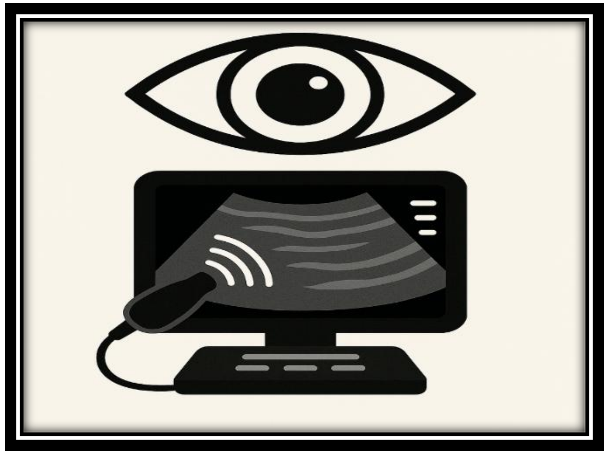
Ultrasound-Guided Vascular Access Cannulation



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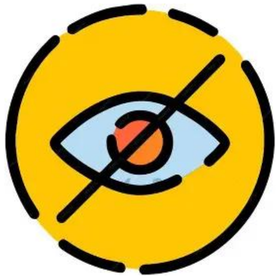
The Necessity Of Using Ultrasound In Vascular Access

- Improves accuracy and safety during cannulation.
- Increases first-attempt success rates and reduces complications such as vessel and surrounding tissues damage and hematomas compared to the “blind” approach.
- Detects early anatomical abnormalities, stenoses, and thromboses.
- Causes less pain and discomfort for the patient.
- Improves the longevity of the vascular access.
- Enhances the nurse’s confidence and professional competence.
- Reduces overall costs.



Ultrasound use can significantly enhance the patient’s experience and minimize complications.

“Why proceed blind, when I can have eyes?”

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Us-guided Needling

Depth adjusts the penetration depth of the ultrasound into the tissues.
Focus optimizes image resolution at a specific depth.
Zoom enlarges the image for a more detailed visualization of the vessels.

Distance measures the space between two selected points on the frozen ultrasound image, helping to assess the size of vessels and structures.

Freeze locks the ultrasound image at a specific moment, allowing analysis and measurements without continuous scanning.

Gain adjusts the brightness of the image by increasing or decreasing the intensity of the echoes, thereby affecting the contrast and clarity of the structures.

Ultrasound Probe for Vascular Access

Linear High-Frequency Probe

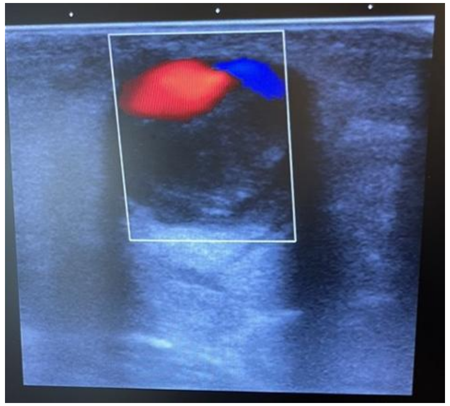
- Provides **high-resolution images** of superficial vessels
- Best for **veins and arteries located < 3 cm deep**

Orientation Marker (Probe Notch)

- Defines the **direction of the ultrasound plane**
- Must **correspond to the orientation marker on the screen**
- Used to **maintain consistent left–right orientation**

In color Doppler, **red** and **blue** show **flow direction, not vessel type**:

red means blood is moving towards the probe and blue means it is moving away



Real-time Us-guided Needling

Four elements must be properly aligned:

1. The probe (defines ultrasound plane)
2. The ultrasound plane
3. The vessel
4. The needle

The possible alignments are:

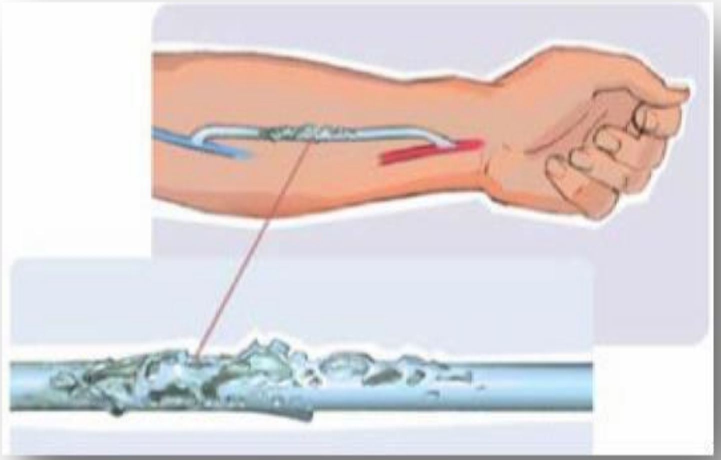
- Probe / Plane–Vessel: **longitudinal or transverse**
- Probe / Plane–Needle: **in-plane or out-of-plane**

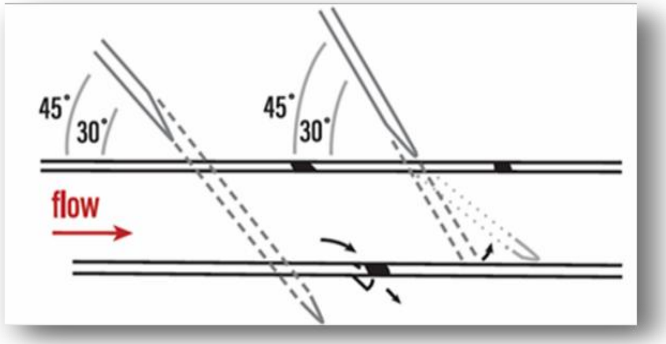
Caution: Accurate identification and localization of the vessel are required before puncture.

The greatest challenge for nurses is the **eye–hand coordination**.

Reducing Cannulation-related Mechanical Complications

- **Hematoma** occurs when the needle passes completely through the vessel wall, allowing blood to leak into the surrounding tissue.
- **Backwall puncture** happens when the needle penetrates the posterior wall, causing injury or bleeding.





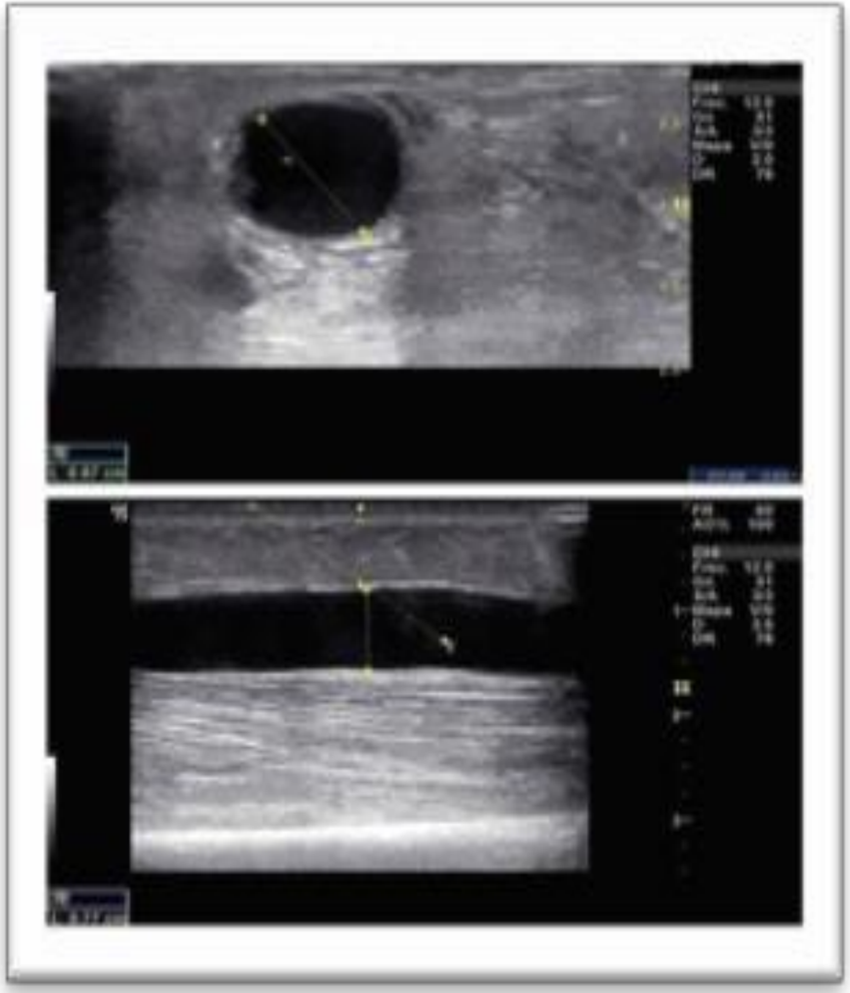
Preventing such complications is an essential part of providing safe and high-quality care.

