WHAT WOULD YOU DO?

Central Line Misplacement Leading to Stroke

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CASE PRESENTATION

The following is a case of iatrogenic trauma. A 23-year-old woman with a history of type 1 diabetes mellitus, an eating disorder, gastroparesis, neurogenic bladder, and schizoaffective disorder was admitted to an outside hospital in diabetic ketoacidosis. A central line was placed emergently, and after placement, a chest x-ray showed a right pneumothorax and an abnormal course of the central line (Figure 1). A right chest tube was placed for the pneumothorax, and this subsequently resolved. A chest CT was performed 3 days later for persistent tachycardia, which showed the central line entering the subclavian artery very close to the innominate artery bifurcation (Figure 2). The patient was then transferred to our institution for management of the misplaced central line.

The patient and family were counseled regarding the risks and possible approaches for repair. The patient was taken to the hybrid operating room, and the central line and right groin were initially prepped and draped sterilely. An initial innominate artery angiogram showed the central line entering near the innominate artery bifurcation. The right subclavian artery was selected, and a wire was advanced into the axillary artery to allow for balloon occlusion control of the subclavian artery if necessary (Figure 3). A wire was then advanced through the central line, the line was removed, and the puncture site at the origin of the subclavian artery was closed with an Angio-Seal device (Terumo Interventional Systems). However, postclosure angiography showed a large thrombus in the subclavian artery at the origin of the right vertebral artery (Figure 4). After discussion, a 7-mm absolute bare-metal self-expanding stent was deployed across the thrombus to prevent distal embolization (Figure 5).

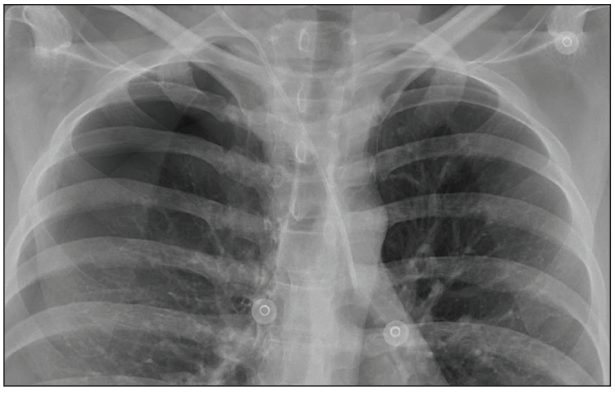

Figure 1

Figure 2

The patient was then transferred to the intensive care unit for monitoring, and left-sided weakness was noted as she was emerging from anesthesia. The stroke team was activated, and CTA was performed, which showed a nonocclusive clot in the right M1 segment of the middle cerebral artery (MCA) (Figures 6 and 7). The stroke team performed thrombectomy and successfully removed the

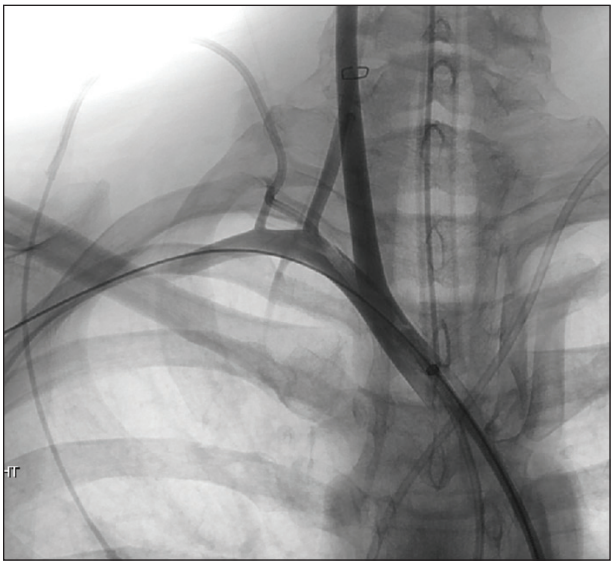

Figure 3

thrombus. However, the patient subsequently developed aphasia, and MRI showed a large posterior left MCA distribution infarct, as well as a right cerebellar infarct and small right MCA distribution infarcts (Figures 8 and 9).

At 1 week postprocedure, the patient had only mild residual expressive aphasia and her motor function has gradually improved.

Central line complications are declining in incidence with increased use of ultrasound guidance and other quality measures. At your institution, who is consulted regarding misplaced central lines in the arterial system? In your experience, is the incidence of this complication decreasing?

Dr. Resnick: Despite cooperative working arrangements, a parallel service nature remains at our institution. As such, this type of consult can go to either interventional radiology or vascular surgery. Although the incidence of inadvertent arterial catheterization does seem to be decreasing with the presence of portable ultrasound to all our hospital intensive care units, sonographic guidance in inexperienced or untrained hands nonetheless still results in complications typically associated with visual landmark-directed vessel access, such as pneumothorax and arterial access.

