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ORIGINAL ARTICLE

Retransplanting a previously transplanted kidney: A safe strategy in times of organ shortage?

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Abstract

Background: The shortage of organs for transplantation remains a global problem. The retransplantation of a previously transplanted kidney might be a possibility to expand the pool of donors. We provide our experience with the successful reuse of transplanted kidneys in the Eurotransplant region.

Methods: A query in the Eurotransplant database was performed between January 1, 1995 and December 31, 2015, to find kidney donors who themselves had previously received a kidney graft.

Results: Nine out of a total of 68,554 allocated kidneys had previously been transplanted. Four of these kidneys were transplanted once again. The mean interval between the first transplant and retransplantation was 1689±1682 days (SD; range 55–5,333 days). At the time of the first transplantation the mean serum creatinine of the donors was 1.0 mg/dl (.6–1.3 mg/dl) and at the second transplantation 1.4 mg/dl (.8–1.5 mg/dl). The mean graft survival in the first recipient was 50 months (2–110 months) and in the second recipient 111 months (40–215 months).

Conclusion: Transplantation of a previously transplanted kidney may successfully be performed with well-preserved graft function and long-term graft survival, even if the first transplantation was performed a long time ago. Such organs should be considered even for younger recipients in carefully selected cases.

KEYWORDS
graft survival, kidney injury, organ shortage, retransplantation

1 | INTRODUCTION

Organ shortage is a common problem in the Eurotransplant (ET) region, especially in Germany. The resulting prolonged waiting time on dialysis increases the cardiovascular risk and thereby the mortality rates of our patients.[1] On the one hand, kidney organ shortage may be explained by the increased need for organs due to demographic changes and the aging of the population, thereby resulting in an increased incidence of end stage renal disease (ESRD) and other end stage organ failures.[2] On the other hand, the number of transplanted organs has decreased dramatically in recent years in Germany. In 2019, 1628 kidney grafts were transplanted in Germany and 3191 in the whole ET

region. These are 628 and 540 less organs, respectively, than in 2010.[3] At the end of 2019, 7148 patients were actively waiting on dialysis to receive a kidney transplant in Germany, and 10,723 patients were on the active waiting list in the whole Eurotransplant region.[4] The waiting period for a deceased donor renal transplant usually ranges between 6 and 8 years in Germany[5] and around 4 years in the Eurotransplant region.[4]

Due to the urgent need to raise the renal transplant rate, new options of donation have already been realized, such as using living renal transplantation across ABO or positive crossmatch barriers,[6–10] kidney exchange programs for living transplantation[7,11] and extending the deceased donor pool by increased utilization of so-called marginal donors. With regard to the latter option, deceased donor renal transplantation by the Eurotransplant senior program,[2,12] double kidney transplantation[13] or even using kidneys with severe acute renal failure[14,15] have been successfully realized.

Another option is the transplantation of a previously transplanted kidney when a deceased donor presents a well-functioning renal allograft.[16–21] This option is hardly used at the moment, but might be a possibility to expand the pool of donors. The question is whether this procedure may be a safe option in times of organ shortage or whether special prerequisites such as good renal function without an extended time frame since the previous transplantation should be fulfilled for successful retransplantation of a previously transplanted kidney. A longer time period since the previous transplantation of the graft might be associated with significant chronic changes, which may not be reflected by serum creatinine or eGFR of the donor, but may compromise graft outcome after another transplantation. We provide our experience of the successful reuse of transplanted kidneys in the Eurotransplant region.

2 | METHODS

With institutional review board approval by the ethics committee of the University of Giessen (AZ 126/21), we conducted a query in the Eurotransplant database between January 1, 1995 and December 31, 2015, comparing the parameters ABO blood group, sex, HLA antigens, and date of birth between the kidney recipients and kidney donors in order to detect those kidney donors who previously received a renal transplant. The numbers of offered and finally accepted kidney grafts for retransplantation were analyzed, as well as the reasons for refusal of such kidney grafts.

