3-1-2011

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As submitted to:

International Journal of Urology

And later published as:

Volume 18, Issue 3, pages 185–193, March 2011

DOI: 10.1111/j.1442-2042.2010.02707.x

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Received 18 October 2010; accepted 20 December 2010.

Review Article

Urological involvement in renal transplantation

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Abstract: Historically, urologists were the primary surgeons in renal transplantation. Specialization and increased complexity of the field of transplantation coupled with a de-emphasis of vascular surgical training in urology has created a situation where many renal transplants are carried out by surgeons with a general surgery background. Because of its genitourinary nature, however, urological input in renal transplantation is still vital. For living donors, a urologist should be involved to help evaluate and prepare certain patients for eventual donation. This could involve both medical and surgical intervention. Additionally, urologists who carry out living donor nephrectomy maintain a sense of ownership in the renal transplant process and provide a unique opportunity to the trainees of that particular program. For renal transplant recipients, preoperative evaluation of voiding dysfunction and other genitourinary anomalies might be necessary before the transplant. Also, occasional surgical intervention to prepare a patient for renal transplant might be necessary, such as in a patient with a small renal mass that is detected by a screening pretransplant ultrasound. Intraoperatively, for patients with complex urological reconstructions that might be related to the etiology of the renal failure (urinary diversion, bladder augmentation), a urologist who is familiar with the anatomy should be available. Postoperatively, urological evaluation and intervention might be necessary for patients who had a pre-existing urological condition or who might have developed something de novo after the transplant. Although renal transplant programs could consult an on-call urologist for particular issues on an as-needed basis, having a urologist, who has repeated exposure to the particular issues and procedures that are involved with renal transplantation, and who is part of a dedicated multidisciplinary renal transplant team, provides optimal quality of care to these complex patients.

Key words: Renal transplantation, urological complication, urological surgery

Introduction

Renal allotransplantation offers the best therapy available to patients with end-stage renal disease (ESRD). The evaluation and management of renal transplantation recipients and donors involves a multidisciplinary effort. From the first days of transplantation, urologists have been intimately involved. The first successful renal transplantation between monozygotic twins was carried out on 23 December 1954 by Dr Joseph Murray, a plastic surgeon, and Dr Hartwell Harrison, a urologist.[1] Fittingly, although a urological cause can only be identified in 1.4–5% of new onset adult ESRD,[2] multiple aspects of renal transplant place it firmly

within the purview of the urologist.

Modern immunosuppression regimens permit outstanding success rates with both cadaveric and living donor transplantation. Augmentation of the cadaveric donor kidney pool with the use of expanded criteria donor kidneys, as well as increasing numbers of living donors, allowed for 17 513 renal transplants for all causes to be carried out in 2007; 11 446 kidneys were derived from deceased donors and 6041 from living donors. Unfortunately, this is a small number compared with the 87 812 ESRD-related deaths that year,[2] and as the incidence of ESRD continues to increase, new diagnoses will continue to far outpace transplantations.[3]

The current role of practicing urologists in transplants has become highly variable and program-dependent. Internationally, the role of the urologist is generally more instrumental. It is not disputed that a urologist with adequate training in vascular anastamotic techniques is capable of carrying out a renal allograft procedure. However, in the current era of multiorgan transplant programs and de-emphasis of vascular training in urology, the surgical role of the urologist in the USA has become less substantial. Training programs have shown this trend. In 1998, 91% of urology residents were provided with some renal transplantation exposure, whereas 20–25% received actual surgical and medical training; in 1997, 81% were provided with renal transplantation exposure, the majority of which was in the pre-urology years.[4] Still, 94% of urology residencies were affiliated with hospitals with a transplant program.[4] However, the genitourinary nature of renal transplantation still requires the input of urologists in multiple facets of the care of both renal allograft donors and recipients.

