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RENAL TRANSPLANTATION IN CHILDREN WITH SEVERE LOWER URINARY TRACT DYSFUNCTION

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ABSTRACT

Purpose: Renal transplantation in children with end stage renal disease due to congenital urological malformations has traditionally been associated with a poor outcome compared to transplantation in those with a normal urinary tract. In addition, the optimal urological treatment for such children remains unclear. To address these issues, we retrospectively reviewed our experience with renal transplantation in this population.

Materials and Methods: Between 1986 and 1998, 12 boys and 6 girls a mean age of 8.4 years with a severe dysfunctional lower urinary tract underwent a total of 15 living related and 6 cadaveric renal transplantations. Urological anomalies included posterior urethral valves in 8 cases, urogenital sinus anomalies in 4, the prune-belly syndrome in 2, and complete bladder duplication, ureterocele, lipomeningocele and the VATER syndrome in 1 each. In 11 children (61%) bladder augmentation or continent urinary diversion was performed, 2 (11%) have an intestinal conduit and 5 (28%) have a transplant into the native bladder.

Results: In this group patient and overall allograft survival was 100 and 81%, respectively. These values were the same in all children who underwent renal transplantation at our center during this era. In the 17 children with a functioning transplant mean serum creatinine was 1.4 mg./dl. Technical complications occurred in 4 patients (22%), including transplant ureteral obstruction in 2 as well as intestinal conduit stomal stenosis and Mitrofanoff stomal incontinence.

Conclusions: Renal transplantation may be successfully performed in children with end stage renal disease due to severe lower urinary tract dysfunction. Bladder reconstruction, which may be required in the majority of these cases, appears to be safe when performed before or after the transplant. A multidisciplinary team approach to surgery is advantageous.

KEY WORDS: kidney, kidney transplantation, bladder, urinary tract, abnormalities

Pediatric renal transplantation poses many challenges. A number of technical, metabolic, immunological and psychosociological factors distinguish children from adults.[1] In addition, children are more likely to have urological causes of end stage renal disease. Approximately 15 to 25% of children with end stage renal disease have associated structural urological abnormalities that may lead to lower urinary tract dysfunction.[2–4] Children at risk for bladder dysfunction include those with previous posterior urethral valves, myelodysplasia, urogenital sinus anomalies and the prune-belly syndrome.

There is increasing awareness that congenital urological disease may adversely influence the success of renal transplantation. Such patients are at increased risk for urinary tract infection, surgical complications, allograft dysfunction and graft loss.[2,5,6] Although new concepts regarding the pathophysiology of obstructive uropathy offer additional understanding, there is a paucity of outcomes data in children who have obstructive uropathy or other dysfunctional bladder problem after transplantation. Moreover, reports conflict regarding optimal management of the lower urinary tract before and after transplantation.[3,6,7–11] We report our experience with renal transplantation in children with end stage renal disease and lower urinary tract dysfunction.

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PATIENTS AND METHODS

Between 1986 and 1998, 12 boys and 6 girls 1 to 15.7 years old (mean age 8.4) with a dysfunctional lower urinary tract underwent a total of 21 renal transplants at C. S. Mott Children's Hospital, Ann Arbor, Michigan. Tables 1 and 2 show the characteristics of the patient population. Posttransplantation followup ranged from 2 months to 11.5 years (mean 4.4 years) and patient survival is 100%. Transplant sources consisted of 15 living related and 6 cadaveric donors.

The etiology of abnormal lower urinary tract function was posterior urethral valves in 8 cases, urogenital sinus anomalies in 4, the prune-belly syndrome in 2, and complete bladder duplication and renal dysplasia, ureterocele, lipomeningocele and the VATER syndrome in 1 each. Evaluation of the lower urinary tract included an elimination interview,[12] physical examination, urinalysis and urine culture, renal ultrasound and voiding cystourethrogram. Preoperative urodynamics were performed in 14 patients. Before transplantation 2 children had urinary drainage into an intestinal conduit. Of the remaining 16 patients 11 underwent augmentation cystoplasty or continent urinary diversion, while 5 underwent transplantation into a native bladder. Augmentation was necessitated by inadequate urine capacity or high intravesical pressure, as demonstrated by cystometrography.

