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Case Report

En-Bloc Kidney Transplant Using an Aortic Extension from a Paediatric Multi-Visceral Donor to a Paediatric Recipient

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ABSTRACT

Renal transplantation is the gold standard treatment for end stage kidney disease (ESKD) in children. EBKT from small paediatric donors under five years of age and weighing less than 20 kg can be a good option for selected paediatric renal transplant recipients. EBKT refers to transplantation of both kidneys from the same donor into a single recipient. The utilisation of these organs has a higher risk of vascular thrombosis, stenosis and ureteral leak in children.

We present the case of a successful EBKT, which was performed with an aortic extension using a segment of the aortic arch since the donor operation included multivisceral donation requiring the patch of the Superior Mesenteric Artery (SMA). This is the first description of utilising the thoracic aorta as an extension graft for EBKT in paediatric multivisceral donor for a paediatric recipient.

The aorta was reconstructed and the en-bloc kidneys were successfully implanted into the left iliac fossa onto the iliac vessels.

Keywords: Renal transplantation; Paediatric; Kidneys; Vascular thrombosis; EBKT

INTRODUCTION

Renal transplantation is the gold standard treatment for end stage kidney disease (ESKD) in children. It improves quality and quantity of life as well as physical and cognitive development. Dialysis is associated with six time's lower patient survival, poor physical growth and lowers than average neurodevelopment [1].

En-bloc kidney transplantation (EBKT) was first described by Carrel in 1908 in a xenograft model [2]. EBKT from small paediatric donors under five years of age and weighing less than 20 kg can be a good option for selected paediatric renal transplant recipients. EBKT refers to transplantation of both kidneys from the same donor into a single recipient [3]. The utilisation of these organs has a higher risk of vascular thrombosis, stenosis and ureteral leak in children [4,5]. Recently, better outcomes have been demonstrated with the improvement of anticoagulation protocols and refinement of surgical techniques [3].

We present the case of a successful EBKT, which was performed with an aortic extension using a segment of the aortic arch since the donor operation included multivisceral donation requiring the patch of the Superior Mesenteric Artery (SMA). The aorta was reconstructed and the en-bloc kidneys were successfully implanted into the left iliac fossa onto the iliac vessels.

CASE DESCRIPTION

Surgical procedure

The donor after brain death (DBD) was a two-year old, 15 kilogram child with irreversible hypoxic brain injury secondary to drowning, with good renal function, without co-morbidities. The procurement was carried outby the cardiothoracic retrieval team, a liver team as well as arenal retrieval team. The heart and lungs were procured as well as the liver and small bowel for a multivisceral transplant. The thoracic aorta, coeliac trunk and superior mesenteric artery (SMA)

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were retrieved as a whole tube. The renal arteries were retrieved beyond that as a second tube all the way to the bifurcation of the iliac arteries. As the recipient team, we were aware of the high risk of stenosis secondary to proximal closure of the aortic tube so an additional aortic arch segment was retrieved to reconstruct the suprarenal aorta on the back bench. Donor kidneys were recovered en-bloc with aorta, inferior vena cava and bilateral ureters in continuity to the bladder insertion. The Inferior vena cava (IVC) was procured including both renal veins and divided 5 mm above the confluence of the right renal vein to the IVC. All of the organs were perfused with University of Wisconsin (UW) solution and packed in an organ-transport-box at 0-4°C.

The en-bloc kidneys measured 7 and 7.5 cm. Back bench surgery was performed after removing additional fat and tissue adherent to the kidneys, all the branches of the aorta and IVC were ligated except for the renal blood supply (Figure 1). The suprarenal aorta and part of the proximal right renal artery were missing due to the nature of the multivisceral retrieval, therefore, these were reconstructed by the addition of a short portion of the aortic arch in an end-to-end fashion with 6-0 prolene running suture top end was closed with 5-0 prolene suture. Similarly, the top end of the IVC was closed with 5-0 prolene running suture (Figure 2). Both ureters were divided from the bladder.

