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ROBOT-ASSISTED KIDNEY TRANSPLANTATION. FIRST EXPERIENCE

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Kidney transplantation is the preferred renal replacement therapy for patients with end-stage renal disease. Traditional surgical approaches consisting of vascular and urinary outflow reconstruction during kidney transplant have been sufficiently studied and standardized. However, surgical techniques are still evolving. The objective of this clinical report is to focus the attention of kidney transplant surgeons and specialists on the currently trending robot-assisted kidney transplantation (RAKT) as a minimally invasive procedure for surgical treatment of patients with end-stage renal disease. In our first experience, good primary graft function was achieved. This shows that RAKT is a surgical option. With considerable number of surgeries and experience, RAKT outcomes would be improved significantly.

Keywords: robotics, minimally invasive surgery, robotic surgery, kidney, chronic kidney disease, end-stage renal disease, kidney transplantation, robot-assisted kidney transplantation.

INTRODUCTION

Though open surgery is the method of choice for kidney transplantation in adult recipients, minimally invasive surgical techniques is not the least to gain their foothold. At this, laparoscopic and robot-assisted nephrectomy from live related donors has largely replaced conventional surgery since the late 1990s [1]. These techniques have established themselves as a standard approach, providing the same function of the graft, same rejection rate, same urological complications, equivalent survival of the patient and the graft, reducing the number of analgesia episodes to relieve postoperative pain, achieving good cosmetic outcomes, and shortened hospital stay [2–4].

András Hoznek was the first to perform RAKT [5]. Currently, more than 500 such operations have been described globally [6], while in Russia the RAKT experience is minimal [7–9]. The RAKT has the following advantages: better visualization, ease of manipulation of instruments, precision accuracy, minimal surgical and infectious postoperative complications, especially in obese patients [10, 11]; however, it is tied to longer operation time and thermal ischemia [12, 13] which, as a result, can affect the aggravation of reperfusion injury and restoration of the graft function [14].

From January to April 2020, at the Petrovsky National Research Centre of Surgery, four RAKTs were performed: 3 from deceased donors, 1 from a relative.

In this article, we present the of the technique and give a description of one of the clinical cases.

The technique used is quite standard for such interventions. The result was obtained for the first robotic operations; it is comparable to those in open surgery and requires further observation.

A 50-year-old male with terminal stage renal disease due to glomerulonephritis. The disease was identified at an examination for bilateral pneumonia in February 2017. The gradual deterioration of renal function led to the development of the terminal stage, and on August 17, 2017, planned renal replacement therapy through an arteriovenous fistula started, and on December 17, 2019, a robotic kidney allotransplantation from a deceased donor was performed. The donor was a 50-year-old female, dead of a hemorrhagic stroke. The selection parameters are presented in Table 1.

SURGICAL TECHNIQUE

The patient was fixed in Trendelenburg position with head end inclined at 20–30° and the table rotated and inclined left at 20–30°. The patient cart (da Vinci System, Intuitive Surgical, USA) with manipulators was located to the right of the operating table at the patient's feet. The most suitable location of the port points was chosen as a basis, similar to their location at a radical prostatectomy. At this, there were some differences, including those from the methodology developed in the course of the IDEAL study (Innovation, Development, Exploration,

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Table 1

Donor and recipient selection: blood group, HLA genotype, HLA incompatibility, cross-compatibility test (crossmatch testing)

Selection parameter	Recipient	Donor
Gender	Male	Female
Age	50	50
Blood type	0(I) Rh(+)	0(I) Rh(–)
HLA phenotype	A 2.10 B 15.15 Dr 6.6	A 2.19 B 15.16 Dr 4.2
Incompatibility	A 19 B 16 Dr 4.2 (MM4)	
Cross-match reaction	negative	

Assessment, Long-term study) [15], and similarities to the method described by Ugo Boggi et al. [16]: the camera port (12 mm) was located slightly higher and to the left of the navel. The working ports (8 mm) were located in an arc deviated to the left at 8 cm from each other. An assistant port was located in the left iliac area. An assistant port in the form of a retractor with an iris diaphragm (Seal Cap Assembly Dextrus, Ethicon, USA) was introduced through 7-cm Pfannenstiel incision (Fig. 1).

