Predictive Factors of Surgical Complications in the First Year Following Kidney Transplantation

Pauline Salamin,[1] Céline Deslarzes-Dubuis,[1] Alban Longchamp,[1] Séverine Petitprez,[1] Jean-Pierre Venetz,[2] Jean-Marc Corpataux,[1,#] and Sébastien Déglise,[1,#] Lausanne, Switzerland

Background: In the recent years, an increased use of marginal donors and grafts and a growing prevalence of peripheral arterial disease in the recipients have been observed. Meanwhile, the open surgical technique for kidney transplantation has not changed. The aim of this study is to analyze all surgical complications occurring in the first year after kidney transplant and to determine potential predictive risk factors.

Methods: Data of the 399 patients who underwent kidney transplant in our University Hospital between January 2006 and December 2015 were retrospectively reviewed. The primary endpoint was the overall rate of vascular, parietal and urological complications at 1 year following kidney transplantation. The secondary outcomes were graft and patient' survival rates, and the identification of predictive factors of the surgical complications.

Results: 24% of patients developed 134 complications. Vascular complication represented 39% of all complications and resulted in 9 graft losses. Parietal and urological complications represented 46–15% of all complications, respectively, No parietal or urological complications were associated with graft loss. 5 patients died during the 1st year, none of these cases was associated with graft loss. The graft survival rate reached 96% at 1 year, including patients still alive. The occurrence of surgical complication was associated with reduced graft survival at 1 year. Using a multivariate analysis, 4 predictive factors were identified: age, deceased donor, operative time and dyslipidemia.

Conclusion: Surgical complications after kidney transplantation remained frequent and age, deceased kidney donors, and operative time were identified as risk factors. As vascular complications were a major cause of early graft loss, efforts should aim to reduce their occurrence to increase graft survival.

INTRODUCTION

Kidney transplantation is the best treatment for patients suffering end-stage renal disease (ESRD), and offers better quality of life, cost-effectiveness and survival compared to dialysis.[1–3] However, kidney transplantation is limited by an inadequate supply of donor to treat all those who could benefit. This resulted in an increased use of marginal donors, with more comorbidities. Similarly, in dialysed patient the rate of diabetes and obesity is growing, as well as the prevalence peripheral arterial disease, which can lead to more technically challenging procedures. Surprisingly, the current open surgical technique for kidney

[1] *Department of Vascular Surgery, Lausanne University Hospital (CHUV) and University of Lausanne, Lausanne, Switzerland*

[2] *Department of Organ Transplantation, Lausanne University Hospital (CHUV) and University of Lausanne, Lausanne, Switzerland*

Correspondence to: Sebastien Déglise, MD, Department of Vascular Surgery, Lausanne University Hospital, Rue du Bugnon 46, Lausanne, 1011, Switzerland; E-mail: Sebastien.Deglise@chuv.ch

[#] *The authors contributed equally to this work.*

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transplants has changed little from the original pelvic operation described in 1951 by Kuss et al. The overall incidence of surgical complications after kidney transplantation ranges between 5%–38%.[4,5] Complications can be divided into vascular, parietal and urological complications. Vascular complications are the most serious and include renal artery and vein stenosis, kinking thrombosis, or anastomosis failure and hemorrhage. Parietal and urological complications included ureteral stenosis, urinary leak, peritransplant fluid collections (hematomas, lymphoceles). Early identification, and treatment is mandatory to save the graft and to improve the prognosis, as surgical complications can threaten the graft, and patient' survival.[5]

The aim of this study is to retrospectively analyze all surgical complications occurring in the first year after kidney transplant, to determine their exact incidence and potential predictive risk factors.

MATERIALS AND METHODS

Study Design

This is a retrospective observational cohort study. Using the medical records of the Department of Vascular Surgery of the University Hospital of Lausanne, we retrospectively reviewed data on all kidney transplants performed at our institution over a 10-years period from January 2006 to December 2015. This study was approved by our local Ethical Committee (CER-VD 2017-01281). Descriptive data collected included recipient gender, comorbidities, operative time, warm and cold ischemia time, presence of multiple vessels of the graft (arteries and veins), calcifications or stenosis of the recipient iliac vessels, presence of peripheral arterial disease (PAD), and expertise of the surgeon. Complications such as vascular, parietal and urological at 1 year after transplantation were analyzed. Patients over 18 years old who has received a kidney transplant were included. We divided the 10-year study period in 3 different groups containing approximately the same number of patients in order to compare the rate of complications. The group 1 included 140 patients between 2006 and 2009, the group 2 included 137 patients between 2010 and 2012 and the group 3 included 123 patients between 2013 and 2015.

