doi: 10.21037/acs-2024-dcd-0032

Cite this article as: Van Raemdonck D, Brouckaert J, Van Slambrouck J, Vandendriessche K, Ceulemans LJ, Rega F. The thoracic surgeon perspective—lung transplantation in controlled donation after circulatory determination of death (cDCD): any conflict with the heart? Ann Cardiothorac Surg 2024. doi: 10.21037/acs-2024-dcd-0032

Editorial

The thoracic surgeon perspective—lung transplantation in controlled donation after circulatory determination of death (cDCD): any conflict with the heart?

Dirk Van Raemdonck[1,2]^, Janne Brouckaert[3,4]^, Jan Van Slambrouck[1,2]^, Katrien Vandendriessche[3,4]^, Laurens J. Ceulemans[1,2]^, Filip Rega[3,4]^

[1]Department of Thoracic Surgery, University Hospitals Leuven, Leuven, Belgium; [2]Department of Chronic Diseases and Metabolism, Katholieke Universiteit Leuven, Leuven, Belgium; [3]Department of Cardiac Surgery, University Hospitals Leuven, Leuven, Belgium; [4]Department of Cardiovascular Sciences, Katholieke Universiteit Leuven, Leuven, Belgium

Correspondence to: Dirk Van Raemdonck, MD, PhD. Department of Thoracic Surgery, University Hospitals Leuven, Campus Gasthuisberg, Herestraat 49, B-3000 Leuven, Belgium; Department of Chronic Diseases and Metabolism, Katholieke Universiteit Leuven, Leuven, Belgium. Email: dirk.vanraemdonck@uzleuven.be.

Keywords: Lung transplantation (LTx); heart transplantation (HTx); controlled donation after circulatory determination of death (cDCD); normothermic regional perfusion (NRP); direct perfusion and procurement (DPP)

Submitted Mar 05, 2024. Accepted for publication Apr 12, 2024. Published online Jun 13, 2024.
doi: 10.21037/acs-2024-dcd-0032
View this article at: https://dx.doi.org/10.21037/acs-2024-dcd-0032

Introduction

Pulmonary allograft transplantation following controlled donation after circulatory determination of death (cDCD) has become an established, safe, and effective clinical practice (1). Reported results from the DCD registry of the International Society for Heart and Lung Transplantation (ISHLT) match those after lung transplantation (LTx) from brain-dead donors. The use of cDCD lungs has grown over the years, now representing 30–50% of all LTx in certain Western European countries (Belgium, The Netherlands, Spain, United Kingdom), Canada and Australia. The number of cDCD LTx in the United States of America (USA) remains limited, accounting for approximately 5% of all organ donation procedures (2).

Body

Since the start of cDCD LTx, thoracic surgeons were master and commander in the chest, as heart transplantation (HTx) from such donors was believed unviable, until recently.

In case of simultaneous cDCD liver or kidney procurement, good coordination between the thoracic and abdominal team is required. The asystolic phase should be kept as short as possible to reduce the risk for warm ischemic damage that might result in biliary strictures and primary non-function (3). Pulmonary allografts are deemed more privileged and less vulnerable to this warm ischemia because inflated lungs carry an alveolar oxygen reserve for continued aerobic cellular metabolism in the absence of circulation (4). Data from the ISHLT DCD registry suggest 99% of reported DCD LTx have a total warm ischemic time <60 minutes (5). More informative would be the functional warm ischemic time, starting once the systolic blood pressure drops below 50–60 mmHg. If there is doubt regarding cDCD lung function, *ex-vivo* lung perfusion should be considered prior to LTx.

The heart and lungs are often procured *en bloc* by

^ ORCID: Dirk Van Raemdonck, 0000-0003-1261-0992; Janne Brouckaert, 0000-0003-1925-9269; Jan Van Slambrouck, 0000-0002-7069-1535; Katrien Vandendriessche, 0000-0002-5405-1343; Laurens J. Ceulemans, 0000-0002-4261-7100; Filip Rega 0000-0002-8428-2302.

the thoracic surgeon. The heart is removed on the back table and sent for biobanking of the valves. This facilitates retrograde flush-perfusion of both lungs via the pulmonary veins prior to static cold storage. When abdominal normothermic regional perfusion (A-NRP) is used to facilitate recovery of abdominal organs from the warm ischemic insult, cDCD lungs can be procured simultaneously and preserved in the standard manner with no reported difference in outcome after LTx (6). Special consideration is required for ligation of the azygos vein and meticulous intrathoracic hemostasis to minimize blood loss from the chest while abdominal organs are being perfused with A-NRP.