Intraoperatively: the 1st step, isolating the iliac vessels (external iliac vein and external iliac artery) on the right. Then, through the assistant manual port, a donor kidney was placed in the abdominal cavity on an ice draped cushion (Fig. 2).

The graft (left kidney) with 1 artery and 1 vein was placed in the right iliac fossa without craniocaudal inversion. Anastomoses were formed: the graft vein "end-to-side" of the external iliac vein with Prolene 5/0, the graft artery "end-to-side" of the external iliac artery with Prolene 5/0 (Fig. 3).

With the blood flow, the graft was evenly filled with blood, turned pink, with the satisfactory turgor. The extravesical Leach-Gregoire anastomosis of the ureter with the bladder on the JJ-stent was formed with PDS 5/0. At the last stage, the graft extraperitonization was performed. At the endo-ultrasound control with color Doppler mapping (CDM) using a robotic drop-in ultrasound transducer (BK medical, Denmark), the blood flow in the graft was evenly distributed (Fig. 4).

The console time – 140 min, the vascular anastomoses formation – 45 min, blood loss – 20 ml.

Induction therapy: basiliximab. Immunosuppressive therapy: tacrolimus from day 1, prednisolone from day 1, mycophenolate mofetil from day 3. 1st day: 5,400

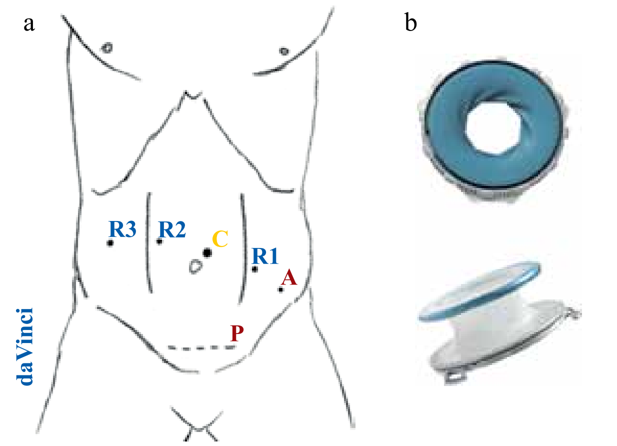

Fig. 1. Robotic kidney transplantation: a – illustration of port placement; b – retractor with sealing cap (Seal Cap "Dextrus"). C – 12-mm camera port; R1, R2, R3 – 8-mm robotic ports, corresponding original numbering of da Vinci manipulators; A – 10-mm assistant port; P – suprapubic incision for retractor with sealing cap; da Vinci – patient cart placement

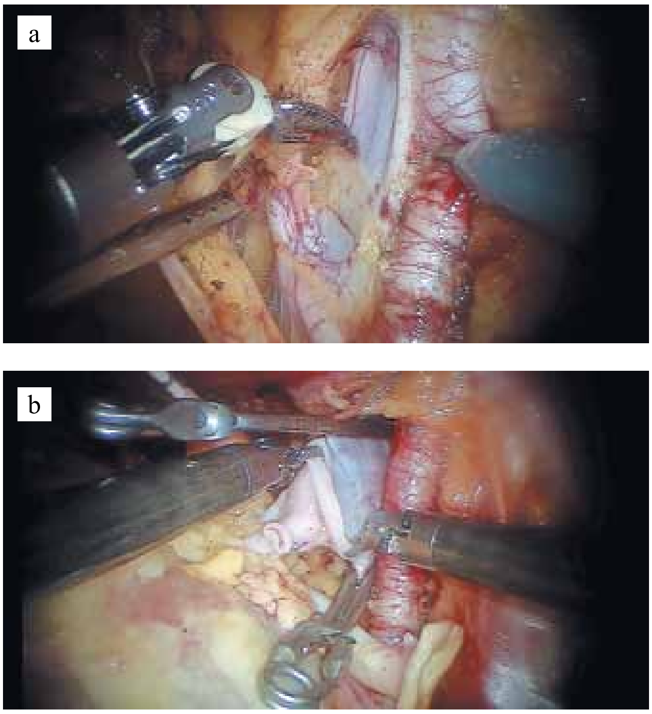

Fig. 2. The initial stage of the operation (preparation for future iliac vessels anastomoses): a – skeletonized iliac vessel bed (artery and vein); b – external iliac vein clamped with a robotic bulldog clamp, try-on before venotomy