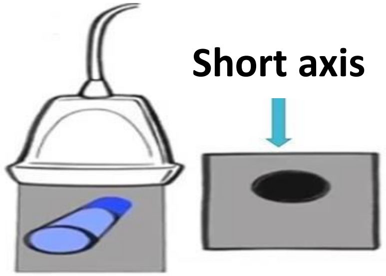
Plane–needle: **In-plane Or Out-of-plane**

It refers to **how the needle is inserted** in relation to **the ultrasound imaging plane**:

Out-of-plane: the needle crosses the plane **perpendicularly** ➤ only a **bright dot** is visible (the tip), not the full needle path.

In-plane: the needle is inserted **along the imaging plane** ➤ the **entire shaft and tip** of the needle are visible.

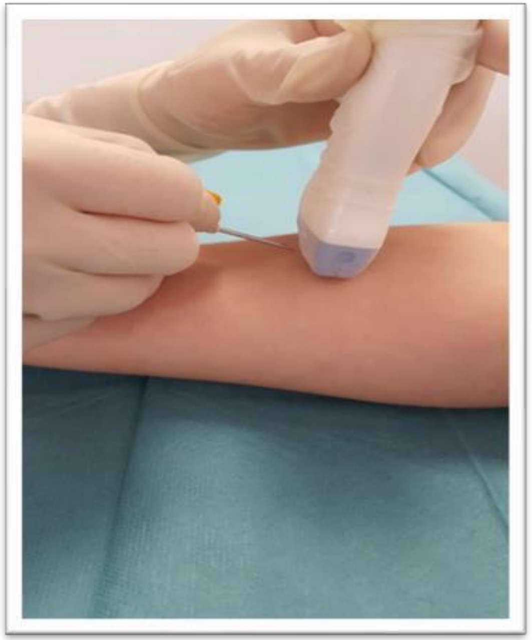




Transverse View

- The vessel appears as a **circular structure** on the screen.
- The needle crosses the ultrasound plane perpendicularly.
- Considered a more challenging technique for real-time cannulation.
- The probe must be **adjusted or moved slightly** as the needle advances.

Transverse view of the vessel



Transverse View

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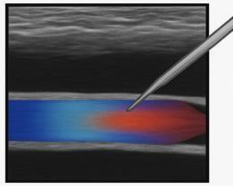
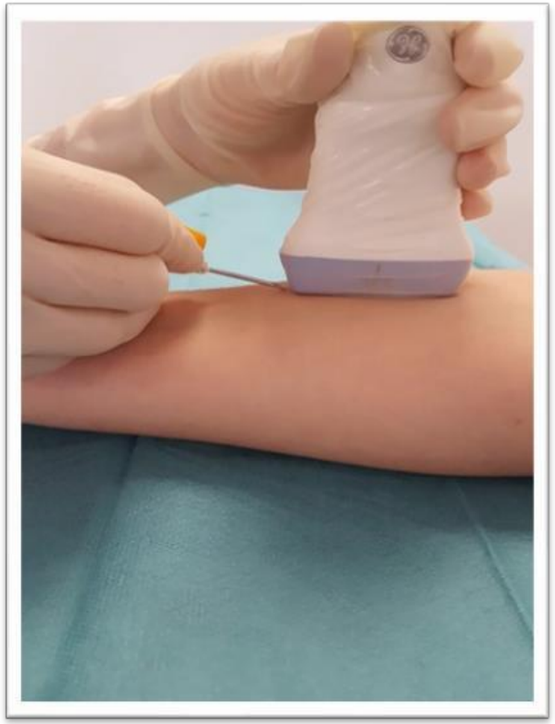
Longitudinal View



Longitudinal view of the vessel

- This approach is generally preferred for real-time cannulation
- It allows the operator to **keep the entire needle visible** within the ultrasound field **during the whole procedure.**



Longitudinal View

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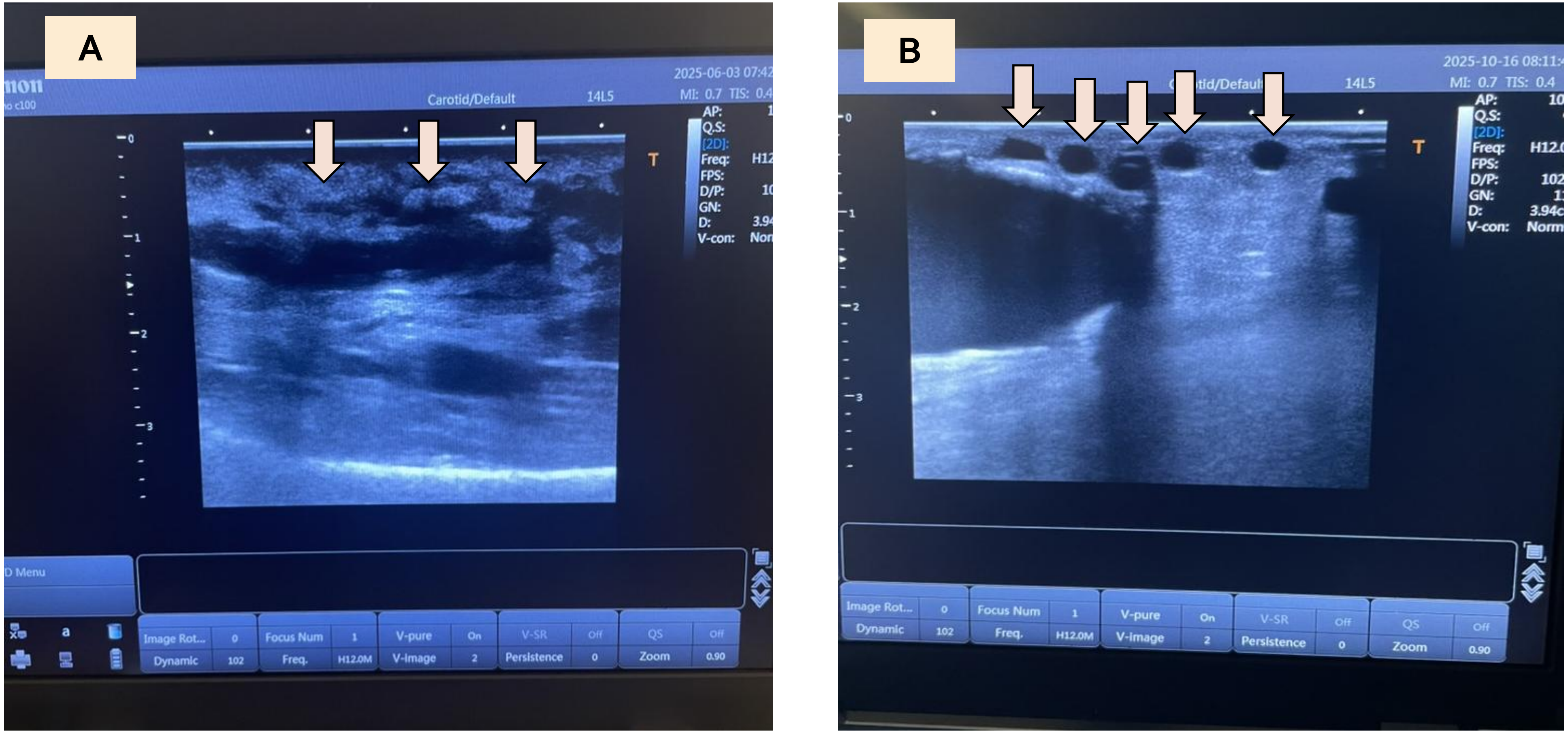
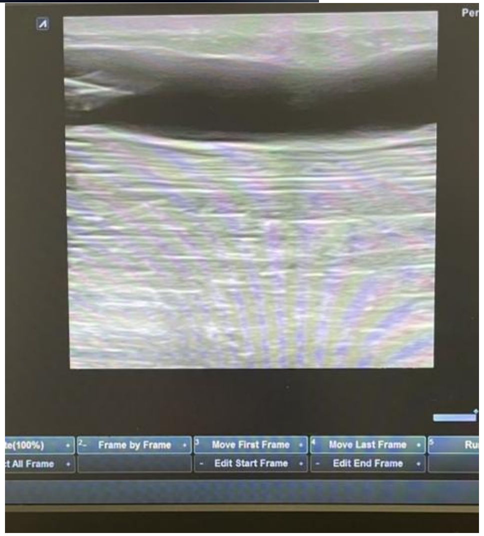
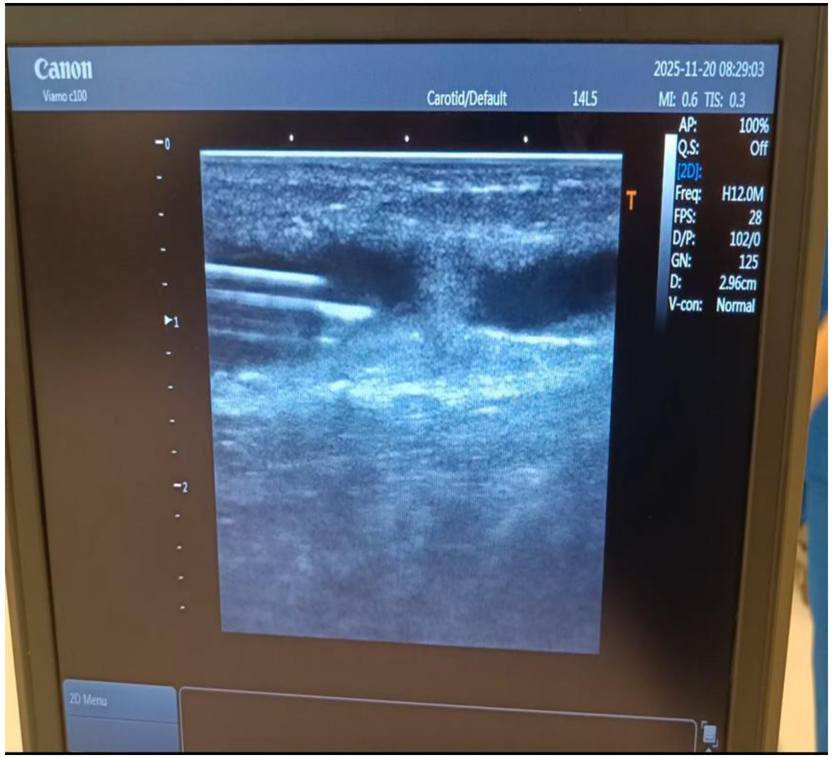
Clinical examples: assessment of the arm before needle insertion: (A) tissue edema (B) collateral network



