Experience with Pyeloureterostomy in Renal Transplantation

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Pyeloureterostomy was used as the preferred method of urinary tract reconstruction in 260 of 371 consecutive renal allograft procedures performed between September 1967 and December 1980. Initially chromic catgut suture was used for the anastomosis in 96 patients with ten complications developing (10.4%). Because of the high incidence of anastomotic leakage (8.3%) with chromic catgut suture, the next 101 pyeloureterostomies were constructed using 7–0 Tevdek. Although urinary leakage occurred in only five of these patients (4.9%), late stone formation occurred along the suture material in three patients (2.9%), influencing the conversion to 7–0 Prolene for this anastomosis. With this suture material, only two complications have occurred in 63 subsequent pyeloureterostomies (3.1%), neither related to the anastomosis. In comparison, eight complications developed in 111 patients who underwent reconstruction with the Politano–Leadbetter method of ureteroneocystostomy (7.2%). The currently recommended method for pyeloureterostomy, as described, when combined with meticulous attention to technical details has made pyeloureterostomy a safe and effective method of urinary tract reconstruction in renal transplant recipients, with morbidity indistinguishable from that of ureteroneocystostomy.

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RECONSTRUCTION OF THE urinary tract constitutes a major source of technical complications following renal transplantation. The state of immunosuppression in these patients necessitates precise surgical technique to avoid significant morbidity and mortality in the post-transplant period. Preference for the ureterovesical anastomosis at most centers is influenced by the comparatively higher rate of complications reported with pyeloureterostomy.[3,12,24,39,40] These unfavorable results with the supravesical anastomosis may reflect inexperience with a more demanding surgical technique.[13,39] However, the benefits derived from successful pyeloureteral reconstruction have been well established. Most importantly, pyeloureterostomy may be used to avoid fistula development or late ureteral obstruction resulting from distal or total ureteral necrosis reported with ureteroneocystostomy.[2–4,16,24,30,39] Further pelvic dissection for exposure of the bladder is unnecessary. Cystotomy with its potential for leakage, hematuria, clot retention, and painful bladder spasms is obviated. Catheter drainage of the bladder is discontinued within 24 hours. Vesicoureteral reflux is precluded if normal anatomy exists prior to transplantation. Additionally, retrograde ureteral catheterization when required, is facilitated by a native ureteral orifice.

Because of these considerations, pyeloureterostomy has been the preferred method of urinary tract reconstruction at the Massachusetts General Hospital since the authors' first series of 25 patients was reported in 1963.[18] In 1974, this experience was enlarged upon with the report of 114 additional pyeloureterostomies constructed from 1967 through 1973.[40] Since that report 236 additional patients have undergone renal transplantation at this center through December 1980. This report updates the authors' experience with urinary tract reconstruction in renal transplant recipients emphasizing the surgical techniques that make pyeloureterostomy a safe and reliable approach.

Methods

The currently recommended technique of pyeloureterostomy incorporates the refinements that have evolved during the authors' 13-year experience with this procedure.

The ipsilateral recipient kidney is removed through the standard renal transplantation incision that has been extended laterally to the mid axillary line for optimal exposure. The recipient ureter is carefully preserved providing there is no evidence of reflux by history or cystogram, and visual inspection discloses no obvious abnormalities. Revascularization of the donor allograft is accomplished by the usual vascular techniques. The recipient ureter is then mobilized, reflecting it from the adventitia of the transversalis to the point at which it courses beneath the remnants of the umbilical artery.

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Submitted for publication: January 21, 1982.

0003-4932/82/1100/0588 $01.10

Incomplete mobilization may create tethering and severe angulation along the course of the ureter providing a site for subsequent obstruction beneath the allograft. A sufficient amount of periureteral tissue must be preserved to prevent devascularization with resultant ureteral necrosis.

