

A technique for rapid control of distal aorta in donation after cardiac death procurements

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Donor shortage continues to be the critical limitation in organ transplantation. Following the recent dissemination of details on the 'super rapid' technique in donation after cardiac death (DCD) procurement [1], DCD livers are increasingly being used. However, the use of DCD livers is severely limited by donor warm ischemic time (DWIT), which should be limited to 30 min or less. The time from incision to aortic perfusion with cold preservation solution is critical. In this letter, we describe a technique to cannulate the distal aorta using a Babcock instrument to facilitate rapid and secured perfusion of the abdominal organs in a DCD procurement.

On arriving at the donor hospital, the procurement team prepares for and awaits the declaration of cardiac death by an independent physician attending to the potential donor. DWIT is defined as the time interval from the extubation to the moment of aortic perfusion with cold preservation solution [2]. After 2–5 min of stand-off, the procurement is started. With sharp dissection, the abdominal incision extending from xyphoid process to symphysis pubis is made with cruciate extensions bilaterally. The intestinal content is displaced laterally. The distal aorta is exposed, clamped distally, incised and cannulated (Fig. 1). A Babcock clamp is used to secure the neck of the cannula head. The Four Lead Arthroscopic Irrigation Set (Baxter 2C4031, 2.6-m long) is used for aortic perfusion. The perfusion with ice-cold University of Wisconsin (UW) solution is begun. The inferior mesenteric vein (IMV) is cannulated with 10-Fr or 14-Fr cannula for female or male donors, respectively. UW solution is perfused with a pressure head of 6-feet height. In the first liter of UW solution, 20 000 and 10 000 U of heparin is premixed in the aortic and IMV perfusions, respectively. Immediately, as the assistant provides cephalad bilateral traction on the rib cage, the diaphragm is sharply opened. The supradiaphragmatic aorta is cross-clamped. The right atrium is opened and venous efflux is drained into the chest cavity. Ice slush is poured into the abdominal cavity. In total, 3 and 2 l of cold UW solution is perfused into the aortic and IMV systems, respectively. No perfusion is performed on the back table. The gallbladder is drained and washed with ice cold saline. At the

completion of cold perfusion, the liver is harvested, packed, and transported in ice cold UW.

Our first DCD procurement was in December 1998. We previously presented our results of liver transplantation using DCD allografts [3]. We have always recorded the time from extubation to the aortic perfusion, but only since January 1, 2007, we have recorded the different time intervals of DWIT, including times from ventilator extubation to cardiac arrest, the hand-off period and the time from incision to hypothermic perfusion with aortic cannulation. From January 1, 2007 to August 11, 2007, 22 DCD procurements were performed, five by the author and the remaining 17 done by others. As shown in the Table 1, we observe the stand-off time, which ranges from 2 to 5 min. The time from the incision to the aortic cold perfusion is kept to a minimum, being 3.00 ± 2.00 min with the Babcock clamping compared with 5.94 ± 1.86 min ($P = 0.029$ by *t*-test) with the conventional technique. However, there is no difference in the overall DWIT (21.20 ± 8.53 vs. 26.06 ± 5.81 min, $P = 0.284$). Although not shown, there were no significant differences in peak levels of international normalized ratio (INR), alanine aminotransferase (ALT), and total bilirubin (T-Bil), or model of end-staged liver disease (MELD) scores between the two groups. This is consistent with previous results that as long as DWIT is <30 min and donor age <60, a DCD allograft should function well [3–5]. Therefore, the technique may increase the effectiveness of DCD procurement without an obvious influence on the allograft function.

To achieve minimal DWIT, the donor aorta must be cannulated for perfusion with cold preservation solution within the shortest possible period of time [4]. With the technique described in this report, knot tying is avoided. The time to apply the Babcock clamp is negligible. More importantly, it allows the surgeon to maintain full control of the cannulated aorta without additional movements required in knot tying. Similarly, following the cannulation of IMV, the cannula can be wrapped with either a suture or umbilical tape and secured with a hemostat instead of tying a knot. Although cold perfusion of the portal system is not universally performed [6,7], we have

