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Renal vein reconstruction with interposition allografts in cadaveric renal transplantation

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Abstract. The short or injured renal vein in cadaveric transplantation is a surgical challenge. Over a 2-year period, we have performed ex vivo renal vein lengthening with an interposition vascular allograft in 17 recipients of cadaveric kidneys. Indications for renal vein extension allografts were a short right renal vein ($N=12$), procurement injury to the vein ($N=4$), and double renal vein ($N=1$). In six cases (35.3%), ex vivo renal artery reconstruction was performed in combination with the venous repair. Our preferred approach is to employ allograft material in ex vivo reconstruction under cold storage conditions. Bench surgery ranged from 10 to 30 min, and the mean in situ anastomosis time was 20 min. The mean length of renal vein prior to reconstruction was 12 mm, and the mean length of venous interposition allograft after revascularization was 27 mm. There were no episodes of vascular thrombosis or primary nonfunction. Three patients (17.6%) required postoperative hemodialysis for acute tubular necrosis, which was subsequently resolved. The mean serum creatinine at 1 month post-transplant was 1.7 mg/dl. These preliminary results suggest that ex vivo renal vein reconstruction with an interposition allograft is a safe and effective modality which should be added to the transplant surgeon's armamentarium in select cases.

Key words: Bench surgery - Ex vivo repair - Microvascular reconstruction - Renal transplant - Renal vein - Venous allograft.

With improvements in donor identification and management, organ procurement systems, and preservation technology, attempts are being made to increase the number of cadaveric organs for transplantation. The wide disparity between organ supply and demand underscores the importance of maximal organ and tissue utilization from the limited donor pool. With the implementation of safe and reliable techniques of multiple organ retrieval, a further imperative is to minimize organ wastage [9]. At our institution alone, nearly 80% of all organ donations presently are multiple organ procurements.

Our current organ wastage rate is about 1%. With the advent of multiple organ retrieval, we began to routinely procure vascular grafts from the donor [8]. As we have gained more experience with the use of vascular allografts in transplantation, we have extended the indications for use of these conduits to include not only renal artery but renal vein reconstruction as well. Surprisingly, the use of venous allografts in renal transplantation has been infrequently reported and its efficacy remains unproven. This report represents a compendium of select cases in which the use of venous extension allografts has permitted an easier operative approach with good technical results.

Materials and methods

Patient population

Over a 2-year period, 275 cadaveric renal transplants were performed at our center. This report comprises 17 recipients of cadaveric renal transplants (6.2%) who underwent ex vivo renal vein lengthening with an interposition allograft. The recipient population consisted of 14 males and 3 females with a mean age of 44.1 years (range 17-73). The primary cause of renal failure was glomerulonephritis in 5 patients, diabetes mellitus in 4, polycystic kidney disease in 4, hypertensive nephrosclerosis in 2, Alport's syndrome in 1, and drug toxicity in 1. Fourteen patients were Caucasian and 3 were not. Primary cadaveric transplants were performed in 14 cases; retransplants were performed in the remaining 3.

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Organ procurement and preservation

Donor nephrectomy was performed by standard techniques with systemic heparinization occurring prior to organ removal or in situ perfusion. In cases not involving multiple organ retrieval, sequential bilateral nephroureterectomy was performed without the use of an en bloc technique. All of the donors were treated with phentolamine in an effort to prevent renal vasospasm. Vasopressor drugs were utilized if clinically indicated, and dopamine was used preferentially.

All transplanted kidneys were harvested locally and preserved with pulsatile machine perfusion using a gluconate-albumin solution (Belzer perfusate) [6]. The donor population included 12 males and 5 females with a mean age of 30.4 years (range 11-57). Maintenance of donor stability with dopamine was required in 12 cases (70.6%). Multiple organ procurements occurred in 9 instances (52.9%), and multiple vessels were encountered in 7 cases. The mean duration of preservation was 25.1 h (range 10-36). During the period of study, only 3 cadaver kidneys were not transplanted (utilization rate 98.9%).

