



## **Dr. Chiara Gori**

Anesthesia and Intensive Care

UOSD Shock and Trauma, San Camillo-Forlanini Hospital, Rome (Italy)

[chiaragori.doc@gmail.com](mailto:chiaragori.doc@gmail.com)

[cgori@scamilloforlanini.rm.it](mailto:cgori@scamilloforlanini.rm.it)



**Diagnostic accuracy, inter-rater variability and learning curve of  
three echocardiographic views for the tip location in adults:  
a prospective observational cohort study**

WOCOVA   
7th World Congress on Vascular Access

# TIP LOCATION

---

- Intra-cavitary ECG (Ic-ECG) is the standard of care for tip location of central venous catheters
- Ic-ECG is not applicable in patients with active pacemaker or supraventricular arrhythmias
- Ultrasound-based tip location has been proposed as alternative in these cases

# AIMS OF THE STUDY

---

- Accuracy of bicaval subcostal window, subcostal 4-chamber window and apical 4-chamber window for the ultrasound tip location in the adult patient compared with the Ic-ECG method
- Inter-operator variability during echocardiography

# METHODS

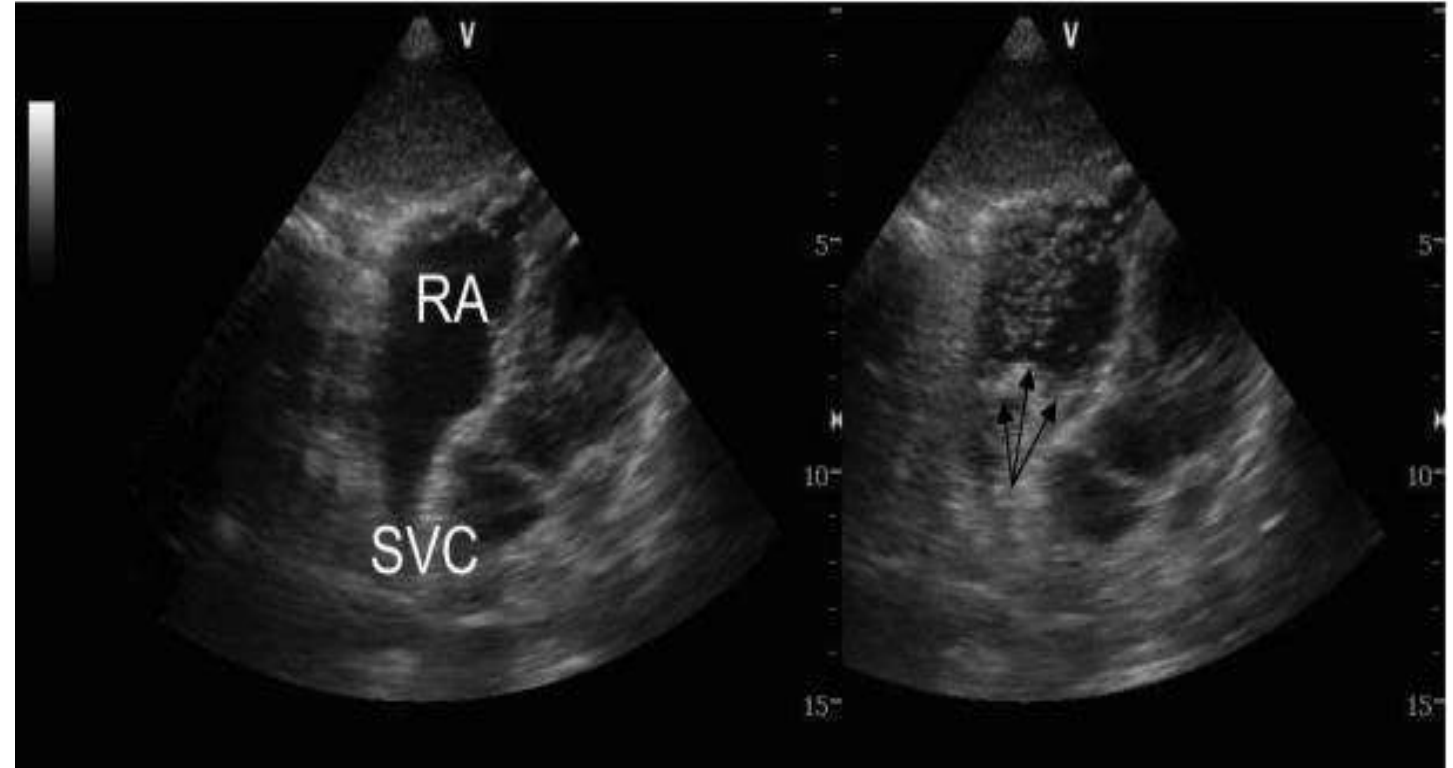
---

- Multicentre observational prospective cohort study conducted from June to October 2021
- All adult patients undergone ultrasound-guided CVC (central venous catheter) insertion and given informed consent were included
- The tip location was evaluated with transthoracic echocardiography (TTE) through bubble test using the three echocardiographic views and then compared with the Ic-ECG

# BUBBLE TEST

## MICROBUBBLING TEST

- 10 mL syringe containing 9 mL of saline solution and 1 mL of air, mixed with a 3-way stopcock to obtain a homogeneous solution
- Injection of 5 mL bolus through the distal lumen of the catheter and observed the pattern of micro-bubbles flow entering the RA (right atrium)



