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| LUMC |
| **PROlonged ex-vivo normothermic machine PERfusion for kidney regeneration** |
| PROPER Study Protocol\_version 8 |
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Prolonged perfusion of discarded human kidneys on normothermic machine perfusion

# *Study summary*

**Rationale:**

Currently kidney transplantation is the only viable option for patients with kidney failure to regain quality of life and health. However, the number of organs available are limited with a widening gap between supply and demand. This widening disparity between the numbers of donor organs available for transplantation and number of patients on the waiting list has forced the transplant community to use donor organs that previously would not have been considered suitable for transplantation. To date, transplant teams use more deceased donor kidneys procured from donors with co-morbidities, i.e. older and extended criteria donors (ECD) and donors after circulatory death (DCD) [1].

In addition, the discard rate of organs from these donors is unacceptably high. A key problem is the uncertainty whether to accept or decline the organ by the responsible clinician at time of offering, as assessment of such kidneys is based on subjective and not properly validated criteria or risk scores. It is very likely that currently discarded organs could have been suitable or made suitable for transplantation, thus significantly enlarging the donor pool [2].

At present in the Netherlands, hypothermic machine perfusion is implemented as standard care for deceased kidney donors. This has been associated with a reduced risk of delayed graft function [3]. Normothermic machine perfusion (NMP) may provide superior organ preservation. This is a method where a kidney is pumped with warmed, oxygenated blood to closely simulate normal physiological conditions.

By using prolonged NMP (pNMP) within physiological conditions, beyond assessing organ quality, long-term preservation could start regeneration in the kidney and potentially allow to treat or recondition poor quality organs prior to transplantation. One hour NMP of donation after circulatory death (DCD) donor kidneys prior to transplantation has shown adequate results. In order to really benefit from the regenerative potential associated with NMP, however, a longer time period of continuous perfusion could be required [3].

The aim of this study is to evaluate the feasibility of prolonged normothermic machine perfusion in human kidneys. The purpose of this study is to establish a protocol for the clinical feasibility pilot for the PROPER study.

**Objective:**

Prolonged normothermic machine perfusion can be used to ex-vivo regenerate marginal donor organs, resulting in increased donor kidney viability and survival of the transplanted organ.

**Study design:**

A multicentre, prospective pre-clinical trial.

**Study population:**

Discarded donor kidneys (n=12) retrieved for transplantation, but were discarded post retrieval or during inspection in the Netherlands. These organs will be transported to either the Leiden University Medical Centre (LUMC) or the University Medical Centre Groningen (UMCG) where the perfusions will be carried out.

**The intervention:**

*Preparation of the kidney*

The discarded donor kidneys were retrieved for the purpose of clinical use, after in situ flushing of the abdominal organs with cold preservation solution, kidneys were retrieved, then stored and transported on hypothermic machine perfusion with University of Wisconsin (UW) MPS solution – which is standard clinical practice in the Netherlands.

The kidneys will be immediately assessed and prepared for connection to the NMP circuit upon arrival in the operating room. Back table preparation and priming of the perfusion machine will be carried out simultaneously. The renal artery patch is attached to a patch holder provided by Organ Assist, whilst the ureter is cannulated with a (diameter) tube to collect the urine. Back table preparation is performed with kidneys still immersed in ice-cold preservation solution by an experienced transplant surgeon. After preparation on the back table, the kidney is weighed. Grafts are then flushed with approximately 200 ml of crystalloid Ringer’s solution, before connection to the NMP device.

*Machine settings*

For normothermic perfusion of the donor kidneys we used the Kidney Assist® device (Organ Assist, Groningen, The Netherlands). This pressure-controlled device delivers a pulsatile flow at 37°C with a mean arterial pressure fixed at 75 mmHg – with no changes in perfusion settings throughout the preservation period. A hollow fiber membrane oxygenator provided oxygenation of the perfusion solution with carbogen (95% O2/5% CO2) at 0.5L/min. Flow, pressure and temperature were displayed on the device in real-time. A new sterile disposable set of tubing, reservoir and oxygenator was used for each kidney.

