

Left carotid artery cannulation for selective antegrade cerebral perfusion in neonatal arch repair after VA-ECMO-related right carotid occlusion: a technical case report

Ilaria Meazza

ilaria.meazza@unimi.it

ASST Papa Giovanni XXIII

Jacopo Capussela

ASST Papa Giovanni XXIII

Antonino Barletta

ASST Papa Giovanni XXIII

Francesca Julia Papesso

ASST Papa Giovanni XXIII

Nicola Uricchio

ASST Papa Giovanni XXIII

Francesco Seddio

ASST Papa Giovanni XXIII

Case Report

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Abstract

Selective antegrade cerebral perfusion (SACP) can be used during neonatal aortic arch repair to reduce neurologic injury, most commonly via the right carotid artery. However, alternative strategies are required when this approach is not feasible.

We report a neonate with critical pre-isthmus coarctation of the aorta who developed complete right common carotid artery occlusion after jugulo-carotid extracorporeal membrane oxygenation (VA-ECMO) support.

Surgical repair was performed via median sternotomy using cardiopulmonary bypass. SACP was established via cannulation of the left common carotid artery, combined with continuous coronary and visceral perfusion to maximize organ protection. Cerebral perfusion was guided by multimodal neuromonitoring.

The procedure was successfully completed without neurologic complications and postoperative imaging confirmed adequate cerebral perfusion.

This case highlights left common carotid artery cannulation as a viable alternative for SACP when standard right-sided access is not available in neonates after VA-ECMO-related carotid occlusion.

INTRODUCTION

Coarctation of the aorta (CoA) associated with arch hypoplasia in neonates often requires repair under cardiopulmonary bypass. Neonates are particularly susceptible to perioperative neurologic injury due to high cerebral metabolic demand. In addition, patients with congenital heart disease often present impaired preoperative cerebral blood flow. In this context, the use of selective antegrade cerebral perfusion (SACP) is widely adopted to protect the brain (1). SACP can be achieved either by interposition of a vascular graft onto the innominate artery or through direct arterial cannulation using small-caliber cannulas, allowing continuous cerebral perfusion and improving surgical safety and postoperative outcomes (2, 3). Despite its increasing use, no standardized protocol exists (3). Moreover, evidence regarding optimal cerebral perfusion strategies in high-risk neonates remains limited, particularly in the presence of pre-existing right carotid artery occlusion.

We report a case of neonatal aortic arch repair in which SACP was successfully established via the left common carotid artery in the presence of complete right carotid artery occlusion, a known complication following VA-ECMO in neonates.

CASE REPORT

A male neonate was born at term with a weight of 2570 g (small for gestational age) and was discharged home on day 4 of life without apparent complications. At 11 days of age, he experienced a sudden cardiorespiratory arrest following an episode of intense crying. Cardiopulmonary resuscitation

(CPR) was initiated by the mother under telephone guidance from emergency services, achieving return of spontaneous circulation (ROSC). Upon arrival of the emergency team, the patient developed severe respiratory distress followed by a second cardiac arrest, requiring advanced CPR with endotracheal intubation and epinephrine administration. He was transferred to our institution with transient ROSC during transport. Given his profound hemodynamic instability, VA-ECMO was established via surgical cannulation of the right internal jugular vein and right common carotid artery. Transthoracic echocardiography was initially inconclusive due to altered flow patterns related to ECMO support (4). VA-ECMO was discontinued after 4 days. Following decannulation and hemodynamic stabilization, echocardiography demonstrated a focal pre-isthmus narrowing, located approximately 5.5 mm distal to the origin of the left subclavian artery, with a peak systolic gradient of 72 mmHg and diastolic runoff (Fig. 1).

A patent ductus arteriosus (PDA) in the process of closure was also present. Upper-to-lower limb blood pressure discrepancy (120/60 mmHg vs. 60/40 mmHg) confirmed the diagnosis of critical coarctation of the aorta. Prostaglandin E1 infusion was initiated. The early post-ECMO period was complicated by severe thrombocytopenia ($< 10,000/\mu\text{L}$), likely multifactorial; septic shock due to *Klebsiella pneumoniae* and *Escherichia coli*, treated with piperacillin-tazobactam; acute kidney injury requiring peritoneal dialysis. Due to this constellation of comorbidities, immediate surgical repair of CoA was deferred until he reached a more stable clinical state. During this period, transfontanellar ultrasound revealed reduced perfusion in the right cerebral hemisphere with ipsilateral carotid artery occlusion and adequate compensatory flow from the left side. Computed tomography angiography confirmed complete occlusion of the right common carotid artery (Fig. 2) and the severe pre-isthmus coarctation with a minimal diameter of 1.5-2 mm.

