DCD Heart and ANRP Retrieval Surgical Protocol

Use in conjunction with DCD Heart Donation Guide to Donor Selection and Assessment Criteria

https://www.odt.nhs.uk/retrieval/policies-and-nors-reports/

Index

Requirements needed of the NORS teams:

The following are required for the successful removal of the heart during NRP retrieval in a DCD donor.

A detailed discussion between cardiothoracic and abdominal teams to agree protocol and steps to be taken.

From the cardiothoracic team

- Senior surgeon who is experienced in DCD Heart retrieval
- Assistant surgeon, scrub, and cold perfusion practitioner
- The ex-situ normothermic heart perfusion machine plus practitioner
- The necessary sterile tubing and adapters to connect to the NRP circuit (3/8 and ½ inch tubing) plus Pacifico cannula to drain SVC
- Diathermy/Bipolar scissors/Ligasure
- Cell saver
- Sutures

From the abdominal team

- Senior surgeon who is experienced in NRP with DCD Cardiothoracic retrieval
- Assistant surgeon, scrub, cold perfusion, advanced perfusion practitioner
- The NRP disposable circuit
- NRP heater/cooler and pump (e.g. Cardiohelp)
- Experienced NRP perfusion practitioner
- 2 x long vascular clamps (long Debakey) for descending aorta and IVC clamping
- 2 x Roberts clamps for SVC and ascending aorta
- Recommended use of femoral ECMO cannula for venous drainage
- For NRP protocol please see https://www.odt.nhs.uk/retrieval/policies-and-nors-reports/

NORS team Mobilisation

- Both NORS team to arrive 2 hours before the planned withdrawal of treatment time

Set up

It is recommended that the donor is transfused to Hb of >100g/L.
This is to ensure that oxygenation of the heart is not limited by anaemia during machine perfusion. Timing of the transfusion – once the CT NORS team is mobile.

Where possible the donor should be moved to the anaesthetic room prior to withdrawal of life sustaining treatment.

Height of the donor bed should be the same as the theatre table. This is done by simply marking the height of the donor's bed by tape on the SNOD's trousers and match this with the theatre table height.

The SNOD will prepare units of packed red blood cells (cross matched to donor) to be available.

- 8 units for DCD heart with abdominal NRP

Preparation of NRP Circuit

Full NRP protocol found on the NHSBT ODT Clinical website. The most recent version must be checked for updates.

The NRP circuit is primed with 1.5 litres of Hartmann's, to which are added 4 units of red cells. The circuit needs to be set up before withdrawal of treatment and warmed to 37°C by circulating through the oxygenator/heat exchanger.

Set up the NRP circuit with an extra venous drainage tubing which will be connected to a Pacifico 90-degree cannula for the SVC.

Diathermy set up of 80/90.

Two long DeBakey vascular clamps will be ready to use by the cardiothoracic team prior to commencing NRP to clamp descending aorta and IVC. Two Roberts clamps will also be ready to clamp SVC and ascending aorta. It has been agreed that clamps will be provided by the abdominal team as they need to stay in place once the CT team has left the operating theatre.

Due to the complexity of the technique, cardiothoracic organs will only be perfused and retrieved for transplantation or valve donation purposes.

Preparation of OCS

- Prepare St Thomas cardioplegia - Add the following medication to 500ml bag of Ringers:

  - 2,500iu of Epoetin Alfa
  - 50mgs GTN
  - 3mls Sodium bicarbonate 8.4% (840mgs in 10ml amp)
  - 10mls cardioplegia concentrate
  - Add heparin 300u/kg

  (Solution to be put back into the ice box but easily accessible for use when donor arrives in theatre)

- Prepare St Thomas cardioplegia for back at implant site – Add the following medication to 1L bag of Ringers:

  - 5000iu of Epoetin Alfa
  - 100mgs GTN
  - 6mls Sodium bicarbonate 8.4% (840mgs in 10ml amp)
  - 20mls cardioplegia concentrate

  (Solution to be put back into the ice box for use when heart is at implant site)

