

An observational study of the blood vessel and subcutaneous tissue placed peripheral intravenous catheter during chemotherapy: a descriptive study

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Introduction:

- Peripheral intravenous catheters (PIVCs) are often removed before the end of treatment because of redness, swelling, and pain (up to 69.0%). This is termed catheter failure (CF).
- A major cause of CF is chemical irritation of vessels by pharmaceutical agents, which often involves damage to the venous endothelial cells at the time of cytotoxic drug administration.
- Thrombus formation on blood vessels during fluid therapy using PIVCs is presumed to result from damage to the venous endothelium cells caused by the infusates and by catheter stimulation.
- Subcutaneous edema is a reported sign of inflammation in CF.
- The effects of cytotoxic drugs on blood vessels and subcutaneous tissues can be visualized by comparing the process of thrombus and edema formation between catheterized blood vessels and the surrounding tissue with and without administration of a cytotoxic agent.

Aims:

To detail the imaging findings of a catheterized vessel and subcutaneous tissue with and without exposure to a cytotoxic agent using ultrasonography.



(FC1-X VA, FUJIFILM, Tokyo, Japan) with a linear-array transducer (13 MHz)

Discussion and Conclusions:

- ◆ There were no significant differences the rate of CF, thrombus or subcutaneous edema formation between the cytotoxic PIVC group and the non-cytotoxic PIVC group. These data suggest that **the venous endothelial cells are not rapidly damaged** and that **CF may not occur at the same time as administration of cytotoxic drugs**.
- ◆ **Inflammatory responses** (e.g., thrombus formation and subcutaneous edema) **remained at 24 h and 48 h after catheter removal**.
- ◆ **Healthcare providers should avoid selecting veins with inflammatory signs** as cumulative damage to the vessel may lead to CF.

Methods:

- Participants were inpatients of a hematology and oncology ward of a university hospital in Tokyo, Japan from June to November 2019.
- Inclusion criteria included >19 years old, requiring a short PIVC for chemotherapy, PIVCs were the first of several placed throughout the duration of hospitalization, and with a diagnosis of lymphoma or leukemia.
- The study protocol was approved by the Ethical Committee of the Graduate School of Medicine, the University of Tokyo (No. 2019040NI-(1)).
- The subcutaneous tissue and veins were observed by ultrasonography (US) immediately after catheter placement, approximately every 24 h after placement, just before and after removal, and at 24 h and 48 h after removal.
- Transverse and longitudinal static images were obtained and qualitatively analyzed (Fig. 1). Patients were divided into the cytotoxic PIVC group or the non-cytotoxic PIVC group on the basis of the drugs used.
- To assess differences in US findings between the two groups, the number of US findings during the catheter dwell time, approximately every 24 h, just before and after removal, and at 24 h and 48 hours after removal was counted.
- To examine the first timing of thrombus and severe edema occurrence, Kaplan–Meier estimate was performed and results were compared using the log-rank test.

Results:

- The number of cases in the cytotoxic PIVC group and the non-cytotoxic PIVC group was 21 and 26, respectively, with mean duration times of 7155 min and 7565 min, respectively (Table 1).
- There were no significant differences in the rate of CF (P=.461) or thrombus (P=.855) or subcutaneous edema (P=.298) formation between the two groups (Table 1, Fig. 2).
- Thrombi were observed in only two US images taken post-placement. However, at catheter removal, thrombi were observed in all except two vessels in the cytotoxic PIVC group and four vessels in the non-cytotoxic PIVC group.
- Moderate subcutaneous edema was observed in seven US images post-placement, while at catheter removal, edema was observed in all but one vessel in the cytotoxic PIVC group and three vessels in the non-cytotoxic PIVC group.
- These thrombi and the presence of edema remained at 24 h and 48 h after catheter removal. Furthermore, thrombi remained until 48 h after catheter removal in the cytotoxic PIVC group compared with the non-cytotoxic PIVC group (P=.047; Table 1).

