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CASE REPORT
Structural intervention

Use of suture-mediated closure device system after inadvertent medport placement in the subclavian artery leading to multi-focal ischaemic infarct: a case report

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Background Totally implantable venous access devices or chemoports are progressively being used in oncologic patients for long-term chemotherapy administration. We present the case of an iatrogenic arterial catheter placement in the aortic arch complicated with multi-focal ischaemic stroke.

Case summary A case of a 73-year-old woman with a history of hypertension, diabetes mellitus, pineal gland tumour status post ventriculoperitoneal shunt, and breast and bladder cancer presented with a 2-week history of impaired balance, dysarthria, and right-sided facial drop. The chemoport was placed less than a month prior to the onset of symptoms at another institution. A brain magnetic resonance imaging revealed a left hemispheric supra- and infra-tentorial subacute ischaemic infarcts. The head and neck computed tomography angiography notably showed a misplaced venous port at the left subclavian artery with a distal tip projecting towards the ascending aortic arch, revealing the most likely aetiology of multi-focal ischaemic stroke. The patient underwent successful subclavian artery catheter extraction and endovascular repair with a suture-mediated closure device system without complications.

Discussion Subclavian artery iatrogenic cannulation may lead to catastrophic outcomes, including stroke. A high level of suspicion for venous port misplacement must be entertained when ipsilateral multi-focal ischaemic infarct occurs in time relation to catheter placement. Conducting an endovascular catheter retrieval and using a suture-mediated closure device is an alternative approach to manual compression in locations where achieving an haemostasis is challenging. A suture-mediated closure device system might be useful for anatomy not amenable to manual compression, such as the subclavian artery.

Keywords Case report • Chemoport • Multi-focal ischaemic stroke • Subclavian artery iatrogenic cannulation • Endovascular catheter retrieval

ESC curriculum 7.4 Percutaneous cardiovascular post-procedure • 9.2 Trauma to the aorta or the heart • 9.9 Cardiological consultations

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Learning points

- A high level of suspicion for venous port misplacement must be entertained when ipsilateral multi-focal ischaemia infarct occurs in time relation with catheter placement.
- Endovascular catheter retrieval and suture-mediated closure device is an alternative approach in locations where achieving an haemostasis with manual compression is challenging, such as the subclavian artery.

Introduction

Totally implantable venous access devices or chemoports are progressively being used in patients with cancer for long-term chemotherapy administration. Chemoports consist of the cannulation of a deep vein, usually the subclavian or internal jugular veins, reaching the superior vena cava and entering the right side of the heart. Chemoports were initially used in 1982 for patients with cancer to facilitate the intravenous administration of abrasive chemotherapeutic agents.[1] Since then, other uses have been added, such as the administration of parenteral nutrition, antibiotics, and i.v. fluids and blood products transfusion.[2] Once a chemoport is placed, the subsequent punctures for vein access are made through the silicone port instead of the vein. Minor complications are associated with the procedure, including haematoma. Furthermore, major complications have been reported, such as catheter dislodgement and migration, deep vein thrombosis, infection, and pneumothorax, all leading to morbidity and early removal of the device.[3] We present the case of an iatrogenic arterial chemoport catheter placement complicated with a multi-focal ischaemic stroke and an alternative for management.

Summary figure

Date	Event
25 August 2022	Insertion of the chemoport
5 September 2022	Patient developed dysarthria, left-sided facial drop, and right hemiparesis
12 September 2022	Arrival to emergency room and diagnosis of multi-focal ischaemic stroke
13 September 2022	Diagnosis of iatrogenic subclavian arterial cannulation as the culprit of patient's symptoms
20 September 2022	Transfer to 'percutaneous coronary intervention/endovascular capable facility'
21 September 2022	Subclavian arterial catheter removed and sealed with suture-mediated closure device. Evidence of severe left subclavian artery (LSCA) thrombosis and therefore started heparin drip for 5 days
26 September 2022	Heparin was discontinued and bridged to warfarin. The international normalised ratio (INR) goal is 2.5
10 October 2022	The patient was discharged to an inpatient rehabilitation facility

