ESC European Society of Cardiology
European Heart Journal - Case Reports
doi:10.1093/ehjcr/ytaa554

CASE REPORT
Congenital heart disease

Axillary artery access for stenting of aortic coarctation in a 1.2 kg premature newborn with malignant systemic hypertension: a case report

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Received 25 April 2020; first decision 7 July 2020; accepted 10 December 2020

Background Axillary artery access is rarely used for demanding percutaneous transcatheter interventions. However, there are many clear advantages.

Case summary We describe this attractive approach in a 3-week-old premature neonate (bodyweight of 1.2 kg) with severe aortic coarctation. Percutaneous transcatheter intervention was performed with analgo-sedation and local anaesthesia; and a coronary stent was placed with a low fluoroscopy time of 2 min. Malignant systemic hypertension (160/54 mmHg) was effectively treated without any residual blood pressure gradient, with the aim for definitive surgery with stent resection and end-to-end anastomosis at the age of 6–12 months.

Discussion Axillary artery access is an attractive, alternative approach to treat newborns and premature infants with low body weight with complex heart diseases.

Keywords Premature newborn • Coarctation • Malignant hypertension • Coarctation stenting • Axillary access • Case report

Learning points

- Severe aortic coarctation in preterm infants with low birth weight remains a therapeutic challenge.
- Axillary artery access can be safely used with light sedation and local anaesthesia.
- Percutaneous transcatheter intervention is a temporary therapeutic palliation for bridging to a definitive surgery or catheter-based intervention.

Introduction

Based on Gerd Hausdorf's experience in the early 1990s,[1] axillary artery (AA) access is part of our repertoire for treating newborns with demanding transcatheter interventions. We previously reported extensively on the AA approach.[2] Indications using the AA access are duct stenting in newborns with duct-dependent pulmonary blood flow, balloon valvuloplasty for the relief of critical aortic valve stenosis, and angioplasty or stent placement for treatment of an aortic coarctation (CoA).[3–5]

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Handling Editor: Sylvia Krupickova
Peer-reviewers: Golnaz Houshmand; Arif Anis Khan; Sylvia Krupickova
Compliance Editor: Anastasia Vamvakidou
Supplementary Material Editor: Deepti Ranganathan

Here, we describe our smallest patient (birth weight of 925 g) in whom AA was used to treat malignant systemic hypertension caused by a severe CoA.

Timeline

Day 0	The cardiovascular exam revealed a 3/6 systolic murmur at the lower-left sternal border and arterial hypertension in the arms; femoral pulses were non-palpable.
Day 1	Transthoracic echocardiography showed a closed arterial duct and a coarctation of the aortic isthmus.
Day 5	The hypertrophied left ventricle was still contracting well, but a significant mitral valve regurgitation was present.
Day 7	Catheterization and coarctation stenting were performed by axillary artery access.
Day 14	Clinical and weekly echocardiographic follow-ups show still excellent result.
Day 26	Patient discharged home with a weight of 2 kg and under the further outpatient follow-up care.
Month 1–8 after discharge	Monthly follow-up examination.
Month 9 after discharge	Planned surgery with removal of the stent and end-to-end anastomosis is intended to perform at an age of 8 months.

