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Masters of Cardiothoracic Surgery

Thoraco-abdominal normothermic regional perfusion in donation after circulatory death heart transplantation: a bridge from DCD to "DBD-like" donation

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Clinical vignette

A 55-year-old man with no past medical history was admitted to a peripheral hospital with extensive intracranial bleeding from severe brain injury. Despite maximal therapy, the prognosis was considered extremely poor and further interventions futile. He did not fulfill brain death criteria, but the family expressed willingness for organ donation. He was transferred to our hospital for donor evaluation after circulatory death (DCD).

After donation consent, evaluation confirmed donation suitability and the donor was transferred to the operative room (OR) to commence withdrawal of life sustaining therapy (WLST).

Surgical techniques

Preparation

In the OR, the donor underwent hemodynamic monitoring using two invasive arterial lines (right femoral artery, right radial artery), Swan-Ganz (SG) catheter, near-infrared spectroscopy and transesophageal echocardiography (TEE). The donor was connected to an electrocardiograph (ECG) and prepped for surgery.

To shorten ischemic time, our surgical team isolated the left femoral vessels to be used for thoraco-abdominal normothermic regional perfusion (TANRP) after declaration of death. Two 8Fr introducers were inserted in the isolated femoral artery and vein and two wires positioned under TEE guidance.

Withdrawal of life sustaining therapies

The donor was extubated and when systolic blood pressure (BP) reached 50 mmHg, 300 UI/kg of heparin was injected. Following asystole, ECG was started for 20 minutes, as required by our national legislation (1). This stand-off period varies worldwide: from 2–10 minutes in the United States, to 5 minutes in the majority of European countries, 10 minutes in Ireland and Portugal, 20 minutes in Italy, and 30 minutes in Russia (2).

Operative technique

After declaration of death, one surgical team cannulated the donor while a second surgical team opened the chest and clamped the innominate, left common carotid, and left subclavian arteries to exclude cerebral circulation. TANRP was commenced through a cardio-pulmonary bypass (CPB) machine aiming for a flow index of ≥2.5 L/min/m^2 at a temperature of ≥35 ℃. A leukocyte filter and a CytoSorb® filter were added to the CPB circuit to reduce

ischemia-related inflammatory burden. The donor was re-intubated and ventilated. The total warm ischemic time (WIT), defined as the time from WSLT to reperfusion, was 40 minutes and the functional WIT (fWIT), defined as the time from systolic BP falling below 50 mmHg and/or peripheral oxygen saturation less than 75% following WLST till reperfusion, was 37 minutes. Shortly after coronary reperfusion, the heart started beating and progressive improvement of biventricular contractility was evident. A vent was placed through the pulmonary artery to decompress the cardiac chambers and TANRP was continued for 90 minutes with evidence of hemodynamic stability. Subsequently, the pulmonary vent was stopped and CPB weaned allowing a sort of DCD to "donation after brain death (DBD)-like" transition.

During the reperfusion time (both on TANRP and beating heart alone), blood tests were performed hourly to monitor lactates, creatine phosphokinase-MB (CK-MB), troponin I, myoglobin, liver and kidney function. After 60 minutes of evaluation in the DBD-like setting, with hemodynamic stability, the graft was considered suitable for transplant by multiparametric assessment using direct vision, TEE imaging, SG parameters and laboratory tests. Acceptance criteria for transplantation included cardiac index >2.5 L/min/m^2, central venous pressure <10 mmHg, pulmonary artery capillary pressure <12 mmHg, and mean arterial pressure >60 mmHg with normal cardiac function confirmed using TEE. The abdominal team proceeded with liver and kidney preparation while our team evaluated the lung grafts confirming lobar pneumonia that contraindicated transplantation use. The recipient, a 60-year-old man suffering end-stage heart failure due to idiopathic dilatative cardiomyopathy, was transferred to the OR and prepared for surgery, as during the beginning of the first experiences of heart transplantation (3).

Completion

To reduce the second cardiac graft ischemic time, the donor's aorta was cross-clamped after almost 120 minutes of DBD-like condition, once the recipient was ready for implant. The graft was arrested with blood cardioplegia administered for 5 minutes at 150 mL/min. The heart graft was retrieved in standard fashion and transferred to the adjoining theater for transplantation. The graft was re-flushed with blood cardioplegia every 15 minutes during transplantation. After 76 minutes of cold ischemia time, once reperfused, the heart immediately started beating in sinus rhythm and CPB was successfully weaned on inotropic support as per protocol (5 µg/kg/min of dobutamine).

Brief clinical outcome

Once in intensive care the recipient was extubated and transferred to the ward after two days. Post-operative course was uneventful, and the patient was discharged on post-operative day 16. Predischarge echocardiogram showed left ventricle ejection fraction of 65% and normal right ventricle and valvular function. At 8 months follow-up, the patient continued to do well. Outpatient echocardiographic and right heart catheterization findings confirmed normal graft function.

Comments

To date, four techniques for DCD donor heart retrieval and preservation have been described: (I) direct procurement and cold storage transportation (DP-CS) (4), (II) direct procurement followed by normothermic machine perfusion (DP-NMP) (5), (III) normothermic regional perfusion followed by normothermic machine perfusion (NRP-NMP) (6), and (IV) normothermic regional perfusion followed by cold storage (NRP-CS) (7). Due to the 20-minute stand-off period required by our legislation, we believe that TANRP through the femoral vessels [either with CPB or extracorporeal membrane oxygenation (ECMO)] is crucial for DCD donation in Italy. Main advantages of TANRP are prompt organ reperfusion and the possibility of reliable organ evaluation that is mandatory in case of prolonged ischemic times. However, the main drawbacks are increased complexity of the whole donation process requiring advanced technologies, specific competencies and ethical concerns related to potential cerebral reperfusion. Pre-mortem testing and procedures vary worldwide, depending on national legislations. For these reasons, it is difficult to define a standardized protocol applicable to all scenarios.

Conclusions

This case is part of a larger DCD heart transplantation experience in Italy encompassing nearly 20 cases-to-date. Our single-center experience, although limited to six patients currently, is encouraging and supports a

20-minute stand-off period and WIT exceeding 30 minutes not being limitations for heart donation. More data in a larger population of patients and longer follow-up are necessary to confirm the safety and efficacy of DCD heart transplantation with prolonged WIT.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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