In this writing, we will review the relevant literature on this topic and summarize the germane findings. The pretransplant urological evaluation of donors and recipients will be discussed. The intraoperative role of the urologist with the allograft procedure, as well as postoperative management issues of the recipient, will also be reviewed.

The living donor

Of the over 6000 patients who donated kidneys in 2007, approximately half were related donations and approximately half were to unrelated parties; 79 of these unrelated donations were altruistic non-directed donations.[3] It is of paramount importance to protect the well-being of those willing to undergo nephrectomy to benefit another person, and in general, one must be able to assure a donor of near normal renal function after donation; to this end, if one kidney is of better function than the other, it is left with the donor. The acceptance of laparoscopic donor nephrectomy has greatly improved the acceptability of the surgery to donors. Of those who are evaluated for donor nephrectomy, approximately 50% of candidates evaluated for live donor nephrectomy will ultimately be excluded; in a 2004 study, the reasons for exclusion were general medical conditions in 34.4% of cases, nephrological concerns in 25.6%, urological disease in 11.7% and ethical concerns in 12.2%.[5]

An important task of the urologist involved in donor nephrectomy is evaluation of the renal, renovascular and urinary tract morphology.[6] Potential donors are initially evaluated with a renal ultrasound; this will exclude donors with significant renal abnormalities, such as unilateral agenesis, large stones, tumors and hydronephrosis. The next step is evaluation of the renovascular anatomy and structure of the collecting system. Currently, computed tomography (CT) angiography followed by delayed plain radiographs or delayed cuts represents the standard method of evaluating the relevant anatomy, although magnetic resonance angiography and urography might be developing a larger role in this evaluation.[7]

Nephrolithiasis

Because the living donor must pass an intensive medical evaluation before being considered for donation, the role of the urologist in screening the patient is limited. One area where a significant role can be played by a urologist is in the evaluation of donors with a history of nephrolithiasis. Nephrolithiasis among donors is a controversial and evolving topic. Historically, a previous episode of nephrolithiasis would have excluded a potential donor. With better resolution CT scans, the increased detection of solitary incidental stones has called into question the practice of disqualifying these patients. Accordingly, current recommendations have relaxed these restrictions.[8] Interinstitutional attitudes regarding accepting stone formers as potential donors is highly variable; however, 77% of institutions will accept a stone former as a potential donor.[9] Recurrent stone formers should be excluded, as well as those with stones >1.5 cm,

contralateral nephrolithiasis, cystine/struvite stones and those at high risk for recurrence, such as those with primary or enteric hyperoxaluria, distal renal tubular acidosis, sarcoidosis, inflammatory bowel disease or other conditions causing nephrocalcinosis. It is recommended that potential donors with a history of stone disease be evaluated with a serum calcium, creatinine, albumin, parathyroid hormone, a urinalysis and urine culture, a helical CT, and analysis of previous stones if available, and a 24-h urine metabolic analysis.[10] At our institution, patients with a history of nephrolithiasis who have donated a kidney are followed long term with annual imaging and 24-h urine metabolic analysis. In order to conform to the maxim of leaving the better kidney with the living donor, the kidney with a stone is selected for donor nephrectomy. As opposed to management after transplantation, we make every effort to provide a stone-free allograft to recipients. This either requires ureteroscopy in a separate operation or at the time of donor nephrectomy. *Ex vivo* bench ureteroscopy with basket stone extraction with or without holmium laser lithotripsy through the ureteral stump, with the kidney on ice and perfused, is described in the literature and is our preferred method of allograft stone management.[11]

