CATHETERIZATION PROTOCOL
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Cath Procedure Diagnosis  Pulmonary atresia/VSD/MAPCAs
Diagnostic catheterization

Hospitalization Requirement  Usually same day admission (SDA) to cardiology ward

Blood on hold (1 unit PRBC)  Not required

Pre-Cath Preparation

Everyone gets:  ECG, CXR (within 6 weeks from cath date; if clinical status is unchanged, within 3 months), CBC (cyanotic condition!)

Conditional tests:  Lytes, BUN, Creat if on digoxin, diuretics (these are rarely required in this condition)
Sickle screen if African/Caribbean descent
Clotting (APTT/INR/antiXa/standard heparin) if indicated (known clotting anomaly, anticoagulation therapy, etc)
Recent Echo not necessary if clinical status unchanged. However, a full study must have been done to document the lesion in detail and most importantly central PAs if present, coronary anatomy and absence/presence of additional VSDs.

Cardiac Catheterization

Indications  Before any patient with PA-VSD can be considered a candidate for a definitive operation, cardiac catheterization it is mandatory to delineate the size and distribution of the true pulmonary arteries and to ascertain the extent of collateral blood supply to the lungs. Also, documenting multiple VSDs and coronary artery anatomy is extremely important, particularly in infants. If this information has not been adequately established by echocardiography, angiocardiographic examination must include ventricular and aortic root angiography.

Diagnostic study may be
I: preoperative
II: postoperative:
   (a) in patients palliated by an RV-PA conduit or aortopulmonary shunt
   (b) following repair – often combined with intervention (balloon dilatation/stent insertion, coil embolizations) – not covered by this protocol
“Buzz words”

“Seagull appearance” of central PAs, wash-in/wash-out, perfusion of the lung segments, single/dual supply

Access

Femoral vein +/- femoral artery; umbilical artery in neonates
Possible routes:
- antegrade: FV → RA → RV → (via VSD) LV → AscAo
- retrograde: FA → DescAo → AscAo → LV
- (possible route in neonates) umbilical artery → DescAo → AscAo → LV

Heparin 50-150 u/kg once vascular access is established (variable dose by staff)

Kit

Sheaths: 5F to vein, 4F Cook sheath to artery. Most patients are either neonates or infants aged 6-10 months. It is possible to do the whole study from arterial access only.

Catheters and wires:
Vein - Berman angio for ventriculogram; Cobra end-sidehole for aortogram/shunt
Artery - Pigtail for ventriculogram and aortogram (insert over a guidewire); Cobra end+side hole, Judkins R coronary (shape similar to Cobra), Judkins L coronary – all these catheters can be used to cross the shunt and for selective injections into MAPCAs. May need to use Terumo glide (usually 0.025”) guidewire to cross the shunt and advance the catheter into “true” PAs.

Haemodynamic data

The patient should be in a stable respiratory and cardiovascular state prior to obtaining hemodynamic data. A baseline arterial or venous gas and saturation should be obtained and FiO2 & pCO2 noted.
If first diagnostic catheterisation, full right heart study is often performed.
Document ventricular systolic and end-diastolic pressures (RVSP=LVSP in this lesion).
Record aortic pressure and saturations (widened pulse pressure may be present if there is a large runoff into the lungs through non-stenosed MAPCAs or through the shunt).
Obtain an estimate of PA pressures: if shunt crossed – direct PA pressure measurement, if ASD/PFO crossed – PV wedge

Angiography

Ao root power injection – to search for collaterals off head and neck vessels, straight AP and lateral; to document coronary arteries, 30 RAO and 60-70 LAO +/- cranial 20-30.

Descending aortogram AP/lateral – using either an occlusion technique with a 5F Berman via an antegrade venous approach or a non-balloon retrograde arterial catheter to demonstrate the number and location of the systemic-to-pulmonary collateral arteries.
LV power injection – to profile ventricular septum LAO 70/cranial 20. This injection may also help visualising coronaries

Selective coronary angios – rarely needed (exceptions - large Ao roots, high flow rates due to the central shunt).

Shunt injection AP/lateral – possible to do from venous but best done from retrograde arterial approach (easier access). “True” pulmonary arteries may be diminutive and have a “seagull” appearance.

Selective R and LPA angiograms to identify the lung segments perfused by each PA, exclude discrete stenoses or tubular hypoplasia. Often a negative “wash-out” pattern can be seen that is due to a stream of unopacified blood from a connecting pulmonary artery or collateral flowing into an area of opacified pulmonary arterial tree. Balloon occlusion of a collateral vessel while injecting into that PA or vice versa is then helpful.

Pulmonary vein wedge injection - is helpful in identifying central pulmonary arteries if the initial aortogram and selective injection of the MAPCAs does not identify a pulmonary artery confluence. Occasionally only one native branch PA is opacified – beware of a disconnected second branch PA, look for it!

Selective hand-injections in MAPCAs AP/lateral - to delineate the extent of pulmonary arterial tree supplied by each collateral vessel and to determine which type of pulmonary artery connection is present (may be enhanced by selective balloon occlusion techniques). Collaterals found to be connected to the central PAs (“dual supply”) may be coil occluded to simplify the operative approach. Some authors suggest [4] that in more complex cases collaterals with severe proximal obstructions supplying significant lung segments isolated from the central PAs should be dilated or stented to improve distal flow prior to unifocalization.

Not all of the above injections are always necessary – base yourself on information available prior to catheterisation and decide as you go along. Remember that perfusion of each pulmonary segment must be accounted for. Watch the amount of contrast given: total dose of contrast should not exceed 10 ml/kg.

Calculations

Summarise the “native” PAs and MAPCAs anatomy in a nice diagram – staff cardiologists and surgeons will love it! Measure central PAs immediately proximal to their giving first lobar branch. Measure collateral vessels that exclusively perfuse large pulmonary segments (“single supply”) and will therefore need to be unifocalised. If central PAs of borderline size or overtly hypoplastic, calculate NAKATA index:

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\text{Nakata index (PA index) } = \frac{\text{RPA area (mm}^2\text{)} + \text{LPA area (mm}^2\text{)}}{\text{BSA (m}^2\text{)}}
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Optimal \(\geq 200\)
Post-Cath Management
Monitor distal pulses if arterial access used, if pulses weak or absent, start Heparin infusion promptly (1 h post-cath).
Maintain good hydration to reduce the risk of thromboembolic complications or hyperosmolality secondary to a large amount of injected contrast.
Generally children can be discharged home on the same day, if access site or other complications may require overnight stay.
Check O2 saturations, vital signs, examine the patient prior to discharge.
Ensure follow-up with referring cardiologist is arranged to discuss catheterisation results and plans for surgery.

References: