WoCoVA
8th World Congress on Vascular Access

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Prevention of primary malposition in neonates: the Neo-ECHOTIP protocol

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Gli Accessi Venosi Centrali a Lungo Termine

GdS Accessi Vascolari Neonatali

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I have no conflict of interest in relation to this presentation

Tip location

E. Use tip locating methods to identify CVAD tip location during the insertion procedure (ie, “real-time”) for neonate, pediatric, and adult patients. Studies have demonstrated greater accuracy, more efficient initiation of infusion therapy, and reduced costs.[1,12] (IV)
   1. Use electrocardiogram (ECG) methods with either a metal guidewire or a column of normal saline inside the catheter lumen and observe the ECG tracing to place the CVAD tip at the CAJ. Follow manufacturers’ directions for use with other ECG-based technology using a changing light pattern to detect tip location.[1,12-30] (I)

22. CENTRAL VASCULAR ACCESS DEVICE TIP LOCATION

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Infusion therapy standard of practice. Journal of infusion nursing 2024

Tip location with IC-ECG

UVC
- Only 2 studies
- Compared with Chest X Ray
- NO TIP NAVIGATION

ECC
- Small studies
- Compared with Chest X Ray
- 1 Fr Catheters???

Editorial

Epicutaneo-caval catheters in neonates: New insights and new suggestions from the recent literature

Consider the use of intracavitary ECG for tip location

In adults and in children, intracavitary ECG is nowadays the gold standard for the intra-procedural verification of the central position of the tip during the insertion procedure, due to its great accuracy and feasibility.[26] So far, few studies have investigated ECC placement with intracavitary ECG in neonates.[45–47] The small number of patients enrolled and the poor quality of the signal, probably related to the small diameter of the catheter, make it impossible to draw a definite conclusion about the feasibility of this technique in the neonatal population. Although, this is an interesting field of research and in the next future intracavitary ECG may be an aid in tip location, together with ultrasound.

Tip location

2. Consider the use of ultrasound for CVAD tip location. The clinical applicability of this is currently limited by the small sample sizes used to demonstrate its efficacy as a reliable and safe method to replace chest radiographs in all ages, and its usefulness is limited by the knowledge, skill, and experience of the operator.[6,33-38] (III)
   a. The addition of agitated saline to enhance transthoracic echocardiography has been shown to be effective in detecting catheter tip position in the lower third of the SVC, as well as detecting catheter malposition through delayed opacification and reduced echogenicity.[6,39] (IV)
3. Consider using ultrasound to confirm catheter tip position in neonates and in the emergency department or other critical care environments where immediate confirmation of tip location is time critical.[6,33,40] (IV)

22. CENTRAL VASCULAR ACCESS DEVICE TIP LOCATION

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Infusion therapy standard of practice. Journal of infusion nursing 2024

Please avoid x-ray

It is relatively inaccurate. As x-rays do not allow the direct visualization of the veins, the location of the catheter tip is assessed indirectly, i.e., using radiological landmarks such as the vertebral bodies, the cardiac silhouette, the diaphragmatic contour, etc.

It is consistently a post-procedural methodology, since fluoroscopy is not considered appropriate in NICU. Thus the use of X-Ray for tip location is associated to an high rate of primary malposition

It is not harmless, since it exposes the neonate to ionizing radiation, which may ultimately be associated with long term damage

Pediatric Vascular Access Practice: Time for Evolution or Revolution?

By Amanda J Ullman RN, MAppSci, PhD, Centaur Fellow, Director-at-Large;
Association for Vascular Access Pediatric Special Interest Group, Senior Lecturer;
Alliance for Vascular Access Teaching and Research (AVATAR) Group, Griffith University

1. **We need to <u>improve central venous access in the neonates</u>, the main issues being:**
   - Define the role of ultrasound (US) -guided central venous catheters (3Fr, PUR, power injectable, high performance) in premature newborns if compared to the use of epicutaneo-caval catheters (ECC) (1-2.7Fr, silicone or PUR, non-power, low performance)
   - Verify the cost-effectiveness and the indication of Near Infra Red Technology in visualizing and cannulating the superficial veins for insertion of ECC
   - Improve the training of health care specialists so to implement the use of new technology for insertion (US, NIR) and for tip location (echocardio, intracavitary EKG) of central access in neonates

Editorial

JVA The Journal of Vascular Access

Neo-ECHOTIP: A structured protocol for ultrasound-based tip navigation and tip location during placement of central venous access devices in neonates

Giovanni Barone[1], Mauro Pittiruti[2], Daniele G Biasucci[3], Daniele Elisei[4], Emanuele Iacobone[4], Antonio La Greca[2], Geremia Zito Marinosci[5] and Vito D'Andrea[6]

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Table 1. Summary of Neo-ECHO tip.

Catheter	Protocol	Probe	Windows
UVC	Tip navigation	Small sectorial probe, 7–8 MHz	Low subcostal longitudinal view
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view
ECCs inserted via veins of the scalp or of the upper limbs	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Acoustic windows of RaCeVA and RaPeVA
	Tip location	Small sectorial probe, 7–8 MHz	Bi-caval view; four-chamber apical view; long axis view of SVC
ECCs inserted via veins of the lower limbs	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Short and long axis view of the femoral vein
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view
CICC	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Acoustic windows of RaCeVA
	Tip location	Small sectorial probe, 7–8 MHz	Bi-caval view; four-chamber apical view; long axis view of SVC
FICC	Tip navigation	Linear "hockey stick" probe, 10–14 MHz and small sectorial probe	Short and long axis view of the femoral vein and subcostal longitudinal view
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view

UVC: umbilical venous catheter; ECC: epicutaneo-caval catheter; RaCeVA: rapid central vein assessment; RaPeVA: rapid peripheral vein assessment; CICC: centrally inserted central catheter; FICC: femoral inserted central catheter.

Neo-ECHOTIP for UVC

Several studies have evaluated the accuracy of US for UVC tip location. According to most authors, the tip can be successfully located in 95-100% of all patients. Different probes have been used:

- Linear probes, 12-13 MHz
- Micro-convex probes, 7-8.5 MHz
- Small sectorial probes

The subcostal longitudinal view was the most common acoustic window, though some authors adopted also complementary windows such as the apical four-chamber view and the parasternal short-axis view . A saline flush was used in some studies as a complimentary aid to enhance tip visualization. Only one study reported the use of US for tip navigation

Neo-ECHOTIP for UVC

Tip navigation protocol:

Probe: small sectorial probe, 7-8 MHz.
Acoustic window: subcostal longitudinal view. This view allows to visualize the pathway of fetal umbilical venous flow from the umbilical vein to the ductus venosus, and further on to the junction between IVC and RA.

Procedure: During catheter insertion, the tip is visualized as it passes through the umbilical vein, the ductus venosus and the IVC. A small pressure with the probe may facilitate the lineup between the ductus venosus and the IVC, increasing the odds to direct the catheter into the proper position

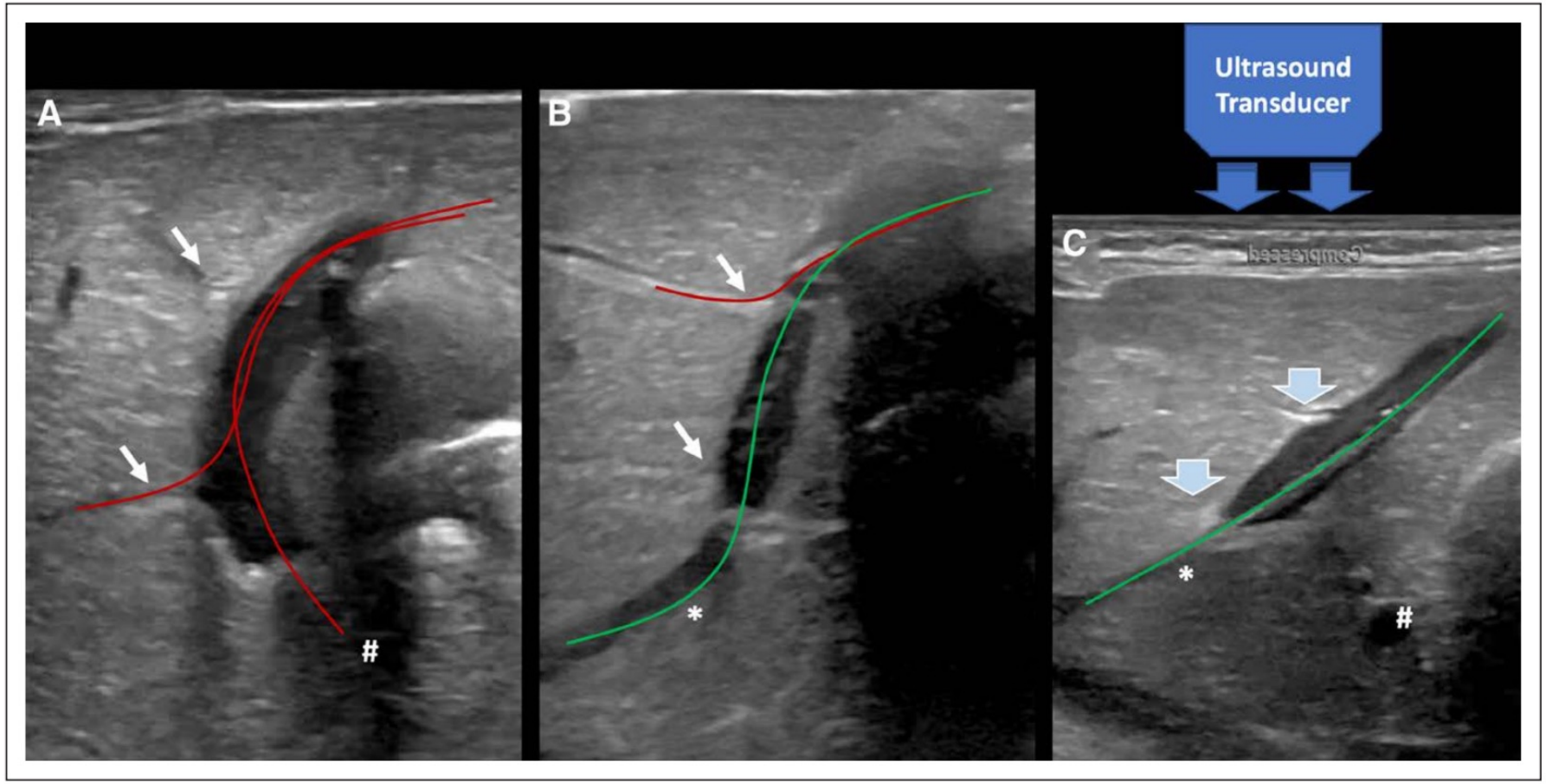
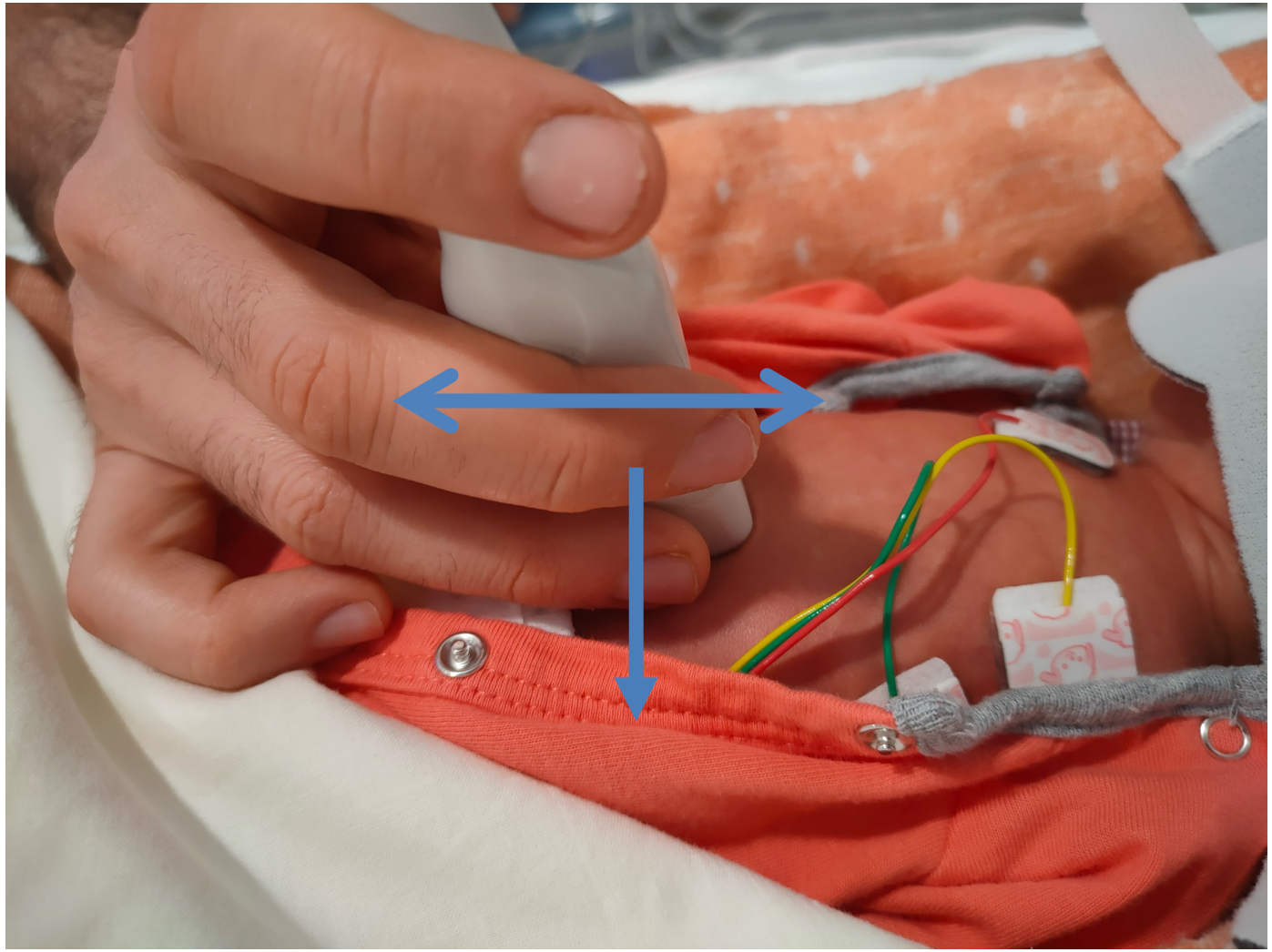


Figure 4. Effect of liver pressure. Ultrasound assists in navigating the path through the portal sinus to the ductus venosus (*), avoiding the left (*small arrows*) and right (#) portal veins that readily accept the umbilical venous catheter and result in malposition. **A** and **B**, *Red lines* accentuate the potential, incorrect courses taken by the catheter into the portal veins. The *green line* represents the optimal catheter course. **C**, With titrated liver pressure, the left portal veins are compressed (*large arrows*), the caudal turn into the right portal veins (#) becomes more acute, and the "S-turn" (seen in **B**) through the portal sinus to the ductus venosus becomes flatter and more favorable.