Definitions

A surgical complication was defined as every complication which needed a surgical reintervention (Grade III according to Clavien's classification).[6]

The cold ischaemia time was defined as the length of time that elapsed between the kidney was removed from the donor to its transplantation into the recipient. The warm ischemia time was defined as the time when the kidney remained at body temperature after its blood supply has been reduced. This corresponds to the time from beginning of first anastomosis to tl the end of the second anastomosis and declamping.

All the patients who already had a laparotomy or had a surgical intervention on the same side of the graft or had undergone a peritoneal dialysis were included in a "surgical redo group".

Surgical Technique

2 different surgeons performed all kidney transplantations during the study period, 1 vascular surgeon and 1 visceral surgeon. Both surgeons led the operation helped by his own team and both used the same surgical technique, as described below.

The graft was prepared off table before the surgery by the surgeon in charge. He examined the quality of the parenchyma and inspected all the vessels, looking for thrombosis or calcification. In the presence of multiple arteries, the surgeon decided either to anastomose the aortic patch directly on the recipient iliac artery or to anastomose the arteries together or to reimplante separately the arteries on the recipient iliac artery. All the multiples veins were either anastomosed together, or reimplant separately or ligated if the vein was very small.

The incision was made 2 cm above and parallel to the inguinal ligament, extending from the lateral edge of the rectus sheath to the anterior superior iliac spine. If encountered, the superficial epigastric vessels may be ligated and divided to improve exposure and to prevent inadvertent bleeding. After dividing the external oblique aponeurosis, the internal oblique and transversus muscles and transversalis fascia were opened laterally. At this point, the peritoneum was separated from extraperitoneal fat and the anterior abdominal wall using a sponge stick. The external iliac artery was found and the external iliac vein lies on the artery's posteromedial surface. Dissections of the vessels were done cautiously and lymphatics vessels were ligated to minimize lymphocele. A bolus of 50UI/kg of Heparin was given prior to clamping. The renal vein was first anastomosed end-to-side to the external iliac vein using 6–0 non-resorbable running suture. The renal artery was then anastomosed to the common or the external

iliac artery, with an end-to-side anastomosis, using 6–0 non-resorbable running suture. Once the kidney was perfused, urinary continuity was restored. The distal part of the ureter was spatulated and anastomosed to the recipient bladder mucosa by 2 running sutures. A double JJ drainage was systematically placed and kept in place for one month.

Post-Operative Management

After the operation, all patients were followed in the organ transplantation center in accordance with standard protocols, and all data were recorded prospectively in a computer database.

The same immunosuppressive regimen has been used in our center since April 2003. Induction therapy is with basiliximab for first kidney transplants. Maintenance therapy comprises tacrolimus, steroids and mycophenolate mofetil After 1 year, in the absence of acute rejection or anti-HLA antibodies, steroids are withdrawn.

Three to 6 months universal CMV (cytomegalovirus) prophylaxis with valganciclovir was administered. Following the cessation of valganciclovir prophylaxis, patients were monitored by PCR for CMV DNA every 15 days during 3 months. Antimicrobial prophylaxis consisted of valacyclovir for HSV (herpes simplex virus) and VZV (varicella zoster virus) for 3 months, cotrimoxazole for 6 months to prevent PCP (Pneumoncystis jirovecii) infection, toxoplasmosis and urinary tract infection.

Endpoints

The primary outcome was the overall rate of vascular, parietal and urological complications at 1 year following kidney transplantation. Arterial/venous graft stenosis, malposition of the graft, arterial/venous graft thrombosis, hemorrhage and hematoma were considered as vascular complications. Lymphocele and eventration/incarceration were considered as parietal complications. Urinary leakage and ureteral stenosis requiring a treatment were considered as urological complications.

The secondary outcomes were graft and patient' survival rates and the identification of predictive factors of the surgical complications. In the univariate analysis, predictive factors used were age, sex, type of donor (deceased versus living), type of surgeon (vascular versus visceral), operative time, warm and cold ischemia, previous renal graft and comorbidities such as hypertension, diabetes, dyslipidemia, obesity, heart disease, chronic obstructive pulmonary disease (COPD), PAD, thromboembolic disease, benign prostatic hypertrophy, previous other organ transplantation, other organ transplantation perioperative.