*Perfusate and infusion solution*

We aimed for a perfusion fluid containing all nutrients, oxygen and protective substances required by a metabolically active kidney. Detailed information of the various components and the biochemical characteristics of the perfusion fluid is provided in paragraph 4. Priming the system.

**Main study parameters/endpoints:**

The kidney function will be assessed by means of perfusion parameters (flow and resistance), functional parameters such as clearance, functional sodium excretion, oxygen consumption, damage markers (LDH, NGAL and KIM-1) and histological evaluation.

**References:**

1. Eurotransplant statistics library. Available at: <http://www.eurotransplant.org>
2. Cohen B, Smits JM, Haase B, Persijn G, Vanrenterghem Y, Frei U. Expanding the donor pool to increase renal transplantation. Nephrol Dial Transplant. 2005; 20(1):34-41.
3. The Benefits of Hypothermic Machine Preservation and Short Cold Ischemia Times in Deceased Donor Kidneys (2018)
4. Hosgood SA, Saeb-Parsy K, Wilson C, Callaghan C. Collett D, Nicholson ML Protocol of a randomized controlled, open-label trial of ex vivo normothermic perfusion versus static cold storage in donation after circulatory death renal transplantation. . BMJ Open 2017;6:e012237. doi:10.1136/bmjopen-2016-012237

TASK 1 – Protocol

# Equipment

## Hardware

1. Kidney Assist
   1. Thermo unit and pump unit
   2. Flow, pressure and temperature (arterial and venous) sensors
2. Kidney Assist Disposable
   1. Arterial metal patch holder (sterile)
   2. Ureter cannula
3. Syramed SP6000 Chroma infusion pump (2x) [may differ locally]
4. Inspection tray
5. Carbogen gas supply (95% O2, 5% CO2)
6. RapidPoint 500 blood-gas analyser [may differ locally]
7. CellSaver
8. Scale

## Consumables

1. Thermo unit
   1. Demineralized water (2L)
2. Infusions
   1. Lectroflex extension tube Ø 1.0 x 2.5; L150 cm MLL/FLL (2x)
   2. 50 cc syringes with Luer-lock (2x)
   3. 3-way valve (2x)
   4. Flolan (epoprostenol) 0.5 mg (1 vial)
   5. Glucose 5%
   6. Aminoplasmal 10% E-free
   7. Cernevit multivitamins (1 vial)
3. Washing RBCs
   1. Bowl Set 225 ml
   2. Collection Set Cardio
   3. Infusion set (spike + tube)
   4. 3-way valve (1x)
4. Urine-recirculation
   1. Blood reinfusion bag 1L [LOT: 1810170187]
   2. 3-way valve (1x)
   3. NaCl 0.9% solution (2-4L)
5. Perfusate
   1. 1 unit of red blood cells (O pos/neg)
   2. Human albumin solution 20% (50 ml) [Albuman]
   3. Cefazoline (1 g)
   4. Calcium gluconate 10% (10 ml)
   5. Mannitol 15%
   6. Sodium bicarbonate 8.4%
6. Ringer’s lactate at room temperature (500 ml)

## Sampling/storage

1. Liquid nitrogen
2. Punch biopsy tool 4 mm Ø
3. Buffered formaldehyde 4% containers + cassettes
4. Ethanol 70% + container
5. Eppendorf tubes (0.5 ml and 0.2 ml)
6. Sticker sheet with labels

# Washing the RBCs

* Using the CellSaver wash the packed cells with NaCl 0.9% (2L)
  + See ‘Protocol: washing RBCs using the CellSaver’
* Add 50 ml of albumin 20% to the bag with washed RBCs
* Fill up the bag till 500 mL with NaCl 0.9%