History of malignancy

The transplantation of organs from patients with a known history of malignancy is a tenuous endeavor with for which risk/benefit assessment must be made on a case-by-case basis, with the benefit of expanding the donor pool being weighed against the risk of donor malignancy transmission. The highest transmission rates for donor malignancies are choriocarcinoma (93%) and malignant melanoma (74%), with mortality rates of 64% and 58%, respectively.[12] As a result, donation of an organ from a patient with a history of either of these malignancies is strictly contraindicated. Likewise, donation of an organ from an individual with a history of lung cancer has a high transmission (43%) and mortality (32%) rate, and also should be avoided.[13] Most other solid tissue tumor types, as well as central nervous system tumors, should be risk stratified with regard to tumor grade (low *vs* high), stage (organ confined *vs* non-organ confined), treatment (standard *vs* non-standard) and disease-free interval, with those tumors deemed to be high-risk for recurrence precluding organ donation.[13,14]

Prostate cancer (CAP) in the aging population has particular relevance to renal donation in light of recent efforts to extend the donor pool by including expanded criteria donors who are elderly in age. As urologists, however, we recognize that CAP is a heterogeneous disease with very disparate clinical courses, especially in the elderly, in whom indolent cancers are more common. Accordingly, some countries have altered their acceptance criteria for patients with suspected CAP. Along with labeling patients with organ-confined Gleason score 6 prostate cancer as being “standard risk” for donation, they also defined organ-confined Gleason score (3 + 4) or locally advanced Gleason score 6 as “non-standard risk”, meaning that it was to the discretion of a transplant center whether to use these organs. “Unacceptable risk” cancers with the highest chance of recurrence (primary Gleason pattern 4, lymph node involvement or metastatic disease) were not recommended for consideration.[15] Histopathological diagnosis was required in each of these cases.

Living donor nephrectomy

Living donor nephrectomy was once solely carried out by urologists. As urological involvement has been de-emphasized in many renal transplant centers; this procedure as well has shifted to conventional transplant teams with general surgery training. At our institution, all donor nephrectomies are laparoscopic and divided evenly between the departments of urology and the transplant surgeons. Utilization of right kidneys, which historically might have excluded patients from donation, has been deemed to be safe and efficacious, and comprises 18% of the donated kidneys at our institution since 2005, a number that is comparable to contemporary series (Table 1). Additionally, for those with complex renovascular anatomy, in the hands of a properly trained surgeon, this procedure is safe and provides a usable renal allograft of equivalent function to kidneys with more straightforward vascular anatomy.[24,25]

The benefits to a urological training program of carrying out laparoscopic donor nephrectomy are obvious. In addition to additional surgical volume, the principles of careful dissection of the entire kidney, hilar control and preservation of ureteral blood supply can be easily translated to other procedures, such as partial nephrectomy.

The recipient

Pretransplant evaluation

The initial evaluation of potential transplant recipients does not necessarily include a urological component and is geared towards ruling out infection, malignancy, non-compliance, and high risks of operative mortality and technical failure.[26] In the USA, most centers employ a multidisciplinary team to carry out the initial evaluation and selection of potential recipients. A thorough history and physical is carried out and a chest X-ray, EKG and abdominal ultrasound are obtained. Basic serological studies are sent; histocompatibility studies, as well as titers for infectious disease, and a PPD test to exclude tuberculosis are obtained. A prostate-specific antigen (PSA) level is also drawn for all males older than 40 years. Mammograms are carried out for women over the age of 40 years. Patients are also evaluated by dieticians, dental professionals, social workers, financial counselors and, for diabetics over the age of 50 years, an ophthalmology consultation is also obtained.[26]

At our institution, urological consultation of recipients is sought under the direction of the multidisciplinary team. Urological evaluation is generally needed for genitourinary oncological concerns, native renal abnormalities and concerns for bladder dysfunction or urethral abnormalities. Pretransplant urological evaluation is principally to determine the suitability of the lower urinary tract or its substitute for receiving the graft kidney and to evaluate for the need for native nephrectomy. The responsibilities of the consulting urologist were well-formulated in 1991 by Cairnes *et al*., "Urological requirements for successful renal transplantation are the absence of urinary tract infections and calculi, a functional lower urinary tract, and the exclusion of a urinary tract malignancy. The goal of the urologist is to rid the urinary tract of infection and calculi and to optimize the condition of the lower urinary tract, which should be sterile, continent, and compliant before implantation of the donor kidney".[27]

