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ORIGINAL ARTICLE

New surgical technique for pediatric en-bloc kidney and pancreas transplantation: the pancreas piggy-back

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Summary

Combined pancreas and kidney transplantation is the therapy of choice for type I diabetes patients with associated end-stage renal disease. To counterbalance increasing waiting lists, there is a clear need to extend the organ donor pool. Although results following simultaneous pancreas and kidney transplantation (SPK) using pediatric organs are encouraging, there is still reluctance in accepting them. This reflects the fear of graft thrombosis and graft failure because of small vessels and little absolute islet cell mass. Simpler transplant techniques for pediatric SPK might lower this threshold. In this article, a novel technique using a "piggy-back" implantation of the pancreas onto the conduits of en-bloc grafted kidneys, performed in two consecutive cases, is presented. This technique is associated with less vascular manipulation, requiring only one arterial anastomosis onto the frequently arteriosclerotic arteries of the recipient for all three organs. One-year follow-up (14 and 12 months) proved excellent graft function of kidneys and pancreas.

Introduction

Combined kidney and pancreas transplantation is the best treatment option for diabetes type 1 with associated end-stage renal disease. There is an increase in waiting lists and waiting times because of a lack of suitable grafts. Despite this scarcity, Eurotransplant, for example, reports that in 2009, only 25.8% of all offered pancreas were transplanted. In comparison, the conversion rate (converting potential donors to actual donors) for liver transplantation is 82%, for hearts 64%, for lungs 77%, and for kidneys 93% [1]. Although results of SPK from pediatric donors are very encouraging [2,3], the use of pediatric donor organs and the expansion of donor criteria in pancreas graft acceptance in general remains hesitant [3]. This reflects the fear of technical failure and impaired outcomes because of little absolute islet cell mass. Trying to minimize the risk of pediatric graft thrombosis, a novel technique of simultaneous pancreas/kidney transplantation (SPK) using pediatric grafts is presented. A piggy-back implantation of the pancreas onto the conduits of en-bloc grafted kidneys was performed. This technique facilitates the use of pediatric organs, as only one single access onto the aorta or common iliac artery is required. Reducing vascular access sites is of particular benefit for long-term diabetic patients. Secondly, the small pancreatic graft is more accessible for a technically easier exocrine drainage.

Material and methods

The characteristics of the two recipients and donors are shown in Tables 1 and 2. The female recipient underwent pre-emptive living donor kidney transplantation for her diabetic nephropathy 10 years prior to SPK.

Table 1. Recipient demographics.

	Age (years)	BMI	Gender	Months on hemodialysis	IDDM for (years)
R 1	44	20.8	F	0*	39
R 2	56	24.6	M	7	34

BMI, body mass index; IDDM, insulin dependent diabetes mellitus.
*Following LRD kidney transplantation 10 years ago.

Table 2. Donor demographics.

	Age	Weight (kg)	Gender	Cold ischemia time in hours (pancreas/kidney)	Cause of death
D1	6	14	M	8/7	Trauma
D2	8	17	F	6/5	ICH

ICH, intracranial hemorrhage.

HLA (A/B/DR)-mismatch was 1-2-2 and 2-1-1, respectively.

Allocation

Because of a lack of matching pediatric recipients, the donor organs were allocated to combined organ adult recipients. In both cases, organ procurement and transplantation were performed by the same surgeons.

Organ procurement

The pancreas, segments of the inferior vena cava and aorta with their renal branches, both kidneys and their ureters including the bladder were removed from pediatric donors following cold perfusion using Celsior® solution (Genzyme Corporation Cambridge, MA, USA).

The livers of both pediatric donors were allocated elsewhere. In addition, the intestinal graft of the second donor was allocated to a pediatric recipient outside Swiss Transplant.

Surgical technique

Organ procurement

The pancreas was recovered with a duodenal segment, spleen, and mesenteric vessels. Arterial reconstruction was performed in case 1 using a short internal iliac artery interposition graft between donor splenic and superior mesenteric artery (SMA) (Fig. 1). Arterial reconstruction in case 2 was a standard Carrel patch with an iliac bifurcation graft. In both cases, the renal grafts were recovered en-bloc including the inframesenteric abdominal aorta, inferior vena cava (IVC), and both ureters (Fig. 2).

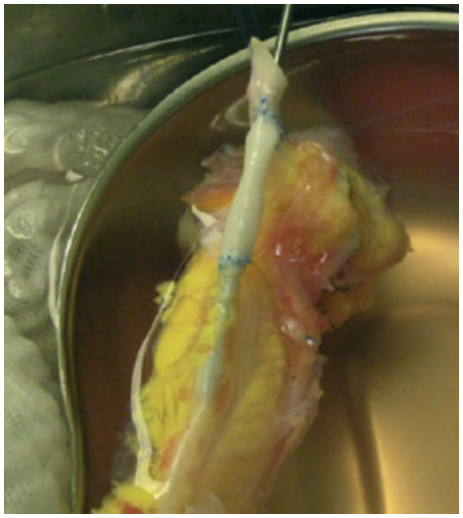

Figure 1 Arterial reconstruction with internal iliac artery interposition, connecting the splenic artery to the SMA. Note that interrupted sutures were used to prevent future stenosis caused by growth.

