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How I do it: Tips, Tricks and Techniques

A PICS society education series

Percutaneous Carotid Artery Access in Congenital Cardiac Intervention

Introduction:

Percutaneous carotid access (PCA) is a relatively new form of vascular access utilized for congenital cardiac catheterization. Due to the inherent advantages of approaching interventions from the carotid vessels, carotid artery access via surgical cut-down has been historically employed for neonatal interventions. However, PCA has a number of advantages over the cut-down approach, including a less-invasive approach, reduced reliance on surgical colleagues, and greater rate of vessel patency following the intervention.[1-3] Further, PCA has been shown to be an optimal approach (especially compared to femoral artery or vein) for specific high-risk procedures including placement of a ductal artery stent, balloon aortic valvuloplasty, and angioplasty/stent of an occluded systemic-to-pulmonary shunt.[2, 4, 5]

(*short paragraph*)

Anticipated challenges of the procedure:

1) Equipment: ultrasound guidance, needle selection, hydrophilic radial sheath, guidewire selection
2) Approach: “flipping” neonate and cath lab setup, limiting sheath time in carotid
3) Procedure: heparinization, minimizing vessel trauma, securing sheath
3) Post-procedural: hemostasis, planned ICU admission, intubation overnight, prophylactic heparin drip, surveillance vascular ultrasound.

(*Please describe any challenges that you may anticipate in doing this procedure*)

TIP 1. Planning and Preparation

1. Access – Performing arterial puncture during PCA can be quite challenging as the carotid artery is not confined in lateral space. Puncture, then, is best completed with a needle that is of small caliber (24-gauge Galt Medical™ or 30-gauge NeoMedical™ Neo-Magic Modified Seldinger Introducer kit) and is exceptionally sharp in order to puncture through the muscular layer of the vessel. Access can be performed with a standard 21-gauge needle perc needle, but improved efficiency with the aforementioned equipment which can avoid vessel "rolling".

2. Imaging – Ultrasound guidance is a requirement during PCA, utilizing a vascular probe with depth set down to ~2cm. Pre-procedural advanced cross-sectional imaging (i.e., CTA) is helpful in planning interventions such as ductal stenting, especially as selection of the right vs. left common carotid artery is critical to the success of stenting in these cases. Some centers have utilized such CTA images to help plan camera angulations during the catheterization procedure. Software applications (such as 3Mensio) allow for virtual implants of stents (outlining the ductal tortuosity index and predicting stent length). A decision regarding which

'Percutaneous carotid access is a team sport…involving the Anesthesia team and techs/nurses as much as the primary operator.'

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carotid artery to access can be influenced greatly by the pre-procedural imaging better characterizing the ductal tortuosity and/or origin.

3. Guidewire selection: it is advisable to use a very floppy, nitinol-tipped 0.014" guidewire through the perc needle when accessing the common carotid artery. Oftentimes, the body of such wires is insufficient to safely advance a 4 french sheath. Therefore, we recommend using a micropuncture dilator to then swap out the 0.014" floppy guidewire for a traditional access guidewire (0.018" caliber) that will be less prone to bending in the percutaneous track. This extra step guards against the devastating vascular complication that can occur if the guidewire easily bends in the perivascular soft tissue with advancement of the sheath.

4. Other – Team preparation and comfort is crucial to limiting sheath time within the carotid artery. Staff familiarity with patient inversion (outlined below) and cath lab

setup will improve efficiency. Having all tools/equipment pulled/ready for usage will help limit procedural time during “crucial steps”.

Tip 2. Tools needed

1. Sheaths – Hydrophilic/radial access short sheaths are preferred for PCA in order to limit trauma to the arteriotomy site. Of note, be wary of the “thin-wall” sheaths (such as the MeritMedical Prelude Ideal™ sheath) if ductal stenting is planned. Some stent platforms will not come back into the thin-wall short sheath if the decision is to change stent size.

2. Catheters – The intended intervention will drive catheter selection, but this can be assisted by pre-procedural cross-sectional imaging. A carotid approach in neonates will significantly decrease the distance to intended intervention (Aortic valvuloplasty or ductal stenting), therefore the utilization of short length catheter and wires will save time if feasible. Additionally, having a “plan for approach” with regards to specific turns/angles an operator will need to navigate from the pre-procedural imaging will guide catheter choice selection.

