

## Horseshoe kidney transplantation

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### ABSTRACT

While horseshoe kidney is the most common renal fusion anomaly, its incidence is low. Horseshoe kidney transplantation is possible either *en bloc* into a single recipient or separated for grafting into two patients, depending on the anatomical characteristics of the vascular and urinary collecting systems. We report a case of horseshoe kidney transplantation into two recipients following division describing the surgical technique used for kidney division and preparation and the vascular reconstruction which was necessary in this case. The transplantations were carried out successfully for both recipients and without complications. Our case suggests that safe use of the horseshoe kidney for transplantation is possible despite the large anatomical variations in the vascular and excretory systems.

#### Key-Words:

Horseshoe kidney; kidney transplantation.

### INTRODUCTION

Horseshoe kidney is the most common renal fusion anomaly, occurring in 1:400 and in twice as many males as in females<sup>1-3</sup>.

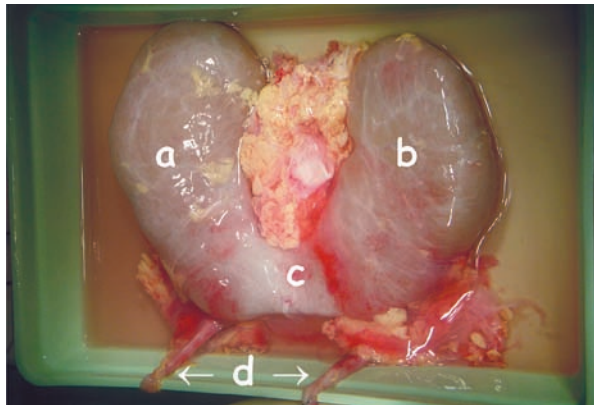
This abnormality occurs between the 4<sup>th</sup> to 6<sup>th</sup> week of gestation and results from the partial fusion across the midline of the two contralateral poles of the metanephric blastema. The configuration of the horseshoe kidney suggests that the fusion occurs before the renal rotation and that it inhibits the normal ascent of

the two kidneys from their final anatomical position. These embryonic anomalies lead to a large anatomical variation in the vascular and excretory systems. In fact, a single renal artery on each side can only be found for both kidneys in 30% of cases<sup>1</sup>. It is more common to find two or three arteries for one or both kidneys or a variable number, starting in the aorta above or below the isthmus, in the common or external iliac vein and the inferior mesenteric artery. The renal pelvis usually shows a ventral position causing the ureters to be located in front of the isthmus. Their insertion in the renal pelvis is generally higher and they are shorter than in a normal kidney<sup>2,4</sup>. In most cases the isthmus is found in front of the aorta and the vena cava, but it may be located between the vena cava and the aorta or behind these blood vessels. Fibrotic tissue makes up 14% of it<sup>3</sup> but it more frequently contains renal parenchyma<sup>2</sup>. In some rare cases, these kidneys have a common excretory system contiguous across the isthmus<sup>2,4,5</sup>.

There has been much greater usage of the horseshoe kidney for renal transplantation in recent years. However, some specific precautions are necessary when transplanting such kidneys.

### CASE REPORT

The male donor was 31 years old and died in an accident resulting in a vascular brain haemorrhage. At the time of the extraction he had a urea level of 25 mg/dl and a creatinine of 1.2 mg/dl. There was no history of urinary infections or kidney disease available. The viral serologic markers were negative



