1730

Liver and Kidney Transplantation From Non-Heart Beating Donors: The Pittsburgh Experience

A. Casavilla, C. Ramirez, R. Shapiro, D. Nghiem, K. Miracle, J.J. Fung, and T.E. Starzl

NINETEEN liver and 51 kidney retrievals (one pediatric pair is considered as a single organ) were performed in 26 non–heart-beating donors (NHBD) over a 5.5-year period. Consent for liver procurement was not obtained in seven cases. Fifty-seven allografts (14 livers and 43 kidneys) were transplanted while the remainder (5 livers and 8 kidneys) were discarded because of macroscopic and/or microscopic findings. This report discusses the outcome in this series of liver and kidney allografts from NHBD.

MATERIALS AND METHODS

Donors were divided into two groups: group 1 or uncontrolled NHBD (UNHBD; n = 14) included patients whose organs were recovered following a period of unsuccessful cardiopulmonary resuscitation (CPR; mean CPR time to perfusion 37 ± 29 minutes, range 10 to 100); and group 2 or controlled NHBD (CNHBD; n = 12) included patients who died after choosing to forgo life-sustaining treatment and developed cardiopulmonary arrest after extubation in an operating room setting (mean time from extubation to in situ perfusion 23.5 ± 9 minutes, range 10 to 42).

Thirteen of 14 donors in the UNHBD group and 8 of 12 donors in the CNHBD group were male. The causes of death in the UNHBD/CNHBD groups were related to trauma (64%/33%), anoxic injury (28%/17%), and subarachnoid hemorrhage (8%/42%); a remaining patient (8%) in the CNHBD group had a brain tumor.

The mean prearrest serum creatinine, bilirubin, and aspartate transaminase (AST) for the UNHBD/CNHBD groups were 1.1 ± 0.5 (range 0.6 to 3.2)/0.8 ± 0.2 (range 0.5 to 1.2) mg/dL, 0.6 ± 0.4 (range 0.2 to 1.6)/0.9 ± 0.3 (range 0.2 to 1.8) mg/dL, and 164.8 ± 140.7 (range 37 to 469)/79.3 ± 62 (range 13 to 251) IU/L, respectively. With one exception in each group, all donors required vasopressors. The mean dopamine dose at the time of laparotomy for the UNHBD and CNHBD groups was 10.9 ± 12.2 (range 0 to 40) and 11 ± 11.5 (range 0 to 35) μg/kg/min, respectively. Most had good urine output prior to procurement (222 [range 0 to 1000] mL/h for group 1 and 231 [range 75 to 650] mL/h for group 2).

The logistics and technique of NHBD procurement have been reported before.[1] In both groups, 30,000 U of heparin was administered prior to laparotomy. The essence of this "super rapid" retrieval technique entails a rapid cooling of the organs prior to any dissection by means of immediate cannulation and perfusion through the distal aorta and inferior mesenteric veins. A subsequent hepatectomy followed by en bloc nephrectomies is performed as expeditiously as possible. The demographics of the kidney and liver recipients are shown in Table 1.

RESULTS

Of the 22 transplanted kidneys from UNHBD, 14 (63.6%) developed acute tubular necrosis (ATN), which lasted a mean of 14.2 ± 12.7 days (range 4–39), and 8 patients (36%) required hemodialysis posttransplant. Twenty patients (95%) were off dialysis by the time of discharge. Two grafts failed from arterial thrombosis and accelerated re-

From the Pittsburgh Transplantation Institute, University of Pittsburgh, Pittsburgh, Pennsylvania.

Address reprint requests to A. Casavilla, Pittsburgh Transplantation Institute, University of Pittsburgh, Pittsburgh, PA 15213.

