

Folded large-bore central catheter in the right internal jugular vein as shown by ultrasound: a case report

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Abstract

Central venous catheters are used for various purposes in the operating room. Generally, the use of ultrasound to insert a central venous catheter is rapid and minimally complicated. An advanced venous access (AVA) catheter is used to gain access to the pulmonary artery and facilitate fluid resuscitation through the internal jugular vein. The present report describes a case in which ultrasound was used in a 43-year-old man to avoid complications during insertion of an AVA catheter with a relatively large diameter. The sheath of the catheter was so thin that a dilator was essential to prevent it from folding upon insertion. Despite the use of ultrasound guidance, the AVA catheter sheath became folded within the patient's internal jugular vein. Mechanical complications of central venous catheter insertion are well known, but folding of a large-bore catheter in the internal jugular vein has rarely been reported.

Keywords

Central venous catheterization, mechanical complication, large-bore catheter, internal jugular vein, pulmonary artery, ultrasound guidance

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Introduction

Central venous catheterization is used to administer medication or fluid and to measure central venous pressure.¹ Central venous catheters can be placed in several sites, but placement of the catheter in the internal jugular vein (IJV) under ultrasound

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guidance is preferred.² Insertion of a central venous catheter is invasive and can be dangerous.³ The American Society of Anesthesiologists Task Force recommends the use of ultrasound during IJV catheterization because it is rapid and safe.⁴ Since 2014, our hospital has been performing IJV catheterization under ultrasound guidance whenever possible. The 9-Fr advanced venous access (AVA) catheter (Edwards Lifesciences, Irvine, CA, USA), one of the various commercially available large-bore central venous catheters, has a port for rapid fluid infusion and pulmonary artery catheter entry. We herein describe a patient in whom an AVA catheter sheath became folded upon insertion into the patient's right IJV under ultrasound guidance.

Case report

A 43-year-old man (55 kg, 165 cm) was admitted to our hospital to undergo aortic valve replacement for treatment of infective endocarditis and aortic regurgitation. His initial laboratory data were as follows: hemoglobin level, 8.2 g/dL; hematocrit, 25.8%; platelet count, 180,000/ μ L, blood urea nitrogen level, 35.0 mg/dL; creatinine level, 5.18 mg/dL; troponin I level, 1.42 ng/mL; prothrombin time/international normalized ratio, 1.45; activated prothrombin time, 44.9 seconds; and C-reactive protein level, 8.6 mg/dL.

The patient's vital signs in the operating room were stable. Local anesthesia was administered using 2% lidocaine, and a

20-G arterial catheter was inserted into the right radial artery. General anesthesia was then induced. We used etomidate at 0.2 mg/kg for sedation, sufentanil at 0.02 μ g/kg/min for analgesia, and rocuronium at 0.6 mg/kg for neuromuscular blockade. The patient had no history of cervical surgery and had not recently undergone insertion of a catheter into the IJV.

After intubation, the patient was positioned to facilitate insertion of the AVA catheter (Figure 1) into the right IJV. In an effort to expand the right IJV, the head was lowered approximately 5 degrees and the face was pointed toward the left. The skin was aseptically prepared, the IJV was punctured with a needle tip under static ultrasound guidance with marking of anatomical landmarks, blood was aspirated, and a guidewire was inserted. The guidewire was inserted until it reached approximately 25 cm from the end of the syringe and was advanced no further to avoid arrhythmia. The presence of the guidewire within the IJV was confirmed by ultrasonography (Figure 2). After a slight incision was made using a scalpel, the AVA catheter combined with a vessel dilator was advanced along the guidewire. No resistance was felt during entry of the dilator along the guidewire into the IJV. When the dilator was considered to have passed the IJV, the sheath was pushed forward; however, the dilator and guidewire were unable to be pulled backward. We assumed that the guidewire tip had become stuck to the vessel wall; therefore, we gently moved

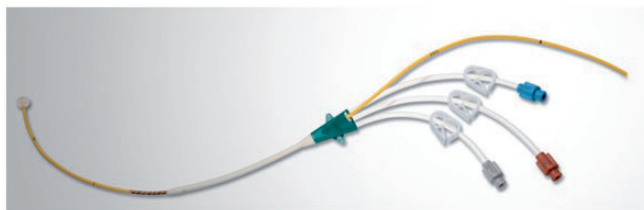


Figure 1. Advanced venous access catheter combined with a Swan–Ganz catheter.

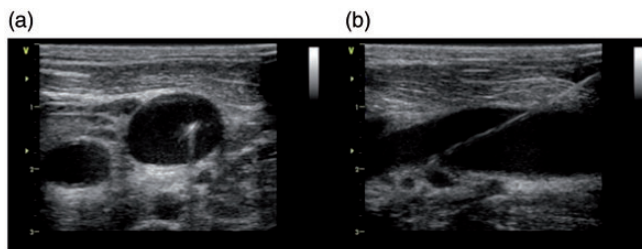


Figure 2. Guidewire in the right internal jugular vein. (a) Out-of-plane view and (b) In-plane view.



