Prevention of Urological Complications after Kidney Transplantation

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THE MORTALITY rate following kidney transplantation has been gradually reduced during the past few years, as knowledge of the management of the operative procedures and immunosuppressive agents has accumulated. Death in the early posttransplantation period is now almost completely preventable,[14] particularly by the prevention of urological complications. The present report is an analysis of the urological complications associated with 200 consecutive kidney transplantations at the University of Minnesota, and an illustration of how a method of urinary tract reconstruction has eliminated death from this cause in the last 100 transplantations.

Methods

Between 1963 and May 30, 1970, 200 kidney transplants were performed in 183 patients at the University of Minnesota Medical Center. Ten patients received a combined pancreatico-duodenal transplant as well as a kidney transplant. Eighty-six transplants were from cadaver donors and 114 were from living related donors. This series has been analyzed in terms of major urological complications, mainly urinary leaks and ureteral obstructions. The analysis does not include data concerning chronic bacteruria, which requires treatment but which seems to be unrelated to late obstruction or reflux.

During the period from 1963–1967 pyeloureterostomy was the most common method of urinary tract reconstruction, although a variety of makeshift arrangements were also employed. Since 1968 (following the arrival at Minneapolis of one of the authors [JSN]), ureteroneocystostomy has been used at this hospital in all but two cases: one patient required ileal conduit urinary diversion and one required pyeloureterostomy because of injury to the donor ureter during removal of the kidney from the cadaver donor.

The operative technic utilized in 98 of the last 100 cases is a modification of the Politano-Leadbetter method.[10] The operative technic is illustrated in Figures 1 and 2. The dome of the bladder is opened, a submucosal tunnel approximately 2 cm. in length is made above the ureteral orifice on the side of the transplant, and the

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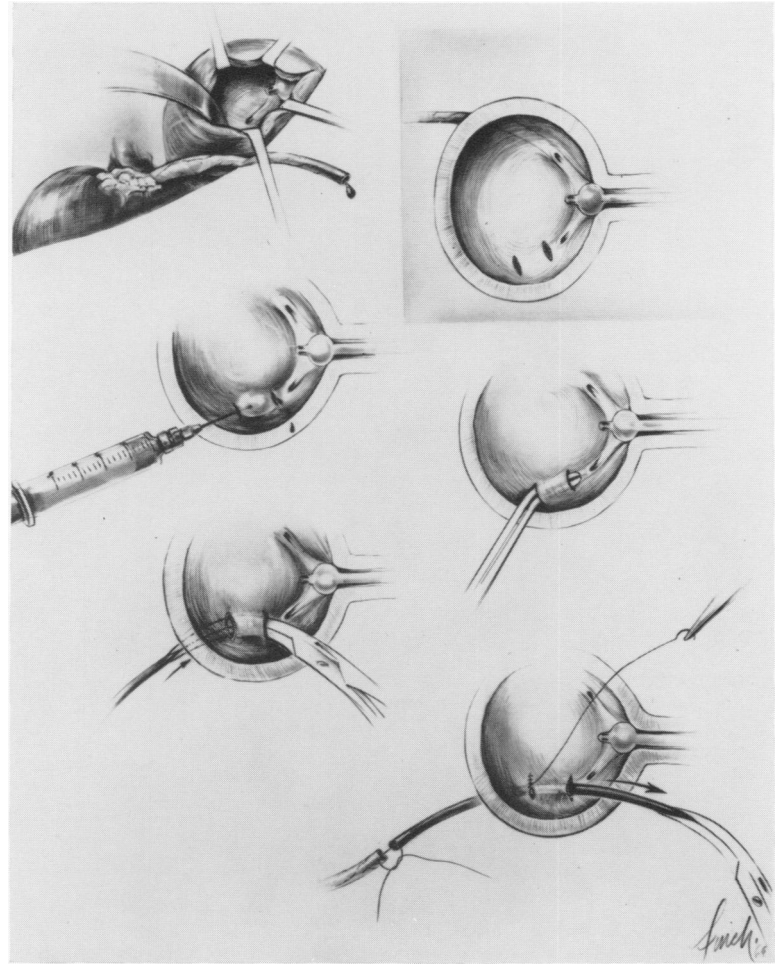

FIG. 1. Cystotomy, formation of submucosal bladder tunnel.

ureter is led through a large tunnel in the bladder wall and then through this submucosal tunnel. The ureter is trimmed back almost to the level of ligation of the periureteral blood supply, is spatulated, and sutured to the bladder mucosa with interrupted sutures of 5-0 plain catgut. One of these sutures should anchor the ureter to the muscle of the trigone. The bladder is closed with two inner layers of running 4-0 plain catgut, and an outer layer of interrupted 4-0 chromic catgut.