Following multidisciplinary discussion and progressive clinical improvement, surgical repair via median sternotomy using cardiopulmonary bypass (CPB) and advanced perfusion strategies was planned.

At 27 days of life, the patient underwent surgical repair. Intraoperative monitoring included right radial and right femoral arterial lines, cerebral near-infrared spectroscopy (NIRS) and transfontanellar Doppler ultrasonography. CPB was established between the ascending aorta (6 Fr arterial cannula) and the right atrium (14 Fr venous cannula). Due to elevated arterial resistance, an additional 6 Fr cannula was temporarily placed in the PDA to provide visceral perfusion, complemented by distal perfusion through the femoral arterial line (20G, 6 cm). At a core temperature of 26°C , the PDA was ligated and divided. SACP was initiated through cannulation of the left common carotid artery using the previously placed PDA cannula, secured with a purse-string suture at the carotid base to minimize vascular trauma. Cerebral perfusion flow was not predetermined but dynamically adjusted based on continuous multimodal neuromonitoring, with the aim of maintaining stable bilateral cerebral oxygen saturation and preserved transfontanellar Doppler flow patterns. Simultaneously, continuous coronary (50 mL/min) and visceral (40 mL/min) perfusion were maintained. The aortic isthmus was closed, controlling the descending aorta with a Castaneda clamp. All ductal tissue was carefully resected. A termino-lateral anastomosis was performed after a retrograde incision of the aortic arch, up to the origin of the first

supra-aortic vessel. The patient was successfully weaned from CPB after rewarming, with low-dose epinephrine.

The postoperative course was uneventful. The patient was extubated on postoperative day 7 and transferred to the pediatric ward on day 14. Serial neurological assessments revealed no new neurologic injuries. Anticoagulation and antiplatelet therapy (heparin and aspirin) were initiated due to thrombosis of the right carotid and femoral arteries. The patient was transferred to a rehabilitation facility on postoperative day 20 and discharged home 45 days after surgery. During this period, echocardiography showed satisfactory surgical results (Fig. 3) with mild residual flow acceleration across the repaired segment (peak gradient 17 mmHg).

Vascular surgery evaluation allowed discontinuation of heparin due to the recanalization of the right femoral artery and stable right carotid artery occlusion.

At one-month follow-up, echocardiographic findings remained stable and aspirin was discontinued. At latest follow-up, nearly one year after surgery, the patient remains clinically stable, with normal growth and no evidence of neurologic impairment.

DISCUSSION

Neurologic injury remains a major concern in neonatal aortic arch surgery, particularly in fragile patients with preoperative hemodynamic instability and a brain already exposed to significant preoperative insults. While deep hypothermic circulatory arrest (DHCA) has historically been used, SACP has emerged as a valuable neuroprotective strategy, allowing continuous cerebral perfusion without increasing mortality or major complications, as reported in comparative studies (5). SACP was selected to maintain continuous cerebral perfusion and minimize the risk of further ischemic injury. SACP usually relies on right-sided arterial inflow; however, carotid artery thrombosis, which is recognized as a complication in neonates after VA-ECMO support (6), may limit its use.

In the present case, preoperative neuroimaging demonstrated preserved collateral cerebral circulation, supporting the feasibility of left carotid artery cannulation. Continuous multimodal neuromonitoring allowed real-time adjustment of perfusion flow, ensuring adequate bilateral cerebral oxygenation throughout the procedure. Perfusion flow rates were selected within ranges reported in the literature and tailored according to real-time cerebral monitoring. Postoperative neurological evaluation revealed no new cerebral injury and follow-up imaging confirmed adequate cerebral compensation despite persistent right carotid occlusion.

An additional relevant aspect is the integration of a whole-body perfusion strategy, combining cerebral, coronary and visceral perfusion. This approach may be particularly beneficial in high-risk neonates with prior circulatory collapse, as it minimizes ischemic burden to multiple organ systems.

Although limited to a single case, our experience supports the concept that left common carotid artery cannulation may be considered for SACP in neonatal aortic arch repair when the right carotid artery is unavailable.