Regarding the first recipient of a kidney graft (who is the current donor), we collected data on age, sex, weight, graft survival, graft function (serum creatinine, BUN eGFR measured by CKD-EPI and proteinuria), cause of death, and whether a right or left kidney was transplanted. With regard to the second and thus current recipient of the kidney graft, we collected data on age, sex, weight, graft function (serum creatinine, BUN, eGFR measured by CKD-EPI and proteinuria) and graft survival, cause of graft loss and cause of death). Furthermore, the interval between the first and the second transplantation was recorded as well as the immunosuppressive regimen of the second kidney graft recipient. We observed and followed-up on the second graft recipients until graft loss or the patient's demise. The data on episodes of graft rejection and biopsy findings (as far as available) were collected.

Statistics. Mean, standard deviation (SD), and range are given. Comparisons between the rejected and accepted renal grafts were conducted with Mann-Whitney test. P values $< .05$ were considered significant.

3 | RESULTS

Between January 1, 1995 and December 31, 2015, a total of 68,554 kidneys were allocated for transplantation in the Eurotransplant region. Nine of these kidneys (.00013%) had been previously transplanted and were offered to be transplanted once again. Four out of these nine kidneys (.000006%) were eventually transplanted again. Two of these were left kidneys and two were right kidneys. By reviewing the rejected donor data, the likely reasons of rejection of the kidneys were decreased kidney function, severe arteriosclerosis of the graft arteries and chronic hepatitis (Table 2).

The mean interval between first transplantation of the renal graft and retransplantation offer was 1689±1682 (SD) days (range 55–5333 days). As shown in Table 1, the mean age of the first donor was 32 years (range 18–54), and of the first recipient 49 years (range 32–61) at the time of this first transplantation. The mean age of the second donor was 53 years (range 37–67), and of the second recipient 66 years (range 65–67). However, the mean age of the graft at the time point of retransplantation was 36 years (range 23–54) and thus younger than the mean age of the current donor.

At the time of the first transplantation mean serum creatinine of the donor was 1.0 mg/dl (range .6–1.3) with a mean eGFR of 87 ml/min (range 68–114). At the time of the second transplantation mean serum creatinine level of the donor was 1.4 mg/dl (range .8–1.5) with a mean eGFR of 55 (range 37–76). Considering that the second donor had only one functioning kidney, graft function appeared somewhat better compared to the first donor in 3 of the 4 cases (Table 1). The average time between the first transplantation and death of the first recipient was 50 months (range 2–110). The mean graft survival time in the second recipient was 111 months (range 40–215) (Figure 1).

Regarding age, renal function measured by serum creatinine and eGFR at the time of the first transplant and the second transplant, and graft survival in the first recipient, there were no statistically significant differences between the accepted and rejected offers (Table 2). In the following, we report details of the four cases with retransplanted kidneys (Figures 1 and 2).

3.1 | Case 1

In July 1993, the kidney of a 36-year-old woman was first transplanted into a 43-year-old man. The first donor died after cerebrovascular

TABLE 1 Characteristics of the accepted first and second grafts

	Case 1	Case 2	Case 3	Case 4
First donor at time of transplantation				
age (year)	36	54	18	20
serum creatinine (mg/dl)	1.1	.6	1.3	1.2
eGFR (CKD-EPI) (ml/min/1.73m^2)	68	114	80	87
cause of death	CVA	CVA	suicide (head injury)	polytrauma
weight (kg)	65	97	70	67
sex	female	male	male	male
right / left kidney transplanted	left	right	left	right
Second donor (first recipient)				
age (year) at time of the first transplantation	43	61	32	59
serum creatinine (mg/dl)	1.5	1.5	1.3	.8
eGFR (CKD-EPI) (ml/min/1.73m^2)	55	37	52	76
cause of death	CVA	CVA	CVA	cerebral infarction
weight (kg)	84	60	50	70
sex	male	female	female	female
age (year) at time of retransplantation	45	61	37	67
total age of the transplanted kidney at time of retransplantation	38	54	24	29
CIT second transplantation (h and min)	15h06min	3h50min	7h47min	10h12min
Operation time second transplantation	n.a.	2h30min	n.a.	2h31min
Delayed graft function[a]	no	no	no	yes
Age of the second recipient (year) at time of transplantation	65	65	65	67
Graft survival in the first recipient (months)	25	2	63	110
Graft survival in the second recipient (months)	215	125	63	40
other organs transplanted from this donor	none	none	liver	right lung, liver
Immunosuppressive treatment (second recipient)				
induction therapy maintenance immunosuppression	None tacrolimus prednisolone	None CyA, MMF prednisolone	Basiliximab CyA prednisolone	Basiliximab tacrolimus, MMF prednisolone

