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Step-by-Step

Robotic kidney transplantation with intraoperative regional hypothermia

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Objective

To describe a novel and reproducible technique of robotic kidney transplantation (RKT) that requires no repositioning, and permits intraoperative regional hypothermia.

Patients and Methods

A GelPOINT™ (Applied Medical, Santa Ranchero, CA, USA) access port was used for delivery of ice-slush and introduction of the graft kidney. The new RKT technique using ice-slush has been performed in 39 patients.

Results

At a mean follow-up of 3 months all of the grafts functioned. There was a marked reduction in pain and analgesic requirement compared with patients undergoing open KT, with a propensity towards quicker graft recovery and lower complication rate.

Conclusion

RKT has been shown to be safe and feasible in patients undergoing living-donor related KT. A prospective trial is underway to assess outcomes definitively.

Keywords

minimally invasive surgery, robotics, kidney transplantation, hypothermia

Introduction

Kidney transplantation (KT) is the treatment of choice for patients with end-stage renal disease, as it offers superior survival and quality of life compared with other treatment options [1]. Minimally invasive KT using the da Vinci surgical system (Intuitive Surgical, Sunnyvale, CA, USA) has recently been described [2,3]. However, current techniques of robotic KT (RKT) require repositioning of the patient side-cart during the procedure and do not allow for intracorporeal cooling of the graft, which is known to be reno-protective and associated with improved graft outcomes [4]. We describe a novel and reproducible technique of RKT that requires no repositioning, and permits intraoperative regional hypothermia.

Step-by-Step Instructions

Patient Positioning, Port Placement and Docking

After induction of general anaesthesia and placement of a urethral catheter, the patient is placed in the same position as for robot-assisted radical prostatectomy (RARP) [5]. All pressure points are padded and the patient is securely strapped to the table in the lithotomy position. A GelPOINT™ (Applied Medical, Santa Ranchero, CA, USA) access port is used for delivery of ice-slush and introduction of the graft kidney. With the patient in the supine position, the GelPOINT is inserted through a 4–5 cm peri-umbilical incision. The GelSeal™ cap is prepared with a 12-mm camera port and a 10-mm assistant port (for sucker) placed through it. Incisions are made in the GelSeal cap around the 10-mm port to allow for introduction of a rigid sigmoidoscope or modified Toomey syringe for iced saline instillation [6]. The GelSeal cap is then attached to the Alexis wound retractor component of the GelPOINT. Pneumoperitoneum is established to 15 mmHg. Under direct vision, four additional trocars are inserted; two 8-mm robotic ports for the left and right robotic arms along the left and right para-median lines below the level of the umbilicus, a third 8-mm robotic port for the fourth arm placed lateral to the left anterior axillary line just below the level of umbilicus, and a 12-mm assistant port along the right anterior axillary line. Apart from the ports placed through the GelPOINT, port placement is identical to that of RARP. The patient is placed in a 20–30 ° Trendelenburg position and the patient side-cart docked between the legs.

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Preparation of the Anastomoses

With Maryland bipolar forceps in the non-dominant hand and monopolar curved scissors in the dominant hand, using a 30 °-down lens, the external iliac vessels are identified and skeletonised, and lymphatic channels cauterised. In males, the vas deferens is identified and preserved, while in females the round ligament is divided. Next, switching to a 30 °-up lens, the bladder is taken down and the extraperitoneal space developed. The bladder is then distended with 250 mL normal saline for creation of the orifice for uretero-neocystostomy. The detrusor muscle and mucosa are dissected to create a 1.5–2 cm orifice for subsequent uretero-neocystostomy.

Intracorporeal Cooling and Introduction of the Graft Kidney

The graft kidney is prepared on the bedside by placing it within a gauze-jacket filled with ice-slush. An opening is fashioned in the gauze-jacket that allows access to the hilar structure. The GelPOINT 10-mm assistant port is removed and replaced with either modified Toomey syringes or rigid sigmoidoscopes for injection of 120–180 mL iced saline slush onto/around the vascular bed. Instillation of ice-slush through the GelPOINT is similar to that previously described for renal hypothermia during robotic partial nephrectomy [6]. The graft kidney is then introduced into the peritoneal cavity through the GelPOINT; the patient side-cart remains docked and all robotic instruments are removed. The camera is removed and camera arm undocked to allow complete removal of the GelSeal cap for resistance-free insertion of the graft kidney through the Alexis wound retractor. Special attention is paid to the orientation of the graft during its introduction, with the lower pole orientated inferiorly and the hilum facing laterally. Once the graft kidney is inserted into the pelvis, the GelSeal cap is reattached and the camera arm re-docked with the camera lens in a 30 °-down position. Pneumoperitoneum is re-established and an additional 120–180 mL ice-slush is introduced immediately to cover the graft.