Dr. Hohenwalter: In general, both vascular surgery and interventional radiology are consulted when a central line is inadvertently placed into the arterial system. I agree that the overall incidence is decreasing in our hospital; however, there are still a handful of cases that occur annually. In addition, patients from local hospitals

Figure 4

Figure 5

are transferred to our institution when this situation occurs, as was the scenario in this case.

Dr. Schramm: At the University of Colorado, arterially misplaced central lines are typically vetted through both the vascular surgery and vascular/interventional radiology services. In this particular case, we would have certainly also involved our colleagues in thoracic surgery given the site of injury and potential need for intrathoracic opera-

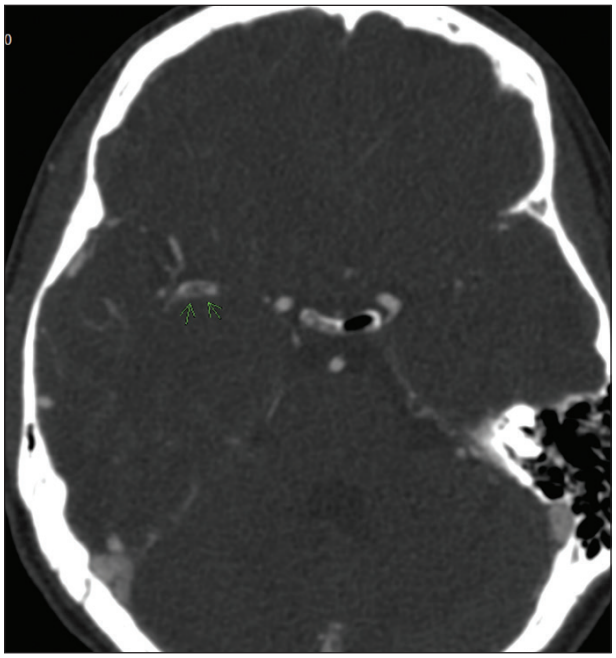

Figure 6

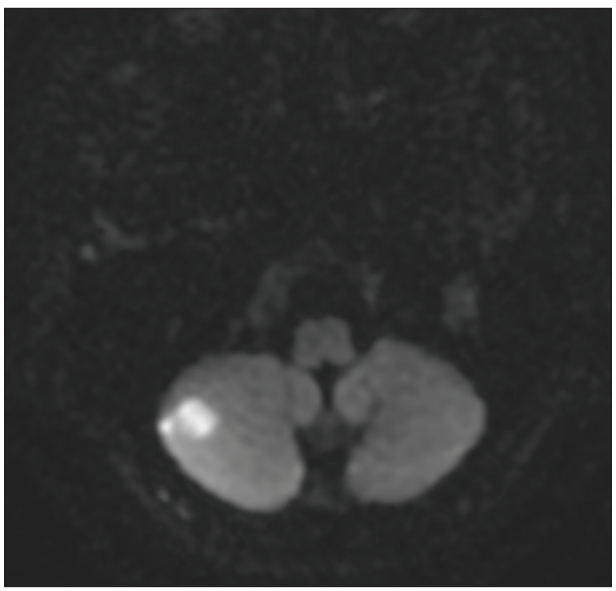

Figure 8

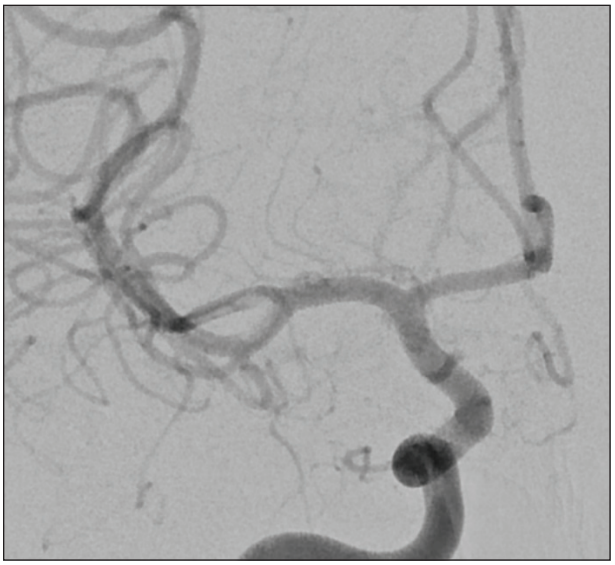

Figure 7

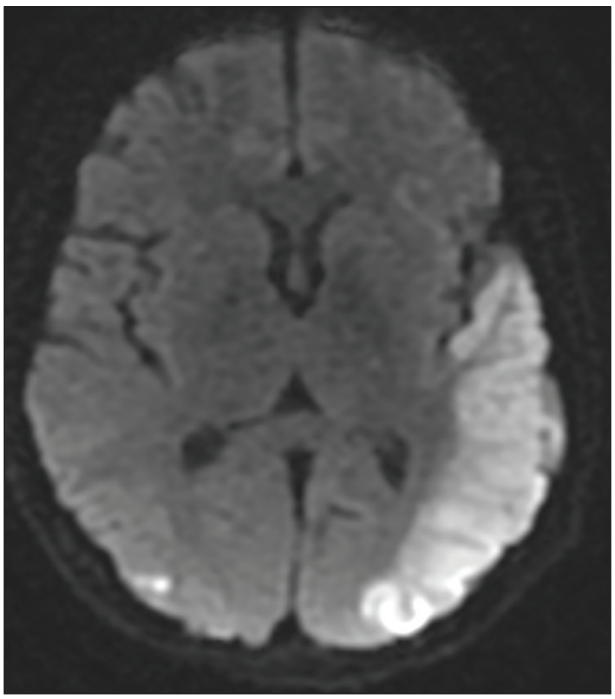

Figure 9

tive intervention for repair. Interventional radiology has its own quality assurance processes, and our incidence of arterial puncture is exceedingly rare given our propensity to use ultrasound for every access case. Emergent central venous access is typically performed at the bedside in the intensive care unit, operating room, or emergency department setting, with special involvement by interventional radiology as needed for patients with difficult access. Most practitioners outside of interventional radiology have transitioned to ultrasound-guided puncture as the preferred method of access. I think ultrasound utilization has led to a marked decrease in inadvertent arterial punctures at our institution, but it is well known that many practitioners still rely on anatomic landmarks for central venous access. This is especially the case during emergent central venous access, when ultrasound may not be readily available and delays in central venous access could compromise patient care. Certainly, these conditions would predispose to inadvertent arterial puncture.

What is your general approach to arterially placed central lines, and how would you have treated this particular case?

