„Option and Pitfalls in Cannulation for Extracorporeal Support“

The Regensburg Experience
Extracorporeal Life Support Group

Dept. of Anaesthesiology
Dept. of Internal Medicine
Dept. of Cardiothoracic Surgery – Perfusion

Alois Philipp

Alois.Philipp@Klinik.Uni-Regensburg.de
Fundamentals for Extracorporeal Support
“Option and Pitfalls in Cannulation for Extracorporeal Support“

- **Pulmonary failure**
  - V-v ECMO
  - one vessel system

- **Circulatory failure**
  - V-a ECMO
  - two vessel system
Peripheral vs Central Cannulation

central

peripherial
Cannulation: Percutaneous vs surgical

Percutaneously using Seldinger's technique

Surgical subclavia artery

Surgical femoral artery and vein
Cannulation for Extracorporeal Support 2007-6/2012

I.  A > V; [n=96]

II. V > A; [n=240]
   Percutaneous vs surgical  [161/79]

III. V > V; [n=261]
Pros and Cons of Percutaneous Cannulation

**Pro:**
- Few staffing and logistic requirements
- Preferred out of cardiothoracic surgery
- Smaller wound surface area
- Reduced risk of bleeding / infection

**Con:**
- Cannulation of wrong vessel possible (arterial vs. venous)
- Complications entail delay of vital therapy
- Limited choice of accessible vessels
Extracorporeal Assist Application

Possible locations of extracorporeal assist application

In-House

Out-of-Hospital

Out-of-Center
## Percutaneous ECMO Implantation

<table>
<thead>
<tr>
<th>Team Composition</th>
<th>V-a In-House</th>
<th>V-v In-House</th>
<th>V-a / V-v Out of Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac surg. (if available) Intensivist or Anästhesist Perfusionist</td>
<td>Intensivist Anästhesist Perfusionist</td>
<td>Anästhesist Perfusionist</td>
<td></td>
</tr>
<tr>
<td>US control of vessels</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Heparin</td>
<td>5000 IE</td>
<td>5000 IE</td>
<td>5000 IE</td>
</tr>
<tr>
<td>Cannulaes Inflow</td>
<td>15 or 17 Fr and 15 cm long</td>
<td>17 or 19 Fr and 23 cm long (or Doppellumen)</td>
<td>Doppellumen not preferred (V-V)</td>
</tr>
<tr>
<td>Cannulaes Outflow</td>
<td>21 or 23 Fr 55 cm long</td>
<td>21 or 23 Fr 38 cm long (Doppellumen)</td>
<td>Doppellumen not preferred (V-V)</td>
</tr>
</tbody>
</table>
Divices for percutaneous cannulation have the right tools
ECMO – Cannulaes (V-V)
V-v ECMO: Positioning of Cannulae

both cannulae from the femoral side
Femoral Artery Cannulation; (V-A ECMO)  
Risk of competitive flow in aorta ascendens
Femoral Artery Cannulation; (V-A ECMO)
Risk of competitive flow in aorta ascendens
Options in V- v ECMO
V-v ECMO; Bi-Caval Dual Lumen
Implantation:
V-v ECMO; Bi-Caval Dual Lumen (Avalon)
Case history:
50 yrs, male

Diagnosis:
Pulmonary embolism, DVB

Special circumstances:
PFO

Ventilator settings and BGA

<table>
<thead>
<tr>
<th></th>
<th>Pre ECMO</th>
<th>2 hrs on ECMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>FiO₂</td>
<td>1.0</td>
<td>0.7</td>
</tr>
<tr>
<td>PaO₂</td>
<td>59</td>
<td>126</td>
</tr>
<tr>
<td>PCO₂</td>
<td>49</td>
<td>29</td>
</tr>
<tr>
<td>TV [ml/min]</td>
<td>695</td>
<td>300</td>
</tr>
<tr>
<td>MV [l/min]</td>
<td>17.2</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Duration of ECMO support 10 days
Discharged from hospital
V-v ECMO both cannulae in femoral veins
Pitfalls in V- v ECMO
Extreme obesity

Particularly risky in out of center ECMO implantation

220 kg

250 kg
Advantage vs Risk
V-v ECMO; Bi-Caval Dual Lumen (AVALON)
Case history:
29 yrs, male
Blast injury Bagram/Afganistan

