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Case Report

Novel treatment of vascular injury from delayed hemodialysis catheter migration by transvenous balloon-assisted embolization with n-butyl cyanoacrylate ☆

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ABSTRACT

Delayed vascular injury (DVI) with a hemodialysis catheter is a rare but potentially life-threatening complication. However, the appropriate treatment for DVI has not yet been established.

A 44-year-old man underwent placement of a hemodialysis catheter via the left internal jugular vein, and the first leukapheresis procedure was performed without complications. However, 3 days after the insertion of the hemodialysis catheter, the patient developed sudden dyspnea. Chest radiographs and contrast-enhanced computed tomography revealed that the catheter tip had migrated and was located outside the left brachiocephalic vein. DVI with catheter migration was diagnosed. To perform safe and reliable hemostasis, we successfully performed transvenous balloon-assisted tract embolization with n-butyl cyanoacrylate and the catheter was removed.

To our knowledge, there has been no previous report of the treatment of balloon-assisted tract embolization with n-butyl cyanoacrylate for DVI caused by a hemodialysis catheter. Our treatment approach may be safe and effective for DVI.

Introduction

Common complications associated with central venous catheters and hemodialysis catheters are categorized as (1) the immediate complications that occur during catheterization and (2) the delayed complications after placement of the catheter. The common immediate complications include failure to place the catheter, arterial puncture, hematoma, air embolism, pneumothorax, and hemothorax. The delayed complications include infection, venous thrombosis, catheter migration, and embolization, and vascular injury [1].

Delayed vascular injury (DVI) is rare but can cause massive bleeding with fatal consequences [2,3]. There is a particularly high risk of venous perforation in cases of left internal jugu-

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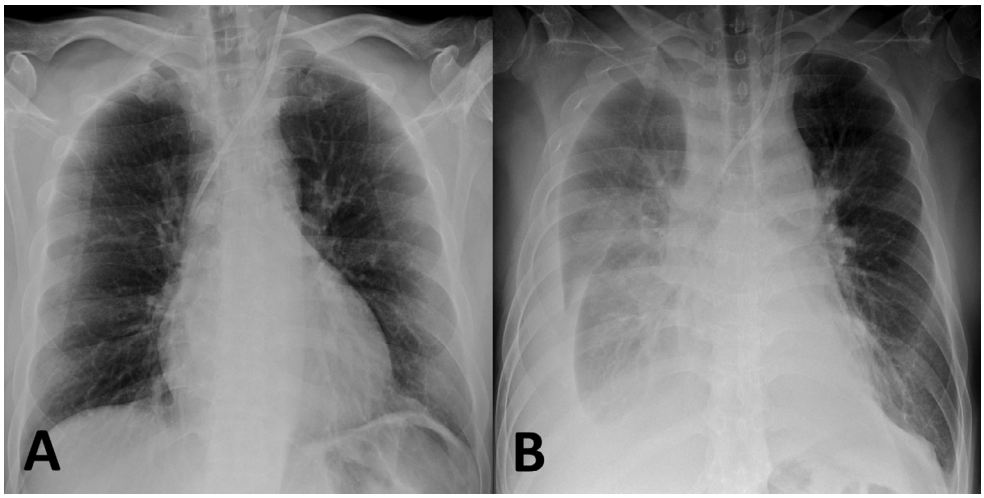

Fig. 1 – Chest radiographs. A: Chest radiograph immediately after hemodialysis catheter insertion shows a well-positioned catheter tip. B: Chest radiograph after 3 days of insertion shows the migration of the catheter tip and bilateral pleural effusion.

