



GAVeCeLT
Gli Accessi Venosi Centrali a Lungo Termine



The state of the art of tip location

Antonio LaGreca
Catholic University, Rome, Italy

Why is the position of the tip of
central lines so important?

Inappropriate position

=

increased rate of
complications

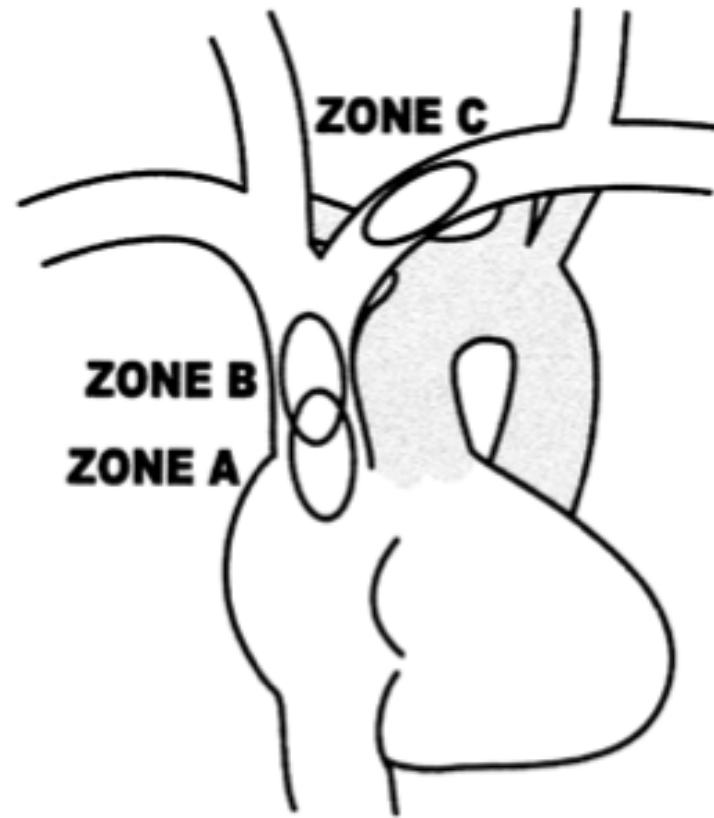
Why is the position of the tip of central lines so important?

Too short:

venous thrombosis
malfunction

Too long:

arrhythmias
tricuspid damage



Fletcher & Bodenham, BJA 2000

Zone A (low SVC/upper right atrium). This is a suitable tip site from any access point in the upper body. We believe catheter tips can be sited safely within the upper right atrium provided they do not abut the atrial wall end-on or pass through the tricuspid valve or into the coronary sinus.^{6 13 20 25 26}

Zone B (upper SVC). This is a suitable site for tips of catheters placed via the right internal jugular route.^{9 10}

Zone C (mid-point, left innominate vein). This is a suitable site for the tip when the catheter is introduced from the left internal jugular or subclavian vein, and reduces the risk of SVC perforation.¹¹

Best position(s) – F&B's zone A

In the lower third of SVC

i.e.: where the SVC is wrapped by the pericardial reflexion

Catheter runs vertically in this tract

On x-ray: 1 -3 cm below the tracheal carina

At the cavo-atrial transition

'oblique', not trasversal junction...

On x-ray: approximately 3 cm below the tracheal carina

In the upper part of right atrium

'safe' area of right atrium

On x-ray: 3 – 5 cm below the tracheal carina

‘tip location’

- Methods to verify that the tip of the catheter is in the desired position (for most central lines, this corresponds to the CAJ)
- The method of ‘tip location’ must be precise enough to allow a safe use of the central line, considering that the tip is verified to be in the correct site.

'tip location' methods

DURING THE INSERTION

- Intracavitary ECG
- Fluoroscopy
- Ultrasound/echocardiography (TTE,TEE)

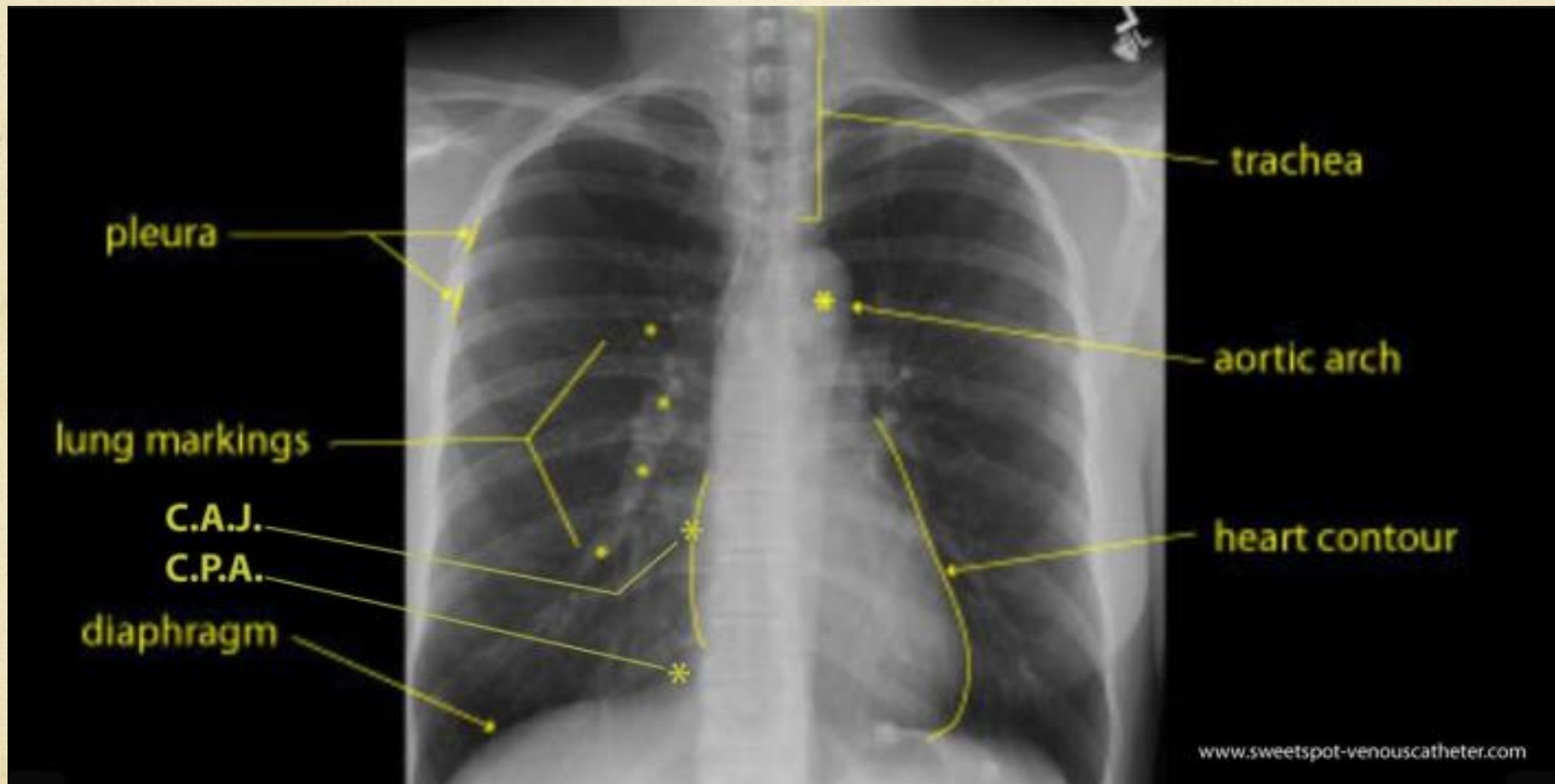
AFTER INSERTION

- Chest x-ray
- CT, MR, angiography
- Echocardiography (TTE)

Radiology for tip location

Control of tip position: radiology

Anatomy of the Frontal Chest X-Ray





UNIVERSITÀ
CATTOLICA
del Sacro Cuore

Control of tip position radiology



1a. Axillary

1b. Brachiocephalic

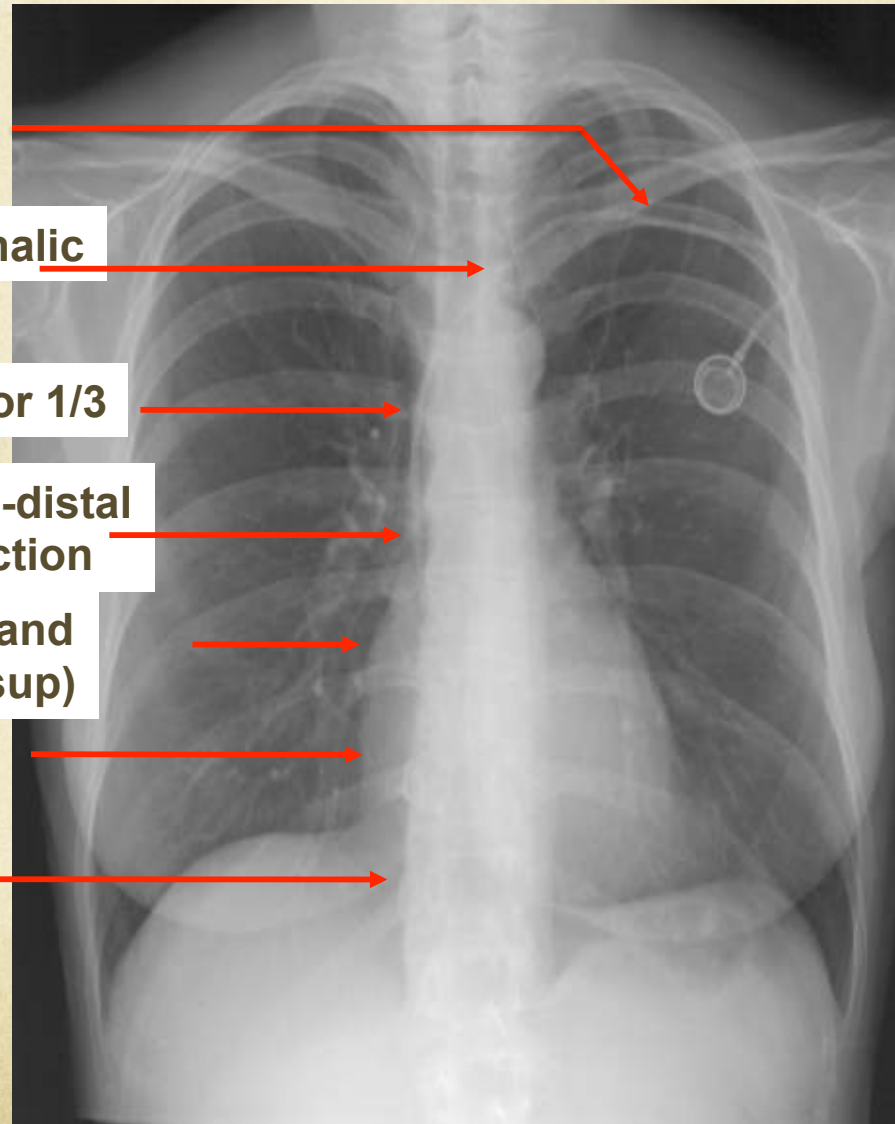
1c. SVC, superior 1/3

2. SVC, medium-distal
1/3 and junction

3. RA (junction and
superior 1/3 sup)

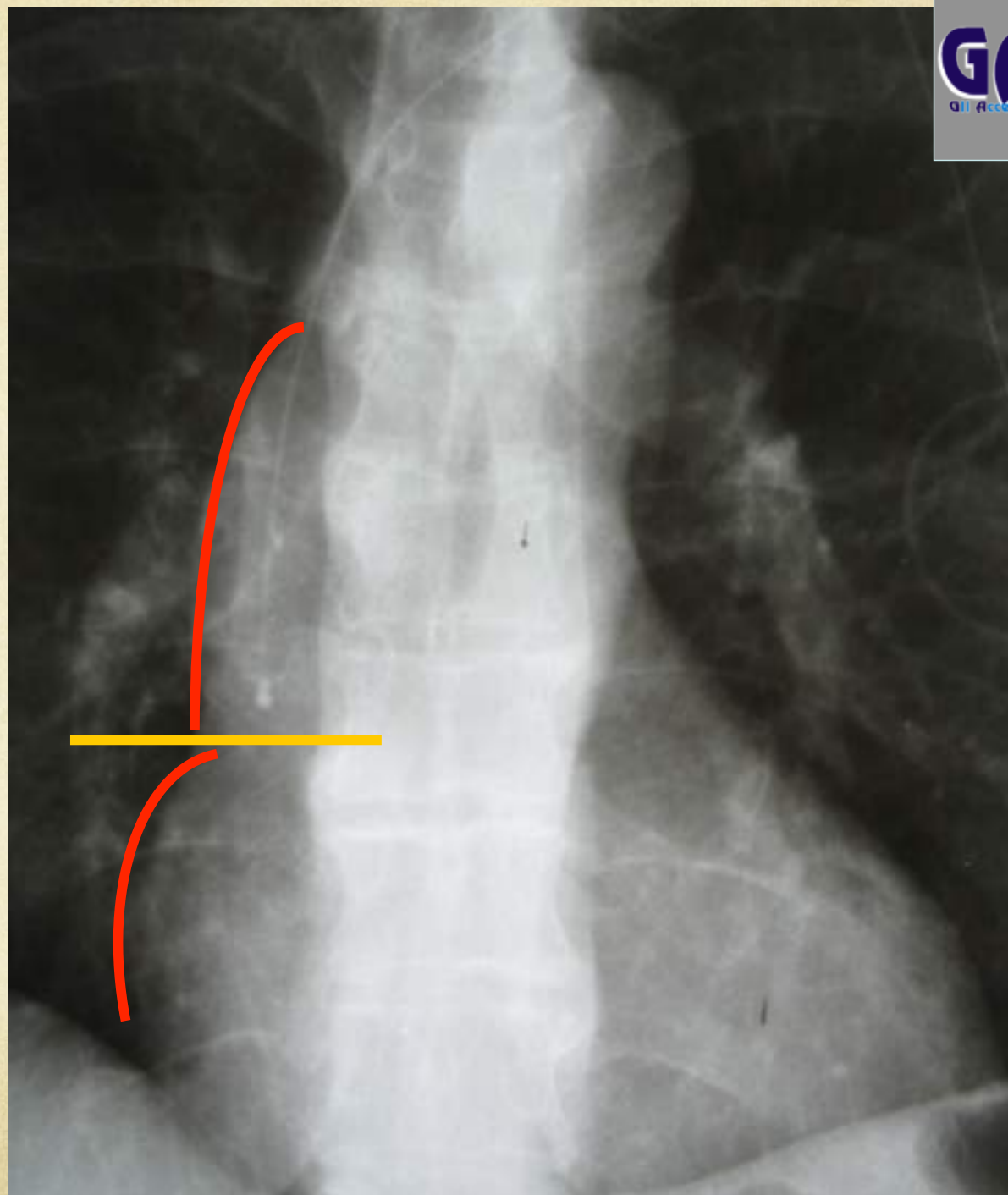
4. Deep atrium

5. IVC



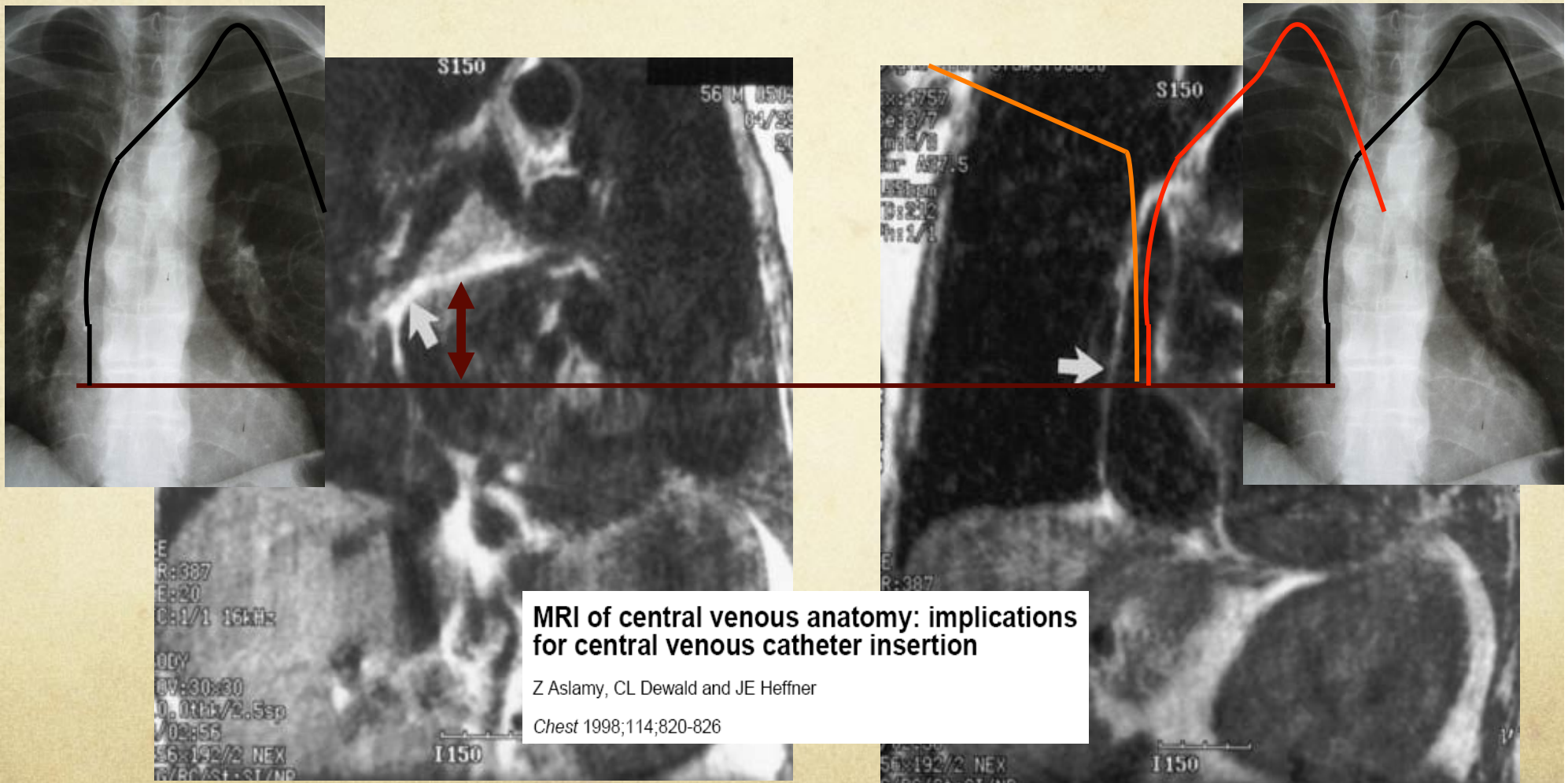
Anatomy of the Frontal
Chest X-Ray





Accuracy of radiological landmarks

In 38% of patients, the cranio-lateral radiological “right” cardiac silhouette is made by the left atrial shadow. As a result, the tip of well-positioned catheters may appear well within the cardiac silhouette and then seem “too long” (Aslamy, Chest 1998);



Accuracy of radiological landmarks

Comparison of radiographic landmarks and the echocardiographic SVC/RA junction in the positioning of long-term central venous catheters

Acta Anaesthesiol Scand 2006; 50: 731–735

Printed in Singapore. All rights reserved

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Conclusion: Both the radiographic SVC/RA junction and the thoracic vertebral bodies are not reliable landmarks for the SVC/RA junction defined by TEE. Physicians should be aware that using the radiographic SVC/RA junction to confirm proper positioning of permanent central venous catheters risks placing the catheter tip in the upper SVC, with subsequent potential long-term complications. More reliable radiographic landmarks for the SVC/RA junction should be investigated.