Abbreviations: CVA, cerebrovascular accident, otherwise not specified; CyA, cyclosporine A; eGFR, estimated glomerular filtration rate calculated by CKD-EPI; kg: kilogram; MMF, mycophenolate mofetil; n.a., data not available; y, years.
[a]Defined by at least one postoperative dialysis treatment.

accident with an excellent serum creatinine of 1.1 mg/dl and BUN of 10.3 mg/dl. The eGFR was 68 ml/min/1.73m^2. In September 1995, the first recipient of the kidney graft also died after a cerebrovascular accident. At the time of death, graft function had deteriorated to a serum creatinine of 1.5 mg/dl and an eGFR of 55 ml/min/1.73m^2. Subsequently, the kidney was retransplanted into a 65-year-old patient. Immunosuppression consisted of tacrolimus and prednisolone without antibody induction therapy. The graft function improved after transplantation and remained excellent following hospital discharge until the patient passed away. According to the patient's last examination in August 2013 (7 days before death due to cardiac arrest after an accident), the graft function of the now 83-year-old patient was still excellent with a serum creatinine value of 1.2 mg/dl with proteinuria probably in the normal range (30 mg/dl).

3.2 | Case 2

This kidney was first transplanted into a 61-year-old recipient in September 1998. The donor was a 54-year-old man who died due to a cerebrovascular accident. The kidney function of the first donor was excellent with a serum creatinine of .6 mg/dl and BUN of 6.1 mg/dl. The estimated GFR was 114 ml/min/1.73m^2. Two months after the successful transplantation the recipient died of a cerebrovascular accident and became the second donor of the kidney graft in November 1998. Compared to the point in time of the first transplantation, the renal function had deteriorated to a serum creatinine of 1.5 mg/dl (eGFR 37 ml/min/1.73m^2) and BUN of 9.3 mg/dl. Immunosuppression of the 66-year-old second recipient of the graft consisted of cyclosporine A, mycophenolate mofetil and prednisolone without antibody induction

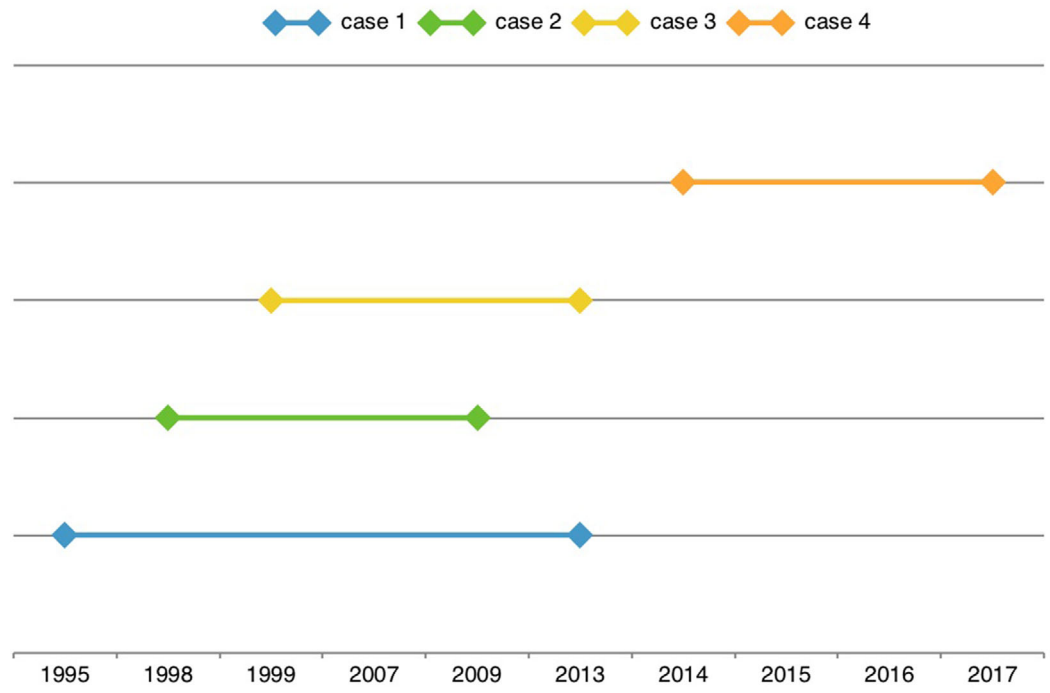

FIGURE 1 Four retransplantations of already previously transplanted kidneys were performed in the Eurotransplant region between 1995 and 2015. For each case, the time period between retransplantation of the graft and graft failure is given