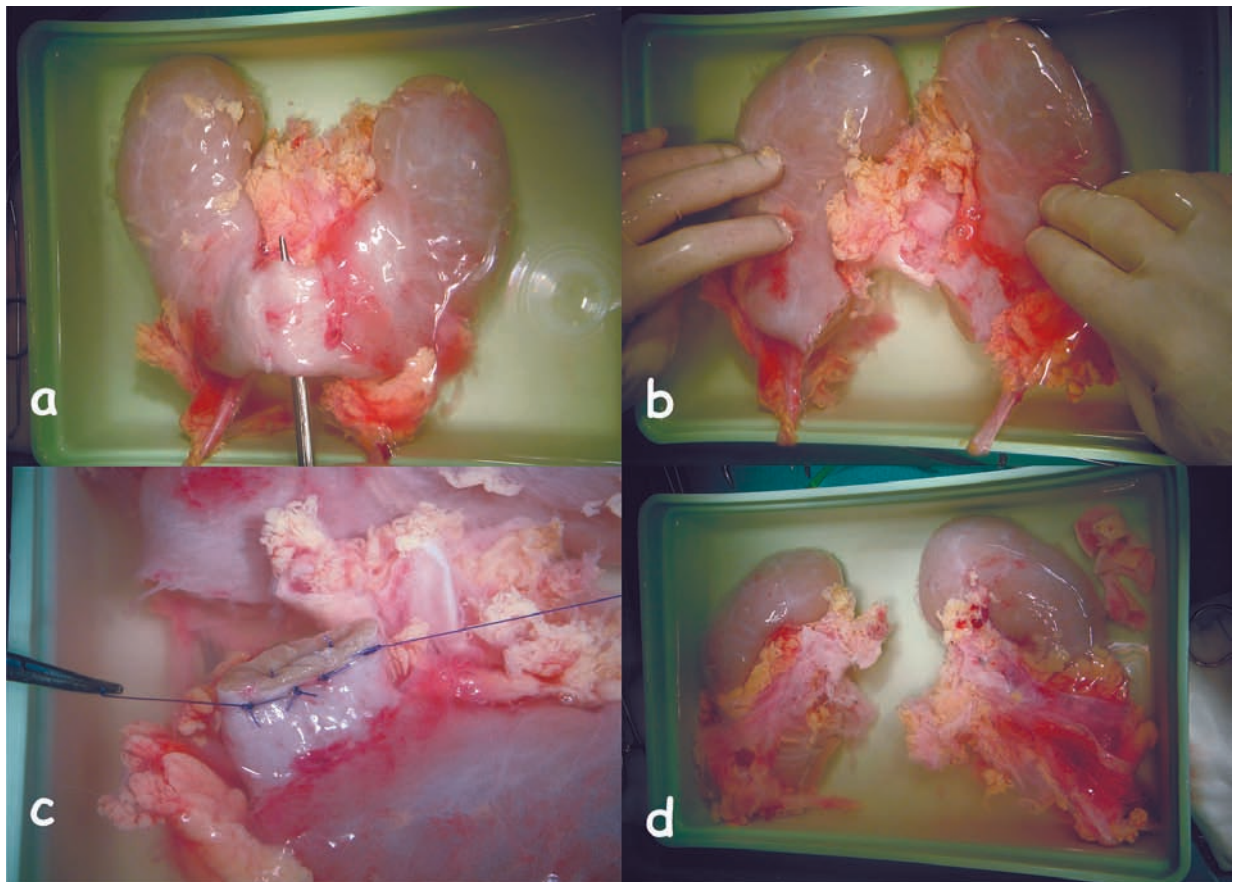
**Figure 1**

Appearance of the horseshoe kidney after extraction: a) right kidney; b) left kidney; c) isthmus; d) ureter behind the isthmus

with the exception of CMV IgG. Our renal transplantation team accepted this kidney, extracted in another hospital by a different surgical team.

The inspection of the horseshoe kidney showed it to have a short and thin isthmus, with a ureter located behind it (Fig. 1). During inspection of the vascular structures, the right kidney was found to have two arteries, one having been completely severed during the extraction. One upper artery and two lower ones with a sole aortic ostium supplied the left kidney. This ostium was partially destroyed during removal.