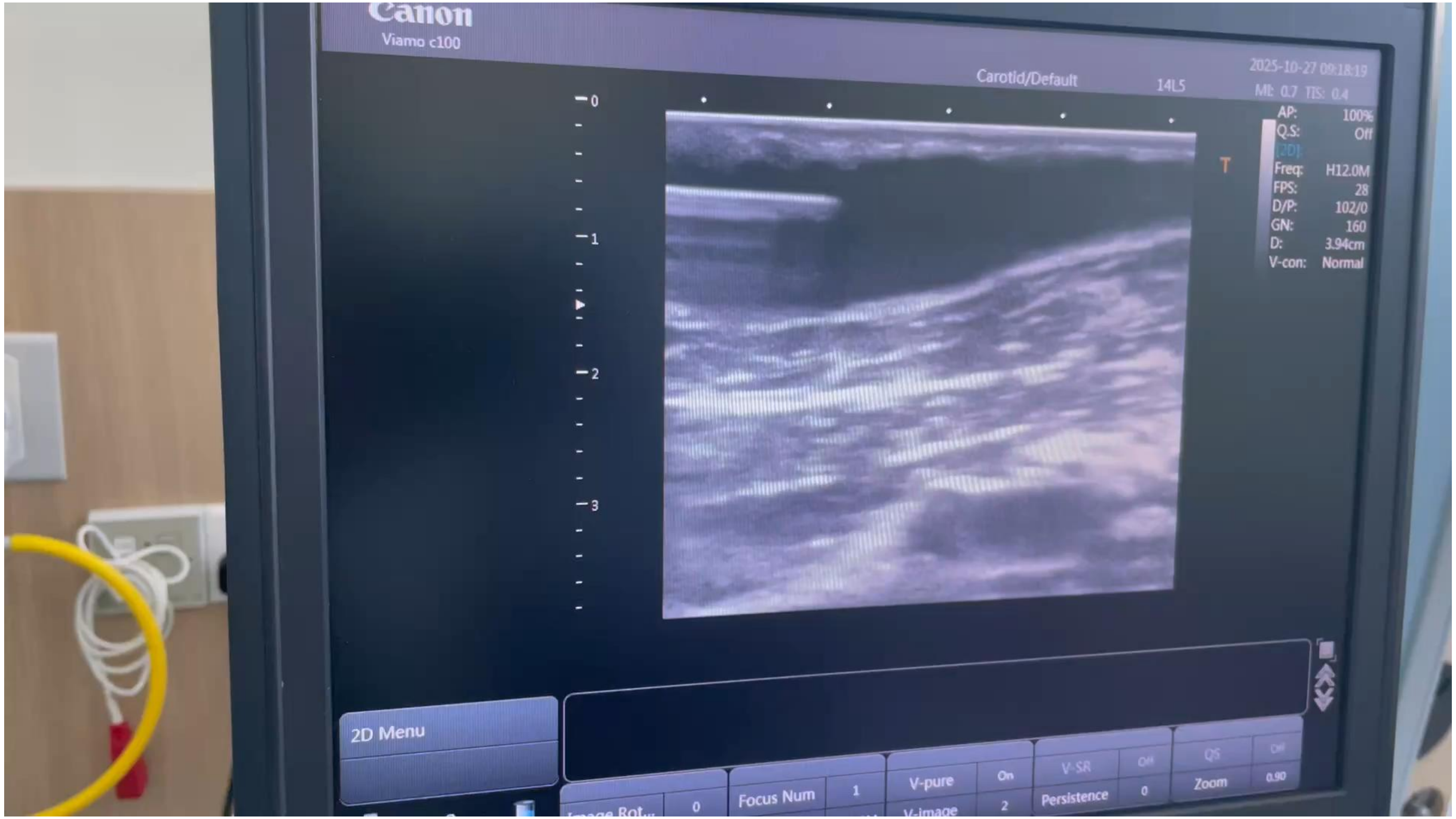
Clinical examples: correct needle positioning

Verification that the needle is free within the vessel lumen





Clinical example: Verification of needle patency within the vessel lumen – visualization of blood jet



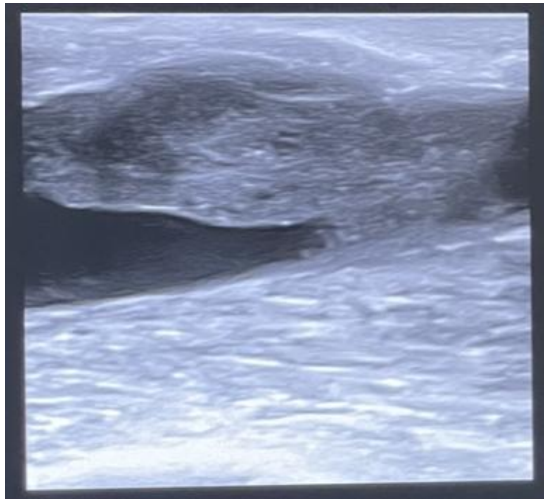
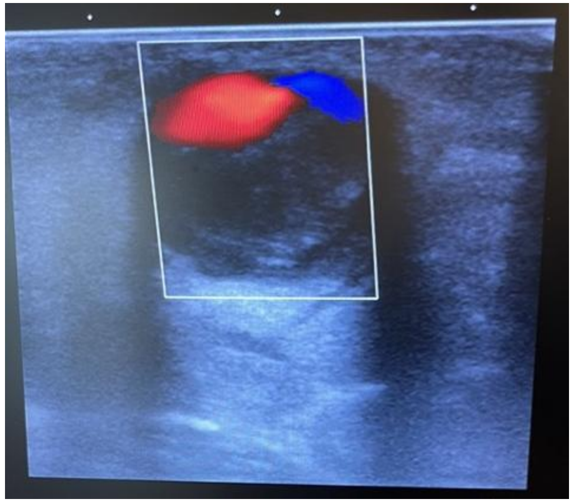
Clinical example: Verification of needle patency within the vessel lumen – visualization of blood jet with normal saline

Clinical example: Increased venous and/or arterial pressure on the dialysis machine - the needle is within the vessel wall

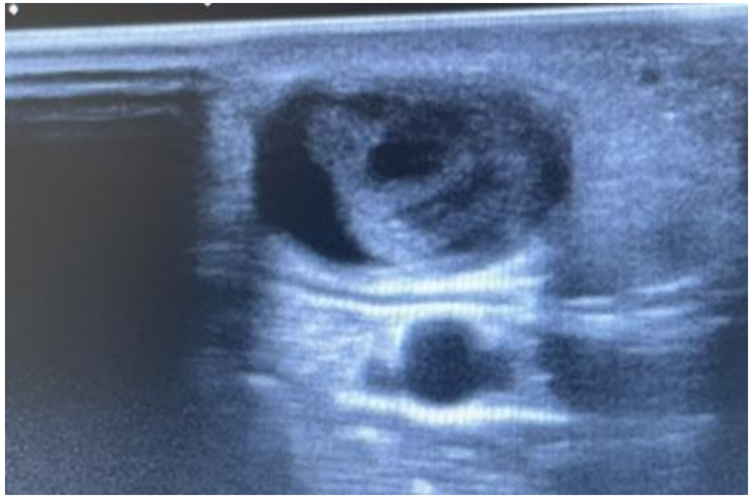
Needle repositioning under ultrasound guidance