therapy. On the 12th post transplant day a first biopsy was administered and rejection therapy with ATG and prednisolone was given due to suspected acute rejection which, however, could histologically not be confirmed. One month later, in December 1998, a second kidney biopsy was performed because of an increased level of serum creatinine. A tubulointerstitial rejection (BANFF I) according to the BANFF 1995 classification[22] was detected and treated with a methylprednisolone pulse therapy. At the time of the discharge from hospital, the patient presented a serum creatinine level of 1.8 mg/dl. Until 2008 the transplant function was excellent with serum creatinine values between 1.3 mg/dl and 1.6 mg/dl and with proteinuria in the normal range. From the beginning of 2009, however, serum creatinine rose up to > 2 mg/dl. In December 2009, proteinuria started to increase from 150 mg/dl to 500 mg/dl. In January 2010, the patient lost graft function and hemodialysis treatment was initiated. A biopsy was not performed, and as a result a chronic humoral rejection could not be confirmed. The patient died of pneumonia at the age of 77 in December 2011.

3.3 | Case 3

The first transplantation from an ideal 18-year-old donor, who died due to a head injury by suicide, took place in May 1994. The first recipient was a 32-year-old woman. The kidney function at the time of the first transplantation of the graft was good with a serum creatinine of 1.3 mg/dl. The eGFR was 80 ml/min/1.73m^2. The first recipient died due to a cerebrovascular accident in August 1999, and became donor to the second 65-year-old recipient. Graft function at that time was good with a serum creatinine of 1.3 mg/dl (eGFR of 52 ml/min/1.73m^2). The Immunosuppression given to the second graft recipient consisted of cyclosporine A and prednisolone with basiliximab induction. Transplant function was excellent until December 2005, with a serum creatinine of 1.2 mg/dl without episodes of rejection. At the same time a significant proteinuria was detected (1000 mg/g creatinine). 8 years after the transplantation the patient was diagnosed with non-Hodgkin lymphoma and mamma carcinoma. Chemotherapy was initiated and cyclosporine A treatment was stopped. In December 2007, recurrent infections (CMV, EBV) and chemotherapy for non-Hodgkin lymphoma with discontinuation of cyclosporine A treatment probably led to transplant failure. The patient died in October 2010 aged 77 years due to PTLD progress and mamma carcinoma (first diagnosed in 2005).

3.4 | Case 4

The first kidney transplantation was performed in January 2005 from an ideal donor who was 20 years old and died after polytrauma with a serum creatinine value at time of donation of 1.2 mg/dl and an eGFR of 87 ml/min/1.73m^2. There was only one mismatch in the HLA antigens (HLA-A/B/C/DR/DQ) between donor and recipient. The first recipient was a 59-year-old woman with suspected chronic glomerulonephritis as cause of ESRD. The first recipient died after ischemic cerebral infarction in March 2014. The last examination (11/2013) showed good graft function with a serum creatinine of 1.0 mg/dl, eGFR of 61 ml/min/1.73m^2 and proteinuria of 90 mg/24h. The pre-donation kidney function was well preserved with a serum creatinine level of

TABLE 2 Characteristics of the rejected grafts

	Case 1	Case 2	Case 3	Case 4	Case 5	mean (sig)
first donor at time of transplantation						
age (year)	51	36	64	42	59	50 (*P* .110)[a]
serum creatinine (mg/dl)	2.0	1.4	0.9	1.8	1.1	1,4 (*P* .286)[a]
eGFR (CKD-EPI) (ml/min/1.73m^2)	29	48	84	34	55	50 (*P* .063)[a]
cause of death	SAB	SAB	ICB	SAB	ICB	
weight (kg)	80	80	65	83	85	
sex	female	female	female	female	male	
right / left kidney transplanted	left	left	left	left	left	
Second donor (first recipient)						
age (year) at time of the first transplantation	48	56	60	68	56	58 (*P* .566)[a]
serum creatinine (mg/dl)	2.1	1.9	1.0	1.4	1.4	1.6 (*P* .550)[a]
eGFR (CKD-EPI) (ml/min)	27	39	86	49	38	48 (*P* .550)[a]
cause of death	ICB	ICB	ICB	SAB	ICB	
weight (kg)	85	105	70	90	75	
sex	female	male	male	male	female	
age (year) at time of retransplantation	50	58	61	73	71	60 (*P* .19)[a]
Immunosuppressive treatment (first recipient)	MMF sirolimus	not known	MMF everolimus	CyA MMF prednisolone	Tacrolimus prednisolone	
Graft survival in the first recipient (months)	22	33	15	54	177	60 (*P* .190)[a]
suspected reason for rejection	probably marginal kidney function	probably marginal kidney function	Status post gastric cancer	severe arteriosclerosis of graft arteries	acute kidney injury and chronic hepatitis B	

