Human heart transplantation from donation after circulatory determined death donors using normothermic regional perfusion: CHU of Liege experience

V Tchana-sato

Department of cardiovascular and thoracic surgery
University Hospital of Liege
Belgium
• I do not have any potential conflict of interest

• Our protocol has been approved by the ethics committee of our institution
Why a DCD heart transplantation program?
Organ donation per million population

- Belgium
- ET
- Linéaire (Belgium)
- Linéaire (ET)

Year:
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017

Donor per million population:
- 30.6 dpmp
  - P=0.001
- 13.9 dpmp
  - P=0.389

Eurotransplant
Together on a life-saving mission

CHU de Liège
 Patients on waiting list in Belgium

Kidney | Heart | Liver | Lung | Pancreas

~ 1300 patients on waiting list
Median time on waiting list
Mortality on waiting list

<table>
<thead>
<tr>
<th>Waiting list</th>
<th>A</th>
<th>B</th>
<th>D</th>
<th>H</th>
<th>HR</th>
<th>NL</th>
<th>SLO</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kidney</td>
<td>25</td>
<td>34</td>
<td>434</td>
<td>40</td>
<td>4</td>
<td>66</td>
<td>1</td>
<td>604</td>
</tr>
<tr>
<td>Heart</td>
<td>8</td>
<td>20</td>
<td>113</td>
<td>10</td>
<td>9</td>
<td>3</td>
<td>6</td>
<td>169</td>
</tr>
<tr>
<td>Lungs</td>
<td>17</td>
<td>7</td>
<td>61</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>103</td>
</tr>
<tr>
<td>Liver</td>
<td>15</td>
<td>45</td>
<td>369</td>
<td>18</td>
<td>24</td>
<td>28</td>
<td>3</td>
<td>502</td>
</tr>
<tr>
<td>Pancreas</td>
<td>1</td>
<td>2</td>
<td>22</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>66</td>
<td>108</td>
<td>999</td>
<td>69</td>
<td>38</td>
<td>118</td>
<td>10</td>
<td>1408</td>
</tr>
<tr>
<td><strong>Total patients</strong></td>
<td>63</td>
<td>100</td>
<td>937</td>
<td>68</td>
<td>37</td>
<td>116</td>
<td>10</td>
<td>1331</td>
</tr>
</tbody>
</table>

± 20% of heart recipient candidates die on waiting list
Liver transplantation from donation after cardiac death donors: initial Belgian experience 2003–2007

Olivier Detry,1 Vincent Donckier,2 Valerio Lucidi,2 Dirk Ysebaert,3 Thiery Chapelle,3 Jan Lerut,4 Olga Ciccarelli,4 Jacques Pirenne,5 Diethard Monbaliu,5 Arnaud De Roover,1 Pierre Honore,1 Xavier Rogiers,6 Bernard De Hemptinne6 and Roberto Troisi6

1 Department of Abdominal Surgery and Transplantation, University Hospital of Liège, University of Liège, Liège, Belgium
2 Department of Abdominal Surgery and Transplantation, Erasme Hospital, Free University of Brussels, Brussels, Belgium
3 Department of Abdominal Surgery and Transplantation, Antwerp University Hospital, University of Antwerp, Antwerp, Belgium
4 Department of Abdominal Transplantation, Cliniques Universitaires St Luc, Université libre de Bruxelles, Brussels, Belgium
5 Department of Abdominal Surgery and Transplantation, University Hospital of Liège, University of Liège, 4000 Liège, Belgium
6 Department of General & Hepatobiliary Surgery, Liver Transplantation Service, Ghent University Hospital & Medical School, Ghent, Belgium

Abstract

The renewed interest in donation after circulatory death (DCD) started in the 1990s following the limited success of the transplant community to expand the donation after brain-death (DBD) organ supply. DCD donors, who fulfill the criteria of donation after circulatory death (DCD), are defined as those who die following a sufficient time allowing to determine cardiovascular death. The donation after cardio-circulatory death (DCD) started in the 1990s following the limitation of the transplant community to expand the donation after brain-death (DBD) organ supply. DCD donors, who fulfill the criteria of donation after circulatory death (DCD), are defined as those who die following a sufficient time allowing to determine cardiovascular death. DCD donation imposes thus an additional forced warm ischemia occurring during the declaration of death and organ retrieval process. Experimental strategies are intervening in both donors and recipients at different phases of the transplantation process have focused on the attenuation of ischemia-reperfusion injury and already gained encouraging results, and some of them have found their way from pre-clinical success into clinical reality. The future of DCD-LT is promising. Consequent efforts should concentrate on the identification of suitable donors (probably Maastricht category III DCD donors), better donor and recipient matching (high risk donors to low risk recipients), use of advanced organ preservation techniques (oxygenated hypothermic machine perfusion, normothermic machine perfusion, venous systemic oxygen persufflation), and pharmacological modulation (probably a multi-factorial biologic modulation strategy) so that DCD liver allografts could be safely utilized and attain equivalent results as DBD-LT.

Keywords: Non-heart-beating donation; Complication; Bile duct; Allocation; Ischemia; Ischemia-reperfusion injury; Liver disease

Conflict of interest: None declared.