The division of the isthmus was then carried out (Fig. 2). Since the isthmus was short and thin, no study of the pyelocaliceal system was made before the division. The isthmus consisted of only renal parenchyma,



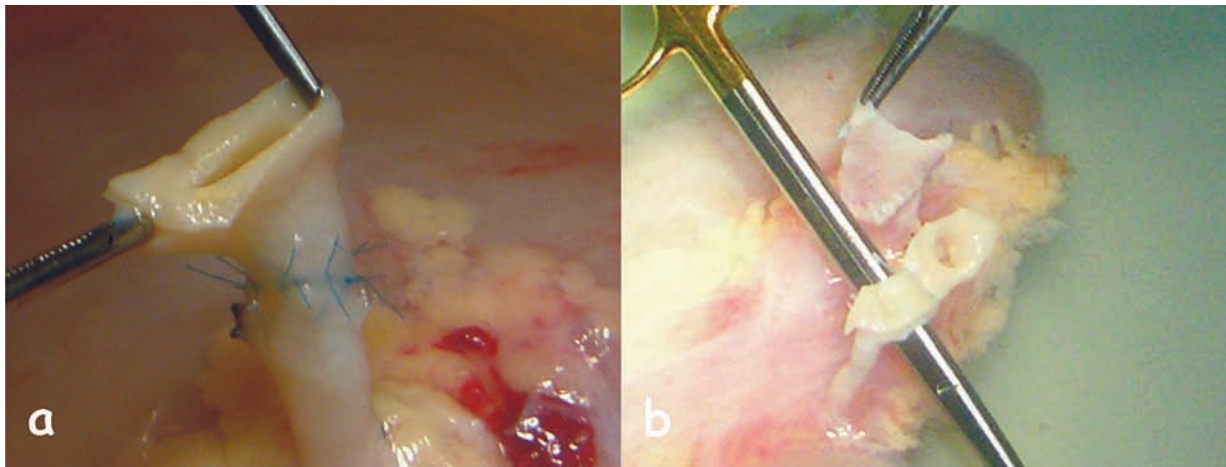
**Figure 2**

Dividing the kidneys: a) short and thin isthmus b) dividing the isthmus; c) haemostatic suture d) section of the aorta and separation of the kidneys.

without the excretory system. Haemostatic sutures were made to close the isthmus on each side.

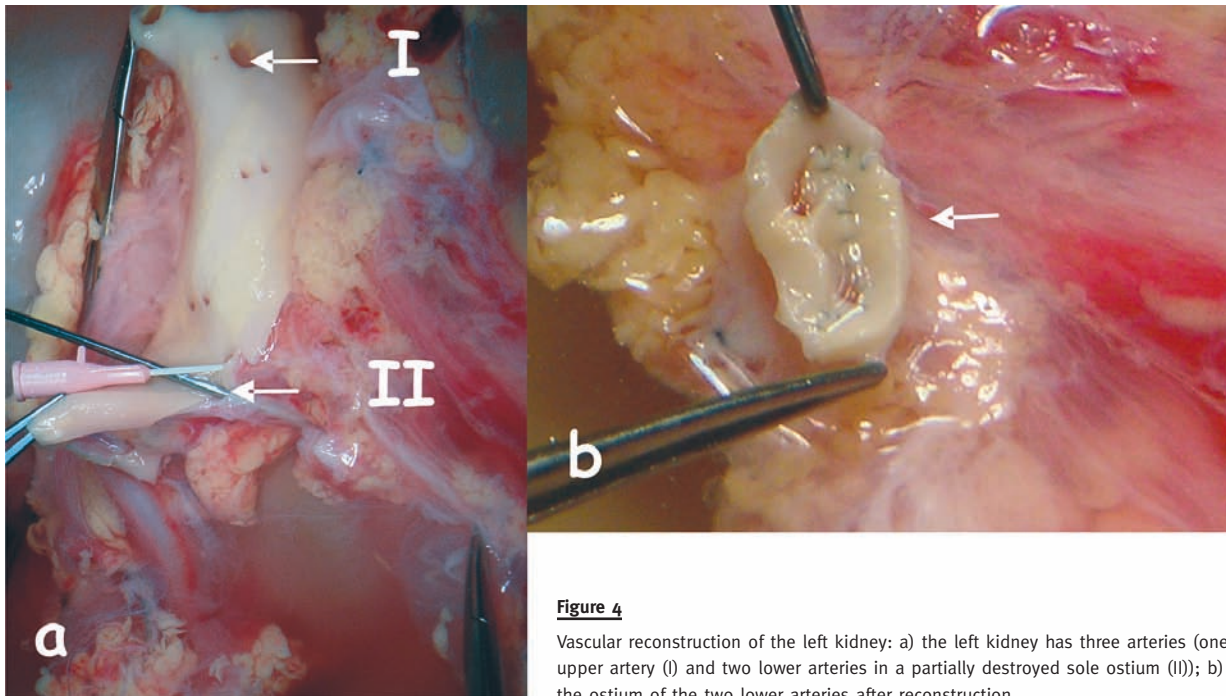
During the extraction, the upper right renal artery was completely severed and the sole ostium for the two lower