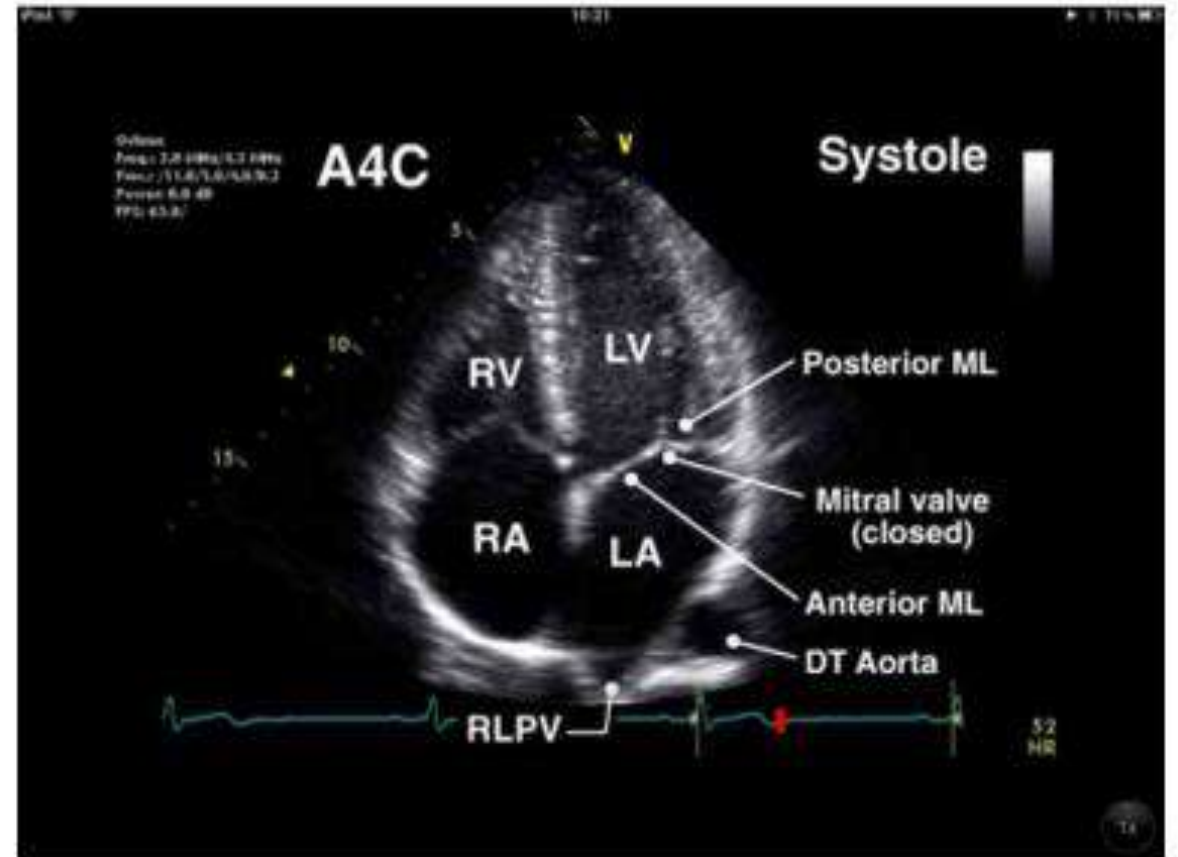
# INTERPRETATION OF MICROBUBBLING TEST

---

CHARACTERISTICS	INTERPRETATION
No bubbles	Possible extravascular or extracardiac misplacement
Few bubbles or appearance > 1 sec for CICC or > 2 sec for PICC	Intravascular misplacement in neck veins or too far from cavoatrial junction
Turbulent flow or direct visualization of catheter tip in RA	Intracardiac misplacement
Linear flow appearance < 1 sec for CICC or < 2 sec for PICC	Correct tip position

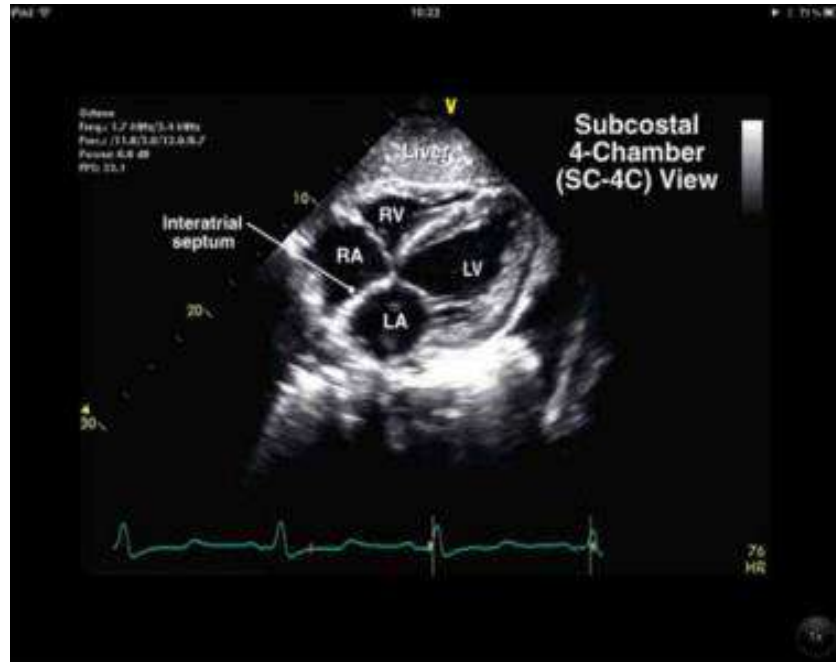
# APICAL 4-CHAMBER VIEW (TTE)

- The apical four chamber view is found by placing the transducer on the apex of the heart, near the apical impulse, at the left fifth intercostal space
- The left and right cavities of the heart and their respective atrio-ventricular valves are found in the right and left regions of the image, respectively
- The left ventricle is on the top right with the left atrium opening into it through the mitral valve, and the right ventricle is on the left side with the right atrium opening into it through the tricuspid valve