Abbreviations: ICB, intracerebral hemorrhage; SAB, subarachnoid hemorrhage; CyA, cyclosporine A; eGFR, estimated glomerular filtration rate calculated by CKD-EPI; kg, kilogram; MMF, mycophenolate mofetil; y, years.
[a]Compared with the accepted offers.

.8 mg/dl and an eGFR of 76 ml/min/1.73m^2 at the time of the second transplantation.

The second recipient was a 67-year-old patient with ESRD due to IgA nephropathy, who was transplanted in March 2014. Graft function was delayed (one post-transplant dialysis) but reached an averaged serum creatinine of 2.6 mg/dl, a measured creatinine clearance of 30 ml/min 1-year posttransplant, without acute rejection episodes. Immunosuppression consisted of tacrolimus, mycophenolate and prednisolone with basiliximab induction. The 4- and 12-month protocol biopsies showed a reactive focal segmental and focal global glomerulosclerosis (4/13 glomeruli in both biopsies) and a 20% chronic tubulointerstitial damage without signs of rejection or cyclosporine toxicity. At that time graft function was stable with a serum creatinine of 2.5 mg/dl.

Thirty-six months after transplantation, hepatitis E was detected associated with ascites formation and significant deterioration of renal function. Immunosuppression with mycophenolate was stopped and because of persistent hepatitis E ribavirin treatment was initiated. Over time, liver cirrhosis CHILD B with ascites and esophageal varices was developed. Within a year, there was a further deterioration in kidney function (serum creatinine between 3.5 mg/dl and 4.4 mg/dl) due to recurrent liver decompensation. In July 2017, hemodialysis was restarted. The patient is still alive.

These data of four recipients of a previously transplanted kidney show a satisfying graft survival rate between 3 and 18 years (case 1 with 6570 days [18 years], case 2 with 3801 days [10 years 5 months], case 3 with 3034 days [8 years 4 months], case 4 with 1075 days [3 years]). All cases demonstrated an immediate functional recovery of the graft without the need for postoperative dialysis therapy.

4 | DISCUSSION

Kidney transplantation remains the preferred therapy for patients with ESRD. However, it is limited by the shortage of kidney donations. Despite attempts to increase the number of deceased and living donors, success has been limited. In times of organ shortage new ways should be found to expand the pool of available organs. The reuse of a