Neo-ECHOTIP for UVC

Probe TIP-Navigation



Neo-ECHOTIP for UVC

Tip location protocol:

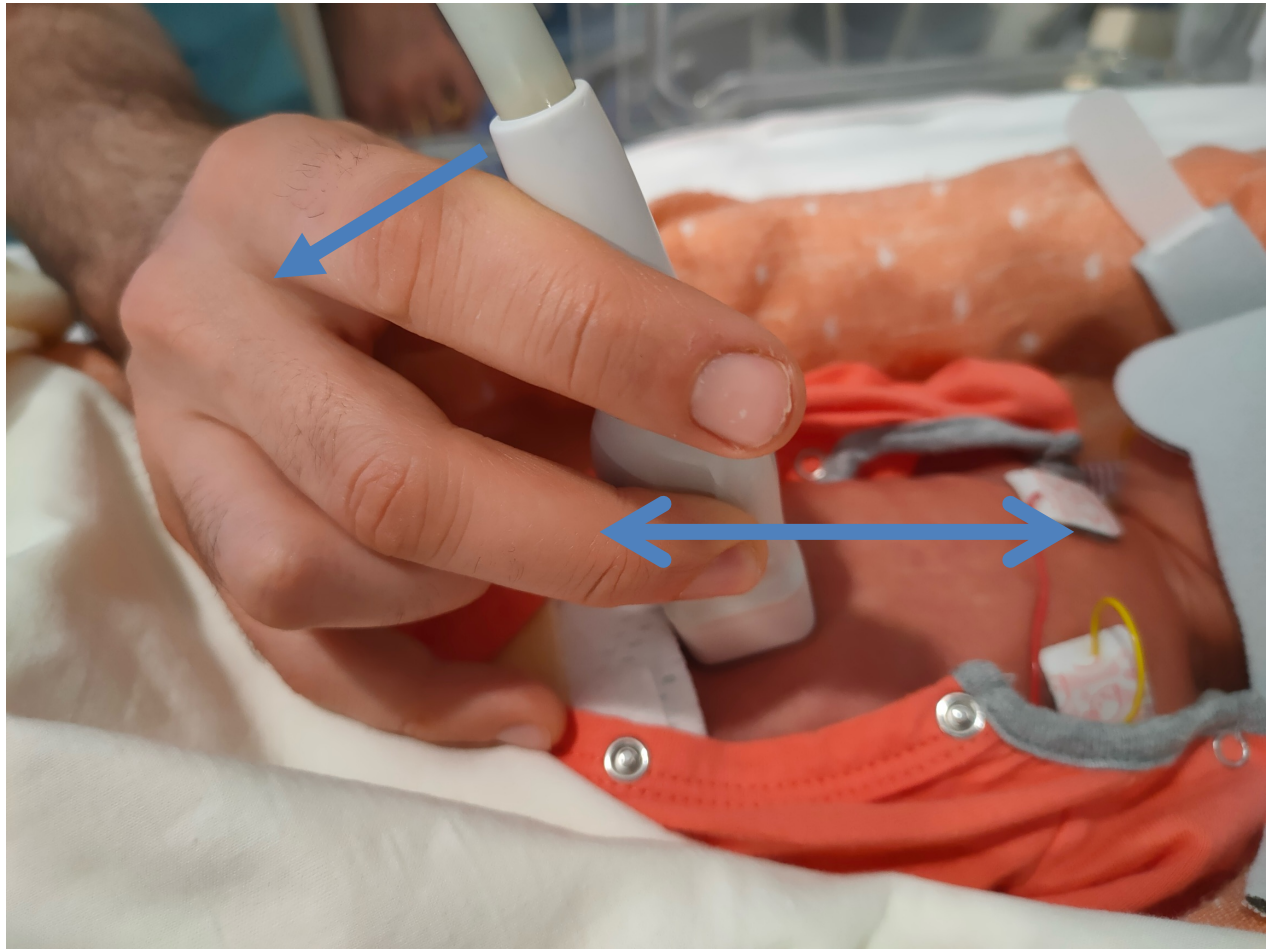
Probe: small sectorial probe, 7-8 MHz.

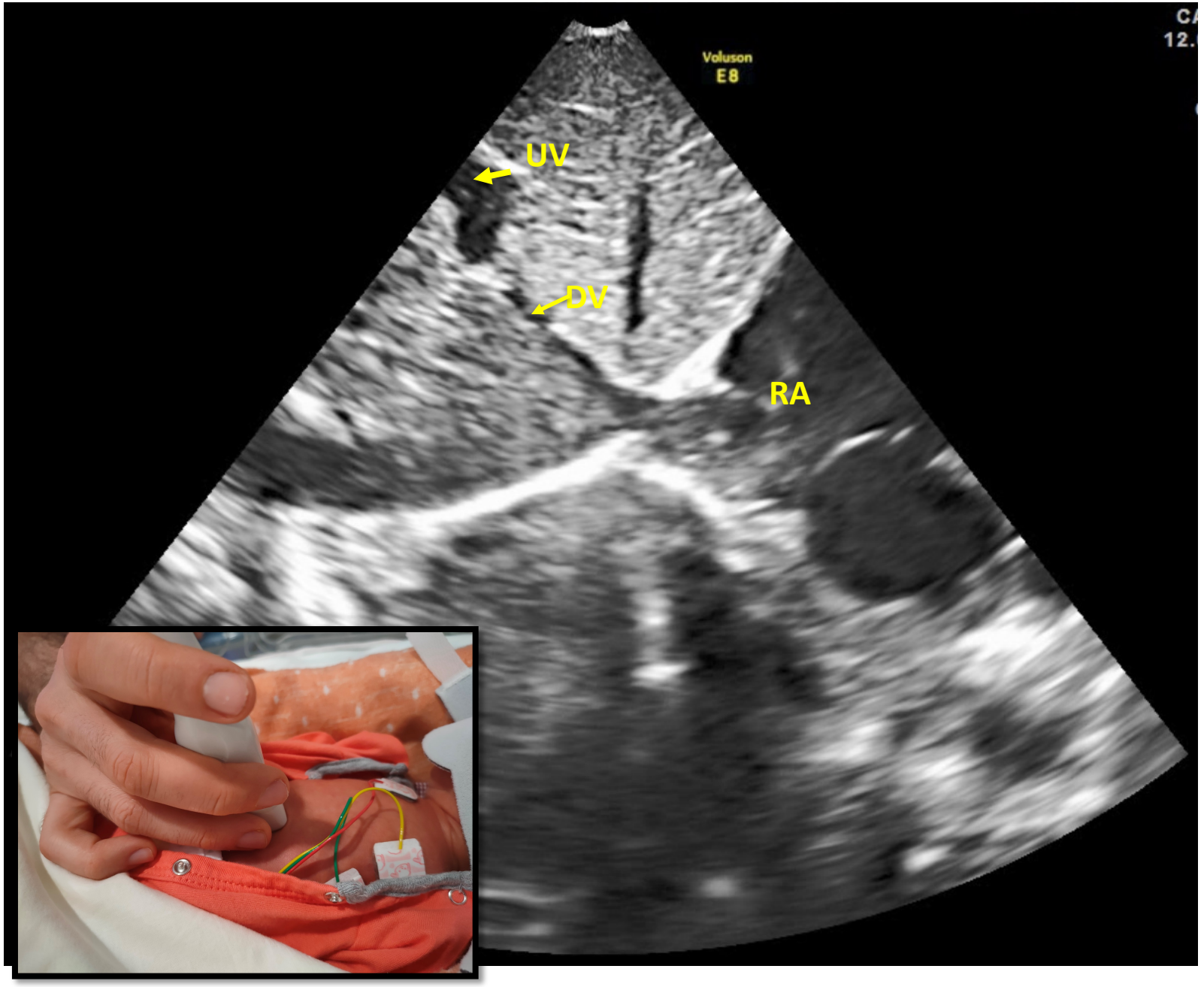
Acoustic window: subcostal longitudinal view. This view allows to visualize the IVC and the RA.

Procedure: the tip is followed until it reaches the target zone, i.e., the junction between the IVC and the RA. A small flush of normal saline (0.5-1 ml) can improve the visualization of the tip