Vascular Anastomoses

The graft kidney is supported on the bladder/bowel with assistance of a fenestrated grasper in the fourth robotic arm. The graft is aligned appropriately for the vascular anastomosis. The external iliac vein (EIV) is clamped proximally and distally using robotic bulldog-clamps (Scanlan™ International, Saint Paul, MN, USA) and a venotomy made using the cold monopolar scissors. Anastomoses are made using a robotic needle driver in the dominant hand and Black Diamond forceps in the non-dominant hand using expanded polytetrafluoroethylene (Gore-Tex®) suture on CV-6 needle (W.L. Gore and Associates, Flagstaff, AZ, USA). The Black Diamond forceps allow precise and atraumatic handling of the vessels and the graft kidney renal vein is anastomosed to the EIV in an end-to-side continuous fashion beginning with the posterior wall. Just before completing the venous anastomosis, the lumen is flushed with heparinised saline via a 5 F ureteric catheter introduced through the assistant port to test the integrity of the anastomosis, and also remove any air bubbles/clots that might have formed during the anastomosis. Next, the graft renal vein is occluded using a third robotic bulldog-clamp and the EIV is unclamped. In a similar fashion, the external iliac artery (EIA) is also clamped and a circular arteriotomy made using a 3.6-mm aortic punch (Teleflex Medical Inc., Research Triangle Park, NC, USA) introduced through the GelPOINT. The renal artery is anastomosed in an end-to-side continuous fashion to the EIA beginning with the posterior wall. The anastomosis is flushed with heparinised saline as described previously. Special care is taken not to traumatise the intimal layer while manipulating the vessels. After completion of the arterial anastomosis the clamps are removed and gauze-jacket cut away. The kidney is visually inspected for colour, turgor and on-table diuresis.

Ureterovesical Anastomosis

The graft ureter is anastomosed to the bladder using the modified Lich-Gregoir technique. The donor ureter is spatulated and mucosa of the bladder approximated with the ureter in a continuous manner using 4-0 polydiaxone suture (PDS; Ethicon Inc., Cincinnati, OH, USA) suture. A 6 F 16-cm JJ stent is introduced through the 12-mm assistant port and inserted into the ureter before completing the anastomosis. The detrusor is closed over the ureter using barbed suture (V-Loc 3-0 CV23 6”; Covidien Inc., New Haven, CT. USA) to create a non-refluxing anastomosis.

Closure

Pneumoperitoneum is lowered to 8 mmHg and an i.v. bolus of 100 mg furosemide administered for diuresis. The graft kidney is retroperitonealised to reduce the risk of graft torsion. Drains may be inserted through the fourth robotic arm and/or 12-mm assistant port sites. Robotic instruments are withdrawn, the robot is undocked and the GelPOINT device is removed. The peri-umbilical fascia is closed in a continuous fashion using zero polyglactin 910 (Vicryl®). The skin is closed with absorbable subcuticular sutures. An on-table Doppler ultrasound of the graft kidney is performed to confirm patency and vascular flow.

Summary

We have now performed RKT in 39 patients. At a mean follow-up of 3 months, all of the grafts functioned. Overall, we have noticed a marked reduction in pain and analgesic requirement compared with patients undergoing open KT, propensity towards quicker graft recovery and lower complication rate; a prospective trial in underway to assess

these outcomes definitively. We now recommend this approach to most patients undergoing living-donor KT.

Conflict of Interest

None declared.

References

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Abbreviations: EI(A)(V), external iliac (artery) (vein); (R)KT, (robotic) kidney transplantation; RARP, robot-assisted radical prostatectomy.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Video S1 Robotic kidney transplantation with intraoperative regional hypothermia.