DCD HEART Functional Warm ischaemia and Stand Down Criteria

- After withdrawal of treatment, regular contact will be maintained with the SNOD regarding blood pressure and arterial saturations on the donor.
    - Functional warm ischaemia begins when systolic blood pressure falls below 50mmHg.
    - 30 minutes from beginning of functional warm ischaemia until cold cardioplegia is delivered will be tolerated before standing down.
    - Essential for the team diagnosing death to be familiar with the Academy of Medical Royal Colleges' Code of Practice for the Diagnosis and Confirmation of Death. View the Code of Practice.
    - If cardiac arrest does not occur within 120 minutes from withdrawal of treatment, consider standing down DCD heart retrieval at this stage, unless death is likely to be imminent.
    - We recommend having a discussion between retrieval and recipient centres after 60 min from withdrawal.

Transfer to operating theatre.

Following verification of death 5 minutes after circulatory arrest, the patient is transferred to the operating table, the SNOD shows the patient's name band to confirm donor identity. This is cross-checked with the donor authorisation/consent form. It is best practice if the physician who has pronounced death attends with the donor to confirm the pronouncement of death in person.

Surgical protocol:

The thoracic and abdominal surgeons will prepare the skin with an alcohol-based skin preparation solution and apply 4 drapes.

A midline sternotomy is performed with a retractor to spread the sternal tables placed upside down. The abdominal surgeon will open the abdomen simultaneously.

For all heart retrievals:

Initially perform the heart assessment for:

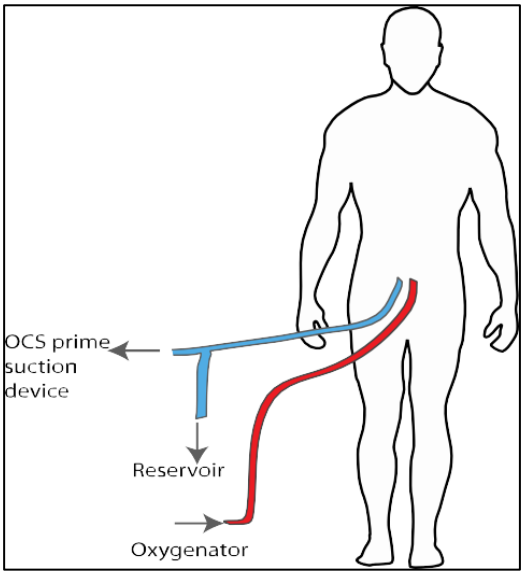
- **coronary disease**
- **visible anomalies**
- **trauma**
- **left ventricular hypertrophy**
- **congenital disease**
- **other causes preventing transplantation**

If none of the above give clear instruction to open and prime the OCS.

The heart assessment can take place while draining blood to prime the OCS.

The NRP circuit needs to have a Y attachment on the venous return limb just above the reservoir and needs to be fitted prior to arrest. This needs to be connected to the cell saver to allow for donor blood drainage needed for *ex situ* heart perfusion but clamped initially.

Figure 1



The NRP circuit is primed with 1.5 litres of Hartmann's, to which are added 4 units of red cells. The circuit needs to be set up before withdrawal of treatment and warmed to 37°C by circulating through the oxygenator/heat exchanger.

A pump sucker will be connected to the reservoir for blood loss recovery. (This is the preferred standard with teams working towards this, until then existing practice will prevail). This will only be used to recover blood from the pericardium if heart retrieval only, or to recover blood from pericardium and pleural space if combined heart-lung retrieval. Blood should not be recovered from the pleural space in the presence of chest sepsis. Additional care must be taken to avoid any perfusion fluid/saline being recovered using this sucker.

THIS ADDITIONAL SUCKER WILL NOT BE USED IN CASES OF PERICARDIAL, MEDIASTINAL OR SYSTEMIC INFECTION. CAREFUL HAEMOSTASIS SHOULD BE PERFORMED IN THE CHEST EVEN IN THE EVENT OF HAVING A PUMP SUCKER AVAILABLE.

IT IS MANDATORY TO FOLLOW THIS STEP SEQUENCE

Abdominal Procedure

1 The circulating pump is stopped, and the sash is clamped and divided; the arterial cannula may be attached and primed at this point.