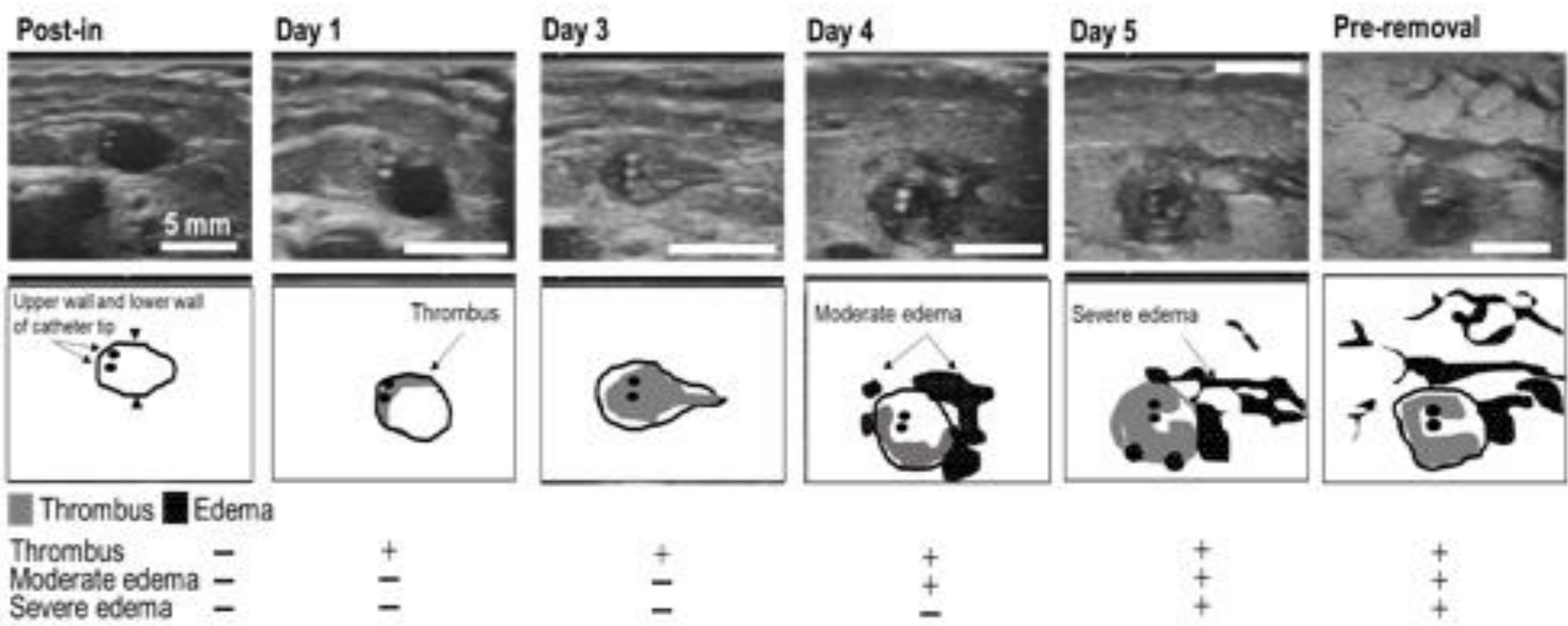


Figure 1. Ultrasonographic images of the catheterization site.

Upper images: short axis images, Lower images: schemes of images
Arrow heads: blood vessel