Indications

Indications for renal vein extension allografts were short right renal vein ($N=12$), procurement injury to the vein ($N=4$), and double renal vein ($N=1$). The incidence of venous injury during organ retrieval was 1.5% and was usually due to unnecessary traction. Recipient factors that played an important part in determining the need for interposition allografts included a narrow, deep male pelvis ($N=10$); obesity with a deep pelvis ($N=3$); prior transplant in situ, necessitating aberrant location of current transplant ($N=2$); and tortuous iliac vessels due to atherosclerosis ($N=2$).

Technical aspects

The allograft material consisted of donor iliac vein in 14 cases, inferior vena cava in 2 cases, and iliac artery in 1 case. All venous repairs were performed by anastomosing a vascular allograft to the renal vein in end-to-end fashion with 5-0 or 6-0 Prolene (Ethicon, Somerville, N.J.) suture material in a running fashion. The venous interposition allograft reconstruction was performed on the back table under cold storage conditions after the kidney had been removed from the pulsatile perfusion apparatus. The kidney was then brought into the operative field as the venous allograft was cut to length and an end-to-side anastomosis was performed to the recipient external iliac vein, again with running 5-0 or 6-0 fine suture material. All patients received mannitol and furosemide prior to release of the vascular clamps. Adequate flow through the interposition graft was documented by noting a soft, easily compressed renal vein on digital examination. The following case reports are illustrative of the variations in surgical anatomy requiring vascular reconstruction.

Case reports

Case 1

A 26-year-old white female with end-stage renal disease due to glomerulonephritis had undergone a living-related donor renal transplant to the distal vena cava and aorta on the right side through a midline abdominal approach 12 years previously. After 10 years, renal function deteriorated due to chronic rejection and

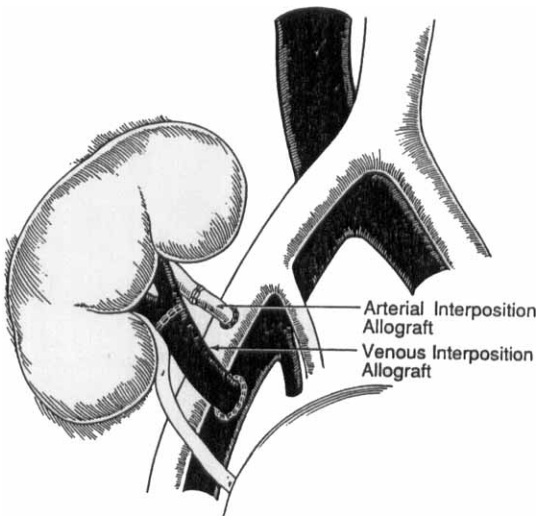

Fig. 1. Use of arterial and venous extension allografts to enable distal placement of donor right kidney on recipient external iliac vessels with anterolateral positioning of the kidney in the iliac fossa

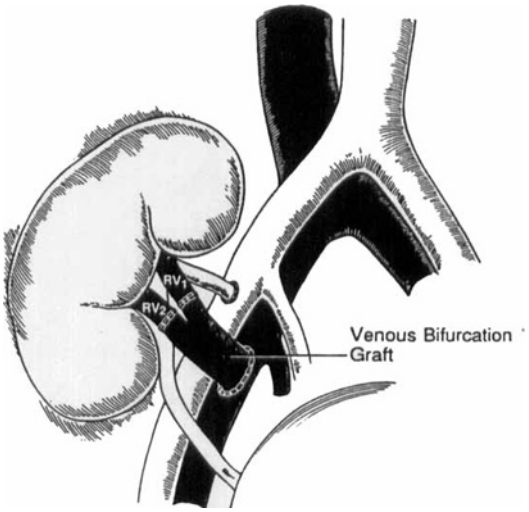

Fig. 2. Use of venous bifurcation allograft to salvage donor right kidney with damaged double renal vein blood supply