Dr. Schramm: Arterially placed central line management often will differ depending on the site of injury, diameter of the cannulation device, and length of cannulation. Typically, primary surgical repair is the first consideration at our institution, especially when treating carotid punctures, which represent a straightforward repair without the need for thoracotomy. When the patient is a poor candidate for open repair, the site of arteriotomy is within the thoracic cavity, or smaller-bore (ie, 7-F triple lumen) access has been performed, closure devices or endovascular techniques can be used as an alternative for decannulation. This is always a multidisciplinary discussion based on patient factors. An intrathoracic puncture site opens the risk/benefit discussion of primary repair versus endovascular repair.

This is a tough case given the age of the patient, site of arterial puncture, and presence of pericatheter thrombosis—which I think is subtle but present on the diagnostic innominate angiogram. Assuming conservative approaches such as heparinization have failed, I agree with the plan for primary endovascular management with a surgical bailout. I think we would have proceeded similarly with a plan for a closure device, based on poor candidacy for a covered stent in this location due to a need to sacrifice the vertebral artery to adequately cover the puncture site with a covered stent. Bailout surgical intervention could be performed; however, the risk of morbidity and mortality would be significant given the intrathoracic site of puncture. First, we would take this patient to a hybrid operative setting, access the groin, and perform angiography of the innominate before planned Angio-Seal or Perclose ProGlide (Abbott Vascular) closure. Unfortunately, new thrombus is noted on the catheter prior to removal. At this point, the worry would be embolization to both the vertebral and/or carotid arteries, which would need a degree of embolic protection of both vessels. I would upsize the existing femoral access to 8 F and ensure secure support wire access through the right subclavian artery and into the right arm in case bailout stenting/suction thrombectomy would be needed. Next, I would place embolic protection devices (Emboshield NAV6 [Abbott Vascular] and SpiderFX [Medtronic] are indicated for cerebral protection) into both the right internal carotid and right vertebral arteries, which could be performed through either contralateral groin or ipsilateral radial access, or a combination thereof. We would then proceed with Angio-Seal closure of the proximal subclavian, as was performed in this case. Once this was done, we would perform thrombectomy with the Indigo mechanical thrombectomy system (Penumbra, Inc.). If thrombus traveled distally down the arm, conventional lysis or suction thrombectomy from a radial approach could be performed.