Case presentation

A 73-year-old woman with a history of hypertension, diabetes mellitus, pineal gland tumour status post ventriculoperitoneal shunt, and breast and bladder cancer presented with a 2-week history of impaired balance, dysarthria, and right-sided facial drop. A venous 9-Fr chemoport was placed less than a month prior to the symptoms' onset. On admission, her blood pressure was 140/85 mmHg, heart rate 66 b.p.m., and oxygen saturation 97% on room air. Physical examination revealed clear lung sounds, regular rate, and rhythm with absent heart murmurs. The neurological assessment was pertinent for labial commissure deviation to the right side but otherwise symmetrical intact bilateral upper and lower limbs motor strength and sensory tests. The patient's serum chemistry, electrocardiogram, transthoracic echocardiogram, and carotid Doppler were unremarkable. A brain magnetic resonance imaging revealed subacute ischaemic cortical infarcts in the left hemispheric supra- and infra-tentorial regions (*Figure 1*).

The head and neck computed tomography angiography was noteworthy because it showed a misplaced intravascular catheter in the left subclavian artery (LSCA) with a distal tip projecting towards the ascending aortic arch (*Figure 2*).

After considering other causes of embolic sources, an intra-arterial catheter was presumed to be the most likely aetiology of the multi-focal ischaemic stroke. The endovascular approach for catheter retrieval within the LSCA was deemed safer than open repair surgery. This strategy was particularly advantageous for this patient presenting with multiple comorbidities and overall poor candidacy for surgical interventions, where procedures like thoracotomy or median sternotomy would

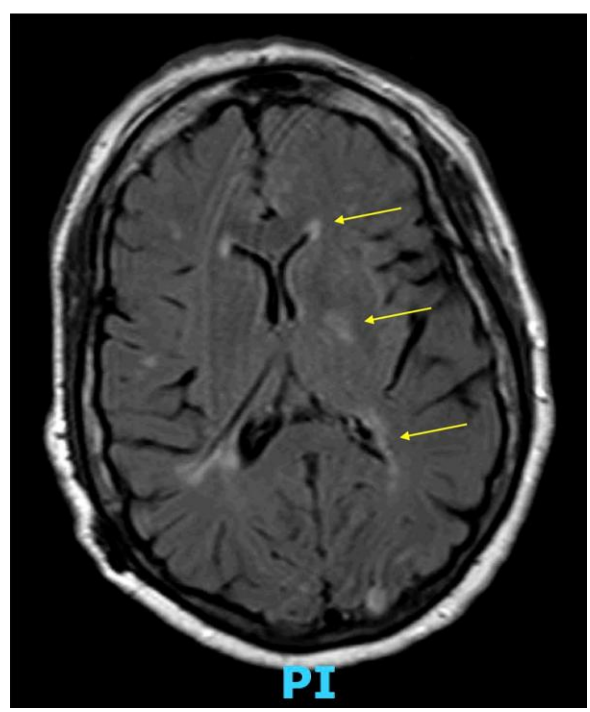

Figure 1 Brain magnetic resonance imaging with evidence of left supratentorial subacute ischaemic stroke (arrows).