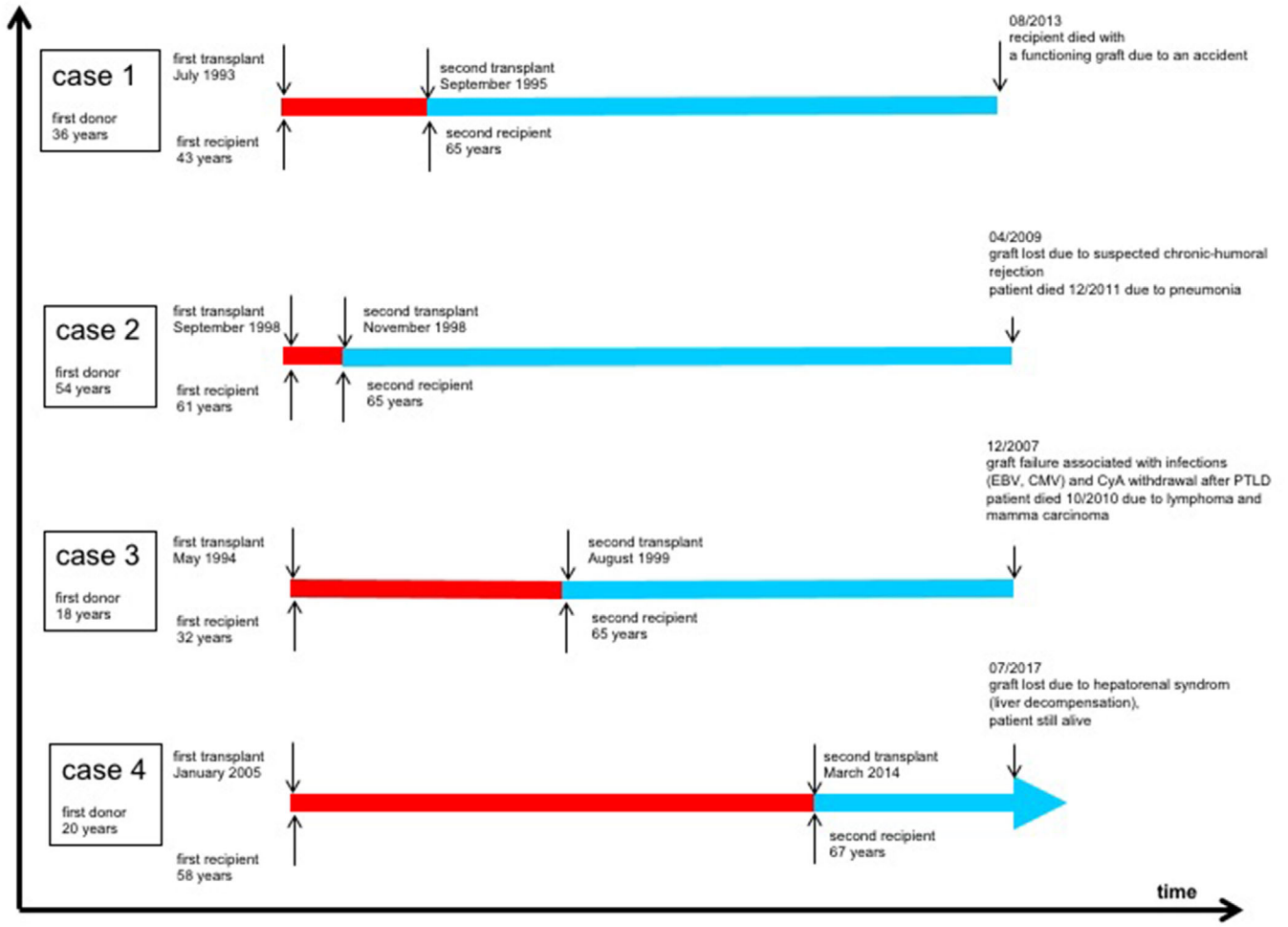

FIGURE 2 Time course of the four renal transplantations. The x axis indicates the time span of graft survival in the first recipient in red, and the time span of graft survival in the second recipient in blue. Labeling shows the dates of the transplantations and the ages of the individual recipients and donors at this time point, as well as the reason of graft failure or patient death in the second recipient. CMV: cytomegalovirus; EBV: Epstein-Barr virus; GN: Glomerulonephritis; PTLD: post-transplant lymphoproliferative disorders; CyA: cyclosporine A

transplanted kidney might be such an approach. As the most common cause of renal allograft loss is death of the patient with a functioning graft,[23] there might be a relevant potential to increase the number of donated kidneys. Ojo et al.[24] analyzed data of the UNOS Scientific Renal Transplant Registry in combination with ESRD patient data in the United States Renal Data System (USRDS) of all renal transplant recipients over 18 years of age from 1987 to 1996 ($n = 86,502$) and found that 21% of these patients ($n = 18,482$) died and 38.1% of those patients deceased ($n = 7040$) with a functioning graft. Veale et al.[25] investigated the period between 2005 and 2014 in the US and were able to prove that every decade about 20–25% of kidney recipients died with a functioning graft. Qiu et al.[26] examined the frequency of death with a functioning graft (DWF) in the Organ Procurement and Transplantation Network/United Network for Organ Sharing (OPTN/UNOS) database between 1988 and 2004 ($n = 207,670$) and found out, that the percentage of DWF was 3% in the first posttransplant year and 6.5% yearly in the 2nd to 5th year posttransplant. The occurrence of DWF increased significantly with advancing recipient age among both deceased and living donor kidney recipients. These data provide evidence of a significantly underused pool of deceased donor kidneys.