Attention is then focused upon the donor pelvis that is cleared of surrounding fatty tissue. The anatomic transition from donor ureter to pelvis may be difficult to delineate, however, a slight flaring at the pelvis usually can be appreciated. The donor and recipient ureters are then aligned so that the location of the anastomosis may be determined. Redundancy or foreshortening of the ureter must be avoided. Rotation of the ureter is prevented by observing the course of the vessels paralleling the ureter. The donor and recipient ureters are then partially transected leaving ureteral remnants to provide a means of stabilization during suture placement. This minimizes the handling of the tissues at the anastomosis, which may create areas of ischemia predisposing to urinary leakage. The ureters are then spatulated at the appropriate level for a distance of 10 to 15 mm (Fig. 1). The anastomosis is performed with loupe magnification.

The initial 7–0 Prolene suture is placed at the apex of the distal donor ureter approximating the recipient ureter in a horizontal mattress fashion. The ideal suture length is 30 inches, permitting easy handling during reconstruction. If this length is not available, a comparable length is provided by tying together two 18-inch sutures.

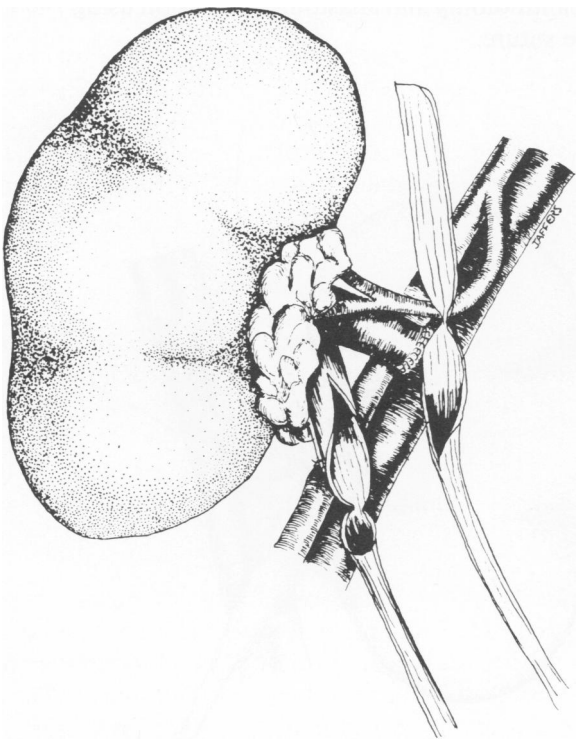

FIG. 1. Alignment of the ureteral segments after partial transection and spatulation of the ureters.

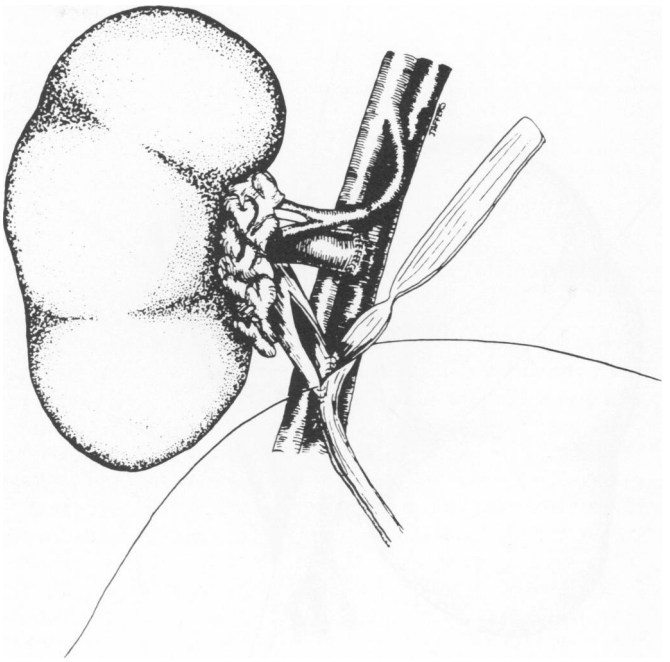

FIG. 2. Transection of the distal donor ureter after ligation of the apex stitch. Initiation of the anastomosis with direct visualization of the recipient ureter.