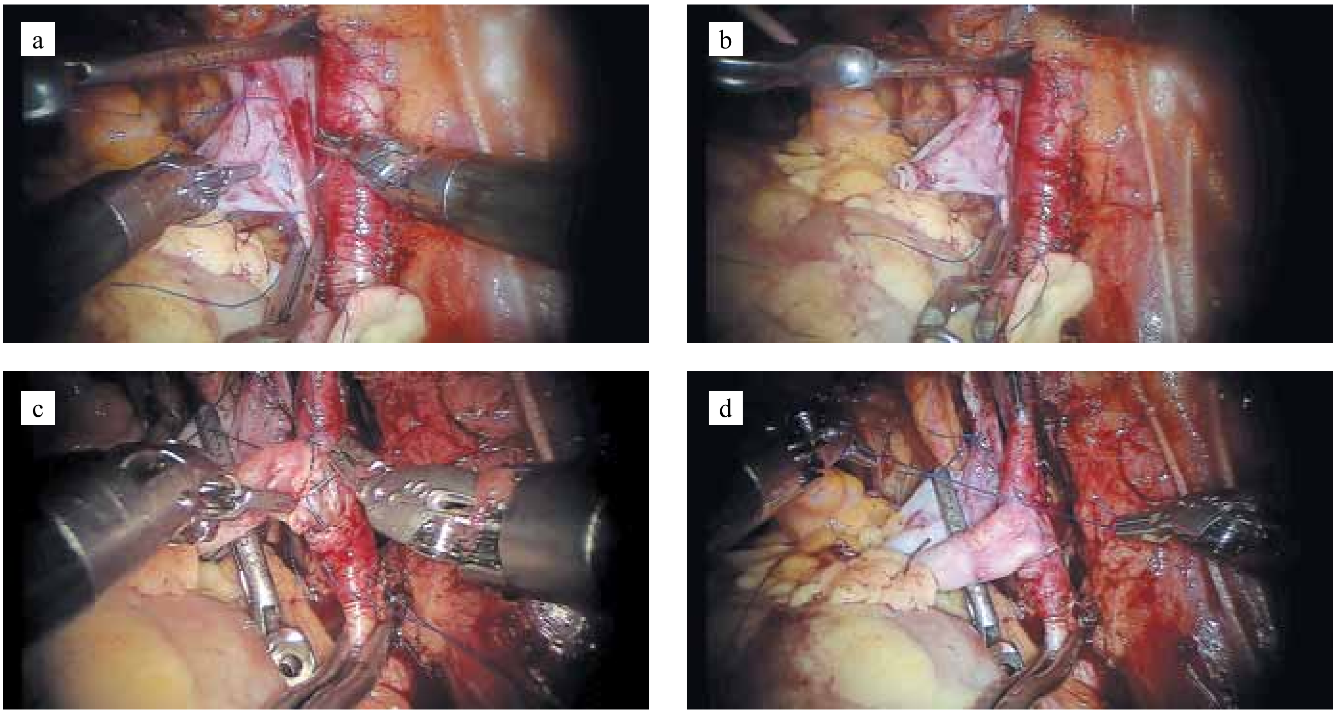

Fig. 3. Stage of vascular anastomoses: a, b – end-to-side venous anastomosis (the external iliac vein clamped with a robotic bulldog clamp): the graft vein – the external iliac vein; c, d – arterial anastomosis end to side (the external iliac artery clamped with a robotic bulldog clamp): the graft artery – the external iliac artery

