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Case Report

# Extravascular Central Venous Line Removal and Endovascular Covered Stent Implantation Guided by 3-Dimensional Computed Tomographic Reconstruction

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**Central venous lines (CVLs) are often necessary in critically ill patients; however, insertion carries risk. Extravascular placement of CVLs can result in significant haemorrhage into low-pressure cavities; therefore, careful planning must be made before removal to avoid uncontrolled bleeding and haemodynamic compromise. We present a unique case using endovascular covered stent implantation to address vessel injury in a critically ill child after extravascular CVL placement.**

A previously healthy 5-year-old boy sustained multiple severe thoracoabdominal injuries after a motor vehicle accident, including liver and splenic lacerations requiring emergent decompressive laparotomy. An 8 F central venous line (CVL) was inserted into the right internal jugular vein anticipating the need for renal replacement therapy. It is unknown whether ultrasound guidance was used for CVL insertion. The insertion was complicated by the extravascular location of the catheter, which was initially undetected; as a result, the CVL tip extended into the pleural space with resultant haemothorax after a blood transfusion through the catheter. A computed tomography (CT) scan of the thorax and abdomen showed the CVL transfixing the right brachiocephalic vein, running within the right thoracic cavity with the tip in the pleural space without penetrating the lung. The patient was stabilized while the misplaced CVL was not removed anticipating the risk of significant bleeding into the thorax on removal, and the child was transferred to our intensive care unit. Because of the child's critically ill status and the desire to avoid excessive transfusion or cardiopulmonary bypass, an endovascular covered stent implantation was considered an option to maintain vessel integrity and control bleeding rather than an open surgical repair. The thoracic CT images were reconstructed using a 3-dimensional (3D) viewing system (EchoPixel, Silicon Valley, CA) to aid in preprocedural planning, allowing a better understanding of the catheter course, entry, and exit sites and the relationship to the surrounding structures and vessels (Video 1, view video online). The 3D reconstructive viewing system refined the course of the CVL, such that the vessel had been impaled through and through in the anteroposterior dimensions. The low right jugular vein puncture resulted in vessel entry just below the clavicle, exiting the vessel posteriorly into the right upper lung, at the level of the brachiocephalic vein and above the innominate vein. Further intraprocedural 3D rotational angiography was not deemed necessary. This allowed for the additional benefit of shortened procedural time in an unstable child. The child was brought to the cardiac catheterization laboratory for standard angiographic assessment, while the room was prepared for possible surgical line removal with cardiopulmonary bypass. Vascular access was from the right femoral vein. Angiography in the superior vena cava demonstrated that the implantation of a covered stent would result in jailing the right brachiocephalic vein to cover both sites of puncture (entry and exit) (Fig. 1A). Given the limited surgical options for repair and patient instability, an endovascular intervention was performed. A Nudel premounted covered stent (39 mm length mounted on a 16 mm balloon) (NuMed Inc, Hopkinton, NY) was positioned to cover both vessel perforation sites, the CVL was removed, and the stent was deployed. Repeat angiography confirmed good position with

## Novel Teaching Points

- Extravascular insertion of central lines can result in significant haemorrhage. Covered stent implantation into the perforated vessel provides a less invasive alternative to achieve vessel haemostasis.
- Precatheterization planning using 3-dimensional imaging provides a superior understanding of the misplaced catheter course and the relationship to the surrounding vessels before the planned intervention.

