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Urological complications of renal transplantation: the impact of double J ureteric stents

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In a 10 year series of 350 consecutive renal transplant operations, the overall urological complication rate was 7.7%. During this period double J stents were introduced and were used either in the treatment of actual urological complications or as a prophylactic measure to protect ureters which had been damaged at retrieval. A total of 34 double J stents were used in 33 patients. The indications were: ureteric obstruction ($n=13$), urinary leak ($n=5$), short transplant ureter anastomosed using an extravesical ureteroneocystostomy ($n=10$) and ureteric injury at the time of organ retrieval ($n=6$). Thirty-two double J stents were inserted at open operation and two were inserted by an antegrade method after percutaneous nephrostomy. Improvement in renal function occurred in 16 out of the 18 cases of urological complications. No kidneys were lost and there were no deaths as a direct result of these complications. In a number of cases the insertion of a double J stent was the only treatment, thus eliminating the need for more complex surgery. All 16 patients who had a ureteric stent inserted as a prophylactic measure at the time of transplantation made uncomplicated postoperative recoveries. Urinary tract infection was relatively common (27%) after double J stent insertion, but other complications were rare. In conclusion, double J stents have proved to be a useful adjunct in the management of renal transplant related urological complications.

Urological complications after renal transplantation are important because they are relatively common and may result in allograft failure or even death. Review of the literature shows that the reported incidence of urological complications after transplantation ranges from 3% *(1)* to 34% *(2)*, but an incidence of 7% was quoted in the most recent large British series *(3)*. The allograft loss rate resulting from these complications may be up to 40% *(4)* and a mortality rate of 68% has also been published *(2)*. Renal transplant associated urological complications are of a particularly serious nature because the compromised organ is a solitary kidney and the patient is heavily immunosuppressed.

Although the surgical techniques for implanting the transplanted ureter into the bladder are now well established and have changed little in the last 30 years, there have been recent advances in the management of transplant-related urological complications. An especially important innovation has been the introduction of the double J ureteric stent. This derives its name from the shepherd's crook configuration at both ends and is also commonly called a double pigtail catheter. These devices are made of either hard polyurethane or soft silicon rubber, and because these materials have a memory for their shape the bent end of the catheter can be straightened by the insertion of a stiff guidewire and will reform its pigtail shape when the guidewire is withdrawn. Double J stents have been used for splinting and draining native ureters since 1978 *(5)* and have now become a routine part of general urological practice. They are, however, equally well suited for use in transplant ureters. This paper reviews our experience of urological complications in 350 consecutive renal transplants with the aim of assessing the impact of double J ureteric stents on the management of transplant associated urological complications.

Patients and methods

During the period 1979 to 1989, 350 renal transplant operations were performed on 317 patients. There were

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189 males and 128 females, with a mean age of 39.1 years (range 10–66 years). There were 321 first, 23 second, 5 third, and 1 fourth transplants in this series. The immunosuppressive protocol used was prednisolone (starting with 100 mg/day) and azathioprine (2 mg/kg/day) in 92 cases, prednisolone and cyclosporin A (starting at 17 mg/kg/day) in 239 cases and prednisolone, azathioprine (1 mg/kg) and cyclosporin A (starting at 10 mg/kg/day) in 19 cases.

In the vast majority ($n = 335$) the ureteroneocystostomy was fashioned using the Leadbetter–Politano technique *(6)*. The bladder was distended with saline via a urethral Foley catheter, a cystotomy was made and the ureter was introduced into the bladder through an oblique submucosal tunnel. The end of the ureter was then spatulated and secured to the bladder mucosa using four interrupted 3/0 chromic catgut sutures. An 8G Nelaton catheter was passed into the ureter and up to the renal pelvis in order to confirm that there had been no technical errors. The bladder was closed with either two layers of 2/0 chromic catgut ($n = 245$) or two layers of 2/0 chromic catgut and a third layer of interrupted 2/0 silk sutures ($n = 90$). In the remaining 15 patients the ureteroneocystostomy was created using an extravesical technique. In all cases the bladder was drained with a Foley catheter for 5 days and the operation site was drained by a suction drain for a variable period. Postoperatively, renal function was monitored daily using plasma creatinine levels. ^{99m}Tc DTPA renography was performed as a routine baseline investigation 48 h postoperatively. Real-time ultrasonography was used to examine all transplanted kidneys on a daily basis during week days and at the weekend when indicated. All scans were performed by the same experienced ultrasonographer and as well as looking for fluid collections and evidence of pelvicalyceal dilatation, graft size was estimated by measuring the cross-sectional area of the transplanted kidney *(7)*. Potential urological complications were investigated in the main by antegrade urography but intravenous urography and cystography were also used in a number of patients.