An EBKT was performed following informed consent from the recipient family, acknowledging that there might be higher risk of technical complications. At the time of recipient assessment, special attention was taken into consideration including favourable vascular anatomy, adequate bladder capacitance and function, no history of thrombophilia, adequate cardiac function, absence of either significant pulmonary or systemic hypertension, no orthostatic or history of hypotension, absence of high-risk of recurrence of kidney disease.

The recipient was a 13 year old male with ESKD on peritoneal dialysis secondary to bilateral renal dysplasia and posterior urethral valves with previous valve resection, bladder augmentation and Mitrofanoff formation. The decision to implant into the left iliac fossa was taken as the Mitrofanoff was in the right iliac fossa and close to the anterior superior iliac spine. A Gibson incision was performed followed by careful dissection of the extraperitoneal space to the iliac vessels and augmented bladder.

The en-bloc kidneys were implanted laterally in the extraperitoneal space. The en-bloc graft was resting on the psoas muscle; subsequently anastomosing the donor distal aorta end-to-side to the common iliac artery with 6-0 prolene running suture and the donor IVC to the external iliac vein end-to-side. Intravenous heparin was administered prior to reperfusion and the kidneys

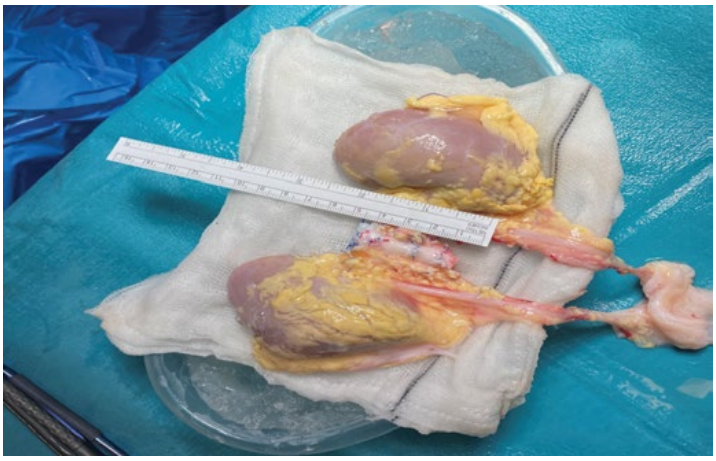

Figure 1: En-block Kidneys on the back table. Both kidneys and the aorta have been prepared for the implant. Both ureters are joined onto the donor bladder.

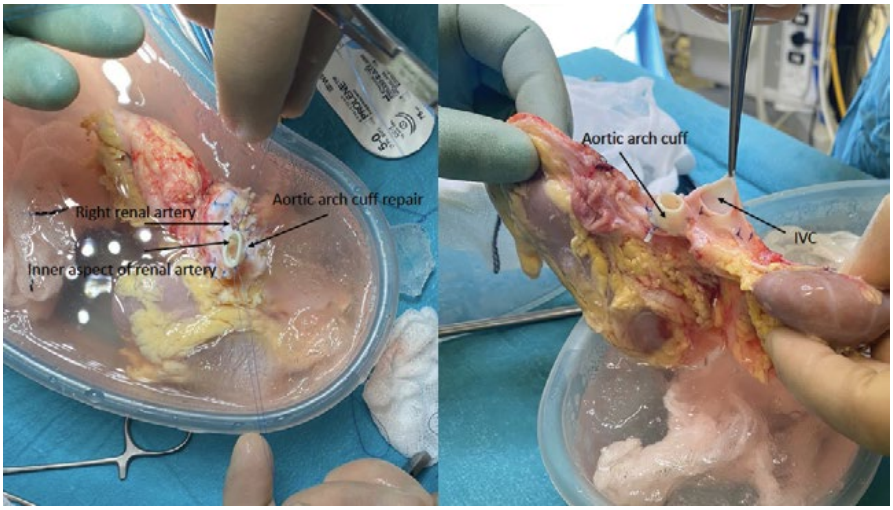

Figure 2: Photos showing the upper aspect of the aorta with its aortic cuff extension and inferior vena cava. The inner aspect of the right renal artery is also shown following the repair.

perfused well (Figure 3). There was a strong palpable thrill in the graft aorta and both renal arteries. Urine output was visible on the table from both kidneys.