Great care is taken to protect the donor ureter during the dissection in the donor as well as during the reimplantation. The ureter is handled as little as possible, the periureteral blood supply is carefully preserved and not stripped back, and the length of the ureter is kept as short as possible to ensure good blood supply to the tip and to prevent kinking from redundancy, although tension must also be avoided. No ureteral splints are used, and the Foley catheter is removed on the third postoperative day. No wound drains are used.

Results

Table 1 outlines the number of urological complications in the 200 transplants done at the University of Minnesota Hospital. The incidence of urological complications was much higher (19%) in the early series than in the late series (3%).

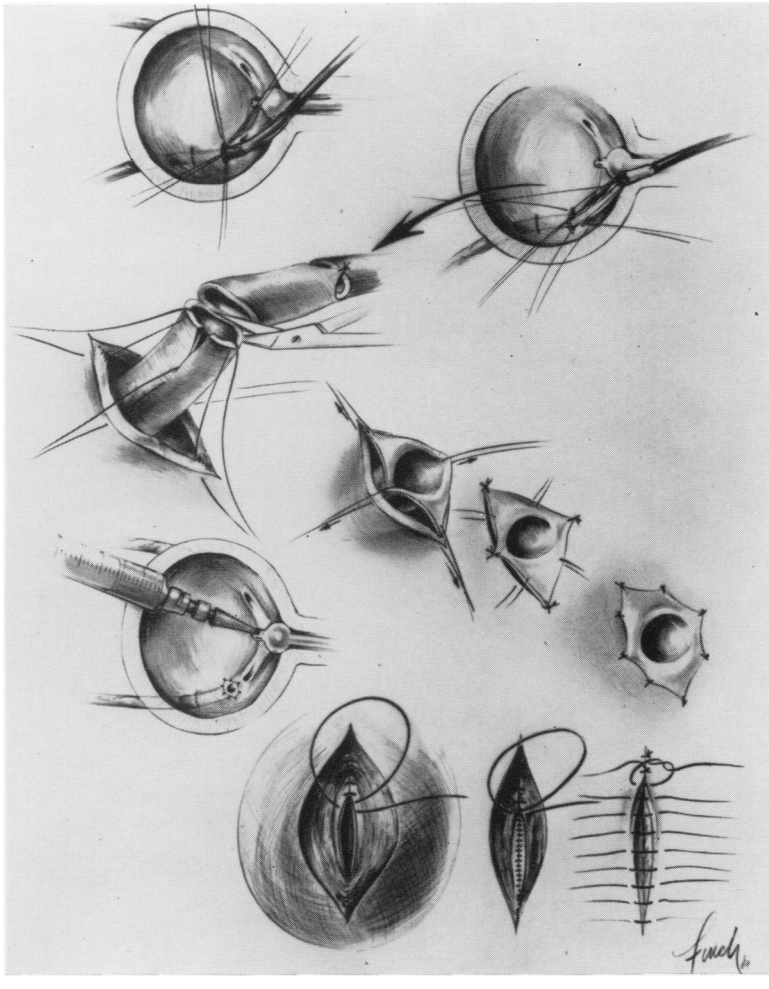

FIG. 2. Spatulation and fixation of ureter, bladder closure.

The mortality following these urological complications was much higher in the early series (79%) than in the late series (0%).

Table 2 gives the incidence of urological complications according to the method of urinary tract reconstruction, for the entire series. The incidence of urological complications following ureteroneocystostomy was 3%, and following pyeloureterostomy it was 26%. Table 3 reveals the mortalities following these complications and shows that 0/3 patients died following urological complications after ureteroneocystostomy, and 14/18 patients died following urological complications after pyeloureterostomy.