Neo-ECHOTIP for UVC

Probe TIP-Location

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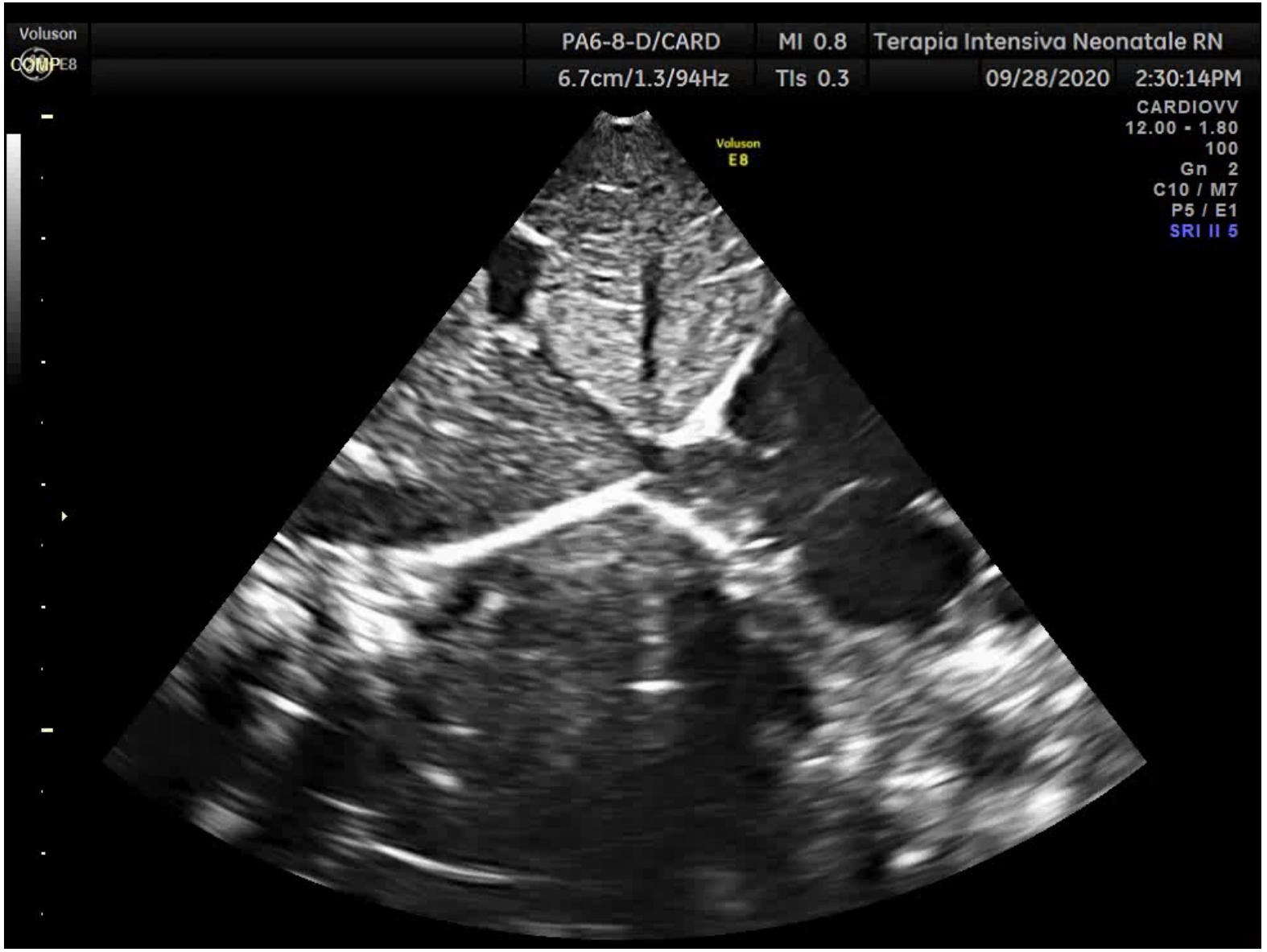
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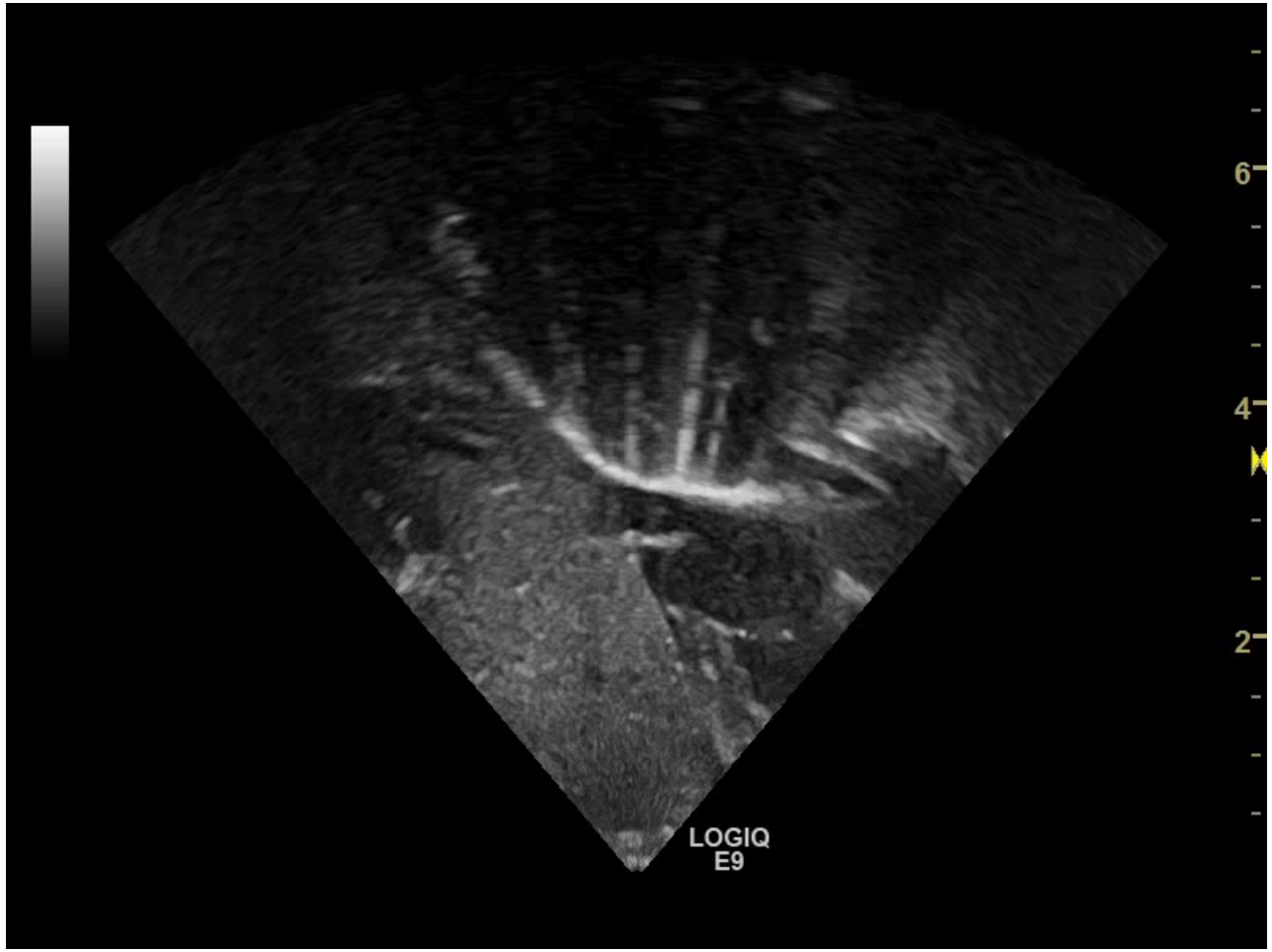
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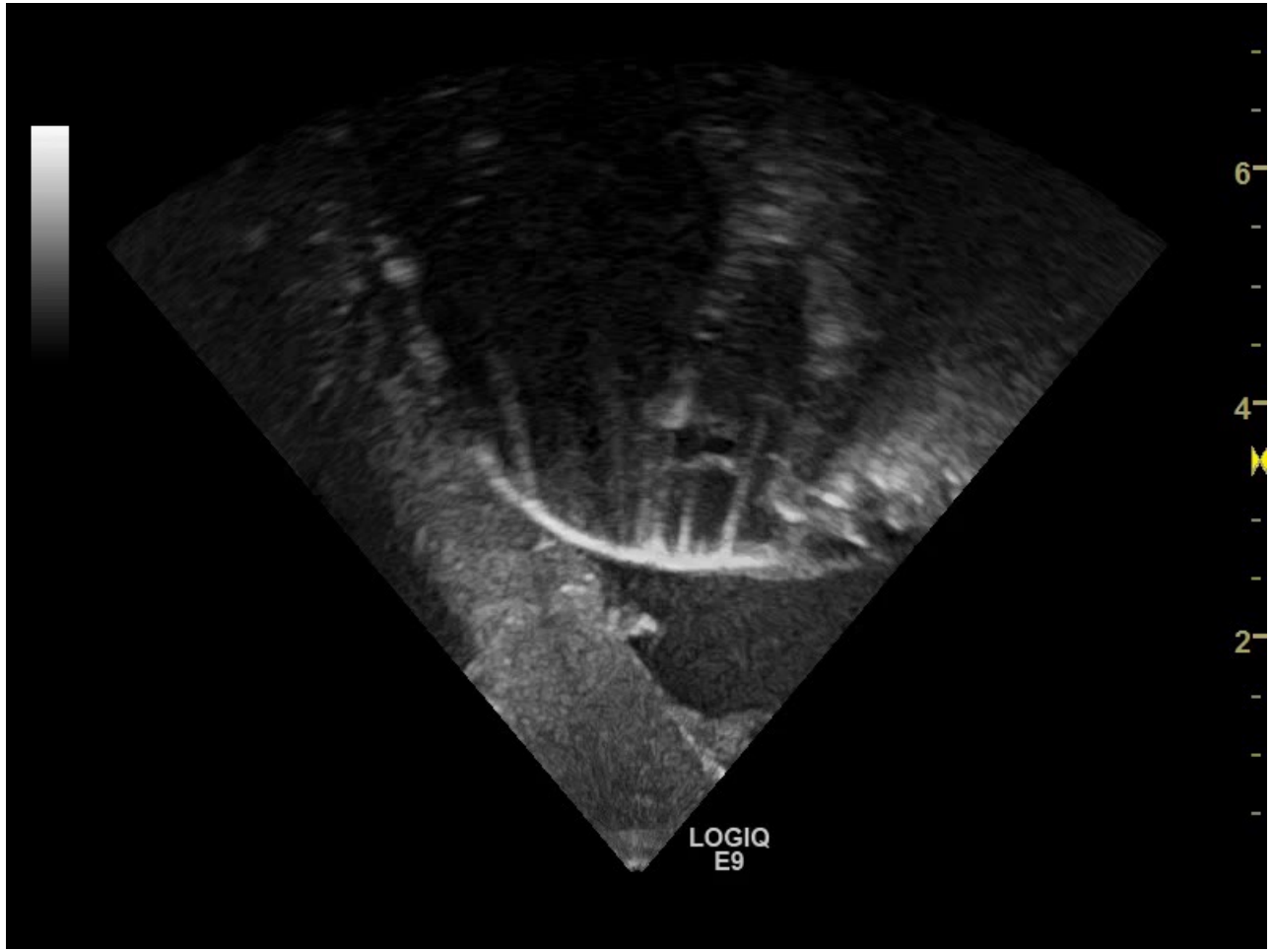
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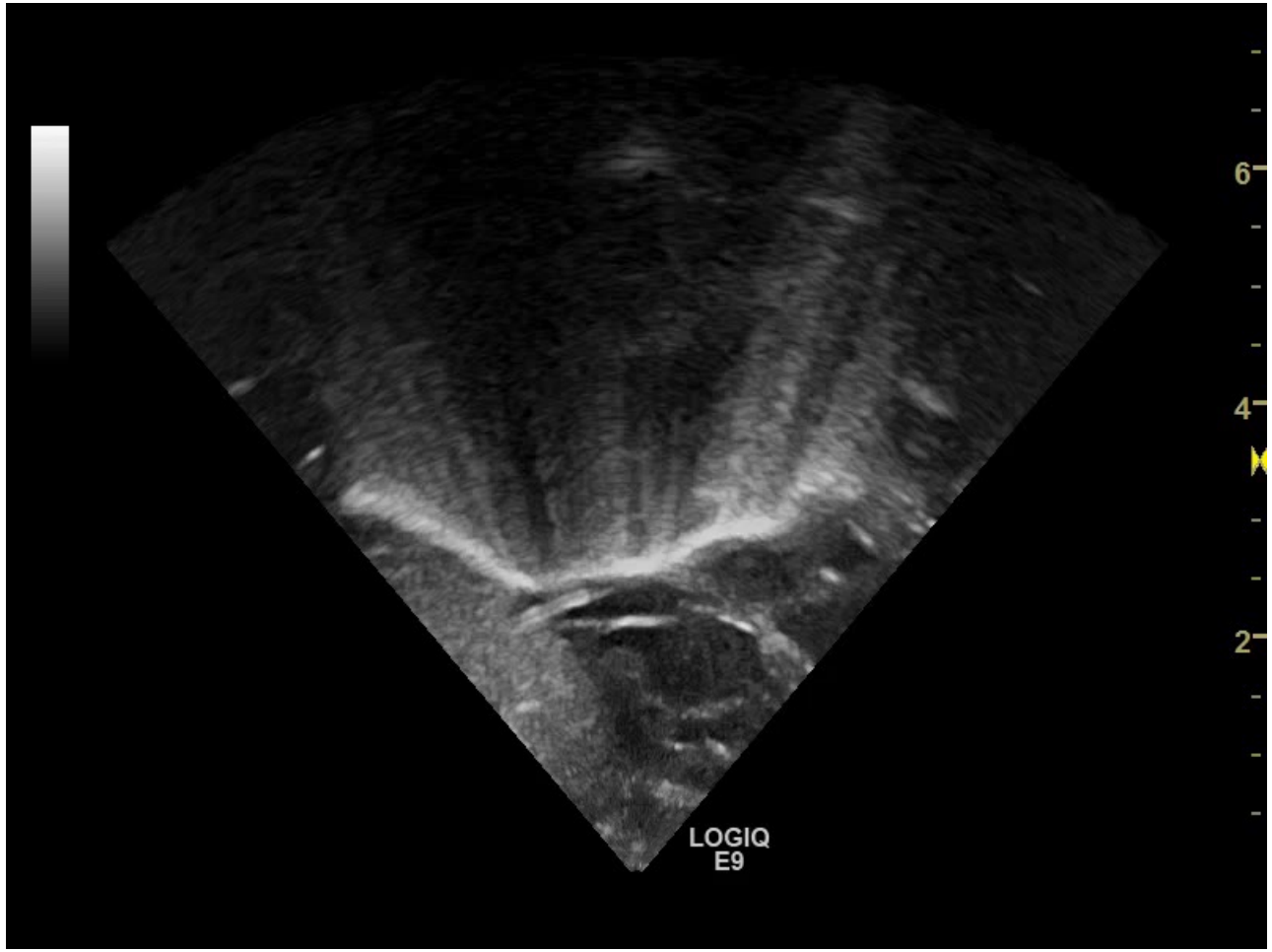
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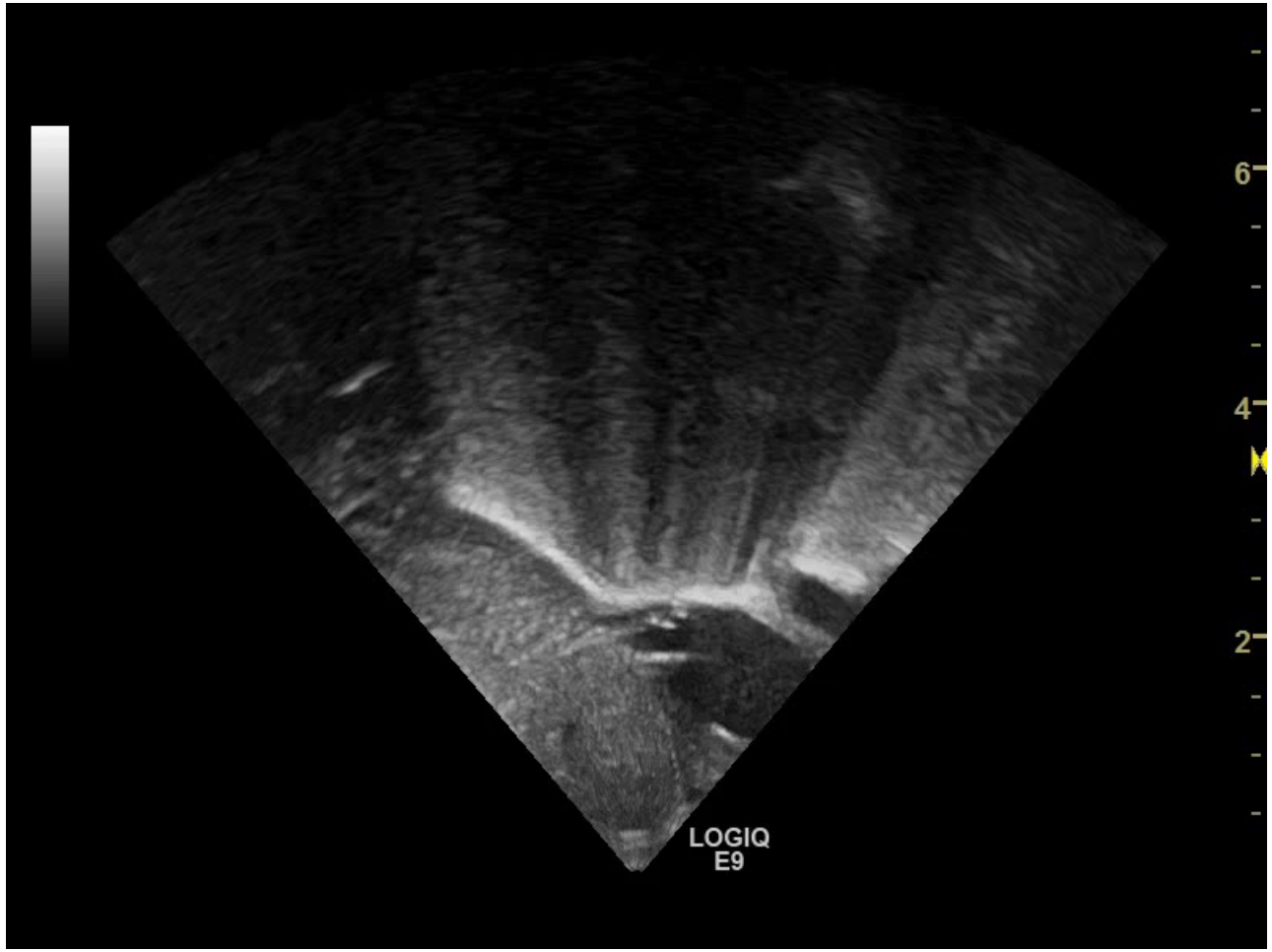
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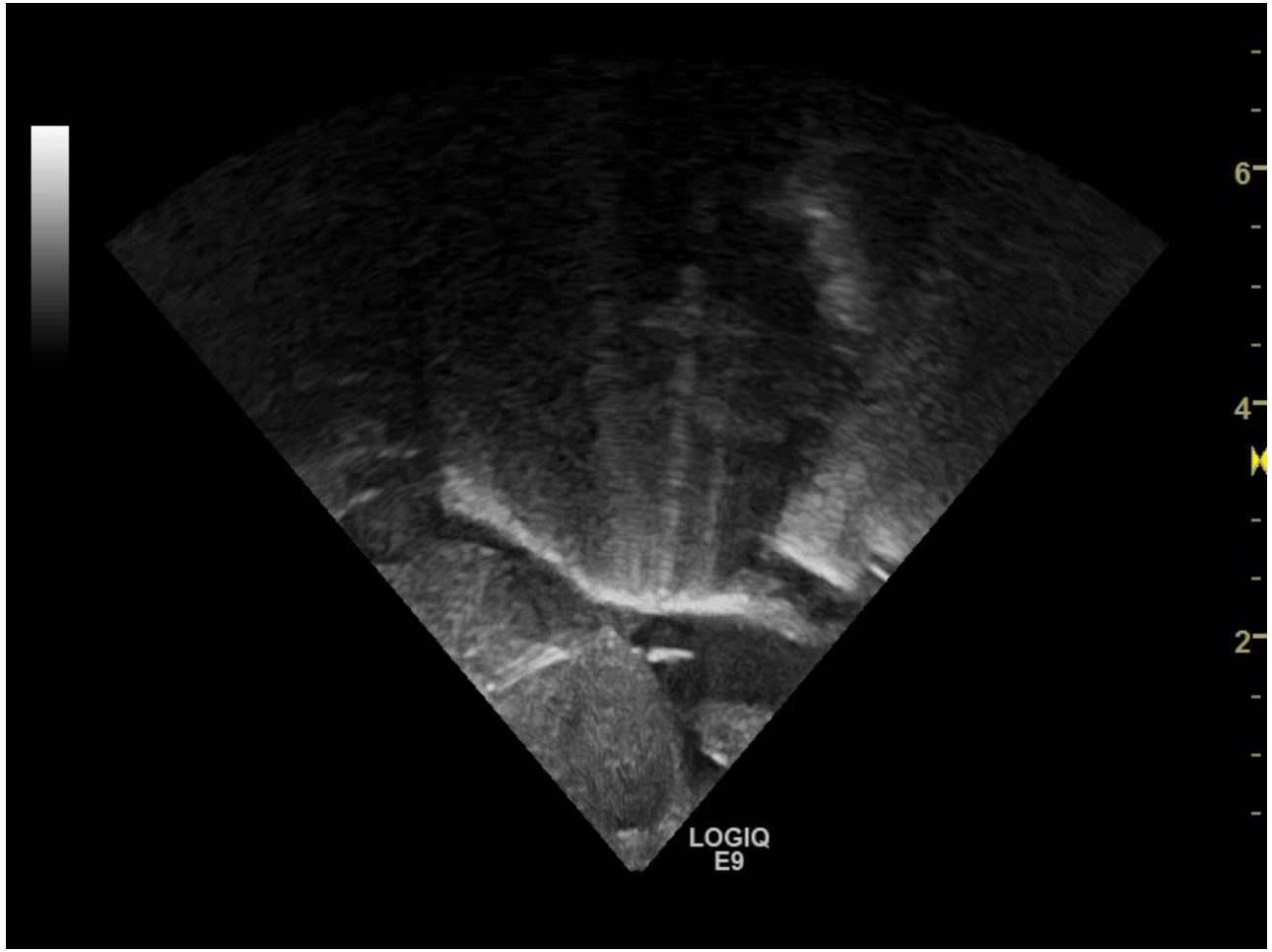
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Is Neo-ECHOTIP protocol effective in preventing primary malposition during UVC placement?