0041-1345/95/$3.00/+0

Table 1. Demographics for Kidney and Liver Recipients

	G1	G2
Kidney patients	22	21
Mean age (y)	41.3 ± 16.0 (range 18–64)	46.2 ± 12.9 (range 18–71)
Sex (M/F)	12/10	13/8
Retransplants	2 (9)%	2 (12%)
CIT (h)	28.5 ± 5.8 (range 14–39)	25.4 ± 8.3 (range 11–37)
PRA		
>40%	3 (14%)	3 (14%)
<40%	19 (86%)	18 (86%)
Antigen match	2.0 ± 1.2 (range 0–5)	2.7 ± 1.6 (range 0–6)
Antigen mismatch	3.5 ± 1.0 (range 1–5)	2.7 ± 1.5 (range 0–6)
Liver patients	6	8
Mean Age (y)	39.7 ± 20.8 (range 0.4–57)	47.2 ± 18.9 (range 15–66)
Sex (F/M)	4/2	4/4
UNOS score (US)	US 4 = 3 patients; US 3 = 3 patients	US 3 = 7 patients; US 4 = 1 patient
EBL (U or PRBC)	10.5 ± 96 (range 1–27)	18.3 ± 12 (range 0–34)
CIT (h)	10.6 ± 2.8 (range 9–16)	11.0 ± 2.5 (range 8–15)
Crossmatch	All negative	All negative

Abbreviations: CIT, cold ischemic time; PRA, panel reactive antibody; EBL, estimated blood loss; PRBC, packed red blood cells.

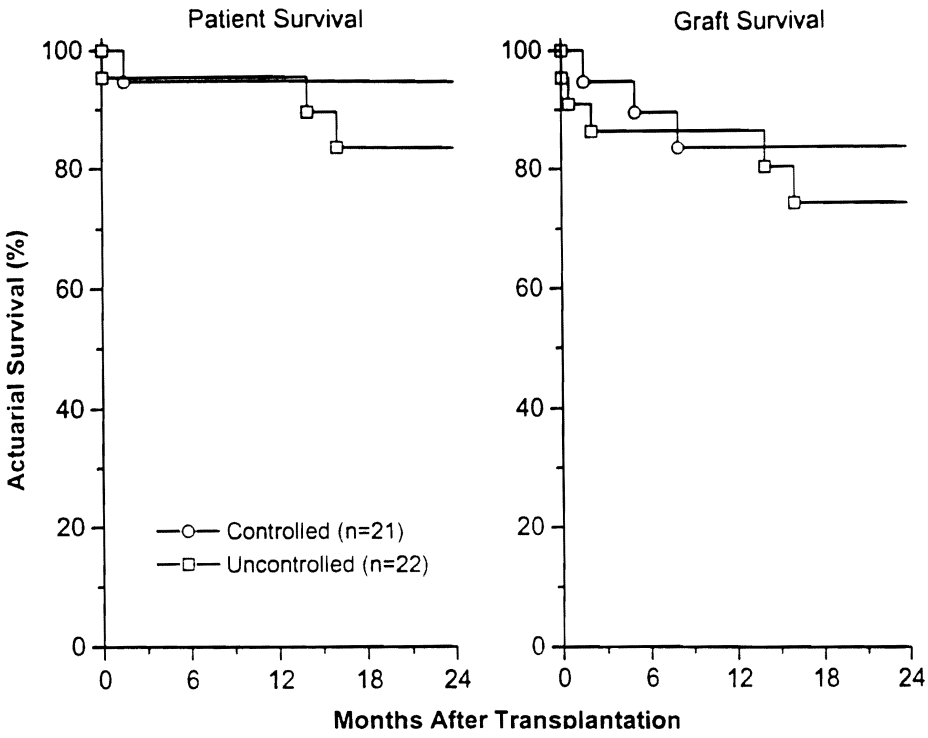

Fig 1. Kidney transplantation utilizing allografts from Non-Heart Beating Donors (January 1989 to July 1994).

jection at 0.5 months and 2 months, respectively. Five patients died, three of whom had functioning kidneys, from respiratory failure, central nervous system (CNS) lymphoma, and sepsis (n = 3) between 1 to 38 months posttransplant. With a mean follow-up of 35 ± 21.4 months (range 14 to 60), 16 kidneys (73%) are still functioning with a mean serum creatinine of 1.7 ± 0.6 mg/dL. The 1-year actuarial patient and graft survival rates were 95% and 86%, respectively (Fig 1).

