Surgical Craft

Surgical illustration of *en-bloc* (dual) kidney transplant from a 16-month old brain-dead donor to an adult recipient

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ABSTRACT

Transplantable organs from pediatric donors have been contributing significantly to donor pool worldwide. Pediatric donors are excellent resources that should be procured whenever available, and with the recent increase in deceased donations in India, more pediatric donors will be available for organ harvesting. We share a rare instance of multi-organ harvesting from a 16-month old brain dead donor and implanting both kidneys *en-bloc* in an adult male, while liver went to a 4-year old child. The report provides the surgical illustration of salient steps of transplanting both kidneys from pediatric donor into an adult, in an en-bloc manner.

INTRODUCTION

End-stage renal disease (ESRD) is a worldwide problem and has an increasing trend in developing country like India, with a crude estimate of ESRD incidence of 151–232 per million population. It is estimated that the need for dialysis is increasing at 10–20% per year.[1] Currently, majority of the transplantable organs are from live-related donors and cadaveric renal transplant rate is only 0.34 per million population per year.[2] As per the deceased donation statistics,[2] a total of 1150 organs were retrieved from 411 multi-organ donors in 2014, resulting in a national organ donation rate of 0.34 per million population per year.

Pediatric kidney allografting to an adult recipient is an established technique and allows utilization of allografts that were previously abandoned and wasted. Pediatric kidneys were first transplanted to an adult recipient using *en-bloc* kidney technique (EBKT) in 1972,[3] and later in 1990, single paediatric kidney transplant (SPKT) in adult was done successfully.[4] While some authors favor single paediatric kidney transplant (SPKT) in view of technical ease and benefiting two recipients,[5] others support EBKT to decrease the chances of hyperfiltration injury and vascular complications.[6,7]

We describe the surgical steps of a successful *en-bloc* kidney transplant from a 16-month old pediatric donor to an adult recipient.

CASE REPORT

Donor details

The donor was a 16-month old male child (blood Group A positive) who sustained head injury due to fall from height. Consent for organ retrieval was obtained from the parents after brain death certification by the appropriate committee. Abdominal sonography did not reveal any significant injury to visceral organs. The right kidney measured 5.3 cm and left kidney measured 5.2 cm longitudinally. At the time of donation, the donor was hemodynamically stable, was not on any inotropic support, and had urine output of about 20–30 ml per hour.

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Recipient details

Ideally, a pediatric recipient would have been preferred, but the pediatric patient in our waitlist was rejected due to unevaluated cervical lymphadenopathy and bilateral hydroureteronephrosis. A 42-year old male who had been on maintenance hemodialysis for 2 years was found fit for transplantation.

Procedure details

The hepatobiliary surgery team retrieved the liver after transecting the aorta and vena cava just above the origins of the renal arteries and drainage of renal veins, respectively [Figure 1a]. Following this, both the kidneys were retrieved *en-bloc*. Infrahilar aorta and vena cava were divided at the level of their branching into the iliac vessels, and both ureters were dissected till their entry into the bladder [Figure 1b]. There was grade I left renal injury, which was not evident on preoperative ultrasound. Bench preparation included the closure of suprarenal transected aorta and cava [Figure 2a] using 6-0 polypropylene suture. All the branches of the aorta and vena cava were ligated except for the renal blood supply [Figure 2b]. *En-bloc* graft was again perfused through the aorta to ensure no leakage through any untied branch, particularly the lumbar vessels.

The right iliac fossa of the recipient was prepared using a modified Gibson incision. The extraperitoneal space was developed and the external iliac vessels were prepared for anastomosis. The *en-bloc* graft was made to rest on the right psoas muscle and the graft venacava was anastomosed terminolaterally to the recipient external iliac vein using 6-0 polypropylene suture. The graft aorta was also anastomosed terminolaterally to the right external iliac artery using 7-0 polypropylene suture. Intravenous heparin was administered just prior to opening the vascular clamp. Both the ureters were anastomosed separately into the bladder using modified Lich-Gregoir technique over double-J stents [Figures 2c and 3].