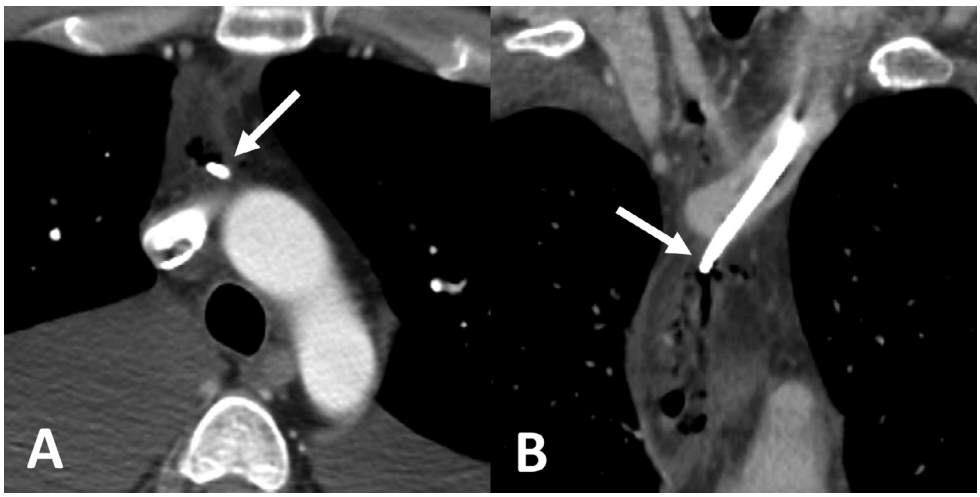

Fig. 2 – Contrast-enhanced CT images of the axial A: and oblique coronal view B. Contrast-enhanced CT shows bilateral pleural effusion and mediastinal hematoma and emphysema. The hemodialysis catheter tip (arrow) was located outside the left brachiocephalic vein.

lar vein puncture because of the anatomical features [1,2,4]. In addition, hemodialysis catheters are of wider diameter and firmer than the usual central venous catheters and hence may have a higher risk of vascular injury and massive bleeding [4].

Simple catheter removal, surgical repair and endovascular treatment with stent graft placement have been reported [1,3,5–8]. However, the treatment of DVI is still controversial. Here we present a case of DVI occurring after 3 days of insertion of a hemodialysis catheter, that was successfully treated by balloon-assisted embolization with n-butyl cyanoacrylate (NBCA: B.Braun Melsungen AG, Melsungen, Germany).

Case report

A 44-year-old man was admitted to our hospital with aggravation of ulcerative colitis. For leukapheresis, the patient underwent placement of a 12-French and 16 cm length triple lumen hemodialysis catheter (GentleCath, COVIDIEN JAPAN, Tokyo, Japan) in the left internal jugular vein under ultrasound guidance. On ultrasound, the right internal jugular vein closely overlapped the carotid artery and hence the left internal jugular vein was chosen for catheter placement. After placement of the hemodialysis catheter, aspiration of blood from all ports of the catheter was confirmed, and the ports were flushed smoothly with saline. Chest radiographs revealed a well-positioned catheter tip (Fig. 1A). The first leukapheresis procedure was performed without problems. However, 3 days after hemodialysis catheter insertion, the patient developed chest pain and sudden dyspnea. Chest radiographs revealed migration of the catheter tip (Fig. 1B). Contrast-enhanced computed tomography showed bilateral pleural effusion and mediastinal hematoma and emphysema, with the catheter tip located outside the left brachiocephalic vein (LBV) (Fig. 2). Ac-

Fig. 3 – Angiographic images. A: Venography via the most proximal hemodialysis catheter port shows the catheter tip (arrow) located outside the left brachiocephalic vein. B: Venography via the microcatheter which is inserted via the most distal hemodialysis catheter port and positioned outside the vessel shows extravasation into the mediastinum. C: Under balloon inflation, the NBCA-Lipiodol mixture (arrow) is injected into the hemodialysis catheter tract via the microcatheter.

cording to these results, we diagnosed DVI from catheter migration.

The diameter of the hemodialysis catheter was large (12-French) and the patient was taking warfarin for a history of cerebral venous sinus thrombosis. Therefore, we considered that the risk of massive bleeding was high. We planned removal of the catheter and hemostasis under general anesthesia because the general condition was expected to deteriorate by simple catheter removal. We first planned balloon-assisted tract embolization with NBCA to perform a safe and reliable embolization. In case the embolization was unsuccessful, hemostasis would be assisted by inflating the balloon at the perforation site. If hemostasis was still unachievable, surgical repair by thoracotomy was planned.

Under general anesthesia, an 8-French sheath (Medikit, Miyazaki, Japan) was inserted in the left brachial vein. A 12.0 × 40 mm noncompliant balloon catheter (MUSTANG, Boston Scientific, Tokyo, Japan) was advanced to the site of perforation of the LBV. A 2.0-French microcatheter (GoldCrest Neo, HI-LEX, Takarazuka, Japan) was inserted via the most distal hemodialysis catheter port and placed outside the vessel. Venography, via the most proximal hemodialysis catheter port, showed the catheter tip located outside the LBV (Fig. 3A). Venography, via the microcatheter, showed extravasation into the mediastinum (Fig. 3B). Using the inflated balloon to control blood flow, the mixture of NBCA and iodized oil (Lipiodol, Guerbet Japan, Tokyo, Japan) (NBCA:Lipiodol = 1:2) was injected into the hemodialysis catheter tract via the microcatheter. The hemodialysis catheter was subsequently removed (Fig. 3C). Hemodynamics were stable after balloon deflation. Post tract embolization venography showed no active contrast extravasation (Fig. 4). Post embolization contrast-enhanced computed tomography revealed NBCA-Lipiodol accumulation at the LBV wall and there were no serious complications (Fig. 5). The patient fully recovered. We obtained informed consent from the patient for publication of the report and associated images.