Immunosuppression regimens changed during this 12-year period. The 2 children who received a transplant before 1991 underwent 5 days of polyclonal induction as well as cyclo-

TABLE 1. *Characteristics of renal transplant recipients with severe abnormal lower urinary tract dysfunction*

Pt. No. — Sex	Age at Transplantation (yrs.)	Diagnosis	Urinary Reconstruction	Catheterization Access	Mos. to Transplantation After Reconstruction	Donor
1 — F	1.3	Bladder duplication, imperforate anus	Cystocystoplasty	Mitrofanoff stoma via ureter	6	Living related
2 — M	1.5	Posterior urethral valves	Sigmoid cystoplasty	Mitrofanoff stoma via appendix	69*	Living related
3 — F	3.3	Ureterocele, bladder diverticula		Urethra		Cadaveric
4 — F	3.5	Bladder agenesis, urogenital sinus anomalies	Ileocecal conduit	Conduit drainage	8	Cadaveric
5 — F	4.2	Urogenital sinus anomalies, imperforate anus, vaginal duplication	Continent diversion	Mitrofanoff stoma via appendix	8	Living related
6 — M	4.9	Posterior urethral valves	Ureterocystoplasty	Urethra	7	Living related
7 — M	6.0	VATER syndrome, imperforate anus	Ureterocystoplasty	Urethra	2	Living related
8 — M	8.0	Prune-belly syndrome		Voids via urethra		Living related
9 — F	8.5	Urogenital sinus anomalies	Continent diversion	Mitrofanoff stoma via appendix	38	Living related
10 — M	8.6	Posterior urethral valves	Sigmoid cystoplasty	Mitrofanoff stoma via ureter	11*	Living related
11 — M	8.9	Posterior urethral valves, Down syndrome	Ileal conduit	Conduit drainage	6	Living related
12 — M	10.3	Posterior urethral valves	Ileocystoplasty	Urethra	5	Living related
13 — F	12.4	Urogenital sinus anomalies	Ileocystoplasty	Urethra	2	Living related
14 — M	13.6	Prune-belly syndrome		Mitrofanoff stoma via ureter		Living related
15 — M	14.6	Posterior urethral valves	Ileocystoplasty	Urethra	4	Living related
16 — M	15.2	Myelodysplasia		Urethra		Living related
17 — M	15.4	Posterior urethral valves	Ileocystoplasty	Urethra	19	Cadaveric
18 — M	15.7	Posterior urethral valves, Down syndrome		Voids via urethra		Living related

* Bladder augmentation was performed after renal transplantation.

sporine A, azathioprine and prednisone. Since 1991, the protocol has included 10 days of polyclonal antibody therapy as well as cyclosporine A (Sandimmune* before 1996 and Neoral* after 1996), azathioprine and prednisone. Graft function was determined by serum creatinine level at fixed intervals.

Our standard transplantation operative technique in all patients included Lich-Gregoir extravesical ureteroneocystostomy into the native bladder or reconstructed reservoir.[13] In patient 6, who previously underwent ureterocystoplasty for a small capacity thickened bladder, transplant-to-native ureter ureteroureterostomy was done. In patients 4 and 11 ureteral reimplantation was performed into an established intestinal conduit. Following transplantation ultrasound was done before and after catheterization to demonstrate adequate drainage. Ultrasound was also performed as needed to discriminate among infection, rejection and obstruction. Voiding cystourethrography was not routinely performed after transplantation.

RESULTS

Graft outcome. We performed 21 renal transplants in 18 children. In patients 3 and 4 the initial graft was lost due to vascular thrombosis but repeat transplantation was successful (tables 1 and 2). Acute rejection developed in 9 of the 19 remaining cases, of which 4 episodes required OKT3, while late acute rejection developed in another 2. All rejection episodes were reversed with antirejection therapy. No child received rejection therapy unless biopsy revealed rejection before the initiation of therapy. In patient 12 the graft was lost 1.5 years after transplantation secondary to therapeutic noncompliance with immunosuppression and catheterization. Before noncompliance serum creatinine was 0.8 mg./dl. (normal 0.6 to 1.2). He underwent a repeat renal transplant with repeat allograft loss at 6 months due to noncompliance. Presently 17 of 18 patients (94%) have a functioning allograft and 1 remains on dialysis. Overall allograft survival is 81% (17 of 21 cases). Mean serum creatinine is 1.4 mg./dl.