Peer reviewers: Bijan Eghtesad, Associate Professor, Department of General Surgery, Cleveland Clinic Foundation, 9500 Euclid Avenue, Cleveland, OH 44195, United States; Tohoku-Sawada, Associate Professor, Second Department of Surgery, Dokkyo University School of Medicine, Kitakyushu, Fukuoka, Japan; Philip Rosenhall, Professor, Pediatrics, USCSE, 500 park avenue Avenue, San Francisco, CA 94114-0136, United States.

© 2012 Baishideng. All rights reserved.

http://dx.doi.org/10.3748/wjg.v18.i33.4491

WORLD J GASTROENTEROL 2012 September 7; 18(33): 4491-4506
ISSN 1007-9327 (print) ISSN 2219-2840 (online)
© 2012 Baishideng. All rights reserved.

Acceptance: March 29, 2012
Published online: September 7, 2012

Donation after cardio-circulatory death liver transplantation

Hieu Le Dinh, Arnaud de Roover, Abdour Kaba, Séverine Lauwick, Jean Joris, Jean Delwaide, Pierre Honore, Michel Meurisse, Olivier Detry

Hieu Le Dinh, Arnaud de Roover, Pierre Honore, Michel Meurisse, Olivier Detry, Department of Abdominal Surgery and Transplantation, University Hospital of Liège, University of Liège, 4000 Liège, Belgium

Abdour Kaba, Séverine Lauwick, Jean Joris, Department of Anesthesia and Intensive Care Medicine, University Hospital of Liège, University of Liège, 4000 Liège, Belgium

Jean Delwaide, Department of Hepatology and Gastroenterology, University Hospital of Liège, University of Liège, 4000 Liège, Belgium

Author contributions: Le Dinh H performed the literature review, and drafted the manuscript; de Roover A, Kaba A, Lauwick S, Joris J, Delwaide J, Honore P and Meurisse M contributed the team involved in the care of the liver transplant patients and they reviewed and commented the manuscript; Detry O supervised the review.

Correspondence to: Olivier Detry, Professor, Department of Abdominal Surgery and Transplantation, University Hospital of Liège, University of Liège, Sart Tilman B35, 4000 Liège, Belgium. olivier.detry@uliege.ac.be

Telephone: +32-4-3667454 Fax: +32-4-3667069

Received: December 9, 2011 Revised: March 27, 2012
Accepted: March 29, 2012
Published online: September 7, 2012

World J Gastroenterol 2012 September 7; 18(33): 4491-4506
ISSN 1007-9327 (print) ISSN 2219-2840 (online)
© 2012 Baishideng. All rights reserved.

Key words: Non-heart-beating donation; Complication; Bile duct; Allocation; Ischemia; Ischemia-reperfusion injury; Liver disease
How to start?
A dedicated multidisciplinary team

- Anesthetists
- Surgeons
- Intensivists
- Cardiologists
- Nurses
- Psychologist
## Donor selection

<table>
<thead>
<tr>
<th>Maastricht Criteria</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>≤ 50</td>
</tr>
<tr>
<td>PMH</td>
<td>No known cardiac diagnosis</td>
</tr>
<tr>
<td>Inotropic support</td>
<td>&lt; 0.3 mcg/Kg/min of noradrenaline</td>
</tr>
<tr>
<td>LVEF</td>
<td>&gt; 50%</td>
</tr>
<tr>
<td>WIT</td>
<td>≤ 30 Minutes</td>
</tr>
</tbody>
</table>
Donor and recipient selection

• Local donor and recipient at the beginning
  - NRP
  - Short cold ischemic time
  - No need to use OCS

• Extend to distal recipient with time and experience
  - 3rd recipient located in another center
  - NRP + cold storage
# Elaboration of a Protocol

## CHU LIEGE vs Papworth

<table>
<thead>
<tr>
<th>Localization of withdrawal of life support therapy</th>
<th>Operating Room</th>
<th>ICU or anesthesia Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analgesia and sedation</td>
<td>ICU: at the discretion of the physicians</td>
<td>OR: volatile anesthetic (sevoflurane)</td>
</tr>
<tr>
<td>Normothermic regional perfusion</td>
<td>Premortem peripheral ECMO cannulas</td>
<td>Central NRP after the sternotomy</td>
</tr>
<tr>
<td>Heparin</td>
<td>IV 25000 UI bolus in the OR</td>
<td>30000 UI in the right atrium after the sternotomy</td>
</tr>
<tr>
<td>Circulatory arrest</td>
<td>Loss of arterial pulsatility and Mean arterial pressure&lt; 30 mmHg</td>
<td>Mechanical asystole</td>
</tr>
<tr>
<td>Death</td>
<td>Circulatory arrest + 5 minutes</td>
<td>Circulatory arrest + 5 minutes</td>
</tr>
<tr>
<td>« Knife to skin »</td>
<td>Circulatory arrest + 5 minutes</td>
<td>Circulatory arrest + 5 minutes + OR transfer</td>
</tr>
</tbody>
</table>
1) Constat de l’absence d’évolution favorable possible
2) Décision et annonce de l’arrêt thérapeutique
3) Annonce de l’intention d’effectuer un don d’organe DCD
4) Absence d’opposition du patient
5) Séduction profonde et ventilation contrôlée
6) Ligne A. fémorale gauche