The basic urological assessment should include a detailed history and physical, urinalysis and urine or bladder wash culture, PSA testing in appropriate patients and review of an abdominal ultrasound with a post-void bladder image. Further studies are indicated for patients with a history of urinary tract abnormalities or evidence of pathology on urological evaluation, such as non-glomerular hematuria, single organism bacteriuria, calculi, hydronephrosis, autosomal dominant polycystic kidney disease or significant post-void residual.[26]

Bladder dysfunction

Outside of the pediatric population, bladder dysfunction is a relatively uncommon contributor to ESRD. Although routine functional bladder studies are not indicated in potential recipients, among those with neurovesical dysfunction, a voiding cystourethrogram (VCUG) and a pressure flow urodynamic study with or without cystoscopy are indicated. The ultimate goal is creation of a low-pressure reservoir for urine storage.[28]

Patients with high-pressure urine storage should be started on antimuscarinic medications and/or a regimen of clean, intermittent self-catheterization (CISC) before renal transplant. The oliguric patient should start CISC before transplantation to permit teaching and familiarity with the technique.[4] Among those unable to carry out this technique, urinary diversion in the form of a suprapubic catheter, conduit, pouch or augmentation cystoplasty will allow for a reservoir that should be safe for transplantation.[29] It is recognized that ureteral implantation into a non-compliant, fibrotic, thickened bladder and consequent high-pressure storage should be avoided because of the associated high incidence of graft loss in these cases.[30]

Urethral stricture

Urethral strictures can be encountered in any patient group and might be idiopathic, traumatic, infectious or iatrogenic in origin. Clinical history and post-void residual measurement are sufficient to suggest the diagnosis; confirmation should be made cystoscopically. Oliguric or anuric patients should be managed only after re-establishment of urine output adequate to avoid a high incidence of re-stricture. Management for transplant patients should be carried out according to the methods established for other patients. Care should be exercised and a high degree of suspicion for infectious complications, because of the need for immunosuppression in these patients.

Benign prostatic hyperplasia

The clinical prevalence of benign prostatic hyperplasia (BPH) has been reported as high as 45% in men in their 50s and 62% in men in their 70s, with histological prevalence being significantly higher.[31] Among the 73 000 patients listed for renal transplantation in 2007, 58% of those were male with a further 58% of these were over the age of 50 years; this amounts to a large proportion of those undergoing or being evaluated for transplantation having clinical manifestations of BPH.[3] In those with a clinical history to suggest an element of BPH, a midstream urine collection to exclude infection, a digital rectal exam and uroflometry with a measurement of post-void residual are sufficient to screen for clinically significant bladder outlet obstruction. For those considered for surgical intervention, a cystoscopy and pressure flow urodynamic study with or without video are prudent to evaluate bladder function.[2]

Initial management for most patients is medical therapy with alpha blocking agents with or without 5-alpha reductase inhibitors. In patients with bladder decompensation and urinary retention, CISC should be instituted before transplantation to allow for bladder emptying and familiarity with the technique. Surgical therapy should be avoided in the oliguric/anuric patient because of the high incidence of bladder neck contractures and urethral strictures secondary to the dry urethral syndrome. If it proves unavoidable, transurethral prostate surgery can be carried out in the oliguric pretransplant patient with the placement of a suprapubic catheter to allow for instillation of saline and voiding, if not feasible by CISC. Additionally, there are data to support that transurethral resection or incision of the prostate can be safely carried out even in the post-transplant setting with minimal complications and effect on renal graft function; often, this sequence is undertaken at our institution.[32]