Parallax

Anatomical variations

Antero-posterior

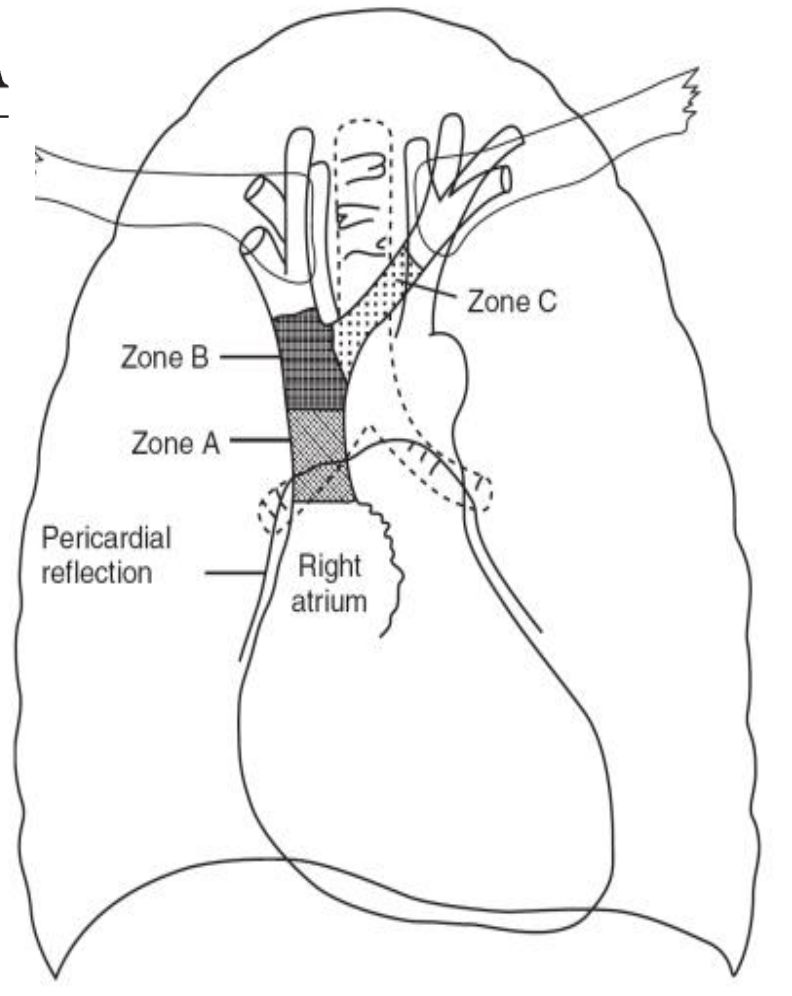
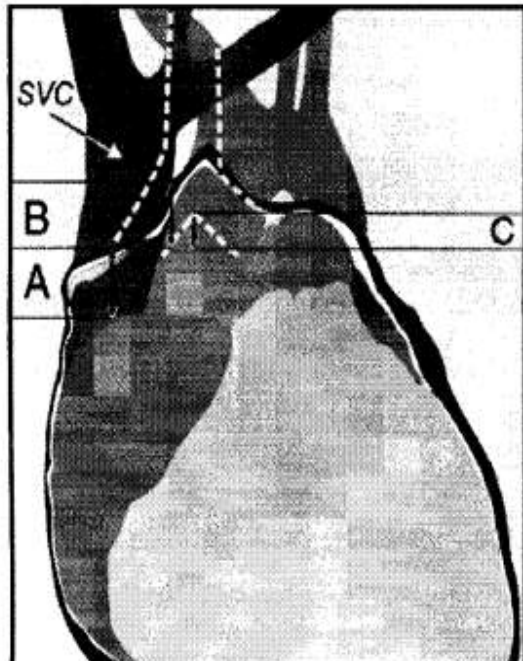
Accuracy of radiological landmarks

British Journal of Anaesthesia 96 (3): 335–40 (2006)
doi:10.1093/bja/aei310 Advance Access publication January 16, 2006

BJA

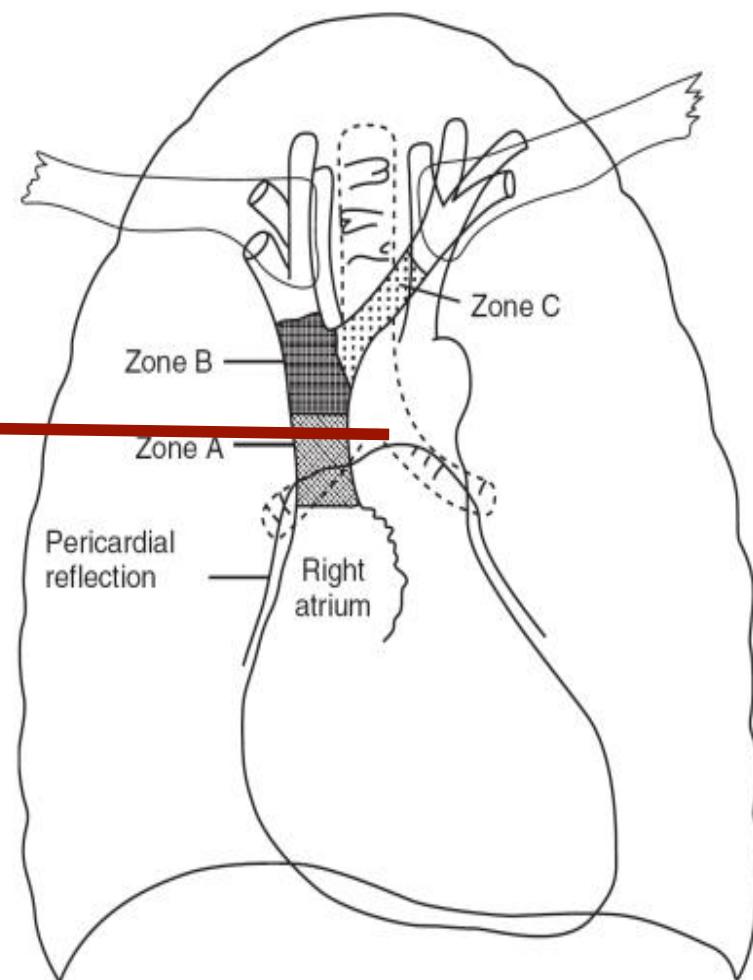
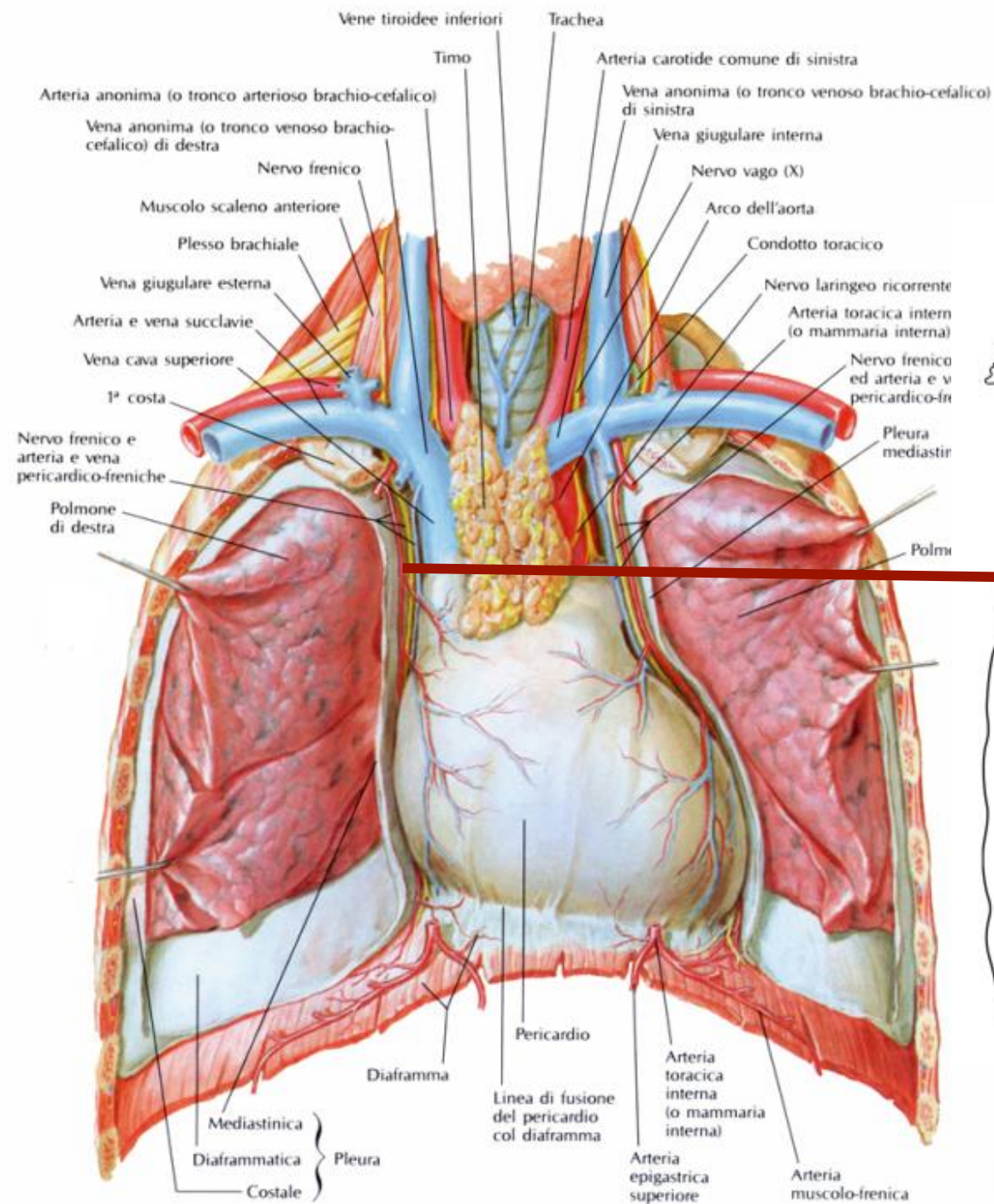
The carina as a radiological landmark for central venous catheter tip position