Bladder and reservoir function. In 5 of the 18 patients with a dysfunctional lower urinary tract there is a functioning native bladder. Patients 3 and 16 catheterize via the urethra. Patient 14 has improved compliance with catheterization after creation of a ureteral Mitrofanoff stoma. Only 2 children maintain adequate bladder emptying without catheterization. Patient 8 with the prune-belly syndrome uses a double voiding regimen, while patient 18 with posterior urethral valves voids every 2 hours and remains dry.

Of the 11 patients who underwent bladder augmentation or creation of a continent urinary reservoir 10 have maintained good reservoir function with clean intermittent catheterization. Patient 12 is on dialysis. Bladder capacity before bladder reconstruction ranged from 10 to 350 ml. (average 150). Preoperatively cystometrography in 8 patients revealed a hypertonic filling curve. In patients 2 and 7 the cystometrogram was somewhat misleading in that the apparent measurements revealed adequate bladder volume and pressure. However, correlation with voiding cystourethrography demonstrated that at least a third of measured capacity was due to the dilated and refluxing upper urinary tract.

Bladder augmentation or urinary diversion was performed an average of 9 months (range 2 to 38) before transplantation. In patients 2 and 10 with posterior urethral valves, bladder augmentation was done 5.7 years and 11 months after transplantation, respectively. Each boy had a history of increasingly difficult catheterization through the urethra. Serial cystometrography also showed worsening bladder compliance. Mitrofanoff stomas allowed them to maintain excellent catheterization schedules. After augmentation or continent urinary diversion reservoir capacity increased by

* Sandoz Pharmaceuticals Corp., East Hanover, New Jersey.

TABLE 2. *Outcome and complications following renal transplantation in children with severe abnormal urinary tract dysfunction*

Pt. No.	Cystometry		Complications	Creatinine (mg./dl.)	Percentile Ht.	Mos. Followup
	Preop.	Postop.				
1	Not done	150 Ml./5 cm. water	Rejection, urinary tract infection, acidosis	0.5	25	16
2	250 Ml./10 cm. water	*	Revision of transplant reimplant, rejection, urinary tract infection, acidosis	0.9	10	70
3	275 Ml./10 cm. water		Allograft thrombosis (transplant 1), rejection (transplant 2), revision of transplant reimplant, urinary tract infection	1.1	Less than 5	138
4			Allograft thrombosis (transplant 1), rejection (transplant 2), stomal revision, acidosis	1.1	Less than 5	135
5	20 Ml./60 cm. water	150 Ml./5 cm. water	Calcium phosphate carbonate renal calculi, urinary tract infection, acidosis	1.9	25	55
6	110 Ml./40 cm. water	425 Ml./18 cm. water	Urinary tract infection, acidosis	1.3	Less than 5	26
7	350 Ml./24 cm. water	500 Ml./10 cm. water	Rejection, urinary tract infection, acidosis	0.9	Less than 5	9
8	300 Ml./20 cm. water		Late rejection, urinary tract infection, acidosis	1.8	5	67
9	10 Ml.	360 Ml./20 cm. water	Rejection, urinary tract infection, stomal revision, acidosis	1.8	10	39
10	200 Ml./35 cm. water	Not available	Rejection, urinary tract infection, acidosis	1.8	Less than 5	38
11	60 Ml./40 cm. water		Uric acid renal calculi, urinary tract infection, acidosis	1.2	25	45
12	240 Ml./40 cm. water	420 Ml./5 cm. water	Rejection of 1 allograft at 18 and 1 at 6 mos.	0.8	5	56
				1.2		
13	40 Ml./100 cm. water	450 Ml./20 cm. water	Late rejection, urinary tract infection, acidosis	2.3	15	78
14	650 Ml./10 cm. water			1.2	40	2
15	45 Ml.	450 Ml./5 cm. water	Urinary tract infection, acidosis	2.1		68
16	300 Ml./20 cm. water		Urinary tract infection	1.8	25	62
17	175 Ml./100 cm. water	300 Ml./10 cm. water	Urinary tract infection	2.7	Less than 5	46
18	130 Ml./10 cm. water		Urinary tract infection	1.4	10	5

* Recent bladder augmentation.

125 to 405 ml. More importantly, post-reconstruction cystometrography revealed that reservoir pressure was 20 cm. water or less at working catheterized volumes. There were no perioperative complications in any patient who underwent bladder reconstructive surgery whether surgery was performed before or after renal transplantation.