Native nephrectomy

The generally accepted indications for pretransplant removal of the native kidneys include solid renal tumors, upper tract urothelial malignancy, symptomatic or bulky polycystic kidneys, renal stones that cannot be cleared by less invasive techniques, persistently elevated antiglomerular basement membrane antibody levels, hypertension refractory to medical therapy, proteinuria unresponsive to medical therapy and chronic pyelonephritis. Additionally, the role of native nephrectomy in the prospective renal transplant recipient at high risk for developing recurrent glomerulonephritis has been called into question.[33] In children, kidneys are frequently removed at the time of transplantation; however, in adults it is generally carried out ahead of time. Nephrectomy is usually carried out at least 6 weeks before transplantation to allow for adequate healing, and the diagnosis and management of any postoperative complications.

The underlying pathology behind a patient's renal failure is an important consideration when contemplating native nephrectomy. Small atrophic kidneys can be quickly removed with unilateral or bilateral lumbotomies, which are generally well tolerated. Laparoscopic and retroperitoneoscopic approaches to native nephrectomy have become relatively commonplace. In cases where a kidney is too large or is chronically infected, a flank approach might be the most reasonable. For patients requiring other procedures, such as total ureterectomy, ileal conduit removal or revision, augmentation cystoplasty or simultaneous renal transplant, an open transperitoneal procedure is indicated.

Nephrectomy in autosomal dominant polycystic kidney disease (ADPKD) is indicated when there are significant symptoms related to the bulky kidneys, such as early satiety, respiratory compromise, pain, if there is significant related hematuria, recurrent infections or if the kidneys extend below the iliac crest compromising the space needed for the renal allograft. Although challenging, the feasibility and safety of the hand-assisted laparoscopic approach for unilateral or bilateral nephrectomy for ADPKD has been described, and is our preferential approach.[34] There are case series that show the safety of simultaneous bilateral nephrectomy for ADPKD and renal transplantation.[35] This approach might be reasonable in a patient who is predialysis and has a living donor. Finally, in the poor surgical candidate, the efficacy of arterial embolization of symptomatic polycystic kidneys has been described.[36]

Genitourinary malignancy

ESRD patients are at elevated risk for acquired malignancies of the kidney, bladder, thyroid and other endocrine organs compared with the general population. The risk of cancers of the lung, colorectum, prostate, breast and stomach is not consistently increased.[37] Stewart *et al*. evaluated over 830 000 ESRD patients and reported high risks of kidney and bladder cancers, especially among females and younger patients. They further reported that patients with toxic nephropathies, especially analgesic nephropathy, are at particularly elevated risk for not only bladder and kidney cancers, but also urothelial cancers of the upper

tract.[38] However, specific screening beyond the evaluation detailed above is not indicated in the absence of a concerning clinical history, physical exam or abnormal pretransplant diagnostics.

Acquired renal cystic disease (ARCD) is a common finding among dialysis patients with male sex, age, African American race and duration of dialysis considered the principal risk factors.[39] ARCD has been documented by multiple studies as a risk factor for the development of renal cell carcinoma (RCC) with a tendency toward less aggressive phenotypes.[39] Any renal cyst with evidence of malignant degeneration must be managed before transplant and the initiation of immunosuppression.

If a renal mass is identified in the native kidney of a potential recipient, further imaging with a plain CT and post-contrast CT is indicated. Laparoscopic radical nephrectomy is the treatment of choice when possible. For RCC, the standard wait time before transplantation is no evidence of disease at 2 years, although the transplant tumor registry, aware of nomograms predicting the indolent course of small renal cell carcinomas, can provide further guidance on modifying this course of action.[40,41] For example, a patient with an incidental (i.e. <5 cm) RCC treated definitively would have no wait time before transplantation. Interestingly, although the definition of an "incidental" renal mass is set at 5 cm by the transplant tumor registry, this does appear to arbitrarily fall in the middle of the TNM staging system for renal cell carcinoma.[41]