Case presentation

A 17-day-old male premature twin, delivered by caesarean section in the 31st gestational week without external malformations was referred due to systolic heart murmur. On the initial examination at rest, the heart rate was 119 b.p.m., blood pressure at upper limb 93/54 mmHg, femoral artery pulses were weakly palpable and the pulse-oximetric measured oxygen saturation was 99%. Cardiovascular examination revealed a 3/6 systolic murmur at the lower-left sternal border, the lungs were clear. Transthoracic echocardiography showed a CoA with a vessel diameter of about 1 mm and an associated systolic peak pressure gradient of 66 mmHg and a low-velocity Doppler-flow pattern obtained from the coeliac trunk. The arterial duct was closed, the aortic valve normal. The hypertrophied left ventricle contracted well, but with a significant mitral regurgitation and associated restrictive interatrial communication of 2–3 mm with a turbulent left-to-right shunt (*Figure 1A–D*). Considering the body weight (1.2 kg), vascular lesion, haemodynamics, and risk-benefit assessment, we decided on palliative treatment with a percutaneous transcatheter procedure using the AA access from the right arm. Following written informed consent of the parents, the baby was catheterized for interventional treatment of the CoA in balanced analgo-sedation, the right armpit was prepared in an aseptic condition (*Figure 2*). For positioning, the head was slightly turned to the left, the upper right limb was angled away from the chest by about 100–120°. After axillary artery puncture, a 0.014-inch Hi-Torque Balance Middleweight (BMW) guide wire (Abbott Vascular, Abbott Park, IL, USA) could easily be advanced to the descending aorta (DAO) and a 2.7 Fr arterial leader Cath (Vygon GmbH, Aachen, Germany) was launched over the wire within the DAO. The position was confirmed by injection of a small amount of contrast medium; the BMW guide wire was exchanged to a 0.021-inch guidewire for subsequent placement of a 4 Fr Glide-sheath Slender (Terumo Corporation, Tokyo, Japan) in the right subclavian artery. After removal of the sheath mandrill, a 0.014-inch Hi-Torque Extra S'port guide wire (Abbott Vascular, Abbott Park, IL, USA) was additionally positioned in the DAO for the interventional procedure and the 0.021-inch guide wire was removed. The invasively measured blood pressure was 160/54 mmHg despite sedation. Angiography through the 4 Fr sheath using 1-ml bolus injection of contrast medium revealed a bovine aortic arch and an extreme coarctation with a diameter of <1 mm and about 4 mm post-stenotic DAO (*Figure 2*). For stenting, the CoA, a 4 × 8 mm Xience Pro coronary stent (Abbott Vascular, Temecula, CA, USA) was advanced over the S'port guide wire through the 4 Fr sheath. After confirming the correct position, the stent was expanded to a diameter of about 4.3 mm. The angiography showed the desired result with a harmonically modelled stent on the vessel wall without pressure gradients (*Figure 2*). Immediately after placement of the stent, the left subclavian artery showed a temporarily decreased blood flow, which looked like a contrast agent-induced vasospasm or may be an air bubble, but without any sequalae. The single intravenous administration of 100 U heparin after placement of the sheath was supplemented with a second dose of 50 U heparin, followed by heparin in a continuous infusion of 300 U/day for further 3 days, before 2 mg/kg of body weight aspirin was administered orally. The 4 Fr sheath was removed, and the right AA very carefully compressed. The total fluoroscopy time was 1.9 min, the product dose × area was 14 μGym^2.

The improvement of the clinical condition correlated with the excellent result in angiography and in the follow-up echocardiography. The post-procedure peak gradient across the coarctation was 25 mmHg. The post-procedure Imaging and Doppler-flow profile of the coeliac artery are shown at *Figure 3*.

Follow-up visits were performed monthly after the child was discharged at 6 weeks of age (*Table 1*). The systolic blood pressure ratio between the upper and lower body remained between 6 and 12 mmHg. However, the calculated peak-Doppler gradient increased meanwhile from 25 mmHg to currently 44 mmHg, which probably represents the progression of the reduced stent-related vascular compliance. The small atrial septal defect was not detectable in the follow-up.

Aspirin administration is expected to continue until the final surgery. Surgical correction with removal of the stent and subsequent end-to-end anastomosis is intended to perform at an age of 8 months.

