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Right Renal Vein Augmentation in Deceased Donor Kidney Transplantation: Importance of the Contiguous Inferior Vena Cava

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ABSTRACT

INTRODUCTION: The short, thin-walled right renal vein (RRV) makes anastomosis and hilar hemostasis challenging in deceased donor kidney transplantation. The right renal artery is twice the length of the vein. The purposes of the present retrospective study were to: (1) describe a surgical technique that uses the contiguous inferior vena cava (IVC) segment to lengthen the right renal vein, and (2) report the surgical outcomes.

METHODS: A total of 44 right deceased-donor kidneys were transplanted into 44 recipients between March 2005 and February 2010. Recipient ages ranged from 19-68 years (28 females; 16 males). We used the contiguous IVC to augment short renal veins in the right kidney allografts. This resulted in a horizontal extension of the RRV, with outflow through the orifice of the left renal vein (LRV). Augmented right renal veins were anastomosed end-to-side to the external iliac vein, and the right renal arteries with aortic patches were anastomosed end-to-side to the external iliac artery in all recipients except 1. Surgical outcomes were assessed.

RESULTS: Among the 44 kidney recipients, 39 were first transplants and 5 were second transplants. The kidneys were placed on the right side (n = 38), left side (n = 5), and into the peritoneum (n = 1). The mean RRV augmentation time was 32 minutes (range, 24-49 minutes); completion of back-table dissection added another 40 minutes. The cold ischemia times ranged from 3 hours 50 minutes to 19 hours. The rewarming times ranged from 34-44 minutes. Immediate graft function was noted in 37 kidneys; 3 patients required dialysis for delayed graft function; 4 patients had slow graft function but did not require dialysis. In a follow-up period ranging from 8 months to 5 years, no graft was lost from vascular complications following the augmentation of the RRV. All 44 venous anastomoses were safe and easy, and kinking of the renal artery was avoided because the reconstructed vein matched the length of the artery.

CONCLUSION: Augmentation of the short RRV utilizing the contiguous IVC is a safe, simple, and reliable procedure that avoids graft loss from vascular complications in deceased donor renal transplantation.

KEYWORDS: Deceased donor right kidney; Short renal vein; Contiguous caval segment; Back-table augmentation.

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Abbreviations and Acronyms

IVC = inferior vena cava
LRV = left renal vein
RRV = right renal vein

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Right Renal Vein Augmentation in Deceased Donor Kidney Transplantation: Importance of the Contiguous Inferior Vena Cava

INTRODUCTION

Kidney transplant surgeons prefer to use left kidneys from deceased donors because the left renal veins (LRV) are long and possess a thick wall. In contrast, the right renal veins (RRV) are short and thin-walled [1,2]. The true length of the RRV depends on the angle at which it drains into the inferior vena cava (IVC): the more acute the angle, the longer the length. In the majority of right veins, there is an oval area on its ventral wall that is close to its connection with the cava. This area is extremely thin, giving the appearance of a defect in integrity. This fragile wall warrants very gentle handling and good assistance during anastomosis to prevent a tear in the vein that may be impossible to repair and result in graft loss.

The short length of the RRV and its thin wall make the venous anastomosis extremely challenging, especially in obese recipients, and may needlessly increase the rewarming time [3]. Additionally, the increase in the kidney size following reperfusion further reduces access to the hilum and area of anastomosis, making hemostasis very difficult.

The right renal artery with the aortic patch is twice the length of the RRV [4]. This disparity in lengths can lead to kinking of the renal artery when the kidney is placed in its final position [5]. To avoid this complication, the donor artery would need to be shortened, resulting in loss of the aortic patch. In the case of multiple arteries, this would mean multiple arterial anastomoses.

Several techniques to reconstruct the RRV have been described in the literature, including IVC flaps, patches, conduits, and different means of stump closure [3-9]. We utilize the attached segment of IVC to lengthen the right renal vein by closing the 2 caval ends, with flexibility in the method of closure. The purposes of the present retrospective study were to describe the surgical technique and report its outcomes.

METHODS

The investigation was a retrospective study of nephrology databases at Riyadh Military Hospital, Kingdom of Saudi Arabia and Albert Einstein Medical Center, Philadelphia, PA, USA. Patient files from March 2005 through February 2010 were studied. All surgeries were conducted by the first author or by fellows who were directly supervised by the first author. The surgical procedures were the same in both settings, with minor modifications as dictated by the anatomy.