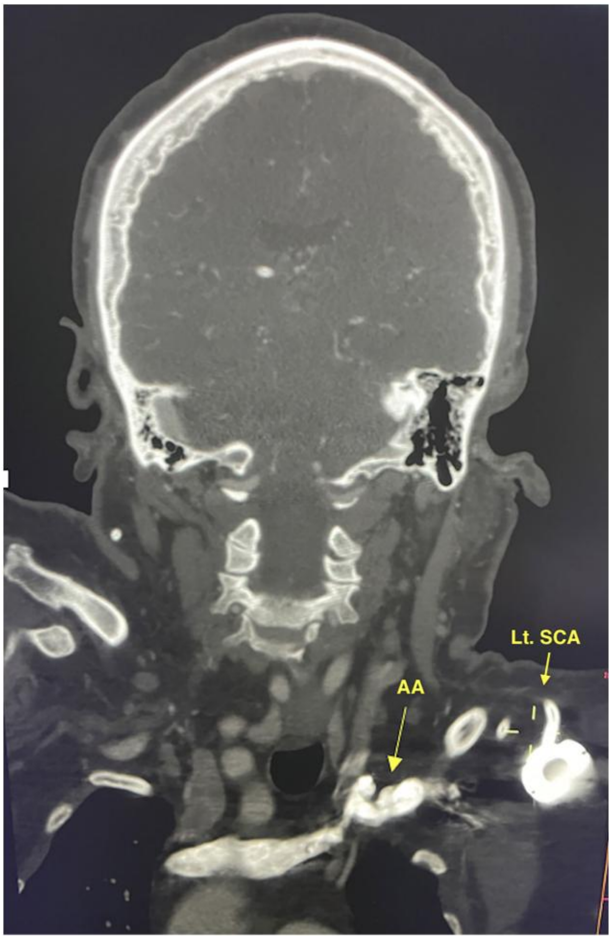

Figure 2 Head and neck computed tomography angiography shows the chemoport entering through the left subclavian artery with the distal tip projecting towards the aortic arch. LSCA, left subclavian artery; AA, aortic arch.

have been required. Subsequently, the patient underwent catheter retrieval in the catheterization laboratory on following days. An angiography with contrast confirmed the presence of a 9-Fr sheath in the LSCA with the distal tip projecting to the ascending aorta (*Figure 3A*). The portal of the chemoport was carefully dissected, and the guiding catheter wire was advanced through the chemoport *in situ* using a 9-Fr catheter (*Figure 4*). Afterwards, the 9-Fr catheter was completely removed, and only the guiding wire was left inside the LSCA (*Figure 3B*). The guiding wire, which was carefully inserted inside the 9-Fr sheath, would eventually ensure the precise placement of the suture closure device at that specific location once the sheath is removed. The angiogram showed evidence of proximal to distal severe thrombosis on LSCA with patent blood flow noted on arteriogram (*Figure 5*; Supplementary material online).

A Perclose ProStyle suture-mediated closure system (Abbott Inc.) was used as a salvage endovascular repair approach for the 9-Fr hole in the LSCA. There were no procedure-associated complications. After these radiological findings, the patient was started on therapeutic anticoagulation with heparin drip, which was continued for 5 days. Heparin bridge with warfarin was started during the hospitalization, reaching an INR goal of 2.5. A left upper extremity arterial Doppler was performed after the procedure, showing adequate forward triphasic flow and suggesting no physiologic significance of the arterial thrombosis seen angiographically. The patient remained hospitalized for 6 more days due to nosocomial complicated urinary tract infection, for which she received intravenous antibiotics. Afterwards, the patient was successfully discharged to an inpatient rehabilitation facility. One and a half year later, she continues to improve clinically, as she is able to walk short distances and continues to receive chemotherapy.

Discussion

Arterial cannulation during the placement of a chemoport is a very rare complication occurring in <1% of all cases.[4] This type of unintended arterial injury can result in severe complications, such as haematoma, pseudo-aneurysm, fistulation, stroke, and aortic dissection.[4] Recent reports suggest that there is an association between central venous catheter (CVC) placement and annual cumulative increasing incidence for ischaemic strokes.[5] Nonetheless, prone patients are usually aged ≤35 years, although the exact pathophysiology of this trend is under investigation.[5] A high level of suspicion for venous port misplacement must be entertained when ipsilateral multi-focal ischaemic infarcts occur in time relation to catheter placement. Arterial catheterization and cannulation lead to shear-induced platelet aggregation; therefore, the production of small clots at the tip of the catheter later produces recurrent embolization of those small clots.[6] Heparinization should be considered, especially if a thrombus is found at the site of the arterial injury, and immediate removal of catheter is not possible.[7] There are scant data regarding the length of therapy for the anticoagulation of arterial thrombosis, considering that the mechanism of clot formation is provoked by iatrogenic arterial instrumentation. We decided to start anticoagulation for 5 days, using the treatment of venous thrombo-embolism's length of therapy as a reference. Multiple randomized control trials have demonstrated that 5-day course of heparin is an effective amount of time for venous thrombo-embolism, as it lowers the risk of bleeding, reduces hospital stay, and reduces the risk of heparin-induced-thrombocytopenia.[8]