The double J ureteric stents used in this series of patients were in the size range 4.8–7G and were all made by Surgitek®, Wisconsin, USA.

Statistical analysis was performed using the Mann–Whitney U test for continuous variables and the χ^2 test for discrete variables.

Results

A total of 31 urological complications occurred in 27 patients, giving an incidence of 7.7% for the series. The complications were urinary leakage in 16 cases and urinary obstruction in 15 cases. Four patients suffered six episodes of urinary leakage from the bladder and nine patients suffered ten episodes of ureteric urinary leakage. The 15 episodes of urinary obstruction occurred in 14 patients.

Table I. Analysis of transplant details in complicated and uncomplicated groups

	Uncomplicated transplants	*Urological complication group*
Recipient age (years)	37 (10–66)	35 (15–59)
Donor age (years)	31 (6–79)	35 (4–66)
HLA mismatch	3 (0–6)	3 (1–5)
Anastomotic time (min)	30 (20–55)	29 (20–35)
Total ischaemic time (h)	22 (10–64)	19 (10–35)

Median (range)

In a comparison of patients who developed urological complications with those who did not (Table I), there were no statistically significant differences in recipient age, donor age, HLA mismatch, anastomotic time, total ischaemic time or type of immunosuppression (Mann–Whitney U test). In addition, there was no significant difference in the incidence of urological complications in patients who had a two-layer bladder closure (22/245) when compared with those who had a three-layer closure (5/90) ($\chi^2 = 1.1$, NS).

In the four patients who suffered a bladder leak, one had an abnormal bladder due to systemic sclerosis and this patient suffered two episodes of releakage. In the second patient, prostatism was subsequently demonstrated and a transurethral resection of the prostate was performed. The third and fourth cases were due to breakage of the continuous catgut suture used to close the cystotomy. In the ureteric leakage group there was evidence of ischaemic damage to the ureter in five cases, damage to the ureter at retrieval with stripping of its blood supply in two cases and in a further two cases there was no obvious cause for the leakage. In the ureteric obstruction group there was evidence of damage to the ureter at retrieval in one case and ureteric ischaemia in seven cases, but in the remaining six cases there was no obvious predisposing factor for obstruction. Four of the patients who developed a urological complication had suffered an acute rejection episode in the preceding month.

All episodes of bladder leakage occurred from the cystotomy. Of the ten episodes of ureteric leakage, three occurred from the upper third of the ureter, one from the middle third of the ureter and six at the ureterovesical junction. In the 15 episodes of ureteric obstruction, this occurred at the pelviureteric junction in four cases, at the ureterovesical junction in ten cases and due to a blocked double J stent in a single case. Episodes of urinary leakage were largely confined to the first month after operation. In cases of obstruction the majority occurred in the first 2 months after transplantation but three episodes occurred at approximately 2 years (Table II).

The clinical details of patients with urological complications are summarised in Tables III and IV. All episodes of ureteric leakage were treated by early operation (Table III). Cases of leakage at the ureterovesical junction were

Table II. Timing of urological complications

Time after transplant (months)	*Episodes of urinary leakage*	*Episodes of urinary obstruction*
<1	11	6
1–2	4	6
12–24	1	1
>24	0	2

usually associated with ischaemic necrosis of the lower ureter. In these patients the non-viable distal ureter was excised and the undamaged proximal transplant ureter was then anastomosed to the native urinary tract by one of two methods. In cases in which there was a sufficient length of undamaged ureter, this was re-implanted directly into the bladder either by the Leadbetter–Politano technique or by an onlay method (extravesical ureteroneocystostomy). If, however, the remaining transplant ureter was too short to reach the bladder, it was anastomosed to the ipsilateral native ureter using interrupted 4/0 chromic catgut sutures.

In two cases of leakage from the pelvis of the transplanted kidney, open insertion of a double J stent was the only treatment. The bladder was reopened and a 4.8–7G double J pigtail stent (Surgitek®, Wisconsin, USA) was introduced through the cystotomy, across the site of leakage and up the transplant ureter to the renal pelvis. The area of leakage was not manipulated directly and the bladder was closed in two layers of absorbable sutures and drained with a Foley catheter for at least 5 days.