Participants

A total of 44 right deceased-donor kidneys were transplanted into 44 recipients whose ages ranged from 19-68 years. There were 28 females and 16 males. Body mass indices ranged from 23-35 in the females and 19-33 in the males.

The donor ages ranged from 15-64 years. The age distribution of the donors was: < 20 years (n = 3), 20-30 years (n = 7), 30-40 years (n = 13), 40-50 (n = 19), and 60-70 years (n = 2).

Surgical Procedure

At the recovery procedure, we separated the venous system of the 2 kidneys by dividing the LRV at the point where it enters the IVC, leaving the entire IVC attached to the right kidney. At the back table, if the superior caval stump was short (as in multiorgan recovery) (Figure 1), it was closed with a running 6/0 polypropylene suture (Prolene; Ethicon Inc, Blue Ash, Ohio, USA) (Figure 2). However, if the superior stump was long (Figure 3), staples were used to save time. The inferior IVC stump is always long and redundant (Figure 3), and is expeditiously closed with a TA stapler (Covidien AG; Dublin, Ireland). This results in horizontal and linear lengthening of the RRV by utilizing the contiguous and thick-walled caval conduit. The reconstructed RRV is straight without any angles and curves and its new exit is the orifice of the LRV in the cava, which is used for anastomosis with the external iliac vein (Figure 4). At times when staples are not available, we have also used polypropylene sutures to close the inferior stump. The reconstructed vein was then tested for leaks by perfusion through the renal artery (Figure 5). Any leaks

Figure 1. Intraoperative Photograph of the Superior Caval Stump and Right Renal Vein.

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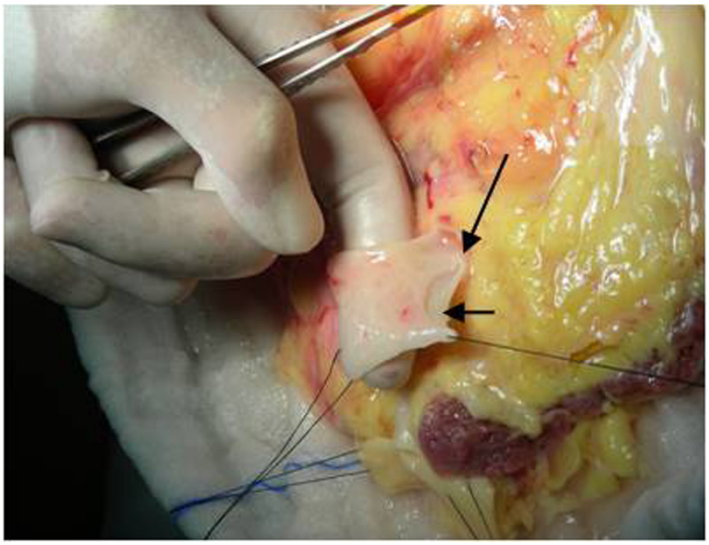

The superior caval stump (short arrow) is virtually nonexistent, making staple closure impossible. The RRV is marked by the long arrow.

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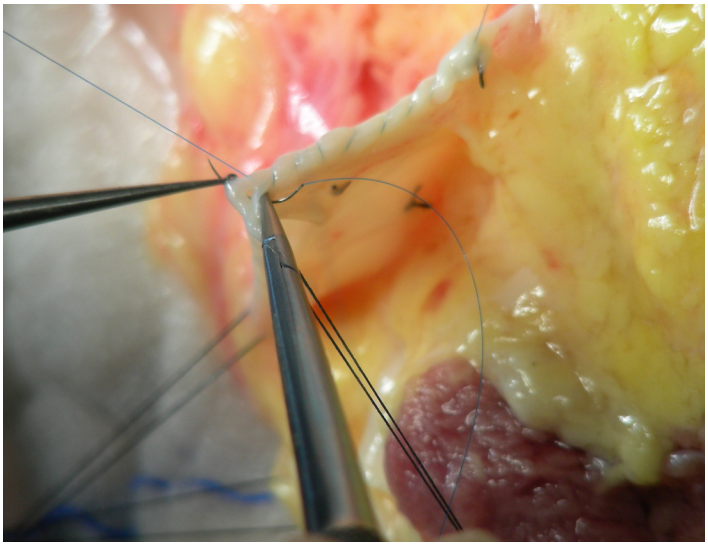
Figure 2. Intraoperative Photograph Showing Closure of the Superior Caval Stump.
doi: 10.3834/uij.1944-5784.2010.12.08f2



Running 6/0 Prolene suture closure of the superior caval stump seen in Figure 1.