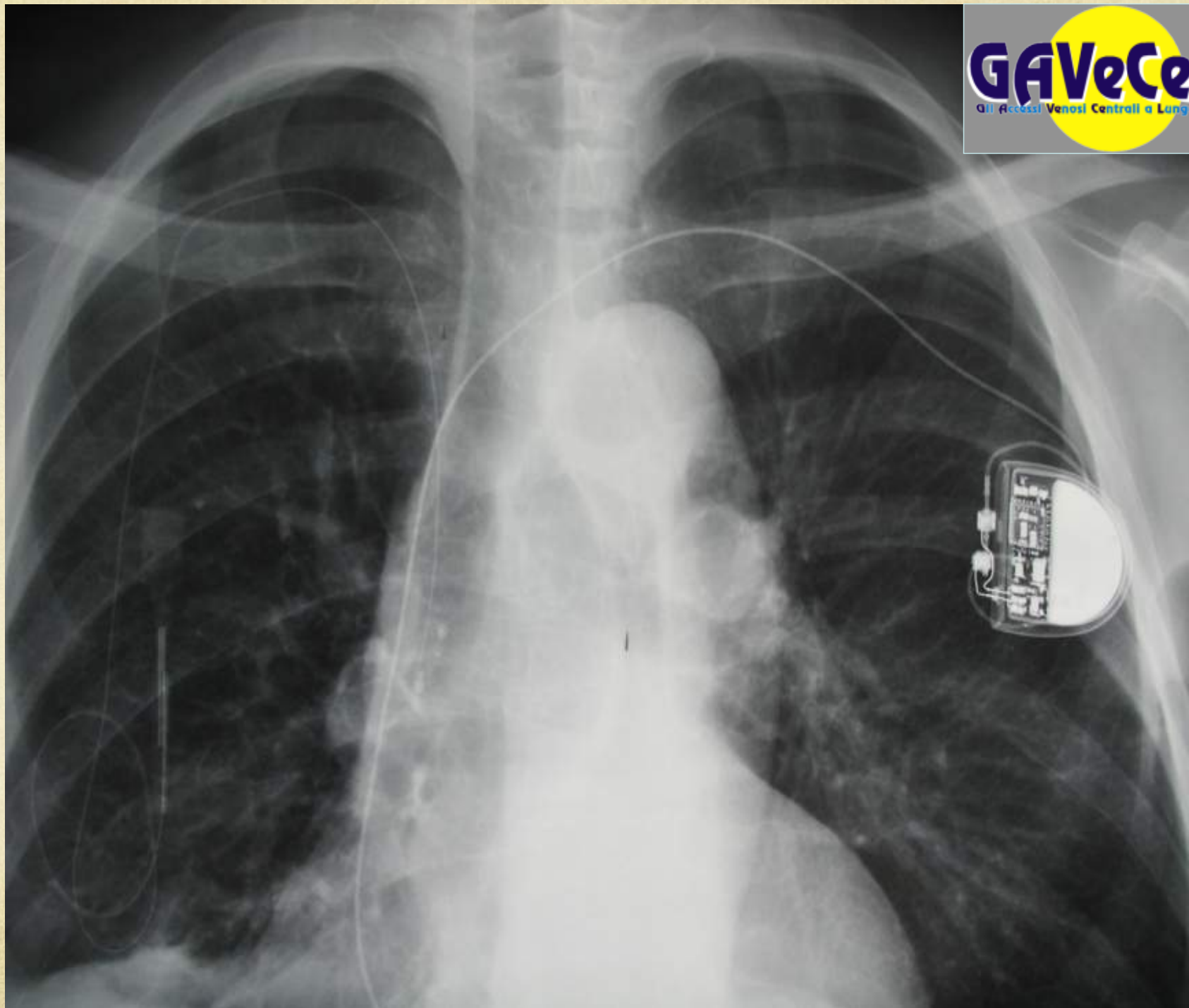
P. A. Stonelake and A. R. Bodenham*

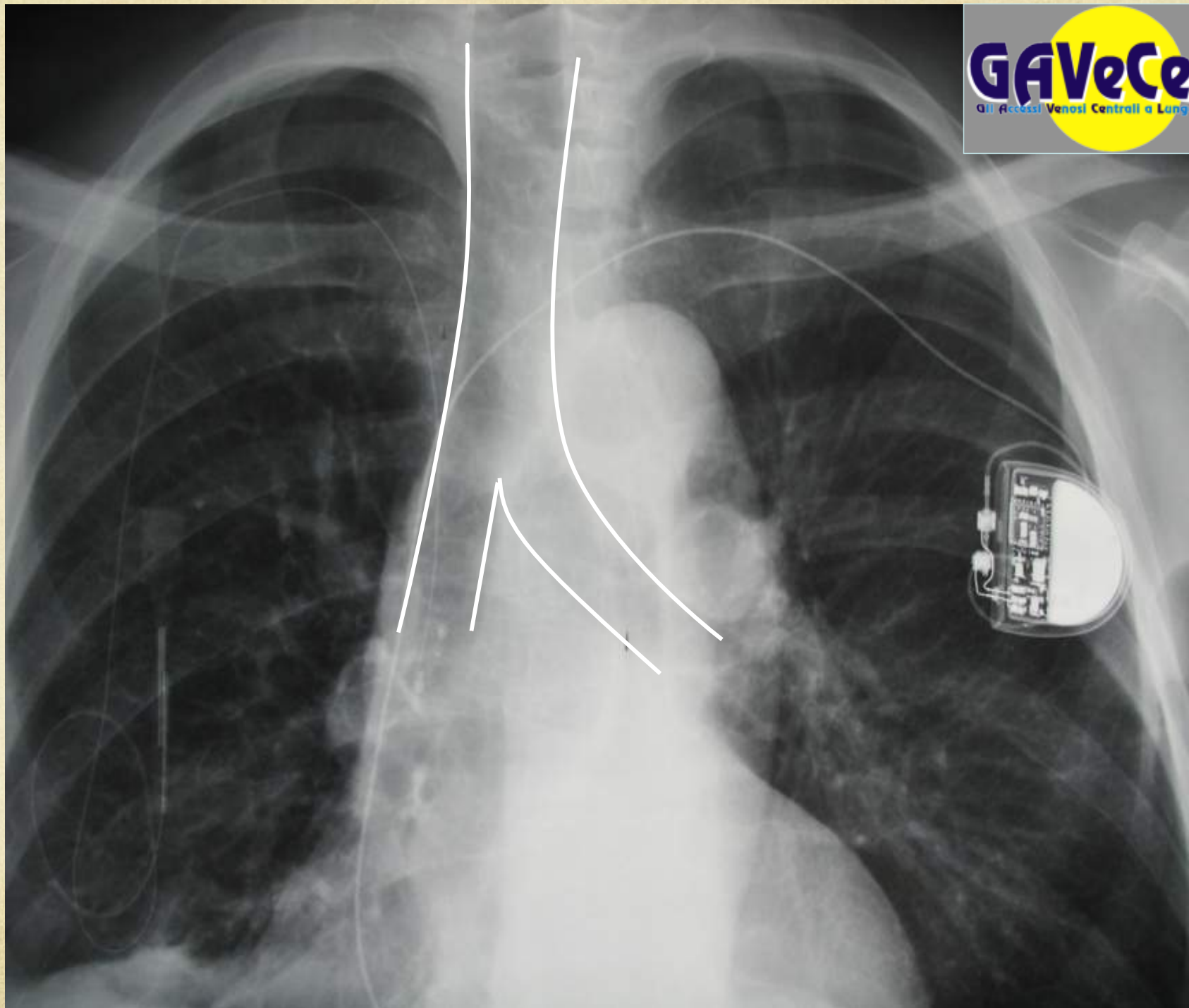


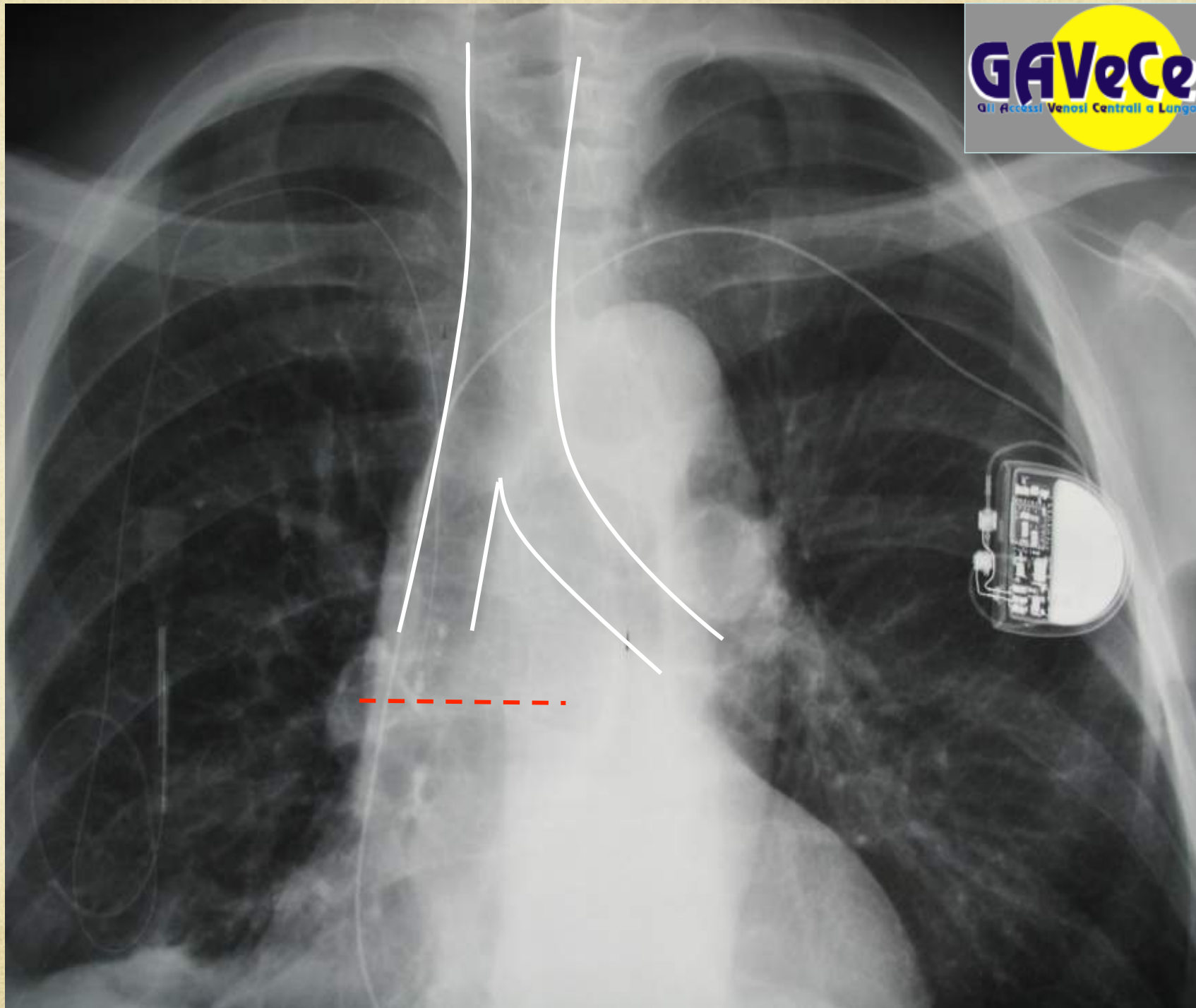
Schuster M

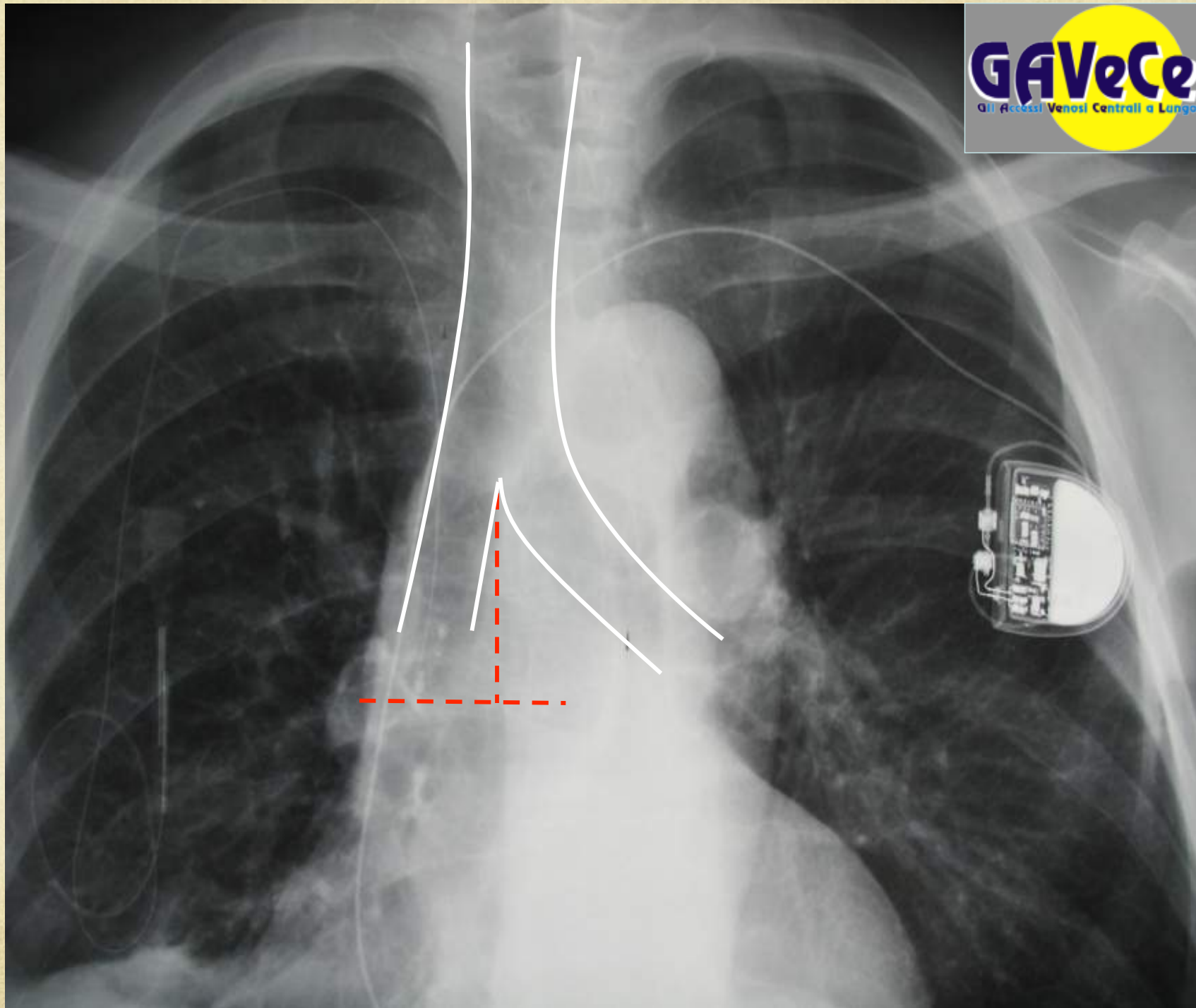
The carina as a landmark in central venous catheter placement, BJA 2000











The carina landmark

The most reliable, repeatable and objective criteria for defining the position of the CAJ

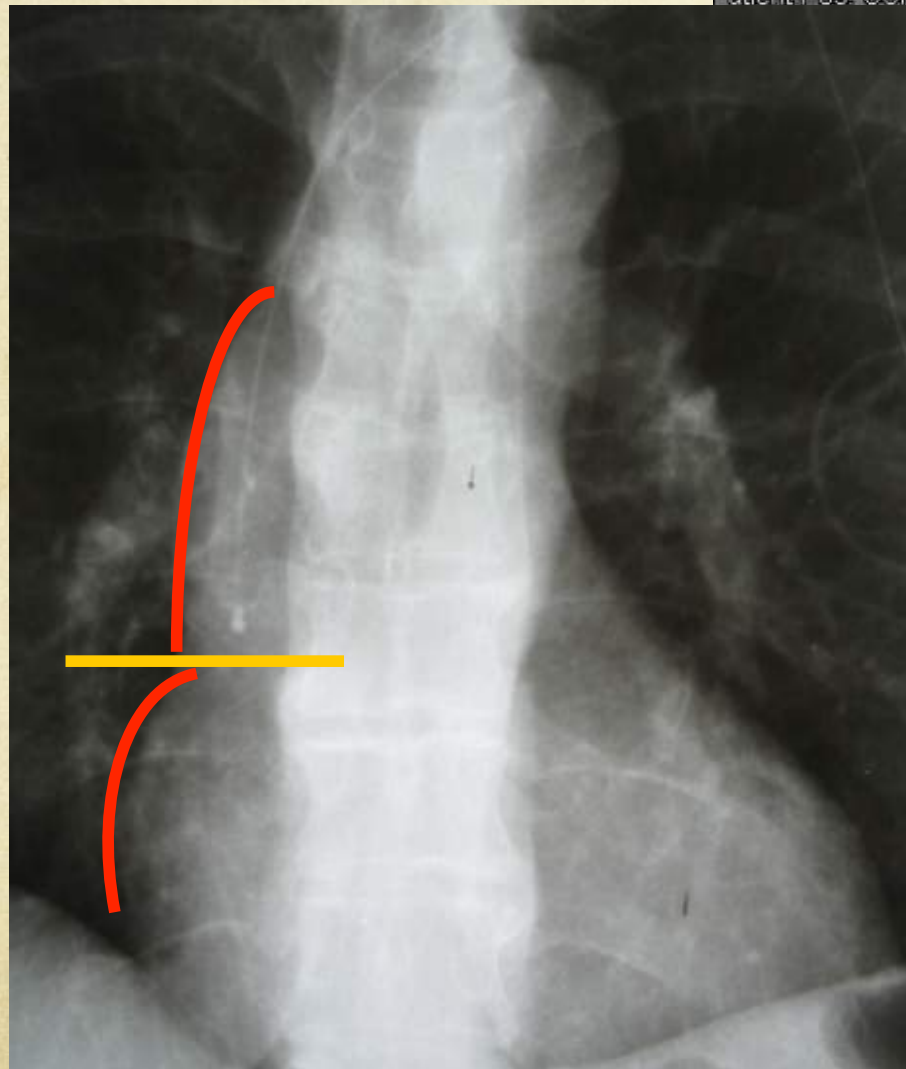
1 cm below the carina (neonates)

1-2 cm below the carina (1mo-3yr)

1.5-3 cm below the carina (4yr-11yr)

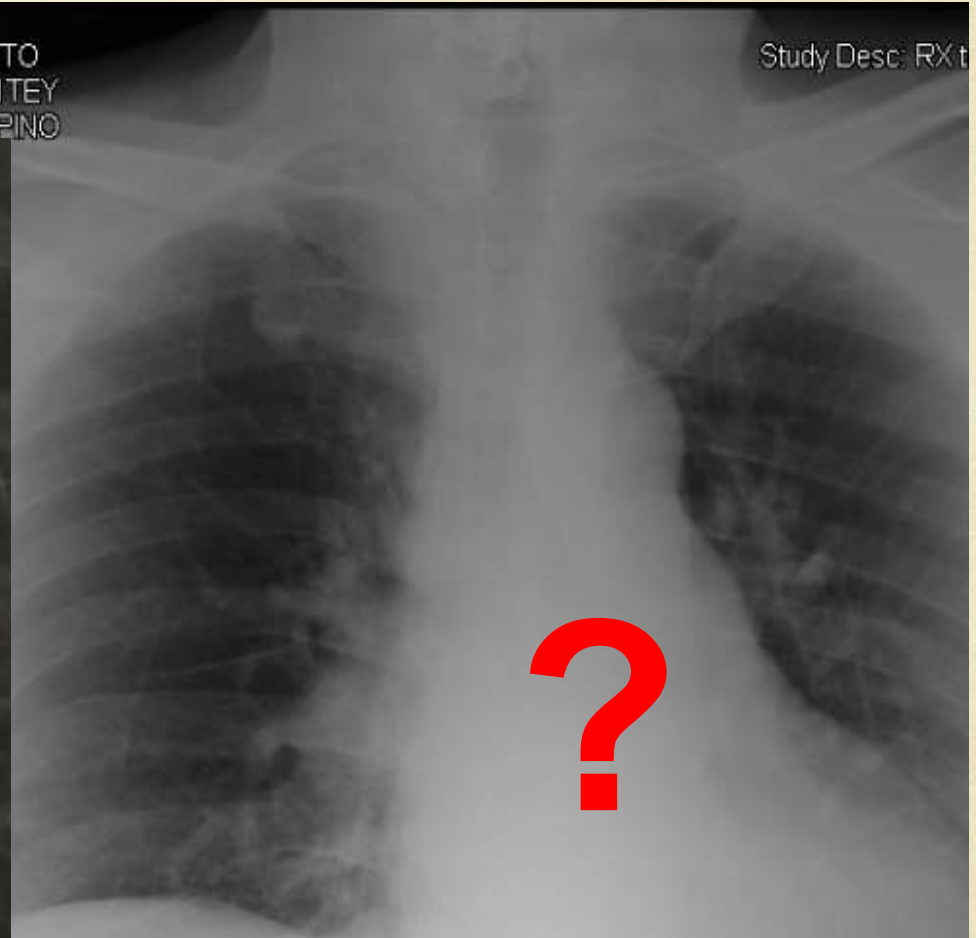
2-4 cm below the carina (> 12yr)

Accuracy of radiological landmarks



1-1
TORACE A LETTO
Acc#IU1138UT1TEY
Patient Pos: SUPINO

Study Desc: RX t



***Bedside
Trunk rotation
Cardiothoracic surgery
Pulmonary “central” oedema***

The Sweet Spot™

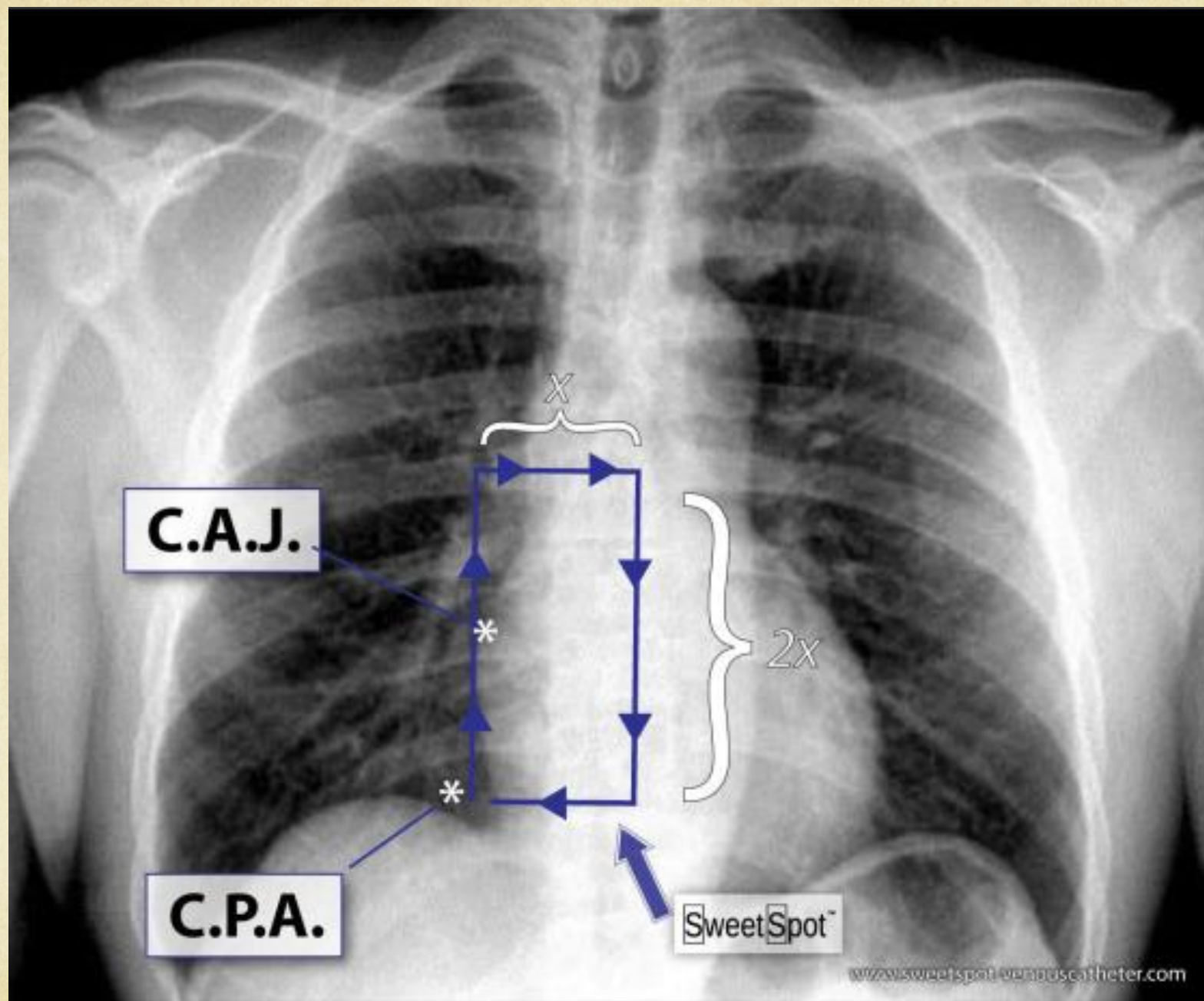


Ken
Symington, MD

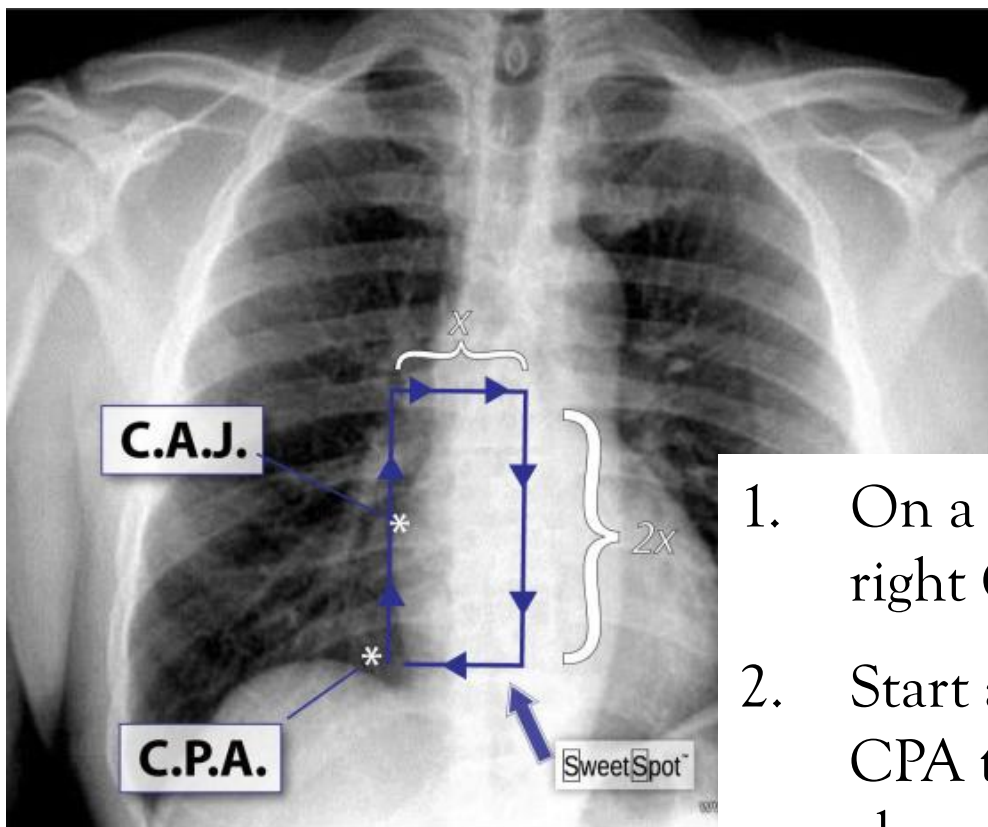
Spokane,
WA

DEFINITION OF SWEET SPOT™

The **SWEET SPOT™** is a rectangular template superimposed on a frontal CXR, whose margins and internal area are acceptable for VAD catheter tip position. This is **tailored to the individual patient's chest x-ray**. As such, it has **no fixed length or width** but does have **fixed proportions** with the craniocaudal length being twice the width on a frontal chest x-ray. Depending on patient anatomy, it can exceed 8 x 4 cm. The template is simply **compared in size to the CXR at hand**. This template is **very easy to memorize and just as easy to teach**.