the patient underwent cadaveric retransplantation to the left iliac fossa via an extraperitoneal approach. Her postoperative course was complicated by severe cytomegalovirus infection, which necessitated a reduction in immunosuppression and eventual acute rejection of the allograft with transplant nephrectomy. Due to minimal residual function of the first transplant, this kidney was never removed. Eighteen months later, a crossmatch-negative cadaver kidney became available and a third transplant was undertaken. A right flank extraperitoneal approach was performed to avoid adhesions. However, due to the patient's small stature, the cadaveric right kidney with short renal vein would not easily fit in the iliac location, due to the presence of the living-related kidney attached distally to the great vessels. Therefore, as shown in Fig. 1, the donor iliac artery and vein were employed as extension allografts to permit lengthening of the vessels and placement of the kidney anterior, lateral, and caudal to the previous transplant. The patient did well postoperatively, as serum creatinine was be-

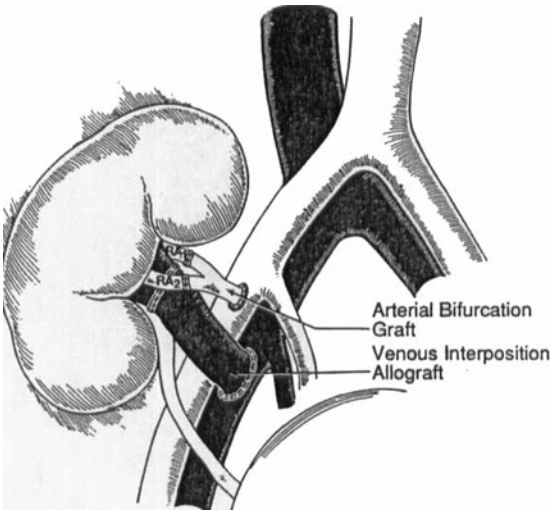

Fig. 3. Donor left kidney with double renal artery blood supply and single renal vein with traction injury. Ex vivo repair was accomplished with arterial bifurcation and venous extension allografts

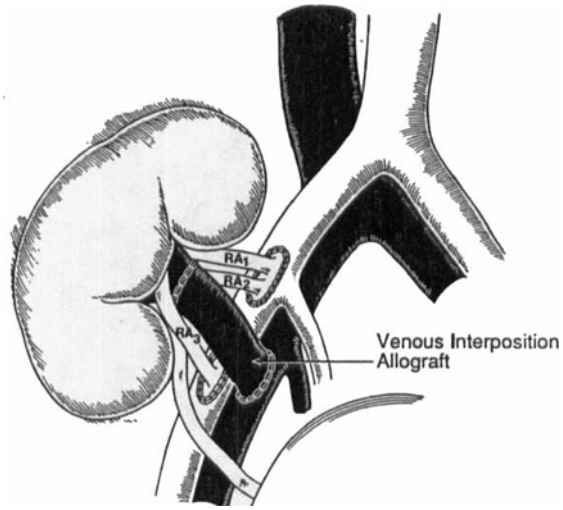

Fig. 4. Donor right kidney with a short renal vein and triple artery blood supply. Renal vein lengthening enabled straightforward vascular anastomoses in a normal anatomic arrangement

low 3 mg/dl within 2 days and 1-month serum creatinine was 1.1 mg/dl. The patient did not require postoperative dialysis and is currently doing well 4 months post-transplant.

Case 2

A 47-year-old white male with polycystic kidney disease presented for cadaveric renal transplantation. The donor right kidney had a double renal vein blood supply, which had been injured during urgent removal from an unstable donor. In addition, the recipient had a deep, narrow pelvis. As illustrated in Fig. 2, a venous bifurcation graft was fashioned from the donor external and internal iliac veins and anastomosed to the renal veins via bench surgery technique under cold storage conditions. The transplant was then performed without difficulty with end-to-side anastomoses to the external iliac vessels as the hypogastric vessels were preserved. The patient did not require dialysis postoperatively and had a serum creatinine of 1.4 mg/dl at 1 month. The patient is currently doing well 5 months post-transplant.