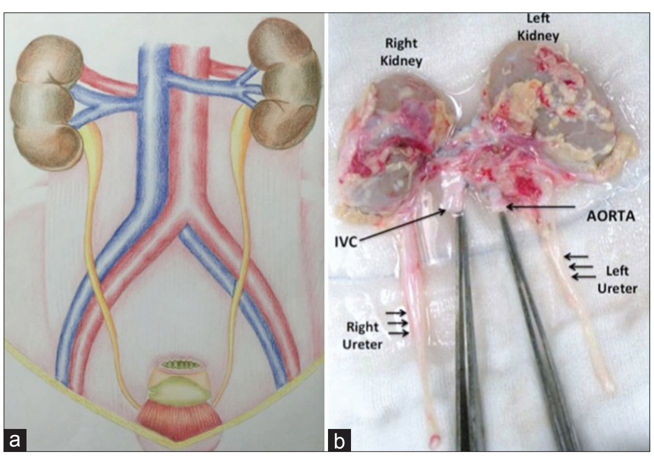

Figure 1: (a) Diagrammatic representation of the donor, after liver was harvested after transecting aorta and vena cava just above the origins of renal arteries and drainage of renal veins, respectively. (b) *En-bloc* harvest of both the kidneys with donor aorta and inferior vena cava and both ureters up to bladder

Postoperative management

The patient was nursed in a dedicated transplant intensive care unit. Allograft status was followed by daily urine output, twice daily serum biochemistry/hemogram, and color doppler studies, in addition to clinical details. He received daily subcutaneous low molecular weight heparin, intravenous infusion of albumin (5%) at 10 cc/h. All attempts were made to prevent dehydration and thereby thrombosis of graft vessels. Fluids and electrolytes were managed based on the daily assessment of clinical and laboratory parameters.

RESULTS

On release of clamps, both the kidneys became pink and turgid. There was good thrill in the graft aorta and both renal arteries with good urine output from both the ureters. The total ischemia time was 267 min. Total operative time was 170 min. Total blood loss was approximately 150 ml. Both the kidneys were well perfused as evident on intraoperative doppler done before closure [Figure 4]. Daily urine output increased from about 5000 ml/day on the postoperative day (POD) 2 to about 16,000 ml/day on the POD 7. Serum creatinine gradually declined and stabilized to 1.4–1.5 mg/dl on the POD 12. Doppler showed normal graft flow pattern and resistive index value of 0.6–0.7 in both graft kidneys. Both the graft kidneys grew from 5 to 5.5 cm preoperatively to 6.5–7 cm by POD 12 [Figure 5]. The Foley's catheter was removed on the POD 8 and drain was removed on the 10th POD. The patient was discharged on POD 12. The patient has been on regular follow-up,

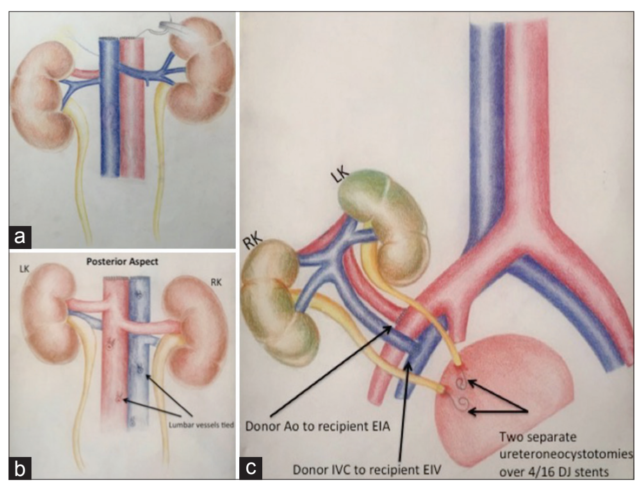

Figure 2: (a) Bench preparation, closing the cephalic ends of both aorta and inferior vena cava. (b) Bench preparation, posterior aspect of harvested kidneys, all the branches were suture tied. RK: Right kidney, LK: Left kidney. (c) Diagrammatic representation after the *en-bloc* transplant is complete. Ao: Aorta, IVC: Inferior vena cava, EIA: External iliac artery, EIV: External iliac vein