How to draw the Sweet Spot™



1. On a frontal CXR, identify the CAJ and the right CPA.
2. Start at a point as close as possible to the CPA that permits a vertical line to be drawn along the right edge of the cardiac silhouette.
3. Go twice the distance of the CPA to the CAJ.
4. Next, continue a horizontal line to your right equaling one-half the length of the previous vertical line.
5. Lastly, turn inferiorly and complete the rectangle.

ORIGIN OF SWEET SPOT™

The **SWEET SPOT™** was created for two main reasons. The first was to **improve patient safety by decreasing the complications caused by improperly positioned venous access devices (VAD)** as encountered by me and other members of my IR practice. The second was to **remove the always subjective and sometimes erroneous chest x-ray (CXR) interpretation of VAD tip position** (as well as resultant unnecessary recommendations for repositioning) in my own large and highly subspecialized radiology group (55 members at present).

Tip location by chest radiology

Two possible approaches which may minimize the subjectivity of judgement:

- The carina landmark
- The Sweet Spot

We compared the two approaches

Both of them, though, have limited accuracy if compared to ECG or US

‘Sweet Spot’ vs. carina: two criteria for
verifying tip location by chest x-ray

Mauro Pittiruti, Andrea Bilancia, Gloria
Ortiz Miluy

AVA 2015

Purpose

The position of the tip of PICCs is often verified at the end of the procedure by chest x-ray (CXR). Though, the radiological criteria for defining tip location are sometimes poorly defined, subjective and/or non-repeatable. We considered two recent methods for tip location at CXR - the Sweet Spot criteria (SSC) (developed by Ken Symington) and the Carina criteria (CC) (developed by German radiologists) – comparing them in terms of feasibility and accuracy.

Methods

Using the radiology database of three hospitals, we examined all CXR performed on patients after PICC insertion, choosing catheters whose tip location had been verified by the intracavitary ECG technique (IC-ECG). Tip location was identified by SSC and CC on all CXR.

Results

We reviewed 1116 PICCs successfully placed by IC-ECG (maximal height of P wave = tip at the cavo-atrial junction).

CC was not feasible in 0.45% (impossible visualization of the carina) and difficult in 1.5% (difficult visualization of the carina); in 97.7%, tip position was appropriate (1-5 cm below the carina), in 0.6% too high (< 1 cm), in 1.2% too low (6-9 cm).

On the other hand, because of unclear visualization of radiological landmarks, **SSC** was not feasible in 0.9% and difficult in 8.6%; in 99.1%, the tip was within the spot (94.2% in the middle, 2.5% close to the superior border, 2.3% close to the inferior border); no tip was visualized outside of the spot.

Conclusions

CC and SSC were similar in terms of feasibility (99.5% vs. 99.1%) and accuracy (97.7% vs. 99.1%).

Though, **CC was easier to perform (98.05%) if compared to SSC (89.5%).**

Fluoroscopy



Expensive
Logistically unsustainable
Inaccuracy of radiological landmarks

Fluoroscopy

It might be used simultaneously for tip location AND tip navigation

Though

- Expensive
- X-ray exposure
- Less accurate than US or EKG
- Not appropriate for bedside VADs (PICCs, short term CVCs)

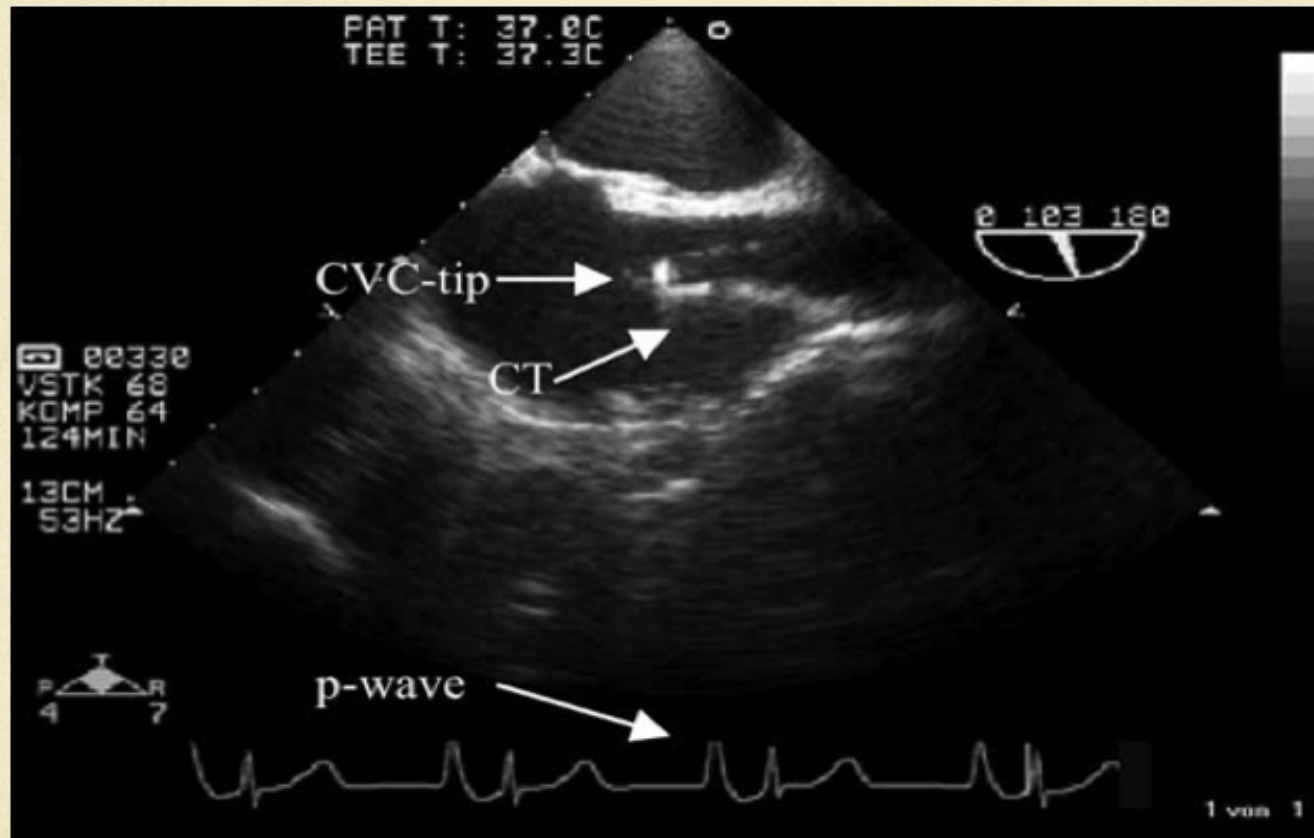
	ICEKG	Fluoro	Chest X-ray	TTE	TEE
applicability	93%	99%	99%	100%	100%
feasibility	+++	++	++	+	+
accuracy	+++	+	++	+++	+++
precision	++	+	+	+++	+++
safety	+++	+	++	+++	++
easiness	+++	+	++	+	+
cost effectiveness	+++	+	+	++	+

Fluoro and chest x-ray are almost always applicable, but they may not be feasible and/or accurate (*poor diagnostic criteria; poor imaging due to obesity, abnormal anatomy, enlarged heart, artefacts,, etc.*). They are not 100% safe and they are expensive.

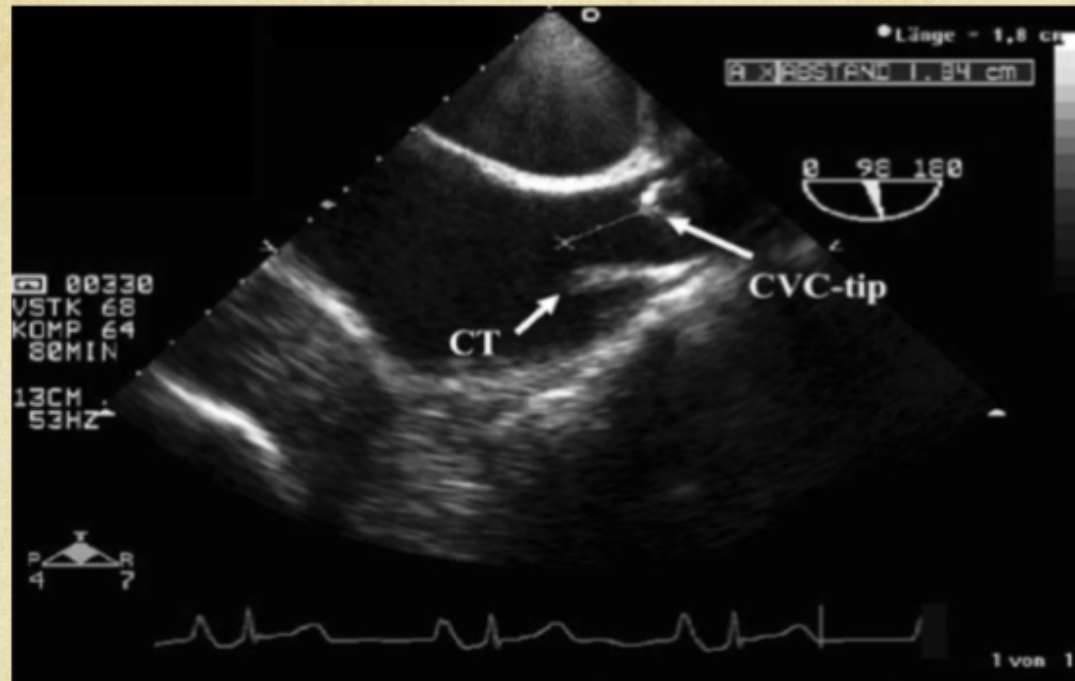
Ultrasound for tip location

Trans Esophageal Echocardiography
The most accurate method
Though: expensive and invasive

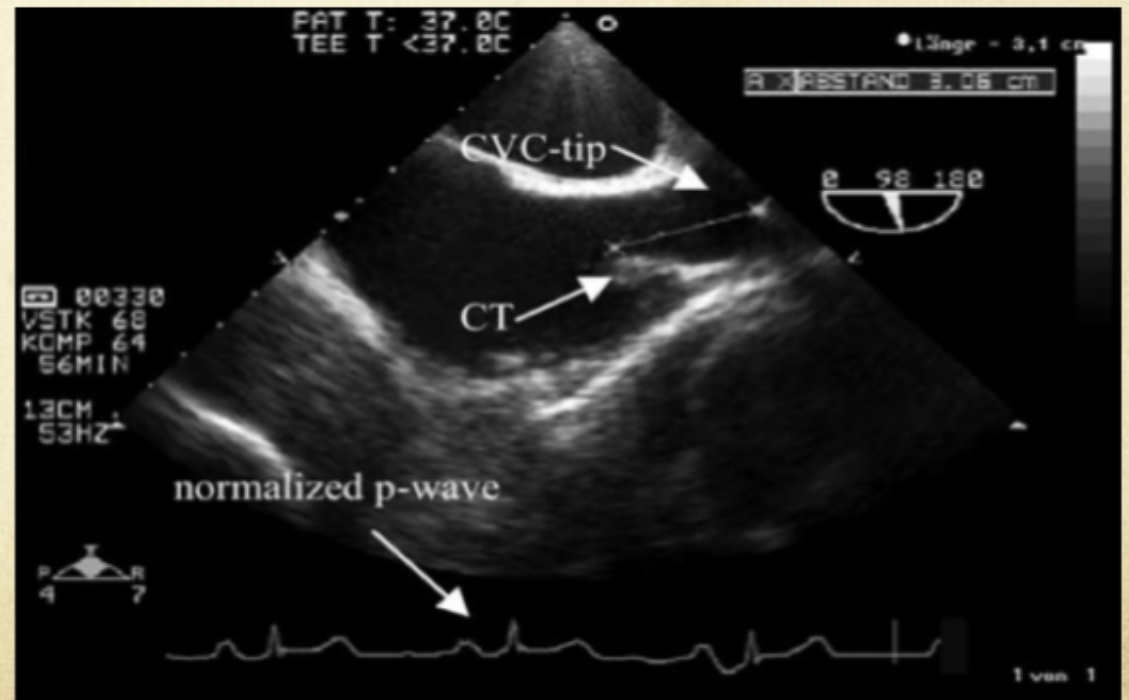
TEE



Tip at CAJ



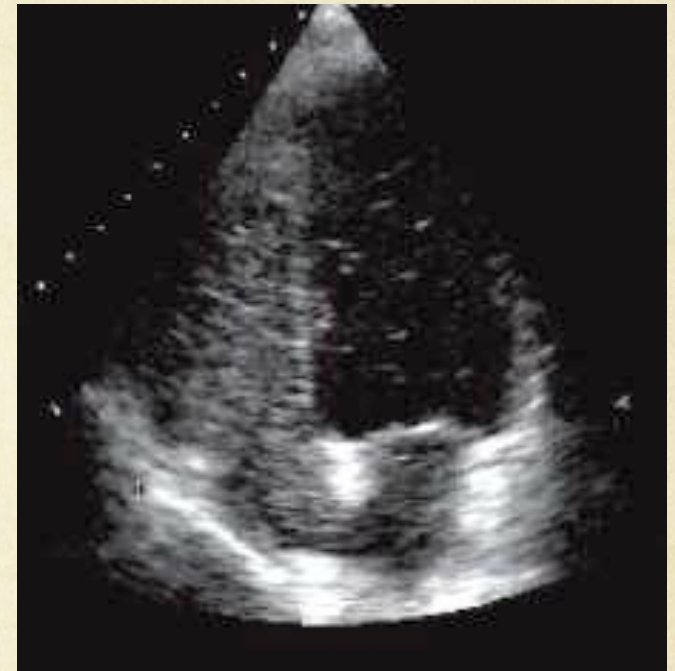
Tip in lower 1/3 SVC



Tip in upper SVC

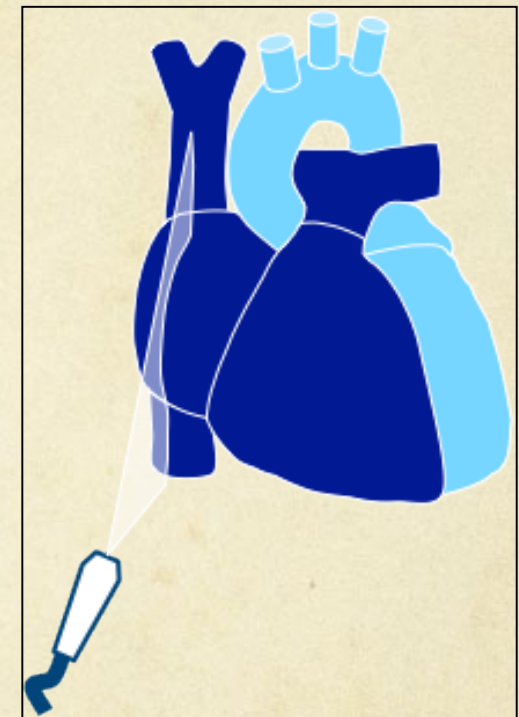
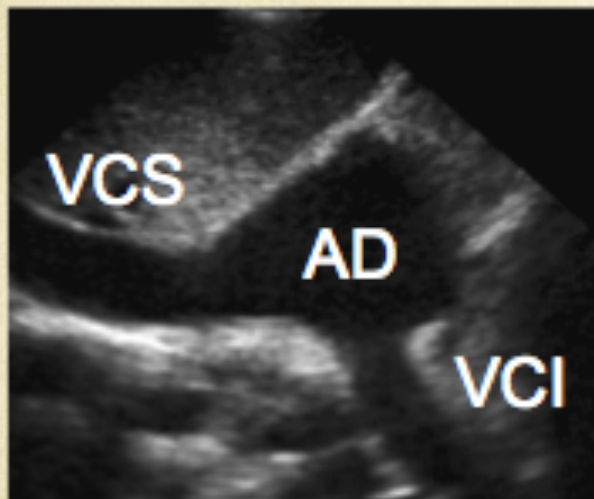
Trans Thoracic Echocardiography

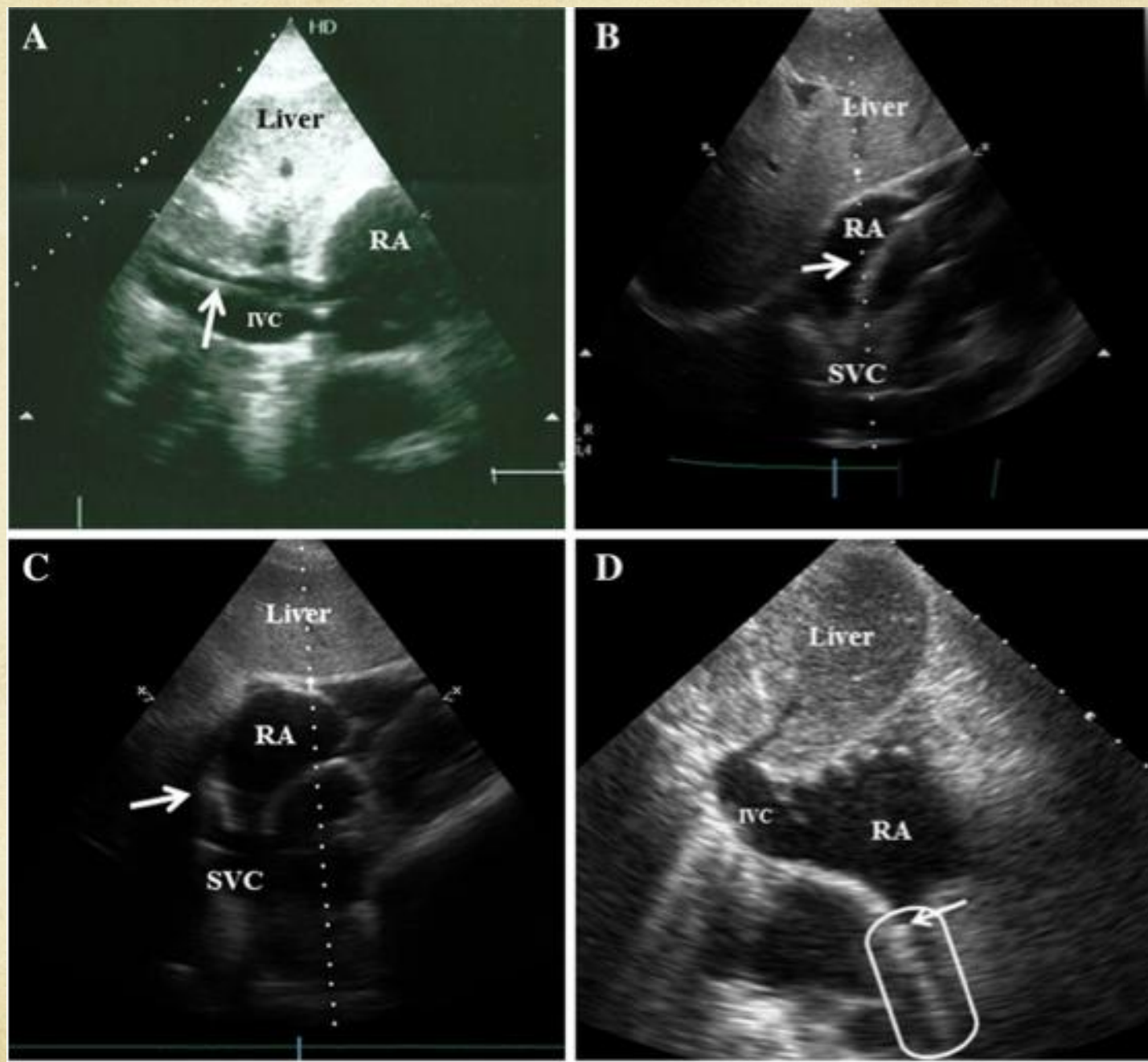
TTE



Accurate and precise

May be difficult or not feasible in
some adult patients
(BPCO, obesity, abdominal surgery,
etc.)

