Owing to the limited donor pool at transplant centers, grafts may be taken from marginal donors with congenital abnormalities, one of the most common of which is a fusion abnormality. Horseshoe kidneys may be transplanted to a single recipient en bloc or to 2 recipients after division. In our clinic, 3 grafts (1 obtained from a living donor and 2 from a deceased donor) were successfully transplanted to 3 patients. In select patients, horseshoe kidneys may be used for transplant.

Key words: Donor, Marginal, Living-related, Deceased donor, Tissue transplantation

The number of patients with chronic kidney failure presenting to transplant centers and awaiting a transplant is increasing rapidly. Despite this increasing waiting list, the donor pool remains relatively static. To increase the size of this donor pool, all potential donors should be evaluated carefully. The most frequent and important problem that transplant centers encounter in this context is an insufficient number of kidneys from deceased donors. One solution for expanding the donor pool is to use a marginal kidney with congenital abnormalities, one of the most common of which is the horseshoe kidney that occurs as the result of fusion abnormalities (1). The rate of horseshoe kidneys is reported as 1 in 300 to 400 children and 1 in 600 to 800 adults (2). Fusion in a horseshoe kidney generally occurs owing to thick parenchyma at the lower pole without a net margin; however, it also may be formed by a fibrotic band in 9% to 14% of occurrences (3, 4). The vascular anatomy in the horseshoe kidney is complex. The number of renal arteries and veins as well as their sizes can vary greatly. There is a single renal artery in only 30% of these patients, and collection system abnormalities of the kidney also may be present. Therefore, urinary tract infection, vesicoureteral reflux, recurrent kidney stones, and hydronephrosis may be frequently observed in these patients (2). Some patients remain asymptomatic, and the abnormality is detected incidentally. There are reports of horseshoe kidneys being transplanted to a recipient en bloc or to 2 recipients after the kidney has been separated into 2 at the fusion point (5). Here, we present our experiences with 3 patients who received successful transplants from donors with horseshoe kidney abnormalities and discuss the related literature.

Case 1

A 32-year-old woman with end-stage renal disease who had been maintained on hemodialysis owing to hypertensive nephrosclerosis and her 42-year-old sister as a haplo-identical donor were admitted to our center for a kidney transplant. During the donor evaluation, ultrasonographic examination of the kidneys revealed no abnormalities. Angiographic examination demonstrated what was believed to be a rotation abnormality of the left kidney (Figure 1).
Although no history of frequent urinary tract infection was apparent on donor evaluation, a micturating cystourethrogram of the donor demonstrated an absence of the vesicoureteral reflux. Surgical exploration via a left flank incision showed that both kidneys were connected with a thick fibrotic band (2 cm thick). A single renal artery and vein were noted in the left kidney. This fibrotic band was transected close to the parenchymal border of the kidney, and the donor nephrectomy was completed. The donated kidney was transplanted in the right iliac fossa, with the renal vein anastomosed to the external iliac vein and the renal artery to the external iliac artery. No complications developed after surgery. Induction therapy composed of a 20-mg dose of basiliximab was administered on days 0 and 4, and tacrolimus (0.15 mg/kg/d) and mycophenolate mofetil (2 g/d) were initiated for maintenance immunosuppression. The patient was discharged on the sixth day after surgery with a creatinine level of 159 µmol/L. During a 30-month follow-up, the patient had no complications or rejection (except for 2 g/d proteinuria that developed in the fourth postoperative month). Her creatinine levels ranged between 71 and 106 µmol/L. The donor’s creatinine level was stable (88 µmol/L) during follow-up, and no proteinuria or urinary tract infections was detected.