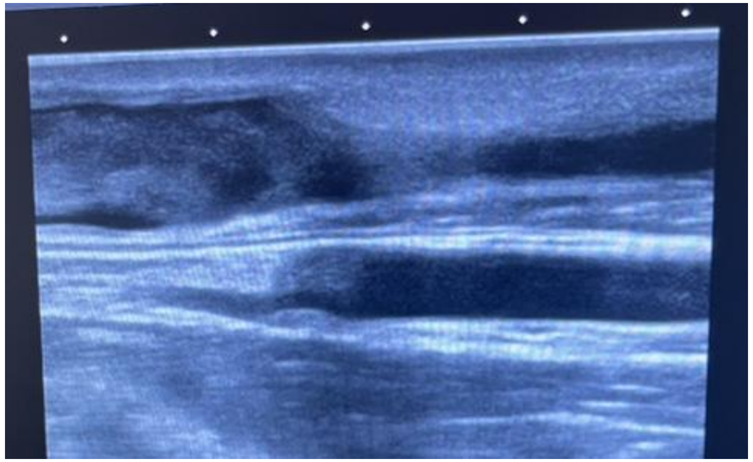
Clinical example: A fistula that appears easy to cannulate, but ultrasound reveals significant stenosis caused by a thrombus



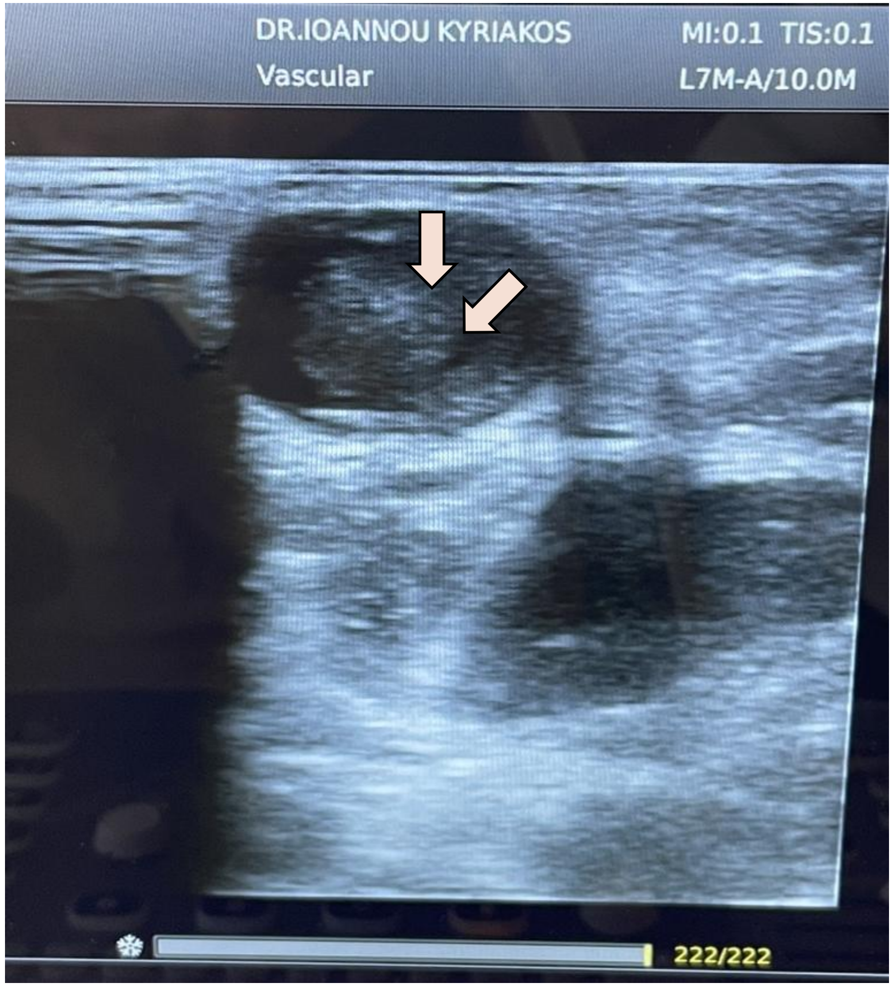
Clinical example: A fistula that appears easy to cannulate, but a significant stenosis caused by thrombus is detected on ultrasound

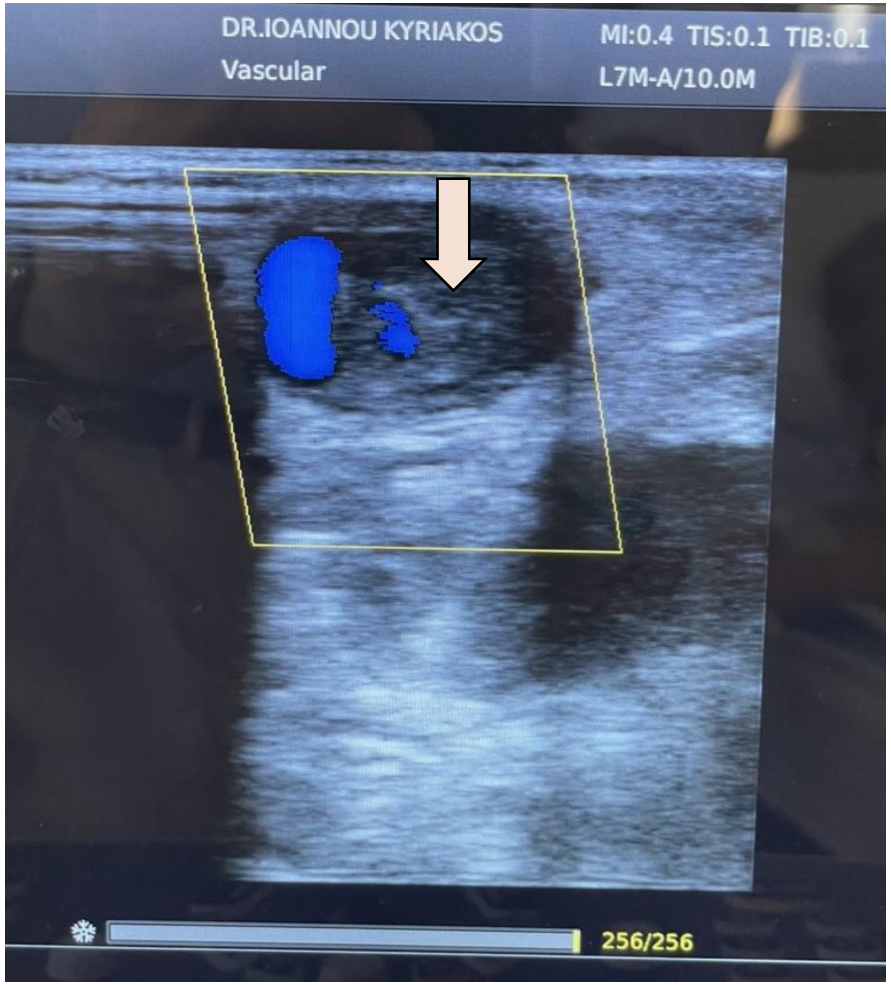




Clinical example:

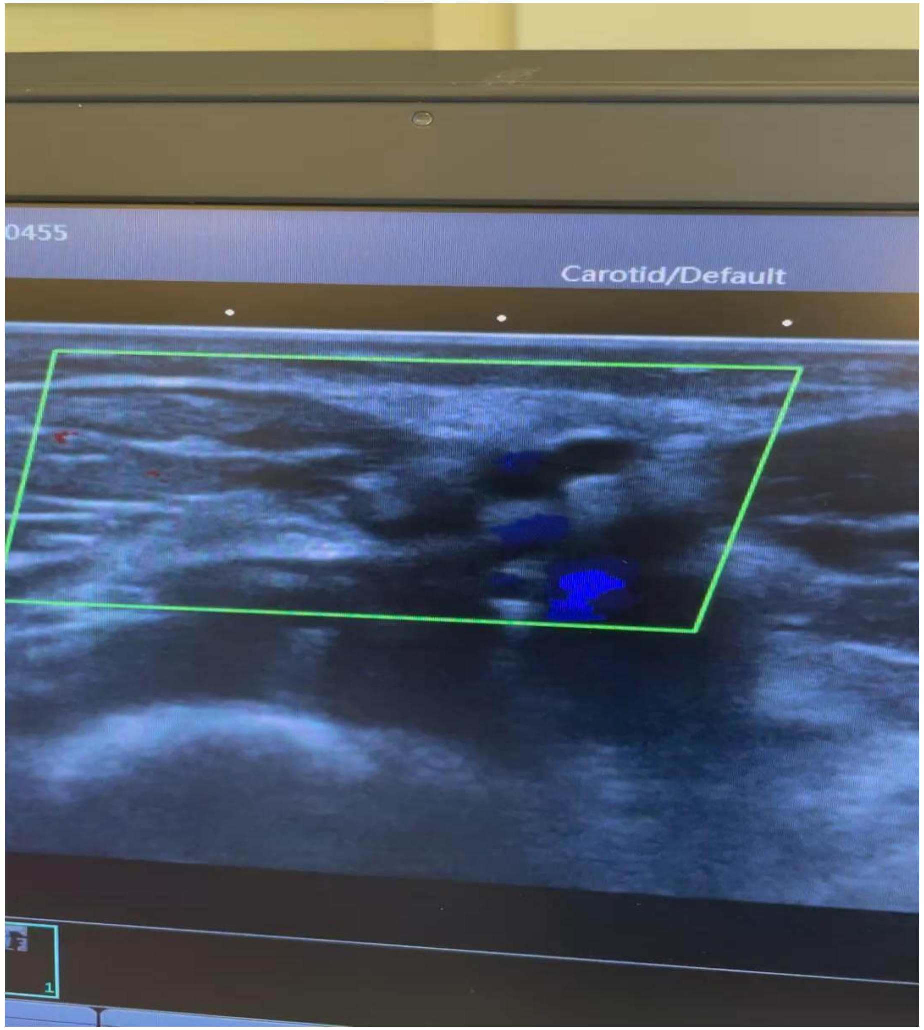
Intraluminal thrombus detected on ultrasound