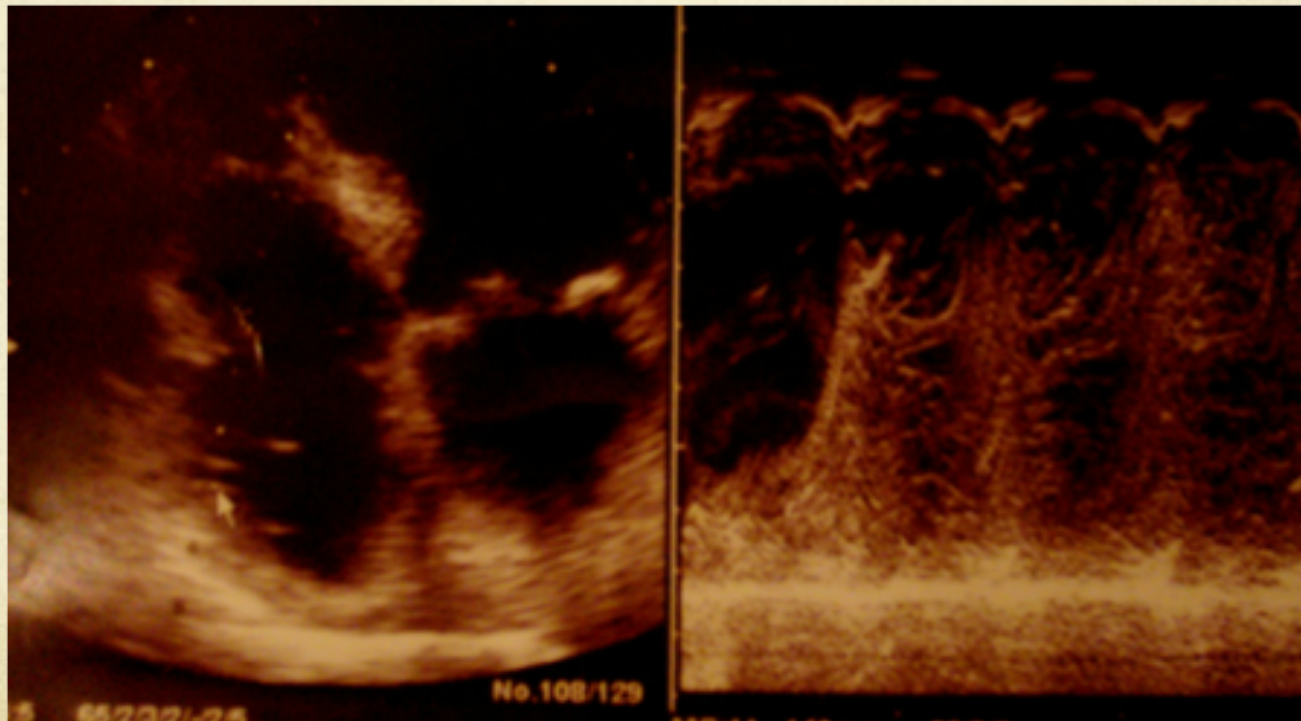




CEUS Contrast-enhanced Ultrasonography

(M-Mode)

- Very accurate
- Needs very specific training



Ultrasonic Examination

An Alternative to Chest Radiography after Central Venous Catheter Insertion?

ERIC MAURY, JEAN GUGLIELMINOTTI, MARC ALZIEU, BERTRAND GUIDET, and GEORGES OFFENSTADT

Service de Réanimation Médicale, Hôpital Saint-Antoine, Assistance Publique-Hôpitaux de Paris, Paris, France

Jerome Bedel
Fabrice Vallée
Arnaud Mari
Beatrice Riu
Benjamin Planquette
Thomas Geeraerts
Michèle Génestal
Vincent Minville
Olivier Fourcade

Guidewire localization by transthoracic echocardiography during central venous catheter insertion: a periprocedural method to evaluate catheter placement

Ultrasound localization of central vein catheter and detection of postprocedural pneumothorax: An alternative to chest radiography*

Antonella Vezzani, MD; Claudia Brusasco, MD; Salvatore Palermo, MD; Claudio Launo, MD; Mario Mergoni, MD; Francesco Corradi, MD, PhD

Brief Report

American Journal of Emergency Medicine 32 (2014) 78–81

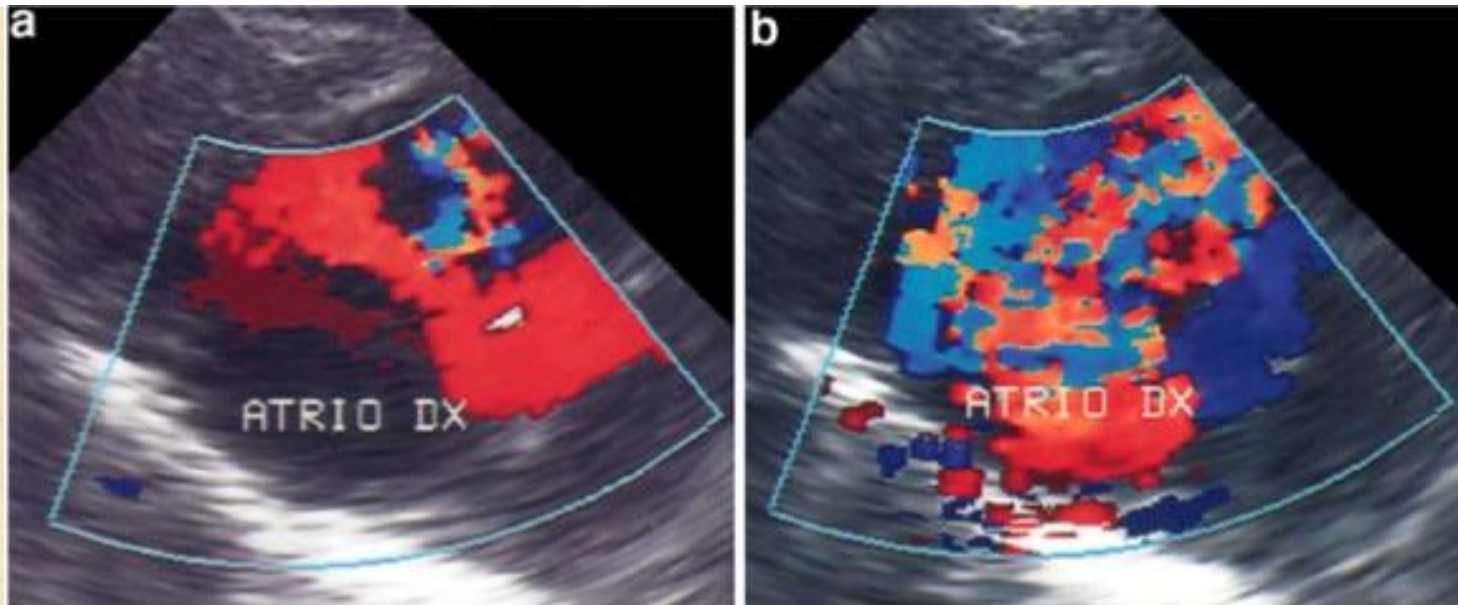
Contrast enhanced ultrasound vs chest X-ray to determine correct central venous catheter position

Francesca Cortellaro, MD ^{a,*}, Luca Mellace, MD ^a, Stefano Paglia, MD ^a, Giorgio Costantino, MD ^c, Sara Sher, MD ^b, Daniele Coen, MD ^a

ORIGINAL ARTICLE

Cecilia Lanza · Marco Russo · Giancarlo Fabrizzi

Central venous cannulation: are routine chest radiographs necessary after B-mode and colour Doppler sonography check?



- Color Doppler signals in the vena cava.
- Increased colour signal due to turbulent flow during infusion of saline solution

ORIGINAL ARTICLE

Cecilia Lanza · Marco Russo · Giancarlo Fabrizzi

Central venous cannulation: are routine chest radiographs necessary after B-mode and colour Doppler sonography check?

Table 2 Malpositions and complications

Complications	Postprocedural chest radiograph	Colour Doppler
Total	13	11
Malposition		
Right atrium	7	6
Axillary vein	5	4
Pneumothorax	1	1

Even better in neonates

J Perinatol. 2013 Oct;33(10):791-4

Epub 2013 Jun 13.

A randomized controlled trial of ultrasound-guided peripherally inserted central catheters compared with standard radiograph in neonates.

Katheria AC(1), Fleming SE, Kim JH.

(1)Division of Neonatology, Department of Pediatrics, University of California, San Diego, CA, USA.

TTE = best choice in neonates



	ICEKG	Fluoro	Chest X-ray	TTE	TEE
applicability	93%	99%	99%	100%	100%
feasibility	+++	++	++	+	+
accuracy	+++	+	++	+++	+++
precision	++	+	+	+++	+++
safety	+++	+	++	+++	++
easiness	+++	+	++	+	+
cost effectiveness	+++	+	+	++	+

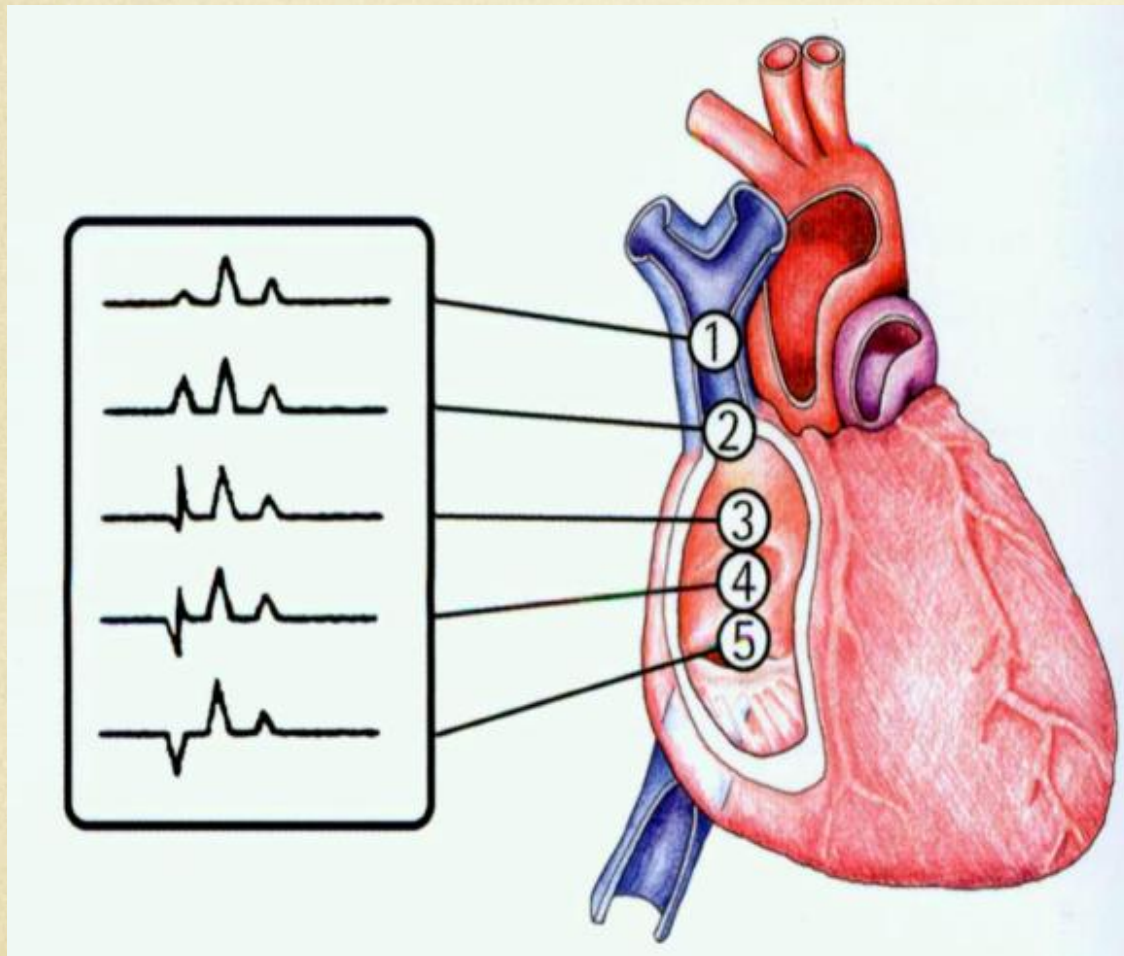
TEE is almost always applicable, is extremely accurate and precise, but has minimal feasibility and minimal cost-effectiveness (too invasive, too expensive, etc.).
(same for CT, MR, Angio, etc.)

	ICEKG	Fluoro	Chest X-ray	TTE	TEE
applicability	93%	99%	99%	100%	100%
feasibility	+++	++	++	+	+
accuracy	+++	+	++	+++	+++
precision	++	+	+	+++	+++
safety	+++	+	++	+++	++
easiness	+++	+	++	+	+
cost effectiveness	+++	+	+	++	+

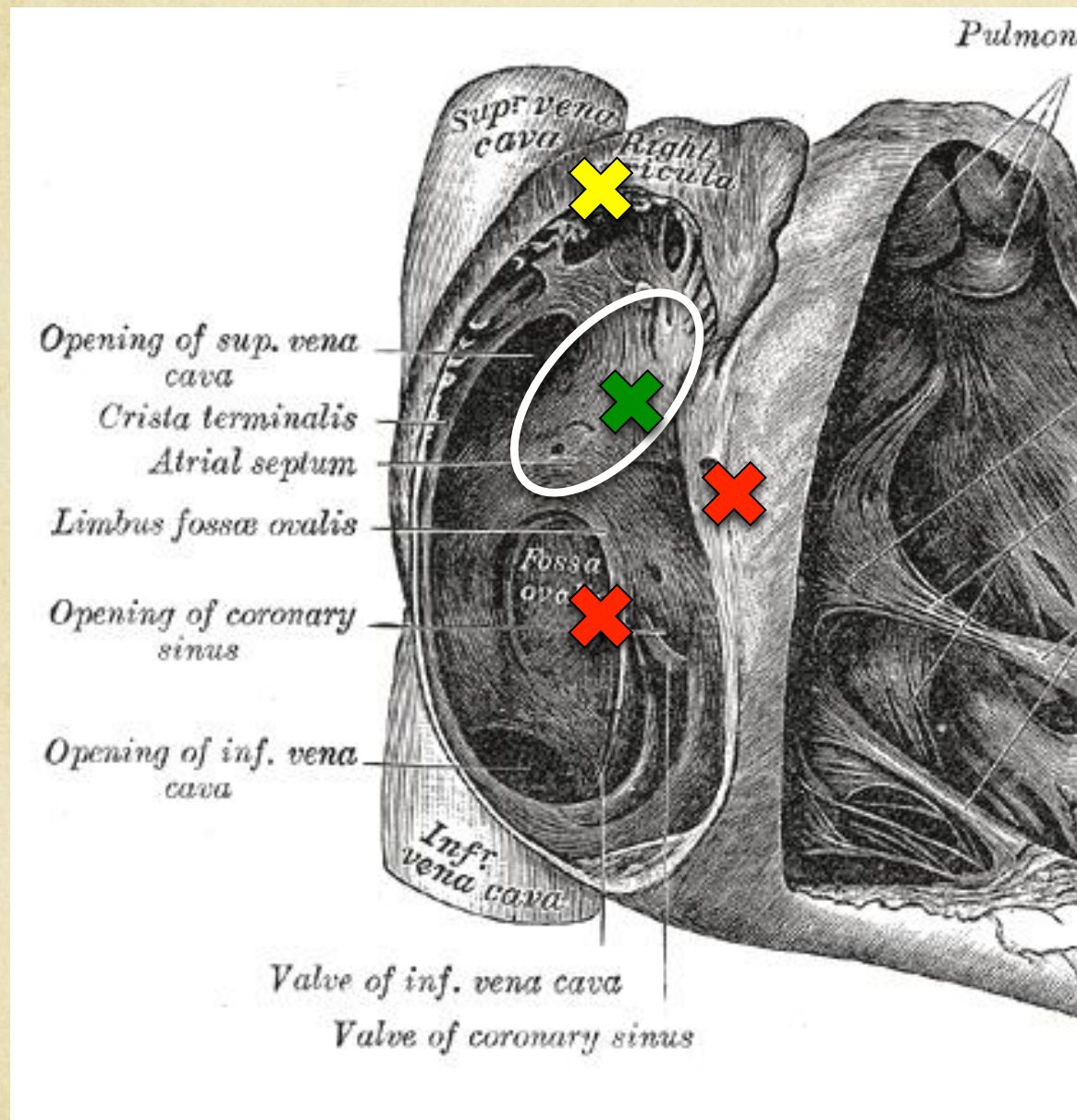
TTE is very accurate (specially as CEUS); it is safe and cost-effective, but (a) requires training and (b) may not easy or feasible in all adult patients.

Intracavitary ECG for tip location

IC-EKG method



- Intracavitary ECG (lead II)
- The intracavitary electrode is the tip of the catheter
- Based on changes of P wave during the progression of the catheter into the central veins
- CAVO-ATRIAL JUNCTION: maximal peak of the P wave (Stas, Yeon, Schummer, Pittiruti/La Greca, etc,) (= CRISTA TERMINALIS)



P increasing



Maximal P



P decreasing
and/or diphasic

A very old method...

Von Hellerstein HK

Recording of intracavitary potentials through a single-lumen saline filled cardiac catheter. Proc Soc Exp Biol Med 71:58-60, 1949

...which has come back.