Real-time ultrasound-guided catheter placement has now become standard of care during CVC insertion, as it increases higher success rate and fewer insertion attempts.[9] Some of the current qualitative practices to assess an early misplaced arterial catheter are observing the colour of the blood and the pulsatile backflow.[6] Arterial blood has a bright red pulsative backflow, but these findings are not specific for catheter misplacement because patients with hypovolaemia or hypoxaemia may not present typical arterial blood qualities. Other objective measurements to assess the catheter placement are the analysis of blood gases and the pressure waveform by the pressure transducer.[9] Additionally, assessing the post-insertion chest X-ray is imperative. If the insertion of the catheter is through the left subclavian vein, the catheter will cross the mediastinum horizontally. Then, the distal part will be positioned vertically, almost colliding with the right side of the cardiac silhouette. Moreover, the subclavian artery runs superior to the subclavian vein; therefore, the catheter should course under the clavicle.[10] Any other placement, especially a catheter running above the clavicle, would suggest arterial positioning.

Once the catheter has been placed and left *in situ*, as in this case, having a high clinical suspicion of catheter misplacement allows the healthcare provider to promptly recognize complications. Ischaemic infarct, especially when ipsilateral, multi-focal, and occurring in time relation to catheter placement, is a warning sign for further workup. There are no definite guidelines tackling the exact management of accidental large-bore (≥7 Fr) arterial cannulation. Therefore, the next step in management is identifying how to retrieve this arterial catheter.

The primary consideration in managing iatrogenic arterial cannulation is whether to pursue an endovascular or open surgical approach. Endovascular techniques encompass options such as percutaneous closure devices, placement of covered stents, or vessel sacrifice. The choice between these approaches typically hinges on factors such as the puncture site and the operator's level of expertise. Ideally, this