The three urological complications which occurred during the last 100 transplants are summarized below.

Case Reports

Case 1. *Retrocecal positioning of third kidney transplant:* JB, a 15-year-old boy, received his third kidney transplant, from his mother, in February of 1970. This kidney was placed in the retrocecal position via a transperitoneal approach. Pyeloureterostomy had been done for the previous transplantations, and ureteroneocystostomy was done at this time. Four weeks post-transplant, oliguria and ascites suggested that the ureterovesical anastomosis was leaking. Reoperation revealed no evidence of urinary leak, but retrograde ureteral catheterization was followed by adequate urinary output. Two weeks later, removal of the ureteral catheter was followed by intraperitoneal

TABLE 1. *Urologic Complications and Mortality after Kidney Transplantation at the University of Minnesota*

	1963–1967 (100 Transplants)				1968–May, 1970 (100 Transplants)		
			Deaths				
Complication (Cx)	No. Patients	%	No. Patients	(% of Cx)	No. Patients	%	Deaths
Urinary fistula	9	9%	8	89%	1	1%	0
Urinary leak (radiologic)	4	4%	2	50%	2*	2%	0
Ureteral obstruction	6	6%	5	83%	0	—	—
Total	19	19%	15	79%	3*	3%	0

* One recipient of kidney and pancreas transplant, and one recipient of third kidney transplant.

extravasation of urine, and the patient was operated upon for the second time. When the distal ureter was found devascularized, it was resected, and a second ureteroneocystostomy was done. The patient is well 5 months post-transplantation, with a serum creatinine of 1.1 mg./100 ml.

Comment: This patient's two previous transplants necessitated the transperitoneal approach. The additional length of donor ureter required for the retrocecal positioning of the kidney may have contributed to the devascularization of the distal ureter. In addition, the transperitoneal location of the ureter may be less conducive than the retroperitoneal location to development of collateral ureteral blood supply.

Case 2. *The post-partum donor ureter:* RK, a 30-year-old man with a long history of diabetes mellitus and renal failure, received a kidney transplant from a living related donor in December of 1969, which was followed by transplant nephrectomy 2 weeks later. In January of 1970, he received a second kidney and a combined pancreatico-duodenal transplant, simultaneously. Because of previous transplantation into the iliac fossa on the same side, the kidney was placed within the peritoneal cavity. The donor had delivered a full-term infant 1 day prior to transplantation, following which she had sustained a fatal intracranial hemorrhage, so that the donor ureters were both dilated at the time of transplantation. One week post-transplant, reexploration was done because of intraperitoneal urine extravasation, and the ureteroneocystostomy was found partially disrupted with the distal ureter partially pulled out of the bladder. A fresh ureteroneocystostomy was performed at a new site, after resection of the distal ureter. Three days later reoperation was again necessary for intraperitoneal urine extravasation. The distal ureter was found devascularized and necrotic, and pyeloureterostomy was done. His postoperative course has been complicated by recurrent infection in the urine and blood, but renal function is excellent (serum creatinine 0.7 mg./100 ml.) 5 months post-transplantation.

Comment: Two factors may have contributed to the urine leak: (1) the blood supply to the dilated postpartum donor ureter may have been inadequate for purposes of transplantation; and, (2) intra-abdominal retraction for the pancreatico-duodenal transplant may have contributed to the initial disruption of the ureteroneocystostomy.

Case 3. *Pyeloureterostomy failure due to devascularization of host ureter:* AK, a 45-year-old man, received a cadaver kidney in April of 1970. The donor's other kidney was already being trans-

TABLE 2. *Urologic Complications after Kidney Transplantation (Univ. of Minn.)*

Procedure	Complications	
Ureteroneocystostomy	3/118	(3%)
Pyeloureterostomy	18/70	(26%)
Ureteroureterostomy	0/4	(0%)
Ileal Conduit	1/8	(17%)
Total	22/200	(11%)

TABLE 3. *Mortality after Urological Complications (Univ. of Minn.)*

Procedure	Mortality
Ureteroneocystostomy	0/3
Pyeloureterostomy	14/18
Ureteroureterostomy	—
Ileal Conduit	1/1
Total	15/22 (68%)