# System setup

1. Place the Kidney Assist (KA), infusion pumps and the back table under the laminar flow plenum.
2. After checking the expiration date of the disposable set – assemble the disposable set to the KA.
3. Connect the sensors.
   1. Connect the venous temperature sensor to the oxygenator as well.
   2. Place a 3-way valve on the connector usually used for the venous temperature sensor. This will be used as a venous sample line and for the return of urine.
4. Connect the reservoir bag for the urine-recirculation system:
   1. Connect the reservoir bag to the urine-outlet (under the reservoir) with one outlet of the bag
   2. Attach the other outlet of the bag to the 3-way valve on the venous line
   3. Make sure the three way valve is CLOSED before continuing
5. **Ensure all connections are tight and taps are closed!**
6. Attach the carbogen via tubing.
7. Fill the thermo unit with demineralized water

# Priming the system

1. Add the following to the washed packed RBC with albumin:
   * 1. Cefazoline (dilute 1 g vile with 10 ml NaCl 0.9%, add 10 ml)
     2. Calcium gluconate 10% (10 ml)
2. Add this RBC unit via the I/V set on the oxygenator to the machine.
3. Remove the air from the pump head.
4. Turn the pump unit on to allow the perfusate to circulate.
   1. Press ‘power’ button
   2. ‘Self-test OK’ 🡪 press the push-dial button
   3. ‘Disposable connected’ 🡪 press the push-dial button
   4. ‘Perfusate level OK’ 🡪 press push-dial button
   5. The pump unit is now in priming mode 🡪 turn the dial button to 100%
   6. First de-air the pump head (use the pump button). Continue de-airing in the direction of the flow. De-air the oxygenator and filter by turning it, left air on the top can be removed with a syringe.
5. Zero the pressure line.
   1. Prime the pressure line by pulling the blue snap tap and using a syringe to aspirate at the same time the perfusate through the tubing.
   2. Turn the valve of the pressure sensor **parallel to the direction of the pressure line.**
   3. Press push-dial button to calibrate the pressure sensor. **Afterwards, turn the valve back to the original position towards the side port!**
6. Press push-dial button and set the pressure and temperature:
   1. Pressure: 75 mmHg
   2. Temperature: 37°C
7. Stop when ‘Connect kidney’ shows on the display. The system is now fully primed. Allow the perfusate to recirculate to body temperature.
8. Turn on the O2/CO2 set the flow rate to 0.5L/min.
9. Take a sample for blood gas analysis, correct the pH accordingly.
   1. Add more sodium bicarbonate as necessary **via the venous sample line** until pH reaches approximately 7.4.   
      [Sodium Bicarbonate (mmol/L) = Volume of circuit (L) x deficit of Base Excess (mmol/L)]
10. Prepare the infusions in 50 cc syringes (2x).
    * 1. Flolan 0.5 mg **[2.9 ml/hr]** = 4µg/hr

(dilute Flolan vile with 50 ml corresponding solvent, add 8 ml to 50 ml NaCl 0.9%)

* + 1. Aminoplasmal 10% **[23.3 ml/hr]**
       - Glucose 5% (**add 1.2 ml** to the Aminoplasmal)
       - Cernevit multivitamins 1 vial (**dilute 5 ml NaCl 0.9% into vile, add 0.5 ml** to the Aminoplasmal)

1. De-air the infusion lines, attach them to the middle of the sampling port using two 3-way valve and set the rates accordingly.

# Attaching the kidney

1. The kidney is prepared and the renal artery and ureter are cannulated by a surgeon under sterile conditions. Remove as much of the peri-renal fat as possible.
2. Take a biopsy and close the opening with a suture.
3. Flush the kidney with 200 ml of Ringer’s solution at room temperature to remove the preservation solution.
4. Weigh the kidney.
5. Prime the arterial patch holder with Ringer’s solution to remove the air.
6. Attach the patch holder to the arterial connection line. Simultaneously press on the button to ‘start perfusion’.
7. Check for leakages and the vein for outflow.
8. **Add 10 ml mannitol 10%.**
9. Turn on the I/V infusions.

