

# Iatrogenic left common carotid artery to right internal jugular vein arteriovenous fistula closure

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## ABSTRACT

We report a minimally invasive approach to the repair of a 2.8-cm × 6.0-cm left proximal common carotid to right internal jugular vein arteriovenous fistula. A 47-year-old woman with coronavirus disease 2019 pneumonia had received extracorporeal membranous oxygenation and developed a rare, presumably cannulation-related, vascular injury. We used a plug designed and typically used for the endovascular management of a patent ductus arteriosus. (*J Vasc Surg Cases Innov Tech* 2022;8:634-7.)

**Keywords:** Arteriovenous fistula; Iatrogenic; Left common carotid artery; Right internal jugular vein

Arteriovenous fistulas (AVFs) encompassing the internal jugular vein (IJV) are rare, with most studies including case reports.<sup>1-3</sup> We present the case of a patient with a 2.8-cm × 6.0-cm left proximal common carotid artery (CCA) to right IJV AVF that had developed as an unforeseen complication of extracorporeal membranous oxygenation (ECMO) cannula placement. Additionally, we have reported a novel occlusion technique for this fistula using an occluding device designed to treat patent ductus arteriosus (PDA) in a severely debilitated patient with coronavirus disease 2019 (COVID-19) pneumonia. The patient provided written informed consent for the report of her case details and imaging studies.

## CASE REPORT

A 47-year-old female patient had presented with a palpable right-sided neck thrill, dyspnea, and dysphagia with swallowing bulky foods 14 days after discharge from a 102-day hospitalization for COVID-19 acute respiratory distress syndrome. The sequelae of the patient's severe COVID-19 pneumonia included right hemidiaphragm paralysis and pulmonary fibrosis, leading to hypoxic respiratory failure and pulmonary hypertension. She required 2 L of oxygen at rest and ≤5 L with exertion. The patient's vascular access history was significant for right IJV and

right common femoral vein venovenous ECMO cannulation that was maintained for 79 days. She had also undergone left subclavian peripherally inserted central catheter placement that was maintained for 71 days and a left brachial peripherally inserted central catheter that was maintained for at least an additional 31 days after removal of the subclavian catheter. The initial workup had included computed tomography angiography (CTA) of the neck, including three-dimensional image postprocessing, which demonstrated a left CCA to right IJV AVF with dilatation of the fistulous tract ≤2.8 cm in diameter and 6.0 cm in length, causing a mass effect on the proximal trachea and esophagus (Fig 1). We presumed that the AVF had developed between the left CCA and contralateral IJV either at ECMO cannula insertion or secondary to the substantial number of vascular catheters the patient had had placed during her prolonged hospitalization.

The left CCA angiogram demonstrated a high flow AVF from the proximal left CCA to the right IJV through a 2.6-mm diameter and 6.0-cm-long connection and a large venous pouch across the upper and thoracic inlet (Fig 2). In addition, the patient demonstrated bovine arch anatomy. The diagnostic angiogram was poorly tolerated, and the patient had required pulse steroids from the procedure owing to increased dyspnea that did not completely resolve and for which she has continued to require long-term oral prednisone therapy.

The patient's poor ventilatory capacity due to pulmonary fibrosis and poor toleration of the diagnostic angiogram meant she was a suboptimal candidate for open surgery, which would have required a median sternotomy. We also anticipated difficulty in her weaning off ventilatory support after the expected prolonged intubation postoperatively, which would have necessitated permanent tracheostomy. Additionally, the patient had received multiple transfusions during her hospitalization and had developed antibodies that would have made any operative procedure challenging owing to the difficulty in obtaining appropriately cross-matched blood products. Finally, the patient expressed a preference for an endovascular, lower operative risk option. Using the principle of shared decision-making, the

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**Fig 1.** Multiplanar reconstruction in a right oblique coronal plane illustrates arteriovenous fistula (AVF) extension from the base of the left common carotid artery (CCA; *black arrow*) to the right internal jugular vein (IJV; *white arrow*) via an aneurysmal fistulous tract.