Diagnosis:
ARDS, chest trauma, craniocerebral injury
Traumatic leg amputation

Site of ECMO implantation: LRCM (Landstuhl)

Special circumstances:
Inferior vena cava filter
Re-cannulation V.fem > DLK V.jug (on arrival at UKR)

Ventilator settings pre ECMO:
FiO$_2$ 1,0; HFJV
PaO$_2$: 72 mmHg, PaCO$_2$: 126 mmHg, pH: 7,10

Duration of ECMO support 7 days
Discharged from hospital
Pitfalls in Cannulation (V-v ECMO)

**Case history:** 27 yrs, female  
Sectio cesarean, Intestinal perforation, Aspiration

**Diagnosis:** ARDS

**Transport:** Following call–150 mins to start ECMO  
Transport by helicopter 120 km

<table>
<thead>
<tr>
<th></th>
<th>Pre ECMO</th>
<th>Day 1 on ECMO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PaO₂/FiO₂ (mm Hg)</strong></td>
<td><strong>39</strong></td>
<td>160</td>
</tr>
<tr>
<td><strong>PaCO₂ (mm Hg)</strong></td>
<td>43</td>
<td>44</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>7.41</td>
<td>7.39</td>
</tr>
<tr>
<td><strong>MV (mL/min)</strong></td>
<td>9.5</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>PIP (cm H₂O)</strong></td>
<td>40</td>
<td>29</td>
</tr>
<tr>
<td><strong>Norepinephrine (mg/h)</strong></td>
<td>2.0</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>MAP (mmHg)</strong></td>
<td>49</td>
<td>65</td>
</tr>
<tr>
<td><strong>HR</strong></td>
<td><strong>150</strong></td>
<td>90</td>
</tr>
</tbody>
</table>
V-v ECMO: Pitfalls in Cannulation - fatal injury

Guidewire stuck

Rupture of the femoral vein

Rupture of the jugular vein

Rupture of the subclavian vein
Options in V- a ECMO
V-a ECMO with different access

Circulatory failure with impaired Gas exchange

Circulatory failure with normal Gas exchange

ECMO; Subclavia artery and Subclavia vein

ECMO; Femoral artery and Femoral vein
Modification in cannulation V-a ECMO

- **Outflow vena jugularis**
- **Inflow arteria femoralis**

**Patient with ICM**
- Resuscitation 35 min
- Femoral vena no guidewire placable
- Extubation day 3 on ECMO
- Day 10 LVAD on ECMO
Modification in cannulation (V-V-A ECMO)

AoAsc in
V. jugularis in

V. femoralis out
Modification in cannulation

Surgical management for Stanford type A aortic dissection: direct cannulation of real lumen at the level of the Botallo’s ligament by Seldinger technique

Laszlo Göbölös, Alois Philipp, Maik Foltan, Karsten Wiebe
Interactive CardioVascular and Thoracic Surgery 7 (2008)
ECMO in Cath Lab - High risk TAVP and PCI

ECMO prevents circulatory failure

A simple method of vascular access to perform emergency coronary angiography in patients with veno-arterial extracorporeal membrane oxygenation

ECMO in Cath Lab - High risk TAVP and PCI

PCI subclavia artery

calcification femoral vessel
Pitfalls in V-a ECMO
ECMO supported CPR

Art. cannulae in femoral vene

Cannulation of wrong vessel
Percutaneous Cannulation for Extracorporeal Life Support
P. Ganselmeier, A. Philipp, L. Rupprecht et. al.
Thorac Cardiovasc Surg. 2011;59: 103-107

Ischaemia
Malperfusion
Dissection of femoral artery
Cannulaes:
Percutaneous Cannulation - De-cannulation

A. fem.

24 hrs with 30 ml

V. fem.

A. fem.
Summary Complications

Limb ischemia – compartment syndrom
- puls oximetry on the toe, US, physical examination,
- distal perfusion avoids leg ischemia
- venous access on the opposite side as arterial inflow

Accidental cannulation perforation / dissection
- Guide wire based approach – use US to identify wire

Embolisation of luminal debris

Bleeding
- skin incision, anticoagulation management

Cannula dislodgment, kinking
- adequate fixation of cannulae
Cannulation for Extracorporeal Support

Resume

don‘t force it