3. Devices – The intended intervention will dictate device selection, but having several options of balloons/stents readily available is crucial to limit sheath time with PCA. This is particularly prudent in ductal stenting, where numerous options for stent length(s) should be available for utilization in a timely fashion. Patients with high grade ductal tortuosity indices can lend to quite variable lengths after these ducti are straightened with a stiff wire system. Further, thorough consideration must be placed to the wire over which to perform the transcatheter intervention. For example, with ductal stenting and PCA, we commonly navigate through the ductus arteriosus with a floppy 0.014” wire to establish adequate wire position into the intended lung field. The wire is then exchanged via a microcatheter to a stiffer 0.014” wire platform in order to deliver the stent into place intra-ductal.

4. Others – Lengthened ventilator and medication line tubing is a must if the neonate “flipped” on cath table. An inverted patient will take the head of the patient away from the Anesthesia team. Ensuring an adequate length of the ventilator tubing and adequate access to medication line(s) will prevent challenges once the patient is prepped and draped for the procedure.

Tip 3. How I do it

1. Pre-procedural Imaging – The decision of which carotid artery (left/right) to perform PCA will be based on the intended intervention and the pre-procedural imaging. In

the example of ductal stenting, consideration to ductal origin and tortuosity index will need to be taken into account as well. As mentioned above, deciding on optimal camera angles and postulating at the intended ductal stent length (and diameter) can be greatly aided by CTA imaging. If there is concern for pulmonary artery coarctation, this may play into which lung bed the distal wire is place during intervention.

2. Perform patient “flipping” (if a neonate) –

-The goal is to invert the patient completely on the catheterization table prior to draping and performing PCA. Patients are transferred from the stretcher to the cath lab table in the “normal” orientation. The Anesthesia team then performs induction, airway stabilization (intubation), and line placement as per their standard routine **(Figure 1)**. Once completed (and tubing identified to be long enough as outlined above), the staff coordinates a patient flip so as to place the feet at the traditional head of the cath lab table **(Figure 2)**. The camera boom is taken to the opposite side of the cath table and fluoroscopic (AP and lateral) images are inverted. The patient is then positioned for adequate access into the expected carotid artery with a shoulder roll and the anesthesia team ensures stable airway security as well as access to the lines for medications **(Figure 3)**. The patient is prepped and draped in a standard fashion. Ultrasound guidance is utilized during PCA and the hydrophilic short sheath is placed as above, the remaining portion of the cath table being dedicated to a working space for the operator and assistant(s) **(Figures 4&5)**.

   a. *Video of patient preparation and then flipping/inversion as attached.

3. Pitfalls to avoid:

-If flipping the patient:

a) make sure to invert the fluoroscopic images. Inversion needs to be done on the AP as well as the lateral camera planes.

b) check the position of the endotracheal tube before prepping and draping the access site. It is much easier to address the tube prior to covering the patient – and in our experience it is quite easy to have a tube advance to the right mainstem, or pulled to the oropharynx, with the flip technique.

-Be very mindful to the depth of the short sheath upon gaining access. If the correct carotid artery is chosen (based on ductal origin), one might find themselves already within the ductus arteriosus solely with the distal tip of the short sheath!

-Post-procedure hemostasis should be performed by a very experienced staff member (or operator) to ensure direct pressure on the arteriotomy site. Consider the usage of the ultrasound to guide pressure location and pressure in order to prevent accumulation of a hematoma.

[*1/2) Details of the individual tip and technique – Use figures, link to videos with Figure legends. 3) Pitfalls to avoid:*]

Tip 4. What complications to expect and how to deal with them

-Inability to change stent platform through the thin wall short sheath. Prevented by utilizing a hydrophilic radial artery short sheath during PCA.
-Hematoma formation. Post-procedure hemostasis should be performed by an experienced operator/staff member. Once hemostasis is achieved, consider another 10 minutes of "supportive" digital pressure on the access site to help prevent pseudoaneurysm. Utilize ultrasound imaging to guide point of pressure onto arteriotomy site and one finger, no gauze.
-Pseudo-aneurysm or clot formation. Once hemostasis is established, transfer to ICU and keep patient intubated overnight with generous sedation. Ensure hemostasis and then provide prophylactic heparin drip overnight. Follow up ultrasound imaging of the carotid is performed the following morning. If any evidence for clot within the vessel lumen, then place on Lovenox therapeutic Lovenox dosing for at least 72 hours and repeat imaging to guide further management.