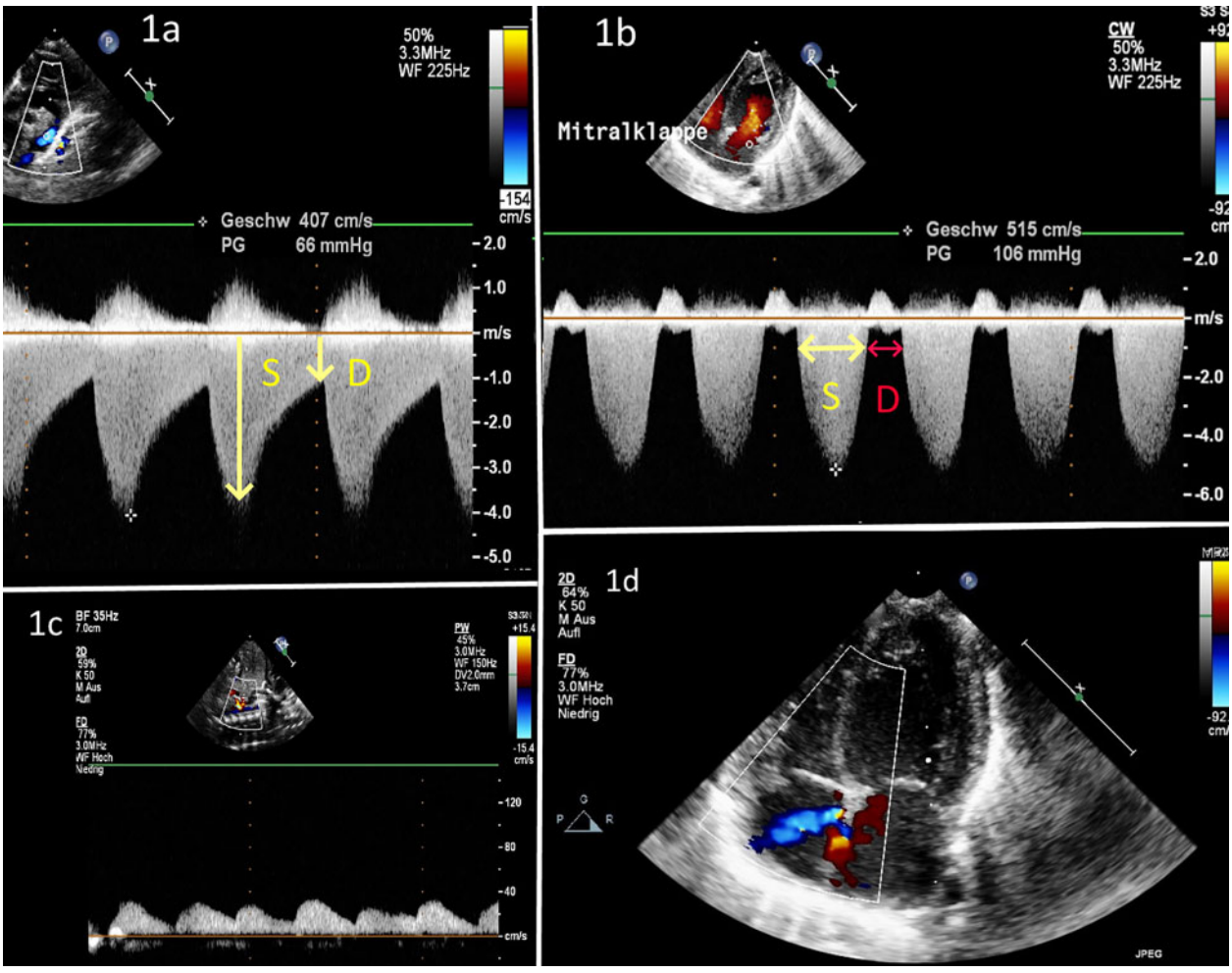

Figure 1 (*A*) The aortic coarctation and the continuous wave Doppler measurements across the aortic coarctation. S marks the systolic velocity and D the diastolic pattern. (*B*) The non-obstructed, diastolic inflow through the mitral valve as well as the continuous wave Doppler (CW) of the mitral regurgitation. (*C*) The almost venous blood flow pattern obtained by pulse wave Doppler (PW) of the coeliac artery. (*D*) The left-to-right shunt across a small, restrictive atrial septum defect.

Discussion

Nowadays, healthcare is divided into communicable and non-communicable diseases.[6] However, the main cause of death in newborns, infants, and children remains a rare, but life-threatening illness. Severe aortic obstruction in a premature baby is one of those non-communicable diseases that require individual decision-making to treat with the lowest mortality and morbidity.

