THE NEW ARMENIAN MEDICAL JOURNAL
Vol.10 (2016), No 2, p. 80-87

Clinical Medicine

EVALUATION OF SURGICAL TECHNIQUE IN LIVING DONOR KIDNEY TRANSPLANTATION

Babloyan S.A., *, Voskanyan M.M., Mkrtumyan K.G., Arakelyan S.H., Geyikyan P.A., Nazaryan H.V., Kyurkchyan Kh.M., Sarkissian A.A., Babloyan A.S.

"Arabkir" Medical Center, Institute of Child and Adolescent Health, Yerevan, Armenia

Received 29/09/2015; accepted for printing 24/03/2016

Abstract

Current study presents analysis of the frequency and nature of intra-operative, early and late post-operative surgical complications of kidney transplantation from living donors taking into account the sides of nephrectomy and implantation, the types of vascular and ureteral anastomoses, as well as the position of the transplanted kidneys.

The study included 98 patients who had undergone living donor kidney transplantation at Arabkir Medical Centre between 2002 and 2012. In the majority of cases (80%) donor-nephrectomy was performed with kidney implantation from left to the right iliac area of the recipient (n=75). Out of 20 cases of right-sided donor-nephrectomy, left-sided implantation was performed in 18 patients, whereas right-sided – in 2. Three recipients out of 98 had kidney implanted in upturned upside-down position, with upper pole down, in order to avoid vascular kinking. The number of patients with 1 kidney artery was 86 (87.8%), 12 had additional arteries, six of them were anastomosed with lower epigastric artery and the rest were combined in a single trunk. Kidney artery was anastomosed with external (73.5%), internal (19.4%) or common (7.1%) iliac artery.

In all cases donor kidney ureter implantation was performed according to Lich-Gregoir technique mainly with application of urethral stent. The latter was removed on average in 15 weeks, whereas the urethral catheter – on day 5-6 post operation.

Main complications were intra-operative bleeding (6), post-operative bleeding (3), lymphocele (9), delayed function of the transplant kidney caused by long warm ischemia (9), arterial thrombosis (3), urethral stenosis (2), stenosis of distal part of ureter (3), proximal (1) and necrosis of distal part of ureter (1), which were successfully corrected in the subsequent surgical interventions. The loss of transplant kidney in various phases of kidney transplantation was detected in 11 cases.

The analysis of early and late post-operative complications showed that in majority of cases the complications after kidney transplantation from living donor were technical in nature, which is possible to avoid by improving the surgical technique. The donor kidneys with specific anatomical structures can be successfully transplanted without affecting the function of transplanted kidney.

Keywords: *kidney transplantation, living donor, surgical technique, surgical complications.*

Introduction

Kidney transplantation is a major surgical intervention including vascular and urologic components. The original description of the surgical operation dates back to 1951, while the first successful living donor kidney transplantation led by Joseph Murray was performed in December 1954 in Boston, USA [*Kuss R et al., 1951; Hamilton D, 1988*]. Though the surgical techniques have not changed significantly since then, there are significant controversies that persist to date.

As an example, while the iliac fossa as kidney implantation site is not in doubt, at least in adults, the choice of side is still debated. Initially it was recommended to implant the donor kidney in the opposite side of the recipient in order to ensure renal pelvis and ureter antelocation, thus facilitating further surgical interventions on them, if

Address for Correspondence:
"Arabkir" Medical Center
Institute of Child and Adolescent Health
30 Mamikonyants Street, Yerevan 0014, Armenia
Tel.: (+374 10) 23-85-26, (+374 93) 41-66-11
E-mail: sergobabloyan@yahoo.com

needed [*John M, 2002*]. The right iliac fossa is preferable due to horizontal and more surface location of the external iliac vessels as opposed to the left-side. Moreover, the left kidney vein is longer. This facilitates the vascular anastomoses [*Stuart M, 2008*]. Significant difficulties are associated with certain anatomic features (multiple renal arteries, early artery branching, etc.), atherosclerotic changes, amyloidosis of Familial Mediterranean fever, etc.

It is well-known that the formation of vesico-ureteral anastomosis has an advantage over uretero-ureteral anastomosis due to its simple technique and anatomical accessibility [*Morris P, Knechtle S, 2008*]. Publications reflect on discussions on the need and terms of ureteral drainage, prevention of anastomosis failure, as well as management of post-operative complications [*Morris P, Knechtle S, 2008; Kakaei F, 2013*].