The risk of bladder cancer in ESRD is increased compared with the general population, with the highest risk incurred by those with a toxic, obstructive or infectious etiology of their renal failure.[38] It is estimated that transplant candidates treated for bladder cancer will have a 29% risk of recurrence.[41] Management of urothelial carcinoma in these patients follows the algorithms set forth for all patients with bladder cancer. A disease-free interval of 2 years is recommended before transplantation and immunosuppression.[42] Finally, special attention must be paid to patients who have been treated with cyclophosphamide for glomerular disease or vasculitis, and to patients with a history of aristolochic acid-induced renal failure, given their high risk for development of urothelial malignancy.[43,44]

Most recent data do not suggest that there is an increased risk for prostate cancer among ESRD patients.[37,45] PSA testing and digital rectal exam have been shown to be clinically equivalent for the detection of prostate cancer on dialysis and after renal transplant compared with age-matched controls.[46] Standard recommendations for PSA testing and screening should be applied to this cohort, given the reasonable life expectancy that is required to be listed for renal transplantation.[45] Therapeutic options for management of prostate cancers discovered in potential recipients are the same as the general population, although most would avoid radiation therapy to the pelvis in a patient considered for a renal transplantation. Pretransplant disease-free wait times for stage I prostate cancer is less than 2 years, stage II is 2–5 years and stage III patients must wait 5 years before transplantation.[47]

The viral etiology (human paplilomavirus 16) of penile cancer would suggest that there is increased risk in patients undergoing immunosuppression; however, to date, there are no data to suggest such an association. A thorough examination of the genitalia, particularly among uncircumcised males, is indicated to rule out the presence of a penile cancer before transplantation.

Testicular neoplasms overall are rare malignancies and, accordingly, a 2005 review of the Israel Penn International Transplant Tumor Registry showed just 56 cases of testis cancer reported in post-transplant patients, comprising <0.1% of malignancies.[48] An international collaborative study of 831 804 patients reported no testis cancers among 25 044 ESRD patients.[37] The post-transplant recurrence rate for testicular cancers is 5%.[41]

Radical orchiectomy presents no surgical problems in the potential transplant patient. The management of nodal disease follows established treatment algorithms, although radiotherapy of the iliac node chain, the so-called "dog leg", risks radiation damage to the area to receive a future allograft.

Intraoperative involvement of the urologist in the renal transplant

Throughout the world and at a minority of institutions in the USA, the renal allograft procedure is carried out by, or in concert with, urological surgeons. Most centers in the USA are consolidated solid organ transplant programs staffed by transplant surgeons with general surgery training; the involvement of urological surgeons in these programs is limited to select cases. In cases of patients with pre-existing complex urological reconstructions, such as an augmentation cystoplasty, orthotopic or heterotopic diversion, a urological surgeon should be available to assist with anatomic identification, protection or

revision of the reconstruction, and creation of the allograft ureteroneocystotomy.

Occasionally, a procured kidney has structural abnormalities that, while not disqualifying its use for implantation, requires specialized reconstruction or expertise to safely graft into a recipient. Duplications of the collecting system might require reconstruction to enable a single ureteroneocystotomy. Impressively, the use of kidneys with congenital fusion abnormalities has been described in the transplant and urological literature.[49]

Urological complications in the kidney transplant recipient

A contemporary series of 1223 patients undergoing kidney transplantation quoted a 7.5% urological complication rate.[50] These complications can be early or late and nearly encompass the entire spectrum of disease managed by urologists.

Early post-transplant period

Hematuria might be seen in the early postoperative course and is usually a result of Foley catheter trauma or the urinary tract reconstruction, particularly if an intravesical ureteral implantation is used. Significant hematuria with clot formation can lead to obstructive uropathy or anastamotic urine leakage. Management with catheter irrigation can usually control the bleeding; however, cystoscopy with clot evacuation and fulguration of bleeding sites might be required should irrigation fail to control the bleeding. If these efforts fail, surgical exploration might be required.