The AA access has been part of our repertoire for interventions in newborns with critical congenital heart diseases for more than two decades. It has previously been published[2,3,5] that this approach is a useful alternative, especially when compared to access to the femoral and carotid artery arteries. As part of a significant CoA, the AA is our preferred access for safety and convenience. Considering CoA-related hypertension, pulsating AA can be easily punctured, especially in an extremely small patient. The AA is not an end-artery. During cannulation of the AA, there is still perfusion through the acromial artery and the second intercostal artery. Percutaneous femoral access in small patients with low-flow femoral arteries poses a high risk of vascular injury and a remaining iliac artery lesion. In our institution, only one newborn has been treated through the carotid artery in the past 25 years. There is ongoing debate on the risks and benefits of carotid vs. axillary access. Our case report should refresh the benefits of AA access, which does not currently require surgical cut-down and can be performed percutaneously. It should also underline that carotid access can be avoided if also a general anaesthesia is required for surgical support. Fatal thromboembolism, carotid occlusion, and carotid stenosis are significant possible complications of carotid access. Another important consideration is airway compression, as a large carotid haematoma could cause tracheal compression or deviation. Therefore, all patients catheterized with carotid access need endotracheal anaesthesia. Furthermore, aortic arch anomalies as here a bovine aortic arch favour further the AA approach. The AA access undoubtedly has its own potential for complications such as arterial dissection, haematoma formation, excessive bleeding, and nerve palsy.[2] Therefore, a step-by-step approach can minimize

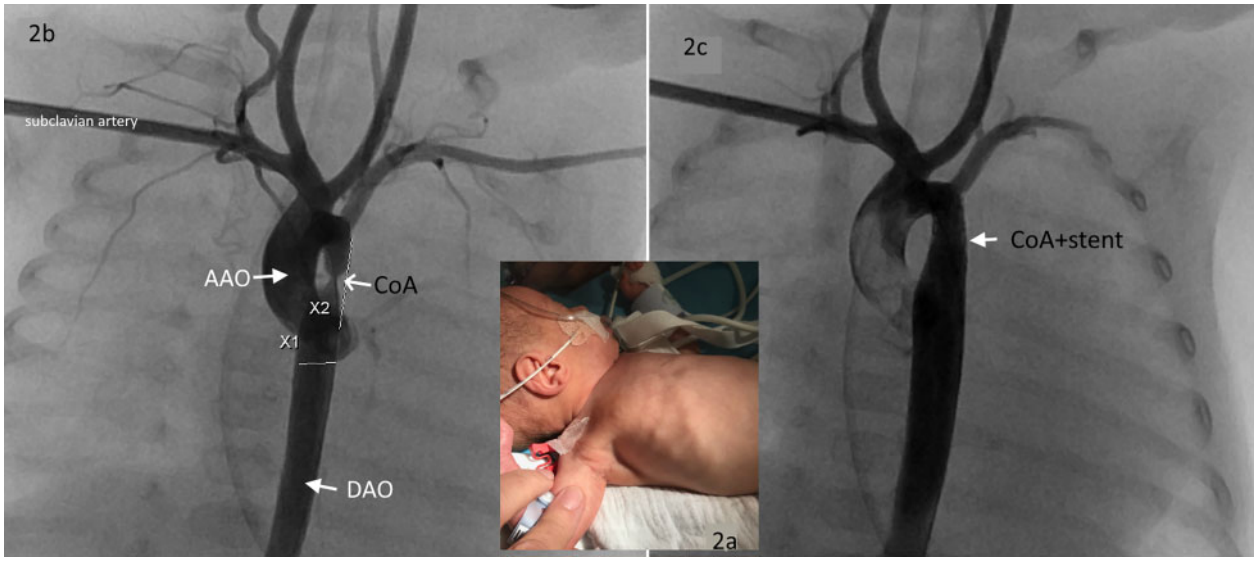

Figure 2 (*A*) The arm pit, where the axillary artery access was performed for percutaneous treatment of the severe aortic coarctation as shown on angiography (*B*) by stent placement (*C*). AAO, ascending aorta; DAO, descending aorta; CoA, Coarctation of the aorta; X1, descending aortic diameter; X2, estimated stent length.