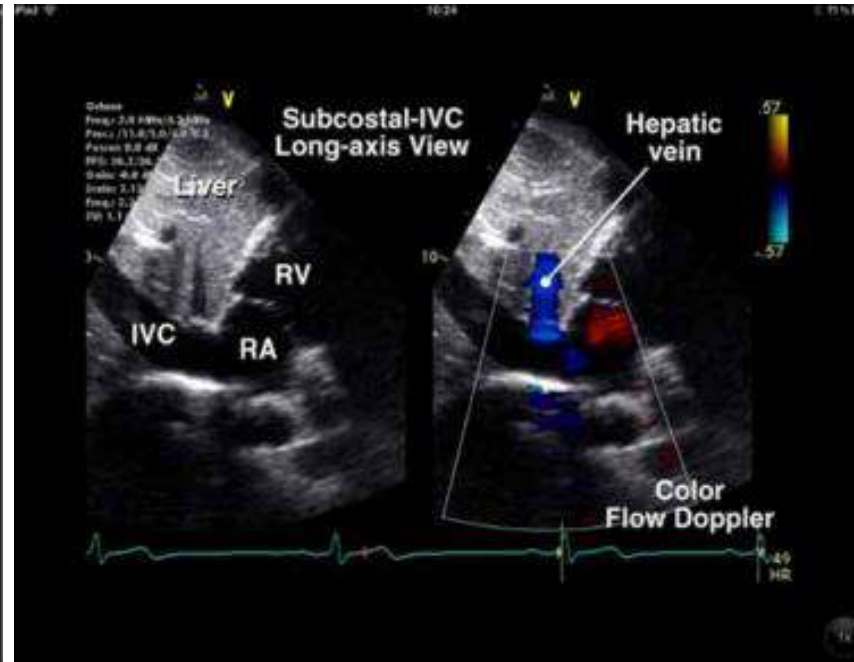




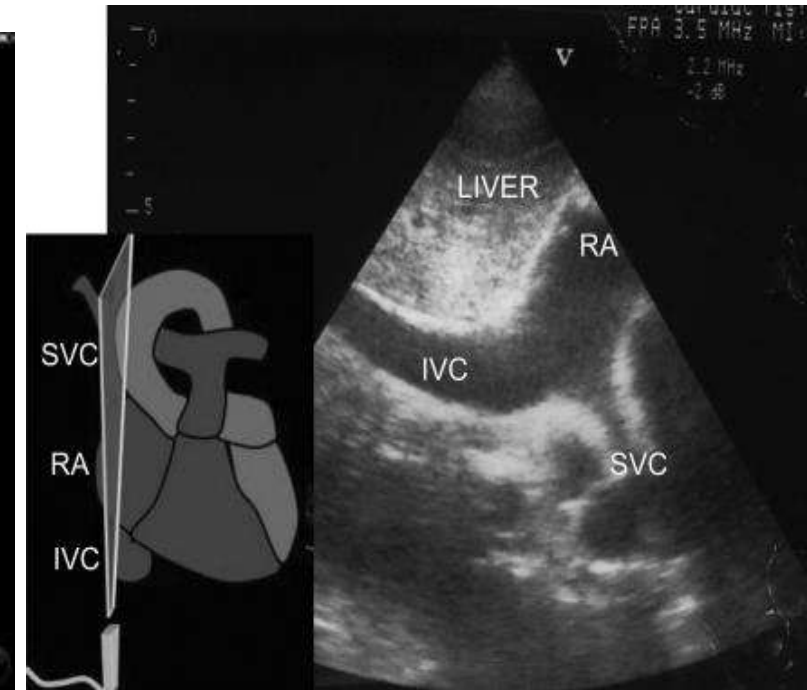
# SUBCOSTAL VIEWS (TTE)



Subcostal 4-chamber view



Subcostal 4-chamber view with IVC long-axis view



Subcostal bicaval view

- Place the transducer beneath the xiphoid, slightly to the right of the sternum
- The subcostal window has many advantages, because there is no bone or lung tissue to obstruct the heart
- Best evaluation of right side cavities

# STATISTICAL ANALYSIS

---

- Continuous variables were expressed as mean  $\pm$  SD. Categorical variables were expressed as relative frequencies (No)
- Bland–Altman analysis was performed to interpret the differences between the measurements and the agreement between Ic-ECG and ultrasonography (US)
- ROC analyses and AUC (Area Under the Curve) were performed to evaluate and compare test sensibility and test specificity.
- Shapiro-Wilk test was performed for normal distribution variables
- All analyses were conducted with STATA software 17/BE

# RESULTS

- Fifteen patients were enrolled
- Only one misplacement occurred and was diagnosed by apical 4-chamber view
- Complications like pneumothorax, arterial puncture and arrhythmias were not observed
- 9 patients were mechanically ventilated
- Ultrasound guided CVC insertion