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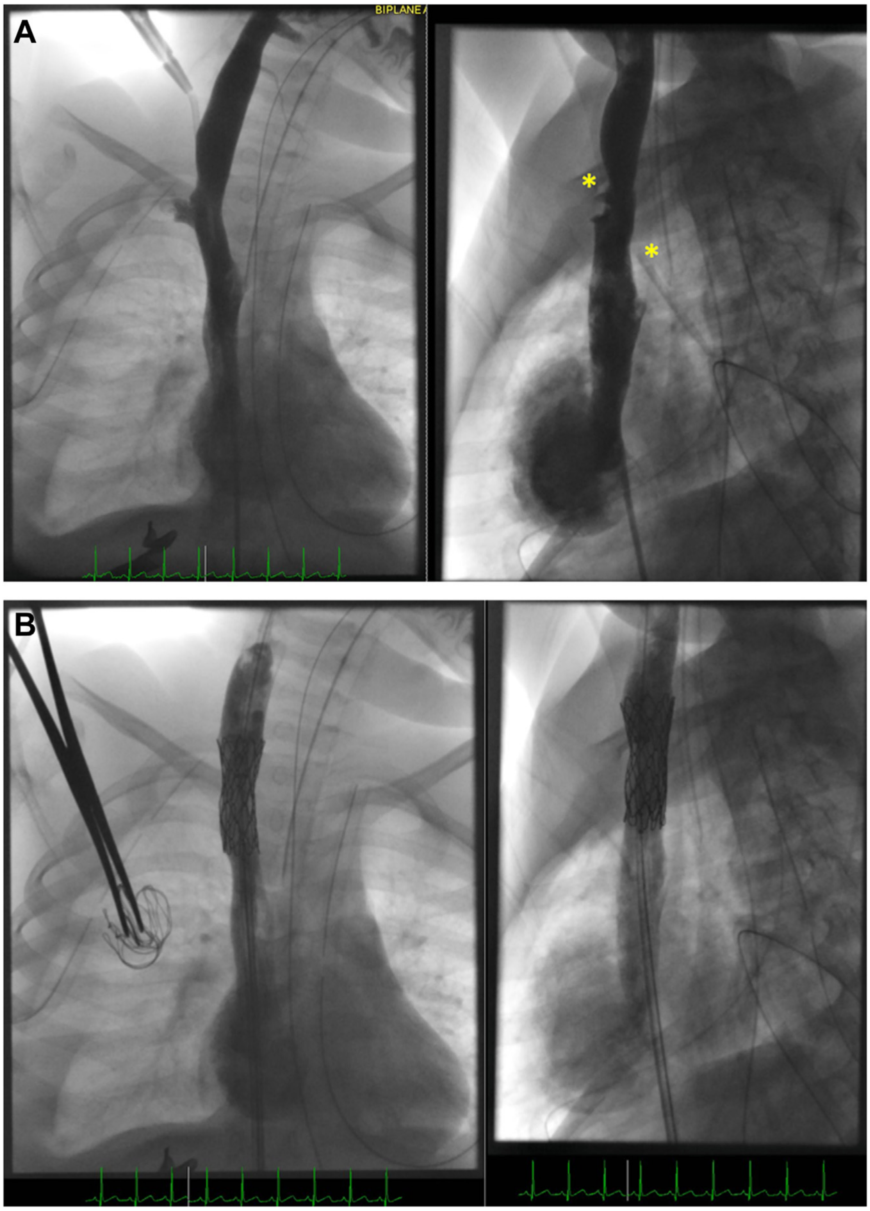


**Figure 1.** (**A**) Pre-intervention SVC angiography: pre-intervention angiography is performed in the SVC with the anteroposterior and lateral views. The CVL is seen on fluoroscopy with entrance and exit sites through the SVC (seen best on lateral, denoted by the **asterisk**). Flow is unobstructed to the right atrium, with contrast influx in the right innominate vein. In the lateral view, the SVC diameter was 12.5 mm proximally and 10.7 mm distally, and anticipated stent length was 35 mm. (**B**) Post-intervention SVC angiography: post-intervention angiography is performed in the SVC in the anteroposterior and lateral views, after CVL removal and covered stent deployment. There is no extravascular leak with coverage of CVL entry and exit sites. No flow is seen in the right innominate vein, which is covered by the stent. Flow is unobstructed into the right atrium. CVL, central venous line; SVC, superior vena cava.

no extravascular leak (Fig. 1B). The child was monitored for right-sided venous hypertension (jailed right brachiocephalic vein), which did not occur because of presumed decompression from venous collaterals in the absence of symptoms.

CVLs provide necessary vascular access, although insertion carries risk.[1] Endovascular covered stent implantation has been described after inadvertent arterial cannulation during CVL placement.[1] Extravascular placement of CVLs causing perforation of a vessel is a rare but serious complication as significant haemorrhage can occur into low-pressure cavities. Infusion of volume can result in haemothorax or pleural effusion.[2] However, removal of a misplaced catheter without consideration of the implications (eg, uncontrolled bleeding from the entry/exit sites) without pre-procedural planning can result in haemodynamic compromise, as manual pressure application after catheter removal may not achieve haemostasis.[3] Endovascular covered stent implantation is a less invasive approach to address the perforated vessel and provides an alternative when surgical repair is challenging due to anatomy or patient clinical instability. Pre-procedural 3D image reconstruction is a tool to provide an understanding of the relationships of cardiac structures and, in this case, detailed venous anatomy to guide the intervention. This included proximity to other vessels at risk of being compromised during stenting and the location where the catheter perforated the vessel, neither of which was clearly defined by the 2D CT scan imaging. Through the interactive interface of the EchoPixel holographic 3D image reconstruction, we were able to understand the anatomic complexity to guide the case. Future directions include periprocedural integration of 3D imaging modalities into the paediatric cardiac catheterization laboratory, which can overcome limitations of 2D angiography and guide complex interventional procedures.[4]

## Ethics Statement

This research has adhered to the relevant ethical guidelines.

## Patient Consent

The authors confirm that consent has been obtained from the family for this publication.

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## Disclosures

The authors have no conflicts of interest to disclose.

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## Supplementary Material

To access the supplementary material accompanying this article, visit *CJC Pediatric and Congenital Heart Disease* at https://www.cjcpc.ca// and at https://doi.org/10.1016/j.cjcpc.2023.12.005