Endovascular management of an iatrogenic injury to the supra-aortic trunk after attempted central venous catheter placement

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ABSTRACT

We have presented the successful endovascular management of an injury to the proximal left common carotid artery following attempted cannulation of the right internal jugular vein in a critically ill patient with multisystem organ failure secondary to infection with SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2). (J Vasc Surg Cases Innov Tech 2022;8:390-5.)

Keywords: Arterial injury; Central venous catheter; Common carotid artery; Endovascular management; Iatrogenic injury; SARS-CoV-2

Injury to a supra-aortic trunk vessel is an uncommon, but devastating, complication of percutaneous central venous catheter (CVC) placement. The incidence of carotid artery injury associated with CVC placement in the internal jugular vein (IJV) has been reported to be in the range of 1 to 7 cases per 1000.[1-5] Successful management depends on the timely recognition of the injury, precise anatomic characterization of the supra-aortic vessel or vessels involved, and expeditious intervention to limit further complications related to hemorrhage, arterial thrombosis, arterial thromboembolism, and cerebrovascular accident. In the present report, we have described the successful endovascular treatment of a CVC-related injury to the contralateral proximal common carotid artery (CCA) with a balloon-expandable covered stent. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT

A 65-year-old male patient with a history of stage III chronic kidney disease was admitted to the intensive care unit of a large military treatment facility with acute respiratory distress syndrome and distributive shock secondary to SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) infection. Treatment included vasopressor support, mechanical ventilation, and continuous renal replacement therapy. Under ultrasound guidance, an attempt was made to place a 13F double-lumen hemodialysis catheter in the right IJV. A postprocedure chest radiograph obtained 1 hour after placement demonstrated likely arterial cannulation, with the tip of the catheter noted in the left side of the mediastinum (Fig 1). The catheter was capped and secured in place to avoid dislodgment. No contributory anatomic or patient-specific factors that would have conferred greater technical difficulty for CVC placement were found.

An urgent noncontrast-enhanced computed tomography scan of the head and a computed tomography angiogram of the head, neck, and chest were obtained to determine the extent of the iatrogenic injury. The catheter was noted to have traversed the neck from the right supraclavicular region in an extravascular plane and entered the arterial circulation at the level of the proximal left CCA (Fig 2). A three-dimensional reconstruction was completed (Fig 3). The completed radiographic survey demonstrated no evidence of acute hemorrhagic stroke, large vessel occlusion, or any obvious nonvascular injury. A continuous heparin infusion was initiated through a peripheral intravenous catheter, and the patient was transported directly from the imaging suite to the hybrid operating room ~4 hours after the initial catheter placement attempt. The cardiothoracic surgery team was consulted before the procedure and was in the hybrid operating room on standby during the surgery in the event that an endovascular solution was not

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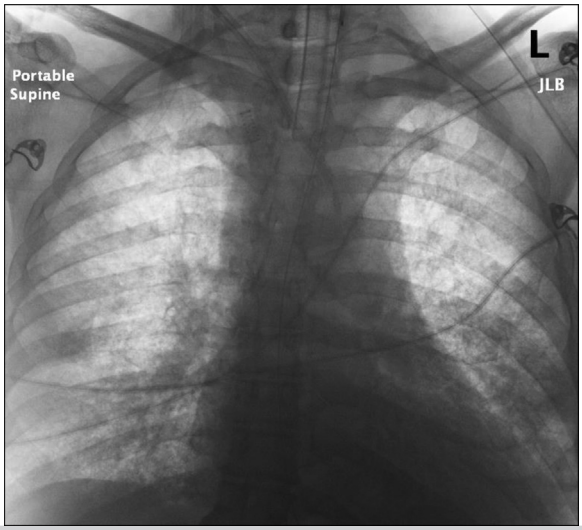

Fig 1. Inverted chest radiograph indicating abnormal position of the distal aspect of the central venous catheter (CVC).

technically feasible and the patient would require median sternotomy with direct, open repair.

The operative findings and techniques were as follows:

1. Percutaneous access was obtained in the right common femoral artery, and a flush angiogram of the aortic arch was obtained (Fig 4). The angiogram demonstrated cannulation of the proximal left CCA, with no concomitant injury to the right CCA or innominate artery.
2. The left CCA was selected and a reverse-curve catheter was placed. A selective angiogram demonstrated the location of the injury to be ~1 cm from the ostium of the vessel (Fig 5).
3. Over a stiff wire, access to the left CCA was secured with an 8F × 70-cm Flexor Raabe guiding sheath (Cook Medical, Inc, Bloomington, IN).
4. A 10-mm × 29-mm Viabahn VBX balloon-expandable covered stent (W.L. Gore & Associates, Flagstaff, AZ) was deployed as the CVC was simultaneously withdrawn. The stent was sized according to the findings from the preoperative computed tomography angiogram.
5. A completion angiogram demonstrated appropriate positioning of the stent graft at the proximal left CCA, with no evidence of active extravasation from the excluded injury (Fig 5).
6. Systemic anticoagulation was reversed with protamine, and the access arteriotomy was closed with a single Perclose ProGlide suture (Abbott Laboratories, Chicago, IL).

DISCUSSION

Inadvertent arterial placement of a large-bore catheter can result in hemorrhage, pseudoaneurysm, stroke, and/or death.[3,6-9] Given the devastating complications associated with arterial catheterization, the early identification of arterial trauma and knowledge of the complication profile is imperative to provide prompt management and mitigate risk.

The current management of catheter removal involves one of three techniques: external manual pressure, open direct arterial repair, or endovascular techniques, including percutaneous vascular closure devices (VCDs). Shah et al[3] compared the manual external pressure method to conventional surgical repair after arterial misplacement during attempted cannulation of the IJV. They concluded that surgical exploration with catheter removal and direct arterial repair was the most effective and safest treatment because no complications were reported after direct arterial repair.[3] Further prospective and retrospective analysis revealed that 30% of patients had developed complications, including stroke, pseudoaneurysm formation, exsanguination, and/or hematoma, following direct manual external pressure. These patients had subsequently required some form of intervention for definitive management.[3] Furthermore, Guilbert et al[8] reported a complication rate as high as 47% with external manual pressure compared with 0% after direct surgical repair.

Although open surgical repair remains a reliable option for the management of iatrogenic injury, endovascular intervention has emerged and demonstrated favorable outcomes.[10,11] Compared with traditional surgical repair, endovascular stent graft repair of traumatic arterial injury has been associated with a decrease in the anesthetic requirement and blood loss and a decrease in associated mortality (22% with open

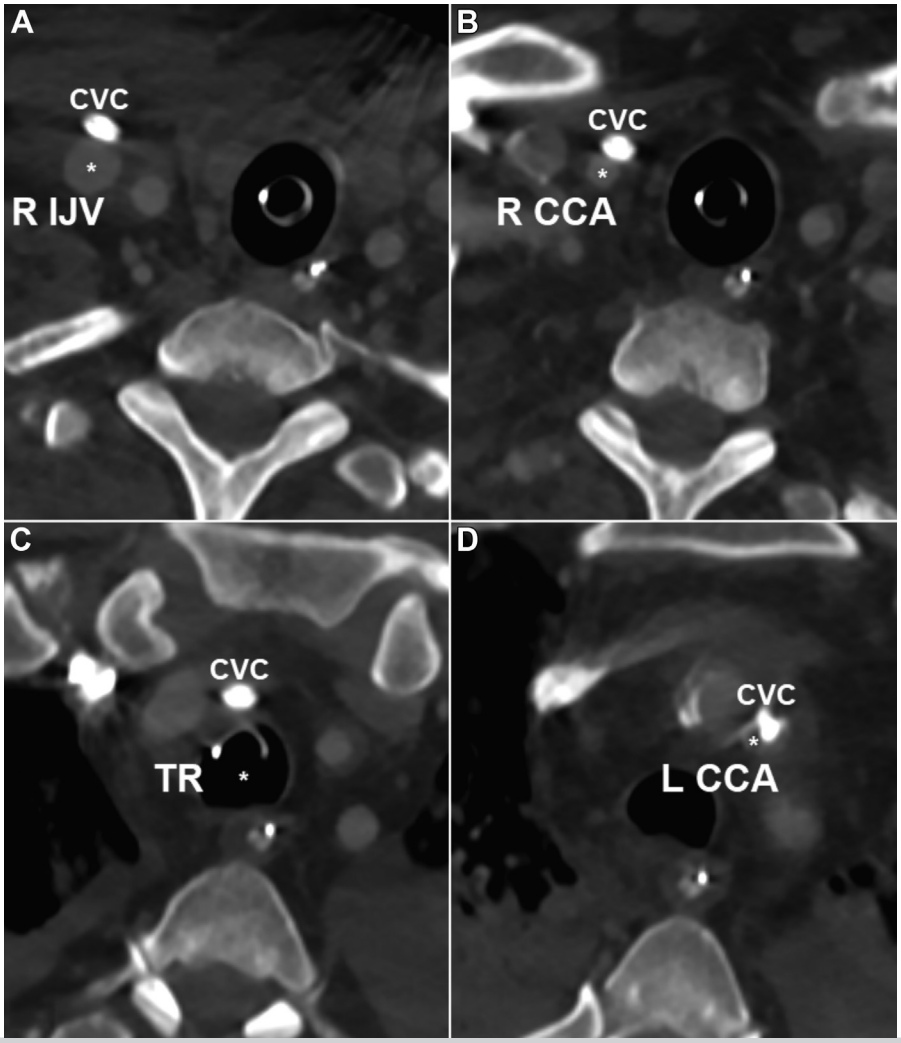

Fig 2. Computed tomography angiogram after a central venous catheter (CVC) placement attempt. **A,** The CVC is anterior to the right (*R*) internal jugular vein (IJV; *asterisk* indicates position). **B,** The CVC is anterior to the R common carotid artery (CCA; *asterisk* indicates position). An intramural hematoma involving the left (*L*) CCA can also be visualized. **C,** The CVC is anterior to the trachea (*TR*; *asterisk* indicates position) without obvious injury to the airway. An intramural hematoma involving the L CCA can also be visualized. **D,** The CVC enters the arterial circulation at the L CCA (*asterisk* indicates position).

surgical repair vs 0.9% with carotid artery stenting).[12] Although any comparison of open and endovascular repair is likely to be hindered by selection bias, endovascular therapy should be considered early in the treatment algorithm, especially for zone 1 or 3 injury. Direct surgical repair is likely to play a greater role in the management of zone 2 injuries, given the straightforward surgical approach. Additionally, injuries near or at the carotid bifurcation are best suited for open repair, because stenting near the bifurcation has been associated with technical difficulty, specifically the risk of bifurcation branch occlusion (ie, external carotid artery).[13,14] Treatment of injuries located at the base of the neck and those with high extracranial locations favors endovascular therapy. If technically feasible, endovascular therapy offers the ability to localize and treat an injury efficiently and from an access location remote from the area of injury.

Several published case reports have shown the use of percutaneous VCDs, including suture- and plug-mediated devices, to be technically effective for managing inadvertent arterial injury.[4,15,16] Although specific devices can be used for large bore arterial closure, little has been documented regarding the application of VCDs for catheter injuries >7F to 8F. In the present patient, the site of the injury, catheter size, and concern for a

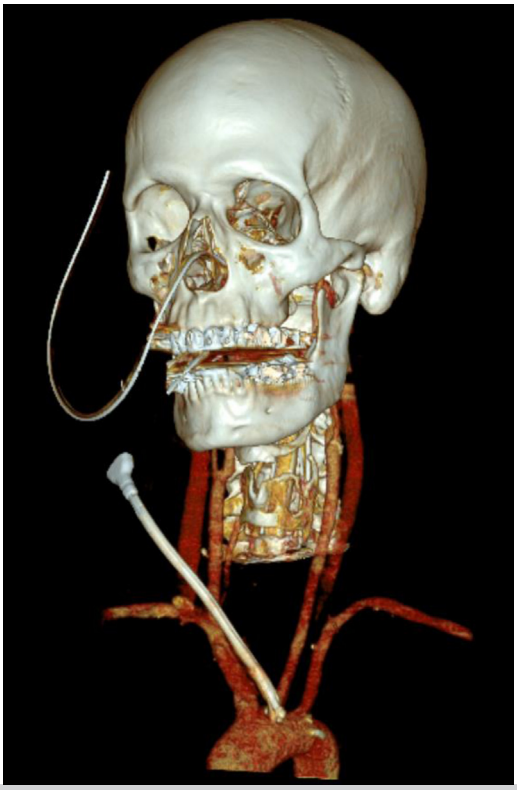

Fig 3. Computed tomography angiogram reconstruction demonstrating aberrant central venous catheter (CVC) placement and subsequent injury to the proximal left common carotid artery (CCA).

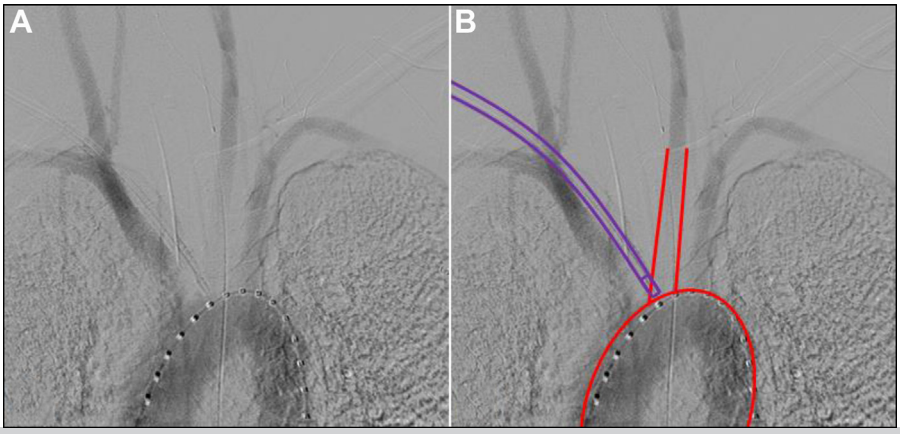

Fig 4. A, Diagnostic angiogram demonstrating aberrant central venous catheter (CVC) placement and subsequent injury to the proximal left common carotid artery (CCA). **B,** Reconstruction of angiogram. *Red lines* identify the major curve of the aortic arch and outline of the proximal left common carotid artery (CCA); and the *purple lines,* the position of the CVC.

thromboembolic event as a consequence of device application precluded the use of a percutaneous VCD. In the event of device failure, an endovascular recovery option would likely not have been possible. In our patient, an injury to the proximal left CCA was successfully managed with an endovascularly deployed balloon-expandable covered stent, obviating the need for a median sternotomy with open arterial repair in a critically ill patient.

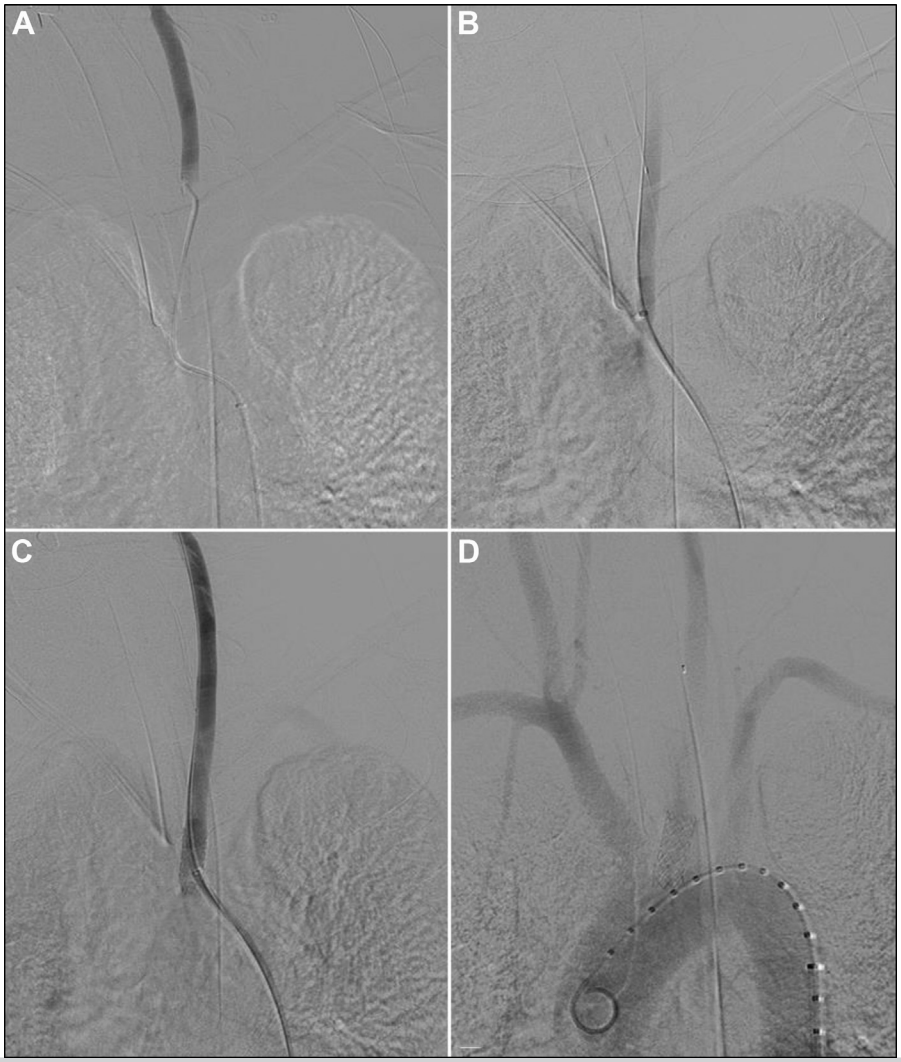

Fig 5. Diagnostic and completion angiograms. **A,** Angiogram showing left common carotid artery (CCA) selection with reverse-curve catheter and selective angiography. **B,** Selective angiogram through the 8F sheath demonstrating the injury location to be ~1 cm from the ostium of the vessel. **C,** Angiogram after deployment of a 10-mm × 29 mm Viabahn VBX balloon-expandable covered stent (W.L. Gore & Associates). **D,** Completion angiogram demonstrating appropriate positioning of the stent at the proximal left CCA.

CONCLUSIONS

We found endovascular therapy to be a safe and effective management strategy for injury to supra-aortic trunk vessels.

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