Pediatric

Fibrin sheath of a peripherally inserted central catheter undepicted with gray-scale (real-time B-mode) ultrasonography: A case report

Naoko Mogi MD\textsuperscript{a}, Motoo Nakagawa MD\textsuperscript{a,*}, Hidekazu Matsumae MD\textsuperscript{b}, Ayako Hattori MD\textsuperscript{c}, Masashi Shimohira MD\textsuperscript{a}, Yuta Shibamoto MD\textsuperscript{a}

\textsuperscript{a}Department of Radiology, Nagoya City University Graduate School of Medical Sciences, 1 Kawasumi, Mizuho-cho, Mizuho-ku, Nagoya, Japan
\textsuperscript{b}Department of Cardiovascular Surgery, Nagoya City University Graduate School of Medical Sciences
\textsuperscript{c}Department of Pediatrics and Neonatology, Nagoya City University Graduate School of Medical Sciences

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ABSTRACT
An 11-year-old male was admitted to our hospital with the acute exacerbation of chronic heart failure. A peripherally inserted central catheter (PICC) was inserted from the left forearm. Ten days after its insertion, the withdrawal of PICC was attempted because of occlusion. However, it was not possible to remove PICC because a fibrin sheath had attached around its tip. A color Doppler and probe compression technique revealed the presence of a fibrin sheath, which could not be detected by gray-scale (real-time B-mode) ultrasonography. This case demonstrated that the color Doppler and probe compression technique is useful for detecting a fibrin sheath.

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Introduction

A peripherally inserted central catheter (PICC) is a type of central venous catheter that is inserted through peripheral veins in the extremities. PICC is generally used under the following conditions: (1) when venous access for a prolonged period is needed; and (2) when substances that are difficult to administer from peripheral veins, such as chemotherapeutic agents, have to be injected directly into the central veins. Venous occlusion due to thrombosis or fibrin sheath formation is associated with this device [1]. Previous studies reported that a fibrin sheath may form around venous access devices. Although a fibrin sheath is typically depicted as a high echoic lesion with ultrasonography [2,3], that around PICC in the present case showed unusual findings. We herein report the ultrasonographic findings of a fibrin sheath surrounding the tip of PICC in our case and review the literature.

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* Corresponding author.
E-mail address: lmlolllolol@gmail.com (M. Nakagawa).
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Case report

An 11-year-old male with Duchenne muscular dystrophy, who was being monitored due to chronic heart failure, was admitted to our hospital with the acute exacerbation of chronic heart failure. The insertion of PICC was attempted through a peripheral vein in the left forearm. However, as it was not possible to forward the tip of PICC proximally beyond the level of the left upper arm, it was used as a peripheral venous line (Fig. 1). Ten days after its insertion, the withdrawal of PICC was attempted because it was occluded. However, its complete withdrawal was not possible; a length of 7 cm remained in the vein. Heparin (8 U/kg/day) was administered to resolve PICC tip anchoring. One day later, the tip of PICC was withdrawn further, and radiography revealed that a length of 1 cm remained in the vein; therefore, it was still not possible to completely remove PICC (Fig. 2). To identify the cause of PICC tip anchoring, ultrasonography with a 5-18 MHz linear probe was performed (HI VISION Ascendus, Hitachi Aloka Medical Ltd, Tokyo, Japan). In the peripheral vein of the left upper arm, ultrasonography showed a fine and slightly meandering high echo, which was considered to be the tip of PICC (Fig. 3). The circumference of the tip of PICC was shown as a hypoechoic area, similar to a normal venous lumen, on ultrasonography; an abnormal echoic lesion that may cause anchoring, such as thrombosis, was not detected (Fig. 3). On color Doppler and power Doppler imaging, there was no blood flow around the PICC tip (Fig. 4). Using manual compression with the probe, the venous lumen at the PICC tip did not change shape (Fig. 5). In the distal vein without PICC, the shape of the venous lumen was easily changed by compression with the probe.

Although abnormal echogenicity was not directly detected in gray-scale (real-time B-mode) imaging, we considered there to be some lesions around the tip of PICC based on these indirect ultrasonographic findings with the color Doppler and probe compression technique. Because it was not possible to manually pull PICC out, the catheter was removed surgically. A fibrin sheath that was elongated, reddish, and translucent was observed at the tip of PICC (Fig. 6). Fibrin sheath formation was detected around the tip of the removed catheter, which tested negative in a bacterial culture.

Fig. 1 – (A) Radiograph of the left forearm after catheter insertion. (B) An enlarged image around the tip of the peripherally inserted central catheter (PICC). The tip of PICC was present at the level of the left upper arm (arrows).

Fig. 2 – (A) Radiograph after withdrawal 10 days after catheter insertion. (B) An enlarged image around the tip of the peripherally inserted central catheter (PICC). It was not possible to pull PICC out, and the PICC tip (1-cm length) remained in the vein of the forearm (arrows).
Discussion

Fibrin sheaths form around catheters and often cause the stenosis or occlusion of a central venous catheter [4]. Fibrin sheath formation around a venous central catheter sometimes leads to persistent occlusion that may result in chemotherapy extravasation [5] and enhance catheter-related infections [6] and persistent bacteremia [7].

Previous studies reported that fibrin sheaths were depicted as high echogenic lesions with ultrasonography [2,3]. However, difficulties were associated with detecting the fibrin sheath around the PICC tip in the present case using gray-scale (real-time B-mode) ultrasonography because the fibrin sheath was hypoechoic, similar to the lumen of the vein. A potential reason for this phenomenon was the histological composition of the fibrin sheath. Histopathologic studies using animal experiments for fibrin sheaths have been conducted. In a previous study using a swine model [8], the sheaths of catheters inserted for 7 days contained a partial or circumferential mixed cellular and noncellular covering consisting of smooth muscle cells, a thrombus, and areas with endothelial cell populations. After 14 days, the sheaths of catheters showed the prominent proliferation of endothelial cells and smooth muscle cells. The sheaths of catheters at 30 and 45 days showed less prominent cellularity and greater collagen content than those

Fig. 3 – Ultrasonography around the tip of the catheter left in the vein of the left forearm (arrow: inserted portion). The linear hyperechoic line is the catheter (arrowhead). There was no abnormal echogenicity around the catheter.

Fig. 4 – Color Doppler image (A) and power Doppler image (B) did not reveal blood flow around the catheter.
may contain various components such as a thrombus, endothelial cells, and collagen [8,9]. Moreover, these components change over time. Thus, echo findings may change over time depending on changes in fibrin sheath components. We were unable to pathologically examine the sheath of the catheter in the present case because the whole fibrin sheath around the tip was subjected to a bacterial culture. Discrepancies in echo findings between the present and previously reported cases may be attributed to differences in the components of fibrin sheaths and the timing of ultrasonography.

This chronological change in echogenicity has also been reported in the echo findings of deep venous thrombosis. The echogenicity of venous thrombosis differs depending on the time course. A fresh thrombosis is depicted as a hypoechoic lesion on ultrasonography. On the other hand, a clot at a chronic stage is echogenic [10]. Therefore, color Doppler and probe compression may be necessary for the diagnosis of deep venous thrombosis [10]. In our case, both of these techniques contributed to identifying the fibrin sheath because gray-scale (real-time B-mode) ultrasonography did not detect it. Therefore, we consider color Doppler imaging with probe compression to also be needed to confirm a diagnosis of fibrin sheaths in veins.

**Conclusion**

Ultrasonographic findings of a fibrin sheath may change in a time-dependent manner. Color Doppler with probe compression may be useful for accurately diagnosing a fibrin sheath.

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