The position of the kidneys were placed laterally and always taking extra caution in the definitive position to avoid any perfusion risk. The blood inflow was from the common iliac artery, through the distal aorta and then to both renal arteries, reason why the proximal closure was performed with the aortic extension. The outflow was performed from the renal veins to the inferior vena cava and then to the external iliac vein. It is important to take into account the final position of the EBKT, since there is a high risk of kinking of both renal arteries and veins.

The ureteric anastomosis was performed by spatulating the distal ends of both ureters and anastomosing the medial walls with 4-0 PDS running suture prior to the implantation onto the bladder. Two 6-french stents were introduced into both ureters and the bladder; subsequently the ureters were anastomosed to the bladder with 4-0 PDS running suture before closure.

While still in theatre and before waking up the patient, a Doppler ultrasound was performed. This showed good perfusion in one kidney but poor perfusion in the medial organ. Immediately the wound was reopened and a kinking was observed in the renal artery due to the limited retroperitoneal space. The decision to open the peritoneum was taken to release the pressure on the en-bloc kidneys. A second ultrasound was performed demonstrating adequate flow into both kidneys after closure.

The patient was sent to recovery and finally back to the ward following satisfactory progress. Subcutaneous heparin was started as prophylaxis against graft thrombosis until discharge. Renal allograft function improved with decreasing plasma creatinine from 744 µmol/l pre-transplant to 235 µmol/l the day after transplant and then 97 µmol/l on day 8 post-transplant giving estimated glomerular filtration rate of 117.33 mls/min/1.73 m^2. He was discharged from hospital at one week on aspirin 75 mg once daily [6]. Subsequent Doppler ultrasounds were satisfactory and measurements of the EBKT were performed (Figure 4).

Follow up

Immunosuppression included basiliximab 20 mg on day 0 and day 4, tacrolimus 0.15 mg/kg twice daily, mycophenolate mofetil 600 mg/m^2 twice daily and rapid weaning of corticosteroids over

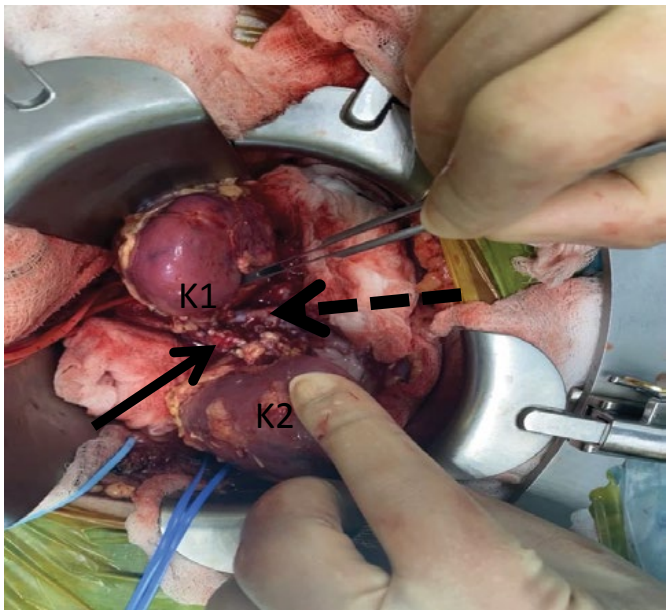

Figure 3: En-block kidneys after reperfusion. The aorta is illustrated with the straight arrow and the IVC with the dotted arrow. Kidneys are designated as K1 is the donor right kidney and K2 is the donor left kidney.