Figure 4. Intraoperative Photograph Showing Completed Right Renal Vein Augmentation.
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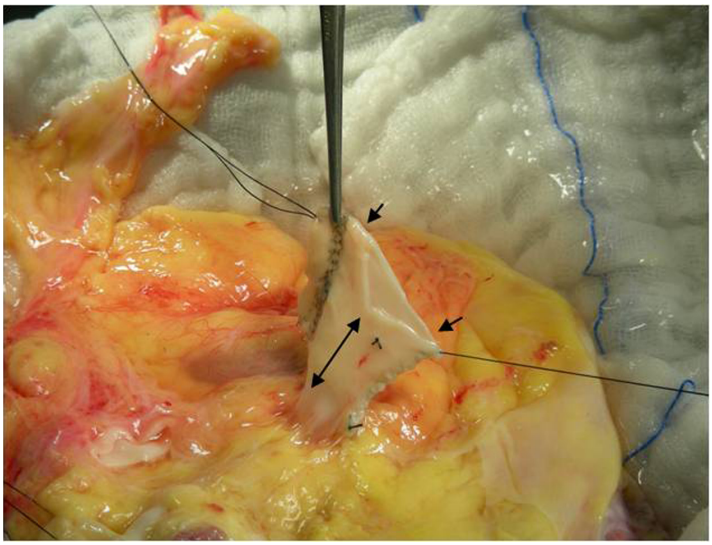
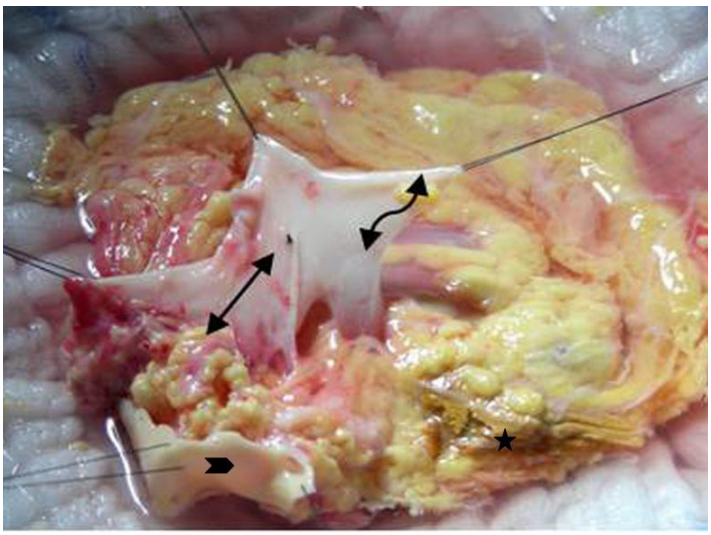


RRV augmentation (from Figure 1), with suture-closed superior stump and staple-closed inferior stump. Note the linear increase in length (double arrow) without any angles or curves. The orifice of the LRV in the IVC is seen (small arrows).

Figure 3. Intraoperative Photograph Showing the Superior and Inferior Caval Stumps.
doi: 10.3834/uij.1944-5784.2010.12.08f3



Long superior caval stump (curved double arrow) and long and redundant inferior stump (straight double arrow). The adrenal gland (star) and the aortic patch (chevron) are visible. Note disparity in length of RRV and artery by location of the aortic patch.

were secured with 6/0 polypropylene sutures. The augmented renal vein then matched the length of the renal artery (Figure 6), allowing use of the aortic patch for arterial anastomosis without any fear of kinking. Following reperfusion, the kidney increases in size and a short RRV would restrict access to the area of anastomosis and hilum. However, a longer pedicle resulting from the augmented vein and the long renal artery permits easy access (Figure 7) for control of bleeding.

Data Analysis

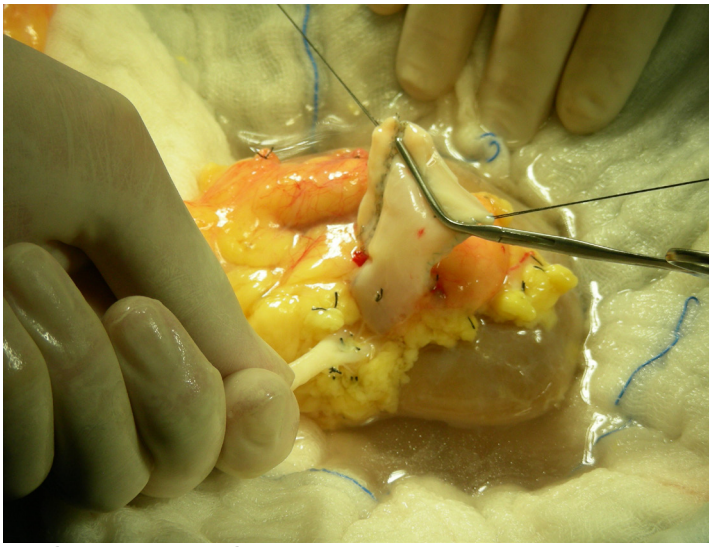
The total times needed for RRV augmentation, cold ischemia, and rewarming were compiled for each patient. Graft function outcomes and postoperative complications were also noted.