The purpose of the present study is to analyze the frequency and nature of peri-operative, early and late post-surgical complications of living donor kidney transplantation, taking into account the nephrectomy and implantation sides, the type of vascular and ureteral anastomoses as well as the location of grafted kidneys.

Material and methods

The design includes observation, retrospective and prospective, clinical and cohort survey. The survey involved 98 patients who had undergone living donor kidney transplantation at Arabkir Medical Centre between 2002 and 2012. One recipient with recurrent kidney transplantation was included. The data, collected till December 1 2014, are summarized. Potential recipients and donors were examined in accordance with European protocols [*EBPG Expert Group on Renal Transplantation, 2000; 2002*]. The donor kidney structural and functional assessment was based on laboratory examinations (blood biochemistry, common urinalysis, etc.), ultrasound examination, angiography with "GE Innova 2000 Cath Lab" (USA) in Nork-Marash and QANCOR Medical Center, and CT angiography with "Siemens Sensation Cardiac 64 slices" (USA) and "Injector Medtron injektron CT2" (USA) in Nairi Medical Center. More recently, invasive angiography has been substituted by CT with intravenous contrast (with the possibility of vascular reconstruction). This method, being less invasive and traumatic, allowed to improve the results.

The relative criterion for donor kidney selection was the existence of a single arterial trunk. However, in some cases (e.g. additional vessels in both sides, etc.), kidneys with additional artery were taken as well.

Iliac vessels in recipients were studied based on Doppler scanning.

Results

From 98 recipients 66 (67.3%) were males and 32 (32.7%) – females. Twice as many donors were female (66.3%) and 39 (39.7%) were parents.

Left-sided nephrectomy was done in the majority of cases (78; 80%), from which 75 kidneys were implanted into the right and 3 to the left iliac fossa. Right-sided donor kidneys were implanted in 20 cases, 18 of which to the left and 2 to the right side. Indications for ipsilateral implantation were the following:

One patient already had a non-functioning transplant.

One patient had transplantation left to left because of intra-surgical complications on the right side (detachment of intima of an atherosclerotic vessel with formation of valvular mechanism, thrombosis of external iliac artery and donor artery). The kidney was removed, repeatedly rinsed by custodial solution and grafted in the left iliac fossa. Prosthetics of the right external iliac fossa of the recipient was performed with "Gore-Tex" vascular graft (USA).

Three other patients had a history of complicated appendicitis/appendectomy or right-sided inguinal hernia repairs.

Eighty six (87.8%) of 98 donor kidneys had a vascular pedicle with single arterial trunk, 6 (6.1%) had relatively big diameter additional trunk and 6 (6.1%) cases had small aberrant arterial branches. In the latter group, main renal artery anastomoses with external iliac artery was performed in 3 patients, and the remaining 3 cases had anastomoses to internal iliac artery. Distal parts of relatively big arteries were anastomosed side-to-side with formation of a single trunk (Fig. 1A). Three (3.1%) donor kidneys had additional veins. One donor had a complete kidney duplex collecting system.