Bladder leaks in this series were also treated by early reoperation. The cystotomy was resutured in two layers and a suction drain was placed in the cave of Retzius. The bladder was drained using either a urethral or a suprapubic catheter and in two cases the transplant kidney was also drained using a Cummings nephrostomy tube.

The management of episodes of ureteric obstruction is shown in Table IV. In the early years of the series the obstructed section of transplant ureter was excised and the remaining proximal part was then anastomosed either to the bladder or to the ipsilateral native ureter. In later years obstructions were managed by inserting a double J stent into the affected ureter without carrying out a resection procedure. In most cases of open insertion the stent was introduced via a cystotomy, but in one case a small ureterotomy was fashioned and then closed with fine catgut sutures. Two double J stents were inserted by an antegrade percutaneous technique. This was achieved by performing a percutaneous nephrostomy and then feeding the double J stent down the ureter from above. These two successes were achieved from five attempts at the percutaneous method.

Table III. Clinical details of 16 episodes of urinary leakage after renal transplantation

Patient age/sex	*Site of leakage*	*Operative treatment*	*Stenting/drainage technique*	*Time stent in situ (weeks)*	*Complications*	*Outcome at 3 months*	
						Functioning graft creatinine ≤130	*Functioning graft creatinine >130*
Ureteric leaks							
45 F	UVJ	Ureteroureteral anastomosis	Nephrostomy + silastic catheter	8	—	+	−
56 M	UVJ	Ureteroureteral anastomosis	Silastic catheter	1	Releakage	NA	NA
56 M	UVJ	Ureteroureteral anastomosis	Nephrostomy	4	—	+	−
57 M	Mid ureter	Ureteroureteral anastomosis	DJS	4	—	+	−
26 M	UVJ	Ureterovesical anastomosis	Silastic catheter	2	—	+	−
19 M	UVJ	Ureterovesical anastomosis	Silastic catheter	3	Late stenosis (4 years)	−	+
36 M	Pelvis	Ureterovesical anastomosis	DJS	3	UTI	+	−
53 F	UVJ	Ureterovesical anastomosis	DJS	6	UTI	−	+
34 F	Pelvis	Stent via cystotomy	DJS	4	—	+	−
17 F	Pelvis	Stent via cystotomy	DJS	2	—	+	−
Bladder leaks							
39 M	Cystotomy	Resuture	Urethral catheter	2	Releakage	NA	NA
39 M	Cystotomy	Resuture	Nephrostomy + suprapubic catheter	1	Releakage	NA	NA
39 M	Cystotomy	Resuture	Nephrostomy + urethral catheter	6	UTI	+	−
53 M	Cystotomy	Resuture	Urethral catheter	3	—	−	+
49 M	Cystotomy	Resuture	Urethral catheter	3	—	+	−
45 F	Cystotomy	Resuture	Urethral catheter	3	—	−	+

UVJ, ureterovesical junction
DJS, double J stent

Table IV. Clinical details of 15 episodes of ureteric obstruction after renal transplantation

Patient age/sex	*Site of obstruction*	*Operative treatment*	*Stenting/drainage technique*	*Time stent in situ (weeks)*	*Complications*	*Outcome at 3 months*	
						Functioning graft creatinine ≤ 130	*Functioning graft creatinine > 130*
29 M	UVJ	Ureterovesical anastomosis	Nephrostomy	4	—	−	+
45 M	PUJ	Stent via cystotomy	Silastic catheter	1	UTI	+	−
26 F	PUJ	Anastomosis to native ureter	Nephrostomy + DJS	2	—	−	+
35 M	PUJ	Anastomosis to native ureter	DJS	6	—	+	−
28 M	UVJ	Ureterovesical anastomosis	DJS	3	UTI	−	+
59 M	UVJ	Ureterovesical anastomosis	DJS	4	—	−	+
29 F	UVJ	Ureterovesical anastomosis	DJS	10	—	+	−
21 M	UVJ	Ureterovesical anastomosis	DJS	8	Pain	−	+
19 M	UVJ	Stent via ureterotomy	DJS	24	—	+	−
20 F	PUJ	Stent via cystotomy	DJS	2	—	−	+
47 M	UVJ	Stent via cystotomy	DJS	72	—	−	+
15 M	UVJ	Stent via cystotomy	DJS	12	UTI	+	−
55 M	UVJ	Stent via cystotomy	DJS	3	Blocked	NA	NA
55 M	Stent	Percutaneous stenting	Nephrostomy + DJS	32	—	−	+
34 M	UVJ	Percutaneous stenting	Nephrostomy + DJS	40	—	+	−

UVJ, ureterovesical junction
PUJ, pelviureteric junction
DJS, double J stent

A number of different types of ureteric stent were used throughout the series (Tables III and IV). In the early years the ureter was stented and drained using either a simple Silastic® catheter passed through the bladder wall and brought out percutaneously ($n=4$), or by a Cummings nephrostomy tube ($n=2$), or by a combination of both ($n=1$). In more recent years the damaged ureter was stented and drained by a combination of nephrostomy and double J stent ($n=3$) or by the insertion of a double J stent alone ($n=15$).