Of the 21 transplanted kidneys from CNHBD, 16 (76.2%) experienced ATN, which lasted a mean of 8.9 ± 8.8 days (range 3 to 30), and 9 patients (43%) required hemodialysis posttransplant. All patients were off dialysis at the time of discharge. The most recent creatinine level is 2.5 ± 1.3 mg/dL at 16.5 ± 15.4 months follow-up (range 1 to 56). One patient with a functioning kidney died at 1.5 months from a pulmonary embolus. Four grafts failed from histologically demonstrated chronic rejection between 5 and 38 months posttransplant. The 1-year actuarial patient and graft survival rates were 94% and 79%, respectively (Fig 1).

Of the six transplanted livers procured from UNHBD, three (50%) functioned with a peak serum bilirubin of 4.2 ± 0.4 mg/dL and a peak AST of 1135 ± 954.6 IU/L during the first week posttransplant. Two of these three patients required retransplantation due to hepatic artery thrombosis (HAT) and cytomegalovirus (CMV) hepatitis at 1.4 and 1.0 months posttransplantation, respectively. One patient with a functioning liver is alive and well at 58 months posttransplant. The remaining three patients required retransplantation within the first week postoperatively because of primary nonfunction (PNF; n = 2) and inadequate portal flow (n = 1). The 1-year actuarial patient and graft survival rates were 67% and 17%, respectively (Fig 2).

Of the eight transplanted livers that were procured from CNHBD, all (100%) functioned with a peak serum bilirubin of 10.5 ± 9.3 mg/dL and a peak AST of 744.6 ± 483 IU/L within the first week posttransplantation. Two patients, both of whom died, required retransplantation at 0.9 and 1.0 months due to HAT. One patient with a functioning liver died of a myocardial infarction at 2 months posttransplantation. The remaining five patients are alive and well between 1 and 26 months follow-up. The 1-year actuarial patient and graft survival rates were 50% and 50%, respectively (Fig 2).

DISCUSSION

The last decade has witnessed the development of transplantation as the treatment of choice for many patients with end-stage organ failure. Thousands of patients who would have otherwise died have been saved by the improved results of organ transplantation. However, this success has also exacerbated the problem of an insufficient number of donor organs. The 1993 annual report of the US Scientific Registry of Transplant Recipients and the Organ Procurement and Transplantation Network[2] highlights how acute this shortage of suitable allografts has become. During the period from 1988 to 1991, the number of patients awaiting transplantation has increased by 54%. During the same period of time, the number of pancreas, liver, heart, and kidney registrants who died while waiting for transplants

