with a single artery, vein, and ureter in both
There was no damage to the vessels or kidney grafts. Satisfactory creation of the extraperitoneal space was achieved. In the first cadaver, the port for the left hand was too close to the pubis and the hand access device; in the second cadaver, the left port was placed more superiorly, and this enabled all ports to be used more comfortably during the entire procedure.

The dissection and preparation of the external iliac artery and vein were completed without injury to the vessels. The entire procedure for the renal artery, renal vein, and ureteral anastomoses was performed with laparoscopic technique without any difficulty.

The total surgical time was 200 minutes with the first cadaver and 180 minutes with the second cadaver. The vessel anastomosis time for the first and second cadavers was 35 and 30 minutes for the renal artery and 28 and 25 minutes for the renal vein. The kidney graft was in the extraperitoneal space at all times.

Discussion

This training model on human cadavers facilitates development of a new laparoscopic approach for human kidney transplant. In this model, the patient was positioned supine, which is more comfortable than the Trendelenburg position used in the transperitoneal approach. Efficient creation of an extraperitoneal space was initiated by using a balloon dilator under direct vision. The time required to dissect the iliac vessels with the present method was similar to open kidney transplant surgery. The working space was satisfactory and was created with a minimally invasive technique. The Pfannenstiel incision (6 cm) was much smaller than the incision used in typical open kidney transplant, and it involved only skin and fascia without muscle division. The position of the ports enabled comfortable use of the ports during the entire procedure, including dissecting the iliac vessels and performing the vessel anastomoses.

Wound complications would be expected to be less with the present technique than typical open kidney transplant because the present incisions are smaller and do not require muscle layer division. This may enable early administration of immunosuppressive agents such as sirolimus because of the lower potential risk of wound complications with smaller incisions. The placement of marking sutures at the superior side of the renal artery and vein and upper pole of the kidney facilitated the orientation of these structures during the surgery to avoid vessel kinking or malrotation of the kidney graft. The fourth port can be placed through the middle of Lap Disc to enable an assistant to flush and suction the surgical field during the procedure.

The present model is technically feasible and may be applicable to clinical human kidney transplant. However, training for laparoscopic vessel anastomosis is required to minimize the rewarming time for the kidney graft. A large animal model previously was established to facilitate the training of surgeons to perform human laparoscopic kidney transplant. The surgical time for laparoscopic kidney transplant may be longer initially than open
surgery but may be shorter in the future after the technique is improved.

Limitations of the present study include the use of human cadavers because graft perfusion and quality of vessel anastomoses could not be assessed. A live animal (pig) model of laparoscopic kidney transplant has been described with orthotopic autotransplant. In the pig model, the renal artery is anastomosed to the stump of the renal artery, the renal vein is anastomosed to the end of the renal vein stump, and the ureter is anastomosed to the ureter in an end-to-end fashion. Although the porcine renal artery is small (diameter, 2 to 3 mm), the frequency of successful vessel anastomosis is 70%, and a reliable and safe vessel anastomosis was confirmed with a laparotomy at the end of the study. In the porcine model, immediate graft function was achieved after successful completion of the vessel anastomoses, and blood loss was minimal.

In conclusion, the present model on human cadavers may provide a feasible approach for training surgeons to perform human laparoscopic kidney transplant. This model complements the previously described porcine model and confirms that laparoscopic kidney transplant may be performed safely and reliably. The present technique may be applied to clinical human kidney transplant, and the minimal use of surgical incisions may be beneficial to kidney transplant recipients.

References