**Fig 2.** Digital subtraction angiogram showing a brachiocephalic injection demonstrating a high-flow arteriovenous fistula (AVF) from the left common carotid artery (CCA) to the right internal jugular vein (IJV).

patient and multidisciplinary team with cardiology, vascular surgery, and interventional radiology elected to occlude the AVF using an Amplatzer duct occluder II (ADO II) plug (Abbott



**Fig 3.** Amplatzer duct occluder II (ADO II) with a finger shown for size reference.

Cardiovascular, Plymouth, MN) via an endovascular approach (Fig 3).

The original design of the ADO II occluder was to treat PDA endovascularly. The device had a 5-mm waist, 6-mm length, and 11-mm disc diameter. The procedure was performed with the patient under general anesthesia and electroencephalographic monitoring to secure the airway owing to the previous significant dyspnea and intolerance of monitored attended local anesthesia during the diagnostic angiography and to detect any neurovascular events. Vascular access was obtained simultaneously with ultrasound guidance using a 4F micropuncture kit (Angiodynamics, Latham, NY) into the right IJV and right common femoral artery. Full heparinization was obtained with an activated clotting time of >250 seconds. Digital subtraction angiography (Fig 4) was obtained using a Simmons 2 catheter (MeritMedical, South Jordan, UT) through the left CCA owing to the patient's bovine arch (Figs 1 and 2). The right IJV access was used via a 6F, 23-cm sheath for precise placement and control of the ADO II plug. This access site allowed us to achieve flush apposition of the ADO II plug to the vessel wall of the left CCA and, thus, avoid thrombotic material accumulation that could potentially embolize to the left side of the brain. Sizing of the ADO II plug was determined by 20% upsizing to the estimated arterial ostium of 2.6 mm. She experienced no intraprocedural neurologic or postprocedural neurologic or access complications. The postprocedural coronal CTA (Fig 5, A)

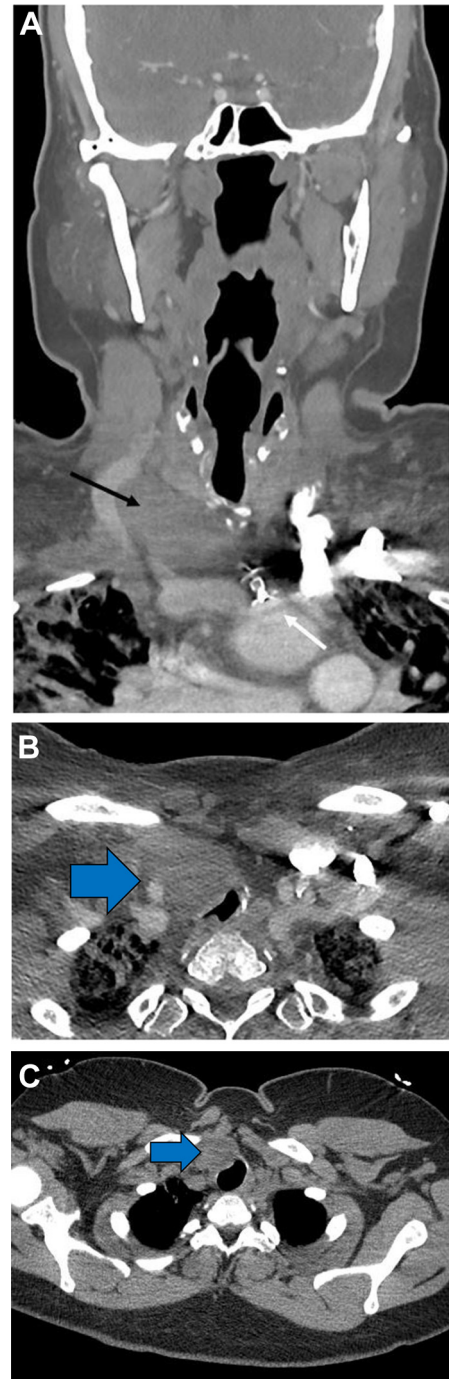


**Fig 4.** Digital subtraction angiogram with contrast injected through the left common carotid artery (CCA) after plug placement with a *white arrow* indicating successful plug placement.

