Procurement of heart and heart-lungs block with simultaneous abdominal
normothermic regional perfusion

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Central Picture Legend:
Isolation of azygous vein in emergency

Central Message:
A priority-based stepwise approach helps conserve the blood and avoid blood loss in a procurement of donor heart and lungs in a donation after circulatory death in combination with abdominal NRP.
Abdominal normothermic regional perfusion (A-NRP) is increasingly used during donation after circulatory death (DCD) due to encouraging outcomes in liver transplantation [1]. However, simultaneous retrieval of the donor heart and lungs poses a challenge due to bleeding in the chest. It causes loss of volume in the A-NRP circuit leading to unstable flow potentially compromising perfusion of abdominal organs. Time spent in controlling bleeding in the chest may delay procurement of thoracic organs leading to increased warm ischemia time, a chance of declining the organs and higher incidence of primary graft failure. A stepwise approach based on the priority of organ preservation helps conserve the blood and avoid blood loss (See Figure 1).

Following circulatory death and 5 minutes of no-touch period, the donor organ procurement is begun.

Heart only retrieval

Priority 1: Donor hearts retrieved after DCD are assessed with the ex-vivo platform- Organ Care System (OCS) that requires priming with approximately 1.2L of donor blood. It is drained into a blood collection reservoir through a cannula introduced into the right atrium (RA). The cannula is put through a purse string that is tied after blood collection to prevent blood loss after removal of the cannula. The absence of coronary artery disease is checked before blood collection to avoid blood loss in case the heart is not suitable for transplantation.

Priority 2: It is essential is to make the donor ‘NRP ready’ by clamping the descending thoracic aorta and introducing a DLP cannula into the arch to ensure a lack of cerebral perfusion.

Priority 3: Isolation of azygous vein is carried out by opening the right pleura and accessing the vein superior to the right hilum. It is either ligated, stapled or liga-clipped.

Priority 4: Cardioplegia resuscitates the arrested heart and it is an utmost priority after above steps. In preparation of cardioplegia, the ascending aorta is clamped proximal to the arch-
venting-DLP and a cardioplegia cannula is introduced proximal to this clamp. Cardioplegia cannot contaminate A-NRP circuit through IVC and it also needs venting. This is achieved by clamping the IVC above the diaphragm and opening the IVC above this clamp.

**Priority 5:** However, before cardioplegia delivery, it is crucial to collect blood from the chambers of heart and lungs. It is done by venting-

(i) IVC between the clamp and the RA that drains the right heart and supra-diaphragmatic body,

(ii) left superior pulmonary vein that drains blood in the post-capillary pulmonary circulation, and

(iii) left pulmonary artery that drains blood from pre-capillary pulmonary circulation.

Blood is collected into the blood collection reservoir mentioned above. A 1.2L of this blood is used for the OCS priming while the rest is returned to the A-NRP reservoir as required. Once the blood is collected, the cardioplegia is delivered along with a topical cooling. The donor heart is procured by cutting the left atrium, pulmonary veins, IVC, SVC, pulmonary artery and the aorta. The pulmonary arteries and pulmonary veins can be individually staple-cut to prevent bleeding following cardiectomy.

While performing above steps, the A-NRP can be commenced anytime after clamping of the descending thoracic aorta and introducing DLP into the arch.

**Tip 1:** Calming of the IVC 10-15 seconds after its commencement of the A-NRP allows drainage of the supra-diaphragmatic body and right-sided chambers of the heart into the A-NRP reservoir. Therefore, the IVC clamping should be delayed until the abdominal team commences the A-NRP as long as it happens before the delivery of the cardioplegia.

Cardioplegia should not be delayed for the A-NRP to start.

**Tip 2:** If the azygous vein could not be ligated before commencement of the A-NRP, it is isolated by clamping the superior venacava (SVC) at two places- near its junction to RA and
near its junction with the innominate vein (Figure 2). It avoids delay in commencing A-NRP and cardioplegia delivery. The azygous vein can be later on dissected and ligated at the time of cardiectomy.

**Heart-lung retrieval**

Initial steps of blood collection for the OCS priming and clamping of major vessels in the chest remain similar to the ‘heart only’ retrieval; however, with lungs being procured for transplantation the blood is vented through left atrial appendage and the distal main pulmonary artery trunk. Following cardiectomy, the antegrade pulmonary perfusion is carried out before lung procurement.

**Discussion:**

Previously we have described the world’s first direct procurement of donor heart along with A-NRP [2]. In the present article, we present our refined technique with a focus on blood conservation. IRB approval and patient consent were not required. Azygous vein if not isolated may drain a significant volume of blood from A-NRP through the RA and internal jugular vein as shown in Supplemental Figure 1. The possibility of donor brain perfusion cannot be ruled out in case of inadequate isolation of the azygous vein and the SVC. As the facilitation of the A-NRP and the delivery of cardioplegia remains the priority, there may not be sufficient time to dissect and ligate the azygous vein. We recommend isolating the azygous vein by clamping the SVC at its junction to RA and near its junction with the innominate vein to facilitate the A-NRP and cardioplegia delivery.

Right side chambers of the heart, pre-capillary and post-capillary part of the lung vasculature must be drained by opening the RA, pulmonary artery and the left atrial appendage respectively. This blood is used in the NRP reservoir to maintain its circulatory volume and flow.
References:


Figure legends:

Figure 1: Priority-based stepwise approach

Figure 2: Isolation of azygous vein in emergency

Suppl Fig 1: Bleeding due to inadequate isolation of azygous vein
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