H0 = Arrêt circulatoire
Activité électrique sans pouls
PAM<30

H+10
Début Ischémie chaude: PAS<50

H+15
Début ECMO
Réanimation cardiaque

H+45
refus don cardiaque vs.
Sevrage ECMO
Évaluation greffon
30-60min

H+100
refus don cardiaque vs.
don confirmé
Reprise ECMO (1h)

H+160
Prélèvement cardiaque
Greffe (salle 2)
Conversion ECMO en NRP (Clamp aorte thoracique) puis IGL par canule A. fém.+ drainage VCI

H+180
Prélèvements viscéres abdos

Switch-off

H+5
Décès
Incision peau
Sternotomie
Clampage supraaortique

⚠️ Reprise de la ventilation
protocol

• Transfer ICU → OR

• Premortem ECMO cannulas insertion

• WLST

• Circulatory arrest + 5 minutes

• Sternotomy and clamping of arch vessels

• Start of NRP
Premortem Insertion of VA ECMO cannulas

- Minimize WIT
- Discussion with the ethics committee
In Situ Preservation of Kidneys From Donors After Cardiac Death

Results and Complications

Maarten G. J. Snoeijjs, MD,* Angela J. E. Dekkers, MD,* Wim A. Buurman, PhD,*
Luc van den Akker, MD,† Rob J. T. J. Welten, MD, PhD,‡ Geert Wilhem H. Schurink, MD, PhD,*
and L. W. Ernest van Heurn, MD, PhD*
Extra-corporeal membrane oxygenation can be done in DCD donors following pre-mortem cannulation prior to or after withdrawal of life-sustaining therapy in controlled and declaration of death in uncontrolled DCD donors, respectively. Cannulas are introduced into the femoral vessels and connected to the circuit. Importantly, recirculation of blood to the brain should be avoided by means of a balloon inserted via the contralateral femoral artery and inflated at the level of the diaphragm. This also excludes the perfusion of the thoracic organs. ECMO is initiated and normothermic preservation installed; some groups maintain temperatures...
## Our experience

<table>
<thead>
<tr>
<th></th>
<th>Donor 1</th>
<th>Donor 2</th>
<th>Donor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>24</td>
<td>48</td>
<td>12</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>Male</td>
<td>Male</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>183</td>
<td>177</td>
<td>162</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>59</td>
<td>94</td>
<td>42</td>
</tr>
<tr>
<td>Cause of WLST</td>
<td>Intracerebral hemorrhage</td>
<td>Intracerebral hemorrhage</td>
<td>hypoxic cerebral damage post hanging</td>
</tr>
</tbody>
</table>
Conclusion

• DCD donor heart transplantation is a clinical reality > expand the organ donor pool

• Dedicated team

• Good donor and recipient selection

• Simple Protocol

• Ethical issues ........
Criteria for transplantation

- MAP >60 mmHg and maximum of 5ug/kg/min of dopamine
- Sinus rhythm
- CI >2.5 l/min/m2
- CVP>12 mmHg
- CWP<15 mmHg
- LVEF>50%
- TEE (no valvulopathy, no segmental cinetic anomality)
<table>
<thead>
<tr>
<th></th>
<th>DONOR 1</th>
<th>DONOR 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>24</td>
<td>48</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>Male</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>183</td>
<td>177</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>59</td>
<td>94</td>
</tr>
<tr>
<td>Cause of WLST</td>
<td>Intracerebral hemorrhage</td>
<td>Intracerebral hemorrhage</td>
</tr>
<tr>
<td>WLST to circulatory arrest (min)</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>FWIT (min)</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Knife to skin to onset of NRP (min)</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>NRP duration (min)</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Restoration of spontaneous sinus rhythm after NRP (min)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>RECIPIENT 1</td>
<td>RECIPIENT 2</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>age</td>
<td>64</td>
<td>59</td>
</tr>
<tr>
<td>gender</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>height</td>
<td>181</td>
<td>177</td>
</tr>
<tr>
<td>weight</td>
<td>64</td>
<td>90</td>
</tr>
<tr>
<td>Etiology of Heart failure</td>
<td>Ischemic cardiopathy</td>
<td>Ischemic cardiopathy</td>
</tr>
<tr>
<td>Pulmonary vascular resistance</td>
<td>1.8</td>
<td>1.49</td>
</tr>
<tr>
<td>Cold ischemic time</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Warm ischemic time</td>
<td>30</td>
<td>53</td>
</tr>
<tr>
<td>Post-transplant support</td>
<td>Dobutamine 5u/kg/min</td>
<td>Dobutamine 5u/kg/min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Noradrenalin Isuprel</td>
</tr>
<tr>
<td>ICU lenght of stay</td>
<td>14</td>
<td>32</td>
</tr>
<tr>
<td>Hopital stay</td>
<td>31</td>
<td>54</td>
</tr>
</tbody>
</table>