Our data show that patients who have already been transplanted are rarely considered as donors again. Maybe the awareness has not yet been raised to consider such organs as transplantable, either in the donor center, so that the organs are not allocated at all, or in the potential recipient center having concerns about chronic histological impairment which might comprise success of retransplantation. Although DWF is a common event, not all patients who die with a functioning graft are suitable donors. Patients who die outside of the hospital and multimorbid patients are usually not eligible for organ donation. The potential number of DWF patients eligible for another transplantation of the same kidney graft is further reduced by the following facts. The five most common causes of death in patients with a functioning graft are cardiovascular events, infections, tumors, cerebrovascular diseases, and bleeding.[26] West et al.[27] found out that 22% of those patients die from infection, 17% from myocardial infarction, and 15% from sudden death. Patients who died of active malignant tumor disease or active infection, such as meningitis or HIV, are not

potential candidates for kidney donation. Despite these many limitations, one would assume a greater number of eligible DWF donors in the ET region between 1995 and 2015 than the nine patients reported by us. Although more specified data on this topic are lacking, potential candidates for retransplantation of a previously transplanted kidney may not be taken into account in our intensive care units. Thus, data regarding this problem should be collected by the national organ donation organizations and efforts should be increased to educate on this topic in the intensive care units.

The data of our four realized cases show that even kidneys that already have been transplanted for a long time may be transplanted successfully again into another recipient after brain death of the first recipient.

In the past, this possibility has been rarely used. Only a few cases of transplanting a previously transplanted kidney are published.[17–21,25,28–30] Furthermore, long-term implications of such a retransplantation are not well known. In some reports there were only short-term outcomes described until 1 year posttransplant,[20,25,30] some reports had a follow up of 1–4 years.[18,19,28] Two case reports showed a successful reuse of a transplanted kidney with a follow-up of 5 years[21] and 12 years,[29] respectively, and all published cases had a good graft function in their follow-up time.

Whether the length of graft survival has an influence on graft survival after retransplantation is not clear. For the first time, our case reports have a follow-up period until the second recipient is required to undergo dialysis again or dies. Indeed, Figure 2 of our report indicates that kidney graft survival might be influenced by how long the first graft survived in the first recipient. However, in case 3 PTLD appeared to play a major role and in case 4 hepatorenal syndrome was suspected to cause graft failure, so that a relation between graft survival time after the first transplantation and graft survival after retransplantation of the same graft may not be shown by our data. Furthermore, reliable histological data are lacking which might show an increase in chronic damage associated with graft survival after the first transplantation.

In the few cases reported in literature, the time of graft function in the first recipient does not seem to have a clear influence on the graft survival in the second recipient. However, the follow-up in many case reports was only short. There were only three case reports with a long-term follow up of 12 years,[29] 5 years,[21] and 4 years,[19] respectively, which showed a long and good graft function (serum creatinine 1.3 mg/dl) also in the second recipient despite a longer lasting graft survival after the first transplantation (9 years,[19] 8 years,[21] and 6 years[29]). Another patient was described with a graft survival of 5 years after a survival of the same graft in a previous recipient for only 8 days (brain death due to intracranial hemorrhage).[30]

Our data show that the transplantation of a kidney that has previously been transplanted may be successful. To our knowledge, no report has been published in which the re-transplantation of a previously transplanted kidney was not successful. Our data from Eurotransplant with four successful transplantations and graft survival times between 3 and 18 years confirm this assumption, although a publication bias in regions outside Eurotransplant may be possible. Compared with the accepted organs, it is noticeable that the eGfR of the rejected organs in the ET region at the time of the second offer is lower (not statistically significant). However, it also reveals that the kidney functions were already lower overall at the time of the first transplantation. Thus, low eGFR may not be used as the only reason to reject the organ for re-transplantation.