In November 2004, a 50-year-old brain dead man was evaluated as a potential donor. His relatives had no history of urologic complaints such as nephrolithiasis, vesicoureteral reflux, or frequent urinary tract infection. Results of a laboratory examination demonstrated his creatinine and proteinuria levels to be 97 µmol/L and 200 mg/day, respectively. A preoperative ultrasonographic examination showed the probability of a fusion abnormality. During surgery, both deceased-donor kidneys were found to be completely connected at their lower poles. The horseshoe kidney was removed en bloc. Both kidneys were determined to have 1 ureter each and an extrarenal pelvis along with multiple renal arteries and veins. At the back table, methylene blue was administered through one of the lower pole renal arteries showing a line of demarcation. The kidneys were transected with a gastrointestinal anastomosis stapler, and 2 different grafts were obtained for transplant (Figures 2 and 3). Each kidney was transplanted to patients with end-stage renal disease (see cases 2 and 3 below).

Case 2

A horseshoe left kidney from a deceased donor with a cold ischemia time of 8.5 hours (Figure 2) was transplanted to a 23-year-old man with end-stage renal disease who had undergone hemodialysis treatment for 7 months. After the rudimentary renal veins of the graft were ligated, the main renal vein was anastomosed to the external iliac vein, 1 renal artery was anastomosed to the internal iliac artery, and the other renal artery was anastomosed to the external iliac artery. After perfusion of the graft, no bleeding or urine leakage from the transected surfaces was detected. Urination started intraoperatively. As an induction agent, antithymocyte globulin (2.5 mg/kg/d) was introduced, and maintenance treatment composed of tacrolimus (0.15 mg/kg/d) and mycophenolate mofetil (2 g/d) was administered beginning 7 days after surgery. The patient was discharged with a creatinine level of 141 µmol/L on the ninth day after surgery. On follow-up, lymphocele occurred during the second postoperative month, which caused obstruction of urine flow from the ureter. A percutaneous catheter was inserted to drain the lymphocele fluid. The catheter was removed 12 days later when the daily lymphocele drainage was less than 30 mL/day. On follow-up, the patient’s creatinine level ranged between 119 and 155 µmol/L, and no surgical complications or rejection episodes were observed.

Figure 2. Transected deceased-donor left horseshoe kidney.

Figure 3. Transected deceased-donor right horseshoe kidney.
Case 3

A horseshoe kidney from a deceased donor with a cold ischemia time of 10 hours (Figure 3) was transplanted to a 31-year-old woman with end-stage renal disease who had been maintained on hemodialysis treatment for 18 months. After the rudimentary renal veins of the graft were ligated, the main renal vein was anastomosed to the external iliac vein, and 1 renal artery was anastomosed to the common iliac artery, and the other renal artery was anastomosed to the external iliac artery. After perfusion of the graft, neither bleeding nor urine leakage from the transected surfaces was detected. Urination started intraoperatively. As an induction agent, antithymocyte globulin (2.5 mg/kg/d), was introduced. Maintenance immunosuppression treatment consisting of cyclosporine (8 mg/kg/d) and mycophenolate mofetil (2 g/d) was begun 7 days after surgery. On the second postoperative day, the patient developed oliguria. Ultrasonography demonstrated a renal pelvis hematoma. This was drained operatively by placing an intraoperative nephrostomy tube into the upper calyx and a double-J stent from the bladder to the renal pelvis. Prothrombin time, partial thromboplastin time, and bleeding time remained within their respective normal ranges during this time. The patient developed no complications following surgery and was discharged 15 days after surgery with a creatinine level of 97 µmol/L. Twelve months after surgery, the patient developed frequent urinary tract infections. At that time, because vesicoureteral reflux of the transplanted kidney was detected, the graft ureter was anastomosed to the recipient’s kidney ureter. At 24 months’ follow-up, the patient’s creatinine levels ranged between 97 and 124 µmol/L, and there were no further complications.

Discussion

A horseshoe kidney is a common congenital kidney abnormality. Its average incidence is 1 in 600 to 800 adults and 1 in 400 children (2). At our center, between 2000 and 2006, two horseshoe kidney abnormalities were found among 830 renal transplant donors (130 deceased-donor, 700 living), which is consistent with the literature. Grafts (1 left kidney from a living donor and 2 kidneys from a deceased donor) were transplanted successfully to 3 recipients. Recurrent urinary tract inflammations due to obstructions in the ureteropelvic junction, kidney stones, or hydronephrosis are frequently associated with horseshoe kidneys (in as many as two-thirds of cases) (2). Since a rotation abnormality was present in these patients, vascular abnormalities also can be found. In our patients, in both horseshoe kidneys obtained from a deceased donor, multiple renal arteries and veins were present. No vascular abnormality was present in the living donor.