(*Brief paragraph or bullet points*)

Summary:

-PCA has emerged as a new option for transcatheter access with improved efficacy for certain interventions and an encouraging safety profile as thus far outlined in mid-term follow up. As the experience of operators with PCA increases, techniques particular to this form of access (such as patient flipping/inversion) and technologies have been identified that facilitate the procedure. The inherent benefits of PCA in certain transcatheter interventions have challenged the norm of that which is performed routinely within the congenital interventional catheterization laboratory.

(Brief paragraph)

References:

(*Limit to less than 5*)

1. Justino H and Petit CJ. Percutaneous Common Carotid Artery Access for Pediatric Interventional Cardiac Catheterization. *Circ Cardiovasc Interv*. 2016;9:e003003.
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3. Bauser-Heaton H, Qureshi AM, Goldstein BH, Glatz AC, Nicholson GT, Meadows JJ, Depaolo JS, Aggarwal V, McCracken CE, Mossad EB, Wilson EC and Petit CJ. Use of carotid and axillary artery approach for stenting the patent ductus arteriosus in infants with ductal-dependent pulmonary blood flow: A multicenter study from the congenital catheterization research collaborative. *Catheter Cardiovasc Interv*. 2020;95:726-733.
4. Ligon RA, Ooi YK, Kim DW, Vincent RN and Petit CJ. Intervention on Surgical Systemic-to-Pulmonary Artery Shunts: Carotid versus Femoral Access. *JACC Cardiovasc Interv*. 2017:In Press.
5. Lahiri S, Qureshi AM, Justino H and Mossad EB. Percutaneous Common Carotid Artery Access for Cardiac Interventions in Infants Does Not Acutely Change Cerebral Perfusion. *Pediatr Cardiol*. 2022;43:104-109.

FIGURES

Figure 1 – Pre-procedure. The anesthesia team intubates and induces patient with the normal orientation on the cath lab table, having the head (red arrow) towards them.

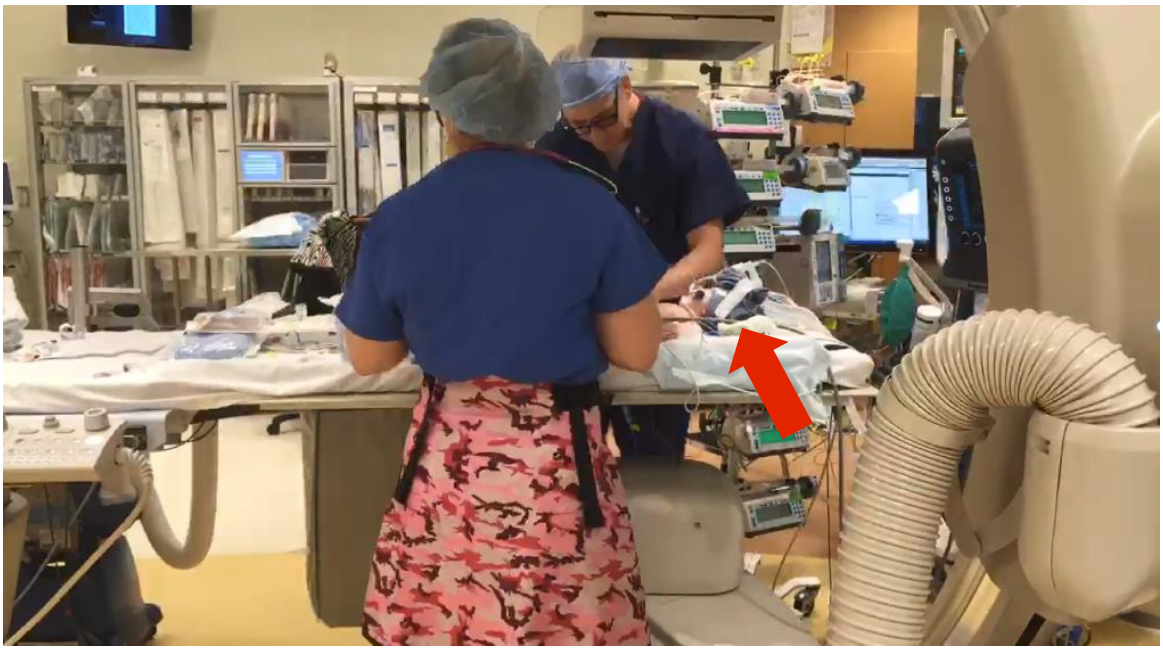

Figure 2 – Patient inversion. After flipping/inverting the patient, the patient's feet are now towards the anesthesia team and the boom is taken to the opposite side of the cath table.