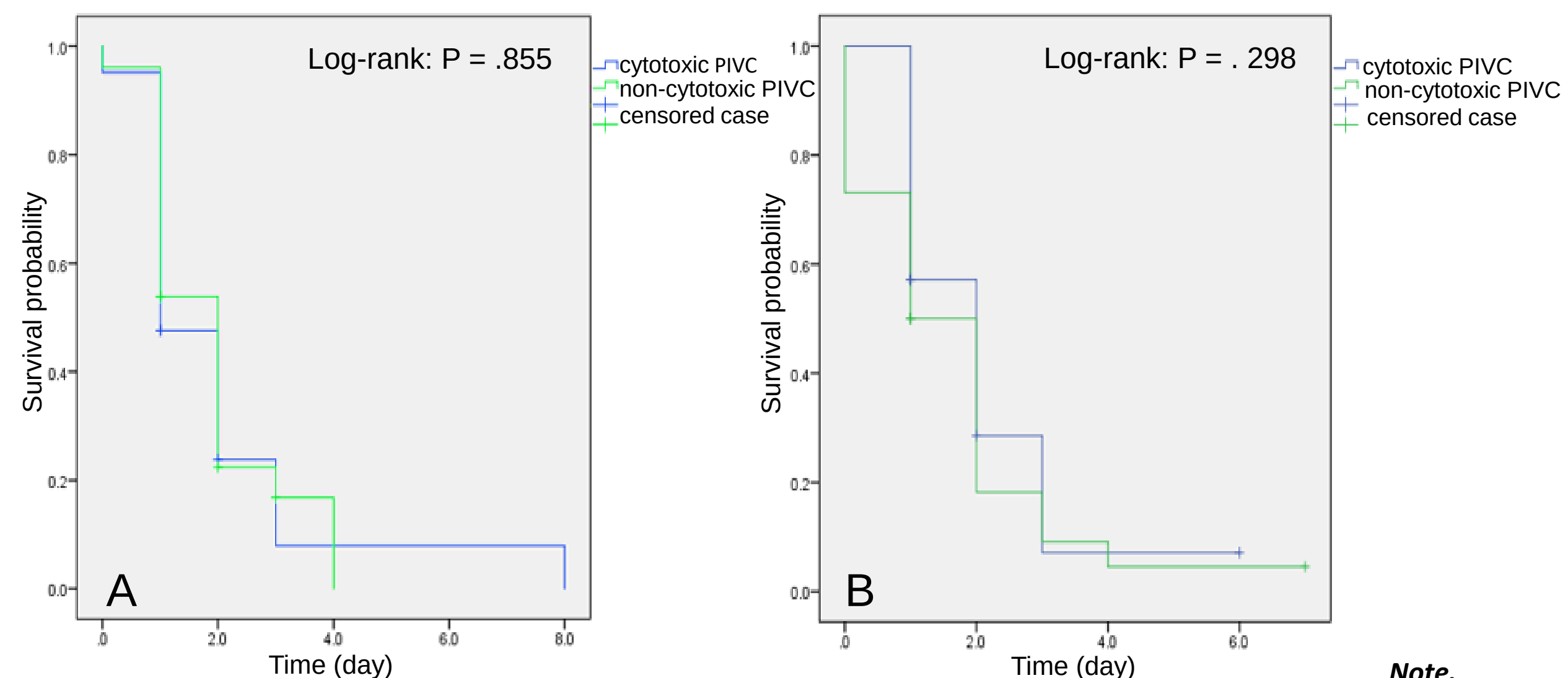


Figure 2. Kaplan-Meier survival plots of thrombus (A) and moderate or severe edema (B) formation.

Table 1. Characteristics of the participants, catheters, and ultrasonographic images.

	Cytotoxic PIVC group (n = 21)	Non-cytotoxic PIVC group (n = 26)	P-value
Age, years	64.8 (17.6)	70.5 (9.6)	.434 ^e
Body mass index, kg/m ²	23.51 ± 4.22	21.03 ± 3.75	.021 ^e
Dwell time, min	7155.2 ± 4060.9	7565.2 ± 3985.8	.600 ^e
CSA of vein at insertion, mm ² a)	8.4 (4.2)	4.7 (3.5)	.004 ^e
Hematocrit, %	34.6 (6.3)	29.5 (7.8)	.018 ^f
Albumin, mg/dL	3.7 (0.4)	3.3 (0.7)	.016 ^f
Catheter size, 22 gauge	21 (100%)	21 (80.8%)	
Insertion site			
Forearm posterior	19 (90.5%)	18 (69.2%)	.077 ^g
Forearm anterior	2 (9.5%)	7 (26.9%)	.128 ^g
Catheter failure	6 (28.6%)	6 (23.1%)	.461 ^g
US findings at pre- or post-removal b)			
Thrombus	17 (89.5%)	21 (84.0%)	.475 ^g
Subcutaneous edema, moderate or severe	18 (94.7%)	22 (88.0%)	.415 ^g
US findings at 24 hours after removal c)			
Thrombus	17 (94.4%)	7 (70.0%)	.116 ^g
Subcutaneous edema, moderate or severe	14 (77.8%)	9 (90.0%)	.399 ^g
US findings at 48 hours after removal d)			
Thrombus	16 (94.1%)	6 (60.0%)	.047 ^g
Subcutaneous edema, moderate or severe	10 (58.8%)	9 (90.0%)	.090 ^g

Note.

Mean (standard deviation) or n (%), CSA: cross sectional area, US: ultrasonography
a) Cytotoxic PIVC group (n = 21), Non-cytotoxic PIVC group (n = 23), b) Cytotoxic PIVC group (n = 19), Non-cytotoxic PIVC group (n = 25)
c) Cytotoxic PIVC group (n = 18), Non-cytotoxic PIVC group (n = 10), d) Cytotoxic PIVC group (n = 17), Non-cytotoxic PIVC group (n = 10)
e) Mann-Whitney U test, F) t-test, g) Fisher's exact test
Cytotoxic PIVC group means cytotoxic chemo flowed via the PIVC; Non-cytotoxic PIVC group means cytotoxic chemo didn't flow via the PIVC; any infusion flowed (antimicrobials, hydration, transfusion, parenteral nutrition, electrolytes, Vancomycin)