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Robot-assisted Kidney Transplantation: The European Experience

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Abstract

Background: Robot-assisted kidney transplantation (RAKT) has recently been introduced to reduce the morbidity of open kidney transplantation (KT).
Objective: To evaluate perioperative and early postoperative RAKT outcomes.
Design, setting and participants: This was a multicenter prospective observational study of 120 patients who underwent RAKT, predominantly with a living donor kidney, in eight European institutions between July 2015 and May 2017, with minimum follow-up of 1 mo. The robot-assisted surgical steps were transperitoneal dissection of the external iliac vessels, venous/arterial anastomosis, graft retroperitonealization, and ureterovesical anastomosis.
Outcome measurements and statistical analysis: Descriptive analysis of surgical data and their correlations with functional outcomes.
Results and limitations: The median operative and vascular suture time was 250 and 38 min, respectively. The median estimated blood loss was 150 ml. No major intraoperative complications occurred, although two patients needed open conversion. The median postoperative estimated glomerular filtration rate was 21.2, 45.0, 52.6, and 58.0 ml/min on postoperative day 1, 3, 7, and 30, respectively. Both early and late graft function were not related to overall operating time or rewarming time. Five cases of delayed graft function (4.2%) were reported. One case (0.8%) of wound infection, three cases (2.5%) of ileus, and four cases of bleeding (3.3%; three of which required blood transfusion), managed conservatively, were observed. One case (0.8%) of deep venous thrombosis, one case (0.8%) of lymphocele, and three cases (2.5%) of transplantectomy due to massive arterial thrombosis were recorded. In five cases (4.2%), surgical exploration was performed for intraperitoneal hematoma. Limitations of the study include selection bias, the lack of an open control group, and failure to report on patient cosmetic satisfaction.
Conclusions: When performed by surgeons with robotic and KT experience, RAKT is safe and reproducible in selected cases and yields excellent graft function.
Patient summary: We present the largest reported series on robot-assisted kidney transplantation. Use of a robotic technique can yield low complication rates, rapid recovery, and excellent graft function. Further investigations need to confirm our promising data.

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1. Introduction

Kidney transplantation (KT) is considered the preferred treatment for patients with end-stage renal disease (ESRD) owing to the greater survival rate and better quality of life in comparison to hemodialysis [1]. Although the open approach remains the gold standard, minimally invasive techniques have been introduced to decrease the morbidity and mortality of open surgery [2], which could be especially important in immunocompromised and fragile KT patients. In 2002 Hoznek et al [3] described the possibility of performing a robotic anastomosis in KT, and in 2010 the first pure RAKT was performed by Giulianotti et al [4] in the USAs. One of the major challenges in RAKT was to keep the kidney cool during vascular anastomosis. Therefore, in 2014 Menon et al [5] standardized the technique with the transperitoneal approach and regional hypothermia. The authors highlighted that RAKT is a safe technique with possible advantages such as low intra- and postoperative complications, better cosmetic results, and superlative vision that could result in better quality of the vascular and ureteral anastomoses. In Europe, the first RAKT was performed by Boggi et al [6] in 2011 as a hybrid case with robotic vascular anastomosis and open ureterovesical anastomosis. The first two European pure RAKTs were performed in July 2015 by Doumerc et al [7] and Breda et al [8]. A year later, Breda et al [9] reported surgical and functional outcomes for 17 patients undergoing RAKT. Starting from these preliminary pure RAKT results, a European Robotic Urological Society (ERUS) RAKT group was created with the aim of collecting prospective data on RAKT in a common database.

The primary objective of this study was to evaluate perioperative and early postoperative surgical outcomes for RAKT performed in eight European institutions. Secondary objectives included functional outcomes and correlations between surgical data and functional results.

2. Patients and methods

2.1. Study design

This was a multicenter prospective observational study on RAKT predominantly from living donors performed at eight European centers (Table 1). The project was integrated in the ERUS RAKT working group to collect prospective data on RAKT.

2.2. Study sample

Data for 120 nonconsecutive patients undergoing RAKT were prospectively collected between July 2015 and May 2017 following institutional review board approval and patient informed consent. Computed tomography was performed for both recipients and donors to identify renal vascular anomalies and iliac artery atherosclerosis. The inclusion criteria were: patients with ESRD (considered as glomerular filtration rate [GFR] <20 ml/min and/or symptomatic uremia and/or need for dialysis); a matched living or deceased donor; >18 yr of age; and body mass index (BMI) ≤40 kg/m^2. The exclusion criteria were: iliac artery atherosclerosis; malignancy; positive virology; severe comorbidity (cardiovascular, pulmonary, or hepatic); highly complex vascular anatomy (ie, >3 arteries, >1 small accessory artery, >2 veins); multiple previous abdominal surgeries; previous transplant (second transplant); or simultaneous dual or multiple organ transplant.

Table 1 – Robot-assisted kidney transplantations (RAKTs) carried out at European centers

Institution	RAKTs (*n*)
Fundació Puigvert, Barcelona, Spain (pilot center)	20
Bakirkoy Sadi Konuk Training and Research Hospital Center Turkey	45
Hospital Clinic, Barcelona, Spain	23
University Hospital of Rangueil, Toulouse, France	10
University Hospital Halle (Saale), Halle, Germany	10
Ghent University Hospital, Ghent, Belgium	6
University Saarland, Homburg/Saar, Germany	4
University of Florence, Careggi Hospital Florence, Italy.	2
Total	**120**

2.3. Study variables and outcomes

Data for sociodemographic variables, surgical and functional outcomes, and early postoperative complications with minimum follow-up of 1 mo were prospectively collected.

The surgical outcomes evaluated included cold and warm ischemia time and rewarming time. Warm ischemia time is the period between renal circulatory arrest and the beginning of cold storage; cold ischemia time is the duration of cold storage, with or without perfusion with a storage solution, before introduction of the graft into the recipient. Rewarming time is the time between removal of the kidney from cold storage and the start of reperfusion while continuously adding ice slush. Other surgical data analyzed were overall operative time, console time, vascular anastomosis time, ureteral reimplantation time, and estimated blood loss. Intraoperative complications included intraoperative vascular injuries, the need for vascular anastomosis revision, and conversion to open surgery in the event of massive bleeding or low blood flow on Doppler ultrasound evaluation. The early (30 d) postoperative complication rate was reported according to the Clavien-Dindo classification [10].

The functional outcomes considered were serum creatinine and estimated GFR (eGFR) on postoperative day (POD) 1, 3, 7, and 30. eGFR was calculated using the Modified Diet in Renal Disease equation (patient >18 yr old) [11,12]. Delayed graft function (DGF) was considered as a need for dialysis in the first postoperative week. Among the functional outcomes, we also included postoperative hemoglobin, evaluation of postoperative pain using a visual analog score (VAS), postoperative hospitalization, and time to double-J removal.

2.4. Surgical procedure (Si/Xi da Vinci)

The first standardization of RAKT was described by Menon et al [5] in the IDEAL phase 2a study. Following this technique, Breda et al [9] reported their first RAKT results with details of the technical aspects and surgical steps. The possible transvaginal introduction route has been described by Doumerc et al [8]. The surgical procedure was standardized in all participant centers. The main surgical steps are summarized and shown in Figures 1–5.

2.5. Surgical experience

All surgical teams involved in this study have thorough expertise in the field of robot-assisted surgery and open KT, with several hundred procedures of each approach performed. Before starting on human