Urine leaks are reported in the literature to occur in 1–3.5% of renal allograft procedures.[50,51] These are generally as a result of anastamotic leakage, obstruction or ureteral ischemia, although other factors, such as infection, inflammation, immunosuppression or extrinsic compression from a large lymphocele or hematoma, might play a role. Management depends on the underlying etiology of the leak. Leaks from the ureteroneocystotomy or the bladder might be treated by prolonged catheter drainage or early surgical repair. A leak from the lower ureter or collecting system might be treated with a percutaneous nephrostomy, antegrade or retrograde stent placement. Ischemic ureteral necrosis leading to urine leak generally requires a delayed surgical approach, such a Boari flap, native to donor ureteroureterostomy, ureteropyelostomy or reimplantation of the donor ureter. Careful preservation of the ureteral blood supply during procurement is critical to avoid ischemia to the donor ureter. Special attention should be paid toward preserving lower pole arteries and the perirenal fat between the renal hilum, the lower pole and the artery, the so called “golden triangle”. Urine leaks as a result of technical errors usually present within the first 24 h, whereas leaks secondary to ureteral ischemia and necrosis present within the first 14 days.

Hydronephrosis of the graft kidney occurs in 3–6.5% of cases.[50,51] Early ureteral obstruction and hydronephrosis might be a result of intraluminal obstruction, blood clot, occult calculi or extraluminal compression from hematoma or lymphocele, and is more common with non-stented anastamoses than stented anastamosis.[52] Extraluminal compression can be alleviated by percutaneous drainage or surgical exploration. Percutaneous nephrostomy tube placement with or without antegrade ureteral stent placement might be required to alleviate the obstruction. ESWL of obstructing stones is an option in the early postoperative period, although percutaneous drainage of the kidney until retrograde ureteroscopy can be safely carried out is also reasonable.[50,53]

Late post-transplant period

The causes of late hydronephrosis include chronic ureteral ischemia with stricture, nephrolithiasis, fungus ball, urothelial tumor and bladder outlet obstruction. Because dilation of the collecting system can occur with vesicoureteral reflux, urinary retention or chronic rejection with cortical loss, ureteral obstruction must be diagnostically proven. Post-void ultrasound should be carried out to evaluate for urinary retention. A VCUG can be carried out to evaluate for vesicoureteral reflux. A diuretic renogram using furosemide and MAG3 (mercaptuacetyltriglycine) or an antegrade nephrostogram can definitively prove ureteral obstruction. Once obstruction is verified, a nephrostomy tube can be easily placed at that time.[54]

Ureteral stricture can be managed endoscopically with balloon dilation, chronic stenting, holmium laser incision or cold knife incision. Retrograde ureteral access in these cases can be difficult, because of the heterotopic position of the graft ureter and lack of strong support to bolster a wire or catheter; prior antegrade placement of a percutaneous nephroureteral catheter is helpful in these cases. Endoscopic

management of strictures is successful in approximately 60% of cases.[55] Open surgical management with techniques such as ureteropelvic anastamosis, ureteral reimplatation, Boari flap, psoas hitch, donor to native ureteroureterostomy or ureteropelvicostomy have technical success rates of 80–100%.[55]

Renal or ureteral calculi develop in 0.17–3% of transplant kidneys.[56–58] The presentation of obstructing stones in a denervated transplant kidney can be highly variable. Patients might complain of pain over the graft site, oliguria or anuria. Stones are commonly discovered during evaluation for rising serum creatinine. Emergency circumstances, such as acute renal failure and/or anuria, require the prompt placement of a percutaneous nephrostomy tube.[54] Management options include ESWL, percutaneous nephrostolithotomy, retrograde ureteroscopic techniques and open stone removal, all of which can be effective depending on the level of expertise with each modality at any given center.[50,51,56] Predisposing risk factors for stone formation include female sex, gout, recurrent urinary tract infection, the presence of an ileal conduit and hyperparathyroidism.[56] The most common metabolic abnormalities cited in transplant patients who develop stones are hypocitraturia (75%), hyperparathyroidism (36%), hypophosphatemia (24%) and hypercalcemia (10%), urinary tract infection is also a common finding (50%).[57] Definitive stone management is best deferred until after the postoperative period, to allow for healing of the reconstruction and optimization of the patient's immunosuppression. A percutaneous nephrostomy tube or ureteral stent can generally temporize a patient until they can undergo an invasive stone procedure.