Confirmed as: Co-author

Manuscript ID: NEO-2024-2-9/R2 RESUBMISSION

Real-Time Ultrasound Tip Location Reduces Malposition and Radiation Exposure during Umbilical Venous Catheter Placement in Neonates. A Retrospective, Observational Study

Type: Research Article

Authors: Vito D'Andrea (Corresponding Author), Giorgia Prontera (Co-author), Francesco Cota (Co-author), Alessandro Perri (Co-author), Rosellina Russo (Co-author), Giovanni Barone (Co-author), Giovanni Vento (Co-author)

Submitted: 2024-04-08

Decision

Accept

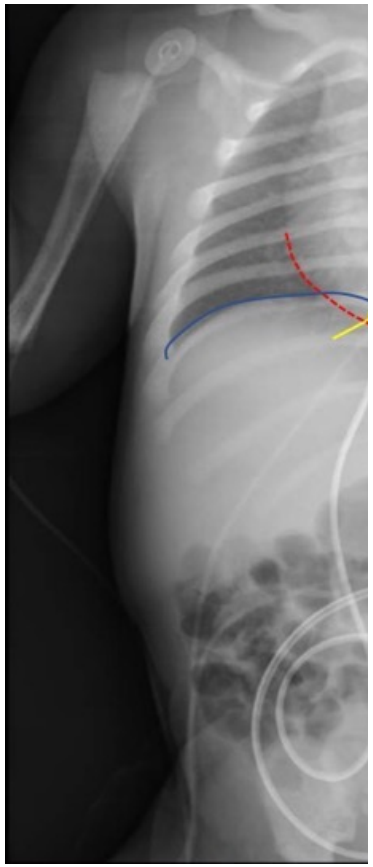

Table 1 Characteristics of study population and reason of UVC insertion

Birth weight (g)	1909 ± 1031.67
Gestational age (wk)	32.9 ± 5.14
Reason of UVC insertion n (%)	
Prematurity	91 (19.7%)
Respiratory disease	148 (32.1%)
SGA/AED/ARED	64 (13.9%)
Asphyxia	75 (16.3%)
Infectious	5 (1.1%)
Cardiologic disease	26 (5.6%)
Difficult IV access	11 (2.4%)
Surgical	7 (1.5%)
Hypoglycemia	4 (0.9%)
Other disease	30 (6.5%)

Table 2 UVC tip location at insertion.

	X-rays group (212)	RT-US group (249)	*P*
Safe position	51 (24.1%)	225 (90.4%)	<.001
Primary malposition	161 (75.9%)	24 (9.6%)	<.001
In the heart position	41 (25.4%)	-	
Intrahepatic position	100 (62.1%)	-	
Prehepatic position	20 (12.4%)	24 (100%)	

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A novel neonatal protocol for Safe Insertion of Umbilical Venous Catheters (SIUVeC): Minimizing complications in placement and management

The Journal of Vascular Access
1–6

DOI: 10.1177/11297298241236220
journals.sagepub.com/home/jva
Sage

Giovanni Barone[1], Mauro Pittiruti[2], Giorgia Prontera[3], Gina Ancora[1] and Vito D'Andrea[3]

Table 1. The eight steps of the SIUVeC protocol.

Pre-procedural evaluation (including US evaluation).
Adoption of pre-assembled insertion kits.
Appropriate aseptic technique (hand hygiene, maximal barrier precautions, skin antisepsis with 2% chlorhexidine in 70% isopropyl alcohol).
Vein cannulation using the smallest catheter that may meet the infusion requirements and choosing widely between single versus double lumen UVC.
Real-time tip navigation and tip location by US (according to the NeoECHOTIP protocol).
Securement of the catheter and protection of the exit site (combining sutureless devices, cyanoacrylate glue, semipermeable transparent membranes).
Post-procedural serial assessment of tip location by US.
Early removal of the device (within 4–5 days).

SIUVeC
Safe Insertion Umbilical Venous Catheter

Jan 2021-March 2024: 510 UVCs

GA	27,2 ± 2 (22-41)
BW	824 ± 154 (340-4270)
Tip of the catheter in central position (Yes/No)	475/510 (93%)
Dwell time	3 ± 1 (1-5)
Elective removal (Yes/No)	462/510 (90%)
Migration	12 (2,3%)
Thrombosis in IVC	-
CRBSI	2 (0,4%)
Other compli.	2 (0,4%)

Unpublished data

SIUVeC
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CRBSI	2 (0,4%)
Other compli.	2 (0,4%)

Unpublished data

Neo-ECHOTIP for ECC

Several clinical studies have evaluated the accuracy of US for tip location during ECC placement. In such studies, the tip was successfully located in a variable percentage of cases, as the percentage of success apparently reaches 100% only when the operator is highly trained:

- Linear probes, 12-13 MHz
- Small sectorial probes

Different acoustic windows have been used: apical four chamber-view; parasternal long and short axis view; long axis view of superior vena cava (SVC); subcostal longitudinal view of IVC (for catheter inserted from lower limbs). A saline flush has been used in several studies to achieve a better visualization of the catheter tip. No study in the literature has investigated ultrasound-based tip navigation during ECC placement.

Table 1. Summary of Neo-ECHO tip.

Catheter	Protocol	Probe	Windows
UVC	Tip navigation	Small sectorial probe, 7–8 MHz	Low subcostal longitudinal view
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view
ECCs inserted via veins of the scalp or of the upper limbs	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Acoustic windows of RaCeVA and RaPeVA
	Tip location	Small sectorial probe, 7–8 MHz	Bi-caval view; four-chamber apical view; long axis view of SVC
ECCs inserted via veins of the lower limbs	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Short and long axis view of the femoral vein
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view
CICC	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Acoustic windows of RaCeVA
	Tip location	Small sectorial probe, 7–8 MHz	Bi-caval view; four-chamber apical view; long axis view of SVC
FICC	Tip navigation	Linear "hockey stick" probe, 10–14 MHz and small sectorial probe	Short and long axis view of the femoral vein and subcostal longitudinal view
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view

UVC: umbilical venous catheter; ECC: epicutaneo-caval catheter; RaCeVA: rapid central vein assessment; RaPeVA: rapid peripheral vein assessment; CICC: centrally inserted central catheter; FICC: femoral inserted central catheter.

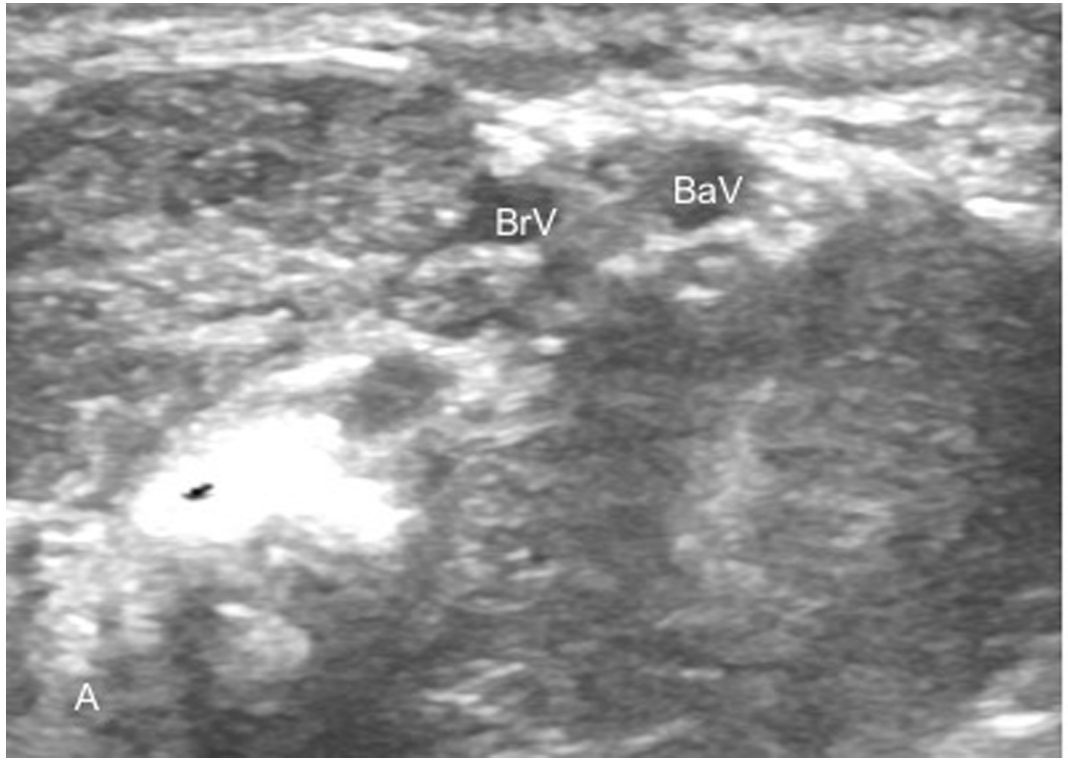
Neo-ECHOTIP for ECC inserted via veins of the upper limbs

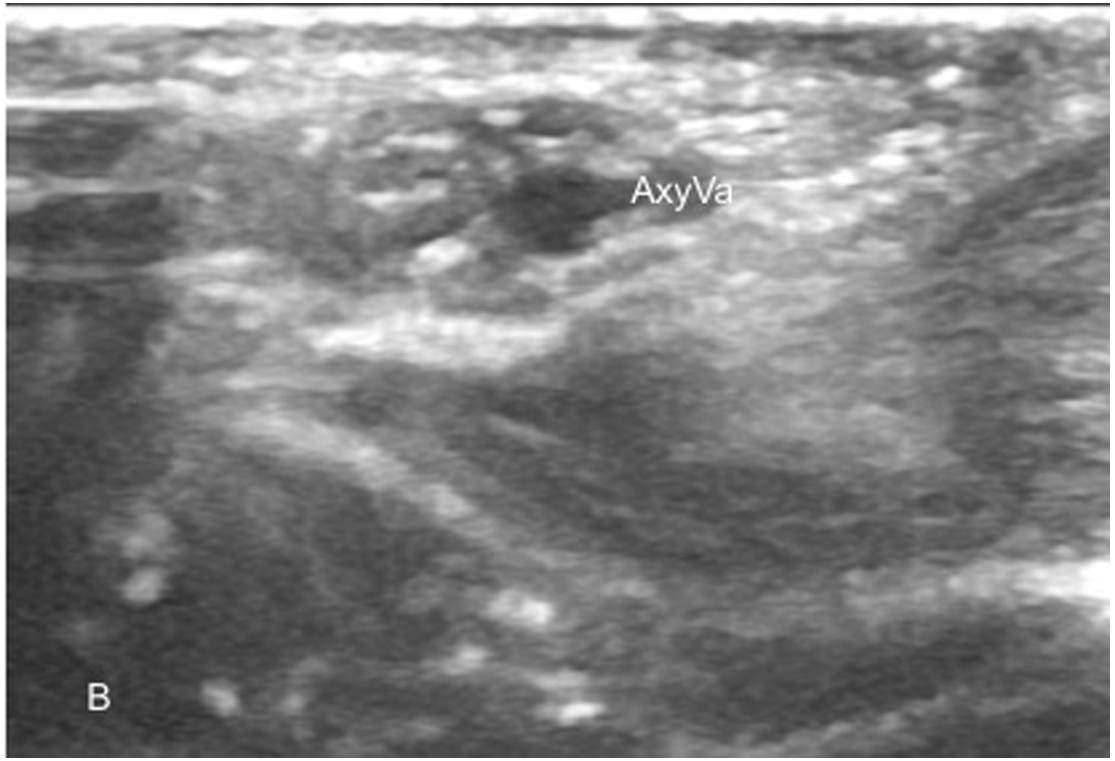
Tip navigation protocol:

Probe: linear 'hockey stick' probe, 10-14 MHz.
Acoustic windows: the protocol includes the acoustic windows of RaCeVA and RaPeVA .

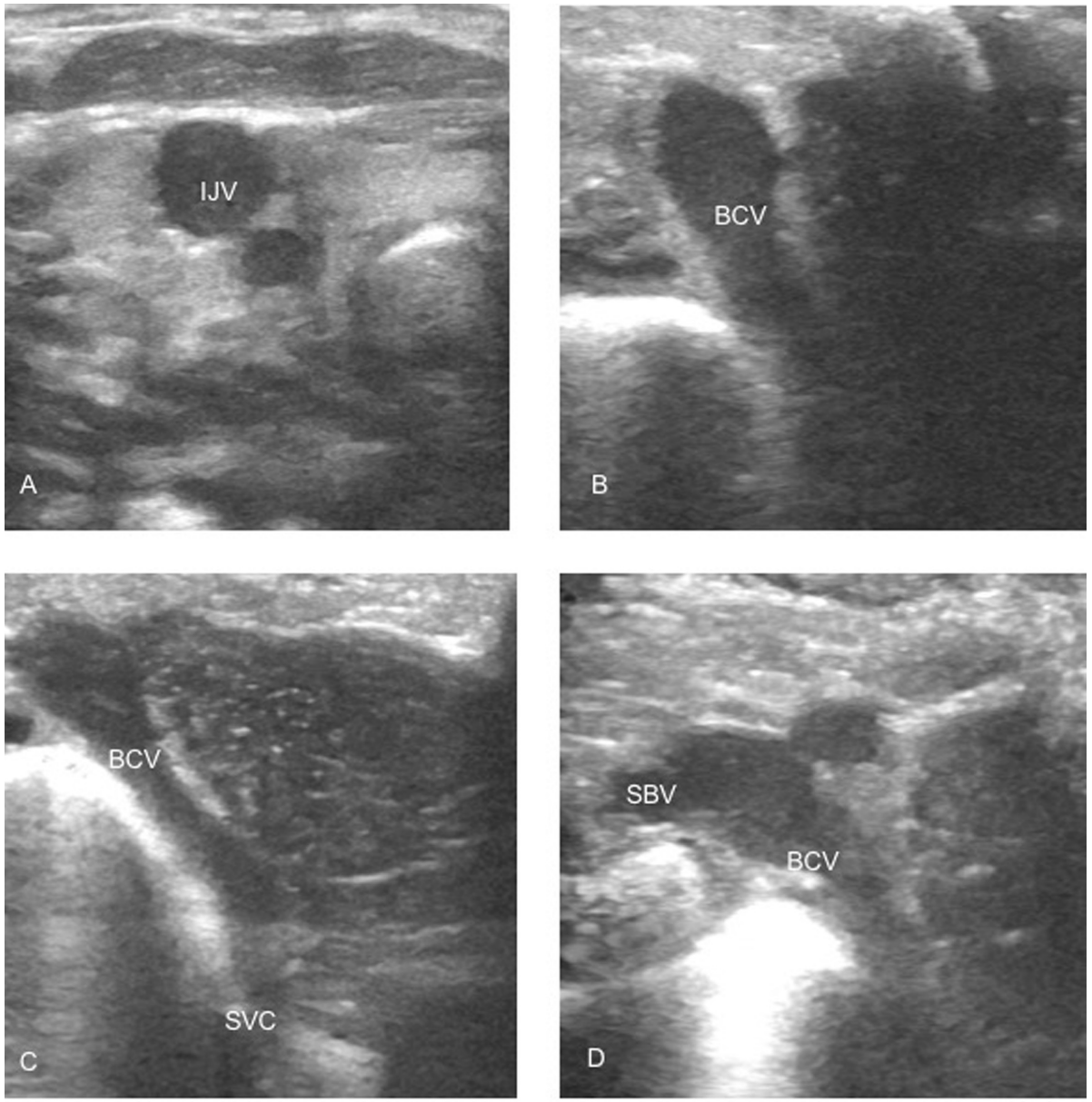
Procedure: the RaPeVA protocol is used in case of difficult progression of the catheter through the deep veins of the arm. The RaCeVA protocol is used for tip navigation of the catheter into the subclavian vein, the brachio-cephalic vein and the SVC, so to prevent primary malposition (such as inside the internal jugular vein) during the maneuver of insertion. The RaCeVA protocol can also easily visualize an ECC inserted into scalp veins as it passes through the internal jugular vein, the brachiocephalic vein and the SVC.