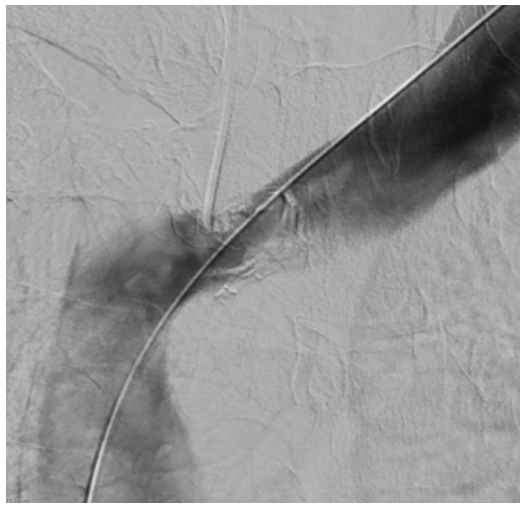

Fig. 4 – Post tract embolization venography shows no contrast extravasation.

Discussion

DVI has a reported incidence of 0.17 to 0.4%, an extremely rare complication, but DVI should be recognized as a life-threatening complication that has been reported to develop relatively early after catheter placement [3]. Previous reports have shown that vascular injury occurs within 4 days after placement [3]. In this case, there was no problem immediately after catheter placement, but DVI developed 3 days after placement.

The clinical findings of DVI are reported to be cardiac tamponade, pleural effusion, hemothorax, and mediastinal hematoma [6]. Previous reports have shown that the mortality rate is 57% [6]; therefore, early diagnosis and treatment are important. DVI could be misdiagnosed at the onset as sepsis,

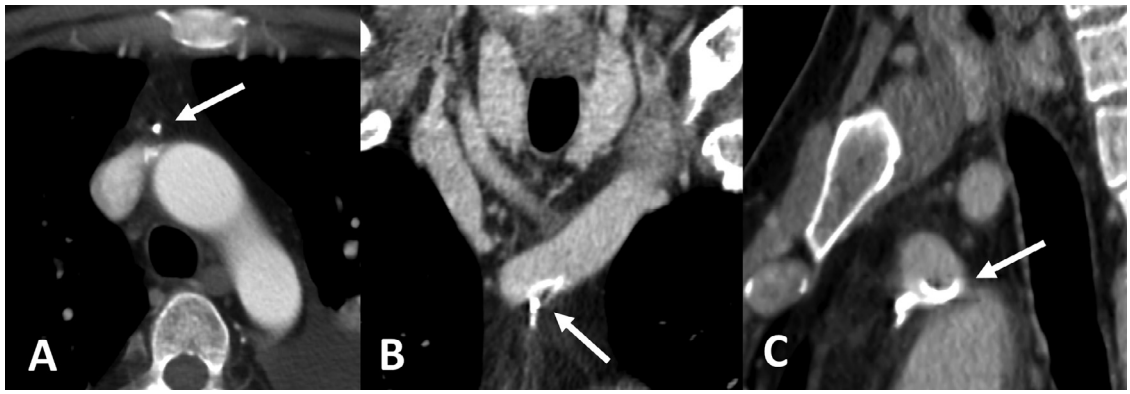

Fig. 5 – Post embolization contrast-enhanced CT images of the axial A: and oblique coronal B: and sagittal view C. Post embolization contrast-enhanced CT shows NBCA-Lipiodol accumulation (arrow) along the inside of the left brachiocephalic venous wall.

thrombosis, or heart failure and diagnosis is frequently delayed [6]. If respiratory failure occurs during catheter placement, we should keep in mind the possibility of DVI. In this case, we diagnosed the DVI early, preventing a more severe outcome.