Double J pigtail stents were also used as a prophylactic measure in cases where the transplant ureter had been damaged at the time of retrieval. In this group there were ten cases in which the donor ureter had been cut excessively short so that anastomosis to the bladder could only be performed using an onlay technique (extravesical ureteroneocystostomy). In a further six cases the ureter had been damaged either by direct laceration or obvious and extensive stripping of its blood supply. In these 16 patients a double J stent was inserted at the time of transplantation in an attempt to protect either the damaged ureter or the extravesical ureteroneocystostomy.

The outcome of the urological complications in this series was defined using four possible end points: (1) a functioning graft associated with a normal serum creatinine, (2) a functioning graft associated with a raised serum creatinine indicating some loss of function, (3) a failed graft, and (4) death. The results at 3 months are shown in Tables III and IV. There were no cases of graft failure or death attributable to urological complications in this series. Of the 27 surviving grafts, 15 were left with normal renal function and 12 had some impairment of function. The type of stenting employed, that is double J stent or other methods, had no influence on the outcome ($\chi^2=0.693$, df = 1, NS). All patients are still under review and the median follow-up time is 23 months. During this period there has only been a single episode of restenosis at the ureteroneocystostomy and this was successfully treated by insertion of a double J stent.

In the group of 16 patients treated by prophylactic stenting, ten survived with normal renal function and six survived with a raised creatinine, but there were no graft failures or deaths. In total, therefore, double J stents were used in 34 cases in this series of transplants, with 18 being used as part of the treatment for a urological complication and the other 16 being inserted prophylactically. The vast majority of double J stents were inserted at open operation but two were inserted by an antegrade percutaneous technique.

When double J stents were used it was intended that they should remain *in situ* for approximately 2–6 weeks. This period was chosen rather arbitrarily on the grounds that it seemed to be a reasonable interval in which to allow for healing to occur. Nevertheless, in a number of cases of obstruction the observed improvement in renal function occurred very slowly and in these cases it was decided to leave the double stent *in situ* for a longer period. On the other hand a number of stents were removed earlier than planned because of the development of complications. In fact only four double J stents were left for more than 3 months and the overall median time *in situ* was 4 weeks (range 1 week to 18 months).

A number of complications attributable to double J stents occurred in this series. Urinary tract infection was the most common, occurring in nine patients (27%). By

comparison, in a group of 50 unstented renal transplants performed in this unit, the urinary tract infection rate in the first 3 months after operation was 14%. The causative organism in double J stent-related infections was a Gram-negative bacterium in seven cases and *Candida albicans* in two cases. Three of the patients with Gram-negative infections suffered a recurrent episode, and four stents were deliberately removed earlier than planned (at 13 days, 20 days, 21 days and 1 month) as part of the treatment. In one of the episodes of candidal infection the patient developed systemic candidiasis with the formation of fungal balls in the right retina. This was successfully treated by prolonged treatment with intravenous and intravitreous amphotericin B. The only other complications in the series were a single episode of pain and dysuria and a single episode of stent blockage, and in both these cases the stent had to be removed. There was no apparent relationship between the length of time for which a double J stent was left *in situ* and the incidence of complications.

Discussion

Although a wide range of figures for the incidence of urological complications after renal transplantation have been published, the incidence of 7.7% in this series is comparable with those of recent large series *(3,8)*. The results of managing urological complications after renal transplantation appear to have improved in recent times and the data presented suggest that graft loss and mortality from this condition should now be avoidable in all but the rarest cases. The causes of transplant-related urological complications are well known, and it is recognised that many are due to errors of surgical technique, both at the time of organ retrieval and at the transplant operation itself. Both types of error can cause ischaemia of the lower end of the transplant ureter and this was recognised as a contributory factor in a number of cases in this series. More direct technical errors of inaccurate suture placement during the fashioning of the ureteroneocystostomy can still occur because this remains a technically demanding part of the operation. It is essential that the surgeon demonstrates that an appropriately sized catheter can be passed from the bladder through the ureteroneocystostomy and right up to the pelvis of the transplanted kidney without any resistance.