The horseshoe kidney transplant was first reported by Nelson and Palmer in 1975 (6). Following their report, a series of 31 cases was added to the literature (7). The horseshoe kidney may be transplanted en block or to 2 recipients after being divided; several studies have demonstrated successful results (8, 9). There are many factors leading to a decision to separate the fusion. One of the most important is the number of renal arteries and veins and the position of these vascular structures (7). Researchers suggest that if a suitable number of artery and vein structures allowing safe anastomoses are present, transplant may be performed by division; however, if arteries and veins are not suitable for anastomoses, the kidney should be transplanted en bloc (5, 7). Research suggests that radio-opaque substances or methylene blue may be used to determine appropriate artery and vein structures (5). After the horseshoe kidney in a deceased donor is removed en bloc, it is transected at the back table according to the demarcation line made via methylene blue administration into the arterial system. Rudimentary veins are ligated, and the main vein is used for the anastomosis (10).

One factor determining transplant type of a horseshoe kidney (ie, single vs en bloc) is the anatomic structure of the urinary collection system. During separation of a fused renal isthmus, the urinary collection system is frequently injured, and owing to the difficulty of managing this complication, a urinary fistula may develop (4). The most important factor to consider when deciding 77 en bloc versus a single division is the thickness and location of the fused part. If the fusion is thinner and formed by a fibrotic band, the probability of urinary collection system injury and postoperative bleeding decreases (5). Since a fibrotic band formed the fusion abnormality in the living donor in our presented cases, no complication was encountered during intraoperative transection. Transection of the horseshoe kidney obtained from the deceased donor was performed at the back table, and no complications were observed during this process. However, a hematoma in our third patient was found inside the pelvis and outside the pelvis renalis on the second day after surgery; this was thought to be due to an unnoticed injury to the collection system. No other problem related to separation of the fusion, either before or after surgery, was seen.
We therefore conclude that the important factor affecting the preferred surgical technique is whether the artery, vein, and urinary collection system have a normal anatomy. Most transplant surgeons believe that there are no significant differences between transplants performed with a horseshoe versus a normal kidney. Some even claim that compared with normal kidneys, more functional tissue exists in kidneys that are transplanted en bloc, and better results are obtained with these kidneys (5). In contrast, some surgeons have reported that the results of transplants using kidneys with abnormalities are worse than those for normal kidneys (11). In their paper presenting the accumulated cases worldwide, Stroosma and associates report that owing to complex vascular and urinary collection system abnormalities, 17 of 80 cases could not be transplanted after division (4). This illustrates that the division process is not an innocuous one. In patients in whom the fusion abnormality is caused by a fibrotic band, a transplant may be performed without hesitation by transecting the isthmus leading to the fusion if there is little active parenchyma. However, for patients in whom the fusion is formed by a thick parenchymal isthmus, complications will occur during the transection process. Therefore, we believe that owing to multiple vascular abnormalities in horseshoe kidneys, urinary collection system abnormalities (eg, extrarenal pelvis), and additional interventions (eg, transections), the risk of morbidity increases. In our patients, we observed no vascular complications due to multiple vascular abnormalities; however, we did see urologic complications including lymphocele, a renal pelvis hematoma, and vesicoureteral reflux. However, compared with other patients transplanted with normal kidneys, we found no significant increase in medical or urologic complications in our patients during long-term follow-up (mean, 24 months).

Since the number of patients awaiting kidney transplant increases while the donor pool remains limited, we believe that despite the higher rate of vascular and urologic complications, the horseshoe kidney is an important donation source that should be carefully evaluated for transplant. In deciding the surgical technique required, it is important to establish whether or not these kidneys have artery, vein, and urinary collection system abnormalities. Although considered risky, many successful renal transplants of this type have been reported.

References