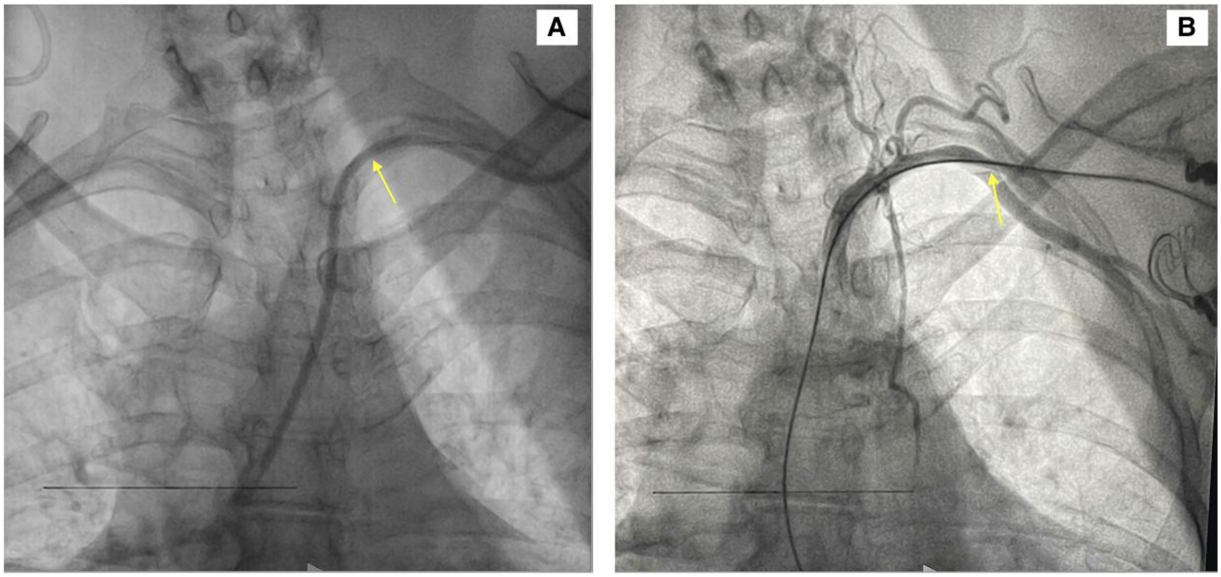

Figure 3 (*A*) Angiogram with contrast depicts the 9-Fr chemoport in the left subclavian artery with the tip at the ascending aortic arch. The arrow shows the catheter at the ascending aorta. (*B*) Guidewire inserted in the LSCA through the 9-Fr sheath [seen in (*A*)], which is already removed (arrow).

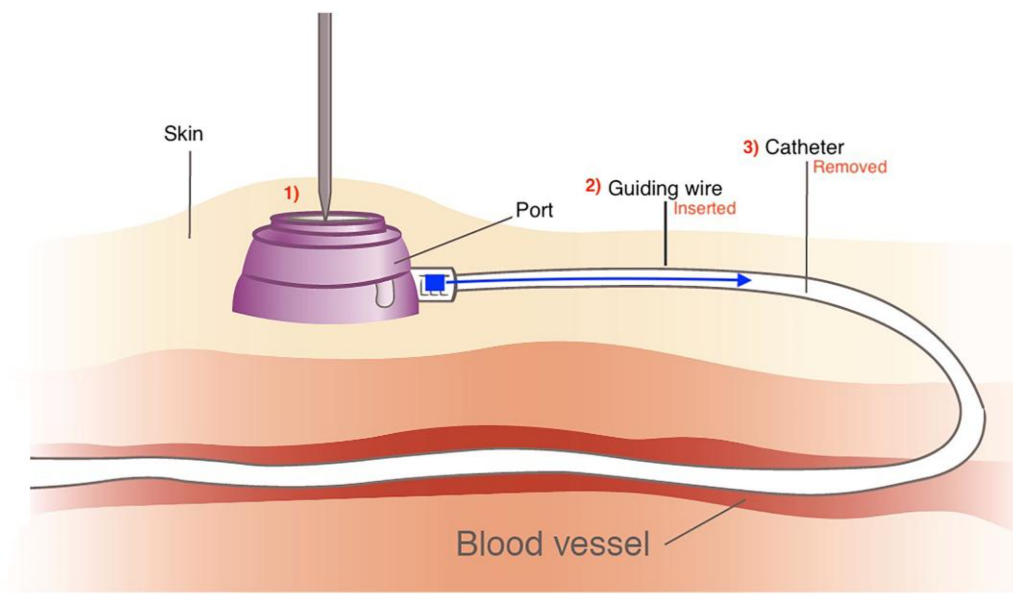

Figure 4 A schematic diagram of the process. The port is dissected (1), exposing the catheter, and the guiding wire (indicated by the arrow) is inserted through the catheter (2). Once the guiding wire is in place, the catheter is removed (3).

decision should involve an inter-disciplinary team, assessing each case individually. For instance, Ghambir *et al.*[11] documented a case involving iatrogenic vertebral artery cannulation, where open repair was deemed the optimal solution due to the heightened risk of stroke associated with the endovascular approach and the anatomical accessibility via the cervical vertebrae.

In contrast, Papastratigakis *et al.*[12] documented a case series involving inadvertent arterial catheterization during CVC placement, all of which were managed with an endovascular approach supplemented by balloon tamponade and external pressure. The affected arteries included the right and left subclavian artery, as well as the right common carotid artery, each accessed accidentally through a vein. In this specific