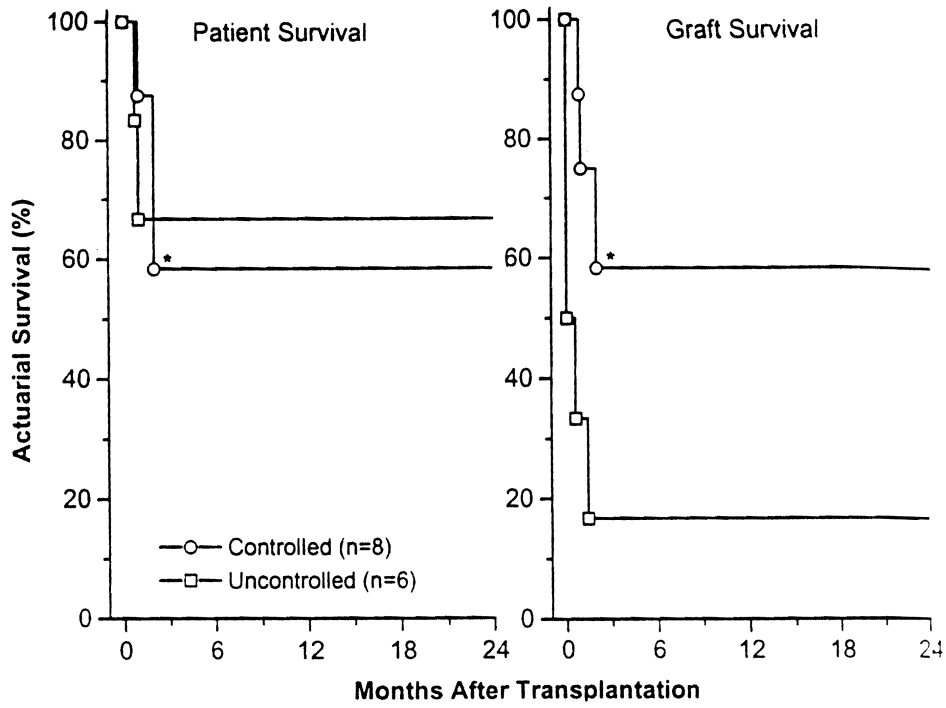

Fig 2. Liver transplantation utilizing allografts from Non-Heart Beating Donors (January 1989 to July 1994). *One patient with functioning liver died of a myocardial infarction at 2 months posttransplant.

increased by 517%, 128%, 58%, and 35%, respectively. In contrast, the number of organ donors during the same period increased by only 15.5%.

Although the need to expand the organ pool is great, these attempts at using NHBD are reasonable only if good quality grafts are obtained. We analyzed our experience with NHBD by dividing them into two categories. The first group consisted of UNHBD. Although 64% of the kidneys from uncontrolled NHBD experienced ATN, the overall 1-year patient and graft survival rates in this group was excellent at 95% and 86%. The quality of these grafts has been sustained over time and with a mean follow-up of 35 months and 73% of these grafts are still functioning. The experience with livers procured from this group of patients was not as satisfactory; 33.3% of the organs transplanted from this group of donors experienced PNF (two of six), one liver with inadequate portal inflow failed within a week posttransplant (technically related), and two of the three patients whose grafts functioned initially required retransplantation because of HAT and CMV hepatitis at 1.4 and 1.0 months, respectively. Therefore, only one of the six livers transplanted from the CNHBD population functioned for a prolonged period of time.

In the CNHBD, results with respect to the kidneys were very similar to the UNHBD. Twenty-one kidneys were transplanted and 76% of these experienced ATN. The 1-year patient and graft survival rates were 94% and 79%, respectively, and with a mean follow-up of 16.5 months, 70% of the kidneys are still functioning. In contrast to the UNHBD group, all eight livers obtained from the CNHBD group functioned. Two grafts were lost due to arterial complications (HAT and arterial vasculitis) at 1.0 month posttransplant. A third graft with stable liver function was lost because of a cardiac death 2 months posttransplant.

This study suggests that the procurement of kidneys from both UNHBD and CNHBD leads to acceptable graft function despite a high incidence of ATN. The function of liver allografts is adequate in the CNHBD but suboptimal in the UNHBD, with a high rate of PNF. In addition, our NHBD liver series shows a 21% incidence of vascular complications, with all patients requiring retransplantation. In conclusion, the results of this small series of NHBD suggest that viable organs can be procured. In our current practice, kidneys from NHBD are utilized for patients awaiting transplantation; livers from CNHBD may be used for patients awaiting transplantation, while livers from UNHBD may be considered only in highly selected cases.

REFERENCES

1. Casavilla A, Ramirez C, Shapiro R, et al: Transplantation (in press)

2. UNOS: Annual Report of the U.S. Scientific Registry of Transplant Recipients and the Organ Procurement and Transplantation Network, 1993.