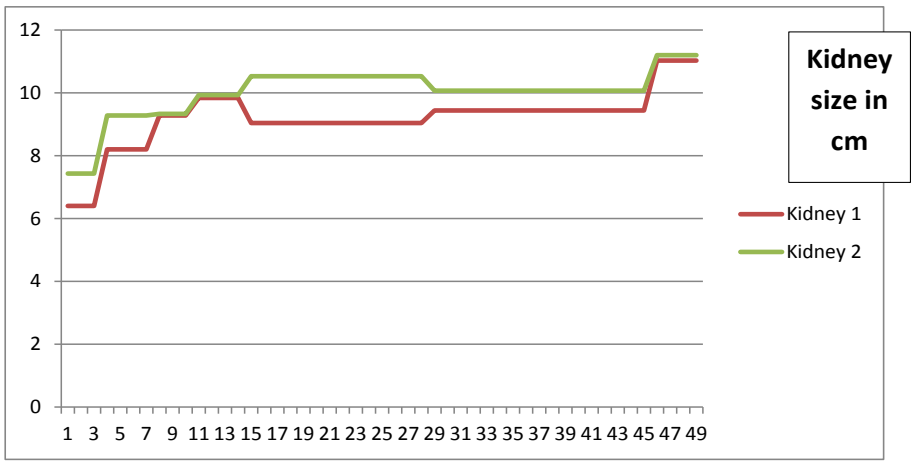

Figure 4: Kidney measurements (cm) at follow up ultrasound scans showing the increase in size during the first month post-transplant.

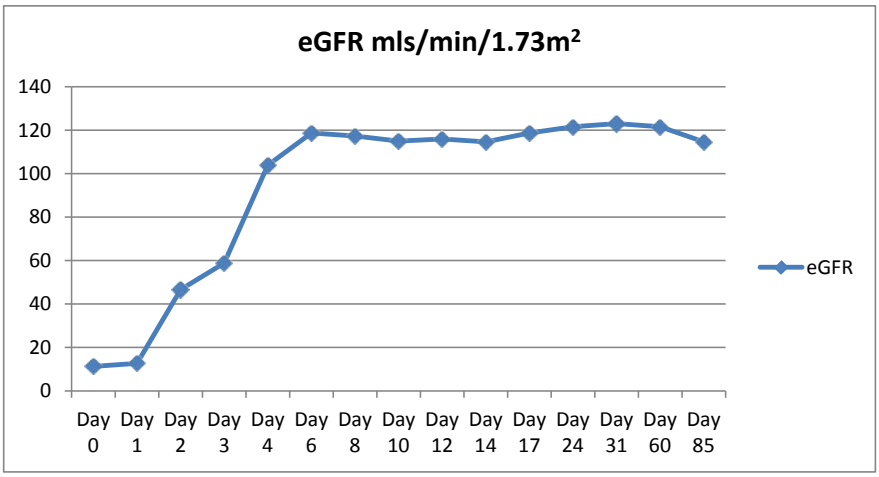

Figure 5: eGFR (mls/min/1.73m²) on the following days post-transplant.