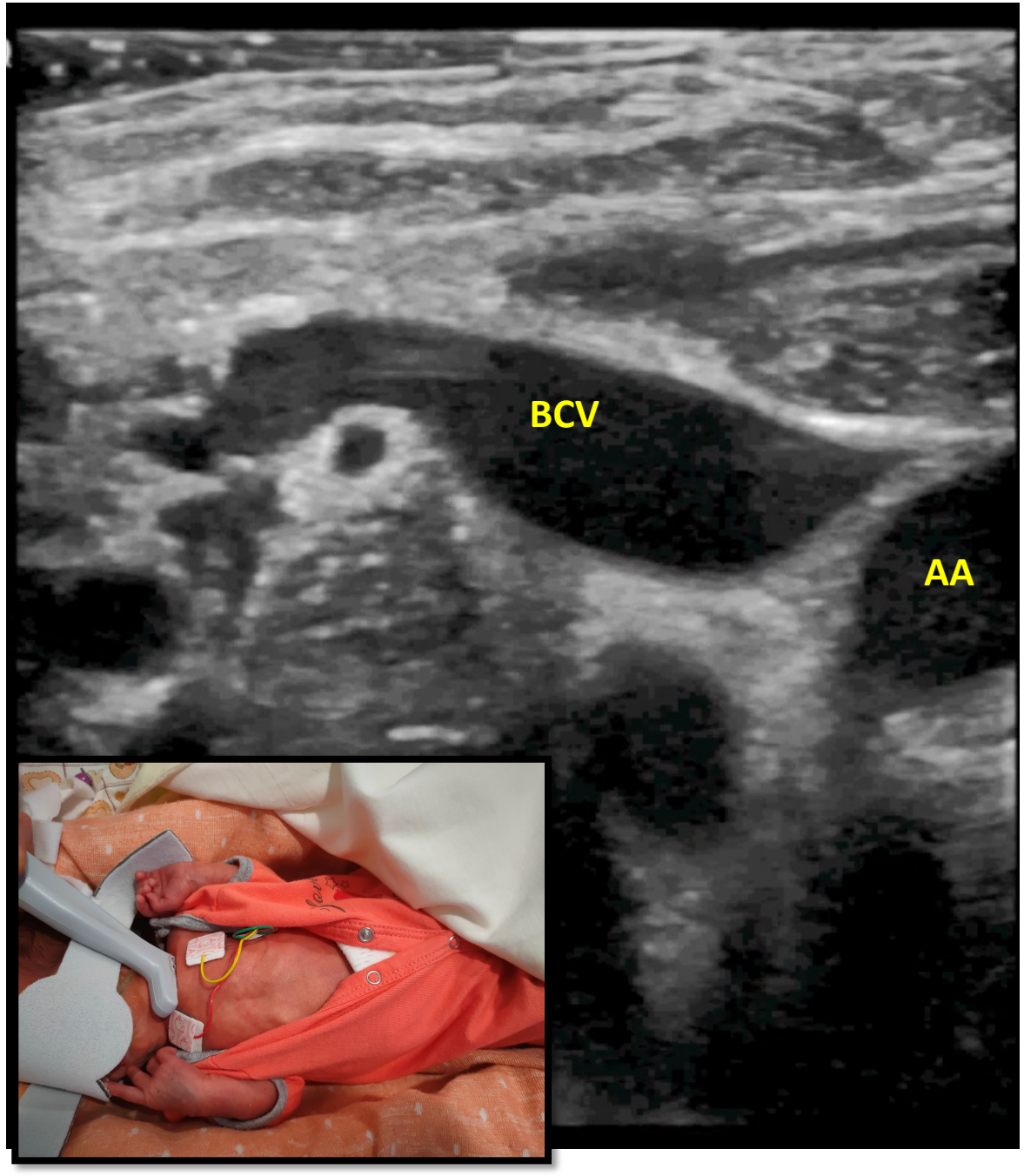
RaPeVa





RaCeVa




BCV
AA

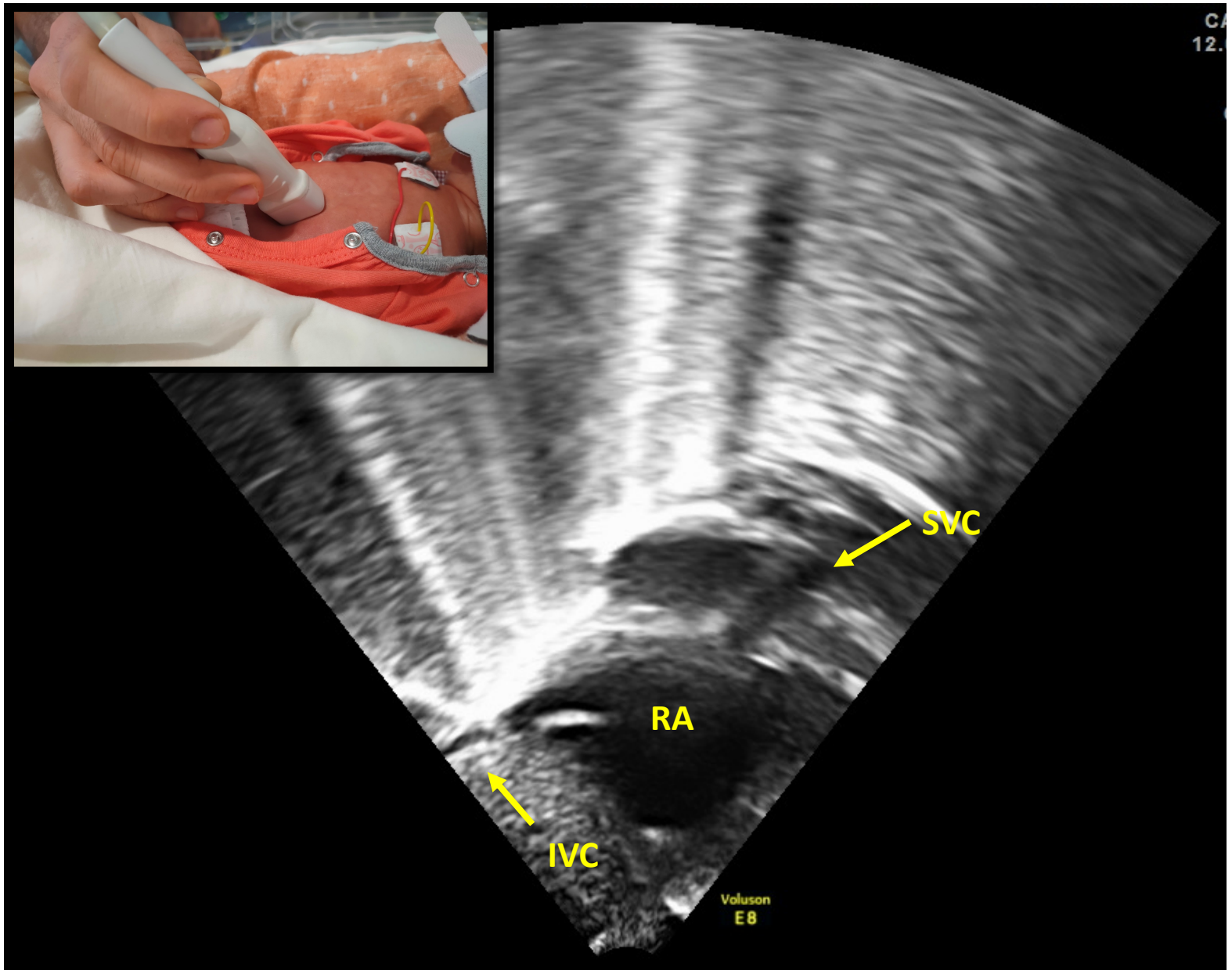
Neo-ECHOTIP for ECC inserted via veins of the upper limbs

Tip location protocol:

Probe: Small sectorial probe, 7-8 MHz.

Acoustic windows: At least three different windows have been used to locate the catheter tip. The most useful ones are the subcostal longitudinal view ('bi-caval' view); the four-chamber apical view; the parasternal, long axis view of SVC.

Procedure**:** the catheter tip is followed until it reaches the target zone, i.e., the transition between SVC and RA. A small flush of normal saline (0.5-1 ml) may help visualizing the tip.


SVC
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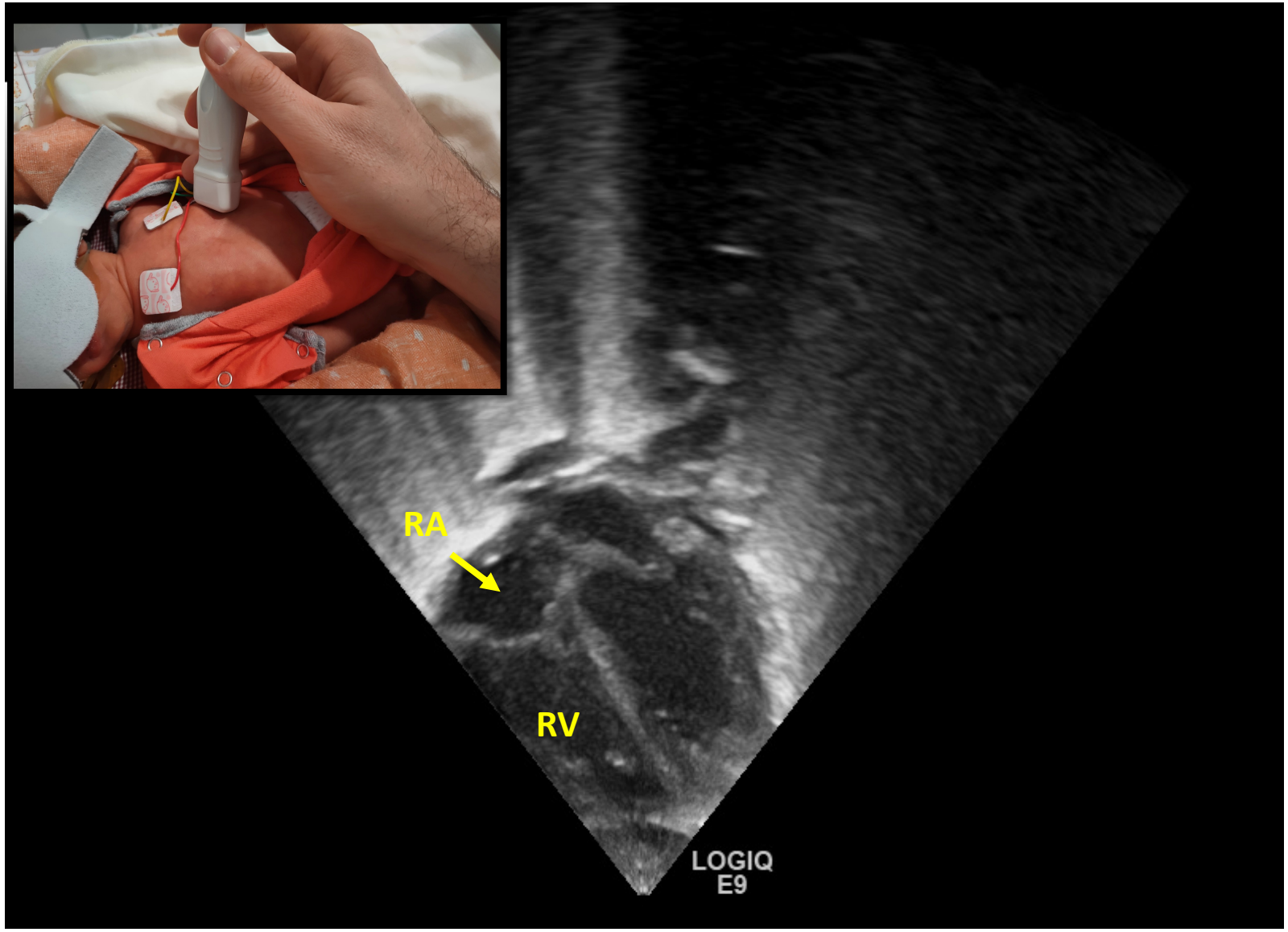
RA
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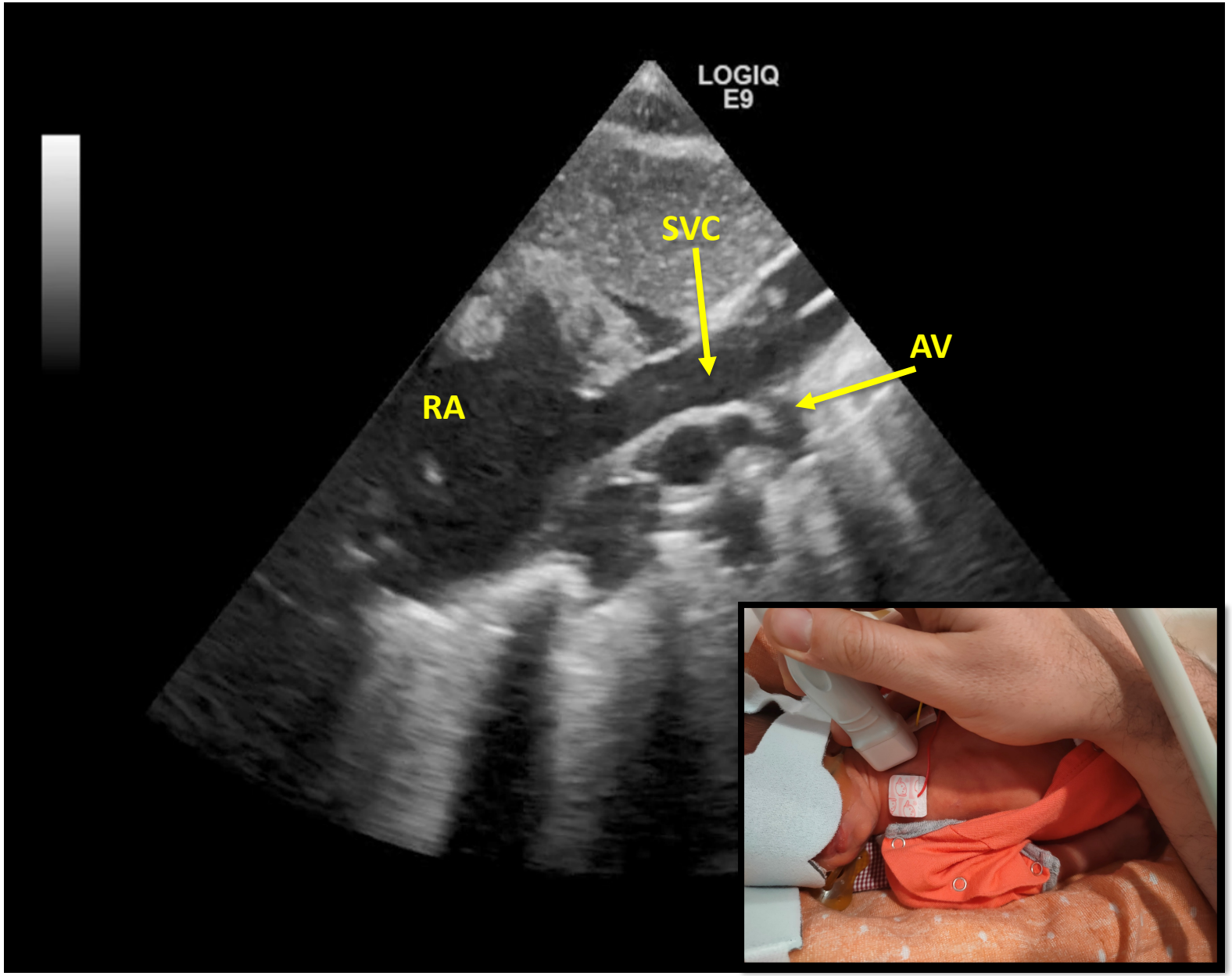
LOGIQ
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LOGIQ
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Table 1. Summary of Neo-ECHO tip.