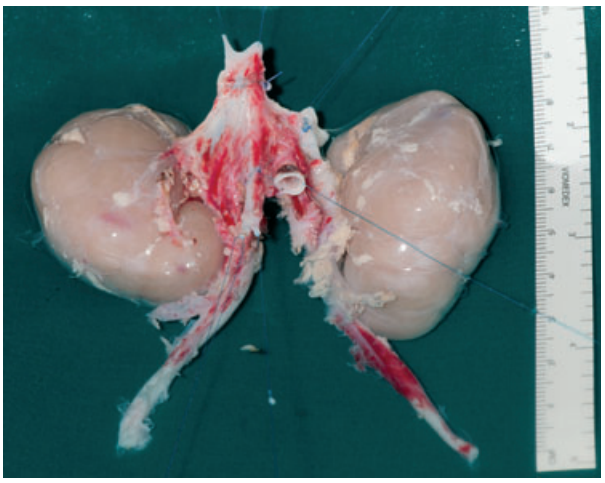

Figure 2 En-bloc kidney graft.

Transplantation

During back-table preparation, the proximal and distal aortic and caval ends of the en-bloc kidney graft were left open. Subsequently, the aortic and caval conduits were anastomosed end-to-side to the recipient's infrarenal aorta and IVC, respectively, using 5–0 and 6–0 Prolene running sutures. The distal openings of the aortic and IVC conduits were then temporarily closed using vascular clamps. For ''piggy-back'' pancreas engrafting, the portal vein of the pancreas graft was anastomosed end-to-end onto the distal part of the donor IVC with 6–0 Prolene. Arterial supply for the pancreas graft was achived by anastomosing the donor SMA (first case) and the Correl

Graft (donor common iliac artery attacht to SMA and splenic artery of the donor) onto the distal part of the donor renal aortic conduit. Exocrine drainage was performed by side-to-side two-layer duodeno-jejunostomy with running 4–0 PDS.

Ureteric reconstruction in case 1 was carried out using a bladder patch, as described by Kato *et al.* [4]. In the second case, two separate ureterocystostomies were performed. All ureters were stented for 6 weeks using 6 CH double-J silicon stents. Figure 3 illustrates the anatomic situation.

Operating times were 7.5 h and 6.2 h (including back-table preparation).

Postoperative course

All grafts showed immediate function with normal fasting blood glucose ever since reperfusion. Hemoglobin A1c was 5.3% and 5.4% at 3 months and 5.3% and 5.4 at 12 months, respectively. Three months post-transplant, both patients presented nearly normal serum creatinine (65 and 105 μmol/l) and normal levels at 12 months (63 and 98 μmol/l). Hospitalization times were 8 and 21 days, respectively (Table 3).

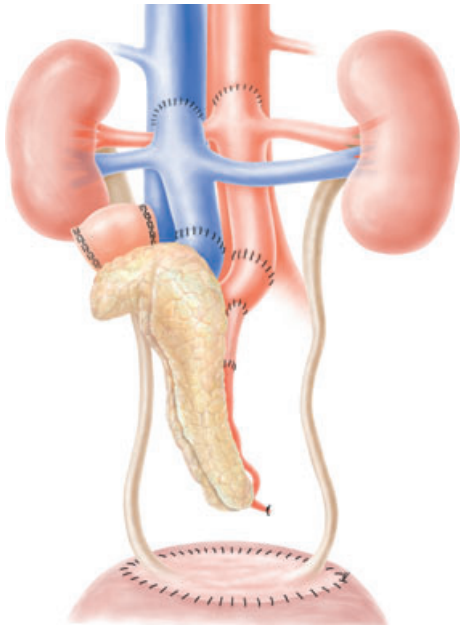

Figure 3 Combined ''piggy back'' en-bloc kidney and pancreas transplantation with bladder patch. (Figure by Stefan Schwyter).

Table 3. Postoperative course.

	LOS	Creatinine 3 months	HbA1c 3 months	Creatinine 12 months	HbA1c 12 months
D1	21	65 μmol/l	5.3%	63 μmol/l	5.3%
D2	8	105 μmol/l	5.4%	98 μmol/l	5.4%

LOS, length of hospital stay.

Immunosuppression

Induction therapy consisted of intraoperative thymoglobulin (1.5 mg/kg) and subsequent doses on days 1 and 2. Mycophenolate mofetil 1000 mg and Tacrolimus 0.05 mg/kg were started twice daily for immunosuppression maintenance. The latter was further adjusted to through levels of 6–8 ng/ml. Prednison was tapered off to 5 mg at 3 months in the first case and withdrawn after 5 days in the second case because of a change of the immunosuppressive protocol.