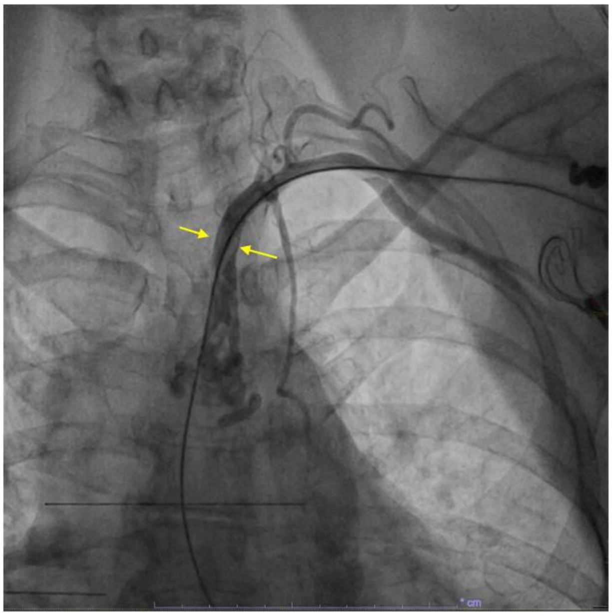

Figure 5 Angiogram shows the proximal subclavian artery with evidence of thrombosis (arrows).

scenario, they recommended against using a closure device, possibly due to concerns regarding the potential risk of arteriovenous fistula formation. Balloon tamponade can also be employed in carotid and subclavian artery injuries due to its low associated morbidity. However, it is important to note its ∼25% failure rate, often necessitating the implementation of a secondary rescue technique.[13] Conducting endovascular catheter retrieval and using a suture-mediated closure device is an alternative approach to manual compression in locations where achieving haemostasis is challenging, such as the neck area. The Perclose ProStyle suture-mediated closure system is a Food and Drug Administration approved for closing common femoral artery and vein access sites in patients who underwent catheterization procedures using 5–21 Fr for arterial sheaths and 5–24 Fr for venous sheaths.[14] We opted for the Perclose ProStyle closure device due to its availability in our institution and the operator's preference and expertise with this specific closure device. It was successfully deployed without complications, and no additional rescue closure device or manoeuvres were required. The Angio-Seal® VIP closure device (Terumo Inc.), a collagen plug, is commonly employed in routine procedures due to its user-friendly techniques. However, based on our experience, suture-mediated closure devices are preferred as the primary choice for iatrogenic arterial cannulation. This preference for suture devices over collagen plugs stems from the requirement for the access site to be smaller than 8 Fr, which limits the versatility of collagen plugs.[15] Nonetheless, collagen plugs may be utilized in hybrid approaches. These include double suture-mediated techniques, combinations of suture and collagen plug–mediated methods, and the combination of suture-mediated techniques with tissue glue injection, which have recently emerged as alternatives for achieving haemostasis, particularly for large-bore puncture sites.[16] Percutaneous closure devices are typically preferred for subclavian arteries to mitigate the risk of neurologic injuries, such as ischaemic strokes. Conversely, covered stents are favoured for addressing conditions like pseudo-aneurysm, arterial dissection, arteriovenous fistula, among others, particularly after a percutaneous closure device has failed.[13] Other types of closure device include the MANTA® plug-based vascular closure device (Teleflex Inc.). Studies have shown that MANTA is not superior to sutured-based closure device, although it required less maneuvers than suture-mediated devices to reach haemostasis.[17]

According to the study by Guilbert *et al.*,[7] large-bore catheter removal with the 'pull and pressure' technique is associated with higher mortality and the highest complication rates when compared to the endovascular management. Also, compression around the neck area is not feasible because of the possibility of jeopardizing cerebral perfusion. Thus, percutaneous closure devices or stents are a safer approach.

Conclusion

Subclavian artery iatrogenic cannulation may lead to catastrophic outcomes, including stroke, pseudo-aneurysm, and death. A high level of suspicion for venous port misplacement must be entertained when ipsilateral multi-focal cortical ischaemic infarcts occur in time relation to catheter placement. Conducting endovascular catheter retrieval and using a suture-mediated closure device is an alternative approach in locations where achieving haemostasis with manual compression is challenging, such as the subclavian artery.

Lead author biography

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Supplementary material

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

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Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

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