RESULTS

Patient Characteristics

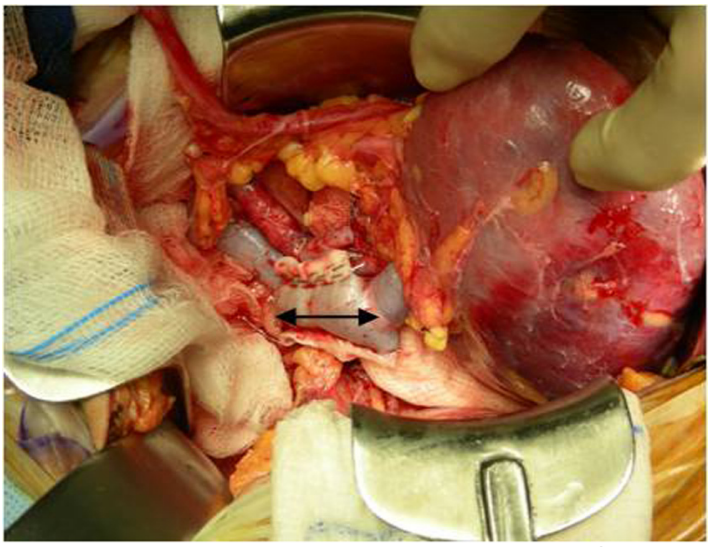
Among the 44 kidney recipients, 39 were first transplants and 5 were second transplants. There were 21 sensitized patients, mainly because of a high number of multiparous females. The kidneys were placed on the right side (n = 38), left side (n = 5), and into the peritoneum (n = 1). The latter patient had exhausted all intravenous access in the neck and groins. The allograft was anastomosed to the left common iliac vein and

Figure 5. Intraoperative Photograph Showing Distention of the Augmented Vein to Check for Leaks.
doi: 10.3834/uij.1944-5784.2010.12.08f5



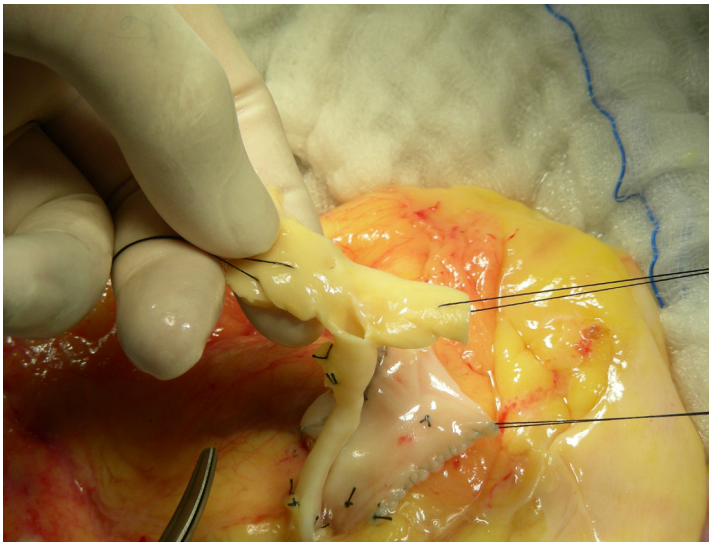
Left renal vein orifice is clamped and the augmented vein is distended to check for leaks, it maintains distension with no leaks. Also note, absence of any angles or curves after augmentation.

Figure 7. Intraoperative Photograph of the Reperfused Kidney.
doi: 10.3834/uij.1944-5784.2010.12.08f7



The extra length provided by the IVC conduit (double arrow), allows easy access to the hilum and anastomoses. The arterial anastomosis with a rim of aortic patch is visible. Note the absence of disparity in the lengths of the artery and vein after augmentation.