Over the last years, it has been proven that cDCD hearts can be recovered for successful HTx. The use of cDCD hearts is on the rise with the implementation of two novel strategies to reverse warm ischemic damage starting with the no-touch period following circulatory arrest: (I) direct perfusion and procurement (DPP) followed by immediate *ex-situ* normothermic perfusion (NMP) after procurement; and (II) thoraco-abdominal normothermic regional perfusion (TA-NRP) *in-situ* prior to procurement. Hypothermic oxygenated machine perfusion (HOPE) of the heart is not yet clinically reported in the setting of cDCD, but experimental data are looking promising when preceded by either DPP or TA-NRP (7).

When using DPP to recover both heart and lungs, cold-flush of thoracic organs is no longer to be initiated concomitantly, but sequentially. Cardioplegia is administered first, while pulmoplegia is delayed until after excision of the heart to shorten its warm ischemic interval. A special dual catheter with a balloon inflated at the tip inserted in each pulmonary artery then allows concurrent antegrade flushing of both lungs (8).

In case TA-NRP is used and weaned once cardiac function has been fully restored, thoracic organs can be evaluated in a manner similar to a brain-dead, heart-beating donor. Both heart and lungs are cold-flushed simultaneously. The thoracic organs are then excised sequentially with the heart coming first, followed by the lungs.

Controversy remains whether TA-NRP leads to lung damage, especially pulmonary edema, with limited reported clinical data so far (9). In our own experience with LTx after TA-NRP, we did not encounter this problem (10). We believe that immediate venting of the left atrium with a small catheter inserted via the interatrial groove at the start of TA-NRP is of utmost importance to prevent hydrostatic lung edema. Upon restoration of antegrade circulation, both lungs are perfused via the bronchial circulation while the heart is still arrested. Blood then pools into the left atrium. This may result in increased right ventricular afterload once the heart starts beating again. Further studies are warranted to investigate the underlying mechanisms of TA-NRP on lung function.

From the start of cDCD HTx, concerns have been raised regarding the impact of heart procurement on concurrent lung donation and implantation. Reported numbers remain low in the USA despite the comparable outcomes and safety of cDCD LTx. The percentage of transplanted lungs from cDCD in 2021 in the USA dropped from 6% to 5%, while a sharp increase in cDCD HTx was noticed (2). Less attention may have been paid to lung procurement, especially when both heart and lungs are to be retrieved and transplanted by the same team from the same institution, because of lack of resources for simultaneous transplantation. Prolonged controlled hypothermic lung storage at 6–10 ℃ using new preservation devices may be a solution to overcome this hurdle in the future.

Conclusions

In summary, no negative impact of simultaneous cDCD heart and lung procurement is to be expected on outcome after LTx when the following conditions are met: (I) good communication between all teams on their specific retrieval protocol prior to starting withdrawal from life-sustaining therapy in the potential organ donor; and (II) continued focus on procurement of both heart and lungs for either combined transplantation in a single heart-lung recipient or for simultaneous transplantation of heart and lungs in individual recipients. A conflict between the cardiac and thoracic surgeon possibly resulting in the loss of precious organs should be avoided by all means.

The lonely days of the thoracic surgeon in the chest during cDCD organ procurement are over. To paraphrase the song "Lonely Days" by the Bee Gees: *Good morning master cardiac surgeon, you brighten up my day. Come sit beside me in your way…*

Acknowledgments

Funding: None.

Footnote

Conflicts of Interest: D.V.R. is supported by the Broere

Charitable Foundation. L.J.C. is supported by a KU Leuven University Chair funded by Medtronic, a research project from the Research Foundation Flanders (FWO) Belgium (G090922N) and is senior clinical researcher for FWO (18E2B24N). F.R. is the main principal investigator of "A Randomized Controlled, Open, Multicentre Clinical Trial Comparing the Use of Non-ischemic Heart Preservation (NIHP) versus Conventional Ischemic Cold Static Storage (ICSS) in heart transplantation" (NCT03991923) supported by XVIVO Perfusion, Göteborg, Sweden. The other authors have no conflicts of interest to declare.

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