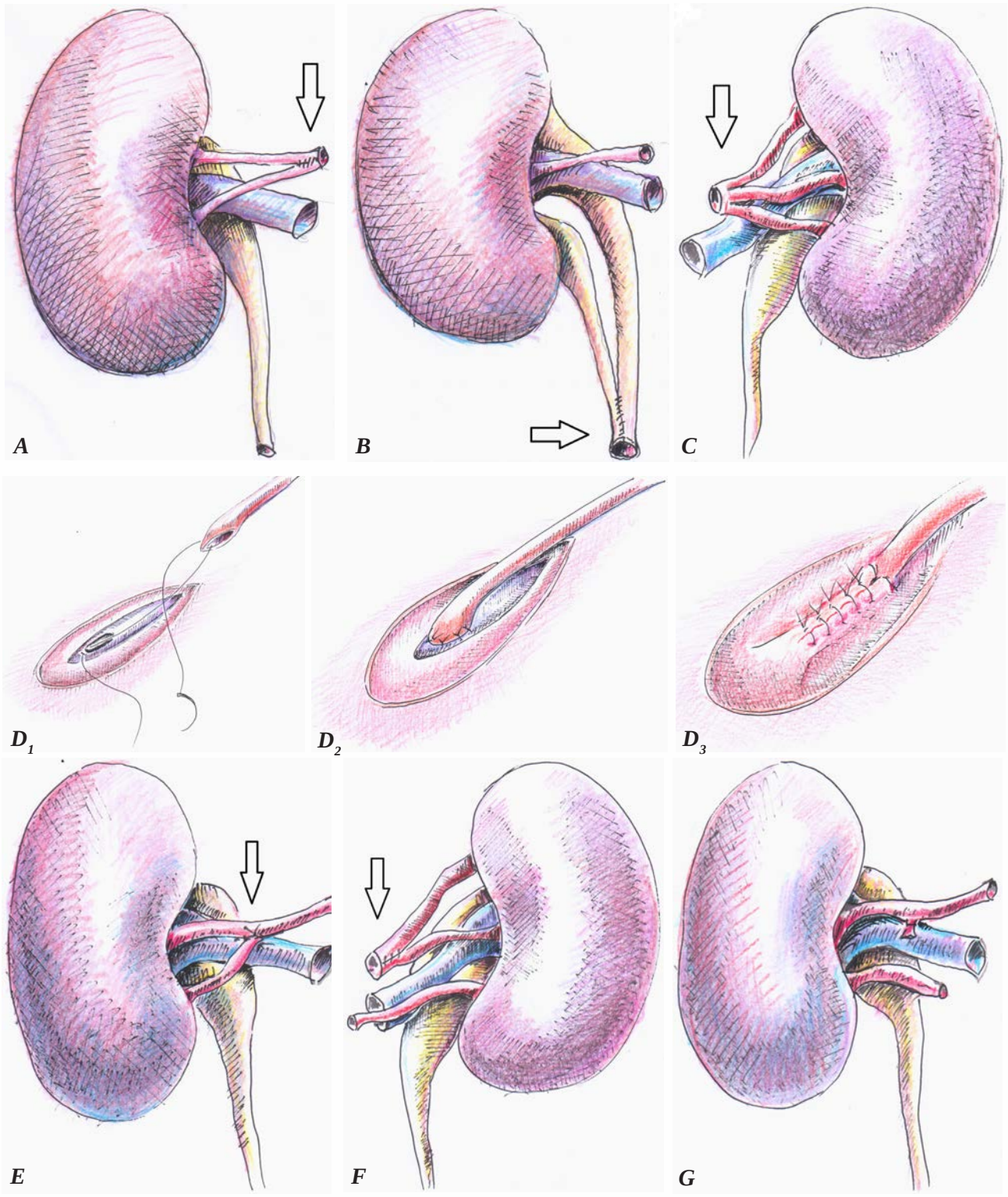

Figure 1. *A schematic presentation of surgical manipulations during kidney transplantation:*
A. *Formation of a single arterial trunk,*
B. *Interureteric distal anastomosis,*
C. *Short common arterial trunk of left kidney,*
D. *Ureteral regrafting according to Lich-Gregoir method,*
E. *End-to-end anastomosis with the stump of segmental branch,*
F. *Formation of arterial trunk from 2 segmental arteries of the kidney,*
G. *Donor kidney with ligated segmental branch.*

Arterial anastomosis end-to-side to the external iliac artery was performed in most of cases (72; 73.5%). In 19 (19.4%) patients anastomosis end-to-end to internal iliac artery was performed because of a short donor kidney artery, atherosclerotic changes of recipient's external iliac artery or certain anatomical peculiarities of arteries (Fig. 2). In 7 pediatric cases (7.1 %) due to small diameter of the external iliac artery, anastomosis was placed with common iliac artery (arteria iliaca communis). In 6 cases donor kidneys had additional arterial branches. All small diameter ones were anastomosed end-to-end to lower epigastric artery (arteria epigastrica inferior) (Fig. 3, 4). The frequency of various options of arterial anastomosis is shown in figure 5.

Renal veins in all patients were anastomosed end-to-side to the external iliac veins (vena iliaca externa) (Fig. 6). Additional renal veins were ligated. One donor kidney had 3 separate venous branches of almost similar diameter, from which 2 were ligated. The vein stemming from the middle part of renal hilus was preserved. After removing of vascular clips the kidney slightly increased in the size, but without any further complications.

Arterial anastomoses were performed using Prolene® 6-0 (Ethicon, USA) and/or Surgipro™ II 6-0 (Covidien, USA), and for venous anastomosis – Prolene 5-0 and/or Surgipro 5-0. Ureter and urinary bladder were connected using PDS® II 4-0/5-0 (Ethicon, USA) and/orDexon™ 4-0/5-0 (Covidien, USA).