In the multivariate model, the predictive factors that were considered statistically relevant ($P < 0.2$) in the univariate analysis were used such as age, sex, type of donor, type of surgeon, operative time, hypertension, diabetes, dyslipidemia, obesity, heart disease and benign prostatic hypertrophy. Mean warm ischemia time was only available in 203 patients, and was removed from the model. Mean cold ischemia time was also removed because of its strong correlation with the type of donor. The COPD predictive factor was analysed in the univariate model with a Fisher's exact test and then could not be used in the multivariate model.

Statistical Analysis

The patient, surgical and complications variables were analyzed using descriptive statistics. Summary statistics are presented as means ± standard deviation, or median as appropriate. The statistical analyses included *t*-tests for 2 independent samples (normality and homogeneity of variances was verified). Categorical variables were compared using the $\chi 2$ test or Fisher's exact test. Baseline predictive factors were initially analyzed univariately. We analysed the correlation between the variables and removed the cold ischemia because of its strong statistical link with the type of donor. Predictive factors that were considered statistically relevant ($P < 0.2$) on univariate analysis were studied in a multivariate logistic regression analysis with backward stepwise selection. We used the ROC and the AIC value to identify the final multivariate model. In the multivariate model, warm ischemia was removed because of its lack of value ($n = 203$). Data were given with *P*-value, statistically significant if $P < 0.05$. All statistical analyses were conducted using STATA software (v14.0).

RESULTS

Baseline Characteristics

Baseline characteristics are presented in (Table I). Median recipients' age was 53.2 ± 14.4 years. Kidney allograft recipients were more likely to be men (67% vs. 33%), and to receive a kidney from a deceased donor (52% vs. 48%). In the majority of cases, this was the first kidney transplantation (83%). A total of 142 patients (35.6%) were included in the redo surgery group. A total of

Table I. Baseline patients characteristics

Variable	$n = (\%)$, mean ± SD
Number of patients	399 (100%)
Mean age (years)	53.2 ± 14.4
Men	266 (67%)
Hypertension	311 (77.9%)
Diabetes	64 (16%)
Dyslipidemia	143 (35.8%)
Obesity	58 (14.5%)
Heart disease	151 (37.8%)
Chronic obstructive pulmonary disease (COPD)	9 (2.3%)
Peripheral arterial disease (PAD)	32 (8%)
Thromboembolic disease	10 (2.5%)
Benign prostatic hypertrophy	25 (6.3%)
Previous other organ transplants (heart/lung/liver)	10 (2.5%)
Other transplants intraoperative	4 (1%)
Iliac calcifications	38 (9.5%)
Multiple vessels of the graft	58 (14.5%)
Arteries	43 (10.7%)
Veins	15 (3.8%)
Surgical redo	142 (35.6%)

Table II. Surgical data

Variable	$n = (\%)$, mean ± SD
Living donor	191 (48%)
Deceased donor	208 (52%)
Graft characteristic :	332 (83%)
First graft	67 (17%)
Regraft	
Mean operative time (min)[a]	155.8 ± 50.2
Mean cold ischemia time (min)[b]	377.3 ± 357.6
Mean warm ischemia time (min)[c]	35.5 ± 12
Surgeon :	275 (69%)
Vascular	124 (31%)
Visceral	

[a] $n = 399$
[b] $n = 399$
[c] $n = 203$

77.9% recipients had hypertension, 37.8% had heart disease, 35.8% dyslipidemia, 16% diabetes and 14.5% were obese (BMI >25kg/m^2). 32 (8%) patients had a diagnosis of PAD. Moreover, 33 (8.3%) recipients had iliac calcifications without stenosis and 5 (1.25%) with a stenosis, which required a surgical management during the transplantation. 2 third of these transplantations (69% vs. 31%) were performed by vascular surgeons. The median cold and warm ischemia time were 377.3 ± 357.6 minutes and 35.5 ± 12.0 mins, respectively. The median operative time was 155.8 ± 50.2 mins (Table II). No patient was lost from follow-up, and the index of follow up at 1 year reached 100%.

Concerning the graft vascularization, 43 (11%) grafts had multiples arteries, 15 (3.8%) had multiples veins with a total of 58 (14.5%) grafts with multiple vessels. All the renal parenchymas were described as good quality by the surgeon in charge.