# Perfusing the kidney

1. Continually monitor the renal blood flow, urine output and appearance of the kidney.
2. Place some droplets of the Ringer’s solution on the artery and vein, to prevent these structures from drying up.
3. Take arterial and venous samples for blood gas analysis, according to ‘Sampling protocol’.
   1. Collect the arterial sample from the arterial sample line (red valve)
   2. Collect the venous sample from the venous temperature 3-way valve.
4. Add more glucose and sodium bicarbonate accordingly. Keep track of this in CRF ‘Added volumes’, substance/time/volume and any additional relevant information.
   1. Add a bolus of 4 ml of glucose 5% when <4.0 mmol/L.
   2. Add a bolus of 4 ml of sodium bicarbonate when <7.3.
5. Take a urine sample from the 3-way valve (close to the venous output), according to ‘Sampling protocol’.
   1. Collect the volume in the reservoir bag with a sterile 50ml syringe (or smaller if volume is less).
   2. Fill the sample tube with urine (4 ml).
   3. Write the amount of produced volume of urine in the CRF.
   4. Recirculate the rest of the urine by attaching the syringe with urine again, turn the valve, return the volume through the venous line.

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| --- | --- |
| **Perfusate** | |
| Washed RBCs | 1 packed cells |
| Albumin 20% | 50 ml |
| NaCl 0.9% | approx. 250 ml. Fill until total 500ml of perfusate |
| Cefazoline 1 g | dilute 1 g vile with 10 ml NaCl 0.9%, add 10 ml |
| Calcium gluconate 10% 10 ml |  |
| Sodium bicarbonate 8.4% | approx. 10-20 ml, to correct pH before reperfusion |
| Mannitol 15% | 10ml, add after reperfusion of kidney |
|  | |
| **Infusions** | |
| 1) Flolan 0.5 mg **[2.9 ml/hr]** | dilute Flolan vile with 50 ml corresponding solvent, add 8 ml to 50 ml NaCl 0.9% |
|  | |
| 2) Aminoplasmal 10% **[23.3 ml/hr]** | 50 ml |
| Glucose 5% | add 1.2 mlto the Aminoplasmal |
| Cernevit multivitamins | dilute 5 ml NaCl 0.9% into vile, add 0.5 ml to the Aminoplasmal |

# Sampling protocol

|  |  |  |
| --- | --- | --- |
| **Time point (T=)** | **Samples** | **CHECK** |
| T≈-10  *(before attaching the kidney)* | Weigh kidney  **Punch biopsy**  Arterial blood gas  Perfusate sample |  |
| T=0:00 | Perfusion parameters  *Picture of the kidney* |  |
| T=0:15 | Perfusion parameters  Arterial blood gas  Venous blood gas  Perfusate sample  Urine sample |  |
| T=0:30 | Perfusion parameters  Arterial blood gas  Venous blood gas  Perfusate sample  Urine sample |  |
| T=0:45 | Perfusion parameters |  |
| T=1:00 | Perfusion parameters  **Punch biopsy**  Arterial blood gas  Venous blood gas  Perfusate sample  Urine sample  *Picture of kidney* |  |
| T=1:30 | Perfusion parameters |  |
| T=2:00 | Perfusion parameters  **Punch biopsy**  Arterial blood gas  Venous blood gas  Perfusate sample  Urine sample |  |
| T=2:30 | Perfusion parameters |  |
| T=3:00 | Perfusion parameters  **Punch biopsy**  Arterial blood gas  Venous blood gas  Perfusate sample  Urine sample |  |
| T=3:30 | Perfusion parameters |  |
| T=4:00 | Perfusion parameters  Arterial blood gas  Venous blood gas  Perfusate sample  Urine sample |  |
| T=5:00 | Perfusion parameters  Arterial blood gas  Venous blood gas  Perfusate sample  Urine sample |  |
| T=6:00 | Weigh kidney  Perfusion parameters  **Punch biopsy**  Arterial blood gas  Venous blood gas  Perfusate sample  Urine sample  *Picture of kidney* |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sample** | **Sample code** | **Volume per sample** | **Number of samples\*** | **Total volume\*** | **Storage** |
| Arterial blood gas | A | 1 ml | 9 | 9 | Syringe with cap |
| Venous blood gas | V | 1 ml | 8 | 8 | Syringe with cap |
| Urine | U | 4 ml | 7 | 32 | Falcon tube |
| Perfusate | P | 4 ml | 8 | 36 | Falcon tube |
| Punch biopsy (upper pole) | B | 4 mm Ø | 5 | - | 50/50: Formalin and isopentane/liquid nitrogen |