Two children received a transplant into an intestinal conduit. Patient 4 with bladder agenesis due to a urogenital sinus anomaly has had an ileocecal conduit all her life, and she has accepted it as part of her body image. In patient 11 with posterior urethral valves and the Down syndrome pretransplant bladder capacity was 60 ml. After discussing various urinary reservoir options with the family the boy underwent a laparoscopic ileal conduit procedure before transplantation.

Urological complications. Technical complications developed in 4 cases. Patients 2 and 3 required revision of the transplant ureteral reimplantation due to distal ureteral stricture and obstruction, patient 4 with an ileocecal conduit underwent stomal revision for difficult appliance placement and patient 9 with continent diversion needed stomal revision for an inadequate flap valve continence mechanism. There has been no reservoir perforation or leakage.

Four years after transplantation nephrolithiasis developed in the allograft in patient 5. She underwent percutaneous nephrolithotomy with complete removal of the stone. The graft is functioning well at 55 months with no stone recurrence. In patient 11 with an ileal conduit renal calculi developed 2 years after the transplant. He had 2 recurrences and each was successfully treated with shock wave lithotripsy.

Urinary tract infections. Urinary tract infections developed in 15 of the 18 patients (83%) (table 2). There was no urinary tract infection in patient 3 with an ileocecal conduit, patient 12 with ileocystoplasty who catheterized via the urethra, and patient 14 with a prune-belly syndrome bladder who catheterized via a Mitrofanoff stoma. In 7 of the 15 patients with urinary tract infection voiding cystourethrography was performed after the transplant, and reflux to the transplanted or native kidney was revealed in 5. Patients 2 and 10 were noncompliant with the catheterization regimens and subsequently had urinary tract infections.

Discrimination between rejection and pyelonephritis was based on several criteria, including positive urine culture, elevated C-reactive protein and renal biopsy in some cases.[14] Children with pyelonephritis had a tender allograft with fever and elevated C-reactive protein. No patient with biopsy proved rejection had a tender allograft. All children on clean intermittent catheterization perform daily aminoglycoside bladder washes (1 to 3 ounces of 480 mg. aminoglycoside in 1,000 cc saline) twice daily. In addition, 2 patients are also on oral antibiotic prophylaxis.

DISCUSSION

Advances in surgical technique and immunosuppression have extended the availability and improved the success rate of renal transplantation, particularly in children with an abnormal lower urinary tract who were previously thought unsuitable candidates for transplantation.[1,4] However, increasing experience with renal transplantation in children has produced evidence that congenital urological disease may adversely influence the success of this procedure due to urinary tract infection, surgical complications, allograft dysfunction and graft loss.[2,5,6]

In patients with a history of posterior urethral valves who undergo renal transplantation others have described a tendency toward progressive allograft dysfunction, implying a deleterious effect of chronic elevated intravesical pressure.[2,6,15] Others have reported a favorable long-term outcome with preservation of the native bladder.[9,10] Patients with posterior urethral valves comprise a spectrum and any

absolute generalization about the suitability or liability of a native bladder in regard to renal transplantation would be misleading. Some valve bladders are safe and others are hostile. There are relatively little data on the natural outcome in children with obstructive uropathy or another dysfunctional bladder problem after transplantation. Reports conflict regarding the optimal management of the lower urinary tract before and after transplantation.[3,6,10,11] Sheldon and Snyder reviewed 33 transplantations reported in the literature that were performed in 28 patients younger than 21 years who had undergone bladder reconstruction.[16] Overall graft survival was 79% and patient survival was 100%. In contrast, Alfrey et al recently reported deleterious effects of bladder augmentation and stated that their experience suggested takedown of bladder augmentation before transplantation, although they offered no urodynamic data to support their conclusions.[11]

Because adequate urinary drainage is necessary for successful transplantation, our approach has been to establish a stable urinary reservoir and storage system before transplantation. The association of upper tract fate and reservoir storage pressure has been widely acknowledged.[17] Each pediatric patient with end stage renal disease who is considered for transplantation at our center is screened for bladder dysfunction. Screening includes an elimination interview,[12] renal ultrasound, voiding cystourethrogram, urinalysis and urine culture. If there is any suspicion of bladder dysfunction, urodynamic evaluation is done to assess capacity, compliance, storage pressures and post-void residual urine volume. A satisfactory urinary tract outlet should be ensured.