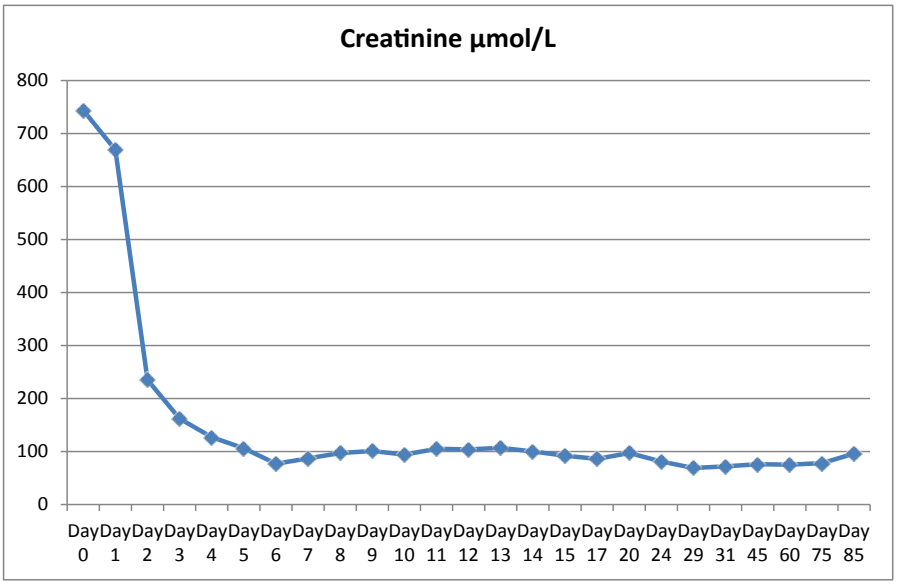

Figure 6: Creatinine (µmol/l) trend in the follow up days after transplantation.

five days. Both stents were removed 28 days after the surgery. The patient is followed up in the post-transplant clinic as per our follow up protocol showing satisfactory progress and stable renal allograft function (Figures 5 and 6).

RESULTS AND DISCUSSION

There is evidence showing that EBKT has better long-term outcomes compared with adult standard criteria deceased donor kidney transplant (DDKT) [7,8]. In the case of living donor kidney transplants (LDKT), the long-term outcomes between EBKT and LDKT are similar [9,10]. We have reported the use of En-Bloc kidneys from a multivisceral donor utilising the thoracic aorta as an extension and therefore being able to utilise both kidneys for an EBKT. This is the first report in the literature using this type of graft in order to preserve both kidneys with the aorta.

EBKT was originally developed to increase the transplanted nephron mass and to overcome the technical challenges of small calibre vessels in paediatric donors. While it has made the technical aspects of procuring and transplanting small paediatric kidneys easier, challenges are still present and surgical experience and technique has been shown to greatly affect outcomes [7,11]. It is important to highlight that EBKT can be procured from donors less than 15 kg with acute kidney injury [12]. Consequently, EBKT has become more widely accepted and has been extended to include donation after cardiocirculatory death (DCD) donors; [13] and infant donors <5 kg body weight [14].

The most common causes for early renal allograft failure are vascular complications, with reported rates of vascular thrombosis between 2.5 to 12.5% in small paediatric donors, considerably higher than thrombosis rates for standard adult donors [8,15,16,10]. Surgical technique, peri-operative blood pressure management, vessel calibre, vessel or kidney torsion, hypercoagulable states, haematomas, lymphocytes and acute rejection have all been suggested as causes for thrombosis [15,17]. The absence of an aortic patch during Single Kidney Transplant (SKT) in paediatric donors less than 12 months with EBKT is also a risk factor for renal allograft thrombosis.

Paediatric small kidney donors, 10-14 kg donors, should not be considered as marginal donors. The difficulty, however, is now in determining when it is more appropriate to perform a paediatric EBKT as opposed to splitting and performing two DDKT. Unfortunately, there are no widely accepted guidelines to direct clinicians but instead based on earlier registry analysis, less than 5 years or 20 kg is being crudely used as the cut-off where EBKT

is preferential to SKT [18]. Paediatric donors less than 15 kg demonstrated no significant outcome difference transplanting en-bloc compared to SKT in one-year survival [15].

Renal allograft survival of ideal standard criteria donors was similar from DDKT from donors weighing >35 kg and EBKT from donors >10 kg. Donor weights between 10-14 kg performed as EBKT had superior outcomes over standard criteria donor kidneys. However, the protective benefit was less than half as compared to single kidney transplants. Authors concluded that from a resource perspective, splitting kidneys from donors 10-14 kg would increase the availability of organs and overall total graft survival years to the recipient population [16].