The knot of the initial suture is secured after completing the transection of the distal donor ureter. The anastomosis is initiated from the apex, first medially for several passes to allow precise suture placement in an area that may be difficult to visualize at a later time. This point is most prone to luminal narrowing with indiscriminate suture placement. The other arm of the apex suture is run laterally for a short distance (Fig. 2). The sutures are placed approximately 1 mm apart and 1 mm deep. Care must be taken to avoid unnecessary withdrawal of the needle from the tissue since a urinary leak may develop from the needle hole unless the next pass of the suture is beneath the initially created hole.

The second double armed 7–0 Prolene suture is then placed in horizontal mattress fashion approximating the proximal recipient ureter to donor pelvis. The anastomosis is then completed laterally (Fig. 3). Finally, the medial aspect of the anastomosis is completed (Fig. 4), keeping the tissue edges taut to avoid redundancy of the ureter between sutures which may result in urinary extravasation.

The completed anastomosis is carefully inspected to exclude leakage. Ureteral stents are not used.

The Politano–Leadbetter technique[33] for ureteroneocystostomy is used in recipients unsuitable for pyeloureterostomy.

The immunosuppressive regimen of Imuran, corti-

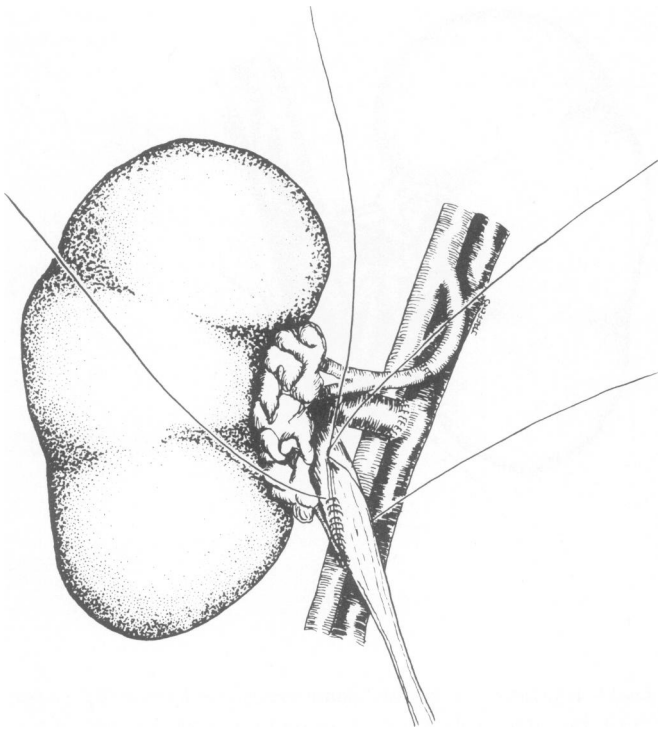

FIG. 3. Ligation of the second corner suture with completion of the lateral anastomosis.

costeroids, and, in selected cases, antithymocyte globulin, is administered to recipients as described previously.[9] The bladder drainage catheter is removed within 24 hours from patients with pyeloureterostomy reconstruction or after four days in patients with ureteroneocystostomy. Upon withdrawal of the Foley catheter, a four-month course of daily trimethoprim sulfamethoxazole is instituted. No perioperative antibiotics are administered.

Results

The current choice of 7–0 Prolene suture for pyeloureterostomy is based upon the authors' experience in the first 197 patients whose urinary tracts were reconstructed by this method.