In patients with a dysfunctional lower urinary tract the goal of therapy is to provide a sterile, compliant, nonrefluxing, low pressure reservoir that is continent and easily emptied. Our initial approach to the hostile bladder before transplantation involves pharmacological agents. In some individuals clean intermittent catheterization may be required to maintain safe pressure and periodic emptying.[7] If intermittent catheterization is necessary, patient and/or family cooperation must be demonstrated before transplantation. The only patient in our series who did not have long-term successful graft survival was a teenage boy who was noncompliant with intermittent catheterization and immunosuppressive medication schedules.

The Mitrofanoff principle has been indispensable.[18] A native urethra may be unsuitable for intermittent catheterization in children with anatomical anomalies that lead to difficult or painful catheterization. When indicated, compliance with intermittent catheterization is critical to ensure allograft survival, and it is greatly facilitated by making catheterization convenient, easy and free of pain. A continent catheterizable stoma may be constructed using appendix, native ureter, tapered ileum or transverse retubularized ileum[19] into an appropriate reservoir. A Mitrofanoff stoma was created in 6 of our patients (ureter in 3 and appendix in 3). In the 3 boys catheterization via the Mitrofanoff stoma dramatically improved bladder management and helped to maintain stable renal function.

Acceptable and safe intravesical pressure of well under 30 cm. water should be maintained within the range of working bladder volumes.[20] Bladder reconstruction is considered if despite pharmacological therapy and adequate drainage, there is evidence of a hostile and noncompliant hypertonic reservoir. Zaragoza et al suggested that the defunctionalized bladder readily regains normal capacity and function after transplantation,[3] which may be true in some patients with medical renal disease. A trial of bladder cycling is helpful for assessing the need for bladder augmentation. If bladder noncompliance or small capacity persists despite mechanical (bladder cycling) and/or pharmacological intervention, bladder augmentation may be required. In our experience children with end stage renal disease secondary to structural anomalies are unlikely to regain normal bladder function after undiversion or transplantation. Of the 18 children in our series with lower urinary tract dysfunction 13 (72%) required augmentation or diversion, while 5 (28%) have maintained the native bladder.

Various options are available for augmentation, including detubularized bowel (ileum, ileocecum or sigmoid), ureter or stomach. We used small bowel and colon safely in the majority of patients. Ureterocystoplasty is an alternative to enterocystoplasty when a dilated ureter is available.[21] Such a determination must be made before native nephrectomy is performed to preserve the ureteral vasculature. Gastrocystoplasty has potential advantages in patients with severe azotemia,[22] including an absence of mucous production, avoidance of metabolic acidosis and possibly fewer infections secondary to the acidic environment. Unfortunately the symptomatic hematuria-dysuria syndrome may develop as well as a possible increased risk of reservoir perforation.[23] No patient in our series underwent gastrocystoplasty.

In children who require lower urinary tract reconstruction we prefer to complete augmentation cystoplasty at least 6 weeks before transplantation and the induction of immunosuppression. However, when abnormal bladder function is not recognized before transplantation, successful bladder augmentation may be performed subsequently.[3,8] In our series patients 2 and 10 underwent post-transplantation augmentation cystoplasty without perioperative complications.

After transplantation it is critical to monitor bladder function. Patients undergo catheterization before and after ultrasound to demonstrate adequate drainage each year for the initial 2 years after transplantation. Often these children have an elevated creatinine level and, thus, the discrimination among infection, rejection and obstruction is important. Bladder dysfunction in the post-transplant child may be manifested by graft dysfunction associated with bladder hypertonicity, hydronephrosis, incontinence or infection. Significant bladder dysfunction may lead to graft loss. If the presence of obstruction is in question, drainage with an indwelling Foley catheter is maintained for approximately 24 hours. If renal function improves, inadequate drainage is likely present. Pyelonephritis is usually heralded by allograft tenderness, fever and a positive urine culture.

Transplant outcome in our patients with a dysfunctional lower urinary tract was comparable to that in our overall pediatric renal transplant population. Patient survival was 100% and overall graft survival was 81% in this subgroup compared to 100% patient survival and 81% 3-year graft survival in all children who underwent transplantation at our center during this era.[24] None of the graft failures in our cases was directly attributable to urological problems.