<b>N.PATIENTS</b>	<b>15</b>
<b>AGE</b>	42 ( $\pm 18,4$ )
<b>BMI</b>	27,5 ( $\pm 6,06$ )
<b>SAPS II</b>	57,3( $\pm 21.8$ )
<b>MECHANICAL VENTILATION (No)</b>	9/15
<b>CAUSE OF ADMISSION (No)</b>	
Polytrauma	9/15
Cardiac Arrest	2/15
Sepsis	1/15
Neurological Injury	3/15
<b>TYPE OF ACCESS (No)</b>	
Internal Jugular Vein	8/15
Axillary vein	5/15
Axillary vein (brachial tract)	3/15
<b>CATHETER MISPLACEMENT (No)</b>	1/15
<b>CATHETERS (No)</b>	
CICC	12/15
PICC	3/15

# RESULTS

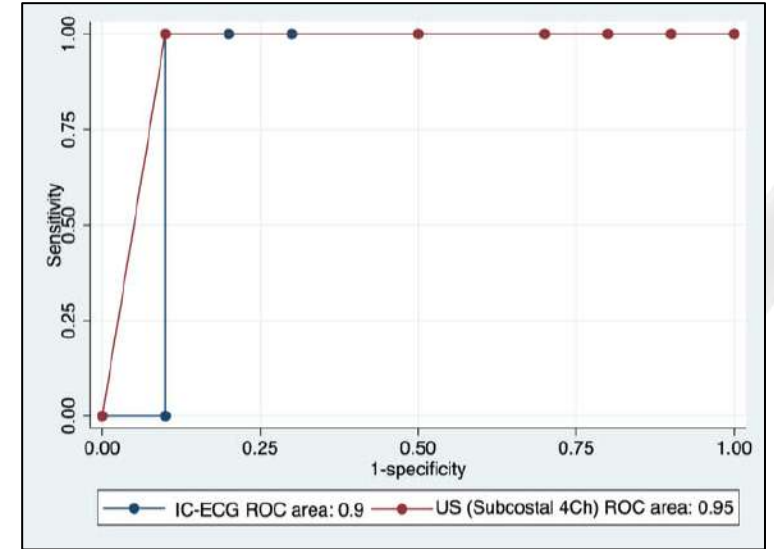
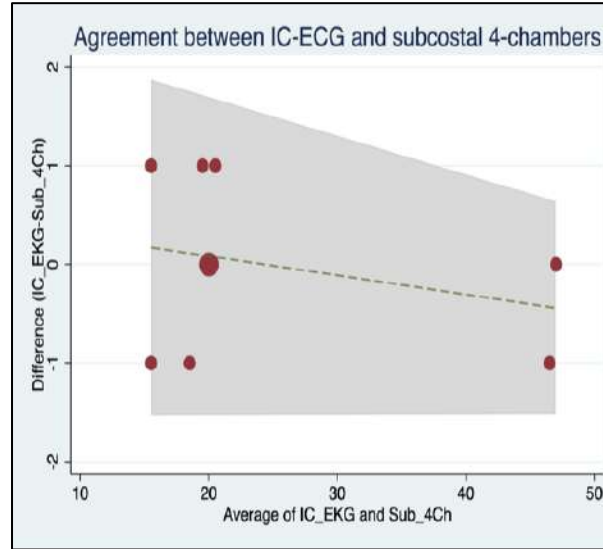
- The subcostal 4-chamber view was the **most easily** obtained (87%), with a steep learning curve and the best agreement.  
7/13 patients were **mechanically ventilated**
- Apical 4-chambers and subcostal bicaval views were obtained in 80% and 60% of cases respectively. All the patients in whom the apical 4-chamber view was not performed were in spontaneous breathing, one of them with COPD
- Half of patients in whom subcostal bicaval view was not obtained were in mechanically ventilated; in those it was obtained, **6 were mechanically ventilated**, 3 were in spontaneous breathing
- Ic-ECG was not performed in two patients: one with a pacemaker rhythm and one with atrial fibrillation rhythm.
- Ic-ECG and subcostal 4 chamber view were performed in the same percentage

	IC-ECG (sec)	US (min)
<b>Mean Time (+/-SD)</b>	58.2 (4.8)	3.9 (1.1)