It has been reported that the position of the catheter tip is closely related to DVI [3,6,9]. When the catheter tip is in direct contact with the vessel wall, the catheter tip may migrate due to the pulsation of the vessel wall from the heartbeat or from postural changes. The physical stimulus of the catheter tip may cause intimal damage to the vessel wall and even cause perforation. From an anatomical perspective, the left-sided catheters have a high risk of DVI [1–4,6]. It has been reported that the left internal jugular vein forms a nearly perpendicular angle with the brachiocephalic vein [2,5]. Therefore, the catheter tip is likely to be located on the inferior wall of the LBV, and we suspect that is how venous perforation occurred in this case. In addition, hemodialysis catheters are of wider diameters and often firmer than the usual central venous catheters and hence may have higher incidences of complications [4]. In this case, a hemodialysis catheter was inserted via the left internal jugular vein, so the risk of complications was high.

At the time of the diagnosis of DVI, the catheter should not be removed immediately at the bedside. It has been recommended that an inappropriately placed catheter should remain in situ until a workup can be completed and the emergency procedure is ready [2]. This is because it is considered that bleeding is controlled by the tamponade of the catheter. Removal of the catheter, before appropriate measures are in place, may result in uncontrolled bleeding and an increased risk of fatal consequences.

There are several reports of treatment for DVI. Conservative treatment with only catheter removal, surgical repair with thoracotomy, and endovascular treatment with stent graft placement have been reported [1,3,5–8]. However, the appropriate treatment for DVI has not yet been established. Conservative treatment with only catheter removal is not a recommended treatment because it may not reliably control bleeding. In this case, the risk of bleeding was considered to be high because the venous perforation was caused by the large-bore hemodialysis catheter and the patient was taking warfarin. Therefore, we considered that conservative treatment with only catheter removal was inappropriate. Surgical repair with thoracotomy is a highly invasive procedure. Therefore, it cannot always be performed, depending on the condition of the patient. The possibility of intra-operative death cannot be excluded. In regards to the endovascular treatment of DVI with stent grafts, it is especially valuable in cases of poor surgical conditions. However, the long-term patency of stent grafts in the venous system remains to be determined [8]. In addition, endovascular treatment with stent grafts for the venous system is not approved in Japan, so we could not perform that procedure.

For this case, we performed a novel treatment of transvenous balloon-assisted tract embolization with NBCA. Various materials are used for tract embolization, including gelatin sponge particles, coils, and NBCA [10]. Incomplete tract embolization may occur with the use of gelatin sponge particle, owing to its soluble and impermanent nature [10]. The risk of rebleeding is increased in patients with underlying bleeding diathesis [10]. The procedure time may be longer owing to the use of multiple coils. In this case, rapid embolization was necessary because of the risk of sudden massive bleeding after catheter removal. In addition, in this case incomplete tract embolization may occur owing to migration of coils because of improper supporting tissue. NBCA is a liquid permanent embolization material, while provides reliable results [10]. NBCA is fast-acting and allows rapid embolization [10]. NBCA does not depend on blood coagulation [11]. Therefore, reliable embolization is achieved even in patients with underlying bleeding diathesis, and the risk of rebleeding is considered to be low [10]. Therefore, we considered NBCA as the most appropriate material in this case.

Furthermore, by using a balloon catheter, the blood flow could be controlled, the risk of NBCA migration to the main trunk was reduced, and reliable embolization was performed. If the embolization is unsuccessful and massive bleeding occurs, bleeding can be controlled by inflating the balloon. We considered this catheter system to be useful as an emergency

procedure when conversion to the surgical procedure is required. We chose the noncompliant balloon to form an appropriate gap between the balloon and the vessel wall. The balloon inflation was performed at a pressure lower than the nominal to prevent complete occlusion. Polymerization of the NBCA cannot occur with complete block of the blood flow.

Embolization with NBCA requires skilled technique, but embolization required for this case is not difficult for an interventional radiologist who is well experienced in the use of NBCA. It is, however, important to determine the appropriate injection volume to avoid any serious complications of NBCA migration, such as pulmonary embolism.

In conclusion, we experienced a case of DVI occurring after 3 days of left-sided hemodialysis catheter insertion. DVI is a high mortality complication, so we should keep in mind the possibility of DVI when respiratory failure occurs during catheter placement. In this case, we performed a treatment of transvenous balloon-assisted tract embolization with NBCA and the outcome was good. This treatment can achieve rapid hemostasis without serious complications. We propose that balloon-assisted embolization with NBCA is a safe and effective treatment for DVI.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2020.05.077.

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