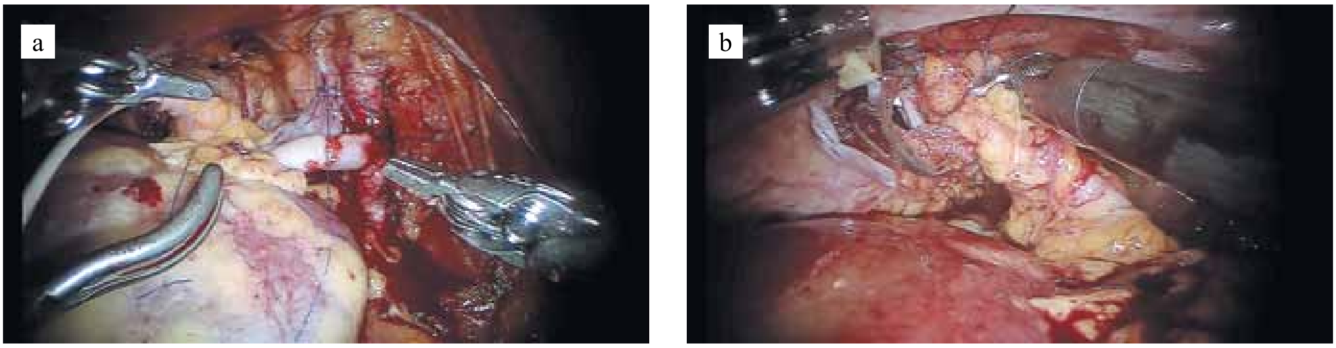

Fig. 4. Kidney graft reperfusion. The stage of urinary outflow reconstruction and graft extraperitonization: a – time of reperfusion; b – ureteroneocystostomy, Lich–Gregoire technique; c – intraoperative ultrasound using a robotic drop-in ultrasound transducer (BK medical, Denmark)

ml of urine. Creatinine on the 1st day: 629 μmol/l (7.1 mg%), glomerular filtration rate (GFR-EPDI) 8.15 ml/min/1.73 m^2. Creatinine suboptimization (<3 mg%) on the 5th day. The patient was discharged on the 14th day with creatinine 109 μmol/l (1.2 mg%), GFR-EPDI 67.6 ml/min/1.73 m^2. Ultrasound: the graft thickness – 6.2 cm, the cortical layer thickness – 0.68 to 0.8 cm, the sinus – 3.1 cm. The pyramids are not changed. The pelvis cavity – 1.4 cm. The parenchyma is not changed. The cortical layer is not changed. The accumulation of fluid around the kidney was not detected. CDM: blood flow – satisfactory (Table 2).

Table 2

Doppler indices in the graft after surgery (14 days)

	Vs, m/s	Vd, m/s	Ri
Renal artery	0.72	0.13	0.82
Interlobar artery	0.27	0.06	0.78
Arcuate artery	0.21	0.04	0.81

Table 3

Doppler indices in the graft after surgery (2.5 month)

	Vs, m/s	Vd, m/s	Ri
Renal artery	0.76	0.16	0.79
Renal artery	0.4	0.1	0.75
Arcuate artery	0.14	0.03	0.8

Examination in 2.5 months after surgery: the graft function – satisfactory: creatinine 111.7 μmol/l (1.3 mg%), GFR-EPDI 66.35 ml/min/1.73 m^2. The patient continues to receive three-component immunosuppressive therapy – tacrolimus, mycophenolate mofetil, and prednisolone. Ultrasound (Fig. 5): the graft – 6.2 cm thick, the cortical layer – 0.7 cm thick, the sinus – 2.9 cm. The pyramids are not changed. Moderate expansion of the pelvis. The parenchyma is not changed. The cortical layer is not changed. The fluid accumulation around the kidney was not detected. Blood flow CMD parameters are shown in Table 3.

CT: low location of the graft in the pelvic cavity, the contrast uniform distribution in the arterial phase. The performed retrograde cystography did not reveal signs of vesicoureteral reflux (Fig. 6).