Catheter	Protocol	Probe	Windows
UVC	Tip navigation	Small sectorial probe, 7–8 MHz	Low subcostal longitudinal view
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view
ECCs inserted via veins of the scalp or of the upper limbs	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Acoustic windows of RaCeVA and RaPeVA
	Tip location	Small sectorial probe, 7–8 MHz	Bi-caval view; four-chamber apical view; long axis view of SVC
ECCs inserted via veins of the lower limbs	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Short and long axis view of the femoral vein
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view
CICC	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Acoustic windows of RaCeVA
	Tip location	Small sectorial probe, 7–8 MHz	Bi-caval view; four-chamber apical view; long axis view of SVC
FICC	Tip navigation	Linear "hockey stick" probe, 10–14 MHz and small sectorial probe	Short and long axis view of the femoral vein and subcostal longitudinal view
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view

UVC: umbilical venous catheter; ECC: epicutaneo-caval catheter; RaCeVA: rapid central vein assessment; RaPeVA: rapid peripheral vein assessment; CICC: centrally inserted central catheter; FICC: femoral inserted central catheter.

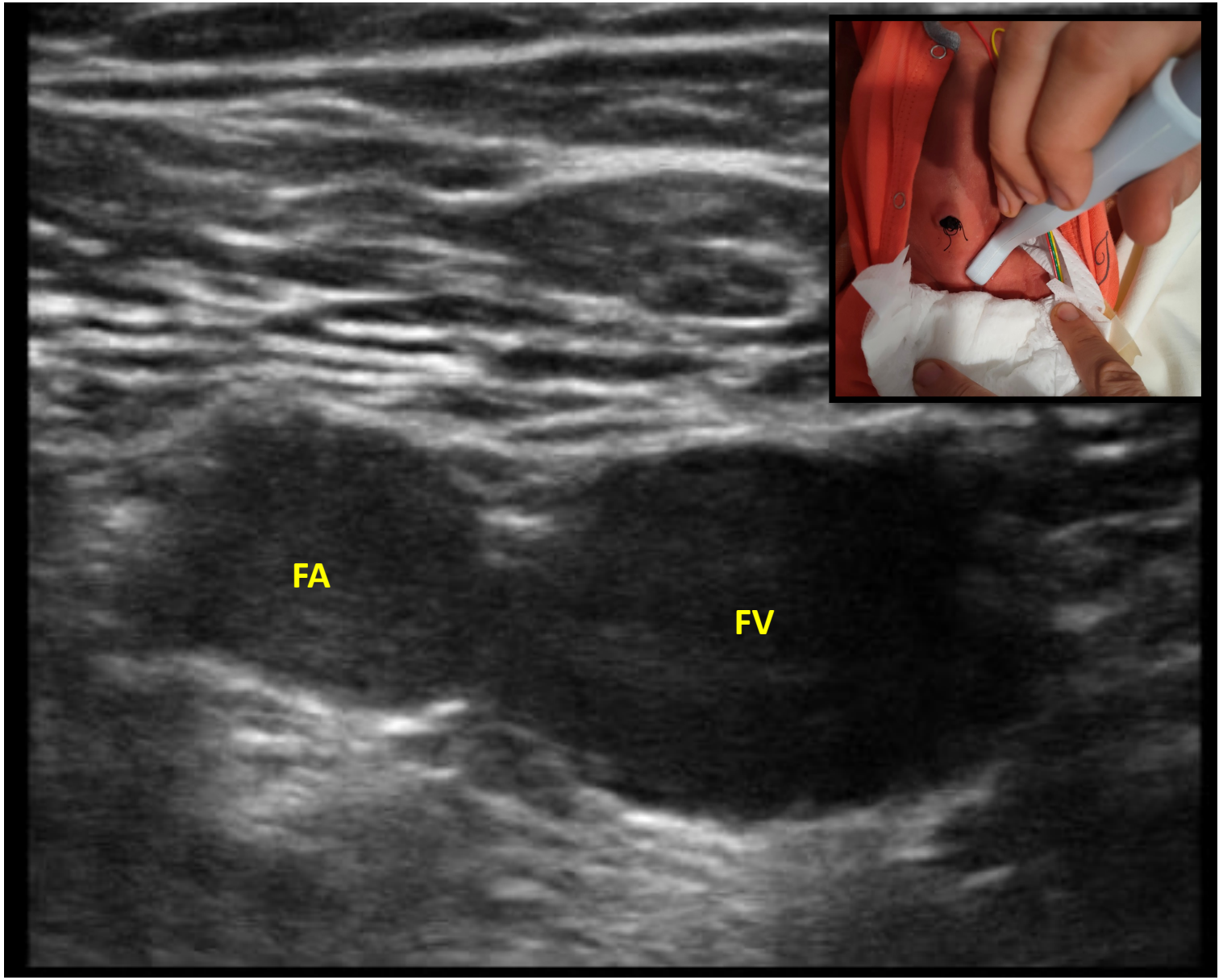
Protocol for ECCs inserted via veins of the lower limbs

Tip navigation protocol:

Probe: linear 'hockey stick' probe, 10-14 MHz.
Acoustic window: short and long axis view of the femoral vein.
Procedure: During ECC insertion, the catheter tip is visualized into the femoral vein and into the iliac vein.

Tip location protocol:

Probe: Small sectorial probe, 7-8 MHz
Acoustic window: subcostal longitudinal view. This view allows visualization of IVC and RA.
Procedure: the tip is followed until it reaches the target zone, i.e. the transition between IVC and RA. A small flush of normal saline (0.5-1 ml) may help visualizing the tip.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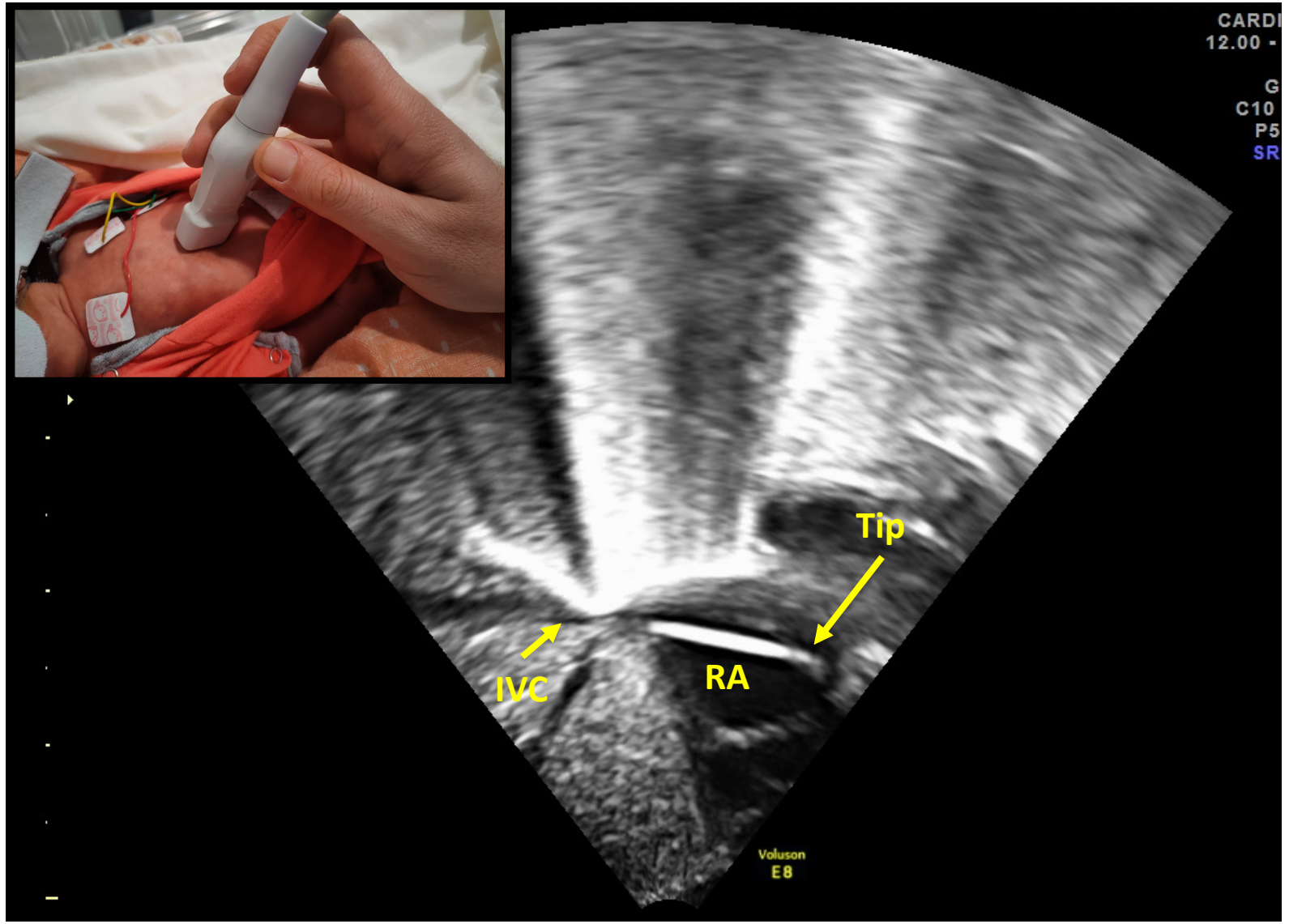
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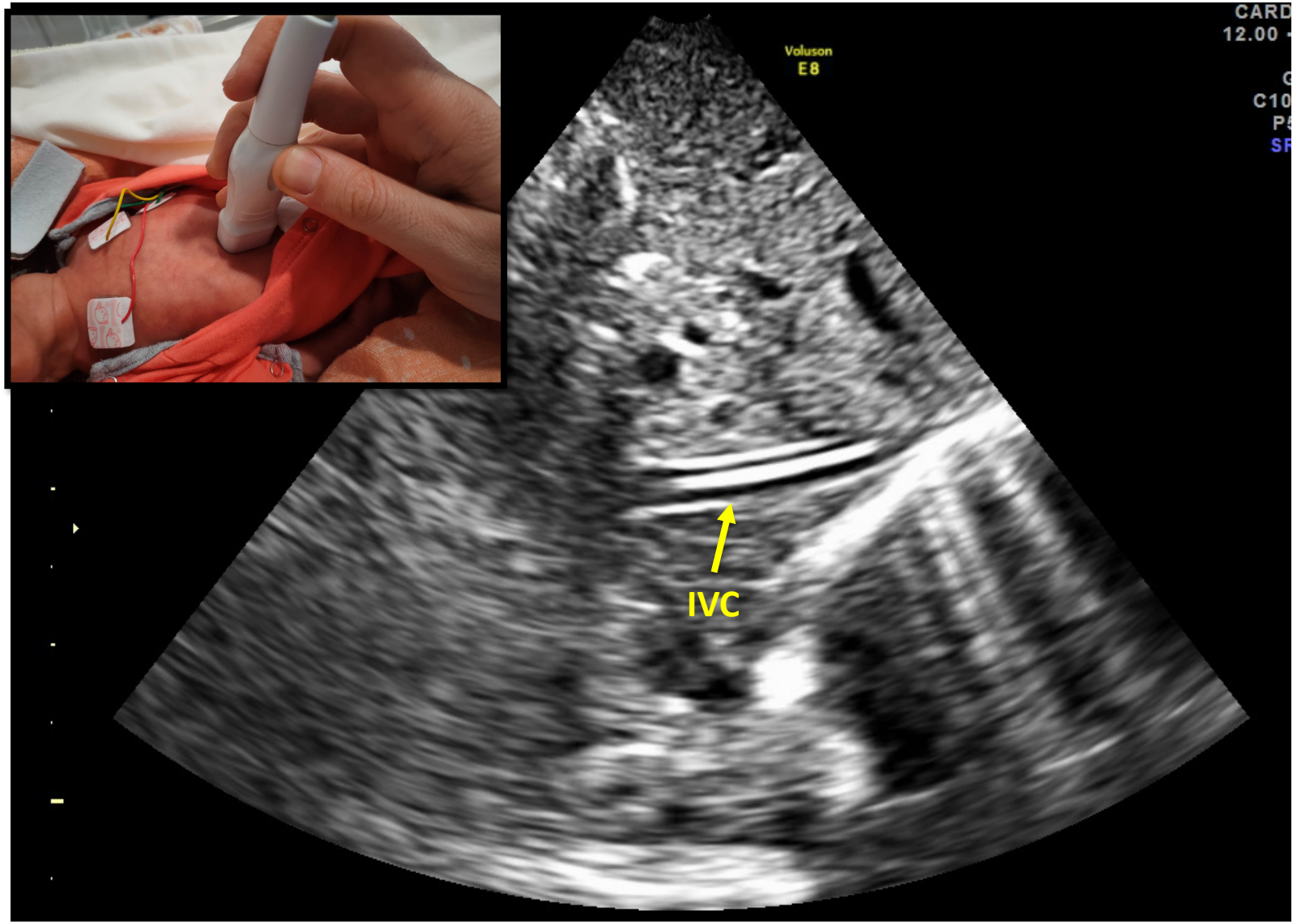

Training issue

Training issues. Even though US-based tip location of ECC has been proved to be effective and safe, many neonatologists still consider chest X-rays as the gold standard for this purpose. This is partly explained by the advanced training necessary to complete this maneuver with RT-US.

To the best of our knowledge, few data are available about the training needed for performing ultrasound-based tip location of ECCs. Clinical studies on RT-US for tip location of ECCs show a direct correlation between the level of expertise of the clinician and the percentage of successful tip visualization.[45]

In our experience, the minimum training requirements for ultrasound-based tip navigation and tip location of ECCs should include:

1. Basic knowledge of targeted neonatal echocardiography and advanced vascular ultrasound assessment (in particular, the RaCeVA, RaPeVA, and RaFeVA protocols).
2. Advanced theoretical training, including the evaluation of several clinical case scenarios (at least 12 h).
3. Practical training supervised by a neonatologist with expertise in ultrasound-based tip location of ECCs (at least 50 cases).

Ultrasound guided Catheter Tip Location in Neonates: A Prospective Cohort Study

Fiorentino Grasso, MD[1], Antonella Capasso, MD[1], Daniela Pacella, PhD[2], Francesco Borgia, MD[3], Serena Salomè, MD[1], Letizia Capasso, MD, PhD[1], and Francesco Raimondi, MD, PhD[1]

Objective To assess point-of-care-ultrasound (POCUS) guided catheter tip location in a neonatal cohort after insertion of percutaneously inserted central catheters (PICCs) from the upper part of the body.

Study design This was a prospective, observational study on PICC tip location. Tip site was assessed by radiological landmarks or direct ultrasound (US) visualization of the cardiovascular structures.

Results One hundred eighteen PICCs (28Gauge/1French) were studied in 102 neonates (mean postmenstrual age 31 weeks, range 25-43 weeks; mean weight at positioning 1365 g, range 420-4180 g). Feasibility of POCUS guided tip location was 92.3% in our population. Failures were significantly associated with mechanical ventilation (aOR 5.33; 95% CI 1.13-29.5; $P = .038$). Agreement between US and radiographic methods was found in 88 of 109 cases (80.7%). Fifteen of 21 discordant cases led to a change in clinical management.