Figure 3 – Patient preparation. A shoulder roll is placed exposing the intended right carotid artery (red arrow) and endotracheal tube secured away from the field.

Figure 4 – Access. The primary operator works from the patient's head towards the intended carotid artery and the ultrasound on the opposite side of the table (white arrow). It is *crucial* to remember to invert the image on the AP and lateral cameras prior to performing fluoroscopy. The medication lines are lengthened to the feet of the patient for easy access by the anesthesia team (red arrow).

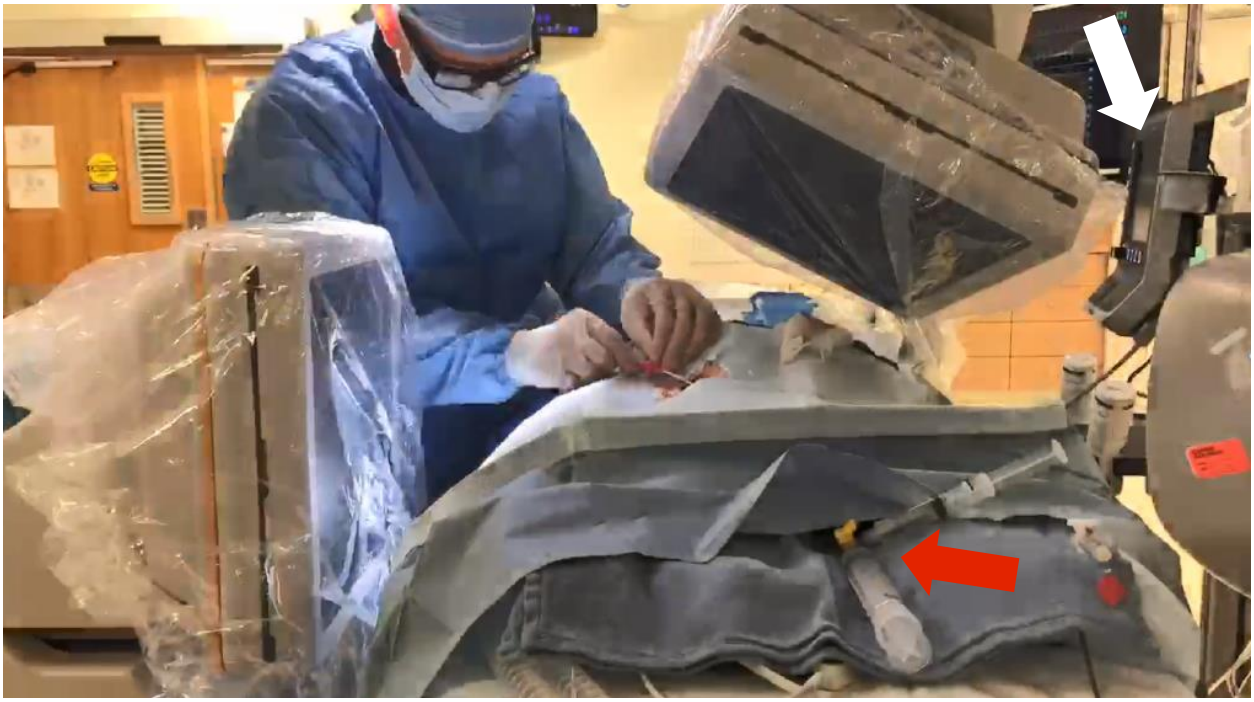

Figure 5 – Workspace. The operator is now able to have the sheath facing them and perform the intended intervention in a patient caudal direction (towards the anesthesia team). The remaining length of the cath table is utilized for wire/catheter/device manipulation.