Case 3

A 33-year-old white female with diabetic nephropathy presented for primary cadaveric transplantation. The donor kidney was a left kidney with a double renal artery blood supply and a single renal vein with traction injury. As portrayed in Fig. 3, the donor common iliac arterial bifurcation and external iliac vein were employed as extension allografts. Bench surgery was performed on the back table under cold storage conditions as three end-to-end anastomoses were constructed. The transplant then proceeded without difficulty as end-to-side anastomoses were constructed between the allografts and the external iliac vessels, allowing the hypogastric vessels to be preserved. The patient experienced excellent renal function postoperatively without need for dialysis and had a 1-month serum creatinine of 1.9 mg/dl. The patient is currently doing well 25 months post-transplant.

Case 4

A 73-year-old white male with end-stage renal disease due to glomerulonephritis presented for primary cadaveric transplantation. The donor right kidney had a short renal vein and triple artery blood supply, as depicted in Fig. 4. In addition, the recipient had a narrow, deep pelvis and moderate atherosclerosis, which precluded easy mobilization of the hypogastric vessels. Therefore, a long venous extension allograft was fashioned from the donor external iliac vein. This permitted easy venous reconstruction and enabled Carrel aortic patches containing arteries to be anastomosed above and below the vein in a normal anatomic arrangement without tension or kinking. The recipient did well postoperatively without requiring dialysis, as the serum creatinine was below 3 mg/dl within 6 days. One-month serum creatinine was 1.8 mg/dl. We have previously reported a similar case of a donor right kidney with three renal arteries and short renal vein in which the donor common iliac artery was utilized as an extension allograft for the vein in the absence of venous allograft material [4].

Results

Sixteen kidneys (94.1%) requiring ex vivo venous reconstruction were right kidneys. Conversely, all but three patients received a transplant to the recipient's right iliac fossa. The mean length of the vein prior to reconstruction was 12 mm. In six cases (35.3%), ex vivo renal artery reconstruction was performed in combination with the venous repair. Bench surgery ranged from 10 to 30 min, depending upon the complexity of the venous and/or arterial repair. An attempt was made to perform as much reconstruction as possible on the back table under cold storage conditions in order to minimize warm is-

chemic injury to the kidney and also to optimize exposure for microvascular anastomoses. The mean in situ anastomosis time was 20 min. The mean length of venous interposition allograft after revascularization was 27 mm. There were no episodes of vascular thrombosis.

Three patients (17.6%) required postoperative hemodialysis for acute tubular necrosis, which subsequently was resolved. A serum creatinine below 3.0 mg/dl was reached at a mean time post-transplant of 6.9 days. In the 14 patients not requiring dialysis, this time occurred at a mean of 5.1 days. For the entire patient group, the mean serum creatinine at 1 month post-transplant was 1.7 mg/dl. Currently, patient survival is 94.1% and allograft survival is 82.4% after a mean follow-up interval of 7.4 months. One patient died due to septic complications at 2 months post-transplant with a patent vascular reconstruction. Two patients experienced irreversible allograft rejection but were without evidence of vascular thrombosis during transplant nephrectomy.

Discussion

Multiple renal arteries (15%-20%) and/or veins (5%-10%) are not uncommon in cadaveric organ procurement; 30%-50% of all donor organs display some anatomic abnormality [2]. Numerous surgical techniques have been described to deal with anatomic variants, including the use of direct microvascular reconstruction with autogenous grafts, allografts, or synthetic grafts. Similarly, modifications of existing techniques have been developed to repair abnormal or damaged donor organs. Our preferred approach is to employ allograft material in ex vivo reconstruction under cold storage conditions to minimize ischemic injury to the organ, optimize operative exposure for microvascular repair on the back table, prevent further dissection or incisions in the patient, and reduce operating time.