Figure 6. Intraoperative Photograph of the Augmented Right Renal Vein.
doi: 10.3834/uij.1944-5784.2010.12.08f6



The RRV matches the length of right renal artery, eliminating disparity in length and enabling use of an aortic patch.

the right common iliac artery, after sacrificing the Carrel patch to prevent kinking of the artery. The kidney was then placed on the right side.

Surgical Outcomes

The mean RRV augmentation time was 32 minutes (range, 24-49 minutes); completion of back-table dissection added another 40 minutes. The longer time for augmentation involved kidneys requiring extra reconstruction because of incomplete or poorly recovered caval segments. The cold ischemia times ranged from 3 hours 50 minutes to 19 hours. The shorter times were for recovery procedures carried out in our hospital, where a cross match was performed prior to donation and the kidneys were taken to the recipient operating room immediately for back-table augmentation and implantation. The longer cold ischemia times were for imported kidneys with delays in cross matches that were initiated after the allografts arrived at our hospital.

The rewarming times ranged from 34-44 minutes. Augmentation did not unduly increase rewarming time because the venous anastomosis was carried out between the orifice of the LRV in the cava and the external iliac vein (the total venous circumference is the same as that of a left kidney).

Immediate graft function was noted in 37 kidneys; we feel that this was because of the shorter cold ischemia times. Three patients required dialysis for delayed graft function; 4 patients had slow graft function but did not require dialysis. In a follow-up period ranging from 8 months to 5 years, no graft was lost from vascular complications following the augmentation of the RRV.

DISCUSSION

The technique we describe is a safe and reliable method of lengthening the deceased donor RRV by using the attached segment of IVC. The IVC segment increases the length of the renal vein so that it matches the length of the renal artery, to mirror donor anatomy. This results in a horizontal extension of the RRV without any angles or curves, so turbulence is avoided. Removal of the disparity in length between the artery and vein allows use of the aortic patch for the arterial anastomosis and the orifice of the LRV for the venous anastomoses. This makes both procedures easy and safe, particularly in the obese recipient. Additionally, the longer vessels allow easy access to the area of anastomosis and hilum. This makes it simple to control bleeding and to prevent kinking of the renal artery when the kidney is placed in its final position [5].

The LRV orifice in the IVC has also been used by other surgeons for a safe and easy venous anastomosis to the external iliac vein [5]. In contrast, live donor renal arteries are shorter because they do not possess the aortic patch and are thus better matched with the length of the RRV, eliminating the disparity in length. Augmentation increases the length of the vein, but because the orifice of the LRV in the IVC was used for anastomosis to the external iliac vein, the rewarming times are similar to those in left kidney transplants.

The most likely complication of augmentation is bleeding from the sutured or stapled edges and thrombosis resulting from poor outflow and turbulence in the vein. Bleeding is obvious as soon as the clamps are removed, and thrombosis usually presents itself early in the perioperative period. In the present study, 3 staple lines needed reinforcement with 6/0 polypropylene sutures because of minor bleeding. More importantly, no renal vein thrombosis was observed in any of our RRV augmentations. In cases without augmentation, control of bleeding can be very challenging because the short renal vein restricts access and, because of its thin walls, it can be avulsed during manipulation and lead to graft loss.

The venous circumference was the same as the left renal vein in both the left and right kidneys. Augmentation makes the venous anastomosis safe and easy [9] by providing a thick-walled cava for the anastomosis to the iliac vein. If the RRV is not augmented and the Carrell patch is used, kinking of the longer artery will result. Kinking is considered a possible cause of transplant renal artery stenosis [10,11].

We outline a surgical technique that provides a natural horizontal extension to the RRV to increase its length. The procedure does not appear to influence the quality of the kidney allograft, its shelf life, delayed graft function, acute or chronic rejection, or long-term outcomes. This technique was successfully performed in a varied donor and recipient population, but requires the IVC to be recovered with the right renal vein. Different methods of RRV augmentation have been described in the literature, depending on the amount of cava available [3-9]. Different approaches are required in the presence of differing amounts of IVC that are available with the right kidney. It is difficult to say exactly what technique will be suitable until the right kidney and its vein are inspected at the back table. All of the techniques described in the literature have similar goals but differ in detail. One feature of our technique is to avoid angles and curves in augmentation [3,8] and provide a vein in natural horizontal continuity with the RRV that facilitates venous outflow and prevents turbulence and the risk of thrombosis.

Organ shortage is universal and it is imperative that all deceased donor kidneys be utilized. We implore all recovery teams to provide the IVC contiguous with the RRV that is suitable for augmentation. This procedure should enable transplantation in all recipients.

Conflict of Interest: none declared.

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