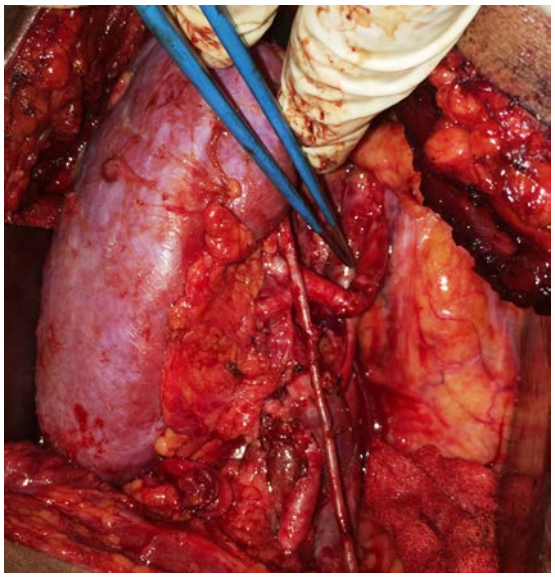

Figure 2. *End-to-end anastomosis between renal artery and internal iliac artery*

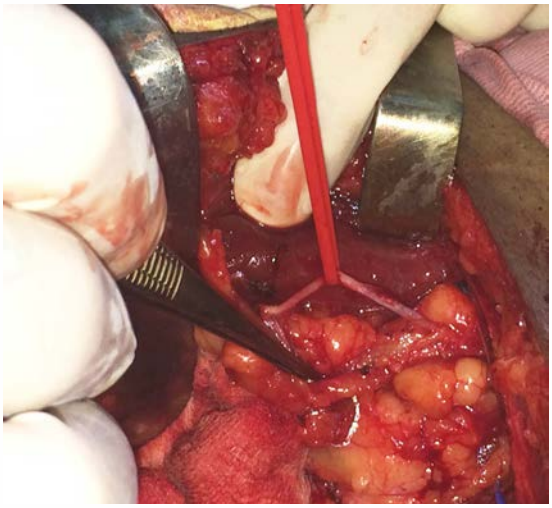

Figure 3. *Mobilization of lower epigastric artery*

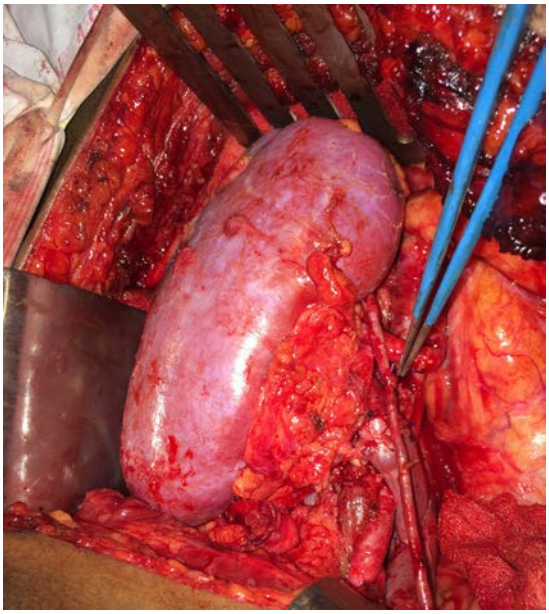

Figure 4. *Anastomosis between upper polar additional renal artery of the donor and lower epigastric artery of recipient*

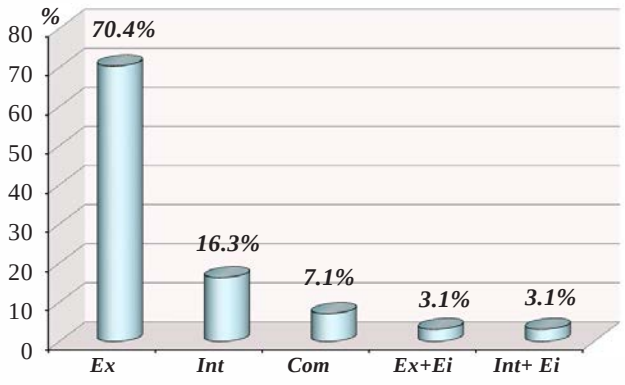

Figure 5. *Options of iliac artery anastomoses.*
Notes: ***Ex*** -externa, ***Int*** - interna, ***Com*** - communis, ***Ex+Ei*** - externa + epigastrica inferior, and ***Int+ Ei*** - interna + epigastrica inferior