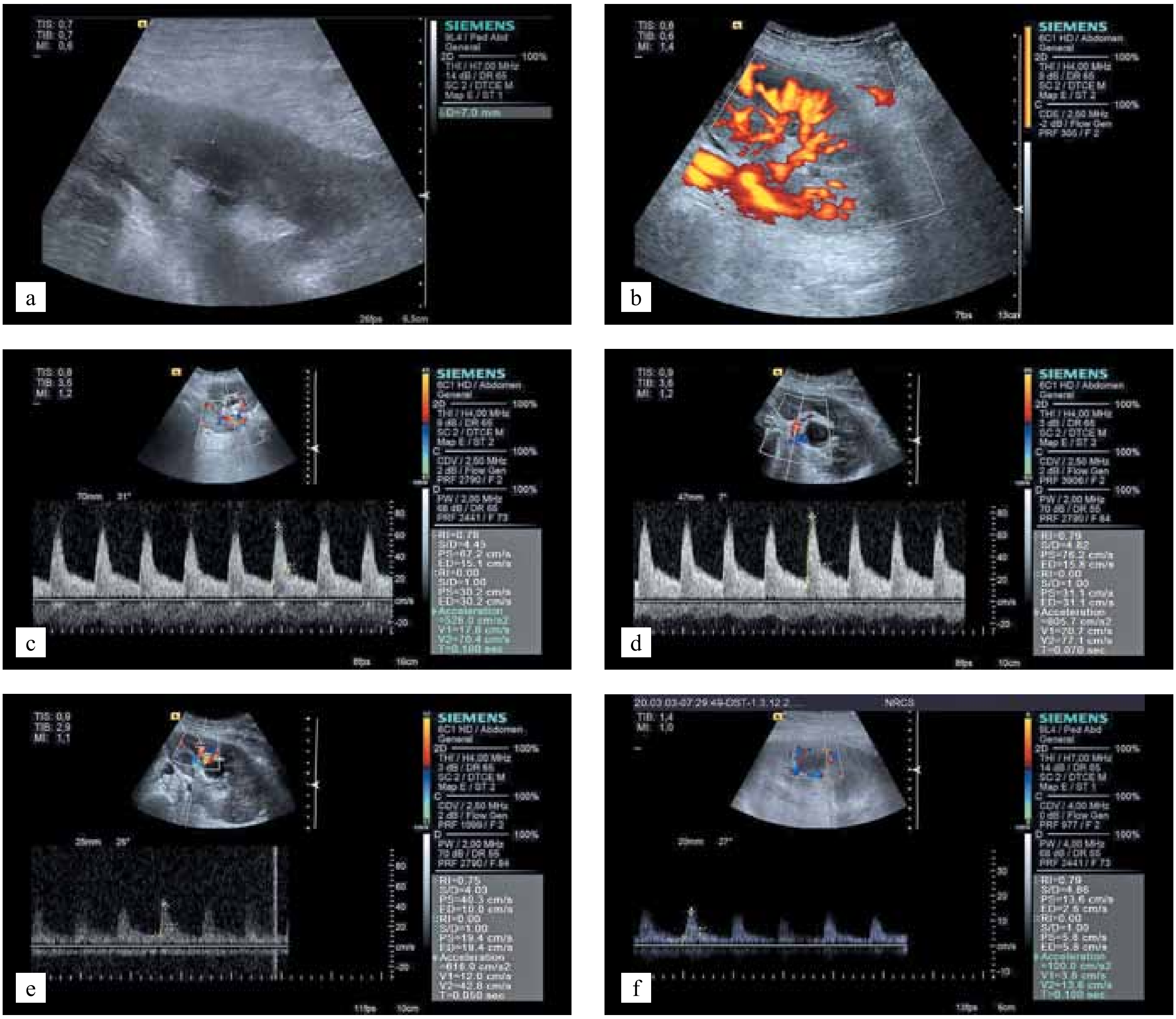

Fig. 5. Ultrasonography, vascular Doppler of the renal transplant 2.5 months after transplantation: a – renal cortex; b – a picture in the power doppler mode; c, d – renal artery; e – interlobar artery; f – arc artery