Conclusions POCUS guided localization of small bore PICC is a non-invasive and effective alternative to the conventional radiogram. The latter should be recommended when US examination fails to locate the catheter tip. *(J Pediatr 2022; ■:1-5)*.

Ultrasound-guided catheter tip location in neonatal central venous access. Focus on well-defined protocols and proper ultrasound training

To the Editor:

We read with great interest the report by Grasso et al regarding the use of point-of-care ultrasound scanning to assess the catheter tip location in a neonatal intensive care unit.[1] As pointed out by the authors, the advantages in the use of point-of-care ultrasound scanning are maximal accuracy of tip location, avoidance of x-ray exposure, and use of a real-time, intraprocedural method that completely avoids the risk of primary malposition.

In our opinion, the most interesting finding of this study is the high success rate in tip location. This is probably secondary to the appropriate training of the health care providers in the use of ultrasound scans and to the adoption of a well-defined protocol for tip location. We have previously proposed a very similar approach,[2] developing a protocol, "Neo-ECHOTIP," which includes the use of 3 different acoustic windows (apical 4-chamber view, bicaval subcostal view, high right parasternal longitudinal view) plus a small flush of normal saline (so-called "bubble test"), so to increase the accuracy of tip visualization.

The Neo-ECHOTIP protocol should be further evaluated in prospective studies before being regarded as a standard of care; hopefully, it may be included as part of training programs for all neonatologists, providing a solid foundation for intraprocedural tip location during catheter insertion.

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Is Neo-ECHOTIP protocol effective in preventing primary malposition during ECC placement?

Real-Time Ultrasound Tip Location Reduces Malposition and Radiation Exposure during Epicutaneo-Caval Catheter Placement in Neonates

Vito D'Andrea, MD[1,*] Giorgia Prontera, MD[1,*] Francesco Cota, MD[1] Rosellina Russo, MD[2]
Giovanni Barone, MD[3] Giovanni Vento, MD[1]

	X-ray	RT-US	*p*-Value
Primary malposition	107 (65.4%)	11 (13.25%)	<0.001
Single repositioning	79 (47.88%)	10 (12.5%)	<0.001
Multiple repositioning	28 (16.97%)	1 (1.2%)	<0.001

The SIECC protocol: a novel insertion bundle to minimize the complications related to epicutaneo-cava catheters in neonates.

Journal:	*The Journal of Vascular Access*

The eight steps of the SIECC protocol.

1.	Pre-procedural evaluation of superficial veins (including the RaSuVA protocol)
2.	Adoption of pre-assembled insertion kits
3.	Appropriate aseptic technique (hand hygiene, maximal barrier precautions, skin antisepsis with 2% chlorhexidine in 70% isopropyl alcohol)
4.	intra-procedural assessment of tip navigation and tip location by ultrasound (adopting the Neo-ECHOTIP protocol)
5.	Securement of the catheter and protection of the exit site
6.	Post-procedural serial assessments of tip location by ultrasound
7.	Removal of the device within 2 weeks

SIECC
Safe Insertion Epicutaneo Cava Catheter

Jan 2021-March 2024: 620 ECCss

GA	28,2 ± 2 (22-41)
BW	725 ± 154 (340-3250)
Tip of the catheter in central position (Yes/No)	602/620 (97%)
Dwell time	12 ± 2 (8-19)
Elective removal (Yes/No)	484/620 (78%)
Migration	23 (3,7%)
Thrombosis	-
CLABSI	19 (3,1%)
Other compli.	7 (1,1%)

Unpublished data

SIECC
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Neo-ECHOTIP for CICC and FICC

Reasons for using RT-US during CICC and FICC placement in newborns:

1. RT-US allows both tip navigation and tip location.
2. RT-US can easily rule-out primary malposition, such as the accidental direction of the catheter into the opposite brachio-cephalic vein.
3. RT-US is an effective rescue strategy when the intracavitary ECG is not applicable (for instance in newborns with atrial flutter).
4. RT US is the only way to evaluate the tip location of a FICC when the tip is scheduled to be inside the IVC.

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Table 1. Summary of Neo-ECHO tip.

Catheter	Protocol	Probe	Windows
UVC	Tip navigation	Small sectorial probe, 7–8 MHz	Low subcostal longitudinal view
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view
ECCs inserted via veins of the scalp or of the upper limbs	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Acoustic windows of RaCeVA and RaPeVA
	Tip location	Small sectorial probe, 7–8 MHz	Bi-caval view; four-chamber apical view; long axis view of SVC
ECCs inserted via veins of the lower limbs	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Short and long axis view of the femoral vein
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view
CICC	Tip navigation	Linear "hockey stick" probe, 10–14 MHz	Acoustic windows of RaCeVA
	Tip location	Small sectorial probe, 7–8 MHz	Bi-caval view; four-chamber apical view; long axis view of SVC
FICC	Tip navigation	Linear "hockey stick" probe, 10–14 MHz and small sectorial probe	Short and long axis view of the femoral vein and subcostal longitudinal view
	Tip location	Small sectorial probe, 7–8 MHz	Subcostal longitudinal view

UVC: umbilical venous catheter; ECC: epicutaneo-caval catheter; RaCeVA: rapid central vein assessment; RaPeVA: rapid peripheral vein assessment; CICC: centrally inserted central catheter; FICC: femoral inserted central catheter.

Neo-ECHOTIP for CICC

Tip navigation protocol:

Probe: linear 'hockey stick' probe, 10-14 MHz.

Acoustic windows: same acoustic windows of the RaCeVA protocol, including proper visualization of the brachio-cephalic veins in long axis on both sides.

Procedure**:** During CICC placement, the brachio-cephalic vein and the SVC should be clearly visualized.

- the needle is visualized during the venipuncture.
- the guidewire is visualized as it passes into the brachio-cephalic vein and into the SVC. It is recommended at this stage also to rule out pneumothorax.
- the micro-introducer is visualized inside the brachio-cephalic vein.
- the catheter is visualized inside the brachio-cephalic vein and then inside the SVC.

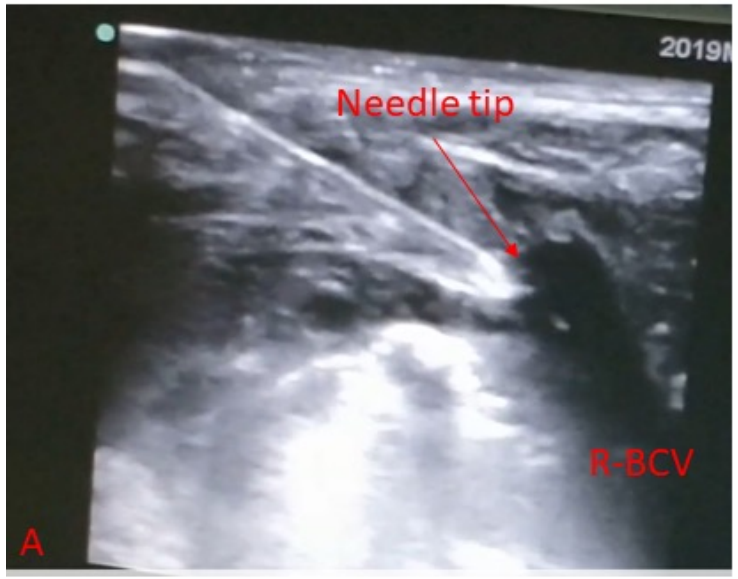
Tip location protocol:

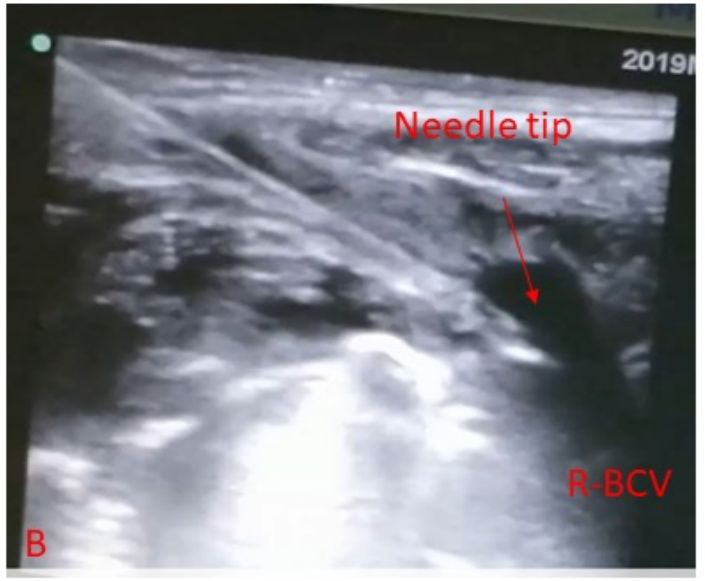
Probe: Small sectorial probe, 7-8 MHz

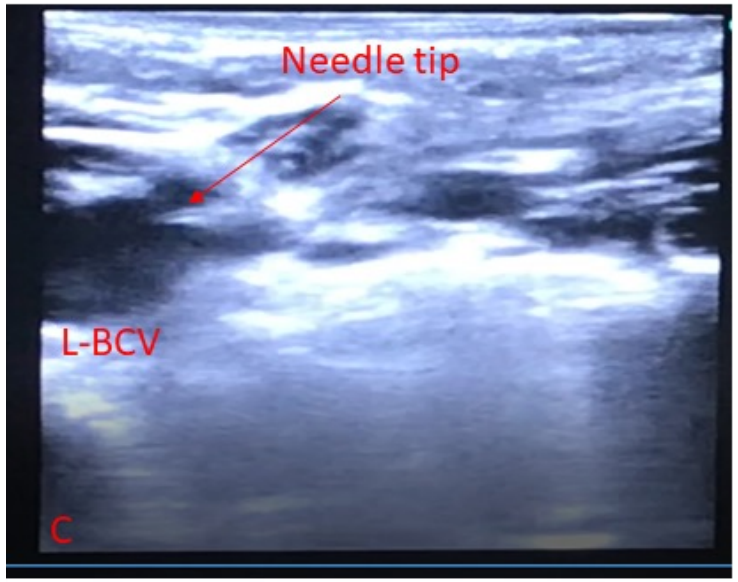
Acoustic windows: three different windows are recommended to locate accurately the tip of the catheter. The most useful ones are the subcostal longitudinal view ('bi-caval' view), the four-chamber apical view, and the long axis view of SVC.

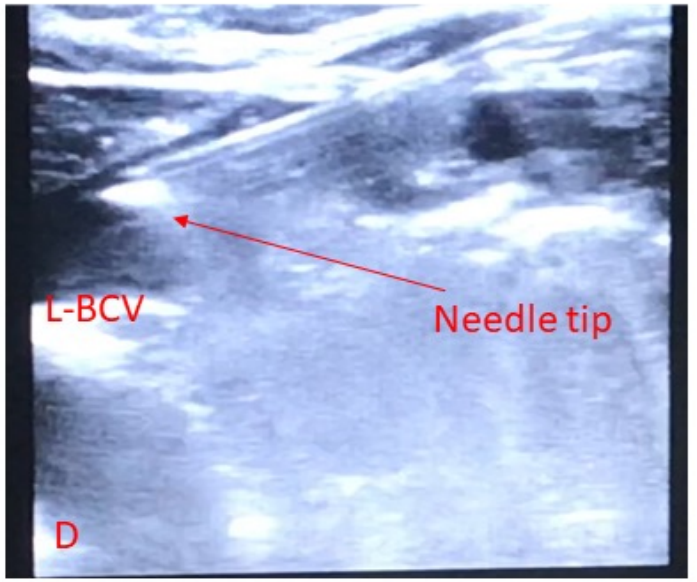
Procedure**:** follow the catheter tip until it reaches the target zone, i.e., the transition between SVC and RA. A small flush of normal saline (0.5-1 ml) may help confirming the tip position.