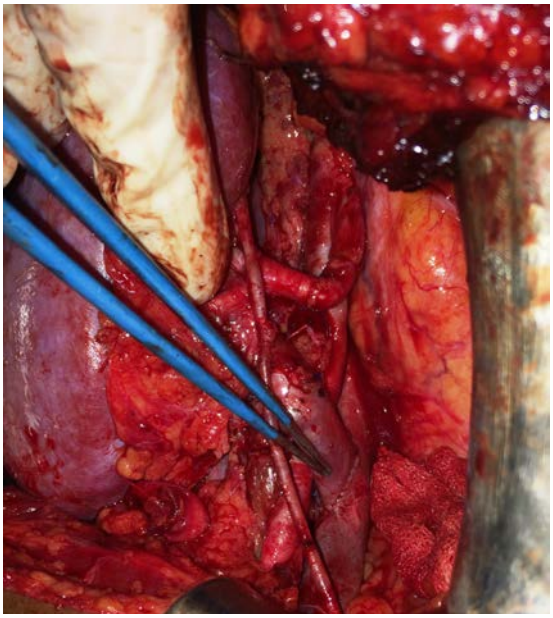

Figure 6. *Venous end-to-side anastomosis between renal vein and external iliac vein*

Since October 2004 three recipients had left-side donor kidneys grafted into the right iliac area in upturned upside-down position. This technique was applied due to anatomic specifics of renal artery, in order to avoid vascular kinking. No complications were detected.

While performing vesicoureteral anastomosis, ureteral stent was placed in all patients, except the one, who had complete duplex donor renal calices and pelvis system. Whereby, a preliminary side-to-side interureteric distal anastomosis was performed under cold ischemic time (Fig. 1B). Ureteral reimplantation of donor kidney was done by Lich-Gregoir technique (Fig. $1D_{1-3}$) [*Lich R et al., 1961; Gregoir W, Van Regemorter G, 1964*]. Urethral catheter was removed on the day 5 or 6 after surgery, while ureteral stents were left for 6 weeks.

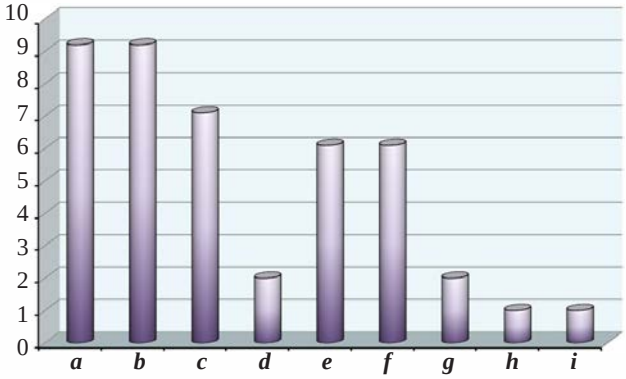

Figure 7. *Main complications in kidney transplantation*
Notes: ***a*** *– lymphocele;* ***b*** *– delayed graft function;* ***c*** *– intraoperative bleeding;* ***d*** *– postoperative bleeding;* ***e*** *– arterial thrombosis;* ***f*** *– stenosis of distal ureter;* ***g*** *– urethral stenosis;* ***h*** *– stenosis of proximal ureter;* ***i*** *– necrosis of distal ureter.*

Intra- and postsurgical complications: The most common complications during kidney transplantation were lymphocele and delayed graft function (9 cases each) (Fig. 7).

Intraoperative bleeding occurred in 9 recipients, from which in 6 immediately upon removal of vascular clips. From these causes anastomosis was not hermetic in 3 cases, not properly ligated small vascular branches in 2 cases, renal capsule injuries – in 2, damage of the wall of kidney vein – in 1, and in 1 case the cause of post-operative bleeding remained unknown. In all cases bleeding stopped intrasurgically. Only 1 case required red blood cell transfusion.

From all aforementioned cases 2 required recurrent surgical interventions. One patient had intensive hemorrhage from perinephric drainage immediately upon closing the wound. Surgical revision revealed bleeding from venous trunk in renal hilus, which was stopped by vein suturing. Another patient was operated on the day 4 due to bloody discharge from drainages and dropping hemoglobin level. However during the revision no bleeding vessel was detected. Large amounts of blood clots were evacuated from the perinephric area.