Chromic catgut suture was used for pyeloureteral reconstruction in 96 patients prior to 1973. Eight anastomotic leaks (8.3%) occurred in this group. Four of these complications were repaired primarily with one kidney being lost from failure of the reconstructive procedure. Two other patients developed urinary extravasation after re-exploration for hemorrhage with both allografts being lost from unsuccessful attempts at reconstruction. The remaining two transplants were salvaged with retrograde catheterization and suturing of the defects. Two additional complications occurred unrelated to the anastomosis. The first was the result of calyceal necrosis from tuberculosis. The second resulted from perforation of the recipient ureter distal to the anastomosis during retrograde catheterization while evaluating an episode of anuria. Both of these kidneys were lost.

Because of the unfavorable incidence of anastomotic complications with chromic catgut suture, the next 101 pyeloureterostomies were constructed with 7–0 Tevdek. Anastomotic leakage occurred in three of these patients with salvage of the kidney in each instance achieved by closure of the defect and nephrostomy tube placement. Two nonanastomotic complications resulted in extravasation of urine. The first was the result of ureteral perforation distal to the anastomosis during evaluation of oliguria 18 days after transplantation. This patient's course had initially been complicated by allograft rupture requiring exploration. The ureteral defect was subsequently closed, however, the kidney was later removed for rejection. The second patient required two explorations in the immediate postoperative period for wound hemorrhage with ensuing ureteral necrosis requiring transplant nephrectomy.

Three patients developed stones at the Tevdek suture line at six months, four years, and five years post-transplantation. In all three cases gross hematuria was the initial manifestation of the existing pathology. Successful correction was achieved in all three patients with pyelolithotomy and anastomotic revision using 7–0 Prolene suture.

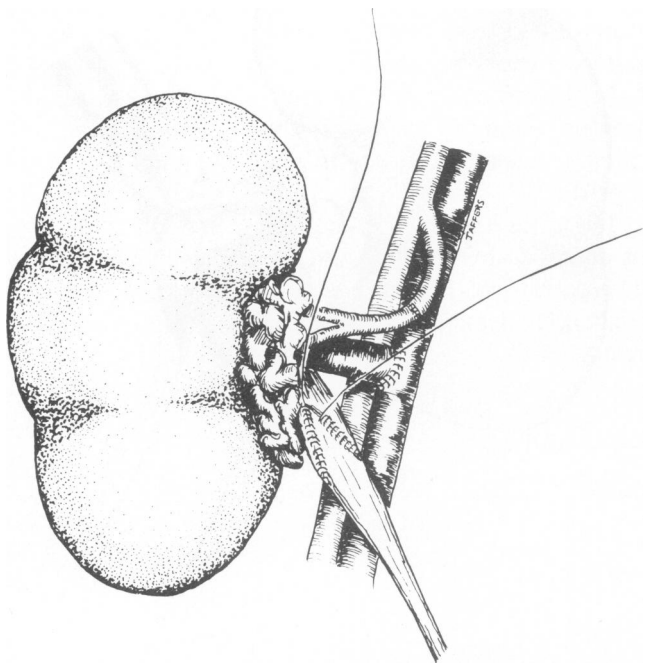

FIG. 4. Completion of the medial sutureline.

TABLE 1. *Complications of Pyeloureterostomy*

Patient	Date	Suture	Complication	Presentation	Method of Repair	Result
PG	1968	chromic	leak	27 days	stent	salvage
PP	1968	chromic	leak	108 days	stent	nephrectomy
RB	1968	chromic	leak	1 day	stent	salvage
JP	1969	chromic	leak	12 hours	stent	salvage
ES	1969	chromic	leak	1 day	stent	salvage
BM	1969	chromic	leak	2 days	stent; nephrostomy	salvage
AG	1970	chromic	leak	12 hours	stent	death
PG	1971	chromic	leak	54 days	stent; nephrostomy	nephrectomy
LS	1972	chromic	leak	14 days	stent; nephrostomy	nephrectomy
MV	1973	chromic	leak	8 days	stent; nephrostomy	salvage
JI	1973	tevdek	leak	24 hours	stent; nephrostomy	salvage
RB	1974	tevdek	leak	1 day	nephrostomy	salvage
WS	1974	tevdek	leak	18 days	nephrostomy	nephrectomy
DW	1974	tevdek	leak	10 days	resuture	nephrectomy
DB	1975	tevdek	stone	5 years	pyelolithotomy	salvage
BL	1975	tevdek	stone	4 years	pyelolithotomy	salvage
SF	1976	tevdek	leak	11 days	nephrostomy	salvage
RS	1977	tevdek	stone	6 months	pyelolithotomy	salvage
JE	1979	prolene	leak	21 days	suture	salvage
MM	1980	prolene	obstruction	4 months	stent; nephrostomy	nephrectomy

