Outside the Protocol: Real-World Challenges in Paediatric Vascular Access

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Motol and Homolka University Hospital Prague, Czech Republic: the largest medical facility in the country and a national tertiary (super-specialised) referral centre for the most complex paediatric and adult patients.

- **Dedicated paediatric vascular access team established at the Department of Anaesthesiology and Intensive Care Medicine** in 2018.
  - Paediatric unit workload: >12,000 anaesthetics/year. Vascular access activity is increasing year by year: Current volume: ~900 central venous catheters/year (16% are medium- and long-term devices) in patients ranging from neonates to young adults

Introduction: For the patients presented in these case reports, central venous access was not optional but essential for the delivery of life-saving or prolonged therapy that could not be safely provided through peripheral access. In these critically ill children, the key challenge was therefore not whether to place a central line, but how to obtain the safest feasible access despite limited venous options, complex anatomy, and substantial procedural risk

Conclusion: In a high-volume tertiary paediatric centre, adherence to vascular access guidelines remains the standard of care; however, selected patients represent a **true "grey zone**," in which full compliance with the recommended vessel choice, catheter-to-vessel ratio, or tip position is not always feasible. This particularly applies to neonates, children with congenital heart disease, major congenital anomalies, mediastinal pathology, altered central venous anatomy, or severely limited venous capital. **In these high-risk situations, individualized decision-making based on careful risk–benefit assessment must take precedence over rigid protocol adherence**.

Such deviations should be explicitly justified, multidisciplinary, and planned together with the **vascular access team**, **intensivist / anaesthesiologist**, **the primary specialty team**, and other **relevant experts** according to the child's condition.

The **multidisciplinary team's decision** should be **clearly communicated to the patient**, whenever feasible, and to the **parents or legal guardians**, with appropriate explanation of **the indication, underlying rationale, anticipated benefits, and potential risks.**

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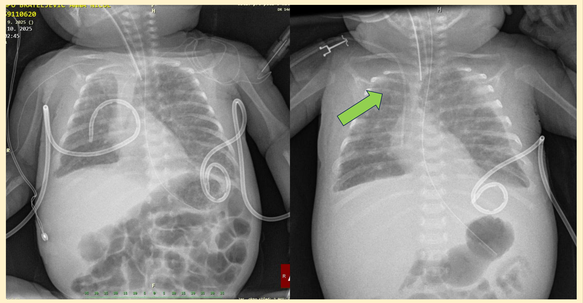
Case 1

Extremely preterm neonate (28 weeks' gestation) **from monochorionic twins** with **prenatal hydrops** (pleural effusion, ascites). **Congenital chylothorax** with prolonged high-output pleural drainage; **genetically confirmed Noonan syndrome**. Prolonged invasive ventilation with **subsequent bronchopulmonary dysplasia**. Late-onset **sepsis episodes** included Klebsiella pneumoniae septic shock and later Staphylococcus aureus bacteraemia associated with CVAD tunnel infection, necessitating repeated vascular access placement/exchange.

Venous access overview :

1. **UVC**
2. **ECC 1 Fr (**left lower limb**)**
3. **ECC 2 Fr (**right upper limb**)**
4. **CICC 2 Fr** in situ (left brachiocephalic vein)
5. **Tunnelled CICC 3 Fr** (right brachiocephalic vein)



Tunnelled CICC (right brachiocephalic vein)

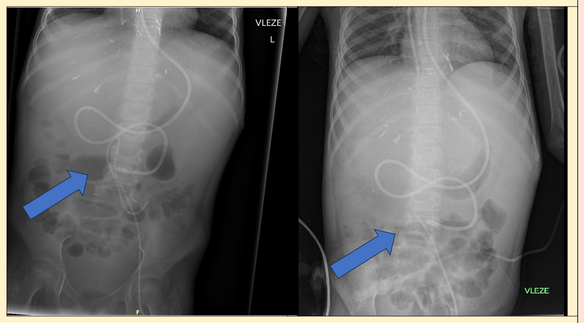
- Mid-term central venous access required due to underlying disease and current clinical status.
- **Pre-procedure mapping:** RAFEVA assessment → **femoral veins unsuitable** (small calibre); prior CVC via **left brachiocephalic vein**.
- **Planned route: Right internal jugular vein (RIJV)**. US guided → **3 unsuccessful punctures** (failed cannulation / unable to advance guidewire).
- **Alternative route: Right brachiocephalic vein**, diameter **0.28 cm** → decision (with primary team) to insert **3 Fr** catheter.
- **Technique:** 22G cannula → free guidewire passage → **Seldinger** → sheath insertion → **subcutaneous tunnelling**.
- **Tip location:** Advanced to **cavo-atrial junction**; confirmed by **ECG guidance + bubble test**.