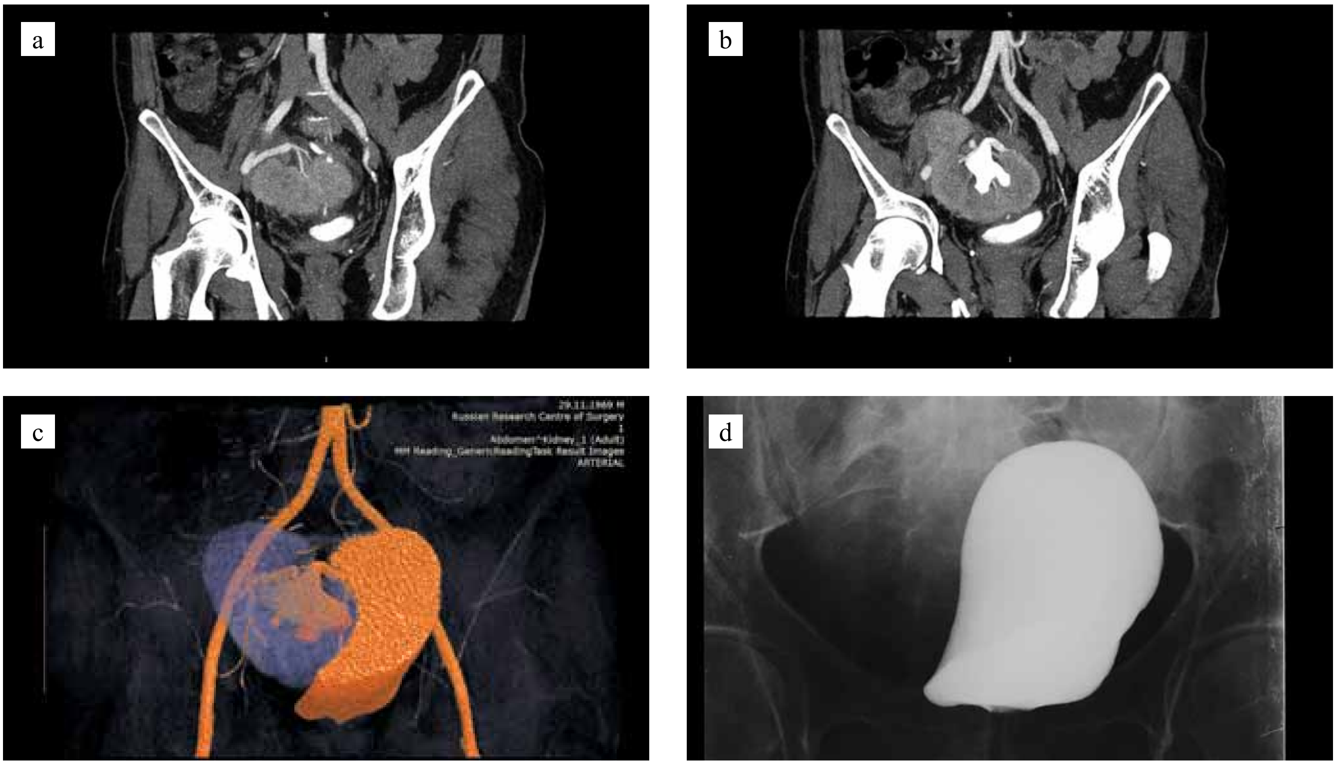

Fig. 6. X-ray diagnostic examination: a, b – computed tomography scans of arterial and uro phase; c – 3d-reconstruction; d – retrograde cystography

All operations were performed using a similar technique. In one case, thrombosis of the venous anastomosis was noted after the start of the blood flow; venotomy and thrombectomy were performed without conversion.

DISCUSSION

In the last decade, along with the growing interest in minimally invasive surgery using robotic systems, the efficiency of its usage has also increased. Organ transplantation also does not stand aside. Thus, along with laparoscopic donor nephrectomy, which has become part of everyday practice, the RAKT is gaining popularity. Performing such a surgical intervention, both from a technical and logistic point of view, is possible from both deceased and live donors, both in a standard situation and in the presence of various anomalies of the donor organ [17]. However, several studies note that surgeons with extensive experience in robotic surgery have minimal or no learning curve for RAKT, regardless of their previous experience in open transplantation, in contrast to experienced fellow surgeons who are familiar with traditional transplant methods [18]. For the traditional surgeon, as with many other robotic procedures, the learning curve can be a significant limitation for large-scale mastery of complex techniques. However, despite the fact that at present, according to the current literature, the generalized results of open and robotic transplantation can be comparable, this problem requires further research.

CONCLUSION

The present clinical observation is comparable with the early experience of the RAKT implementation in other transplant centers [19]. The absence of postoperative complications, minimal use of analgesics, early activation, discharge of the patient, and, above all, satisfactory functioning of the graft are good outcomes of the first experience of performing such a high-tech surgery.

The authors declare no conflict of interest.

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