**\*(excl. additional hours after 6 hrs)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sample** | **Code** | **Processing** | **Storage** |
| Urine | U=0:30  U=1:00  U=2:00  U=3:00 U=4:00  U=5:00  U=6:00 | Supernatant (snapfrozen)  Per timepoint, alliquot:  5 x Eppendorfs 0.2 ml  2 x Eppendorfs 0.5 ml | -80⁰C |
| Perfusate | P=-10  P=0:30  P=1:00  P=2:00  P=3:00 P=4:00  P=5:00  P=6:00 | Supernatant (snapfrozen)  Per timepoint, alliquot:  5 x Eppendorfs 0.2 ml  2 x Eppendorfs 0.5 ml | -80⁰C |
| Punch biopsy (upper pole) | B=-10  B=-10 | Container of formalin  Metal container (snapfrozen) | Cassettes:  🡪 24-48hrs in formalin  🡪 transfer to ethanol 70%  Metal container: -80⁰C |
| B=1:00  B=1:00 | Container of formalin  Metal container (snapfrozen) |
| B=2:00  B=2:00 | Container of formalin  Metal container (snapfrozen) |
| B=3:00  B=3:00 | Container of formalin  Metal container (snapfrozen) |
| B=6:00  B=6:00 | Container of formalin  Metal container (snapfrozen) |

# Storage of samples

* 1. **Biopsies**

Using the biopsy punch take a biopsy sample from the upper pole. Position the punch over the biopsy site and gently apply rotational and downward pressure on the punch instrument. Use a forceps to lightly grasp and lift the sample tissue, taking special care not to crush it. If necessary, use a surgical blade to cut the base of the tissue. Confirm that no tissue has been left in the punch instrument; you should be able to see through the entire hollow tube inside the instrument. See figure 1.

As there will be no coagulation in the perfusion setup, it is likely that each biopsy site needs to be stitched to stop bleeding.

Place the biopsy on a gauze and cut it into two equal halves along the vertical axis. See figure 2. One half of the biopsy is stored in formalin and the other half is snap-frozen.

Formalin

* Place the biopsy in a formalin container, labelled correspondingly
* Store the container at room temperature

Snap frozen

* Place the biopsy in the metal container, lined with a paper filter and labelled correspondingly, and place the container in the isopentane/liquid nitrogen, leave it there until stored at -80°C

After 24-36hrs

* **Using a pencil** write down the kidney experiment + timepoint on the side of the cassette
* Transfer the biopsy from the container onto the cassette and store the cassette in a container with ethanol 70%. Dispose the formalin containers.