Tip navigation 1

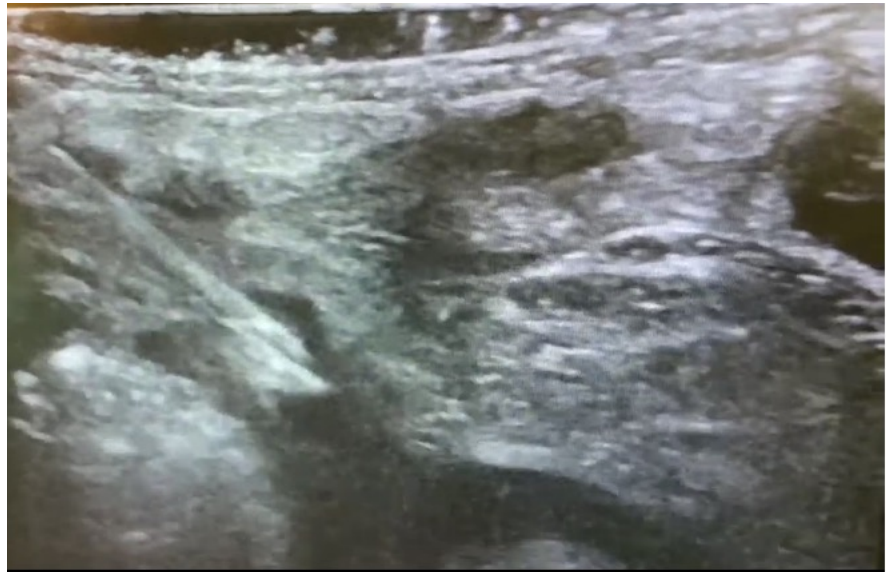


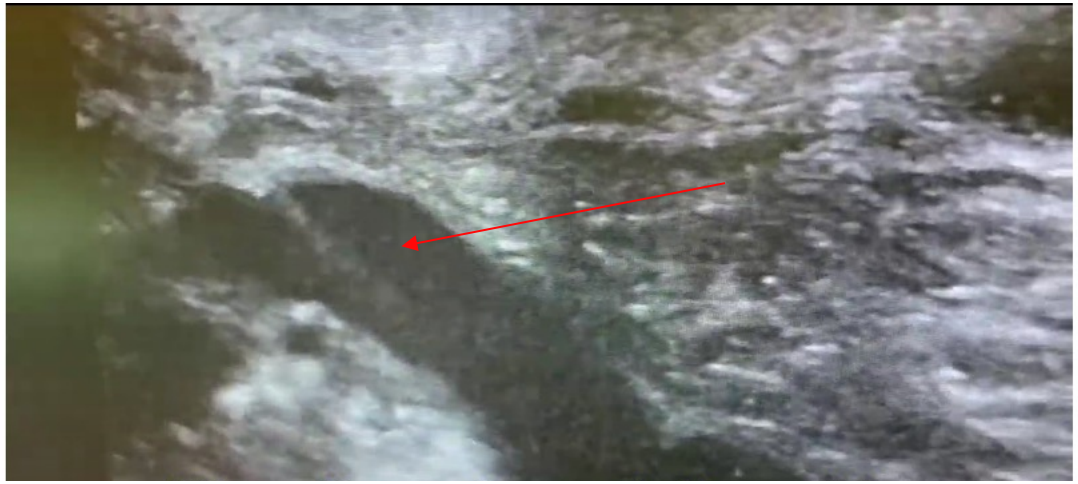


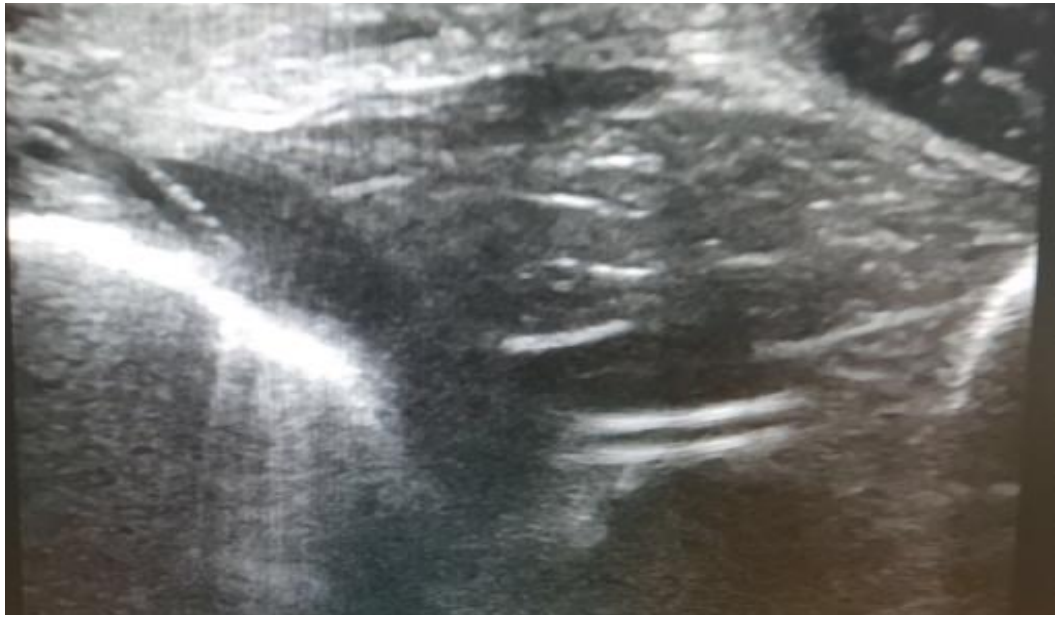




Tip navigation 2





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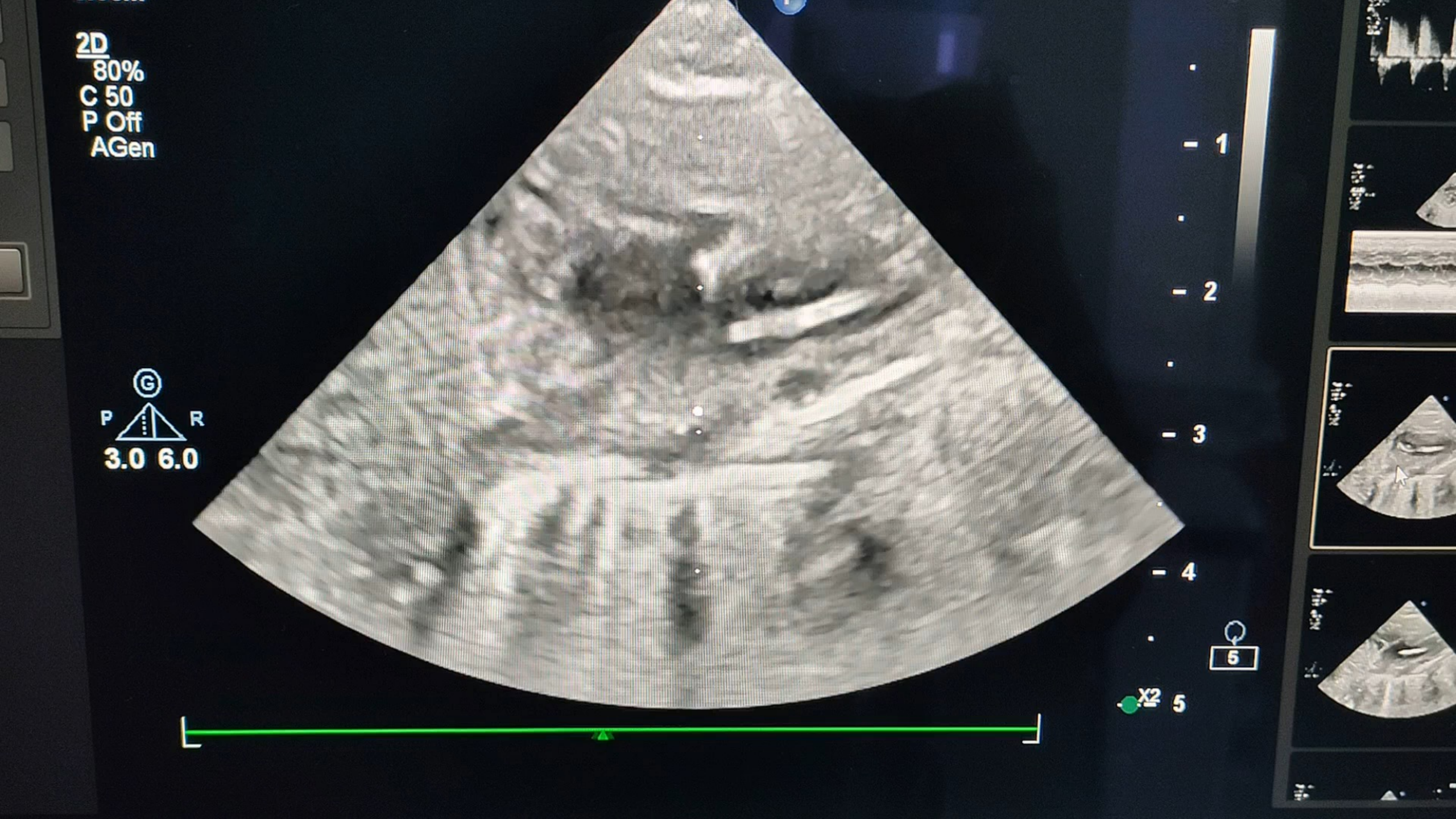
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Neo-ECHOTIP for FICC

1. Tip navigation protocol:

   Probe: linear 'hockey stick' probe, 10-14 MHz

   Acoustic window: **RaFeVa**

   Procedure: During FICC placement, the femoral vein should be clearly visualized.

- the needle is visualized during the venipuncture
- the guidewire is visualized as it passes through the femoral vein (long axis).
- the micro-introducer is visualized inside the femoral vein
- the catheter is visualized inside the femoral vein and then inside the iliac vein.

Tip location protocol - A:

Probe: Small sectorial probe, 7-8 MHz

Acoustic window: subcostal longitudinal view. It's mandatory to visualize properly the IVC.

Procedure**:** the catheter tip is visualized as it passes through the IVC.

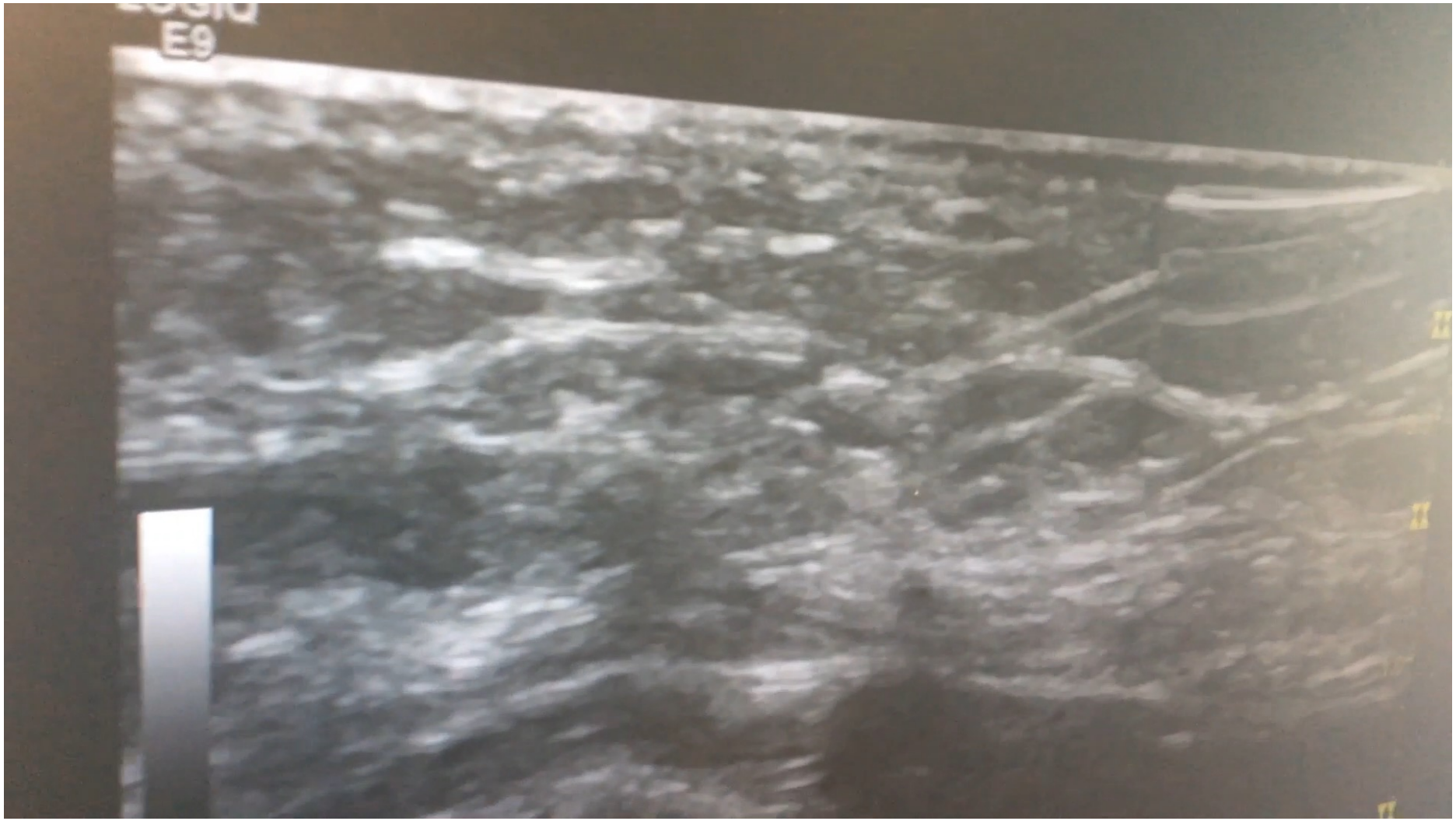
If hemodynamic monitoring is not required, the catheter tip of the FICC is placed below the renal veins

Tip location protocol B:

Probe: Small sectorial probe, 7-8 MHz

Acoustic window: subcostal longitudinal view, so to visualize IVC and RA**.**

Procedure**:** the catheter tip is visualized as it reaches the target zone, i.e., the transition between IVC and RA. A small flush of normal saline (0.5-1 ml) may help visualizing the tip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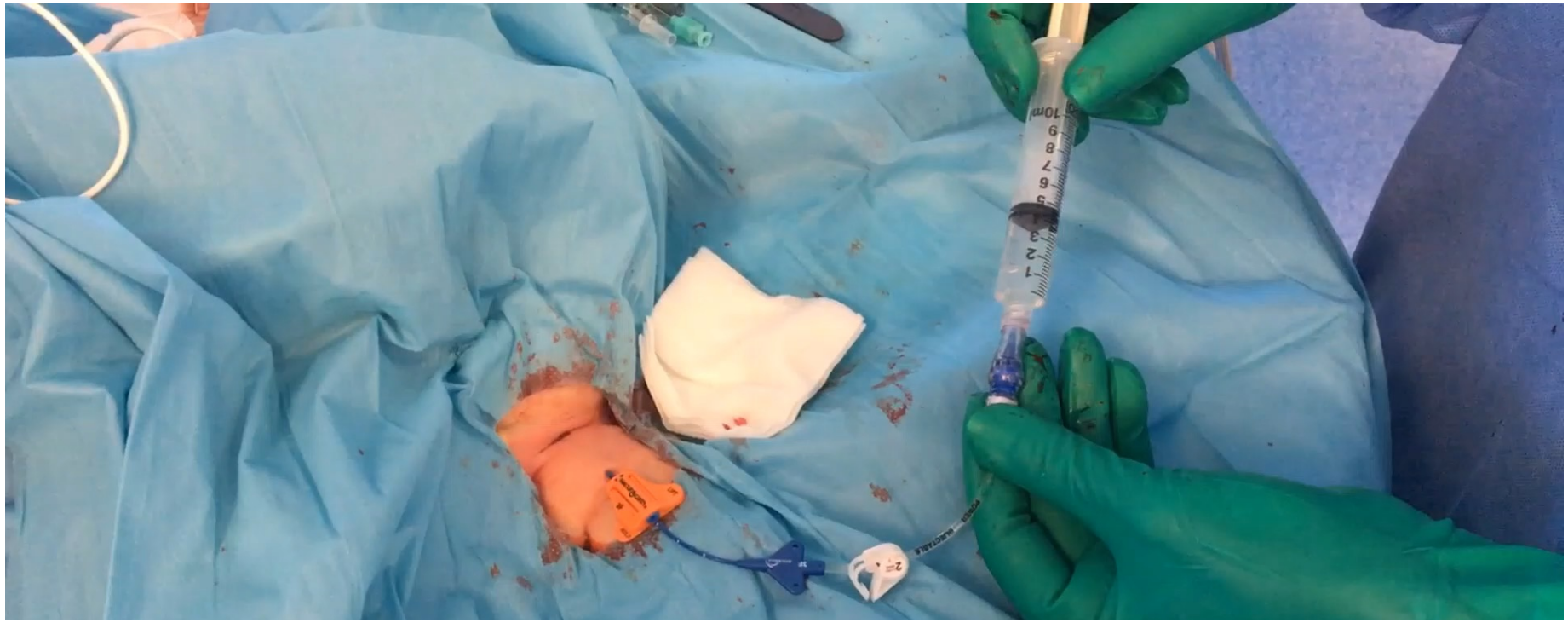
Bi-Caval view

Bi-Caval view



The intracavitary ECG method for tip location of ultrasound-guided centrally inserted central catheter in neonates

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Abstract

Background: The correct position of the tip of a central venous access device is important in all patients, and especially in neonates. The traditional method of tip location (approximated intra-procedural length estimation + post procedural chest X-ray) is currently considered inaccurate and not cost-effective by most recent guidelines, which recommend the adoption of tip location by intracavitary electrocardiography (IC-ECG) whenever possible.

Methods: This study prospectively investigated the applicability, the feasibility, the accuracy, and the safety IC-ECG for tip location in neonates requiring insertion of ultrasound-guided centrally inserted central venous catheters (CICCs) with caliber 3Fr or more. All catheter tip locations were verified using simultaneously both IC-ECG and ultrasound-based tip location, using the Neo-ECHOTIP protocol.

Results: A total of 105 neonates were enrolled. The applicability of IC-ECG was 100% since a P wave was evident on the surface ECG of all neonates recruited for the study. The feasibility was also 100% since an increase of the P-wave was detected in all cases. The accuracy was also 100%, since a perfect match between IC-ECG based tip location and ultrasound-based tip location was found. There were no adverse events directly or indirectly related to the IC-ECG technique; no arrhythmias occurred.

Conclusions: When applied to ultrasound guided CICCs, tip location by IC-ECG is applicable and feasible in neonates, and it is safe and accurate.

Keywords

Conclusions

- Neo-ECHOTIP protocol is **stepwise and standardized procedure**, potentially useful to perform both ultrasound based **tip navigation and tip location**, in all central venous access devices currently used in NICU
- **It's based on evidences from many published clinical studies**.
- The extensive use of real time US in NICU is crucial **to reduce the incidence of primary malposition.**
- Some of these maneuvers are easy and require only a minimal training, while some others imply a well trained operator.
- Current evidence and common sense suggest that ultrasound-based tip location will have an **increasingly important role for CVAD in NICU**, considering its many advantages in terms of accuracy, cost-effectiveness and safety


THANK YOU
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