Postoperative urinary retention and voiding dysfunction have been reported in up to 27% of males over 60 years-of-age after renal transplantation.[59,60] These patients are treated by similar guidelines as outlined in the Pretransplant section. Urinary retention as a result of BPH, refractory to medical therapy, can be safely treated with transurethral resection or incision of the prostate, even as early as 15 days after transplantation.[27,45,53] Finally, patients with confirmed hypocontractile bladders and urinary retention post-transplantation should be maintained on CISC.[51,59]

The incidence of most malignancies is higher in kidney transplant patients than the general population; there is a 15-fold increase in the risk of kidney cancer, a threefold risk of bladder and testis cancers, and up to a twofold risk of prostate cancer. Additionally, patients with bladder cancer were more likely to present at an earlier age with more advanced disease.[61,62] In general, all cancer therapies for genitourinary cancers are available to the renal transplant patient. Pelvic lymphadenectomy on the side of the allograft might not be feasible and radiation in the region of the transplanted kidney should be avoided because of the risk of damage to the transplanted kidney and ureter. The use of bacille Calmette–Guérin (BCG) is disputed in the literature, but there are reports of its safe and efficacious use in superficial bladder carcinoma and carcinoma *in situ*.[63]

Conclusions

In the USA, the role of the urologist as the primary surgeon has declined over the years, though many notable figures in urology maintain the presence of our field in the transplant community. The involvement of urologists in training with transplantation has followed a similar trend. A minority of urologists will be intimately involved in renal transplantation, but transplant patients will be seen by a great many. It is the obligation of educators in urological training to familiarize the next generation of urologists, if not with renal transplantation, at least with the management of the many complications that these patients face.

The participation in living donor renal procurement provides teaching opportunities to training programs. The principles of careful and complete dissection of the hilum, vascular control and ureteral dissection with preservation of blood supply are important lessons applicable to multiple types of urological renal surgery.

Renal transplantation patients are at elevated risk for genitourinary cancers, BPH, bladder dysfunction and any number of allograft-related complications. Because of the intrinsically urological nature of renal transplantation, it is our belief that a urologist should be familiarized with the recipients preoperatively. We believe that a urologist should be included in the multidisciplinary review of candidates, though it might not in all cases be necessary to include a urologist in formal consultation.

Although the future of American urologists as technicians implanting renal allografts into suitable ESRD patients is uncertain, there will always be a place for the urologist in the care of these patients.

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Table 1 Utilization of right kidney for laparoscopic living donor transplantation at authors' institution and contemporary series

Author/institution	Total (*n*)	Left/right	% of right
Breda *et al.* University of California Los Angeles (2007)[16]	300	297/3	1.0%
Sundaram *et al.* Indiana University (2007)[17]	253	237/16	6.3%
Jacobs *et al.* University of Maryland (2004)[18]	738	709/29	3.9%
Su *et al.* Johns Hopkins University (2004)[19]	381	362/19	5.0%
Ko *et al.* Mayo Clinic Arizona (2008)[20]	400	359/41	10.3%

Chin *et al.* Mt. Sinai Medical Center (2009)[21]	512	430/82	16.0%
Fisher *et al.* University of Michigan (2006)[22]	200	191/9	4.5%
Posselt *et al.* University of California San Fransisco (2004)[23]	387	333/54	14.0%
Thomas Jefferson University Hospital (2005–2010)	150	132/28	18.7%