left renal arteries partially destroyed. The upper right vascular artery was rebuilt with end-to-end vascular anastomosis. After that we made one sole patch for the joint implantation of the upper and lower right arteries (Fig. 3). On the left, the ostium serving the two lower



**Figure 3**

Vascular reconstruction of the right kidney: a) upper right artery completely severed during extraction and rebuilt with end-to-end vascular anastomosis; b) the upper and lower right arteries were joined with a single patch



**Figure 4**

Vascular reconstruction of the left kidney: a) the left kidney has three arteries (one upper artery (I) and two lower arteries in a partially destroyed sole ostium (II)); b) the ostium of the two lower arteries after reconstruction

renal arteries was rebuilt (Fig. 4). The left kidney was to be implanted using two independent arterial anastomosis; one for the upper renal artery and one sole patch for the two lower renal arteries.

The right kidney, in cold ischaemia for 26 hours, was implanted in the right external iliac veins of a 44 year old female patient with four HLA compatibilities (2 in AB and 2 in DR). This patient had chronic renal failure caused by autosomic dominant polycystic kidney disease and had been undergoing haemodialysis for about a year. The immunosuppressive regime used was ciclosporin, mycophenolate mofetil (MMF) and prednisolone. The left kidney, in cold ischaemia for 19 hours, was implanted in the left external iliac vein of a 34 year old male patient with four HLA compatibilities (2 in AB and 2 in DR). This patient had chronic renal failure caused by reflux nephropathy and had been undergoing peritoneal dialysis for around three years. The immunosuppressive regime used was the same. Both patients showed good progress in kidney function.

## ■ DISCUSSION

As the shortfall of kidneys available for transplantation increases, surgeons are seeking to widen the pool of donors. Although horseshoe kidneys are not common, their use in renal transplants has been documented recently. The main problem with using these kidneys for transplantation is the enormous anatomical variability, particularly in the vascular system, which makes the technical aspects of such a transplant more difficult. The increased time in cold ischaemia and the increase of the probability of vascular thromboses were other disadvantages encountered<sup>2</sup>. For these reasons there are certain conditions that must be met before a horseshoe kidney is used for transplantation. Firstly, information as to the history of the donor should be collected where there are signs of previous incidence of urological pathology<sup>2,6</sup>. Although the majority of horseshoe kidneys are asymptomatic and function normally, there may be some complications. In 13% of cases, the patients suffered from persistent urinary infections or pain and 17% developed recurrent urine calculi<sup>5</sup>. Around 80% showed some degree of hydronephrosis<sup>4,5,7</sup>, either non-obstructive or obstructive. The former may be caused by vesico-ureteral reflux. The obstructive

hydronephrosis seems to be related to the obstruction of ureteropelvic junction, present in more than 30% of cases<sup>4</sup>. This, in turn, may be affected by the high insertion of the ureter, and by its ventral positioning, with some angulation which is occasionally significant over the lower pole of the kidney<sup>4</sup>. The ureteral duplication and ureterocele also seems to be more frequent in horseshoe kidneys<sup>1</sup>. When procuring organs for transplant, knowledge of this sort of donor historical detail forewarns the surgeon to check and possibly correct adverse anatomical alterations. There are authors who recommend the systematic revision of the ureters to avoid obstruction<sup>2,4,5</sup>. These same authors recommend the use of a stent to anastomise the ureter to the bladder for the transplant of horseshoe kidneys on the basis that there is a greater likelihood of distal ischemia lesion of the ureter and an increased incidence of hydronephrosis in these cases.