*Fig. 1: Taking a biopsy*

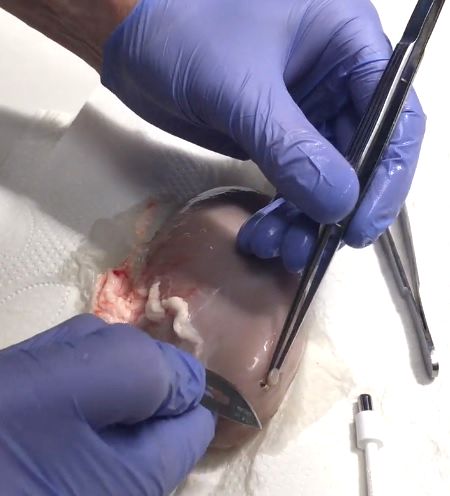
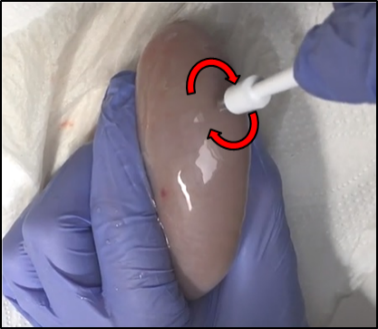
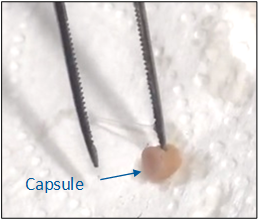


Fig. 2: Slicing the biopsy

Capsule



* 1. **Perfusate**

Perfusate samples can be collected at the sample port.

Arterial perfusate from the red valve.

Venous perfusate from the venous 3-way valve (originally for temperature sensor).

For a sample and a blood-gas sample:

* Use the arterial perfusate (red) sample port
* Using a 5 ml syringe, withdraw 3 ml and empty this into the reservoir of the kidney (this is perfusate from the ‘dead space’).
* Use the same syringe to withdraw 5 ml.
* Sample 4 ml of this in the correspondingly labelled tube. Store at room temperature.
* Use the 1ml left **for the arterial blood-gas measurement –** put a cap on the syringe.
  1. **Urine**

Collect 5 ml urine in a 5 ml tube from the ureter cannula.

* 1. **Storage**

**Centrifuge the samples as soon as possible!**

* Use the centrifuge in the OPR.
* Check the caps are tightly shut. Equally divide the tubes in the centrifuge, balance with a ‘dummy tube’ if necessary.
* Centrifuge at 4⁰C and a rate of **1300 RCF for 15 minutes.**
* After centrifuging, carefully aliquot the supernatant
  + Perfusate into 0.5 (2x) and 0.2 (5x) ml Eppendorf tubes, labelled correspondingly
  + Urine into 0.5 (2x) and 0.2 (5x) ml Eppendorf tubes, labelled correspondingly.
* Snap freeze the aliquoted samples in liquid nitrogen and store them in -80°C afterwards.

# CRF: Normothermic machine perfusion

\*B=Punch biopsy (upper pole), Abg = arterial blood gas, Vbg = venous blood gas, U = urine, P = perfusate (arterial), 📷 = take picture of kidney