Rate of Complications

Of the 399 patients who underwent renal transplant, 134 complications were observed in 97 (24%) patients (Table III). The rate of complications for all the transplantations reached 33.5%. We observed a total of 52 (39%) vascular complications, of 62 (46%) parietal complications and of 20 (15%) urological complications.

Table III. Surgical complications and reintervention during the first year

Total number of complications Vascular complications:	134 (100%) 52 (39%)	Interventions 134 (100%)
Arterial/venous graft stenosis	7	2 percutaneous angioplasty (1) 3 arterial anastomosis revision 1 ilio-renal venous bypass 1 explantation
Malposition of the graft	6	4 graft repositioning 2 arterial anastomosis revision
Arterial/venous graft thrombosis	7	1 thrombectomy and salvage of the graft 6 explantation
Hemorrhage	7	1 arterial anastomosis revision 1 venous anastomosis revision 1 hemostasis by clip 1 hemostasis by direct venous suture 1 hemostasis and reimplantation of the graft (aorta/veina cava inferior) 2 explantation
Hematoma	25	25 hematoma evacuations and hemostasis
Parietal complications:	62 (46%)	
Lymphocele	43	36 surgical drainages
(Recurrence of lymphocele)	(14)	21 percutaneous drainage s
Eventration/Incarceration	19	20 repair of eventration
(Reccurence of eventration/incarceration)	(1)	
Urological complications:	20 (15%)	
Urinary leakage	11	4 double J catheter 7 ureterovesical anastomosis revision
Ureteral stenosis	9	2 double J catheter 2 nephrostomy 5 ureterovesical anastomosis revision

The vascular complications ($n = 52$, 39%) occurred in 49 patients. The rate of patients with vascular complications reached 12.3%. Among the vascular complications, there were 7 vessel graft stenoses. 2 were treated by percutaneous transluminal angioplasty, and 4 with open revision. 1 of them could not be corrected and led to graft explantation. 6 graft malposition was recorded, 4 of them were treated by graft repositioning, and 2 of them required also an arterial revision with a patch angioplasty. 7 graft thromboses occurred, leading to 6 early graft explantations (86%) with a mean time to explantation of 2.8 ± 3.5 days. 1 graft was saved after a successful surgical thrombectomy. 7 graft revisions and hemostasis were required following post-operative hemorrhage, resulting in 2 graft losses. Overall, 29% of all post-operative hemorrhage led to graft explantation. Overall, 17% of vascular complications led to a graft loss.

Almost half of the complications were parietal complications ($n = 62$, 46%). These 62 complications occurred in 53 patients. The rate of patients with parietal complications reached 13.2%. The rate of parietal complications was 15.5%.We observed a total of 57 lymphoceles including 14 recurrences. Open surgical drainage was performed in 36 cases and percutaneous drainage in 21. 19 incisional hernias (eventration/incarceration) were identified and repaired by open surgery.

20 (15%) urological complications were observed including 11 urinary leakages and 9 ureteral stenoses. These 20 complications occurred in 19 patients. The rate of patients with urological complications reached 4.8%. The rate of urological complications was 5%. Among the 11 urinary leakages, 4 were treated by double J drainage, and 7 required open surgery with a revision of the ureterovesical anastomosis. 9 ureteral stenoses were treated by 2 double J catheters, 2 nephrostomies and 5 ureterovesical by anastomosis revisions.

The 10-years study period between 2006 and 2015 was then separated in 3 groups in order to distinguish a difference between the complications rate. Group 1 included 140 patients from January

Table IV. Anatomical factors

	$n = (\%)$	Withcomplications	Withoutcomplications	P value
Multiple arteries	43 (11%)	12 (9%)	31 (12%)	0.49
Multiple veins	15 (3.8%)	5(3.7%)	10 (3.8%)	1
Multiple vessels		15 (11.2%)	43 (16.2%)	0.23
Arteries	58 (14.5%)			
Veins	43 (11%)			
	15 (3.8%)			
Surgical redo	142 (35.6%)	34 (25.3%)	108 (40.7%)	0.003
Iliac calcifications	38 (9.5%)			
without stenosis	33 (8.2%)	12 (9%)	21 (7.9%)	0.7
with stenosis	5 (1.3%)	3 (2.2%)	1 (0.4%)	0.11

2006 to December 2009, group 2 included 137 patients from January 2010 to December 2012 and group 3 included 122 patients from January 2013 to December 2015. The total number of complications in each group was 55, 32 and 47, respectively. These complications occurred in 37 patients (26%), 26 patients (21%) and 34 patients (28%), respectively, without any difference between the groups. The total number of graft losses was 7 (5%), 4 (2.9%) and 3 (2.5%), respectively.