Important to know are potential risk factors for an unfavorable outcome, when accepting or rejecting organ offers. In principle, extensive scar tissue can make surgical access difficult for a retransplantation. Scar tissue could be avoided by creating wide margins around the allograft.[25] During procurement it must be secured that the renal vessels are flushed. This means that an additional canula might be placed not only in the aorta but in the iliac artery. Then a patch of the donor iliac artery and vein has to be taken to maintain the original vessel length. In the presence of adhesions around the initial anastomosis the vessels must not be dissected. Furthermore, by trimming the iliac patch on the artery and vein, a larger volume vessel anastomosis could be created. Because the renal vessels have already been once dissected, re-grafting could result in further shortening of these vessels. Depending on the adhesions the ureter can be shortened or like in childrens' transplantations used with a bladder cuff. Due to anatomical reasons regarding the blood supply of the ureter this might result in a higher complication rate as insufficiencies or stenosis.

It has to be considered that progression of senescence after retransplantation of a previously transplanted kidney may be accelerated due to repeated ischemia reperfusion injury especially in grafts that have undergone chronic damage after the first transplantation.[31,32] The retransplanted kidneys in our cases were rather young at the time of the retransplantation and thus may better cope with oxidative stress and acute kidney injury posttransplant than older kidneys.[33] However, it appears difficult to predict the extent of the existing chronic damage of an already transplanted kidney at the time of such an organ offer without performing a biopsy. On the other hand, despite the widespread use of pre-implantation biopsies, there is no consensus on their value in predicting allograft survival.[34,35]

Regarding the ideal donor data of the original donor in case 4, a 20% chronic tubulo-interstitial damage 4 and 12 months after retransplantation of this graft seems not adequate and shows that a well preserved pre-donation kidney function 9 years after the first transplantation (serum creatinine of 1.0 mg/dl, measured creatinine clearance of 49 ml/min, proteinuria within the normal range 4 months before donation) does not necessarily indicate the rate of chronic tissue damage despite a nearly full HLA A/B/C/DR/DQ match. Furthermore, chronic changes in kidney grafts are common (29% of the grafts after ½–1 year with a gradual increase to 63% after 10 years[36]).

As the collected data of graft outcome in our series and also in the published case reports[16–21,25,30] are satisfactory, we suggest that the offer of an already transplanted kidney should be carefully considered, especially in case of rather young first donors with currently good graft function of the first recipient. Even with normal serum creatinine and in the absence of proteinuria and albuminuria, a graft biopsy should be mandatory prior to transplantation to rule out major chronic damage. The fact that a kidney has already been transplanted for a long time should not necessarily be a reason to reject such a graft.

As retransplanted grafts may survive for a long time in the new recipient, such organs should not in general be considered for older recipients only, but also for younger ones in carefully selected cases.

Although a high percentage of patients with functioning transplants die, many of them can unfortunately not be considered as organ donors. The reasons are manifold. One is impaired renal function due to chronic damage to the graft, technical difficulties in harvesting the transplanted kidney and the increased risk of infection and/or neoplasm transmission from an immunocompromised donor.

In conclusion, the donation of a previously transplanted kidney to another recipient has received little attention so far and has been performed infrequently. Our report shows that retransplantation of a kidney graft may successfully be performed, even if the first transplantation was long ago. However, careful consideration of the donor (first and second donor) data appears to be necessary in order to exclude major chronic injury. As the potential to perform such retransplantations appears to be underused, efforts should be made to focus on such donations, both in the donor centers to make aware the feasibility, and also in the transplant centers to increase the acceptance of these grafts after careful consideration. However, it must also be realized that the above points, due to the low number of cases, can only be considered in addition to the other multi-faceted approaches.

CONFLICTS OF INTEREST

The authors of this manuscript have no conflict of interest to disclose.

AUTHOR CONTRIBUTIONS

Study concept and design: Hristos Karakizlis (HK), Philipp Boide (PB) and Rolf Weimer (RW). *Acquisition of data*: Hristos Karakizlis (HK), Marieke van Rosmalen (MR), Philipp Boide (PB), Ingolf Askevold (IA), Serge Vogelaar (SV), Thomas Lorf (TL), Gabrielle Berlakovich (GB), Martin Nitschke (MN), Winfried Padberg (WP) and Rolf Weimer (RW). Statistical analysis: HK. Analysis and interpretation of data: HK, MR, RW, IA, PB. Drafting of the manuscript: HK, RW, WP, IA. Critical revision of the manuscript: MR, PB, IA, SV, TL, GB, MN, WP, RW.

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DATA AVAILABILITY STATEMENT

The datasets used or analyzed during the current study are available from the corresponding author on reasonable request.

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