TABLE 4. *Urological Complications after Kidney Transplantation*

Center Reporting	Urological Complications	
Boston (PBB)[8,18]	15%	(23/158)
Cleveland (Clev. Clin.)[16]	25%	(35/142)
Denver (Univ. Colo. 1962–63)[15]	5%	(2/42)
Los Angeles (Child. Hosp.)[2]	39%	(9/23)
Los Angeles (UCLA, VA)[7]	15%	(22/142)
Minneapolis (Univ. Min. pre 1968)	19%	(19/100)
Minneapolis (Univ. Minn. 1968 ff)	3%	(3/100)
Montreal (Roy. Vict.)[6]	27%	(16/59)
Palo Alto (Stanford)[9]	24%	(9/37)
Richmond (MCV)[11]	11%	(9/98)
San Francisco (Univ. Calif.)[1]	4%	(9/220)
Total	14%	(156/1108)

planted into a second recipient when the ureter of the remaining kidney was injured near the pelvis. Because A. K. was sensitized to horse serum proteins and had already received a dose of goat antilymphoblast globulin (ALG) for the current transplantation, and because the tissue match was excellent (B+), the transplantation was completed in spite of the ureteral injury. Because of the ureteral injury, pyeloureterostomy was done rather than ureteroneocystostomy. Three weeks postoperatively a cutaneous urinary fistula appeared, and at reexploration the host ureter adjacent to the anastomosis was found devascularized and leaking. This segment was resected, and a pyeloureterostomy was again performed, with nephrostomy and catheter ureterostomy splint as protection. The area of the anastomosis again broke down, and 7 weeks post-transplant, transplant nephrectomy was carried out. The wound was drained. A. K. is on dialysis awaiting retransplantation.

Comment: The blood supply to the host ureter was inadequate for pyeloureterostomy, although this was not apparent at the time of transplantation.

Table 4 shows that in 1108 kidney transplants from 10 centers, there were 156 urological complications (an incidence of 14%). Table 5 reveals that of the 156 patients who developed urological complications, 48 died as a result of these complications (a mortality rate of 30%). Table 6 is a compilation of these urological complications according to the method of urinary tract reconstruction. Of the 891 transplants where the method of urinary tract reconstruction was clearly stated, 745 patients had ureteroneocystostomy, 134 patients had pyeloureterostomy, and 12 patients had ureteroureterostomy. The incidences of urological complications were 9% following ureteroneocystostomy and 28% following pyeloureterostomy. There were only 12 ureteroureterostomies in this collected series, but eight of these 12 patients developed urological complications.

Discussion

According to Williams *et al.*[18] the diagnosis of urological complication following kidney transplantation is not always easy. It may be difficult to distinguish rejection from urinary obstruction or extravasation, particularly if corticosteroids are being administered. In the oliguric patient who does not respond to antirejection therapy, however, urologic evaluation should be undertaken. Radiographic studies may be diagnostic,[3] and radioisotopic technics with a scintillation camera may also be revealing.[17] If these technics do not provide adequate diagnostic information, cystoscopy and retrograde ureteral catheterization should be considered.

A variety of causes have been postulated for the urological complications reported by the various centers. In 1966 Leadbetter *et al.*[5] recommended pyeloureterostomy because the incidence of urological complications following ureteroneocystostomy was as high as 17%, largely due to poor blood supply to the tip of the donor ureter. However in Leadbetter's series of 25 pyeloureterostomies there were two urinary leaks and one urinary obstruction. A long length of donor ureter, which might tax the blood supply to the tip, is not needed for ureteroneocystostomy, except rarely when the kidney is placed retrocecally in an adult who has had previous transplantations (Cases 1 and 2). The retrocecal positioning of the kidney in small children does not require a long length of donor