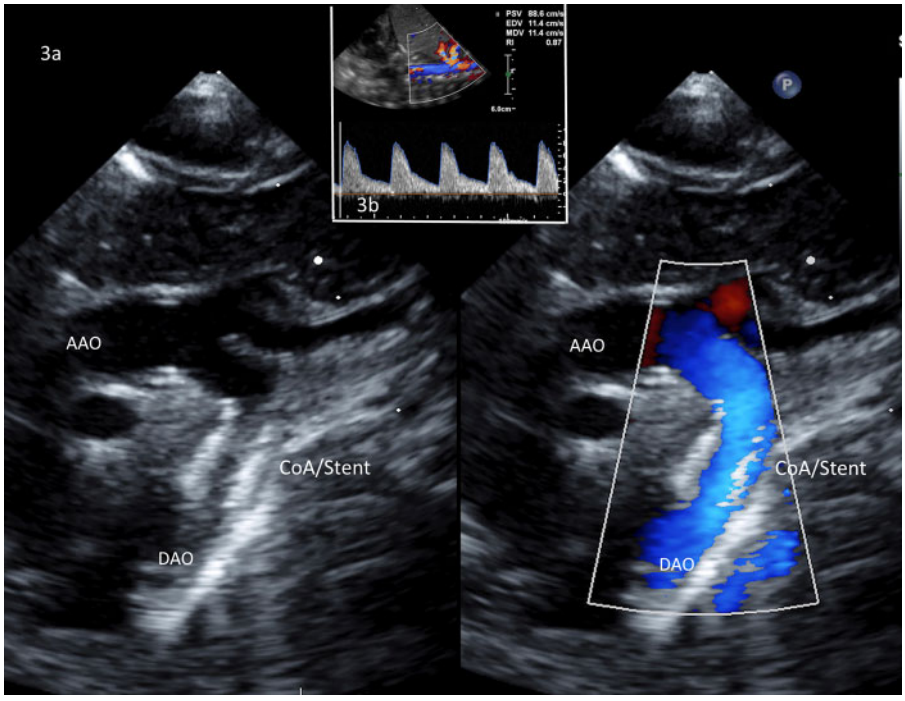

Figure 3 (*A*) The positioned coronary stent in the descending aortic arch in 2D- and Color-Doppler echocardiography; (*B*) the normalized blood flow in the coeliac artery. AAO, ascending aorta; DAO, descending aorta; CoA, Coarctation of the aorta.

complications by using AA access with a low radiation in a premature infant. Another important reason for stenting the extreme stenotic lesion is that only ballooning of the lesion would be less effective and any effect would only last for a short period of time. As part of our aim to achieve an effective relief from life-threatening CoA, we chose a short stent of sufficient width so that the surgeon can perform a stent resection later in childhood with an end-to-end anastomosis regardless of whether an adaptive re-dilatation of the stent should become necessary in the meantime.

Table 1 Results of monthly follow-up examinations

Follow-up time (month)	Doppler peak gradient (mmHg)	Bodyweight (kg)	BP upper extremities (mmHg)	BP lower extremities (mmHg)
1	25	2.3	90/50	84/58
2	28	2.6	85/63	86/53
3	44	3.4	94/65	83/72
4	48	3.9	97/58	84/49
5	46	4.6	—	—
6	44	5.2	92/57	81/44

BP, blood pressure.

Conclusion

In summary, our case report again shows that axillary access is an attractive, alternative approach to the treatment of newborns and premature babies with low bodyweight and complex heart diseases.

Lead author biography

Anoosh Esmaeili, MD, is a senior paediatric cardiologist at the University Hospital of Frankfurt/Main. His areas of interest include catheter intervention of congenital heart disease and paediatric intensive care medicine.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient's parents in line with COPE guidance.

Conflict of interest: none declared.

Funding: none declared.

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