Urinary tract infection. Urinary tract infection was a frequent problem in this group that affected 83% of our patients, a much higher rate than Mochon et al previously reported in children with a normal bladder.[5] The predisposing factors appeared to be noncompliance with intermittent catheterization in 2 patients and vesicoureteral reflux in 5 of 7 (71%) who underwent voiding cystourethrography. Urinary tract infections continued to develop despite various prophylactic strategies, including intravesical instillation of aminoglycoside antibiotics. These patients clearly require close monitoring for impaired graft function related to reflux and/or repeated infection. Ongoing counseling on compliance with catheterization and monitoring bladder flora with adjusted prophylaxis may help to decrease the incidence of infection.

Metabolic complications. The potentially devastating metabolic consequences of gastrointestinal segments in the urinary tract are well known.[25] Hyperchloremic acidosis may develop in patients who undergo enterocystoplasty, although experience with electrolyte abnormalities in pediatric enterocystoplasty is less readily available. Kass and Koff noted metabolic acidosis in 14% of children with enterocysto-

plasty.[26] In our experience 12 of the 17 children (70%) with a functioning graft currently receive alkali supplementation because of metabolic acidosis, including 8 of 9 (89%) in whom bowel segments were incorporated into the urinary reservoir. However, it is difficult to ascribe acidosis in our cases completely to the use of intestinal segments since there may be other causes of acidosis, including renal insufficiency due to chronic rejection and tubular dysfunction secondary to cyclosporine[27] or long-term prophylactic trimethoprim-sulfamethoxazole therapy.[28]

Another critical long-term concern when incorporating intestinal segments is the effect on childhood growth and development. This issue is particularly worrisome in patients with decreased renal function or renal failure. Children who undergo renal transplantation are frequently below the 5th percentile for height.[4] Several factors may contribute to growth failure in this population, including acidosis, renal osteodystrophy, malnutrition and resistance to the effects of growth hormone.[27] In children who have a transplant with enterocystoplasty acidosis related to bladder augmentation may have a further detrimental impact on growth. In our series there was no correlation between the presence or absence of metabolic acidosis and height. Of 9 children (78%) at or above the 5th percentile for height 7 were receiving alkali therapy versus 5 of 8 (63%) below the 5th percentile (not significant, Fisher's exact test). Whatever the cause, metabolic acidosis should be monitored and treated aggressively to promote normal linear growth.

Malignancy. The incorporation of intestinal segments into the urinary tract in children who undergo renal transplantation adds a new variable to our understanding and long-term treatment of these patients. The majority of data on uro-intestinal malignancy after urinary tract reconstruction comes from the ureterosigmoidostomy experience in which there is an overall risk of malignancy 80 to 550 times greater than that in the general population.[16] For newer modalities of reconstruction, such as enterocystoplasty or continent urinary diversion, the opportunity for followup has been much shorter and the incidence of malignancy has been comparably small to date. In children who have a transplant additive depressed immunity may result in an increased risk of ureterointestinal malignancy.[30] These observations underscore the need for surveillance with any intestinal interposition into the urinary tract. Patients with renal transplantation and intestinal urinary reconstruction should undergo periodic endoscopic evaluation.

CONCLUSIONS

As children with posterior urethral valves, myelodysplasia and various other congenital anomalies of the urinary tract survive early infancy, some eventually need renal transplantation. An improved understanding of bladder dysfunction and advances in urological reconstruction offer children who undergo renal transplantation improved graft survival and a higher quality of life, so that the factors that contributed to native kidney dysfunction do not impair the transplanted kidney. We emphasize the importance of a transplant team approach consisting of transplant surgeons, pediatric nephrologists and pediatric urologists. Our experience shows that pre-transplant management of bladder dysfunction with bladder training, pharmacological agents and intermittent catheterization may optimize a successful outcome in renal transplantation. In patients with an inadequate bladder reservoir augmentation performed before transplantation is safe and facilitates good allograft function. Close surveillance is imperative in children who have undergone transplantation into an abnormal native bladder. When bladder function or compliance deteriorates, bladder augmentation may be done after transplantation without increased technical or perioperative difficulty. All children with enterocystoplasty, especially those with a renal transplant who are on immunosuppression, should be closely monitored for metabolic acidosis, and the intestinal segment should be periodically examined for stones, debris or tumor formation.

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