TABLE 5. *Mortality after Urological Complications*

Center Reporting	Mortality	
Boston (PBB)[8,18]	39%	(9/23)
Cleveland (Clev. Clin.)[16]	20%	(7/35)
Denver (Univ. Colo. 1962–63)[15]	100%	(2/2)
Los Angeles (Child. Hosp.)[2]	0%	(0/9)
Los Angeles (UCLA, VA)[7]	27%	(6/26)
Minneapolis (Univ. Minn. pre 1968)	79%	(15/19)
Minneapolis (Univ. Minn. 1968 ff)	0%	(0/3)
Montreal (Roy. Vict.)[6]	25%	(4/16)
Palo Alto (Stanford)[9]	33%	(3/9)
Richmond (MCV)[11]	22%	(2/9)
San Francisco (Univ. Calif.)[1]	0%	(0/9)
Total	30%	(48/156)

ureter. The blood supply to the donor ureter in ureteroneocystostomy may in fact be better than the blood supply to the recipient ureter in pyeloureterostomy, since the recipient ureter may be entirely dependent on the vesical artery for its blood supply. This may be an important factor in the higher rate of urological complications following pyeloureterostomy.

Ureteral vascular rejection was reported by Haber *et al.*[4] in 1965, in two instances of early transplant failure and death. Although ureteral vascular occlusion may rarely occur with a hyperacute rejection process involving the kidney and the ureter, Robertshaw *et al* in 1966 [12] showed that in 60 canine and seven human renal transplants, light microscopy failed to reveal a single instance where ureteral rejection was present in the absence of kidney rejection. Furthermore, the two human kidney grafts which had undergone chronic rejection for 15–16 months showed no evidence of ureteral rejection. It therefore seems improbable that ureteral rejection is a significant cause of ureteral complications. If it were, one would expect more urological complications following transplantations from unrelated than related donors; and there is no recognizable difference in the incidence of such complications between these two groups.

Salaman *et al.*[13] employed a size 6 umbilical catheter as a ureteral splint, brought out through a cystotomy, when delayed transplant function was anticipated because of long ischemic time. The ureteral catheter is rarely, if ever, necessary. In fact the catheter may act as an obstruction, and it is difficult to keep in position in the face of ureteral peristalsis.

In a series of 23 transplants in children with ages of 2–17 years by Fine *et al.*,[2] the urinary tract was reconstructed by ureteroneocystostomy in 21 of the 23 children. Two children had ureteroureterostomies, and both leaked. Of the 21 children with ureteroneocystostomy, there were nine urological complications, including urinary leaks in two of five chilren who had had obstructive uropathy and abnormal bladders, and urinary leaks in two of four children who received kidneys from donors younger than 5 years old. All of these children survived urological complications, but these data suggest that in children obstructive uropathy in the host and the use of the small donor kidney and ureter may increase the urological complications.

TABLE 6. *Urological Complications According to Method of Urinary Reconstruction*

	Ureteroneocystostomy	Pyeloureterostomy	Ureteroureterostomy
Cleveland (Clev. Clin.)[16]	9/122	2/9	3/4
Los Angeles (Child. Hosp.)[12]	7/21	—	2/2
Los Angeles (UCLA, VA)[7]	15/127	0/2	3/6
Minneapolis (Univ. Minn.)	3/118	18/70	—
Montreal (Roy. Vict.)[6]	6/41	10/18	—
Palo Alto (Stanford)[9]	4/20	5/15	—
Richmond (MCV)[11]	9/96	—	—
San Francisco (Univ. Calif.)[1]	7/200	2/20	—
Total	60/745 (9%)	37/134 (28%)	8/12 (67%)

In the 75 transplants done in patients under 20 years of age at the University of Minnesota, there were only three instances of urinary obstruction and two urinary leaks. Urinary complications therefore need not be more common in children than in adults.

Both Belzer *et al.*,[1] and Prout *et al.*,[11] agree that ureteroneocystostomy with careful operative technic is a successful method of urinary tract reconstruction. In the last 100 kidney transplants done at the University of Minnesota, utilizing this technic of reconstruction, excluding recipients of kidney-pancreas grafts and recipients of second and third kidney grafts, there have been no urological complications.

Summary

1. The incidence of urological complications following kidney transplantation at the University of Minnesota has been reduced from 19% in the first 100 transplants to 3% in the last 100 transplants (January, 1968–May 1970).

2. Pyeloureterostomy has been followed by urinary leak or obstruction in a high percentage of cases.

3. Ureteroneocystostomy has resulted in no urological complications in the primary transplants done since January of 1968.

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