Clinical example:

Intraluminal thrombus detected on ultrasound



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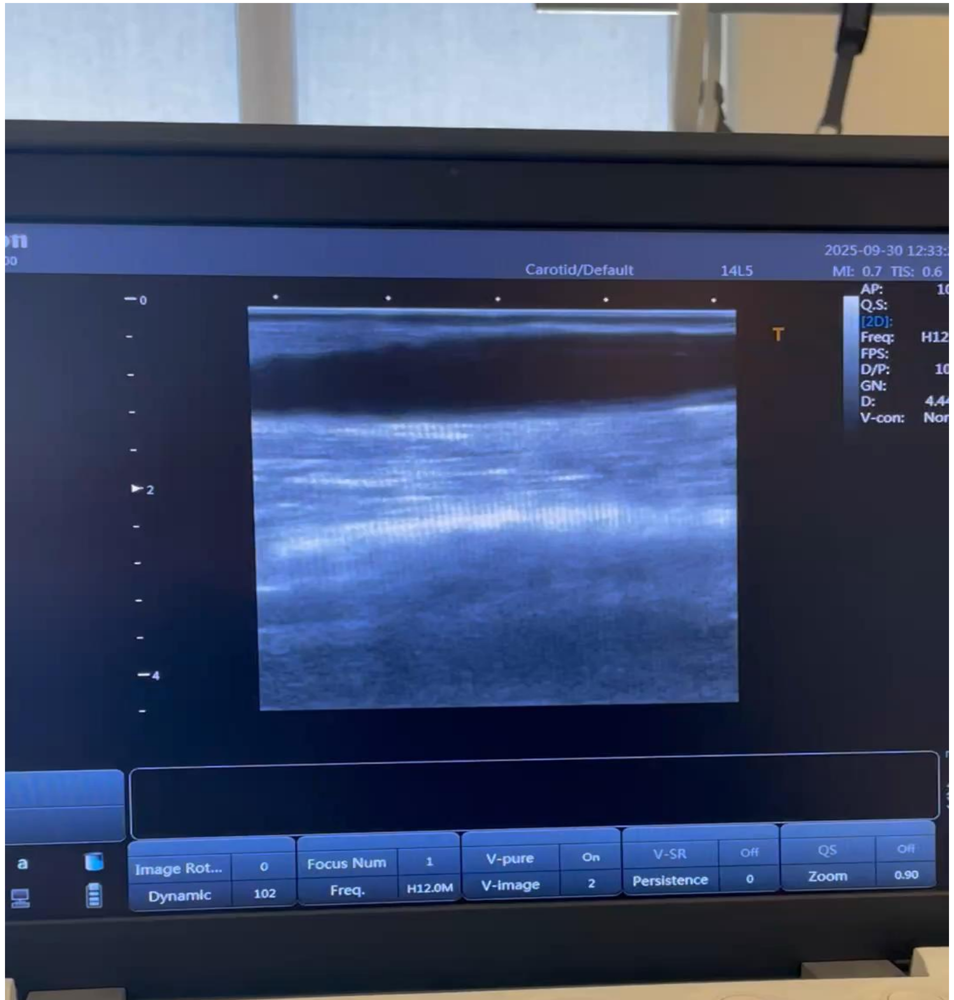
Clinical example: Reason for ultrasound assessment: increased venous pressure on the dialysis machine.

<u>Ultrasound findings</u>: vein compression due to underlying hematoma.



Clinical example: Increased venous pressure on the dialysis machine → intraluminal thrombus and severe post-stenotic narrowing of the vein (possibly the underlying cause of the thrombus formation)

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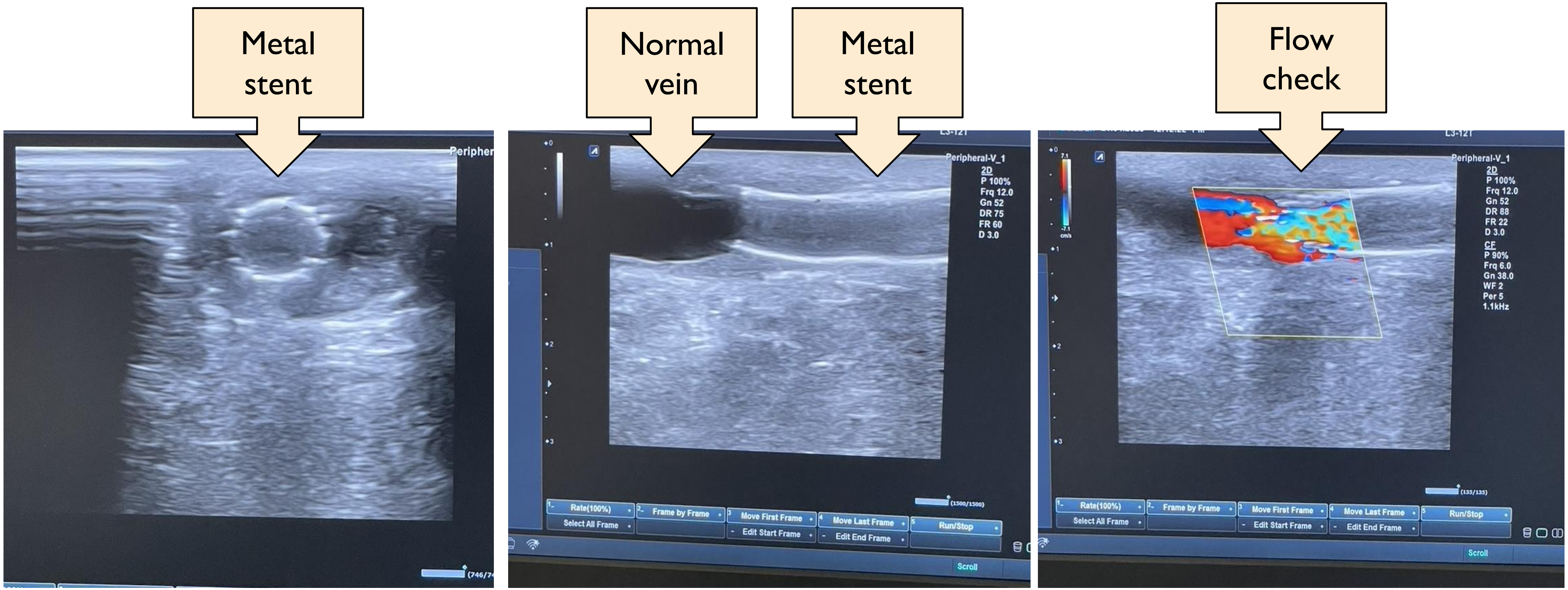
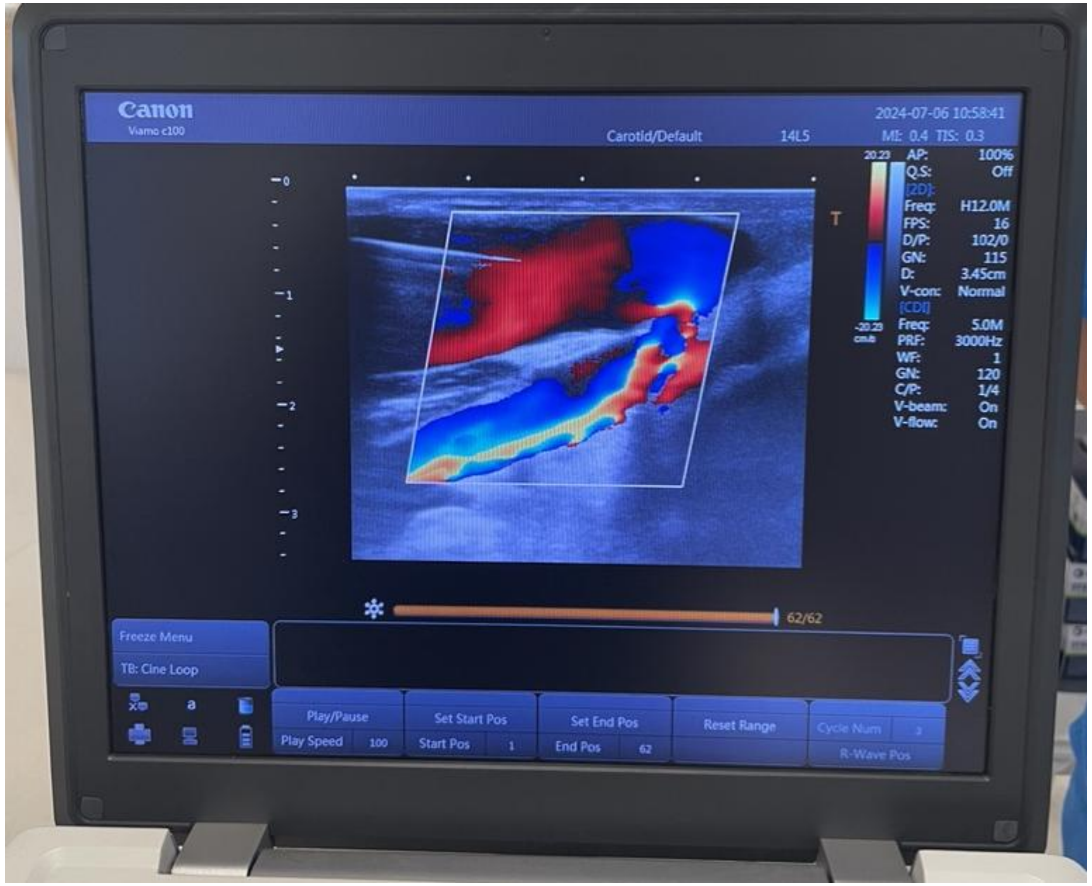
Clinical example: Patient after interventional radiology procedure with placement of a **metal venous stent**