R E S E A R C H & I N T E R N A T I O N A L

The EKG method for positioning the tip of PICCs: results from two preliminary studies

Mauro Pittiruti¹, MD, Giancarlo Scoppettuolo², MD, Antonio La Greca¹, MD, Alessandro Emoli³, RN, Alberto Brutti⁴, RN, Ivano Migliorini¹, RN, Laura Dolcetti², RN, Cristina Taraschi², RN, Gennaro De Pascale², MD
¹Dept. of Surgery, ²Dept. of Infectious Diseases, ³Dept. of Oncology, ⁴Intensive Care Unit
Catholic University Hospital, Rome, Italy

Abstract

Two preliminary studies were conducted to determine feasibility of using the electrocardiography (EKG) method to determine terminal tip location when inserting a peripherally inserted central catheter (PICC). This method uses the guide-wire inside the catheter (or a column of saline contained in the catheter) as an intracavitary electrode. The EKG monitor is then connected to the intracavitary electrode. The reading on the EKG monitor reflects the closeness of the intracavitary electrode (the catheter tip) to the superior vena cava (SVC). The studies revealed that the EKG method was extremely precise; all tips placed using the EKG method and confirmed using x-ray were located in the superior vena cava. In conclusion, the EKG method has clear advantages in terms of accuracy, cost-effectiveness, and feasibility in conditions where x-ray control may be difficult or expensive to obtain. The method is quite simple, easy to learn and to teach, non-invasive, easy to reproduce, safe, and apt to minimize malpositions due to failure of entering the SVC.

JAVA 2008

Applicability

- The IC-EKG method is applicable **to any central venous access**, valved or not, peripherally inserted or not, independently from the access technique.
- Current limit of IC-EKG method: **it is applicable only in patients with evident P wave in the surface ECG**

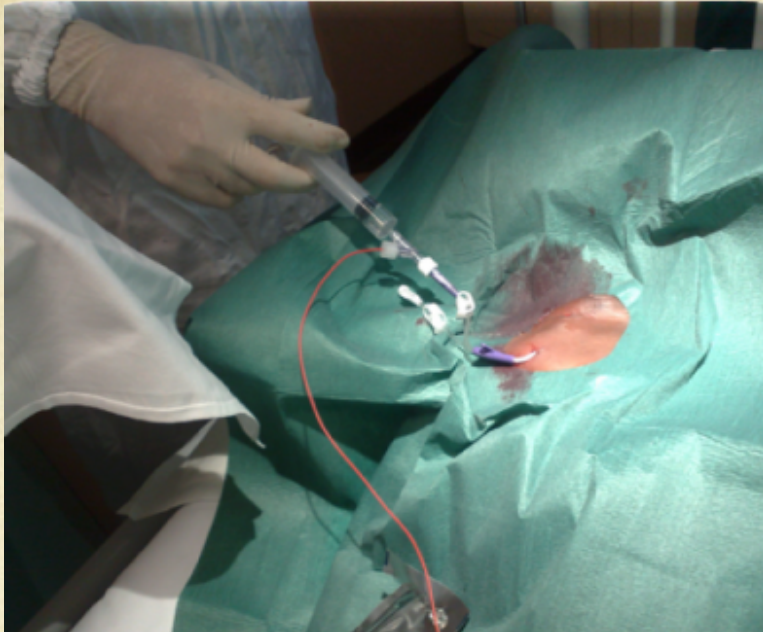
This excludes **7 – 9 %** of patients: atrial fibrillation, pacemaker (if constantly active), so called 'junctional rhythm', atrial flutter, etc.

Applicability

Applicability is not a relevant issue in pediatric patients.

In the recent GAVeCeLT Multicenter Study on IC-ECG in Children (5 hospitals, 309 patients), applicability was 99.4%:

- Only in 2 children out of 309, the P wave was not identified on the surface ECG, so that IC-ECG was not performed
 - One child 2 mo. old
 - One child 5 yr old

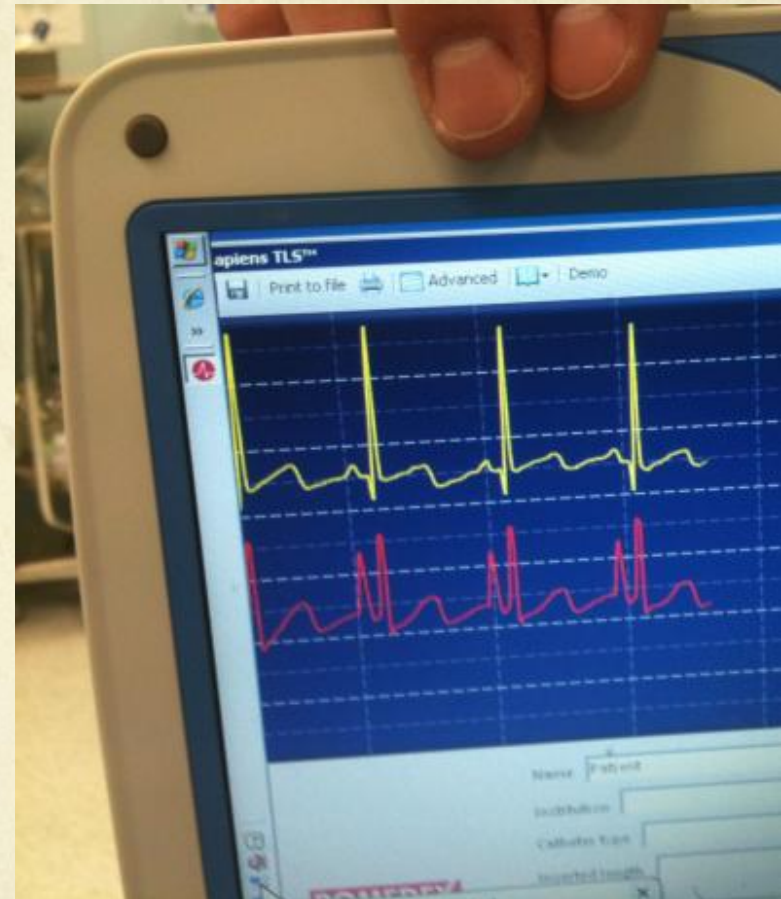


What about applicability of IC-EKG in neonates ?

- Preliminary personal experience (**47** cases, not included in the multicenter study)
 - Saline technique
 - Caths >3Fr, central insertion, US-guidance
 - Age 3hrs – 29 days; weight > 950 gr

RESULTS

- Applicability **100%**
- Feasibility : 45 cases out of 47 (**96%**)
- Accuracy: **100%** (check by x-ray and/or echocardiio.)



Feasibility

Feasibility = in which % of cases do we get an 'atrial P' in the intracavitary EKG?

- **GAVeCeLT multicenter study 2012:**
 - 1440 patients, any type of VAD
 - All pts with evident P on basal ECG
 - Both saline technique and guidewire technique
 - Overall feasibility **99.3 %**
 - Feasibility with the saline technique **99.9 %**
 - Feasibility with the guidewire technique **98.6 %**

GAVeCeLT pediatric multicenter study on IC-EKG - 2013

309 children (5 hospitals)

any type of VAD

only saline technique

307/309 had evident P on basal ECG

An 'atrial P' was detected in **305/307**

Applicability was **99.4 %**

Overall feasibility **99.4 %**

Feasibility

0.6 – 0.7 % of failure ('not feasibility')

depends on:

- Technical problems of the connection between monitor and catheter

- Technical problems of the ECG monitor

- Experience of the operator (ability to recognize P changes)

- Low signal (catheter < 3Fr)

Feasibility

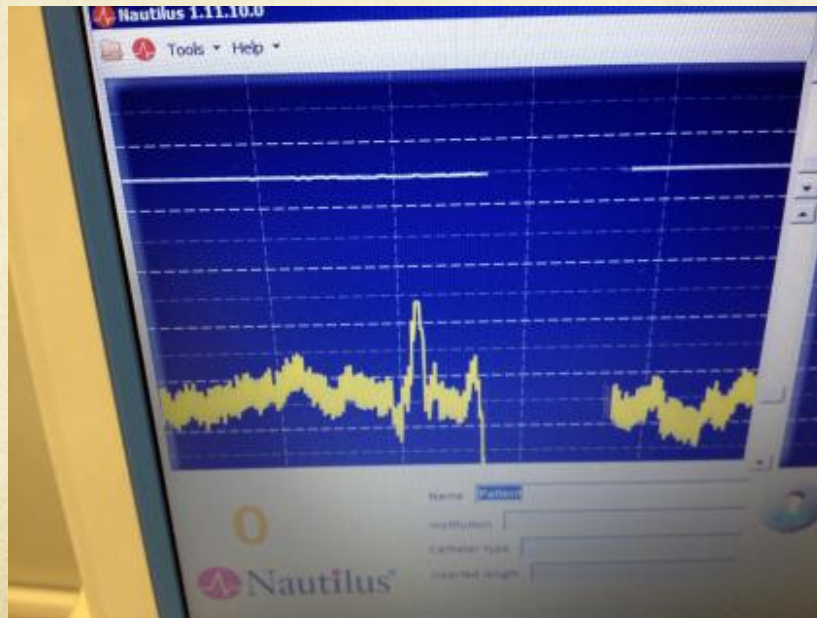
Technical problem of the connection between monitor and catheter

- Saline technique better than guidewire technique
- Some cables may not work properly
- Air bubbles in the catheter
- Poor connection between alligator clip and stylet (or guidewire)

Feasibility

Technical problem of the ECG monitor

- AC interferences, lack of appropriate filters



Feasibility

Experience of the operator (ability to recognize P changes)

Improve feasibility ?

- 1) Use of 'dedicated' ECG monitor or ECG monitors specifically designed for the IC-EKG + use of good quality cables
 - Good electrical connections
 - Proper filters
 - Protection from interferences

Improve feasibility ?

2) Appropriate training of the operators

- Short courses (2 days)
- Short learning curve (few procedures)

proper procedure:

a - advance while P is increasing

b - stop when diphasic

c - pull back until maximal value

Education/training

We will need more 'formal' training courses to teach the EKG method



Accuracy

Accuracy = in which % the 'atrial P'
corresponds to the cavo-atrial junction?

Almost **99%**

IC-EKG - Is it accurate?

In the last two decades, many clinical studies have proved the accuracy of the EKG method:

- Compared with radiological methods
- Compared with trans-esophageal echocardiography (TEE)

TEE vs IC-EKG

Accurate Central Venous Port-A Catheter Placement: Intravenous Electrocardiography and Surface Landmark Techniques Compared by Using Transesophageal Echocardiography

Koung-Shing Chu, MD*, Jong-Hau Hsu, MD†, Shie-Shan Wang, MD‡, Chao-Shun Tang, PhD§, Kuang-I Cheng, MD§, Chien-Kuo Wang, MD||, and Jiunn-Ren Wu, MD†

*Department of Anesthesiology, Kuo General Hospital, Tainan, Taiwan; and Departments of †Pediatrics, ‡Surgery, §Anesthesiology, and ||Medical Imaging, Kaohsiung Medical University, Kaohsiung City, Taiwan

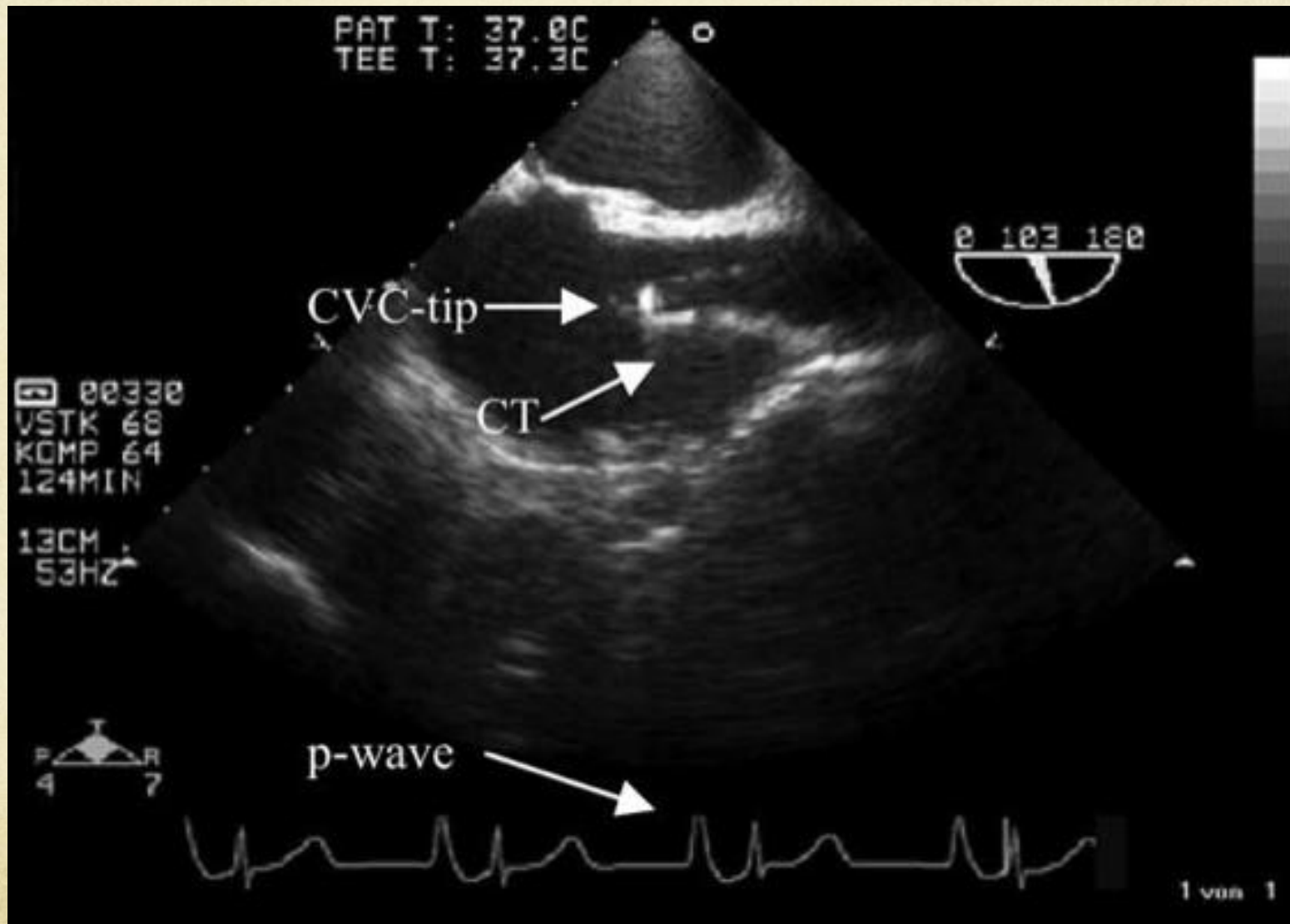
2004

Cavoatrial junction = maximal P wave (EKG)

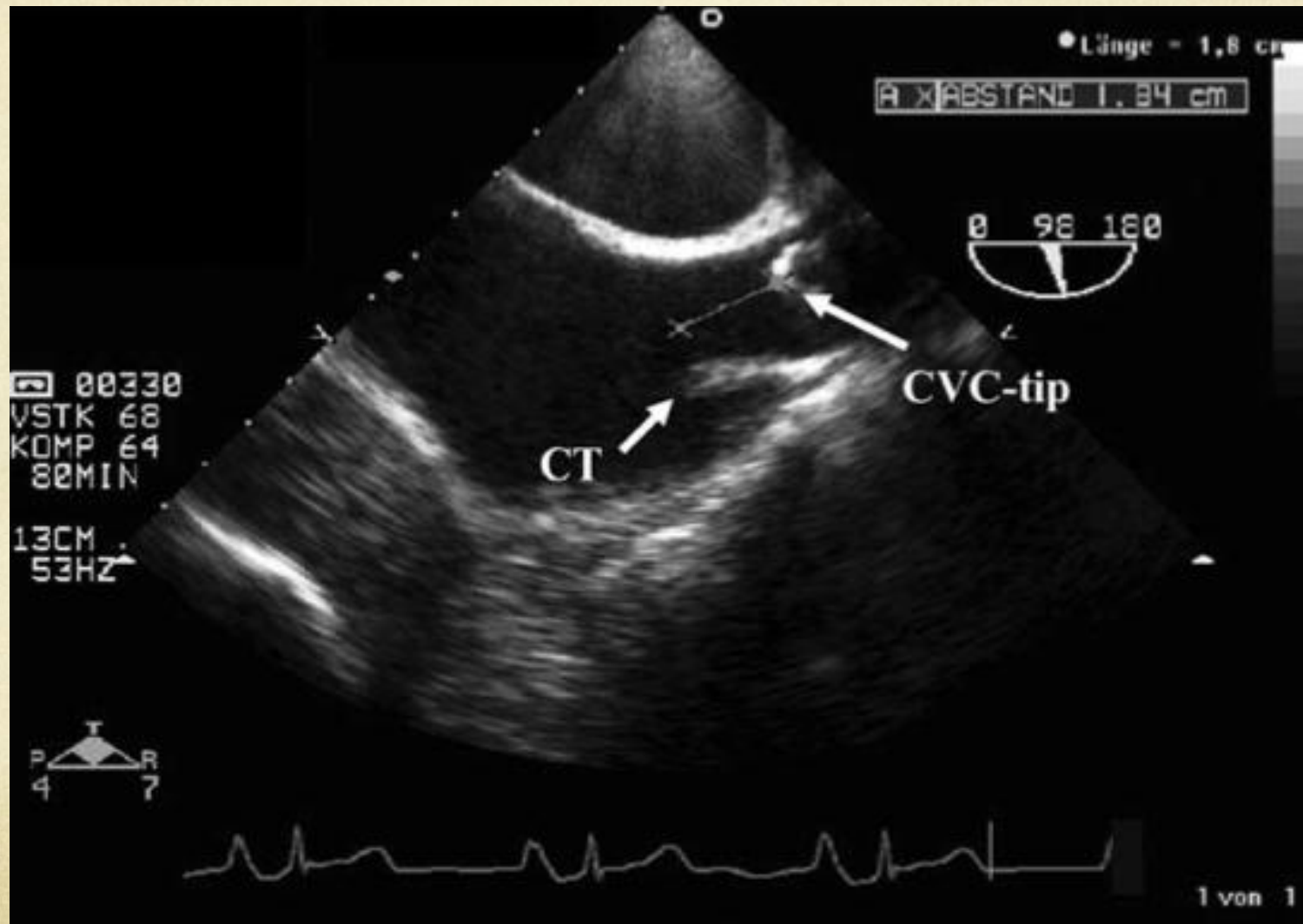
Cavoatrial junction = crista terminalis (TEE)