It has been suggested by some workers that a decreasing incidence of transplant-related urological complications in recent years has been associated with the use of better immunosuppressive protocols and, in particular, the recent trends for the use of lower doses of steroids *(3)*. In the series described here there was no difference in the incidence of urological complications when comparing patients who received azathioprine and prednisolone with those who received cyclosporin and prednisolone. However, both these groups received the same doses of steroids and therefore the role of this particular factor cannot be commented on. An acute rejection episode in the previous month only occurred in four cases, and there was no evidence to suggest that the degree of HLA mismatch was associated with the likelihood of complications. This finding is in agreement with the work of others *(9)*.

Although a variety of techniques have been used to perform the ureteroneocystostomy, the results of our series endorse the work of other groups in suggesting that the Leadbetter–Politano technique has stood the test of time and is associated with an acceptably low complication rate *(3,8,9)*. Nevertheless, it is clear that the onlay technique of creating an extravesical ureteroneocystostomy *(10)*, which we have used in a small number of cases, is also a successful method.

The operative treatment of transplant-related urological complications is usually extremely difficult because it involves reoperation at a time when the transplant kidney, its blood supply and ureter are being surrounded by fibrous tissue. The risks are not lessened by the fact that surgery has to be carried out in a group of patients who have previously had long-term renal impairment with all its consequences and who are immunosuppressed. In this context, the utilisation of the double J stent has been a particularly important innovation. The dissection required to isolate an area of damaged transplant ureter is extremely difficult and dangerous. In contrast, it remains relatively easy to approach the bladder after this has been distended with fluid and to reopen the cystotomy. This allows the passage of a double J stent into the transplanted ureter and we have found that this manoeuvre alone has been enough to treat a number of urological complications. This has vastly simplified the reoperative surgery, providing the expedients of speed and safety.

Double J stents have a number of advantages over the nephrostomy tubes and Silastic stents which have previously been used in this context. These external forms of drainage need to be secured by suturing to the skin and have the potential problems of infection, dislocation and urinary fistula on removal. In contrast, double J stents are totally internal and self-retaining.

This series shows that the outcome of patients with complications has generally been satisfactory, with no episodes of graft loss, no mortality and one-half the patients have been left with normal renal function. The numbers involved are relatively small and no statistical advantage of the double J stent over nephrostomy tubes or Silastic stents was shown. This is not surprising in that all these devices perform the same function in protecting anastomoses and draining urine. In patients who are left with a decrement in renal function after their complication, it is more likely that this is a result of the severity of the complicating process rather than the type of treatment performed. Furthermore, other complications such as acute tubular necrosis, acute rejection and cyclosporin toxicity were present in several cases. The final creatinine achieved at 3 months is a reflection of all these influences, but was presented as an objective, albeit non-specific, indicator of the early results.

The use of double J stents as a prophylactic measure has been controversial. The outcome in this group was

good, with no urological complications and no graft loss or death. It is, however, accepted that it is impossible to assess the impact made by stenting *per se* in these cases. Whether or not the routine use of double J ureteric stents can reduce the incidence of urological complications after renal transplantation remains an unanswered question, and there is perhaps scope for a controlled trial in this area.

Double J stents are associated with recognised complications. In this series the high incidence and occasional severity of urinary tract infections were of considerable concern. It is therefore recommended that all patients should undergo urine culture at least twice a week while their stent is *in situ*. In an attempt to limit the incidence of urinary tract infections, stents should be left in place for the minimum time possible to allow healing, and it is suggested that 4–6 weeks is the most appropriate interval. The development of fungal infections in two patients was of particular concern and this must be actively sought in these immunosuppressed patients. Other complications of double J stents were rare, with only single episodes of pain and blockage and no episodes of perforation, encrustation or migration of the stent—all of which have been described when these devices have been used in native ureters *(11)*. Double J stents can only be removed cystoscopically and although this was performed in most cases under a general anaesthetic, it is possible to remove stents under local anaesthetic with a flexible cystoscope.

In conclusion, the prevention and treatment of urological complications remains an important and difficult area for the renal transplant surgeon. The use of the self-retaining double J stent has simplified the surgical management of a number of cases in this series. Our experience of inserting stents via the percutaneous antegrade route is small, but greater use of this less invasive procedure is almost certainly the way forward.

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