Figure 3. Removal of the twisted guidewire tip.

the dilator and guidewire back and forth in an attempt to loosen them. Despite these efforts, the dilator and guidewire were not removed simultaneously; instead, the guidewire was removed first, followed by the dilator. Upon pulling the guidewire out, we found that its end was bent and curved (Figure 3).

We considered that the catheter was in the appropriate position despite the fact that the guidewire tip was twisted upon removal. We attempted to irrigate the vessel lumen with saline to remove air and prevent blood clot formation, but the blood was not regurgitated. We assumed that the sheath was malpositioned and thus repeated the ultrasound examination, which revealed that the AVA catheter sheath was folded inside the right IJV (Figure 4).

We gently withdrew the AVA catheter to avoid additional injury. The AVA catheter was pulled out with no resistance, and the IJV was manually compressed for 5 minutes. We observed traces of small pleats in the end of the AVA catheter

sheath, and we considered that they had been caused by folding and stretching of the end of the sheath upon removal. After removing the AVA catheter, we attempted to gain access to the left IJV. Left IJV catheterization using a new AVA catheter and subsequent performance of the operation were uneventful. At 6 and 12 hours postoperatively, we observed no tenderness, swelling, or color change at the right IJV catheterization site, and no further examination was performed thereafter.

Ethical permission was obtained from the Chonnam National University Hospital Institutional Review Board (CNUH-EXP-2017-283). Written informed consent was obtained from the patient.

Discussion

The Seldinger technique (thin-wall needle technique) is commonly used to obtain safe access to a central vein. The desired vessel is punctured with a sharp hollow needle, a guidewire is advanced through the lumen of the needle, and the needle is withdrawn. A central venous catheter is then passed over the guidewire into the vessel.⁵ A large-bore catheter is inserted using the Seldinger technique and its modifications. In conventional central venous catheter insertion, the sheath is inserted after the dilator has been removed. When using a large-bore catheter, however, the dilator and sheath are simultaneously inserted along the guidewire. The catheter

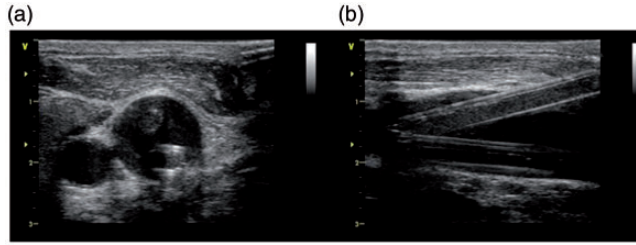


Figure 4. Folded advanced venous access catheter sheath in the right internal jugular vein. (a) Out-of-plane view and (b) In-plane view.

must be loaded onto a dilator when inserted into a patient because the sheath is soft and minimally resistant to external forces. The guidewire and dilator are removed at the same time, and only the sheath remains in the blood vessel.

Mechanical complications such as hemothorax, cardiac injury, and arteriovenous fistula can occur when using a dilator.⁶ Dilators that are used for insertion of large-bore catheters are stiffer and thicker than those used for insertion of conventional catheters. A thick dilator can damage blood vessels other than the target vessel.⁷ Large-bore catheters may require vigorous force during insertion, which may cause vascular injury.⁸ A large-bore catheter also causes mechanical problems caused by its large size and soft sheath. The sheath of a large-bore catheter has a large diameter but is soft and less resistant to external forces. Because of their large diameter, such sheaths may cause the vessel to rupture upon insertion.⁹ A thin sheath has weak resistance to external force and may fold on itself due to pressure from and advancement past the surrounding tissue.¹⁰ The sheath can rotate and become occluded by its own weight.¹¹ The middle portion of the sheath may fold, and the conduit may become partially blocked.¹² Such morphological plasticity can lead to unexpected mechanical complications, as in the present case.

We assume that the events that occurred in our patient were due to the interaction between the distal part of the guidewire located on the posterior wall of the vessel and the soft catheter sheath. We hypothesize that in such cases, the tip of the guidewire seen in the ultrasound image is fixed to the blood vessel; the soft sheath within the blood vessel cannot be advanced because the guidewire is fixed, and the sheath therefore starts to bend. As the pushing force increases, kinking of the sheath also increases. Previous reports have shown that the tip of the catheter can travel back to the head during IJV catheterization^{13,14}; however, this does not occur with large-bore catheters.¹² We postulate that a 7-Fr catheter would bend into a U shape because it is stiff and that a 9-Fr catheter would kink into a V shape because it is soft. Conventional catheters and large-bore catheters differ in the degree of resistance to bending force because of differences in their inner diameter and thickness of the sheath wall. This is consistent with the previous finding that catheters have different bending resistances upon insertion depending on the material of which they are made.¹⁵

Ultrasound guidance allows for safer performance of central venous catheterization. However, static ultrasound is only used for vessel puncture and guidewire localization. Therefore, when inserting a

large-bore catheter, the various complications caused by a thick guidewire and large catheter cannot be prevented by the use of static ultrasound. In the present case, we performed ultrasonography to confirm that the guidewire had been placed in the vessel, but a complication still occurred. In conclusion, large-bore catheter sheath insertion is more safely performed with real-time than static ultrasound guidance.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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