Survival Rates

Within the first year, 14 (3.5%) graft losses were observed. Among these 14 graft losses, 12 (86%) kidneys were explanted. 9 of them were due to vascular complications, representing 64% of all the graft losses. There was no graft loss associated with parietal or urological complications. The mean time to graft explantation was 53 ± 25 days. Among the patients still alive at 1 year, the graft survival reached 96% (380/394). Patients with surgical complications had a statistically significant reduced graft survival rate (91% vs. 98%, $P < 0.001$).

5 patients died (1.25%) during the first year. 4 were due to events unrelated to surgery, and 1 patient died of heart failure following a surgical evacuation of a perigraft hematoma. None of these cases was associated with a graft loss. The mean time to death was 135.4 days ± 122.3 days.

Predictive Factors

First, we looked to the association between some anatomical factors such as the presence of multiple vessels of the graft and occurrence of complications (Table IV). There was no significant difference between the groups with and without complications regarding the presence of multiple vessels. There were significantly less patients with redo surgery in the group with complications (40.7% vs. 25.3%). Finally, there was no difference regarding the presence of iliac calcifications between both groups.

Predictive factors of complications were first investigated through univariate analysis (Table V). The type of donor (deceased versus living) was the most important predictive factor of surgical complication on univariate analysis with an OR of 2.71. In our center, complications were less frequent, when surgery was performed by a vascular surgeon (OR = 0.517, $P = 0.007$). Comorbidities predicting surgical complications were heart disease (OR = 1.89, $P = 0.007$), dyslipidemia (OR = 1.801, $P = 0.013$), and obesity (OR = 1.97, $P = 0.024$). Of note, the rate of regraft, which reached 17% didn't influence the occurrence of complications ($P = 0.593$).

According to the results of the univariate analysis, our study population was then separated into 2 groups of patients (Table VI). The first group included all patients operated by the vascular surgeon ($n = 275$) and the second group included the patients operated by the visceral surgeon ($n = 124$). The number of patients with surgical complications were $n = 56$ (20%) and $n = 41$ (33%), respectively. The p-value calculated to compare the proportion of all complications in the2 groups was $P = 0.093$. When considering only the vascular complications and analysing each subgroup of these complications, no significant difference was observed between both groups (data not shown). The only statistically significant difference was the mean operative time, which was lower in the group operated by the vascular surgeon (149.3 ± 50.4 mins) than in the group operated by the visceral surgeon (170.3 ± 46.6 mins) ($P < 0.001$).

Next, in multivariate model, we entered all predictive factors associated with outcome at

Table V. Predictive factors

	UNIVARIATE			MULTIVARIATE		
	OR	Confidence interval	*P*-value	OR	Confidence interval	*P*-value
Age	1.02	1.012 :1.048	0.001	1.021	1.002 :1.040	0.027
Sex (men =1)	1.717	1.023 :2.882	0.04			
Type of donor (deceased = 1)	2.71	1.66 :4.43	0	2.77	1.665 :4.606	0
Surgeon (vascular = 1)	0.517	0.321 :0.838	0.007			
OP time	1.006	1.002 :1.011	0.003	1.007	1.003 :1.011	0.003
Warm ischemia ($n = 203$)	1.036	1.006:1.066	0.016			
Cold ischemia	1.001	1.0002 :1.0015	0.01			
Regraft	1.176	0.648 :2.135	0.593			
Hypertension	0.705	0.415 :1.197	0.196			
Diabetes	1.52	0.847 :2.738	0.16			
Dyslipidemia	1.801	1.130 :2.871	0.013	1.743	1.054251 :2.884	0.03
Obesity	1.97	1.093:3.581	0.024			
Heart disease	1.89	1.19 :3.009	0.007			
BPCO[a]			0.121			
Peripheral arterial disease (PAD)	1.46	0.667 :3.208	0.342			
Thromboembolic disease	2.12	0.586:7.68	0.252			
Benign prostatic hypertrophy	1.82	0.78 :4.28	0.165			
Previous other organ transplants (heart/lung/liver)	1.344	0.340 :5.305	0.672			
Other transplants intraoperative[a]			0.576			

[a]Fisher's test

P-value <0.2 including age, sex, type of donor, type of surgeon, mean operative time, hypertension, diabetes, dyslipidemia, obesity, heart disease and benign prostatic hypertrophy into stepwise multivariate regression. Mean warm ischemia time was only available in 203 patients, and was removed from the model. Mean cold ischemia time was also removed because of its strong correlation with the type of donor. Predictive factors that remained statistically significant were: deceased donor (OR 2.8), dyslipidemia (OR 1.7), age (OR 1.02) and operative time (OR 1.01) (Table IV).