Renal allograft failure is a major concern for all paediatric donors, EBKT or SKT, with most single centre studies and transplant registries reporting early renal allograft failure at higher rates than those of standard adult donors. After approximately 12 months post-transplant, survival outcomes with EBKT equal that of SCDT, with studies showing superiority of EBKT over living donor kidneys [8,10].

The use of EBKT has gained growing acceptance with favourable outcomes, patients receiving such allografts have an increased incidence of vascular thrombosis [14,8,19]. Renal Ultrasonography (US) is the reference standard for post-operative evaluation of renal transplant recipients and is usually performed early after transplantation. Post-operative ultrasound involves evaluation of peri-transplant fluid collection, spectral analysis of the donor aorta, inferior vena cava, renal arteries, and veins and intrarenal arterial Resistive Indexes (RI) of each kidney [20].

Previous research on intrarenal arterial RIs and on transplanted arterial velocity has been focused largely on the clinical importance of elevated RIs and velocity. The list of differential diagnoses for increased RI in the immediate postoperative setting includes venous thrombosis [21].

Thrombosis does not necessarily occur at once at a discrete time point. Rather, it may have to be regarded as a continuous process that evolves throughout a definite time span [20]. The initial thrombotic event may occur at the level of the capillaries or venules before propagation into the main arteries or veins [22]. It is also considered that decreased RIs, is associated with a higher rate of thrombosis [20].

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Non-selective use of antiplatelet and anticoagulation medication may decrease the risk of developing thrombosis [23,24]. However, post-operative antiplatelet and anticoagulation medication can increase the risk of haematoma development, reoperation, and transfusion requirements [24].

Previous studies have suggested that paediatric EBKT should be performed for donors <10 kg whereas single kidneys for use in two recipients is appropriate when the donor is >20 kg in size [25,16,26]. However, donors weighing between 10 and 20 kg represent an undetermined area in achieving the proper balance between utilisation and outcomes [27,28]. In a large retrospective UNOS registry analysis of donors <10 years of age from 1995-2007, reported that kidneys from donors with a 15-19, 10-14 and <10 kg body weight were used for EBKT in 40%, 65% and 86% of adult recipients [16]. In a subsequent UNOS registry analysis of donors <10 years of age span 1987-2007, it was reported that kidneys from donors with a 10-13, 13-15, 15-20 and >20 kg body weight were used for EBKT 64%, 49%, 24% and 4% of adult recipients [29]. In addition, they noted that although paediatric EBKT functioned better than single kidneys for all paediatric donor weight groups studied, acceptable graft outcomes could be achieved with single KT from donors >10 kg because the graft failure risk declined above this donor size.

It was considered that the risk of renal allograft failure may be higher when transplanting kidneys from small paediatric donors into paediatric recipients [25,16,30,15,10]. However, recent studies demonstrate improving results as size-matching between donors and recipients from a functional and growth perspective [14,31].

This case is particularly important since the use of an aortic extension on the proximal aorta has never been described before in the literature. The only description in the literature in the case the kidneys are procured en-bloc in multivisceral donors requiring a graft on an aortic patch including the SMA and coeliac axis origins. It has been described before by using a 1 cm segment of the distal abdominal aorta, opened it longitudinally, and fashioned a single aortic patch with which the proximal aorta was closed [32]. However, in this case the 1 cm required aorta was obtained from the aortic arch; this way the infrarenal aorta could be kept long enough to successfully perform the anastomosis. The availability of the distal abdominal aorta and IVC for inflow and outflow confers better graft positioning rather than short vascular cuffs. It is important to highlight the importance of using autologous aorta compared to using venous grafts, in order to prevent aneurysmatic vein dilatation and rupture after long-term exposure to arterial pressure [33-39].

CONCLUSION

Recipient selection and donor assessment is a cornerstone to success in KT from small paediatric donors. We demonstrate the feasibility of the en-bloc procedure and the use of an aortic extension as an alternative for vascular reconstruction with good outcome. The retrieving team should be aware of the potential reconstruction challenges, especially in the case of multi-visceral donors.

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