Between January 1978 and December 1980, 63 patients have undergone pyeloureteral reconstruction using 7–0 Prolene. Only two complications have occurred in this group. In one patient leakage proximal to the anastomosis became apparent 21 days after transplantation, apparently the result of unrecognized injury to the pelvis during donor nephrectomy. The allograft was salvaged with re-exploration and suturing of the defect. The other patient developed an obstruction distal to the anastomosis four months after transplantation due to angulation of redundant ureter. Retrograde catheterization resulted in ureteral perforation distal to the obstruction with subsequent allograft loss despite revision of the pyeloureterostomy and repair of the defect.

In the entire series, therefore, 20 urological complications occurred (7.9%), resulting in six transplant nephrectomies and two deaths, with salvage of twelve allografts.

In comparison, the technique of ureteral implantation as described by Politano and Leadbetter[33] was used in 111 patients found unsuitable for pyeloureterostomy. Eight complications were encountered in seven allograft recipients (7.2%) with six allografts salvaged (Table 2). Three patients developed urinary leakage in the immediate postoperative period. Salvage of the kidney was achieved with nephrostomy tube placement and ureteral stenting in one patient and by reimplantation in the other. The latter patient subsequently obstructed his ureter four months later requiring reimplantation for allograft salvage. The third patient had a successful conversion of his implant to a pyeloureterostomy.

Two patients developed urinary leaks complicated by abscess formation in the late postoperative period. Both kidneys were removed despite attempts at correction.

Obstruction developed in the remaining two patients five and nine days after transplantation. An obvious point of obstruction was not found in the first patient after re-exploration, but urinary flow was reinstituted with lysis of adhesions. The second patient underwent successful reimplantation for preservation of renal function.

Discussion

The major objection to the use of pyeloureterostomy in renal transplantation has been the reported unacceptable incidence of anastomotic leakage in the post-

TABLE 2. *Complications of Ureteroneocystostomy*

Patient	Date	Presentation	Complication	Method of Repair	Result
DJ	1969	1 day	leak	stent; nephrostomy	salvage
MC	1969	1 day	leak	reimplantation	salvage
MC	1969	4 months	obstruction	reimplantation	salvage
WT	1974	13 days	leak	pyeloureterostomy	salvage
MS	1978	5 days	obstruction	adhesiolysis	salvage
AB	1978	9 days	obstruction	reimplantation	salvage
JC	1979	4 months	leak	reimplantation	nephrectomy
PG	1980	1 month	leak	reimplantation	nephrectomy

TABLE 3. *Results of 260 Pyeloureterostomies*

Method	Number	Obstruction	Leak	Stone	Salvage
chromic	96	0	10	0	5/10
tevdek	101	0	5	3	6/8
prolene	63	1	1	0	1/2

operative period.[3,12,13,21,23,28,29] Complications with this anastomosis other than leakage have been rare.[4,8,13,19] Ability to achieve significant reduction in the incidence of urinary extravasation would therefore make pyeloureterostomy an attractive option for reconstruction in allograft recipients. The necessity for this type of anastomosis is apparent in those cases in which foreshortening of donor ureter precludes a ureterovesical reconstruction. Furthermore, this procedure may be the only safe option for reconstruction when the distal ureter appears ischemic from excessive stripping of donor periureteral tissue. The condition of the bladder may further preclude ureterovesical anastomosis in some instances.[28,39] For these reasons familiarity with a successful technique for supravesical anastomosis is mandatory for surgeons engaged in urinary tract reconstruction in renal transplantation.