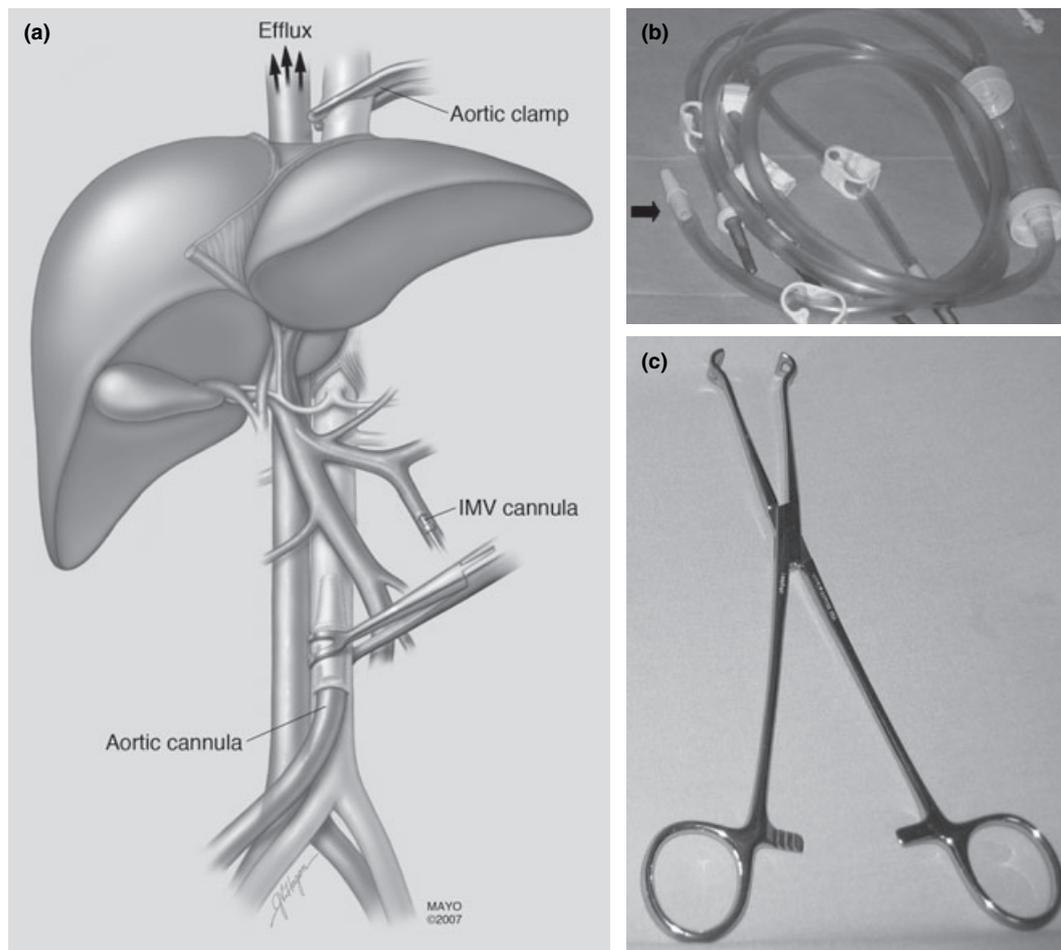


Figure 1 (a) Aorta is cannulated and secured with a Babcock clamp in a donation after cardiac death procurement. The inferior mesenteric vein cannulation is secured as seen to the left of the aortic cannulation. (b) The tip of the cannula is inserted into the aorta and the clamp is applied to the hard neck of the cannula (arrow). (c) A typical Babcock clamp that is used to secure the aortic cannula.

Table 1. Times from extubation to cardiac arrest, incision, and hypothermic perfusion of the aorta in donation after cardiac death procurements using Babcock clamp versus conventional technique with knot tying to secure the aortic cannula.

	Extubation to cardiac death	Hand-off period	Incision to cold perfusion*	DWIT (min)
Babcock clamp ($n = 5$)	13.80 \pm 8.17	4.40 \pm 0.89	3.00 \pm 2.00	21.20 \pm 8.53
Conventional ($n = 17$)	15.83 \pm 6.61	4.28 \pm 1.87	5.94 \pm 1.86	26.06 \pm 5.81

DWIT: donor warm ischemic time, in minutes, is the sum of the times from extubation to cold perfusion. The values are expressed as mean \pm SD.

* $P = 0.029$ by Student's t -test.

always cannulated and perfused the portal system in addition to the aorta. In the absence of evidence from a randomized-control study, we continue to perform both aortic and mesenteric vein perfusions.

Although at some donor hospitals, heparin may be given immediately before or at the time of withdrawal of the mechanical ventilator, this is not a norm. In our practise, in most cases, heparin is given at the time of the

hypothermic perfusion. We incorporate 20 000 U of heparin in the first bag of the cold UW solution for the aortic perfusion, and 10 000 U in the portal solution. Other approaches to the DCD organ perfusion include the use of low-viscosity solutions such as HTK and Marshall's solution and thrombolytic agents. However, the use of thrombolytic agents remains to be investigated [4].

In conclusion, the technique described in this article allows for a secure and effective approach to the aortic cannulation for organ procurement from a DCD donor. The ease and effectiveness of the technique may promote confidence in DCD procurement, which may lead to an increase in DCD organ utilization.

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References

1. Casavilla A, Ramirez C, Shapiro R, *et al.* Experience with liver and kidney allografts from non-heart-beating donors. *Transplantation* 1995; **59**: 197.
2. Reddy S, Zilvetti M, Brockmann J, McLaren A, Friend P. Liver transplantation from non-heart-beating donors: current status and future prospects. *Liver Transpl* 2004; **10**: 1223.
3. Nguyen JH, Gopalan VS, Hughes CB, *et al.* Non-heartbeating (NHB) donor liver allografts may be successfully used to expand the donor organ supply. *Am J Transplant* 2002; **2**(Suppl. 3): A1128.
4. Muiesan P, Girlanda R, Jassem W, *et al.* Single-center experience with liver transplantation from controlled non-heart-beating donors: a viable source of grafts. *Ann Surg* 2005; **242**: 732.
5. Fujita S, Mizuno S, Fujikawa T, *et al.* Liver transplantation from donation after cardiac death: a single center experience. *Transplantation* 2007; **84**: 46.
6. El-Rassi Z, Barcet S, Mechet I, *et al.* The outcome of 400 consecutive liver grafts using the aortic perfusion-only technique. *Transpl Int* 2005; **17**: 772.
7. Lin QY, Chui KK, Rao AN. Rapid donor liver procurement with only aortic perfusion. *World J Gastroenterol* 2001; **7**: 884.