Clinical example:

Anatomical variation leading to recirculation



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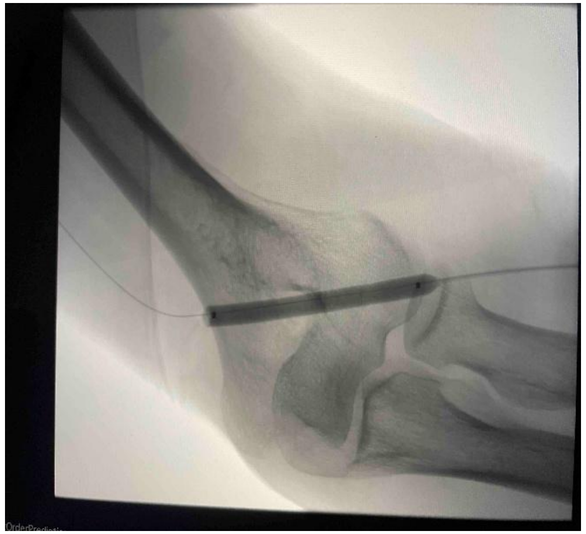
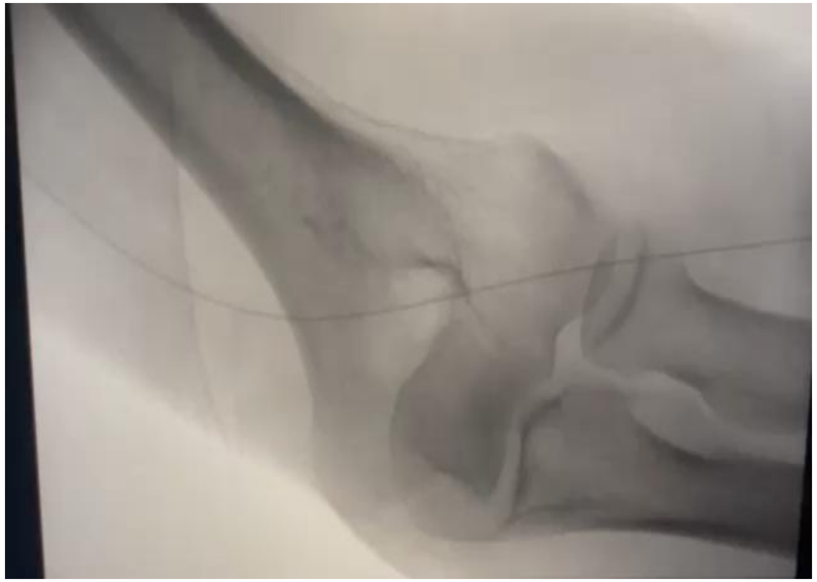
Clinical example:
Anatomical variation leading to recirculation