Case 2

A 7-year-old girl with **Joubert syndrome** (congenital hepatic fibrosis, nephronophthisis/ESKD), **Chiari I**, and developmental delay underwent **liver transplantation** for **refractory oesophageal variceal bleeding**. The course was complicated by **right pleural effusion with complete right lung atelectasis** requiring **CT-guided drainage** and **suspected cholangiogenic sepsis** (prolonged inflammation; antimicrobial/antifungal escalation). She developed a **hepatic artery anastomotic dissection/ stenosis** with deteriorating flow, treated by **balloon angioplasty**, **two stents**, and **repeat angioplasty** for distal restenosis. Post-transplant she remained **anuric and dialysis-dependent** (CVVHD → **chronic**, intensified for fluid overload). A **chronic HD catheter** required **exchange for dysfunction**; **echo** showed normal cardiac function and a **suspected mural thrombus** in the **right brachiocephalic vein** near the SVC confluence.

Vascular access overview:

1. **CICC** (right brachiocephalic vein)
2. **PICC** (left cephalic vein)
3. **Long-term tunnelled haemodialysis catheter** in situ (left internal jugular vein)
4. **Tunnelled FICC 5 Fr (left femoral vein)**



Tunnelled FICC (left femoral vein)

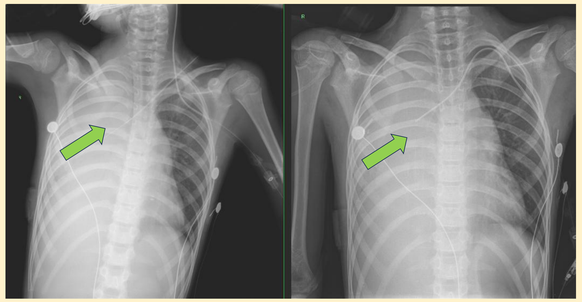
- Mid-term venous access indicated for the ongoing severe and complicated clinical condition
- **Pre-procedure mapping: RACEVA assessment** → **right brachiocephalic vein unsuitable** - a **suspected mural thrombus** (likely related to a previous CICC), **left brachiocephalic vein occupied** - long-term haemodialysis catheter
- **Technique: Left femoral approach** → uncomplicated **ultrasound-guided puncture** under **GA, tunnelled 5 Fr double-lumen FICC** inserted → tunnelled to the upper thigh
- **Tip location: Assessed by X-ray** due to **inconclusive ECG tip navigation**
- **Post-procedural X-ray** showed marked **catheter looping,** most likely due to post-transplant distortion of the inferior vena cava → **repeated repositioning** required → catheter left in a **non-ideal but functional position** with appropriate precautions and recommendations clearly communicated

Case 3

A 10-year-old boy with **a large mediastinal lymphoma, pleural effusion, and superior vena cava syndrome** was indicated for chest drain insertion. **Severe respiratory insufficiency** occurred during general anaesthesia and **VV ECMO** was initiated. After initiation of **chemotherapy**, the mediastinal mass gradually decreased in size, resulting in clinical stabilization and improvement in ventilatory parameters. Decannulation from veno-venous ECMO was therefore planned. Due to the anticipated need for ongoing therapy, placement of a **dual-lumen mid-term central venous access device** was indicated.

Vascular access overview:

1. **Recent ECMO decannulation** (right femoral vein and right internal jugular vein) - ECMO
2. **CICC 5 Fr** in situ (left femoral vein)
3. **Tunnelled CICC 5 Fr (left brachiocephalic vein)**



Tunnelled CICC (left brachiocephalic vein)

- Due to the anticipated need for ongoing therapy, placement of a dual-lumen mid-term central venous access device was indicated.
- **Pre-procedural mapping: RACEVA assessment** and **chest X-ray** → right femoral vein and right internal jugular vein excluded - recent vv-ECMO decannulation, left femoral vein already occupied by a FICC → **left brachiocephalic vein selected**
- **Technique: US-guided puncture** of **the left brachiocephalic vein** → resistance encountered during guidewire advancement → US tip navigation unsuccessful, chest X-ray demonstrated guidewire malposition (most likely in collateral veins) → **a second puncture** closer to the venous confluence → smooth guidewire passage → catheter inserted using the Seldinger technique with sheath insertion and subcutaneous tunnelling → **ECG confirmed satisfactory catheter tip position**