Lymphocele (collection of lymphatic fluid detected by ultrasound examination lasting more than 1 month) was found in 38 (38.8%) out of 98 recipients. However, only 9 (9.2%) cases required further interventions. Indications included intensive pain, and urine outflow disturbance due to compression. Five patients had 1 to 8 percutaneous punctures, with final elimination of lymphocele. One patient had laparoscopic fenestration of lymphocele into abdominal cavity. In 2 cases temporary external drainage was introduced with further marsupialization into abdominal cavity.

Delayed graft function in most cases is due to acute tubular necrosis and is detected in 9 (9.2%) recipients. The diagnosis of acute tubular necrosis is based on the biopsy in 3 cases and on clinical ground – in 6. The average warm ischemic time in the acute tubular necrosis group was 61.8 ± 21.2 minutes (47-117) versus 45.3 ± 9.5 minutes (26-80) in patients without acute tubular necrosis ($p<0.001$) [*Voskanyan MM, 2014*]. Albeit the dura-

tion of warm ischemic time plays apparently key role, it is not the only factor contributing to acute tubular necrosis. In some patients with immediate renal function the warm ischemic time exceeded 1 hour (maximum 80 minutes), whereas delayed function was detected in a patient with that of 47 minutes. Clearly, individual renal sensitivity to ischemia plays important role in acute tubular necrosis. It is noteworthy that throughout the entire process of anastomosing all kidneys were wrapped in ice-soaked pads. The anastomosis type and implantation side had no impact on the duration of warm ischemia time (H- Kruskal-Wallis criteria 3.150; p=0.533; U-Mann–Whitney 869.00; p=0.206).

Arterial thrombosis was developed in 3 recipients, including in 1 as complication of the concomitant morbidity, i.e. homocysteinemia. In 2 other cases arterial thrombosis was developed as a consequence of the method of anastomosis that was chosen not optimal for certain anatomic features of the donor arteries. The donor of the first patient (recipient A) had early branching of the renal artery trunk resulting in opening of 3 segment branches into a short common site (Fig. 1C). On CT-angiography segmental arteries of the left kidney conflate into the common trunk forming kidney artery (early branching) (Fig. 8). To ensure the donor's safety, longer than needed stump of renal arteries was left, which resulted in short common

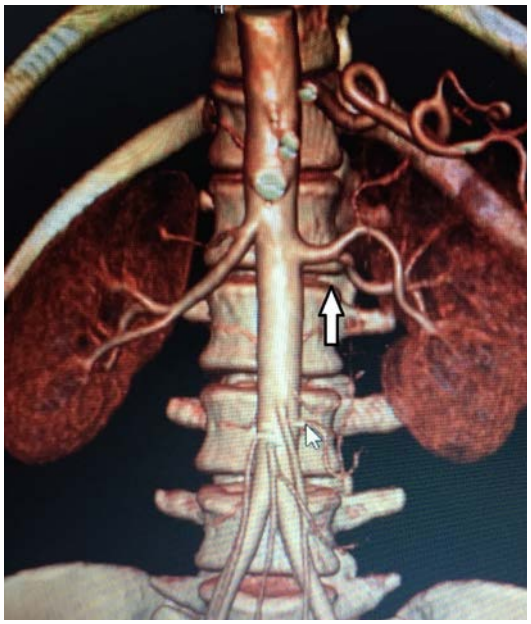

Figure 8. *CT angiography of the donor of recipient A (the arrow shows early branching of the artery trunk)*

arterial trunk of the donor kidney. This led to narrowing of one of the segment branches with the anastomosis stitch and dysfunction of transplanted kidney in post-surgical period. Doppler scanning revealed depleted blood circulation of the kidney pole with further complete thrombosis of the arterial trunk.

In another case (recipient B) the cause of arterial thrombosis was the attempt to reestablish the blood flow in the donor's kidney segmental branch that was accidentally ligated in close vicinity of common arterial trunk during nephrectomy. End-to-end anastomosis was performed to the stump of segmental branch (Fig. 1E). This led to the thrombosis of segmental branch and extension further of the thrombus into renal artery.

The donor of recipient B had right side nephrectomy (single kidney artery) (Fig. 9A), so the left kidney had 2 arterial trunks (Fig. 9B).

