DCD Lung and ANRP Retrieval Surgical Protocol

Contents

Requirements needed of the NORS teams:

The following are required for the successful removal of the lungs during NRP.

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 lung retrieval
- Assistant surgeon, scrub and cold perfusion practitioners
- The necessary sterile tubing and adapters to connect to the NRP circuit (3/8 and ½ inch tubing) plus Pacifico cannula to drain SVC
- EndoGIA Medtronic vascular with angled tip stapler and AMV tan reloads x10 (45 & 60mm)
- EndoGIA Medtronic vascular stapler AMT purple x2 (60mm)
- EndoGIA Medtronic vascular stapler AXT black x1 (60mm)
- Automatic liga clips (orange and blue)
- Diathermy/Bipolar scissors/Ligasure
- No 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
- Consider using an 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

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 lung with abdominal NRP

Preparation of NRP Circuit

Full NRP protocol found on the ODT Clinical website. The protocol should be checked for recent updates. Only the current version is approved for practice.

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 all cardiothoracic organs will be perfused and retrieved only for transplantation or valve donation purposes.

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.

If the patient has been extubated as part of treatment withdrawal, the airway should be reintubated with a cuffed endotracheal tube as soon as possible after death has been confirmed to prevent contamination of the airways with gastric contents (the likelihood of which increases considerably during the retrieval laparotomy).

a. At a point no earlier than 10 minutes after the onset of irreversible asystole, the lungs are re-inflated with a single vital capacity breath of oxygen-enriched air.
b. Cyclical ventilation, either with an anaesthetic machine or by hand-bagging, should start during lung perfusion to aid distribution of perfusate. Cyclical ventilation of the lungs is not allowed until the retrieval team has started to flush the lungs and vented the left atrium. As per the National Standards for Organ Retrieval.

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 team will cannulate the right femoral artery and right 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.

3 The abdominal team will wait for the cardiothoracic team to clamp the descending thoracic aorta and vent the aortic arch with a 24 French cannula prior to starting of the pump. When this is done, the cardiothoracic team will announce for all to hear. Only then can NRP commence.

4 Abdominal surgeons will then support the cardiothoracic team.

Cardiothoracic procedure

1 The chest is opened in the midline and sternum split. Meticulous haemostasis with wax and energy device.

2. Pericardiotomy

3. The left pleural space is opened, and DESCENDING THORACIC AORTA IS CLAMPED. The act of clamping the descending aorta should be announced loud enough for all to hear and the time will be recorded.

4. Placement of 24 French24Fr cannula in the ascending aorta to ensure absence of brain perfusion during NRP.

5. Dissect the azygos. Either tie off or if unable to visualise clearly place a clamp or staple above and below the azygos.

6. Now you are ready to start the NRP.

Once the aortic vent cannula (24F) is in place and open to air, and the azygos is dealt with, the cardiothoracic surgeon announces that the aortic arch is vented and the abdominal NRP can start. The time will be recorded on the NRP Passport. If there is copious arterial bleeding from the aortic vent cannula, the NRP pump must stop and the clamp on the descending aorta must be re-positioned to ensure it completely occludes the aorta. Only then can the NRP pump re-start.

7. Bronchoscopy should be performed as soon as practicable and include thorough bronchial toilet if an additional surgeon is available, or later after pneumoplegia completion.

8. Cannulate the PA using a purse string and large (>22Fr) cannula and directly attach to suction cannister (0.5-0.8L) to drain the heart, lungs, and upper limbs.

9. Once it stops sucking attach the ante and retrograde plegia.

10. Clamp the proximal PA across the full circumference.

11. Cut the LA appendage.

12. Antegrade pneumoplegia as per UK National guidelines is administered. Simultaneously, the pleurae are opened widely and lungs inspected and palpated, ensuring adequate delivery of flush and topical cooling with copious volumes of 4°C saline.

CT WILL WAIT after delivering antegrade pneumoplegia to complete 30min ANRP prior to continuing with any further dissection. CT NORS might choose to use this time to repeat bronchoscopy or assess in more detail the lungs.

THIS WILL ALLOW ESTABLISHMENT OF ANRP flows for at least 30min, a period crucial to liver recovery. Risk of bleeding is minimal at this stage.

The abdomen may be opened at a suitable point as per lead abdo surgeon decision.

In agreement with both lead surgeons the start of cardiothoracic dissection time can be negotiated.

For each vessel to be stapled, consider using a sling to ensure the whole diameter of the vessel is stapled.