The described method of pyeloureterostomy, which has evolved from the authors' 13-year experience in 260 patients, has markedly reduced the incidence of anastomotic leakage. The present technique incorporates careful preservation of ureteral vascularity, adequate mobilization of the ureter, and precision in surgical technique as described above. The type of suture material used is also felt to be an important aspect in pyeloureteral reconstruction.

Chromic catgut has long been a popular material for use in restoration of urinary tract continuity, and was used in the first 96 patients. The significant resistance of this material when drawn through the tissues was felt to hinder proper seating of the suture and to cause cutting of the tissues predisposing to urinary extravasation. The high incidence of anastomotic leakage (8.3%) with chromic catgut prompted a change to 7–0 Tevdek. Fewer urinary leaks occurred with this material, however, urinary calculi eventually developed at the sutureline in several patients. All required pyelolithotomy and anastomotic revision for correction.

Because of this unsatisfactory experience with Tevdek, monofilament Prolene stone was selected for supravesical reconstructions since evidence suggests that prolene is quickly covered with urothelium avoiding a nidus for stone formation.[15] Although calculus formation on Prolene suture has been reported in two patients,[14] an unknown suture size was used in one patient, and 4–0 Prolene was used in the other. In these patients a much finer 7–0 suture is used providing a smaller surface area, thereby allowing better coverage by the transitional epithelium. Furthermore, on the basis of *in vivo* and *in vitro* studies, monofilament suture with its smooth and homogeneous surface neither initiates nor supports urinary lithiasis.[42] Calculi have not been observed in this group of patients with a maximum follow-up of three years; however, further observation will be necessary to define precisely the risk of this complication. There have been no anastomotic leaks encountered in the 63 consecutive pyeloureterostomies constructed with 7–0 Prolene (Table 3).

Some centers have reported a remarkable absence of urologic complications with use of the alternative ureterovesical anastomosis.[11,17,22,41] Nevertheless, a variety of complications have been encountered with use of this method of urinary tract reconstruction. Varying degrees of ureteral necrosis (0–7%) may occur both early and late in the post-transplant period predisposing to leakage and obstruction.[2–4,12,16,23,30,39] Anastomotic leakage has been reported in 0% to 13% of allograft recipients after ureterovesical procedures.[1–4,6,10,13,20–25,30–33,37] Additionally, urinary extravasation may develop from the cystotomy closure.[1–4,24,26,37] Obstruction early in the post-transplant period may be related to ureteral swelling within the muscular tunnel or from kinking of a portion of ureter.[1,3,4,10,13,16,25,30,33,37] Late obstruction is primarily a result of ureteral fibrosis. This may arise from distal ureteral ischemia or necrosis. Episodes of allograft rejection may exacerbate this process.[38]

Significant hematuria, an uncommon problem with pyeloureterostomy, has occurred with ureteroneocystostomy and may require endoscopic cauterization or re-exploration for control.[26,39]

The actual incidence of ureteral reflux in patients with ureterovesical reconstructions is not known but has been reported to occur in 10% to 20% of patients evaluated.[10,17,20,34] The clinical significance of this is not yet known. Intrarenal reflux has been suggested as a factor in the etiology of pyelonephritis and allograft failure.[5,34,36] This may become an important factor in the deterioration of renal function with achievement of consistent and prolonged allograft survival.[27]

Criticism of pyeloureterostomy suggesting inevitable loss of the allograft should anastomotic complications develop has not been sound.[8,13,21] There were no allografts lost due to excessive foreshortening of recipient ureter. The opposite ureter may be used should this unusual situation arise.[13,21]

Pyeloureterostomy has been the preferred method of urinary tract reconstruction at this unit and is felt to offer certain advantages over both external as well as transvesical methods of ureteroneocystostomy. This technique has proved to be a safe, reliable method of reconstruction in transplant recipients.

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