DISCUSSION

In this retrospective study including 399 patients following kidney transplantation, 24% of patients developed complications requiring a surgical reintervention during the first year following the surgery. This is in accordance with previous studies, with a rate of surgical complications varying between 15.5– 38%.[5,7] Efforts to limit complications in surgery, and optimize hospital throughput are intensifying as the number of patients with access to care increases, even as hospital reimbursement and expansion are constrained. In addition, graft survival was significantly decreased when a surgical complication occurred, confirming previous reports.[5,7–10] However, in contrast to these reports, patient survival wasn't affected.

Parietal complications were the most frequent cause of reintervention, with an incidence of 13.2%, lymphoceles. This is higher than previously published, which varies between 1.8– 8,4%.[5,20] In our study, we included every lymph collection that accumulates around the graft requiring surgery, including recurrence. When excluding the lymphocele recurrence ($n = 14$), rate of lymphocele was 11%, which is in accordance with the published studies. Importantly, this never led to death or loss of the graft function. Among published factors impacting lymphocele formation, treatment of transplanted patients with the mammalian target of rapamycin (mTOR) inhibitors, were shown to negatively influence healing of lymphatic

Table VI. Vascular surgeon and visceral surgeon, Variable: $n = (\%)$, mean ± SD

	Vascular surgeon($n = 275$)	Visceral surgeon($n = 124$)	*P*-value
Men	173 (63%)	93 (75%)	0.018
Age (years)	52.8 ± 14.1	54.1 ± 15.1	0.414
Hypertension	221 (80.4%)	90 (72.6%)	0.083
Diabetes	39 (14.2%)	25 (20.1%)	0.132
Dyslipidemia	103 (37.5%)	40 (32.3%)	0.316
Obesity	42 (15.3%)	16 (13%)	0.534
Heart disease	91 (33%)	60 (48.4%)	0.004
Chronic obstructive pulmonary disease (COPD)[a]	4 (1.5%)	5 (4%)	0.144
Peripheral arterial disease (PAD)	20 (7.3%)	12 (9.7%)	0.413
Thromboembolic disease	6 (2.2%)	4 (3.2%)	0.537
Benign prostatic hypertrophy	16 (5.8%)	9 (7.3%)	0.583
Previous other organ transplants (heart/lung/liver)	7 (2.6%)	3 (2.4%)	0.941
Other transplants intraoperative	1 (0.4%)	3 (2.4%)	0.091
Living donor	188 (68.4%)	3 (2.4%)	0
Deceased donor	87 (31.6%)	121 (97.6%)	0
Graft characteristic :			
First graft	233 (84.7%)	99 (79.8%)	0.227
Regraft	42 (15.3%)	25 (20.2%)	0.227
Mean operative time (min)	149.3 ± 50.4	170.3 ± 46.6	0.0001
Mean cold ischemia time (min)	255.3 ± 337.6	647.8±229.9	0
Mean warm ischemia time (min) (n=203)	35.7 ± 11.7 ($n = 191$)	32.3 ± 17.3 ($n = 12$)	0.354
Total number of complications	75 (100%)	59 (100%)	0.093[b]
Vascular complications	33 (44%)	19 (32.2%)	
Parietal complications	35 (46.7%)	27 (45.8%)	
Urological complications	7 (9.3%)	13 (22%)	
Graft loss	7 (2.5%)	7 (5.6%)	0.143[a]

[a]Fisher's test
[b]comparaison of the proportion of different complications in the two groups

channels damaged during surgery,[21] but the exact pathophysiology is unknown, and this wasn't examined here. In addition, renal biopsy has previously been reported to cause damage to lymphatic structures.[22] Robot-assisted kidney transplantation was recently introduced to reduce the morbidity of open kidney transplantation.[23] In the largest reported series, only 1 case (0.8%) of lymphocele was reported.[24] These results should stimulate further research to improve surgical technique, aiming at lowering surgery complication rates, rapid recovery, and better graft function.