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Date:** | | | | | **Experiment: K­­­­­­\_\_\_\_\_** | | | | **ET number:** | | | | | **Researchers:** | | | |
| **Kidney:**  *Left/Right* | | | *HMP: yes/no* | | *WIT:\_\_\_\_\_\_\_\_* | | *CIT:\_\_\_\_\_\_\_\_\_* | | | | *Reason of discard:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* | | | | | | |
| **Weight pre-perfusion (g):** | | | **Priming:** | | | | | | | | | | | | **Start NMP:** | | |
| **Time** | **T (min)=** | **Flow (ml/min)** | | **Intra-renal resistance (ru)** | | **Pressure (mmHg)** | | **Temperature (°C)** | | **Temperature return (°C)** | | **Urine-output (ml)** | **Volume correction** | | | **Extra additions to perfusate:** | **Samples\*** |
|  | **-10** |  | |  | |  | |  | |  | |  |  | | |  | **B Abg P** |
|  | **0** |  | |  | |  | |  | |  | |  |  | | |  | 📷 |
|  | **15** |  | |  | |  | |  | |  | |  |  | | |  | **Abg Vbg P U** |
|  | **30** |  | |  | |  | |  | |  | |  |  | | |  | **Abg Vbg P U** |
|  | **45** |  | |  | |  | |  | |  | |  |  | | |  |  |
| **1h** | **60** |  | |  | |  | |  | |  | |  |  | | |  | **B Abg Vbg P U** 📷 |
|  | **90** |  | |  | |  | |  | |  | |  |  | | |  |  |
| **2h** | **120** |  | |  | |  | |  | |  | |  |  | | |  | **B Abg Vbg P U** |
|  | **150** |  | |  | |  | |  | |  | |  |  | | |  |  |
| **Time** | **T (min)=** | **Flow (ml/min)** | | **Intra-renal resistance (ru)** | | **Pressure (mmHg)** | | **Temperature (°C)** | | **Temperature return (°C)** | | **Urine-output (ml)** | **Volume correction** | | | **Extra additions to perfusate:** | **Samples\*** |
| **3h** | **180** |  | |  | |  | |  | |  | |  |  | | |  | **B Abg Vbg P U** 📷 |
|  | **210** |  | |  | |  | |  | |  | |  |  | | |  |  |
| **4h** | **240** |  | |  | |  | |  | |  | |  |  | | |  | **Abg Vbg P U** |
| **5h** | **300** |  | |  | |  | |  | |  | |  |  | | |  | **Abg Vbg P U** |
| **6h** | **360** |  | |  | |  | |  | |  | |  |  | | |  | **B Abg Vbg P U** |
| **7h** | **420** |  | |  | |  | |  | |  | |  |  | | |  | **Abg Vbg P U** |
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| **End** |  |  | |  | |  | |  | |  | |  |  | | |  | **B Abg Vbg P U** 📷 |
| **Weight post perfusion:** | | **Remarks:** | | | | | | | | | | | | | | | |

# Sampling checklist: Normothermic machine perfusion

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sampling checklist:  Put a**  **when completed** | **Experiment no: K** | | | **Donor ET no:** | |  |  | **Researchers:** | |  |  | **Date:** |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Timpoint** | -10 | 0 | 15 | 30 | 45 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 300 | 360 |
|  |  | 0h |  |  |  | 1h |  | 2h |  | 3h |  | 4h | 5h | 6h |
| **Weigh kidney** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Punch biopsy** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Arterial bloodgas** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Venous bloodgas** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Perfusate sample** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Urine sample** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Perfusion parameters** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Picture of kidney** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Timepoint** | 420 | 480 | 540 | 600 | 660 | 720 | 780 | 840 |  |  |  |  |  | end |
|  | 7h | 8h | 9h | 10h | 11h | 12h | 13h | 14h |  |  |  |  |  |  |
| **Weigh kidney** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Punch biopsy** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Arterial bloodgas** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Venous bloodgas** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Perfusate sample** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Urine sample** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Perfusion parameters** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Picture of kidney** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

# RAPIDPoint 500 normal range

|  |  |  |
| --- | --- | --- |
| Blood gasses | Arterial | Venous |
| pH | 7.35 - 7.45 | 7.32 - 7.42 |
| pCO2 (mmHg)  (kPa) | 35 - 45  4.6 - 6 | 41 - 51  5.4 - 7.3 |
| pO2 (mmHg)  (kPa) | 75 - 100  10 - 12 | 35 – 50 |
| HCO3 (mmol/L) | 21 – 29 | 21 - 31 |
| BE | (-2) - (+3) | (-2) - (+3) |
| sO2 (%) | 95 - 98 | - |
| HCT (%PCV) | 38 - 51 | 38 - 51 |
| Hb (g/dl) | 12 - 17 | 12 - 17 |
|  |  |  |
| Chemistry | Arterial | |
| Na+ (mmol/L) | 135 - 148 | |
| K+ (mmol/L) | 3.5 - 4.5 | |
| Cl- (mmol/L) | 98 - 106 | |
| Ca++ (mmol/dL) | 1.12 – 1.32 | |
| Glu (mmol/L) | 3.5 – 7.8 | |
| Lac (mmol/L) | 0.36 – 1.25 | |