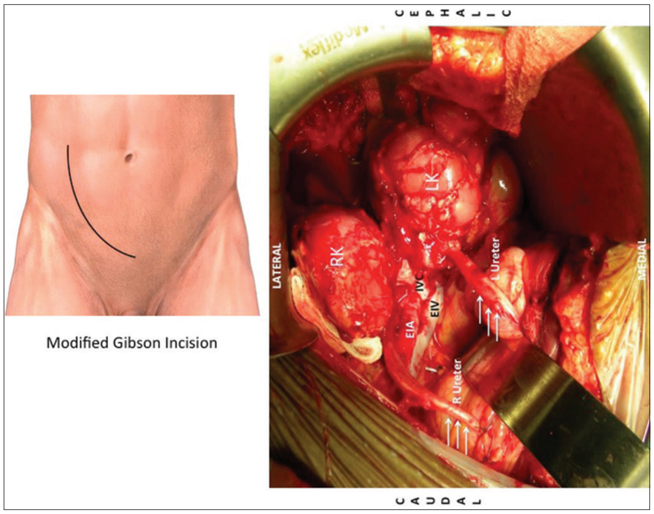

Figure 3: Intraoperative photograph of completed *en-bloc* transplant

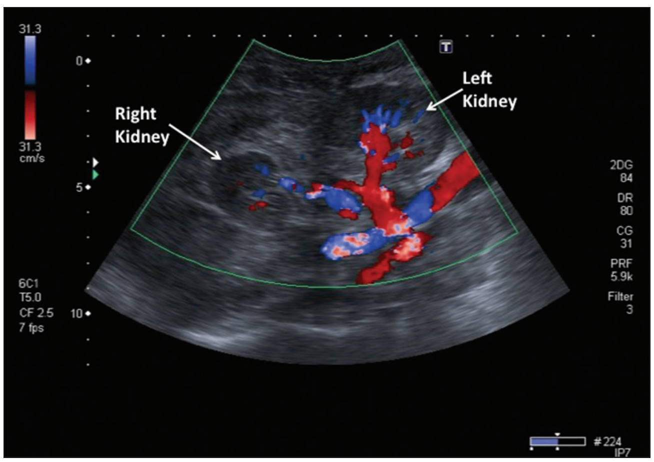

Figure 4: Intraoperative Doppler showing well-perfused both the kidneys

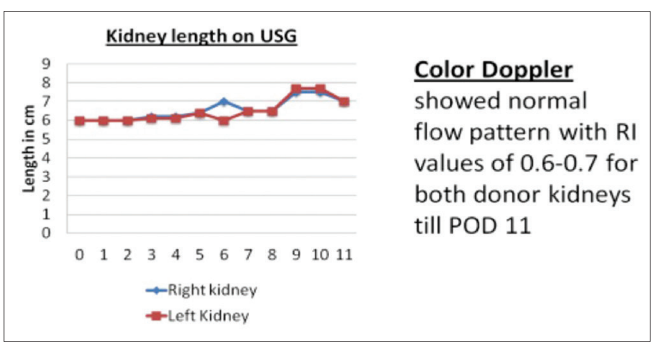

Figure 5: Graph showing increment in the lengths of both the kidneys on serial sonography

and now, at 1-year follow-up, his serum creatinine is 0.83 mg/dL, glomerular filtration rate (GFR) is 71.52 ml/min, and each kidney measures 8.2 cm on sonography.

DISCUSSION

Pediatric deceased organ donation can help in increasing the organ pool in countries with high organ demand like India. However, the status on how to best utilize the cadaveric pediatric kidney is still not very clear. The problems faced while utilizing the pediatric cadaver kidneys include minimum age for accepting the pediatric kidney, whether to perform pediatric SPKT or EBKT, whether to prefer pediatric recipient or adult recipient that too in the absence of well-defined organ allocation policy, complications and outcome following pediatric donor kidney transplant and optimal immunosuppression for the pediatric kidney recipients.

Historically, pediatric recipients were preferred for pediatric renal donors; however studies showed increased incidence of graft loss due to thrombosis in these cases.[8] These results encouraged the use of pediatric donor kidneys for adult recipients. However, a few authors reported the suboptimal outcomes in these subgroup of transplants and attributed these results to probable hyperfiltration injury to graft kidneys.[9,10] In a retrospective comparative study of 66 EBKT from pediatric donors and 434 adult kidney transplants (AKT), the authors reported a similar 1 year (83.3% vs. 89.2%) and 5 years (81.1% vs. 84.6%) graft survival rates, respectively ($P = 0.56$).[11] The recipients in both the groups were age matched. Similarly, Hobart *et al.*[12] in their study of 33 pediatric EBKT and 33 AKT found equivalent 3-year graft survival of both the groups (87.3% vs. 84.2%, respectively, $P = 0.35$). Hernández *et al.*[13] in their study of 73 EBKT and 497 AKT reported similar outcomes in terms of long-term graft survival. In a published report of the United Network for Organ Sharing (UNOS) database analysis (1988–1995), the overall 5-year graft survival rate was poorer in pediatric kidney donor group compared to adult kidney donor group.[6] However, further long-term analysis of the UNOS database (1988–2006) reported superior 10-year graft survival rates of pediatric kidney donors over adult standard criteria donors despite higher graft loss at 1 year in pediatric donors.[14] These results have shown good graft survival outcomes of pediatric kidney donors, and they should not be considered marginal donors.