2 Once the donor is in theatre, the abdomen is opened through a midline incision. (This step may be **delayed** until after NRP is established through groin cannulation, which permits more space for the CT team who will open the chest at the same time).

3 The venous cannula is placed in the right common femoral vein (or iliac vein or IVC) and connected to the venous limb of the sash, with care to exclude air. Care should be taken not to insert too much length of cannula to prevent it going into the right atrium.

IF there is problem with achieving venous cannulation for blood drainage (OCS), the thoracic team may choose to cannulate the right atrial appendage; this cannula should be removed, and the appendage ligated before starting NRP or else air will be entrained in the circuit and NRP fail. For this reason, atrial cannulation is a last resort.

4 Clamps are removed and 1.5L venous blood drained out and diverted into the collecting receptacle for the heart Organ Care System (OCS) (such as the cell saver system used by Harefield).

5 The Y-connector is then clamped, and venous return blood now diverted to drain back into the NRP reservoir (see figure 1). Please ensure having the correct connectors – 3/8, and ½.

6 The arterial cannula is placed in the right femoral artery, common iliac artery, or aorta while the venous drainage occurs.
During the above, the CT team will open the chest in the midline and split the sternum. They will cross clamp the descending thoracic aorta, place the vent in the aortic arch and announce this so that NRP can start.

Abdominal NRP must not start until both teams have confirmed for all to hear that the descending aorta is clamped and aortic arch is vented via a 24Fr cannula.

7 Once the heart is removed it is important to check the security of the supra-hepatic IVC clamp – this may need to be sutured in place to avoid inadvertent unclamping or slipping from the cut IVC. The cut ends of the pulmonary vessels and SVC may be oversewn with 3/0 Prolene at this stage also. While the cardiac surgeons should ensure haemostasis in the chest, in reality it is the abdominal surgeons who are usually free at this stage and can stop large vessel bleeding.
There should be no major bleeding.

Cardiothoracic Procedure

The chest is opened in the midline and sternum split while the abdomen is being opened. Pericardiotomy is performed.

1. The left pleural space is opened, and DESCENDING THORACIC AORTA IS CLAMPED above the diaphragm to isolate abdominal NRP. Priority will be given to ensure absence of brain reperfusion via NRP system. The act of clamping the descending aorta should be announced loud enough for all to hear and the time will be recorded on the National DCD Heart Passport.

2. Placement of a 24 French cannula in the aortic arch, at least 5cm from the aortic valve, to demonstrate absence of brain perfusion (a 24Fr cannula fits precisely in the incision made by an 11-blade inserted to its hilt).

   Once the arch cannula is in place and open to air, the cardiothoracic surgeon announces that the aortic arch is vented and NRP can start. The time will be recorded on the National DCD Heart Passport. If there is sudden, copious arterial bleeding from the arch cannula, the NRP pump must stop and the clamp on the descending aorta must be re-positioned to occlude the aorta. Only then can the NRP pump re-start.

Abdominal NRP must not start until both teams have confirmed for all to hear that the descending aorta is clamped and aortic arch is vented via a 24Fr cannula.

3. The SVC and azygos vein are dissected to ensure enough length.

4. The IVC is dissected around. If the tip of the venous cannula is inside the right atrium, the abdominal team should be asked to pull the cannula back below diaphragm to allow for IVC clamping at a later stage. Check to ensure the venous cannula does not encroach into the right atrium.

The heart is assessed for any visible anomalies, palpable coronary artery disease, left ventricular hypertrophy, trauma, congenital disease etc.

5. Drain 1.3-1.5L of donor blood – either through a side arm from the NRP circuit or two-stage cannula from right atrium.

6. Once 1.3-1.5L of donor blood has been received into the receptacle / cell saver for the OCS prime, CLAMPS ARE PLACED ACROSS THE IVC ABOVE THE DIAPHRAGM, AND THE SVC *CAUDAL* TO THE AZYGOS. The SVC is transected caudal to the clamp placed below azygos vein.