Retrospective analysis of 2 cases gives good basis to conclude that the following modifications could help to optimally address prevention of arterial thrombosis:

Recipient A – removal of the small "arterial site", formation of a single arterial trunk by connecting 2 relevantly big diameter segmental branches (Fig. 1F. The formed arterial trunk could be connected to internal or external iliac artery and the third segmental branch – to the lower epigastric artery (Fig. 4).

Recipient B – to leave the segmental trunk ligature applied during nephrectomy (Fig. 1G), to anastomose the renal artery to external or internal iliac artery and connect the segmental branch either to the lower epigastric artery (which was successfully done in six recipients, Fig. 4) or to the external iliac artery.

Ureteral complications. Complications related to distorted urinary tract patency of donor kidneys were detected in 5 patients. In all cases dilatation of ureter and renal pelvis as well as elevated creatinine level of blood were present. Four patients out of 5 had urine outflow disorder inflicted by the leisure of distal part of the ureter: stenosis – 2, cystic transformation – 1, necrosis – 1. All 4 patients had ureteral resection and reimplantation in the bladder. Obstruction of ureteral proximal part was corrected by pyeloplasty. Good results were registered in all cases of reintervention.

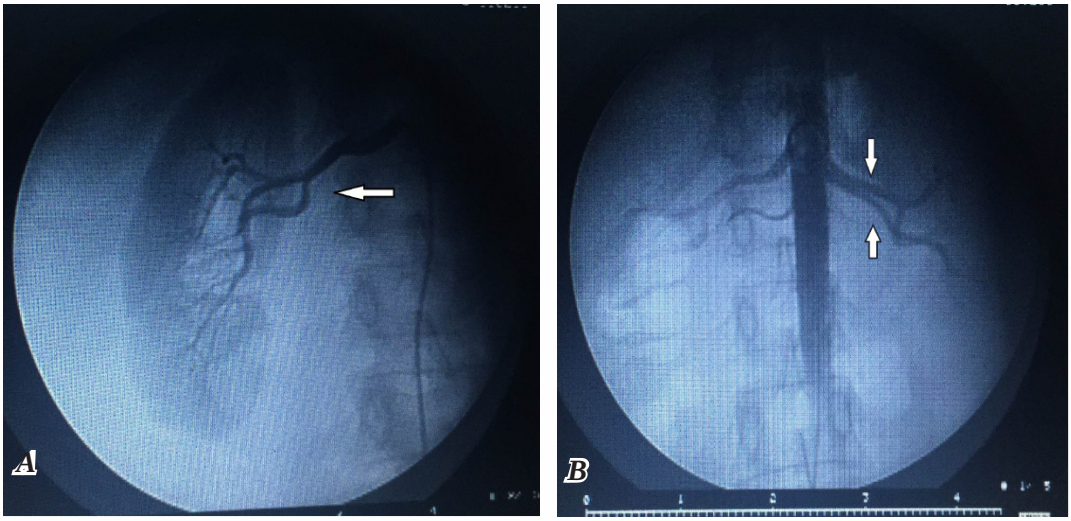

Figure 9. *Selective angiography of the right (**A**) and left (**B**) kidney of the donor of recipient B. The arrow shows in **A**- the artery branch ligated during nephrectomy, in **B** - the arrows show 2 arterial trunks of the left kidney*

Urethral stenosis. Narrowing of the urethra was detected in 2 male recipients and was considered as a complication of the urinary catheterization (no dysuria reported prior to transplantation). In both cases urethral catheters were removed on day 6 after surgery. Most probably there was urethritis with further formation of urethral stricture, diagnosed by ureteroscopy. In 1 patient the stricture was in bulbar part and in the second in pendulous part of urethra. In both cases treatment started with urethral bougienage, which turned effective in patient with stenosis of the pendulous urethra. The patient with bulbar stenosis had circumcision because of cicatrical phimosis and transurethral dissection of urethral stenosis. Later the patient had a second dissection of the stricture and several urethral bougienages.

Loss of graft function was detected in 11 cases. The causes were:

Arterial thrombosis as a post-surgical complication – 2,

Arterial thrombosis induced by homocysteinemia – 1,

Severe acute rejection resistant to immunosuppressive therapy – 1,

Curtailed dosage of immunosuppression in patients with Kaposi sarcoma – 1

Pulmonary tuberculosis – 1,

Noncompliance – 4,

Chronic allograft nephropathy – 1.

Thus, only in 2 cases (2%) graft loss was directly related to the type of donor kidney artery anastomosis. From 11 cases only 4 (4.1%) required graft removal. Because of close adhesion with enveloping tissues of the capsule of the transplanted kidneys the nephrectomy was done primarily subcapsular with no further post-surgical complications.