EBKT was developed to increase the overall nephron mass, to decrease the chances of hyperfiltration injury, and to reduce the difficulty of vascular anastomosis. Both, Bresnahan *et al.*[6] and Bhayana *et al.*,[14] in their long-term UNOS database analysis, showed that in the age group of <5 years, despite higher incidence of early (6 months) vascular thrombosis in EBKT group, the overall graft survival outcome was superior in EBKT group compared to single pediatric kidney donors (SPKT). These results led to policy of EBKT for pediatric donors younger than 5 years of age and SPKT for elder donors. Kayler *et al.*[15] reported a similar graft survival outcome with EBKT in donors weighing up to 10 kg and better graft survival with EBKT in donors weighing 10–34 kg, when compared to standard criteria donors. Their study concluded EBKT for donors up to 34 kg and SPKT for donors more than 35 kg. Although these studies have shown superior results of EBKT for donors <5 years and 34 kg, many authors have proposed that the combined results of both the kidneys in SPKT will outnumber the superior outcome of EBKT and will benefit two recipients rather than single recipient in EBKT. Therefore, the decision to perform EBKT or SPKT should be based on the waiting list at the center and the expected survival of the recipients.

Irrespective of the type (EBKT or SPKT), there are higher chances of vascular thrombosis after pediatric kidney donor transplant. Bhayana *et al*.[14] reported 10% graft thrombosis after pediatric donor kidney transplant in the age group of 0–5 years. This risk had dissipated by the time of the 5-year follow-up examination (1.1 vs. 1.6 mg/dl, $P = 0.14$). Out of 33 EBKT, Hobart *et al*.[12] reported vascular thrombosis in 6 recipients (18%). Contrary to conventional thinking, routine use of anticoagulation has not shown to decrease the incidence of vascular thrombosis.[11,16] However, in our case, we anticoagulated the patient with low molecular weight heparin for 2 weeks posttransplant.

Other factors which may have an effect on the pediatric kidney transplant outcome include optimal recipient BMI and age and optimal immunosuppression protocol. Currently, there is no well-defined immunosuppression strategy for the recipients of pediatric kidneys. Hobart *et al*.[12] used same immunosuppression protocol for EBKT group ($n = 33$) and AKT group ($n = 33$) and reported similar rate of rejection (acute and chronic), delayed graft function, and long-term graft survivals. Other authors[13,14] have also reported similar rejection rates[14] and similar graft survival outcomes using similar immunosuppression protocols, for both pediatric and adult kidney donor groups. Many studies have discredited the theory of hyperfiltration injury to small nephron mass of pediatric kidneys in an adult recipient. A compensatory hypertrophy of pediatric kidney to reach adult size is seen by 18 months posttransplant and the GFR of pediatric kidney is significantly higher than adult kidney by the 50th month.[14] A single-center, prospective study from Norway,[17] of 19 adults who received pediatric kidneys, reported a 65% increase in volume of graft at 1-month posttransplant and a substantial 2.6-fold increase from baseline at 1-year ($P < 0.001$). They concluded that pediatric kidneys when transplanted into adults have substantial potential for growth and improvement of function during the 1st year. Many authors concluded that the allocation of pediatric kidney should not be based on age and weight of recipient.[12,14,18] Indian experience, in this regard, is limited to a single case published by Modi *et al*.[19] They reported successful EBKT from a 5-year old brain-dead donor to a 42-year old female. At 2.5 years follow-up, each kidney measured 11 cm and an estimated glomerular filtration rate of 88 ml/min/1.73 m^2 was impressive. This estimated GFR is a rarity in any SPKT whether living donor or deceased donor, adult or pediatric. The technical details and the outcome, in this case, were instrumental in our decision to attempt EBKT in present case, the youngest brain-dead donor from India.

CONCLUSION

The present report demonstrates the surgical steps involved in *en-bloc* dual kidney transplant from a pediatric donor into an adult recipient. Surgical illustration will encourage the readers to attempt this procedure when they are faced with a similar situation.

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