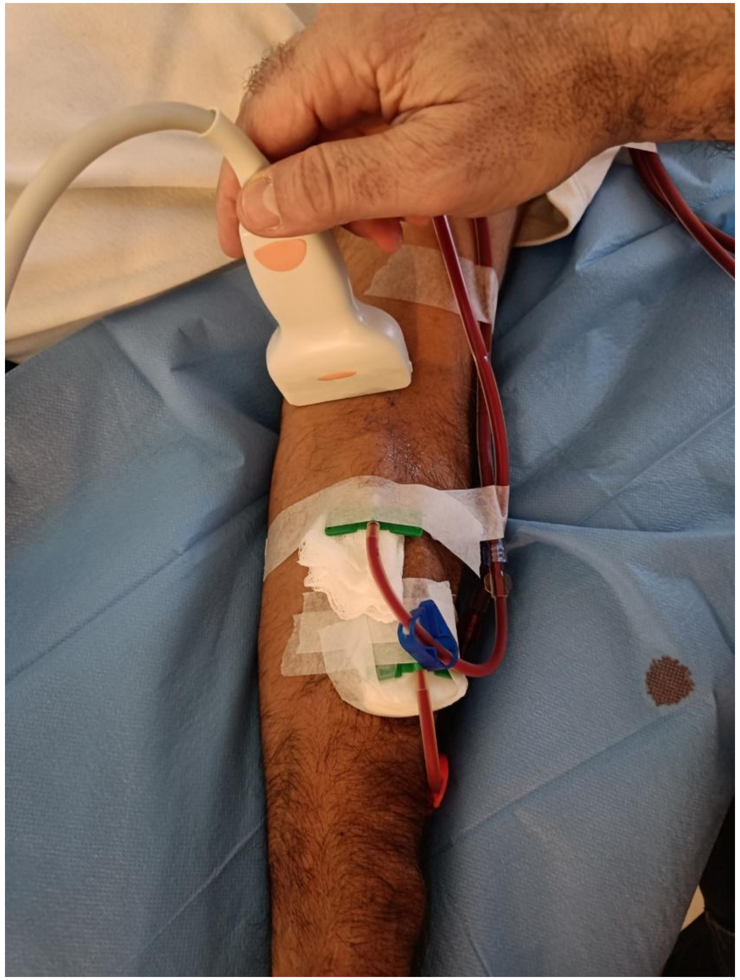


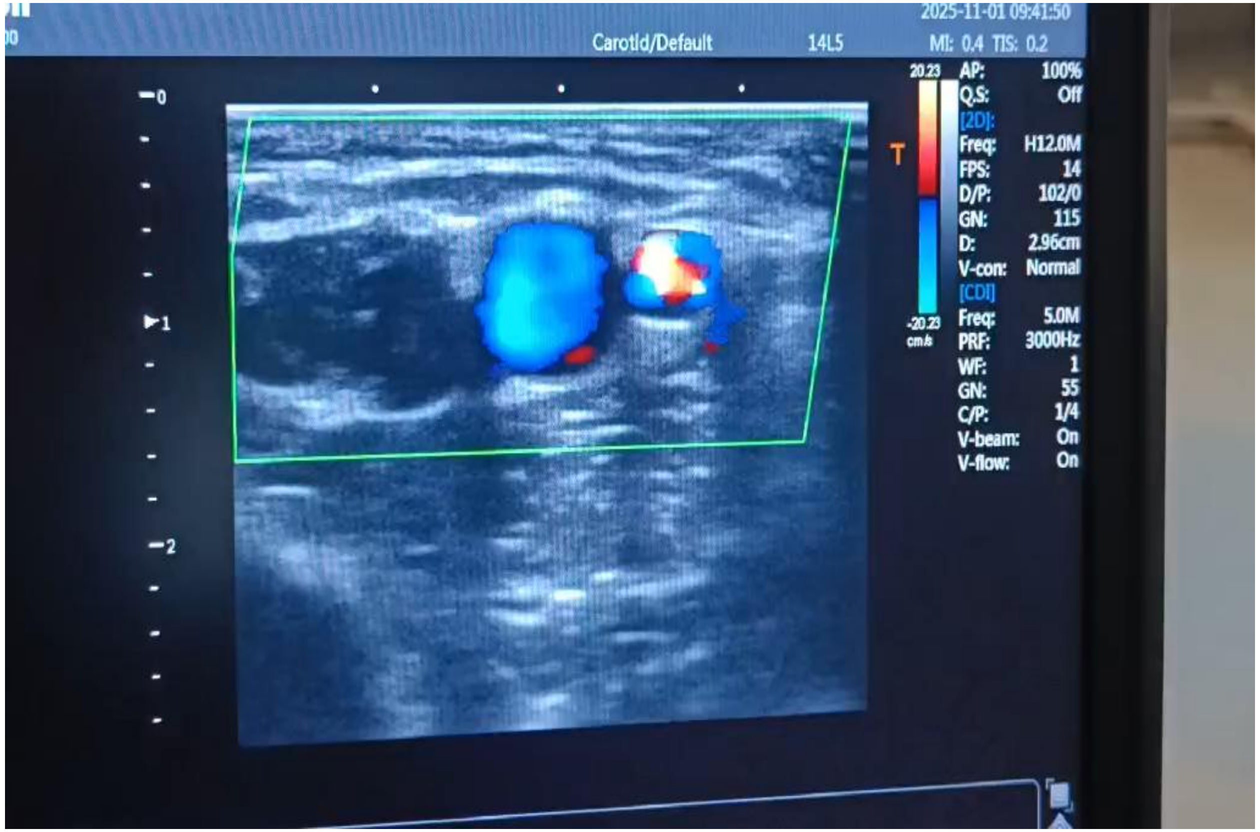


ΕΞΕΤΑΣΗ 03.07.2024	ΑΠΟΤΕΛΕΣΜΑ	ΜΟΝΑΔΕΣ
3094-0 Ουρία	↑ 243	mg/dL
38483-4 Κρεατινίνη	↑ 14.33	mg/dL
62238-1 eGFR, MDRD	↓ 3.54	mL/min/BSA
2947-0 Νάτριο (Na)	144	mmol/L
2823-3 Κάλιο (K)	4.94	mmol/L
1959-6 Διττανθρακικά (CO2)	↓ 18.8	mmol/L
1751-7 Λευκωματίνη (Albumin)	4.01	g/dL
2774-8 Φώσφορος (P)	↑ 6.07	mg/dL
49765-1 Ασβέστιο, Ολικό (Ca)	8.24	mg/dL

ΕΞΕΤΑΣΗ 07.08.2024	ΑΠΟΤΕΛΕΣΜΑ	ΜΟΝΑΔΕΣ
3094-0 Ουρία	↑ 170	mg/dL
38483-4 Κρεατινίνη	↑ 10.71	mg/dL
62238-1 eGFR, MDRD	↓ 4.96	mL/min/BSA
2947-0 Νάτριο (Na)	141	mmol/L
2823-3 Κάλιο (K)	5.07	mmol/L
1959-6 Διττανθρακικά (CO2)	24.1	mmol/L
2774-8 Φώσφορος (P)	3.38	mg/dL
49765-1 Ασβέστιο, Ολικό (Ca)	↓ 8.03	mg/dL

Clinical example: Artery–Vein Differentiation: Critical for Safe Cannulation





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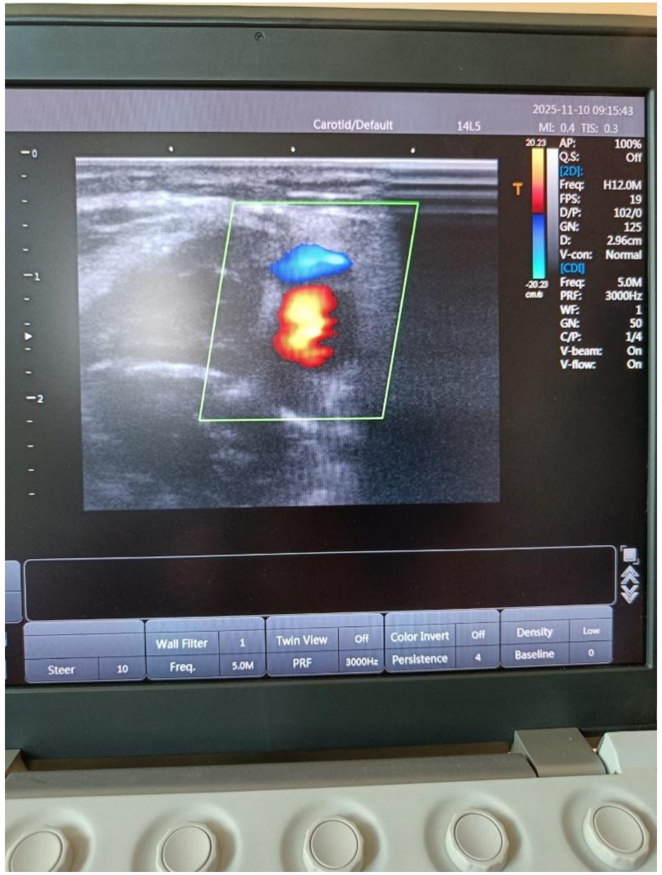
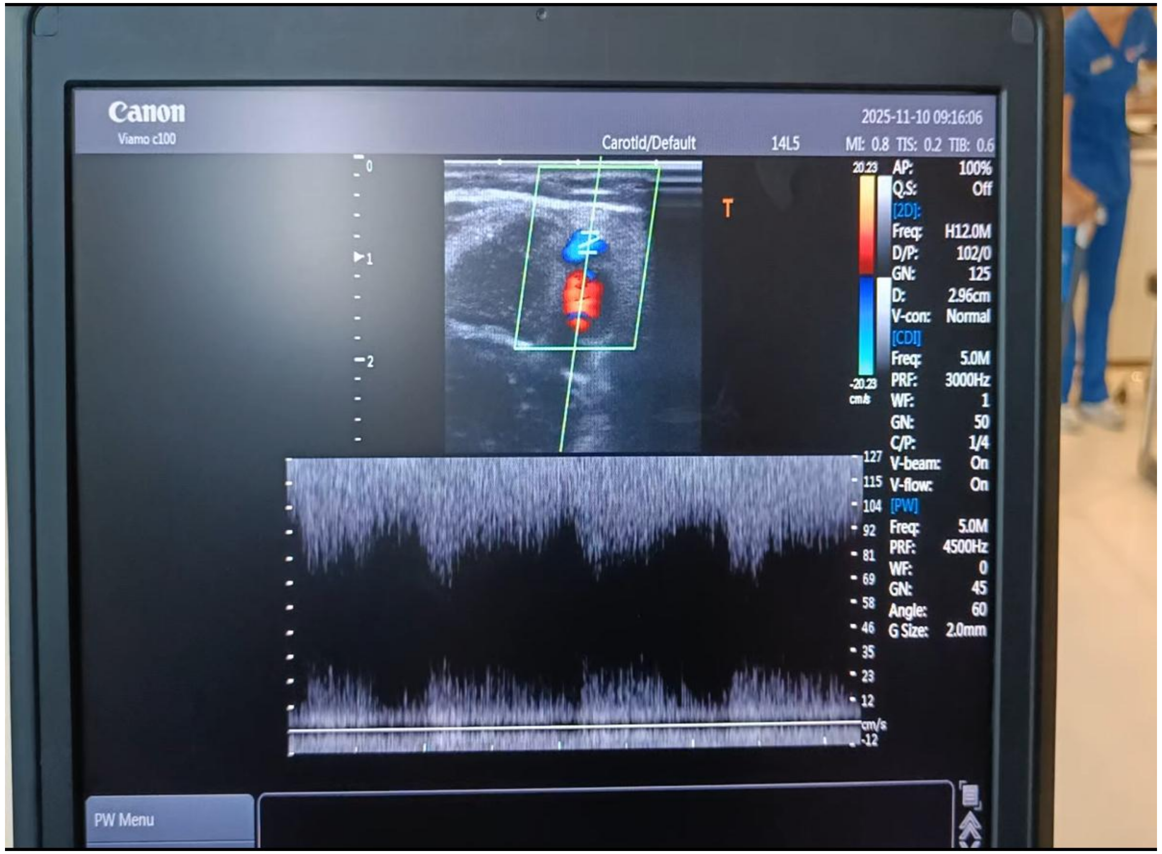
Clinical example: Artery–Vein Differentiation: Critical for Safe Cannulation





Clinical example: Central venous stenosis. Preventive referral to interventional radiology for angioplasty.