7. The ascending aorta is clamped, in addition to the descending thoracic aortic clamp.

8. IVC is opened just cranial to the clamp for venting and left atrium is opened at level of pulmonary veins for pulmonary return.

9. Cardioplegia supplemented with 25000 IU heparin, EPO, and 50 mg of GTN is administered via a large bore needle PROXIMAL to the cross clamp. The previously placed cannula, distal to the cross clamp, at the level of the arch will remain in situ and open to air.

10. Once cardioplegia is finished, the large bore cannula is removed.

11. The heart is then excised leaving all previously placed clamps in situ to

minimize blood loss.

12. **The azygos vein must be ligated twice and cut in between.**

13. Establish with the abdominal team and identify team member who is going to secure potential bleeding points. – stitch (3/0) IVC stump (with or without the clamp in place), SVC, azygos, and pulmonary veins.

14. The heart graft is prepared at the back table and re-perfused with ex situ normothermic perfusion technology in the usual manner.

Preparation of the DRP-DCD heart prior to Ex-Situ perfusion

- The heart is immediately placed into a basin of ice cold sterile saline solution.

- Dissection made to free the aorta from the pulmonary artery placing and securing the appropriately sized perfusion connector for the Organ Care System (OCS) with the supplied cable tie. Teflon pledgeted aortic stitches are used to further secure the aorta to the OCS so reducing the risk of disconnection during travel to the recipient hospital.
- The heart is placed and de-aired onto the primed OCS.

- Insert and secure LV vent through the left atrium into organ chamber.

Place ventricular pacing wires in case pacing is required at a later stage.

PA cannula (Protocol difference)

Harefield retrieval – PA cannula secured and connected. (SVC and IVC - sutured) and connect blue flow probe – follow Transmedics protocol.

Glasgow/Papworth retrieval – PA cannula NOT connected, allowing free drainage.

OCS perfusion parameters during transport:

Commence OCS perfusion of donor heart aiming for:

- Mean AOP 55-70 mmHg
- Aortic flow of 900-1100 mL/min-
- Coronary flow 650-750 ml/min
- Heart rate 70-90 BPM with V-pacing
- Once heart rhythm and perfusion are stable consider synchronising perfusion depending on discussion with implanting team

Acquire simultaneous AV blood samples. Perfusate targets are:

- Hct >15%
- Calcium 1.0-1.3 mmol/l
- Bicarbonate 22-29 mmol/l
- pH – 7.3-7.45

Video clip to be transferred to implanting centre at 30min reperfusion on the rig. In order to reduce OCS perfusion time, a direct communication between lead retrieval and lead implanting surgeon should be established en route. Both parties must agree on good organ function, before the recipient preparation begins.

Transport

Ensure to travel with a safety ice box and roadside bag which will include.

- Ice, cardioplegia, giving set + pressure bag, 8 litres of cold saline

Roadside bag – sterile instruments, sterile gloves different size, sterile gowns, 3 packing bags for heart.

Cardioplegia at recipient site (agreed telecom 2.9.20)

Once implanting team are happy to receive the heart,

- The retrieval team have set up to administer cardioplegia.
- All 3 teams will administer St. Thomas at retrieval and implant site when retrieving for any 6 of the 7 UK centres.
- Harefield will carry both Custodiol and St. Thomas and will have a choice of Custodiol or St. Thomas when retrieving for Harefield.

(Refer to St. Thomas preparation on page 7)

Trouble shooting.

- Check placement heart on the rig (twist, impaired drainage)
- Syringe drives
- Flow probes and sensors
- Module position within the rig
- Redo medication preparation

Set up of Transmedics OCS and use of Cell Saver

Papworth have developed an OCS training manual for DCD hearts and an OCS blood collection with cell saver manual. These are available for reference on the NHSBT ODT microsite: Policies and NORS reports - ODT Clinical - NHS Blood and Transplant

OCS perfusion parameters during transport:

In general, it is recommended to maintain the OCS in manual rather than automatic mode.

Changes to flow and pacing have an immediate effect whereas changing the infusions of epinephrine or maintenance fluid may take minutes to take effect.