CONCLUSIONS

This strategy may represent a practical alternative for neuroprotection in selected neonates when right carotid access is not available. Careful preoperative assessment and intraoperative multimodal neuromonitoring are essential to ensure adequate perfusion. In fragile neonates, individualized perfusion strategies integrating cerebral, myocardial and visceral perfusion may contribute to global organ protection. Further studies are needed to better define standardized protocols and optimal perfusion parameters.

Declarations

Conflict of interests:

the authors declare that there is no conflict of interest.

Informed consent:

no identifiable information was disclosed in writing this article, however the patient's parents have given their informed consent.

Author Contribution

I.M. and J.C. wrote the main manuscript text. A.B. is the neuroradiologist who performed the preoperative imaging and neuromonitoring during surgery. F.J.P., N.U. and F.S. are the pediatric cardiac surgeons that operated the patient. All authors reviewed the manuscript.

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Figures

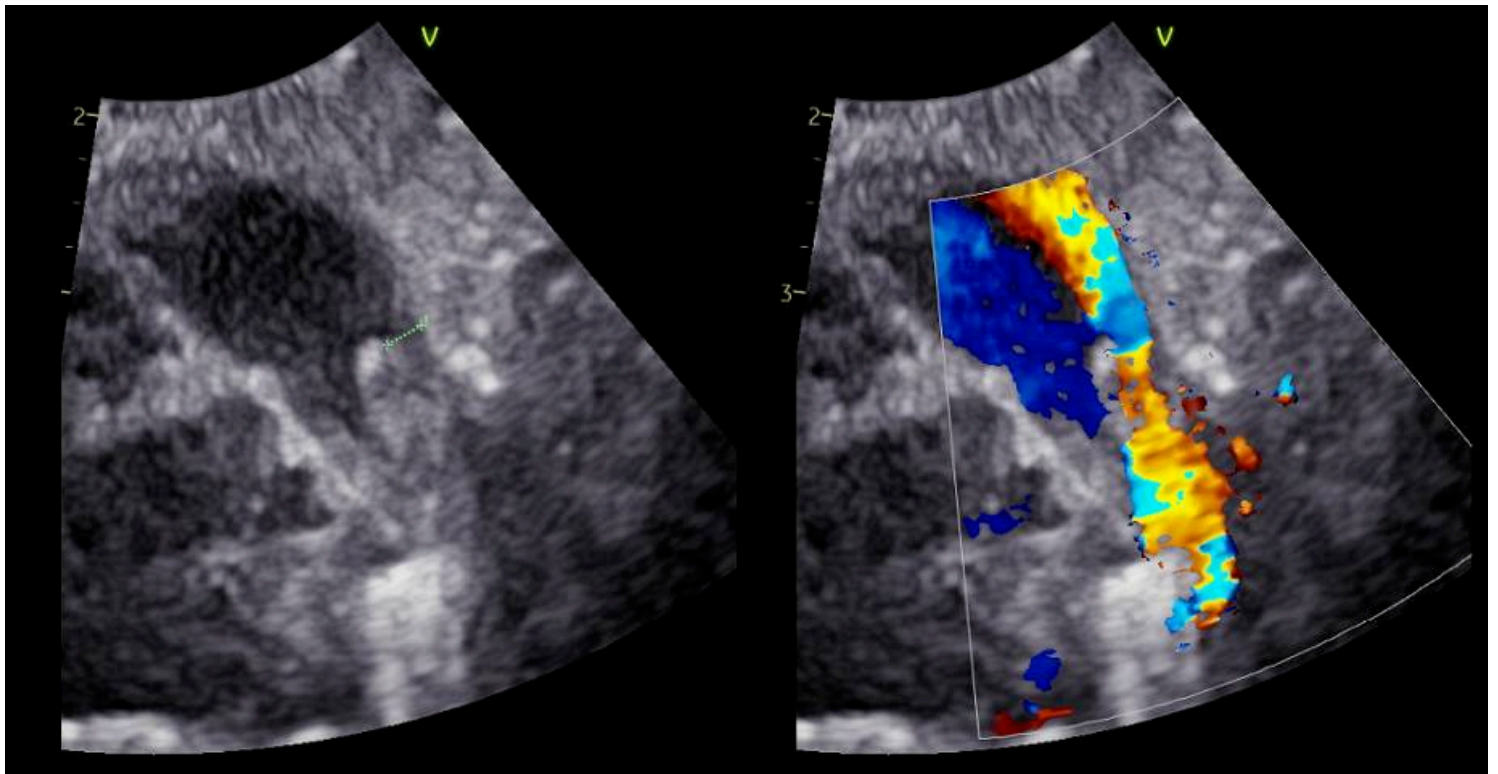


Figure 1

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Figure 2

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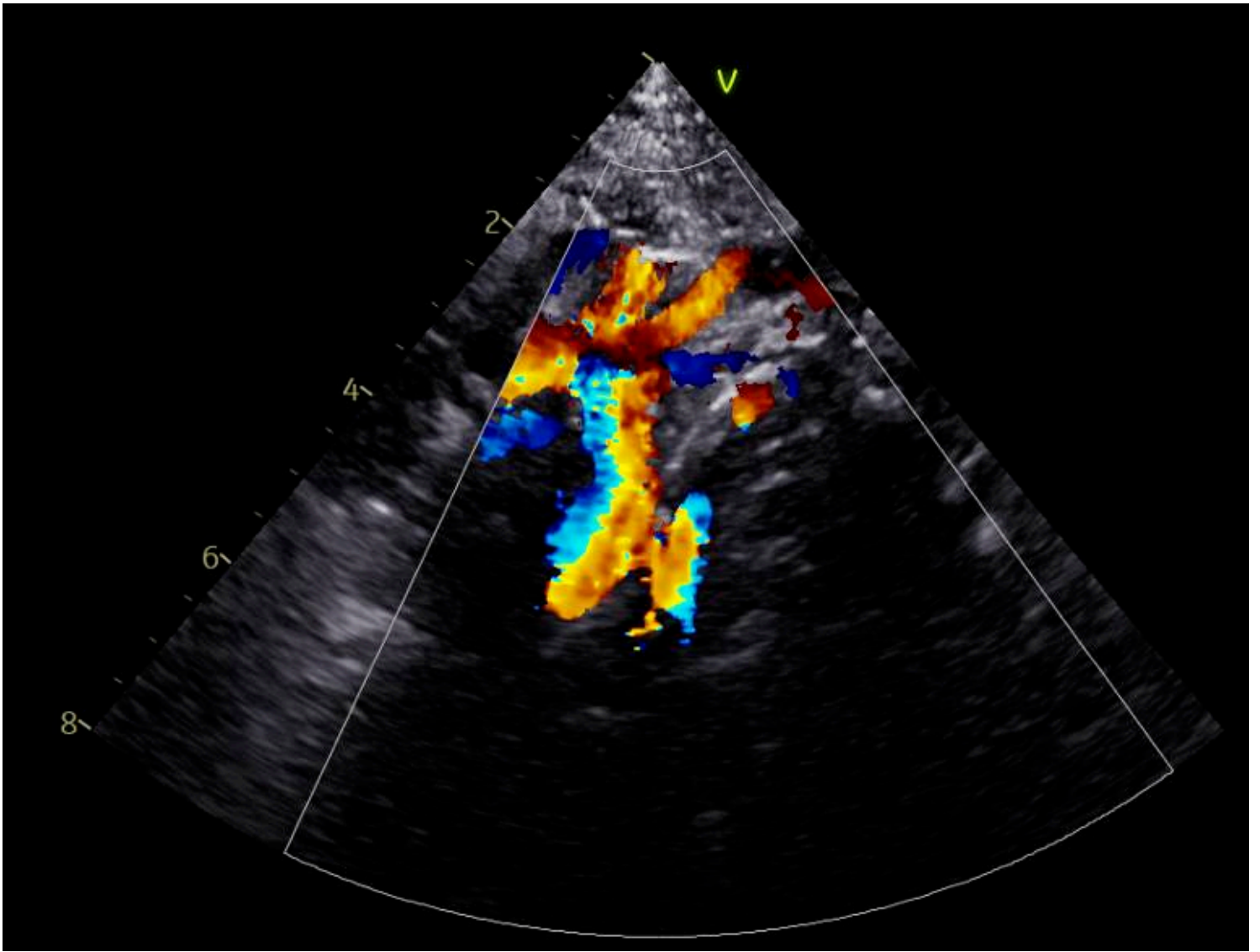


Figure 3

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