Kidney Transplantation in Inbred Rats

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Strains of rats are available in which renal allotransplantation can be performed with controlled, predictable rejection responses or without any rejection at all. Guttmann, Lindquist, and Ockner [1] and Guttmann and Lindquist [2] used such strains to study the immunogenic stimulus of rejection. Despite the obvious advantage of using rats in experimental renal transplantation, not many investigators have used them because of the technical difficulties of the operation. To facilitate our experiments, we developed a simpler surgical technic and have obtained excellent results.

Material and Methods

Donor rats are anesthetized with intraperitoneally administered pentobarbital sodium, 50 mg per kg of body weight. The recipients receive open cone ether after the donor kidney is fully prepared. The simplest ophthalmologic instruments are used including an inexpensive set of eye glasses with 2x magnification and a wide depth of field. (Figure 1.) For the vascular clamp, the prongs of a small Hartman mosquito forceps are filed down to 1 mm in thickness and Silastic® tubing is fitted over each prong to protect the vessels. To obtain the least leakage or obstruction, we use 9-0 nylon for all vascular anastomoses. Sterile technic is not necessary.

The abdomen of the donor is opened through a long vertical midline incision. The mesenteric attachment is released up to the superior mesenteric artery, which is doubly ligated and divided at the aorta to allow wide, easy exposure. We have found that the right kidney is easiest to use. The aorta, vena cava, right renal artery, renal vein, right adrenal artery, and lumbar arteries are freed. (Figure 2.) The right adrenal artery is doubly tied and divided. The kidney is freed without being touched, leaving a cuff of fat with which to grasp it. The ureter, which is no more than 1 mm in diameter, is also freed all the way up to the bladder, leaving a thick envelope of periureteral fat. A liberal cuff of bladder is excised where the ureter enters.

The aorta and vena cava are tied above and below the renal artery and vein. After a small cut is made in the vena cava for outflow of saline, a 10 cc syringe with a 25 gauge needle is inserted into the donor aorta for perfusion with normal saline at room temperature. (Figure 3.) In removing the kidney from the donor, a wide cuff of aorta and vena cava is taken with the renal artery and vein. By grasping the perirenal cuff of fat, the kidney is lifted out of the donor, inverted, and placed into the right flank of the recipient whose aorta and cava have been prepared for

Figure 1. The instruments required are inexpensive and few.
the transplant. (Figure 4.) The donor kidney is never manipulated or moved from this position.

The vascular clamp described previously is applied to a cuff of donor vena cava into which a vertical cut is made. An end to side anastomosis is accomplished by suturing the posterior row inside and the anterior row outside without moving the kidney or having to retract the vessels. (Figure 5.)

A seraphim clamp is placed across the renal vein to prevent back perfusion into the kidney, and the vascular clamp is taken from the vena cava and applied to the aorta. (Figure 6.) Similarly, the renal artery is anastomosed end to side to the aorta without moving the kidney. The seraphim clamp on the renal vein and the vascular clamp on the aorta are removed and Oxycel® is applied to the anastomosis for a minute. The kidney usually starts producing urine in one to ten minutes. Total clamping time is generally under an hour. However, longer clamping times of an hour and a half do not seem to impair the results. Cooling has not been used.

The dome is cut off the recipient bladder, and the bladder cuff of the donor ureter is sutured to the recipient with 7-0 chromic running watertight suture. (Figure 7.) The wound is closed after leaving 10 ml of saline in the peritoneal cavity as fluid and electrolyte replacement. The ether cone is removed, and the rat usually awakens in minutes. We have not experienced graft failure or hypotrophy of the transplanted kidney. One case of ureteral obstruction occurred at an area that was left without an adequate envelope of periureteral fat.

Comments

The technic of renal transplantation in rats originally described by Fisher and Lee [3] and Lee [4] involved a difficult set of vascular anastomoses in which the kidney has to be flipped back and forth and the renal artery and vein easily get in the way of each other.

Figures 2 through 7. A schematic illustration of the steps for performing transplantation. (See text for details.)
Figure 8. An intravenous pyelogram of the host rat. The kidneys have equal function and normal ureteral conduct of urine even two full months postoperatively.

We have simplified the technic by clamping the aorta and vena cava separately and suturing the posterior row inside. The kidney is never manipulated and the vascular anastomoses are made very easily. The extra step of cooling the kidney is not done. Finally, a thick envelope of perireteral fat insures good blood supply to the ureters and protection against obstruction caused by adhesions.

Klein and Gittes [5] have also studied the three-kidney rat and report finding various degrees of hypotrophy in the transplanted kidney when the original two kidneys are left in the recipient. In all our rats, the host kidneys were left intact, but there was no hypotrophy of the grafted kidney. (Figure 8.) With our technic, laboratory studies involving kidney transplants in rats can be performed with little concern for any damage that might occur during the transplantation process.

Summary

The rat is a superior laboratory animal for the study of renal transplantation because of the availability of strains sufficiently inbred to allow adequate experimental control of rejection. However, technical difficulties have stood in the way of its popular use. A revised technic with minimal renal manipulation and a simplified vascular anastomosis is described.

References