Commence OCS perfusion of donor heart aiming for:

• AOP: 55-70 mmHg

• Aortic flow: 800-1100 mL/min

• Heart rate: 70-90 BPM with V-pacing

Aim CF: 650-750 ml/min

• Once heart rhythm and perfusion are stable consider synchronising perfusion depending on discussion with implanting team.

Acquire simultaneous AV blood samples. Perfusate targets are:

• Hct: >15%

• Calcium: 1.0-1.3 mmol/l

• Bicarbonate: 22-29 mmol/l

• pH: 7.30-7.45

Parameters to consider prior to final decision.

- AOP 55-75 mmHg with Maintenance fluid <30 ml/Hr
- Aortic flow 800-1100 ml/min
- HR
- Total lactate trend decreasing over time
- Lactate consumption profile i.e. $Lac_{Art} > Lac_{Ven.}$
- Contractility
- Prescence of superficial petechia and/or oedema
- FWIT < 30min i.e. Time from SBP<50mmHg to start of *in situ* cold perfusion.
- OCS perfusion time + all the above + predicted preparation of implant (for example, if OCS > 4hours and redo surgery with predicted additional 2-2.30 hours OCS perfusion) need to assess all the above real time
- If in doubt, call on-call retrieval consultant surgeon at Royal Papworth Hospital for advice

Recipient Centre Guidance

- Recipient team should assemble at the hospital once asystole has occurred.
- It takes at least one hour on the OCS to have an initial assessment of the heart.
- The DCD Team should leave the donor hospital with the OCS machine to travel to the recipient centre within 60 minutes of the heart being placed on the OCS machine.

Appendix 1: Safety Checklist for Direct Retrieval of the Heart

SAFETY CHECKLIST FOR DIRECT RETRIEVAL OF THE HEART/ HEART AND LUNGS AND *IN SITU* NORMOTHERMIC REGIONAL PERFUSION OF THE ABDOMINAL ORGANS

TO BE COMPLETED AT HANDOVER	***CTH SURGEON***	***ABDO SURGEON***
1 Protocol reviewed prior to WLST	☐	☐
2 Debrief completed prior to WLST	☐	☐
3 CTh team equipment ready	☐	
(Cell saver, Clamps, OCS, Fluids for perfusion)		
4 Abdominal team equipment ready		☐
Leading surgeon; Full name and signature		

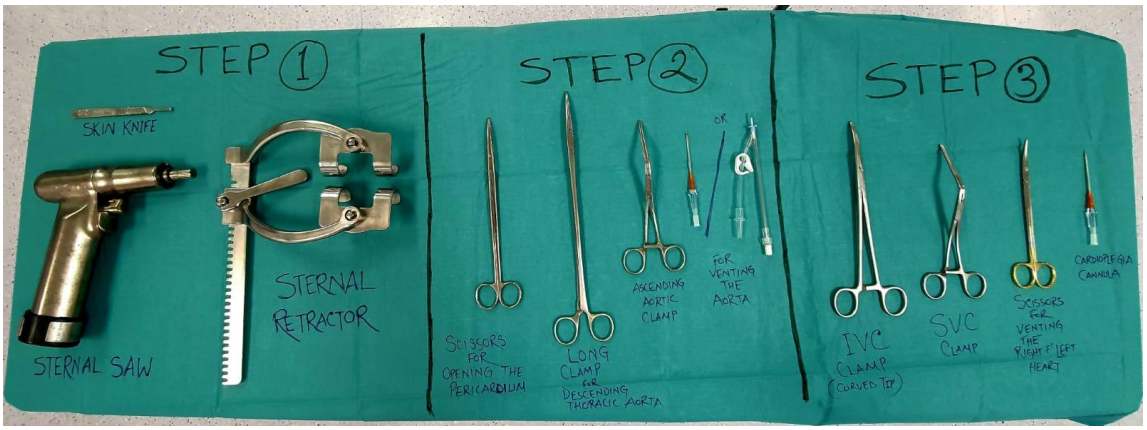
TO BE COMPLETED PRIOR TO START ABDOMINAL NRP

(Time to be noted and signed by Abdominal team Perfusionist)

1 Descending Aorta x clamp time

Appendix 2: Scrub trolley set up.