100% accuracy - In 30 patients, EKG = TEE

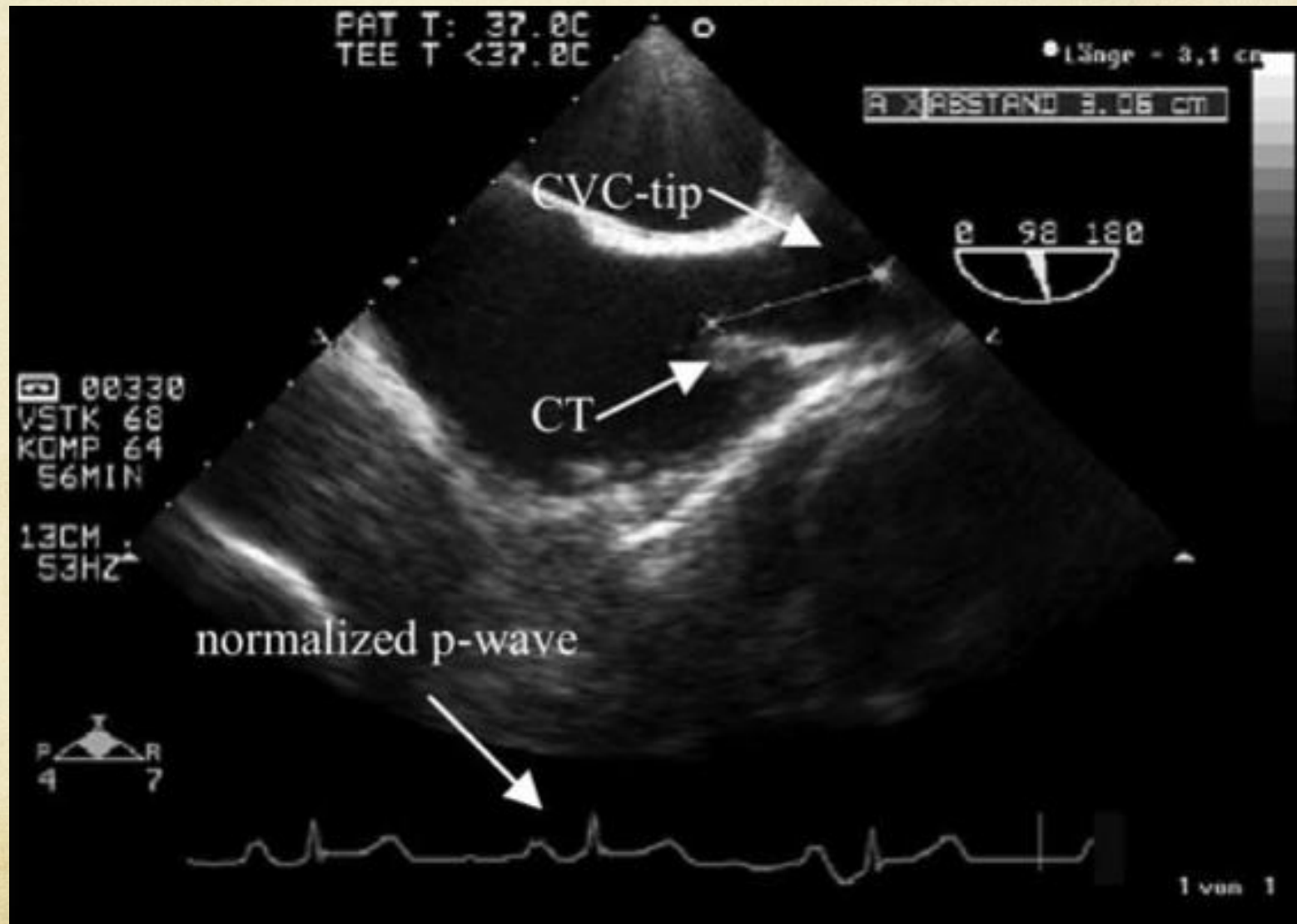
Tip at the cavoatrial junction



TIP in lower 1/3 of SVC



Tip in middle 1/3 of SVC



TEE vs. IC-EKG

Transesophageal echocardiographic evaluation of ECG-guided central venous catheter placement

[Évaluation échocardiographique transœsophagienne de la mise en place d'un cathéter veineux central guidée par ECG]

Yunseok Jeon MD,* Ho-Geol Ryu MD,* Seung-Zhoo Yoon MD,* Jin-Hee Kim MD,† Jae-Hyon Bahk MD‡

[1] International Anesthesia Research Society Journal

54 patients

Cavoatrial junction = crista terminalis

Conclusions: During ECG-guided central venous catheterization, the tallest peaked P wave may be used to place the CVC tip at the SVC/RA junction, the normally-shaped P wave identifies the mid to upper SVC, and biphasic P waves identify RA localization.

2006

IC-EKG vs. X-Ray

The Accuracy of Electrocardiogram-Controlled Central Line Placement

Ralf E. Gebhard, MD*

Peter Szmuk, MD†

Evan G. Pivalizza, MBChB,
FFASA‡

Vladimir Melnikov, MD‡

Christianne Vogt, MD‡

Robert D. Warters, MD‡

BACKGROUND: Electrocardiogram (ECG) guidance to confirm accurate positioning of central venous catheters (CVC), placed before surgery in the operating room, is rarely used in the United States. We designed this randomized, controlled trial to investigate whether the use of this technique impacts the accuracy of CVC placement.

METHODS: Patients in group ECG ($n = 147$) had a CVC placed using right-atrial ECG to guide catheter tip positioning. CVCs in group NO-ECG ($n = 143$) were positioned without this technique.

RESULTS: Overall, guidewire-ECG control resulted in more correctly positioned CVCs (96% vs 76%, $P \leq 0.001$) without increasing placement time. Significantly more CVCs were placed in the middle of the superior vena cava in group ECG ($P \leq 0.001$), although placement into the right atrium or right ventricle and into other vessels occurred significantly more often in group NO-ECG ($P \leq 0.001$). Twenty patients in group NO-ECG required repositioning of their CVC after surgery, whereas this maneuver was necessary only in three patients in group ECG ($P \leq 0.001$).

CONCLUSIONS: ECG guidance allows for more accurate CVC placement, and should be considered to increase patient safety and reduce costs associated with repositioning procedures.

(Anesth Analg 2007;104:66-70)

147 pts – correct tip positioning in 96 %

2007

TEE vs. IC-EKG vs. X-Ray

Transesophageal Echocardiography for Verification of the Position of the Electrocardiographically-Placed Central Venous Catheter

Joerg Ender, MD, Gabor Erdoes, MD, Eugen Krohmer, MD, Derk Olthoff, MD, PhD, and Chirojit Mukherjee, MD

Objective: Compare changes in P-wave amplitude of the intra-atrial electrocardiogram (ECG) and its corresponding transesophageal echocardiography (TEE)-controlled position to verify the exact localization of a central venous catheter (CVC) tip.

Design: A prospective study.

Setting: University, single-institutional setting.

Participants: Two hundred patients undergoing elective cardiac surgery.

Interventions: CVC placement via the right internal jugular vein with ECG control using the guidewire technique and TEE control in 4 different phases: phase 1: CVC placement with normalized P wave and measurement of distance from the crista terminalis to the CVC tip; phase 2: TEE-controlled placement of the CVC tip; parallel to the superior vena cava (SVC) and measurements of P-wave amplitude; phase 3: influence of head positioning on CVC migration; and phase 4: evaluation of positioning of the CVC postoperatively using a chest x-ray.

Measurements and Main Results: The CVC tip could only be visualized in 67 patients on TEE with a normalized P wave. In 198 patients with the CVC parallel to the SVC wall controlled by TEE (phase 2), an elevated P wave was observed. Different head movements led to no significant migration of the CVC (phase 3). On a postoperative chest-x-ray, the CVC position was correct in 87.6% (phase 4).

Conclusion: The study suggests that the position of the CVC tip is located parallel to the SVC and 1.5 cm above the crista terminalis if the P wave starts to decrease during withdrawal of the catheter. The authors recommend that ECG control as per their study should be routinely used for placement of central venous catheters via the right internal jugular vein.

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KEY WORDS: intra-atrial electrocardiogram, central venous catheter, TEE, positioning

2009

200 patients - accuracy 99% for EKG, 88% for X-ray

Endovascular electrocardiography to guide placement of totally implantable central venous catheters in oncologic patients

Cecilia Pelagatti, Gianluca Villa, Andrea Casini, Cosimo Chelazzi, Angelo Raffaele De Gaudio

Department of Critical Care, Section of Anesthesiology and Intensive Care, University of Florence, Florence - Italy

ABSTRACT

Purpose: Appropriate tip position of totally implantable central venous catheters is essential in order to prevent catheter-related complications, in particular thrombosis. Endovascular electrocardiography is an economic and safe method to guide placement of catheters into the central veins. Although widely utilized, there is still lack of conclusive evidence about its efficacy. The aim of the study was to assess the efficacy and safety of endovascular electrocardiographic guided placement compared to the anthropometric method.

Methods: Endovascular ECG was employed to guide electrocardiographic placement of a central venous catheter in a cohort of oncologic patients. The rate of correct placement and the incidence of catheter-related thrombosis were considered. Patients in which central venous catheters were inserted with the anthropometric technique were considered as control group.

Results: The rate of correct placement was 91% and 50% for ECG-guided and anthropometric catheters ($p < 0.0001$) respectively. None of the patients suffered from early insertion-related complications. The rate of catheter-related vascular thrombosis was lower for ECG-guided catheters (3.6% vs. 9.6%, n.s.), in particular for left-inserted catheters (0% vs. 33.3%, $p = 0.02$).

Conclusion: Endovascular electrocardiography was more effective than the anthropometric technique in placement of implantable central venous catheters and was associated with a lower incidence of catheter-related thrombosis, in particular for those inserted from the left-side.

Accuracy = 91 %

2011

Intra-cavitary ECG is an effective method for correct positioning the tip of tunneled Groshong catheters

Giuseppe Capozzoli, Gino Accinelli, Loris Fabbro, Roberta Pedrazzoli, Franco Auricchio

Anesthesia and Intensive Care Unit, Bolzano Central Hospital - Italy

ABSTRACT

Background: Intra-cavitary electrocardiography (ECG) is a well-known method for correct positioning of the tip of central venous catheters (CVC). A significant increase in the P wave, as registered by the intra-cavitary electrode, signals the entrance of the catheter into the right atrium.

Methods: In this prospective observational study, 155 consecutive oncologic patients were enrolled for cannulation of the right or left internal jugular vein for insertion of a tunneled Groshong catheter. In 150 patients the tip was positioned by means of intracavitary ECG. Five patients with atrial fibrillation (N=4) or pacemaker in place (N=1) were excluded from the study. As the P-wave amplitude began to increase, the catheter was secured in that position and the insertion depth was registered.

Results: Intra-cavitary ECG was always apt to detect the increase in the P wave. On the post-operative chest x-ray all Groshong catheters except two were in the correct position.

Conclusions: The need for chest x-ray or fluoroscopy may be virtually eliminated by using the ECG technique.

Accuracy = 99 %

2012

GAVeCeLT Multicenter Study

2012

J Vasc Access 2012; 13 (3): 357-365

ORIGINAL ARTICLE

DOI: 10.5301/JVA.2012.9020

The intracavitary ECG method for positioning the tip of central venous catheters: results of an Italian multicenter study

Mauro Pittiruti¹, Daniele Bertollo², Ermanno Briglia³, Massimo Buononato⁴, Giuseppe Capozzoli⁵, Luigi De Simone⁶, Antonio La Greca¹, Cecilia Pelagatti⁷, Pier Sandro Sette⁸

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⁸Department of Anesthesia and Intensive Care, Ospedale Fracastoro, San Bonifacio - Italy

GAVeCeLT Multicenter Study

8 hospitals, **1440** patients

2012

Any type of central VAD

Intra-procedural IC- EKG vs. post-procedural X-Ray

X-ray criteria for CAJ:

CAJ = 3 cm below the carina

Lower 1/3 SVC = 1-3 cm below the carina

Upper 1/3 RA = 3-5 cm below the carina

GAVeCeLT Multicenter Study

IC-EKG (intra-op.) vs. Chest X-Ray (postop.)

Total Match (Accuracy): 95,4 %

Mismatch EKG/Xray = **3.8 %** (55 cases)

in 44/55 cases, tip was higher on X-Ray

... but in most of these patients post-op- Chest X-Ray
had been performed **in standing position**

GAVeCeLT Multicenter Study

IC-EKG (intraop.) vs. Chest X-Ray (postop.)

...considering the confounding factor that IC-EKG had been performed in supine position and Chest X-Ray in standing position:

Match (Accuracy): 99 %

GAVeCeLT Pediatric Multicenter Study

Accuracy = 95.8% (307 children)

2014

Age < 4yr 96.2%

Age 4-11yr 95%

Age 11-18yr 96.8%

In the **95** cases performed with a dedicated ECG monitor (Nautilus) accuracy was higher: **98.8%**

The intracavitary ECG method for positioning the tip of central venous access devices in pediatric patients: results of an Italian multicenter study

Francesca Rossetti¹, Mauro Pittiruti², Massimo Lamperti³, Ugo Graziano⁴, Davide Celentano⁵, Giuseppe Capozzoli⁶

¹Department of Anesthesia, Children's Hospital 'Meyer', Firenze - Italy

²Department of Surgery, Catholic University Hospital, Roma - Italy

³Department of Neuroanesthesia, Neurological Institute 'Besta', Milano - Italy

⁴Department of Surgery, Children's Hospital 'Santobono', Napoli - Italy

⁵Pediatric Intensive Care Unit, Catholic University Hospital, Roma - Italy

⁶Department of Anesthesia and Intensive Care, Ospedale Civile di Bolzano, Bolzano - Italy

2014

False positive

Extremely rare false positive (atrial P ok, but the tip is not at the CAJ)

Arterial or pleural position of the tip

Pericardial reflection

Vascular malformations

False positive ?

- Some false 'atrial P waves' may be associated with very rare complications such as extravascular or intra-arterial position of the CVC
 - Not described for PICCs
 - Described only for non-tunnelled CVCs positioned with the 'blind technique' (risk of non-intravenous position of the CVC)
- Not one case in GAVeCeLT Multicenter Study (1440 pts) where all VADs were inserted by ultrasound guidance

False negative

Extremely rare false negative (no atrial P, but the tip is at the CAJ)

*Poor interpretation of the operator
(children)*

Vascular malformations

Technical problems (poor conductivity)

EKG - Is it safe?

Yes

GAVeCeLT Multicenter Study 2012:

1440 patients, any type of VAD

No complication - directly or indirectly related to the EKG method – was reported

The overall incidence of arrhythmias was low (**0.7%**)

GAVeCeLT Pediatric Multicenter Study 2013:

309 children, any type of VAD

No complication - directly or indirectly related to the EKG method – was reported

EKG method means safety

- No x-ray exposure
- No risk of arrhythmias
 - The whole manoeuvre is performed under EKG monitoring
 - The operator enters the heart with the catheter, not with a guidewire (saline method!)
 - The operator knows in any moment where the tip is
 - No risk of getting close to the tricuspid or to the ventricle
- Intracavitary EKG = no risk of electric hazard
- No risk of malpositions potentially missed at x-ray
- Easy-to-read documentation of the tip position

Easiness

Easiness

Easy to perform

Easy to teach

Easy to learn

Old fashioned ECG monitor: it worked well for us for a decade.....





New defibrillators/ECG monitor: terrific for the EKG method.....

Getting easier ?

The guidewire technique has been abandoned and completely replaced by the saline technique, which appears to be

- Simpler

- Safer

- Easier

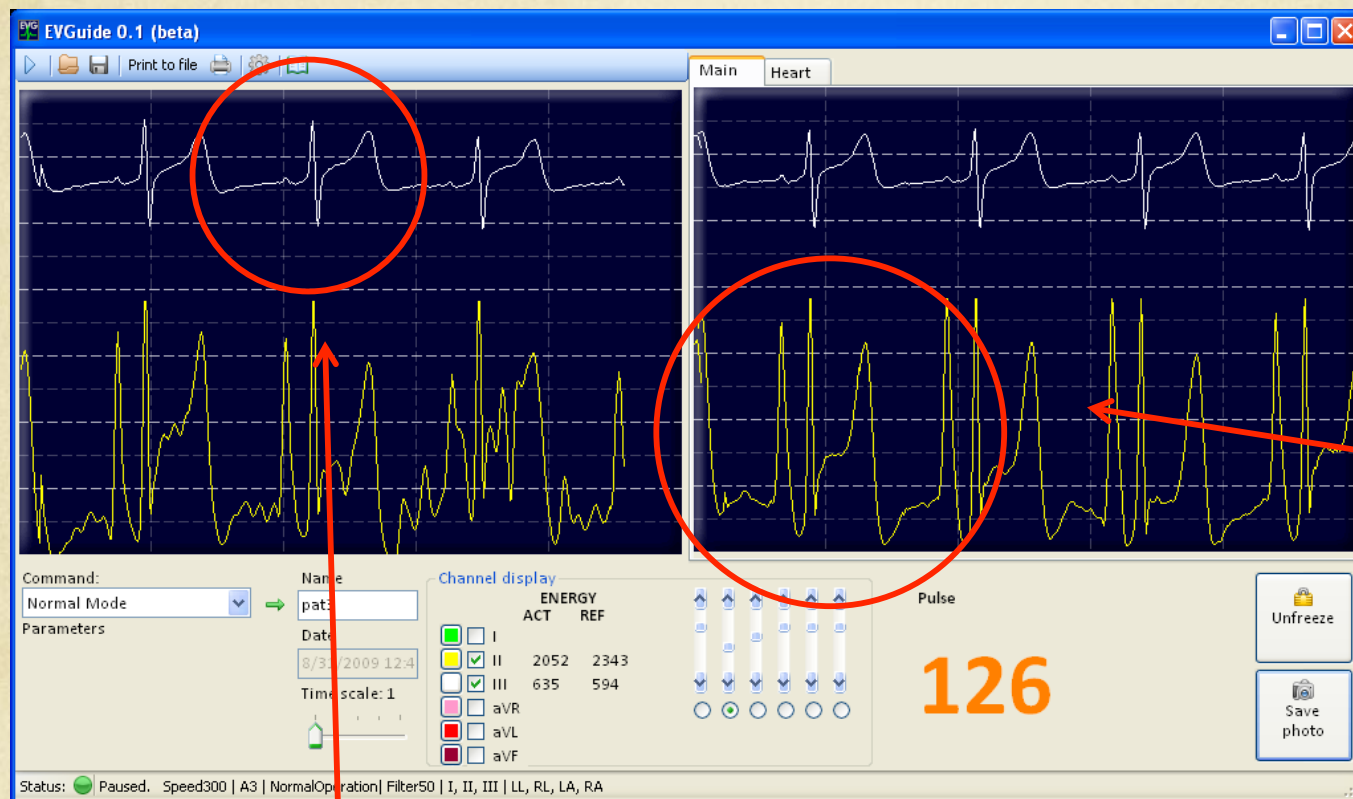
- And works with all catheters

Saline technique is getting even simpler and easier by means of dedicated ECG monitor such as Nautilus and Nautilus Delta

The method is easy... even easier with a dedicated monitor

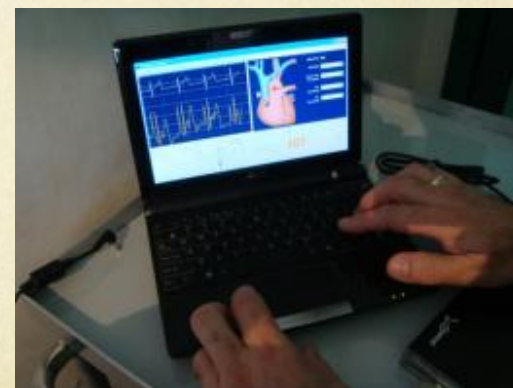


Nautilus



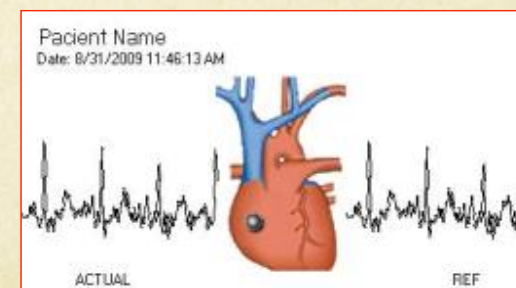
Intracavitary reading
(Atrial P wave)

