Split-graft technique in neonatal heart transplant for aortic atresia

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Abstract

We describe a neonate with aortic atresia and hypoplastic aorta, listed for heart transplant after extracorporeal membrane oxygenation resuscitation and ductal stenting. The donor aorta was detached from the graft, after an isolated arch reconstruction prior to the transplant itself in a routine fashion. To the best of our knowledge, this is the first reported case of neonatal arch reconstruction before transplantation performed with grafts from the same donor in a split-way strategy.

Keywords: Transplantation • Congenital • Neonate • Hypoplastic heart • Aortic arch • Split

CASE REPORT

A 3.2 kg male child was born with the diagnosis of aortic atresia, ventricular septal defect, balanced ventricles and 1.5 mm hypoplastic ascending aorta. On Day 2, he collapsed due to retrograde arch obstruction and was resuscitated with extracorporeal membrane oxygenation (ECMO) (right carotid and jugular vessels, centrifugal pump). The ductus was stented and both pulmonary branches were banded, prior to ECMO retrieval after 6 days of circulatory support, with a step-up on inotropes (milrinone plus adrenaline). Because the contractility was grossly affected, a Norwood technique was ruled out and the patient was listed for heart transplant. After 32 days (weight 3.2 kg, height 49 cm, body surface 0.2 m²), a heart from a 14-month old donor weighing 12 Kg became available. Both donor and recipient were O(+) blood type. The patient was cannulated through the pulmonary artery for the arterial return (the first supra-aortic vessel was discarded because of the previous neck ECMO approach) and both vena cavae for venous return, and cooled down to 18°C. On the arrival of the harvesting team, the graft was checked and a segment of the ascending aorta that included the entire arch was removed, keeping the heart again in cold solution to maintain the cold ischaemia period. Back to the surgical field, in a brief period of circulatory arrest, the arterial cannula was removed, and the donor aorta was detached from the graft, after an isolated arch reconstruction prior to the transplant itself in a routine fashion. To the best of our knowledge, this is the first reported case of neonatal arch reconstruction before transplantation performed with grafts from the same donor in a split-way strategy.

Trimming its second and third vessels to match the opened arch in the recipient for the next anastomoses (graft-arch to recipient-arch). Finally, the arterial cannula was again removed from inside the ‘new’ arch and secured to the first aortic-graft vessel which happened to be a side-arm for cannulation. A cross-clamp was applied to the base of the new ascending aorta and circulation was resumed. The heart was removed and the transplant followed in a routine fashion, with sequential anastomoses of the left atrium, inferior vena cava and ascending aorta. Pulmonary artery and superior vena cava anastomoses were completed after releasing the aortic clamp. Extracorporeal circulation lasted for 372 min, whereas total ischaemia was 157 min. The lapse of time between cardioplegic delivery and aortic clamp removal, defined as hot ischaemia, was 64 min. Due to the mismatch between donor and recipient weight, the chest was left open and finally closed after 5 days. He was extubated on the 25th postoperative day. Six months later, the patient is doing well (Videos 1 and 2). Transplant for hypoplastic heart was first described by Bailey et al. [1] in 1986. Several groups adopted this strategy [2] which was then overtaken because of the scarcity of donors and improvements in the management of the Norwood pathway. On the other hand, transplants in univentricular patients pose a unique challenge [3] in reconstructing vascular structures, either after Norwood, Glenn or Fontan procedures. Several strategies have been described to overcome these hurdles which, undoubt- edly, add technical difficulty and ischaemia time to the procedure. Our patient presented a hypoplastic aorta, ductal stenting, left subclavian artery arising from the coarctation site and aberrant right subclavian artery as a fourth supra-aortic vessels coming off the descending aorta. The right carotid artery had been previously handled (neck ECMO) and a Norwood procedure was ruled out because of poor ejection fraction. A standard anastomosis between the donor aorta and the recipient in a Norwood-like approach...
Figure 1: (A) Hypoplastic arch with four supra-aortic vessels. Stent in ductus and bilateral banding. RC: right carotid; LC: left carotid; LS: left subclavian; ARS: aberrant right subclavian. (B) Sequential cutting of ascending aorta, ductus and descending aorta. Ductal tissue removed (including stent and origin of left subclavian artery). (C) Recipient-arch undersurface opened to create a patch. Mouth fashioned in the donor arch after trimming the second and third supra-aortic vessels, so as to match the recipient’s arch. (D) Final result with anastomoses in the descending aorta, arch and ascending aorta (arch to graft).

Figure 2: (A) Retrograde aortic injection showing diminutive ascending aorta (AA), right carotid artery (RC), left carotid artery (LA), left subclavian artery (LSA), descending aorta (DA), ductus (D) and aberrant right subclavian artery (arrow). (B) Postoperative echography (supra-sternal view) showing good patency and gradient-free aortic arch reconstruction.
fashion (either with autologous or with heterologous material) would have been a time-consuming, circulatory-arrest procedure sacrificing both subclavian arteries. Instead, a graft-arch to recipient-arch without circulatory-arrest strategy respected the anatomy albeit two anastomoses were necessary. Attention was paid to the ischaemia time, leaving the graft in cold bag while addressing the arch to keep the ischaemia cold [4] rather than hot. Again, the standard approach (left atrial first, aorta second or third anastomoses) would have rendered the whole period of ischaemia on the hot rather than on the cold side. The Melbourne group [5] reported three patients with arch reconstruction simultaneous to heart transplant after failed Fontan. They replace the whole arch by synthetic material in two patients and with donor tissue in the third one. Their 2-fold message is addressing the anatomical reconstruction prior to transplantation and keeping the ischaemia time as accurate as possible. Our case fits nicely in this philosophy because we could manage the arch before the transplant and kept the hot ischaemia time short. On top of that, the growth potential is guaranteed because of the same donor graft, and arch distortions are less likely to develop in an end-to-end anastomosis rather than a long-spatulated Norwood-like suture. We think that our split-graft technique for addressing the hypoplastic and stented arch is simple and reproducible in neonates and infants, saves hot ischaemia time and yields good results in the short-medium term.

Conflict of interest: none declared.

REFERENCES