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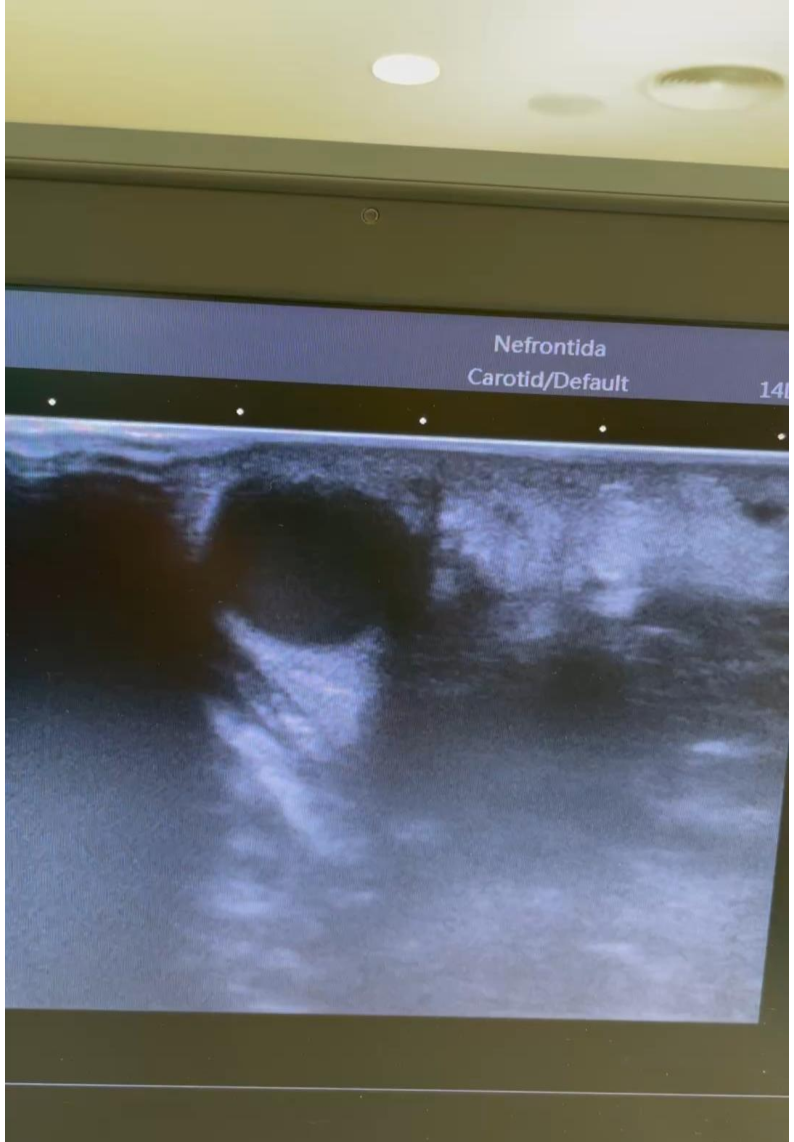
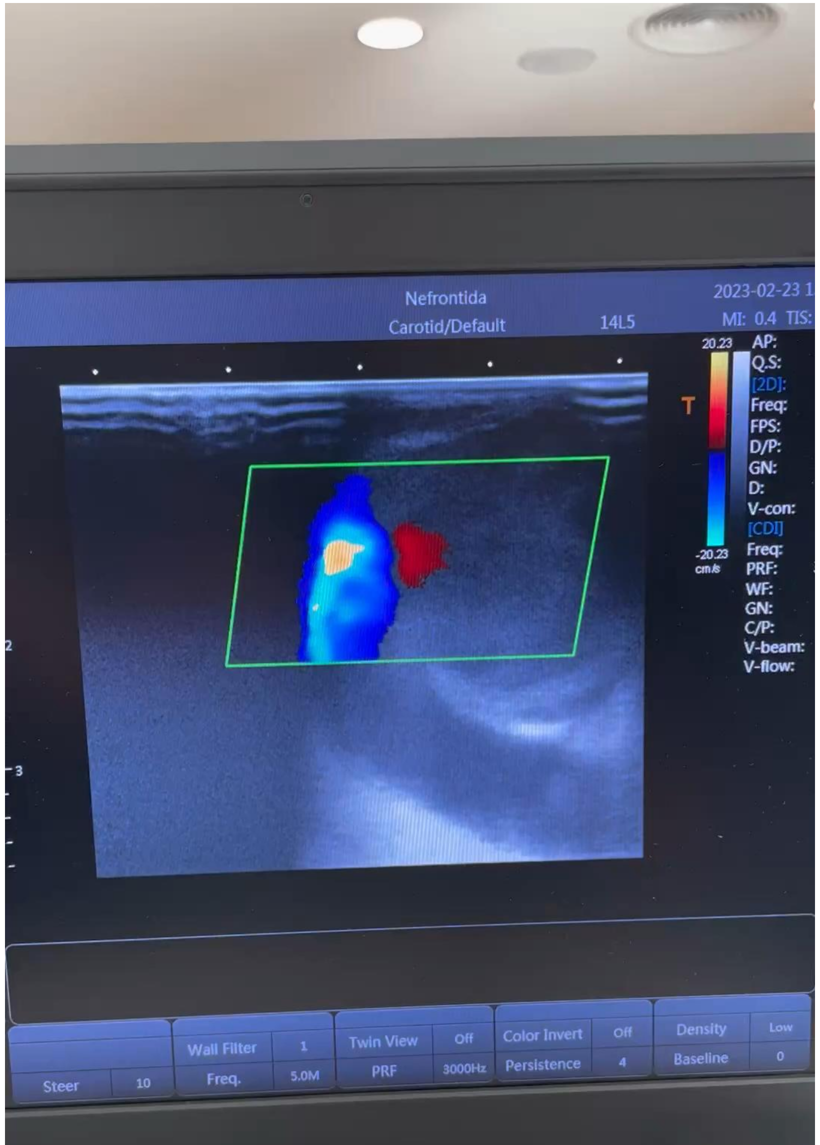
Clinical example: Venous aneurysm





Technology And Equipment

- **Technology now offers portable ultrasound probes** the size of a smartphone, with **high frequency, high resolution**, and even **wireless models**.
- **Extremely user-friendly** and **ideal for the needs of nephrology nurses** in clinical practice.

Challenges Of Implementation In Clinical Practice

- Recognition of the **need for education and specialization** of the nephrology nurse.
- **Equipment cost** and technical availability **Vs** the cost of complications.
- Requirement for **continuous practice** to ensure effective and safe use.
- **Resistance to adopting new techniques** among some staff members.
- Need for **institutional integration** of the technique into dialysis protocols.

Ultrasound-guided cannulation is recommended by international bodies (KDOQI) as a safe and evidence-based practice.

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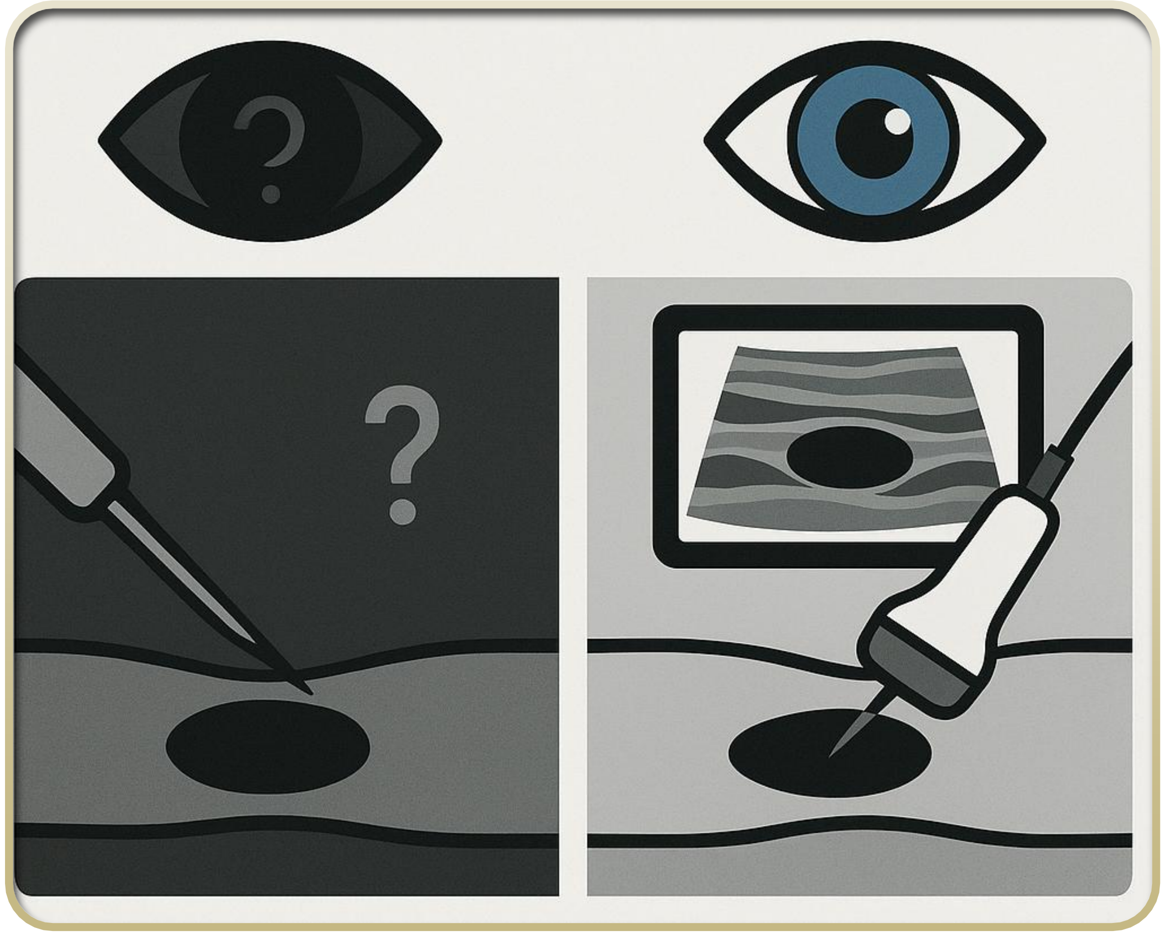
“Why proceed blind,

when I can have eyes?”



Thank you for your attention