Dr. Resnick: In these situations, my first need is for an arterial phase contrast-enhanced CT of the neck/chest. This imaging is important because it provides noninvasive detail of exactly which vessel was accessed, where vessel entry occurred, what intervening structures were traversed, what critical vessels/structures are near the entry site, and what potential complications may have already occurred. A quality scan will also allow for identification of catheter-associated thrombus before device removal. When possible, I also obtain a brain MRI to see if any subclinical embolization has already occurred. In this case, the coronal CT reconstruction (Figure 2) shows that the catheter enters the subclavian artery just central to the vertebral artery, and critically, there is no evidence of pericatheter thrombus.

My approach to this patient would begin with systemic anticoagulation and obtaining the previously mentioned imaging, followed by diagnostic arteriography and potential catheter removal. If catheter-associated thrombus was obvious on either CTA or angiography, then surgical catheter removal or percutaneous removal with thrombolysis/thrombectomy would be warranted. In this case, it does not appear that catheter-associated thrombus was present, and as such, under full anticoagulation, I would traverse the accessed vessel with a guidewire and place a long guiding sheath proximal to the inadvertent arterial entry site to allow for control angiography during and after catheter removal and vessel closure. My typical method in such cases is to have the appropriately sized balloon open and on the wire during vessel closure to allow for rapid balloon tamponade if closure is incomplete or unsuccessful. Although plug-mediated closure is entirely appropriate, my preference is for suture-mediated closure because it allows for wire maintenance through the arteriotomy and, thus, the ability to attempt additional closure procedures if needed.

In this case, arteriography after catheter removal showed tubular thrombus with a shape and location similar to the preexisting catheter, suggesting that thrombus had formed and was associated with a fibrin sheath (Figure 3), which can begin developing immediately after catheter placement and can completely cover a catheter down to the tip in as short as 2 weeks. The newly formed thrombus was in a challenging location to manage given the adjacent vertebral and carotid arteries, and complete removal without some embolization into one or both of these vessels seems unlikely. I would initially try to perform suction thrombectomy via the prepositioned guiding sheath; if that was unsuccessful, I would then move on to rheolytic thrombectomy.

Dr. Hohenwalter: Our general approach is to evaluate the exact entry point of the line, usually with CTA. A discussion with vascular surgery, interventional radiology, and cardiothoracic surgery (if indicated) would then be pursued. The ultimate decision regarding our approach is based on imaging characteristics and this discussion. Options considered include a closure device with/without femoral arterial access, covered endograft placement, and surgical removal and repair of the artery. In this case, surgical repair would require a sternotomy. I would evaluate with angiography and use a closure device because there does not appear to be enough landing zone for a covered endograft.

In this case, the patient had bilateral stroke as a result of embolization of pericatheter thrombus. What type of imaging do you routinely perform to determine if pericatheter thrombus is present?

Dr. Resnick: Given the high special resolution and rapid image acquisition, I prefer CTA for preprocedural pericatheter thrombus identification, as was done in this case. Ultrasound might add additional information, depending on patient body habitus, but I don't routinely obtain ultrasounds in these cases. Angiography can also be helpful in thrombus identification, and although we don't have angiographic images prior to catheter removal, my guess is the initial angiogram didn't show catheter-associated clot before removal. Unfortunately, in this case, it doesn't seem that the fibrin sheath could have been identified prior to catheter removal, despite optimal preprocedural imaging.

Dr. Hohenwalter: We usually perform CTA. This case was interesting because the central line was in place for > 3 days. Usually, an arterial location is recognized and treated much sooner. The CT performed at an outside hospital did not demonstrate pericatheter thrombus. Once the catheter was removed, the follow-up angiogram demonstrated a large filling defect across the origin of the vertebral artery. At that point, we discussed both endograft and bare-metal stent placement versus surgical embolectomy. We elected for a bare-metal stent with the intent to prevent migration of the embolus.

We discussed this case at a multidisciplinary morbidity and mortality conference and concluded that, in retrospect, because the catheter was in for 3 days without systemic anticoagulation, echocardiography could have been performed to evaluate for pericatheter thrombus, despite the lack of demonstration on the CT. Once recognized, an alternative treatment approach would have been pursued.

Dr. Schramm: In the case of carotid puncture, the first step in assessment should be conventional ultrasound. This would both confirm inadvertent arterial placement as well as evaluate for the presence of pericatheter thrombus. When the tip of the catheter cannot be visualized with ultrasound, the next step, in my opinion, should be CTA. In this case, likely because it wasn't yet known that the catheter was malpositioned, the catheter itself was the site for contrast injection. Pericatheter thrombosis in this setting can be missed due to beam hardening and mixing artifact of the highly dense contrast with unopacified blood. Additionally, CTA would best characterize additional injuries and catheter course for repair planning. As was performed in this case, we would likely strongly consider formal angiography for thrombosis evaluation before removal given the length of catheter placement. ■

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