Complications

In case 1, a re-hospitalization because of a urinary infection with *Escherichia coli* bacteria and a hydronephrosis of the left kidney occurred 10 days after discharge. Because of distal ureteric obstruction and failed retrograde stenting, the bladder patch was removed surgically and both ureters were implanted separately using Lich-Grégoire-antireflux plasty and re-stenting. The histological evaluation of the resected bladder patch revealed scarring and fibrosis of the bladder patch associated with BK-Virus infection (dsDNA- polyomavirus). Therefore, Valacyclovir therapy was initiated for 12 weeks. Because of this specific complication, the bladder patch technique was not performed in the second case.

Discussion

We are reporting the youngest pediatric donor for SPK transplantation in Switzerland so far.

The advantages of the described technique are as follows:

1 Limited vascular manipulation in the recipient, which is particularly important for diabetic patients with major arterial calcifications.

2 An almost orthotopic placement of the en-bloc kidney graft, which reduces the risk of graft dislocation and associated thrombosis as described for iliac fossa placement.

3 Reduced risk of en-bloc kidney conduit thrombosis because of unidirectional blood flow within the conduits.

4 Increased accessibility for exocrine drainage of the relatively small pancreatic grafts.

The only potential downside of this technique is a prolonged cold ischemia time for pancreas grafts, whereas the kidney cold ischemia period is shortened. Additional concern arises from the fact that two kidneys are used for just one adult recipient. Reasons for en-bloc transplantation were the lack of pediatric recipients and the feasibility of simultaneous pancreas/kidney transplantation. Swisstransplant reports only 15 kidney transplants from donors

Table 4. Use of pediatric donor organs for pancreas transplantation in various regions (conversion rate).

	Swiss transplant*	Euro Transplant	OPTN
2006	3/5 (60%)	13	3
2007	1/6 (17%)	18	4
2008	1/3 (33%)	16	2
2009	1/7 (14%)	16	5
2010	1/6 (17%)	16	4

*Absolute number (conversion rate).
OPTN, organ procurement and transplant network.

in this age group in the period of 2000–2010 (3 from child to child, 12 from child to adult).

There is little experience with SPK transplantation from pediatric donors. During the last 10 years (2000–2010), only eight donors younger than 16 years were allocated for SPK in Switzerland. The youngest donor was 13 years old and had a weight of 40 kilograms (Table 4).

A retrospective single-center analysis of 142 adult recipients of pediatric SPK transplantation by Fernandez *et al.* showed graft survival rates superior to recipients of adult donor organs [3]. Nevertheless, pediatric pancreas/kidney transplantations are only performed in very few centers routinely.

With respect to kidney transplantation, it is of note that there is still no consensus on when to split pediatric en-bloc kidneys for transplantation into two adult recipients. The risk of failure of grafts from small pediatric donors is greatest when single kidney transplantations are performed using organs from donors weighing 1–10 kg. [5,6] As graft failure from pediatric donors with a weight exceeding 10 kg is lower than in kidneys from donors >60 years of age, some authors propagate single kidney allocation for donors with a weight >10 kg [5,7]. Nevertheless, inferior outcomes for en-bloc kidney transplantation regarding projected life years with donors weighing more than 10 kg were described. As SPK is a more lifesaving procedure, the use of both organs for only one recipient may be justified.

Another technical improvement reported is the bladder patch described by Kato *et al.* [4], where a partial bladder wall transplantation, including the donor's ureters, is performed. This avoids the necessity of two ureterocystostomies in case of en-bloc pediatric kidney transplantation. Adapting this technique to our first case required repeated surgery as a result of hydronephrosis, probably because of a BK-virus infection. As this technique was not successful in the first case and BK-virus association was not proven, we decided to perform standard ureterocystostomy with a Lich-Grégoire-antireflux technique thereafter.

Finally, one could argue that there is no physiological drainage of the pancreas graft into the portal venous system. Despite numerous studies, there is no clear evidence that portal venous drainage is associated with improved outcomes [8].

In conclusion, the pancreas piggy-back technique might well prove advantageous in selected cases because of reduced vascular manipulation in the recipient, a lower risk of graft thrombosis, and an increased range for exocrine drainage, and it might enlarge the donor pool for SPK.

Authorship

MW: wrote the paper, collected data, assistant surgeon in one case. TB: wrote part of the paper (Introduction, Immunosuppression, part of the discussion.). ES: reviewer of the paper, literature research. MS: Co- surgeon in one case, reviewer of the paper. FI: collected data (Swisstransplant). PAC: reviewer of the article, responsible clinic director. JGB: Development of the technique, responsible surgeon in both cases, wrote part of the paper, major reviewer of the paper.

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