Scrub trolley set up:

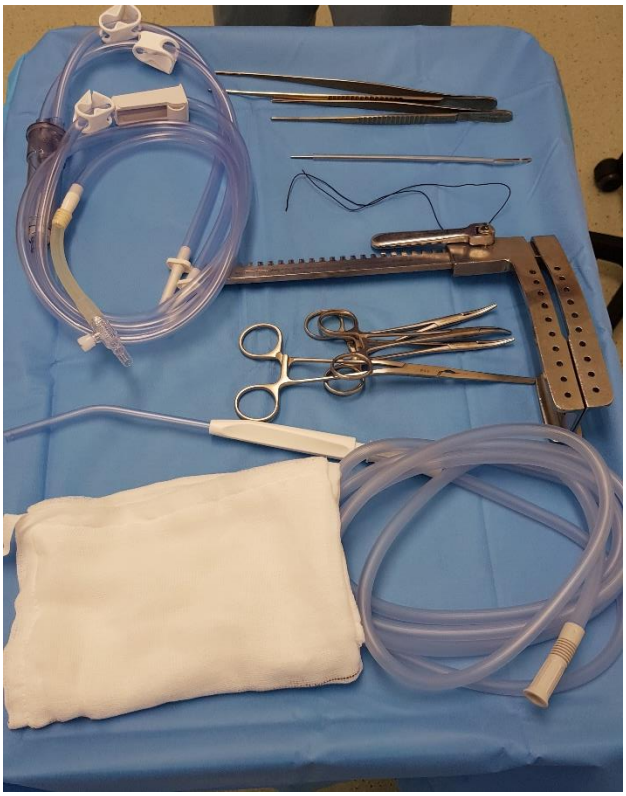


The above figure demonstrates the scrub trolley discipline, which correlates with the surgical steps, and this can be very helpful in the DCD with A-NRP retrieval specially at the very beginning of the process till the start of the antegrade cardio and pneumoplegia. This is not only helpful but also comfortable for the surgeons and the scrub to work in harmony and to prevent unwanted events as well as to maintain sterility in a hasty procedure.

Some teams would prefer a second trolley is prepared for the assistant and will be on the left of the donor.

The trolley contains: SEE PHOTO

Two suckers (Cell saver and wall sucker - Cell saver marked by a black tie to distinguish from wall sucker and not be used once cardioplegia started)
Clamp for the SVC
Two Dunhill clips
One Abdo pack
Heparin syringe
Two forceps
Chest retractor
Cardioplegia and pneumoplegia lines



Appendix 3: Cardiothoracic Synchrony between surgeons

Cardiothoracic Synchrony between the Surgeons

SURGEON 1	SURGEON 2
• Skin Incision • Sternotomy	Handle the suckers and the plegia lines
	• Placing the Sternal retractor Not fully opened in order not to stretch the pericardium
• Opening of the pericardium • Opening of the Left pleura • Retracting the Left lung to expose the descending thoracic aorta	
• Inject heparin in right atrium	Inject heparin in PA
	• Clamping the Descending Thoracic Aorta with a long clamp
• Incising right atrial appendage and collection blood for OCS	
• Ascending Aortic clamp • Insertion of venting needle distal to the clamp	
	• Securing the venting needle/cannula
~~• Rule out CAD~~	
• Venting the Right (Clamping the IVC in the pericardium and Flush cutting) and Left Heart (through LAA or LSPV) • Inserting with wide bore cannula (medicut) **and holding it in place** proximal to the ascending aortic clamp to deliver antegrade cardioplegia	• SVC clamp caudal to Azygos away from SA node
	• Connecting the cardioplegia line to the cannula

	• Surface cooling with cold saline
• At the completion of the cardioplegia, careful procurement of the heart (after securing the Azygos and ensuring adequate SVC length)	• Helping the Surgeon 1
• Heart out and preparing it for OCS in the back table	
	• Securing bleeding points and ensuring haemostasis for a smooth A-NRP run