Clinical Outcomes of Ultrasound-Guided Peripheral Intravenous Catheter Placement in Patients with Systemic Sclerosis and Difficult Intravenous Access

Mari Abe[1,2,3], Shunsuke Miura[4], Ryugo Sekiyama[4], Kazuki M Matsuda[4], Shinichi Sato[4], Gojiro Nakagami[3,5]

1: Department of Nursing, The University of Tokyo Hospital, Tokyo, Japan
2: Research Institute for Next-Generation Nursing Education, Tokyo, Japan
3: Department of Gerontological Nursing/Wound Care Management, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan
4: Department of Dermatology, The University of Tokyo, Graduate School of Medicine, Tokyo, Japan
5: Global Nursing Research Center, Graduate School of Medicine, The University of Tokyo, Japan

Background

What is Systemic Sclerosis?

Systemic sclerosis (SSc) is a rare autoimmune disease (approximately 20,000–30,000 patients in Japan; ~1 in 4,000–6,000 individuals) characterized by fibrosis and vasculopathy, predominantly affecting middle-aged women.
(Denton & Khanna, 2017)

Clinical problem

Patients with SSc often have difficult intravenous access (DIVA) due to skin fibrosis and vascular changes.

Limited elbow extension due to skin sclerosis in SSc, requiring ultrasound guidance for vein selection.

Real-world issue

At our university hospital, securing intravenous access in patients with SSc is often challenging and time-consuming, potentially compromising treatment efficiency and patient quality of life.

Research gap

First-attempt success is associated with a lower risk of catheter failure (Takahashi T, et al., 2017), highlighting the importance of achieving success on the first attempt.

Although ultrasound guidance is recommended for DIVA and its effectiveness has been demonstrated in various populations (Poulsen et al., 2023), its clinical effectiveness in patients with SSc remains unclear.

Objective

To evaluate the effectiveness of ultrasound use for peripheral intravenous access in patients with systemic sclerosis.

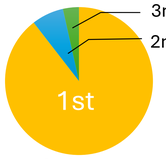
Results

Number of the cases: 57

Needle-Guided Ultrasound Catheter Placement

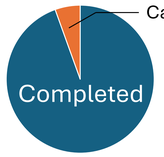
A) Skin sclerosis increases insertion resistance, causing skin depression.
B) Ultrasound shows the needle tip approaching the vessel (white arrow).
C) The target vein shifts during puncture, while a deeper vein (orange arrow) remains stable, indicating that the observed movement is due to displacement of the target vein rather than probe motion. Ultrasound enables real-time tracking and successful cannulation.

First-attempt success rate: 89.5%



Attempts to successful catheter placement

Catheter failure rate: 5.5%



Catheter outcomes

Single vs Multiple Punctures

Variable	Single n = 51	Multiple n = 6	p-value
Age	61 (53-66)	47 (39-50)	0.006
BMI	20.9 (18.2-22.5)	28.4 (20.3-32.4)	0.022
Invisible and non-palpable	64.7	66.7	1.000
History of DIVA	72.5	83.3	1.000
Upper limb sclerosis	52.2	75.0	0.614
Catheterization site			
Forearm	78.4	50.0	0.080
Non-forearm sites	21.6	50.0	

Values: % or median (IQR)

Treatment Completion vs Catheter Failure

Variable	Completion n = 52	CF n = 3	p-value
Age	60.5(53-66)	47 (39-52)	0.056
First attempt success	92.3	33.3	0.029
Ultrasound use for needle guidance	100.0	88.5	1.000
Vein diameter (mm)	2.4 (2.0-3.0)	2.0 (1.8–2.0)	0.026
Vein depth (mm)	6.0 (2.0-6.0)	3.0 (2.0–4.75)	0.182
Immunomodulatory therapy	3.8	66.7	0.012

Values: % or median (IQR)
n = 55: 2cases were excluded due to missing data

Methods

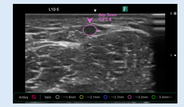
Study design & participants

This retrospective observational study included adult inpatients with SSc who underwent peripheral intravenous catheter placement using ultrasound for vessel selection and/or needle guidance at a university hospital in Japan between July and October 2024.

Catheter placement using ultrasound

Catheter placement was performed by a single Experienced nurse using a handheld ultrasound Device (5–10 MHz linear probe; iViz air)
Surshield® Surflo® 2 (Terumo Corporation, Japan)

The ultrasound used in the hospital; iViz air, FUW-1 (FUJIFILM SonoSite, Inc., USA)



Automatic vessel detection with real-time diameter and depth display.

Definitions

- **DIVA**: documented history of difficult IV access
- **Catheter failure**: unplanned removal due to complications (pain, swelling, phlebitis, infiltration, occlusion)
- Accidental/self-removal excluded

Data collection

- Patient characteristics (age, BMI, type of therapy, upper sclerosis)
- Vascular and access-related variables (visibility/palpability, history of DIVA, vessel size and depth)
- Procedural variables (catheterization site, vein selection)

Outcomes

- First-attempt success rate (%)
- Catheter failure rate within 7 days (%)
- Comparison of single vs multiple attempt, Treatment completion vs catheter failure: Mann–Whitney U test, Fisher's exact test (Significance: $p < 0.05$)

Discussions & Conclusion

- Ultrasound may be useful for overcoming **DIVA** even in patients with systemic sclerosis, a population with difficult intravenous access.
- Multiple punctures appeared related to **catheter failure**, consistent with a previous study (Takahashi T, et al., 2017).
- **Achieving first-attempt success**, potentially by effective use of ultrasound guidance, may help **reduce catheter failure**.