13. Ascending aorta is stapled (tan angle tip 45 or 60mm) proximal to aortic vent cannula,

14. SVC, IVC dissection is performed. Staples (tan angle tip 60mm) are placed across the IVC above the diaphragm (as high as possible) and the SVC (tan angle tip 45 or 60mm) caudal to the Azygos. The IVC is opened just proximal to the staple line for venting and the left atrial appendage is vented widely.

15. Cardiectomy following the national protocol ensuring that IVC, SVC, aorta and azygos are secured and haemostatic.

16. The heart will be temporarily removed prior to the lungs being retrieved.

17. Ensure the NRP venous cannula is pulled below the clamp. Cardiectomy performed leaving **a long IVC cuff below previously placed staples.** Ascending aorta and SVC are both cut caudal to staples, which stay in place to avoid bleeding. Staple SVC

below the azygos and reassess the need to add another staple line above the innominate vein confluance with the SVC.

18. Deliver retrograde pneumoplegia through the pulmonary veins.

19. The pericardium is now empty. If the lungs are suitable and accepted for transplantation the rest of dissection will be completed while abdominal NRP continues, being careful to avoid bleeding.

    The care and detail required to retrieve lungs whilst NRP is running is the same as would be required in a living patient. The abdominal organs may be lost if the lung retrieval is performed in haste. If we are to build a future with novel technologies, both teams need to support maximal organ retrieval and utilization.

20. Cut the right side of the pericardium, in the right cardio phrenic angle and cut the phrenic nerve and go down until you meet the anterior wall of the oesophagus and stop there. To do so, you will cut and dissect the inferior pulmonary ligament.

21. Do the same on the left side cardiophrenic angle and cut the phrenic nerve and go down until you reach the anterior wall of the descending aorta. To do so, you will cut and dissect the inferior pulmonary ligament.

22. Now cut across the pericardium to join between anterior wall of oesophagus to anterior wall of aorta.

23. Ensure the sternotomy is as widely open as possible.

24. Take the right lung out of the chest, put in on the left side and you have a good view of the posterior wall of the right hilum and posterior mediastinum. Using energy device, dissect along the anterior wall of the oesophagus from low to high and stop at the arch of the azygos/membranous part of the trachea. (To ensure no membranous perforation of the trachea). This ensures no bleeding from small arteries beneath the anterior wall of the oesophagus. Stay very close to oesophagus. Usually one bronchial artery which can be divided with energy.

25. For safety, staple the azygos again (45 mm tan) and return the right lung into the chest.

26. Place the right lung back in the chest, take the left lung out of the chest and put on the right side. Develop the plane between anterior wall of aorta and lung block/pericardium from inferior to superior. Dissect along the anterior wall of the descending aorta with energy device (may use clips also if required) until you reach the aortic arch. Staple the aortic arch just below the left subclavian artery (60 mm tan).

27. Place the left lung back into the chest.

28. Go upwards and staple and divide the innominate vein (45mm tan).

29. Once the innominate vein is cut; on right we have SVC, left side innominate vein and ascending aorta. (On ascending aorta, there are great vessels; BC trunk, Left CC, and Left SC artery). Dissect between SVC on right and ascending aorta on other side, will arrive to just in front of the carina.

30. Staple the BC trunk (45 mm tan), now dissect the trachea upwards until you reach the neck on the anterior wall of the trachea, ascending aorta on the left with arch vessels and superior vena cava with venous confluent on the right side.

31. Dissect on right side of trachea to reach the posterior dissection plane previously performed. Use a 60mm tan stapler.

32. On left side of trachea, will reach the left posterior plane previously performed, at the origin of the left subclavian artery. Again, 60 mm tan stapler.

33. As high as you can, separate the trachea from oesophagus (using blunt dissection). Then inflate the lungs after withdrawing (accordingly) the ETT. Use 60 mm purple re-load to staple the trachea, or black stapler in cases of severe calcification. Now complete the plane between the trachea and the oesophagus – under vision.

34. Remove the lungs.

35. Retrograde pulmonary venous flush of the lungs is performed on the back-table at the donor site and Lungs are packed as per National protocol.

36. Heart to be returned into the chest and document this action in the patient clinical notes.

The cardio-thoracic surgeon should ensure haemostasis in the chest during and at the end of retrieval, before leaving the donor hospital. Excess bleeding may result in an unusable liver, pancreas, and kidneys.