The adult renal vein averages 32 mm in length on the right, in contrast to 84 mm on the left [1]. The short renal vein is a technical inconvenience and a surgical challenge. It limits exposure of the venous anastomosis and compromises renal mobility for the arterial anastomosis and final position of the kidney. Previous options to solve this problem have included complete mobilization of the iliac artery and vein with sacrifice of the hypogastric vessels, placement of the transplant on the distal inferior vena cava and common iliac artery, positioning the kidney medially, anteriorly, and/or transversely in the iliac fossa, accepting an anastomosis under tension, or constructing a vena cava extension [1, 5, 10]. Vena cava extension is an acceptable method of lengthening a short right renal vein or of dealing with multiple veins. However, it may involve long or multiple suture lines and result in a size discrepancy between donor and recipient vessels. In addition, it is not a valid option in cases of venous injury in the renal hilum.

The diversity of donor and recipient anatomic variations which challenge the transplant surgeon require surgical versatility, judgment, and innovation. We believe that venous extension allografts offer certain advantages, including a venous anastomosis without tension or torsion, a minimal vascular dissection technique in the recipient with preservation of the hypogastric vessels and decreased operating time, and flexibility in placement of the arterial anastomosis and final kidney position.

The techniques of ex vivo vascular repair with hypothermia have been previously well described in a variety of settings, especially with respect to renal artery reconstruction [3, 7]. However, venous reconstruction with extension has not been routinely advocated, due to the fear of thrombosis. Optimum management of the donor organ begins with careful procurement, including identification and salvage of accessory vessels. Small accessory renal veins can be ligated with impunity. The short or injured renal vein or donor kidney with multiple vessels may benefit from lengthening with venous allografts, as described above, without the risk of thrombosis. Recipient factors which may play an important part in determining the need for interposition allografts include a narrow, deep pelvis (especially in muscular male or obese patients); a technically difficult vascular dissection, due to scarring from previous surgery or atherosclerosis; atypical transplant location, due to prior transplant, severe atherosclerosis, or anatomic abnormality; and the necessity for maintaining hypogastric perfusion, thus limiting operative exposure.

The development and implementation of new operative strategies must parallel advances in organ retrieval technology to maximize efficient utilization of limited allograft resources. We are encouraged by these preliminary results, and we believe that ex vivo renal vein reconstruction with an interposition allograft is a safe and effective modality that should be added to the transplant surgeon's armamentarium for select cases. With refinements and further experience in multiple organ procurement, the use of vascular allografts may find wider application and permit combined liver and pancreas retrieval from the same donor.

References

1. Barry JM, Fuchs EF (1978) Right renal vein extension in cadaver kidney transplantation. Arch Surg 113: 300
2. Belzer FO, Schweizer RT, Kountz SL (1972) Management of multiple vessels in renal transplantation. Transplant Proc 4: 639-644
3. Belzer FO, Salvatierra O, Palubinskas A, Stoney RJ (1975) Ex vivo renal artery reconstruction. Ann Surg 182: 456-463
4. Brandl JP, Stratta RJ, Belzer FO (1988) Ex vivo renal vein reconstruction with interposition arterial allograft during cadaveric renal transplant: a case study. Transplant Proc (in press)
5. Corry RJ, Kelley SE (1978) Technic for lengthening the right renal vein of cadaver donor kidneys. Am J Surg 135: 867
6. Hoffmann RM, Stratta RJ, Sollinger HW, Kalayoglu M, Pirsch JD, Belzer FO (1988) Efficacy of clinical cadaver kidney preservation by continuous perfusion. Transplant Proc (in press)
7. Merkel FK, Straus AK, Andersen O, Bannett MD (1976) Microvascular techniques for polar artery reconstruction in kidney transplants. Surgery 79: 253-261
8. Starzl TE, Halgrimson CG, Koep LJ, Weil R, Taylor PD (1979) Vascular homografts from cadaveric organ donors. Surg Gynecol Obstet 149: 737
9. Starzl TE, Hakala TR, Shaw BW, Hardesty RL, Rosenthal TJ, Griffith BP, Iwatsuki S, Bahnson HT (1984) A flexible procedure for multiple cadaveric organ procurement. Surg Gynecol Obstet 158: 223-230
10. Taylor RJ, Hakala TR, Rosenthal JT (1985) Use of vena cava to extend the right renal vein in cadaveric transplants. Surg Gynecol Obstet 160: 279-280