Although vascular complications were less frequent, they accounted for two third of graft loss, and were the unique cause of graft loss among the 3 groups of complications. In our study, and others,[8,9,11,12] thrombosis was the most deleterious vascular complications as it resulted in early graft loss in 86% of cases. Possible causes for thrombosis include technical failure, kinking of the renal artery, postoperative hypotension, a hypercoagulable state or atherosclerosis of the recipient vessels. Another cause of early graft loss was the occurrence of post-operative hemorrhage. Although its incidence was similar to graft vessel thrombosis, the consequences were less dramatic with only 29% of them resulting in graft explantation. The rate of early graft loss in our series reached 2%, which is lower than previously published results.[13,14] This could be explained by the inclusion of living donors, or the systematic use of intraoperative Doppler ultrasound.[15] Our ageing population is associated with an increase incidence of diabetes, obesity, peripheral arterial disease and renal artery atherosclerosis. The consequences are an increase need for vascular reconstruction up to 30%.[16] Many problems can be prophylactically corrected if detected during preoperative evaluation. In our center, we regularly performed aorto-iliac reconstruction, prior to kidney transplantation.

This remains controversial, but allows patients with advanced iliac atherosclerosis to become eligible for transplant. The impact of vascular complications on the graft outcomes [16] rises the role of vascular surgeon during kidney transplantation.[17] In answer to Lejay's editorial.[17] Inston and colleagues stated that urological challenges were common, and that urological complications were more frequent than vascular complications.[18] In the present study, the frequency of urological complications was low, and represented only 15% of all complications and such a complication. Importantly, they never led to graft loss.

Predictive Factors

Not surprisingly, deceased donor was the most important risk factor for complications with an OR of almost 3.[12,29] Interestingly, regraft had no influence on developing surgical complications. As already demonstrated,[30,31] obesity increased the risk of surgical complications and therefore reduced the graft survival. Elderly patients represent the fastest growing group of patients awaiting transplantation, and recent high-volume registry studies have shown reduced mortality rates for elderly patients receiving renal transplants compared with waiting-listed patients.[25] In our analysis, older patients underwent more surgical reinterventions for complications (OR 1.021). Age matching of donors and recipients is currently clinical practice. Interestingly, when using marginal donor (>60 years old, or >50years with comorbidities), donor age is most strongly associated with transplant outcomes.[26] In previous clinical studies, age has been linked with the development of chronic rejection and graft failure.[27] These results are in contrast with two other studies which demonstrated that increasing age was associated with and improved transplant outcome.[25–28] However, when analyzing the patient survival and uncensored graft survival, the transplant outcome among the recipients >60 years was the worst among the entire study population; moreover, the risk of graft loss was the highest when they received a graft from an old donor.

Moreover, the ischemia and the operative time were also associated with an increase risk complications in our multivariate model (OR 1.007). This point raises the question of surgeon's experience. We could imagine that operative time decreased with increased experience. However, it was not supported by our findings. Indeed, the rate of complications remained the same between the 3 different periods of times despite an increased experience in the surgeons. In their study, Grodstein et al. demonstrated that resident involvement in renal transplantation had no effect early graft function, confirming the limited impact of surgeon's experience.[19] Moreover, they concluded that renal transplantation seems to be a safe way to teach anastomotic techniques.

Although vascular complications were not the most frequent, they were the most dangerous. Therefore, every effort should be done to reduce their occurrence and their consequences to allow for the best possible care. Considering that atherosclerosis is the most common comorbidity among elderly patients, and chronic renal failure and hemodialysis, as predisposing factors, further increases the risk of arterial disease, we advice that surgeons with vascular skills have to be involved in any program of renal transplantation. Moreover, careful evaluation of the recipient in order to optimize the intervention as well as adequate off table preparation of the graft seems to be a good strategy to reduce the operating time.

Limitations are acknowledged. The retrospective design and relatively small number of patients could lead to type II errors. Type I error was addressed by multivariate analysis. Two third of our patients were male and suffered hypertension, which may limit the generalizability of our results.

In conclusion, surgical complication after kidney transplantation is frequent, occurring in about one quarter of patients. Age, deceased kidney donors, and operative time were significant risk factors. Vascular complications are a major cause of early graft loss and efforts should aim to reduce vascular complications to improve graft survival.

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