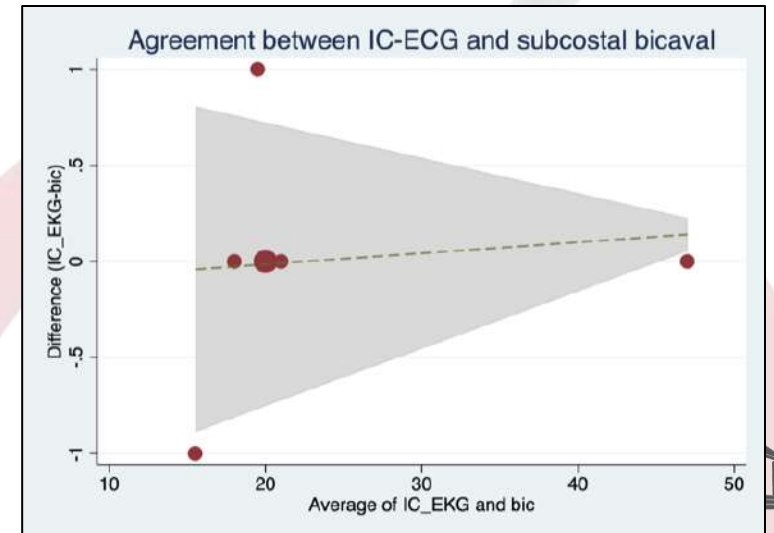
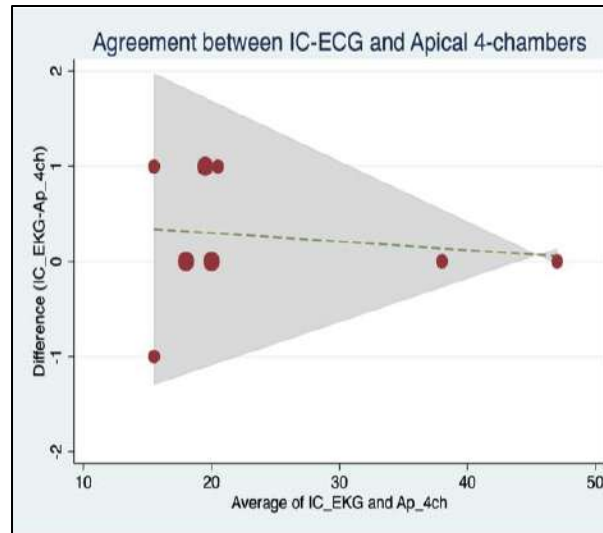
	PATIENTS N.	%
<b>IC-ECG</b>	13/15	87%
<b>Subcostal bicaval view</b>	9/15	60%
<b>Subcostal 4-chamber view</b>	13/15	87%
<b>Apical 4-chamber view</b>	12/15	80%

# RESULTS

The **subcostal 4-chambers view** showed the **highest sensitivity** and the **best agreement** with Ic-ECG



The **subcostal bicaval view** has more values **around «zero»** that is the maximum level of agreement



# DISCUSSION

---

- At least one of the three echocardiographic views was feasible in **all patients** enrolled
- All of three echocardiographic windows were obtained in **more than half of patients**
- Smit et al (**TTE in 2548 patients**) meta-analysis → **high specificity** (98.9%) with sensibility rate of 68.2%
- **Ultrasound** is an **effective** tip location method and it can be feasible in patients where Ic-ECG can not be performed
- During central vein catheterization, catheter misplacement was verified by the **absence of microbubbling test** and confirmed by the ultrasound neck veins where the catheter was → intra-procedural tip location: less discomfort for the patient, no further central vein catheterization
- Subcostal views → **best feasibility** in mechanically ventilated patients (less affected by ventilation?)
- Bicaval subcostal view → **more accuracy** in tip displaying in cavoatrial junction

# CONCLUSIONS

---

- The **TTE** with bubble test is a **safe** and **accurate bedside** method for tip location
- TTE can be easily applicable in most patients, even in those where the IC-ECG cannot be used
- The **subcostal-4-chamber view** seems to be the **easiest to identify**, especially in ventilated patients
- Further samplings will be needed to confirm these preliminary results and to investigate inter-operative echocardiographic variability