demonstrated thrombosis of the AVF and perfect placement of the ADO II plug within the left CCA (<5% plug extension into the CCA) and AVF. An axial cut of the postprocedure CTA, demonstrating a thrombosed AVF pressing on the airway is shown in Fig 5, B. The patient underwent clinical follow-up and cross-sectional imaging follow-up at 4 weeks (Fig 5, C) after the initial procedure, which demonstrated thrombosis of the AVF. She will continue dual antiplatelet therapy with aspirin and ticagrelor (clopidogrel nonresponder) for  $\geq 12$  months to mitigate concerns for thrombus formation and possible embolization from the left CCA.<sup>4</sup>

## DISCUSSION

The incidence of postcatheterization AVF is rare (<2%).<sup>5,6</sup> These AVFs typically result from femoral cannulation. Cases of iatrogenic AVF due to IJV catheterization have been reported.<sup>2,3,7</sup> Droll and Lossing<sup>3</sup> cited three cases of AVF that had occurred between the right CCA and right IJV in 2004. They reported that the first AVF had occurred in 1976 from IJV catheter placement that had developed a fistula between the inferior thyroid artery and the IJV.<sup>8</sup> All previously reported AVFs were ipsilateral to the catheter placement site. To the best of our knowledge, we have reported the first case of an AVF that had developed in contralateral vessels across the



**Fig 5.** A, Coronal view of postprocedure computed tomography angiography (CTA) demonstrating thrombosed arteriovenous fistula (AVF; *black arrow*) and plug (*white arrow*). B, Axial view of postprocedure CTA demonstrating a thrombosed AVF pressing on the airway (*blue arrow*). C, Axial view of 4-week postprocedure computed tomography scan demonstrating decreased size of the thrombosed AVF (*blue arrow*).

upper mediastinum and neck. Nonetheless, all AVFs can be a source of morbidity for patients, including arterial steal, fistula mass effect, embolization, and high-output heart failure.<sup>3,9</sup>

Endovascular covered stent placement, embolization, and occlusion have emerged as the most common approaches to treating symptomatic or otherwise unresolved AVFs in the modern era, instead of open surgical options.<sup>7</sup> Intervention will always be associated with risk, which must outweigh passivity. Covered stenting of the affected artery can be an excellent option. However, in some cases, such as the present one, stenting will be impossible because the fistula origin was so proximal to the branching point of the bovine arch. The distance from the bifurcation to the fistula was <5 mm, which would not successfully have excluded the AVF. Matsuo et al<sup>2</sup> reported an AVF that had developed between the right subclavian artery and right IJV and was repaired successfully through coil embolization using a double-catheter technique in 2020. Although much less invasive than open surgery, endovascular embolization or occlusion is not without risk. The unintended embolization of a vascular plug from a high-flow structure such as a carotid artery to the brain would be devastating. Second, careful manipulation of the fistulous tract using ultrasound and fluoroscopic guidance have been recommended to ascertain that all wire and catheter manipulation is performed under direct visualization. Finally, the patient's increasing fistula size had caused dysphagia, airway impingement, and increased work of breathing. She desired and benefited from a multidisciplinary endovascular approach. If left untreated, her AVF could have progressed to devastating neurologic complications, airway compromise, or heart failure.

## CONCLUSIONS

We have reported a left CCA to right IJV AVF that was successfully treated using a minimally invasive approach

to close an AVF with an occluding plug originally designed for the treatment of PDA.

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