When a horseshoe kidney is identified in a donor, the harvesting strategy must take into account the wide anatomical variety of these kidneys and the risk of damaging important vascular structures. For this reason a perfusion through the iliac arteries, *en bloc* extraction, with the aorta and cava vein remaining intact<sup>2,5</sup>, and the severing of the ureters next to the bladder is recommended<sup>2,8</sup>.

A detailed inspection should be carried out in back-table. The vascular structures in each kidney and the anatomy of the excretory system should be identified and an evaluation of the characteristics of the isthmus carried out. This careful analysis is crucial when deciding whether to transplant the kidneys *en bloc* or separately.

The transplant of these kidneys *en bloc* leaving all the arteries and aorta intact may obviate lesions to the vascular structures and the need for prolonged reconstruction work. Technically, the implantation of a horseshoe kidney *en bloc* is similar to paediatric kidney transplantation. Nevertheless, most authors suggest that horseshoe kidneys should be separated whenever possible.

Although it is rare to find a common excretory system at the isthmus level, the probability increases with a wide and thickened isthmus. Some authors recommend a retrograde pyelography be carried out to identify this situation before dividing the isthmus<sup>2,3,9</sup>.

The irrigation of the isthmus with multiple and anomalous blood vessels may be compromised during division. In these circumstances it is more prudent to opt for a transplant *en bloc*. When opting for separation of the kidneys, suitable vascular reconstruction work must be carried out. Half of the aorta should be kept as a patch containing the apertures of all the homolateral renal arteries.

The ipsilateral implantation of each kidney is recommended since both the veins and the ureters are shorter than usual<sup>2,5,10</sup>.

The careful separation of the isthmus, without causing any lesion to the excretory system and a satisfactory haemostasis are key points. The most frequent complications of the separated kidneys are haemorrhage and urinary leak originating in the divided isthmus<sup>2</sup>.

There are as yet no defined recommended procedures, but the current relevant literature contains suggested algorithms for evaluation and transplantation of the kidneys with fusion anomalies<sup>3,8</sup>. We believe the decision whether or not to divide the anomalous fused kidneys depends on the age of the donor, the clinical history and renal function of the renal parenchyma, the anatomy of the vascular and excretory system, isthmus thickness and the results of the renal biopsy<sup>8</sup>.

Although there are few documented cases, a Dutch study concluded that there was no significant difference in the results of transplantation of the horseshoe kidney *en bloc* or after separation<sup>2</sup> and that the results of transplantation of horseshoe kidneys (whether *en bloc* or split) are the same as those found when transplanting normal kidneys<sup>11</sup>. Nevertheless, long term follow-up data has yet to be analysed.

If the donor has no known medical history of renal disease and the horseshoe kidney is correctly harvested, it should not be ruled out for transplantation based on anatomical variation. The success of the horseshoe kidney transplant is dependant on a suitable vascular reconstruction, the evaluation and careful separation of the isthmus and the avoidance of the urethral obstruction.

There are some documented cases in the relevant literature of the use of horseshoe kidneys from live

donors<sup>7,12</sup>. These same authors argue that the ability to conduct a pre-operative study on the anatomical vascular viability makes the use of these kidneys from live donors viable<sup>7</sup>. The use of horseshoe kidneys from live donors could be important in select cases. However, these kidneys from live donors should be used only if there is no other potential donor available and if the vascular anatomy allows for reliable reconstruction. There is no consensus as to whether the division of a horseshoe kidney for renal transplantation from a live donor leads to a higher incidence of complications for the donor<sup>5</sup>.

The tendency in the future is likely to be the ever increasing use of horseshoe kidneys for transplantation. There are documented cases of the use of these kidneys for combined kidney and pancreas transplantation<sup>13</sup> and the transplantation of kidneys with cross fusion anomalies<sup>7</sup>.

The documented cases confirm that it is possible to use horseshoe kidneys for renal transplant, the increased technical difficulties notwithstanding. The procurement and use of this type of kidney should be encouraged.

**Conflict of interest statement.** None declared.

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