Conclusion

Present study confirms the generally accepted opinion that the transplanting of donor's left kidney in the recipient's right iliac fossa is the most convenient approach. However, it is also possible to implant right kidney into recipient's right iliac fossa and even turn upside down if needed.

Most common early complications in our patients were bleeding – 9 (9.2%), acute tubular necrosis – 9 (9.2%), and arterial thrombosis – 3 (3.1%). In later stages the following complications were detected: lymphocele – 9 (9.2%), urethral obstruction – 5 (5.1%), and urethral stenosis –2 (2%).

Post-surgical hemorrhage in most cases should be attributed to improper anastomosing; poor quality of minute vessel ligation when taking donor kidney or the latter's treatment under cold ischemia.

Long-term warm ischemic time was the main cause of delayed graft function. It shpulf be mentioned, that anastomosis type and side of implantation had no impact on warm ischemic time.

Arterial thrombosis in 2 cases was related to technical inaccuracy during donor nephrectomy and further selection of the type of arterial anastomosis. Application of alternative methods, described by the authors could possibly help avoiding further development of renal ar-

tery thrombosis.

To prevent lymphocele, the lymphatic vessels should be thoroughly ligated when taking the donor kidney and preparing the recipient's iliac fossa for implantation. In most cases lymphocele can be eliminated by recurrent punctures. In case of failure, good results can be achieved both by internal (laparoscopic fenestration) and external drainage.

The most common complication related to transplanted kidney ureter was distal stenosis, which required resection and reimplantation of the ureter in the bladder. It is important to preserve the vascularization of the ureter during nephrectomy and kidney preparation for future implantation. For this purpose it is recommended to preserve the periurethral tissues (blood supply).

Although recipient urethral stenosis is rather uncommon complication, its management remains a challenge. Hence we recommend not only short-term catheterization with small-diameter catheters, but also strict hygiene and careful handling.

The loss of function of transplanted kidney in 4 recipients due to noncompliance allows to state, that sociologists and psychologists must be involved in the process of follow-up and treatment.

Acknowledgement

Author expresses his gratitude to Dr. P. Geyikyan for providing photos for this manuscript.

REFERENCES

1. *Kuss R, Teinturier J, Milliez P*. [Some attempts at kidney transplantation in man] [Published in French]. Mem Acad Chir (Paris). 1951; 77(22-24): 755-764.
2. *Hamilton D*. Kidney transplantation: A history. In P.J. Morris, Ed., Kidney Transplantation Principles and Practice. W.B. Saunders Company. Philadelphia. 1988. pp. 1-11.
3. *John M*. Renal Transplantation, In: Campbell's Urology, Eighth Edition. Elsevier Science. Philadelphia, Pennsylvania, USA. 2002. pp. 358-359.
4. *Stuart M*. Renal Transplantation, In: Smith's general Urology, Seventeenth Edition. Lange Medical Publication. New York, USA. 2008. pp. 547-548.
5. *Morris PJ, Knechtle SJ.* Kidney transplantation: Principles and practice. 6th edition. Elsevier, Philadelphia. 2008. pp. 163-168.
6. *Kakaei F, Nikeghbalian S, Malekhosseini SA.* Kidney Transplantation Techniques in Thomas Rath (Ed.): Current Issues and Future Direction in Kidney Transplantation. 2013. pp. 180-182.
7. *EBPG Expert Group on Renal Transplantation*. I.4 Contra-indications for transplantation. Nephrol Dial Transplant. 2000; 15(7): 5-6.
8. *EBPG Expert Group on Renal Transplantation.* European best practice guidelines for renal transplantation. Section IV: Long-term management of the transplant recipient. IV.11 Paediatrics (specific problems). Nephrol Dial Transplant. 2002; 17(4): 55-58.
9. *Lich RJ, Howerton LW, Davis LA.* Recurrent urosepsis in children. J Urol. 1961; 86: 554-558.
10. *Gregoir W, Van Regemorter G.* Le reflux vesico-ureteral congenital. Urol Int. 1964; 18: 122-136.
11. *Voskanyan MM*. [Ways to improve immediate and remote results of kidney transplantation in the Republic of Armenia: abstract of a thesis for PhD degree] [Published in Russian]. YSMU after M. Heratsi. 2014. pp. 13-14.