Surface ECG

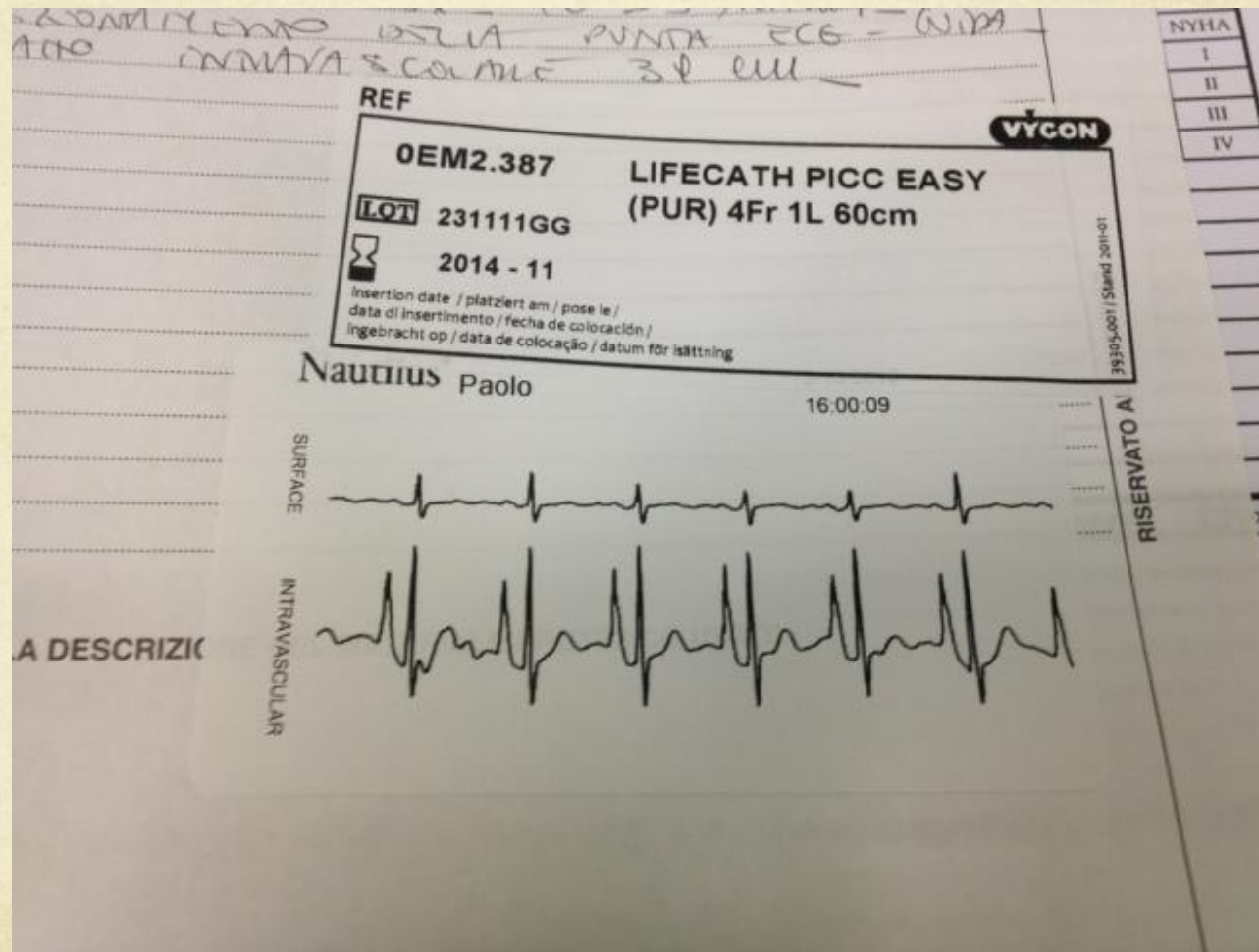




Print out for the patient's chart



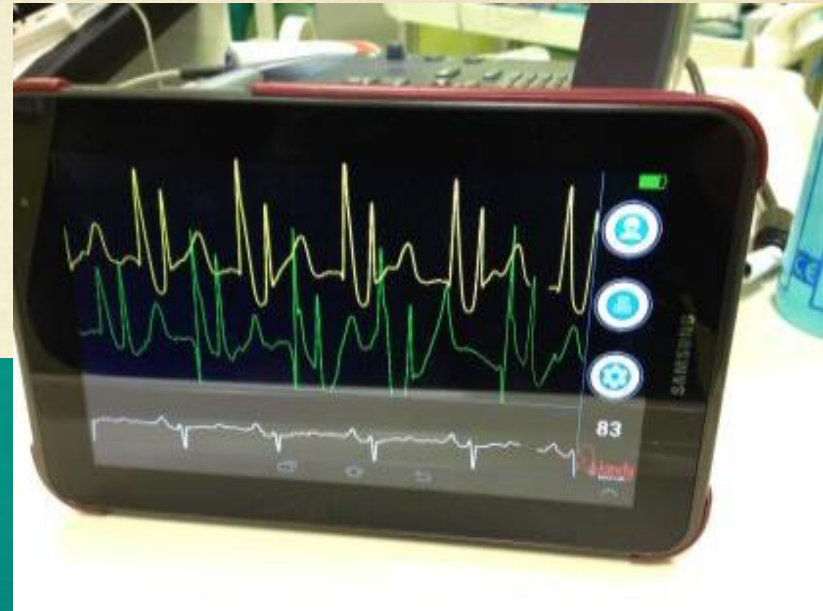
Documentation



Nautilus vs. standard EKG monitor

- Easy to use:
 - Pre-setted monitor
- Easy identification of P changes:
 - Direct comparison surface EKG vs. IC-EKG
 - Direct comparison between different positions of the tip ('freezing' one position on the right side of the display)
- Easy documentation
 - Print-out of the IC-EKG

Even better: Wireless IC-ECG

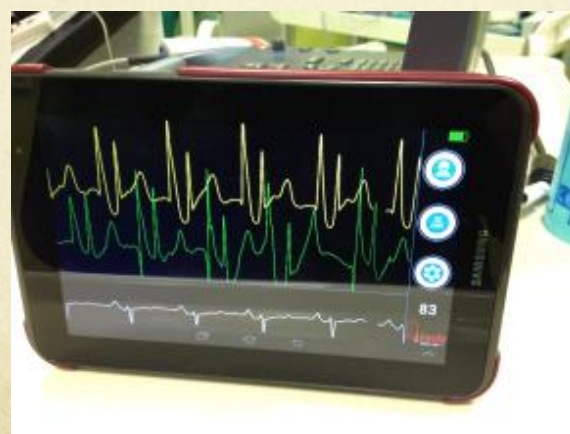


Delta

Delta (Romedex) is **a new wireless system specifically dedicated to the IC-ECG**, which consists of a small box connected to the ECG cables, sending data to a smartphone or a tablet by bluetooth technology.

The phone/tablet is provided with a software application which allows to display both the surface and intracavitary ECG.

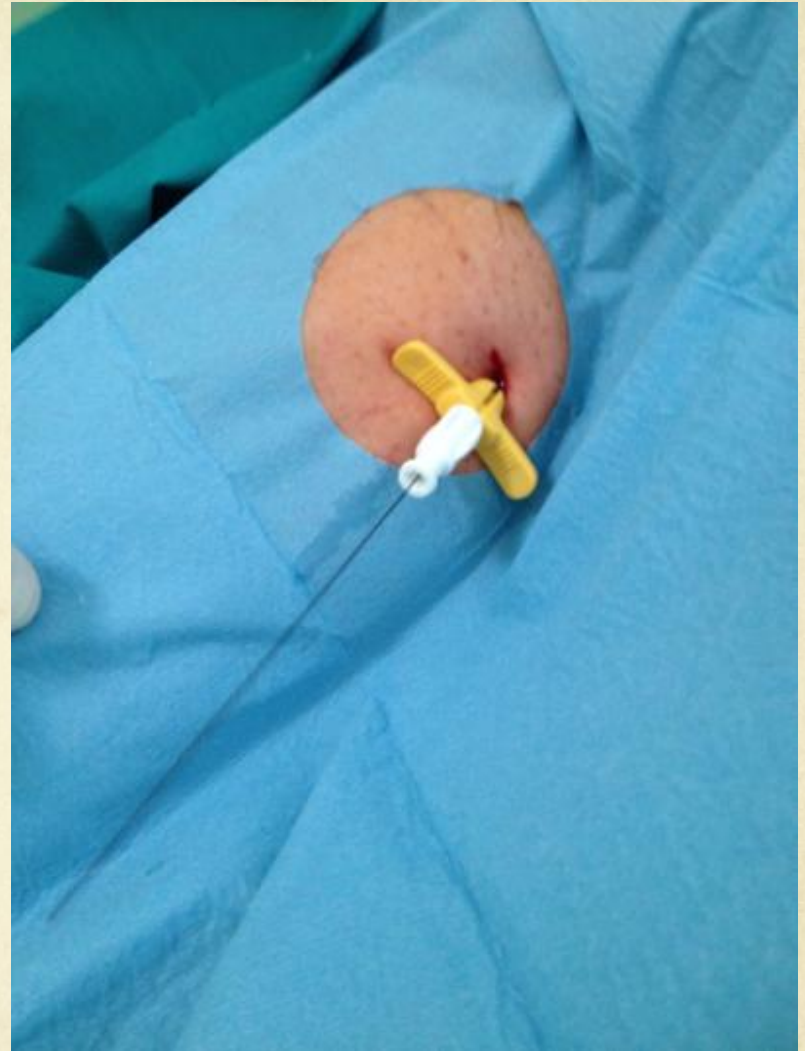
The system can be operated by command buttons placed on the box or directly by touching the screen of the phone/tablet.

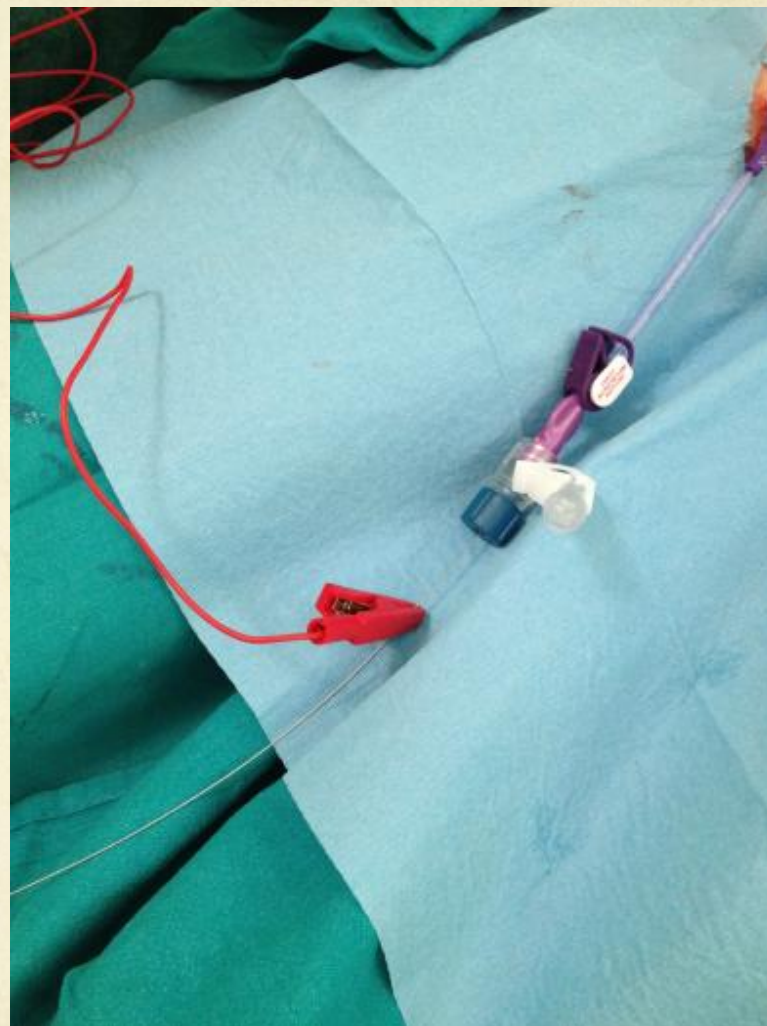


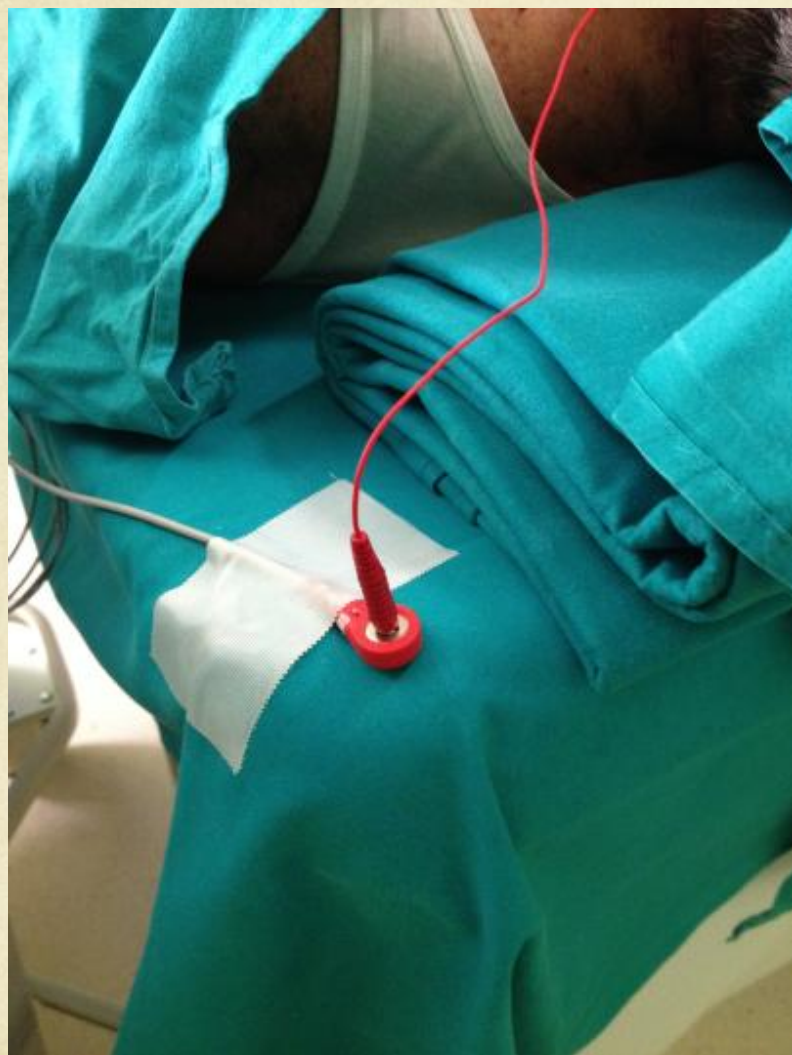
The IC-ECG method is performed according to the standard procedure.

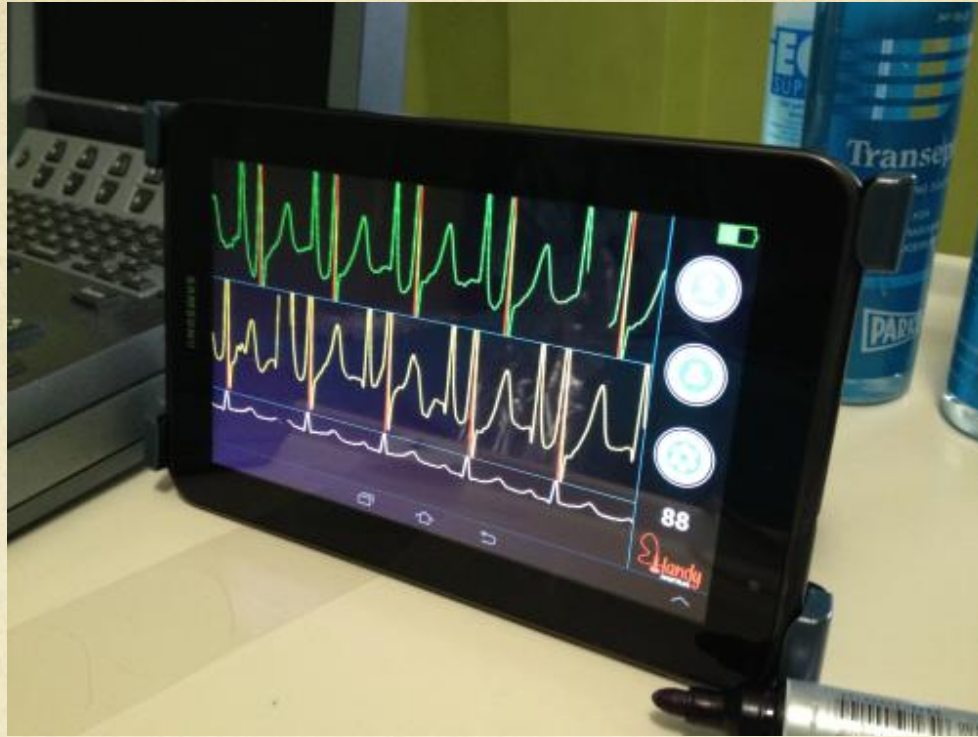
The identification of the peak of the P wave (corresponding to the cavo-atrial junction) is made easy by the freeze function, which can be operated either from the box or from the phone/tablet.

At any time, the display can be saved and/or printed for documentation.











The new device was adopted for tip location in **207** central VADs (154 PICCs, 49 ports, 2 short term CICC's and 2 cuffed-tunneled catheters) placed after cannulation of different veins (96 basilic, 41 brachial, 57 axillary-subclavian, 6 internal jugular, 7 brachio-cephalic) .

The P wave was evident on basal ECG in all patients.

A peak of the P wave was easily detected in all patients.

The P wave was evident on basal ECG in all patients.

A peak of the P wave was easily detected in all patients.

In **36** patients (28 PICCs and 8 ports), the procedure was simultaneously carried out both with a standard dedicated ECG device (Nautilus, Romedex) and with the new wireless device: no differences were noted in terms of performance.

This new wireless system for IC-ECG had an optimal clinical performance in terms of applicability and feasibility.

Transmission of the data to the moveable device by bluetooth simplified the wire connections.

Some potential advantages over other ECG monitors are:

- the system is light and easy to carry - which makes it ideal for bedside insertion;
- it can be operated by the same professional inserting the VAD;
- it implies no risk of electrical hazard;
- it can be used on a personal portable device, allowing easy storage of data and easy printing for documentation.

DELTA

Presented in WoCoVA 2014 and AVA 2014

No published paper available yet

Central venous access in neonates and children: tip location using a new wireless device for intracavitary ECG

Mauro Pittiruti, Davide Celentano
and Daniele Biasucci

Catholic University Hospital, Rome - Italy

AVA 2015

Purpose

Tip location of central lines is particularly important in children and ideally it should be assessed during the procedure.

We have adopted the intracavitary ECG method (IC-ECG) since a decade. We report our recent experience with a wireless device for IC-ECG.

Methods

We reviewed all centrally (CICC) and peripherally inserted central catheters (PICC) placed in our Pediatric Intensive Care Unit (PICU) using a wireless IC-ECG device (Delta, Romedex).



Methods (2)

All insertions were performed according to our [PICU protocol](#): sedation or general anesthesia, ultrasound scan of all veins, maximal barrier precautions, skin antisepsis with 2% chlorhexidine, ultrasound guided venipuncture using a micro-introducer kit, tip location by IC-ECG (maximal height of the P wave = cavo-atrial junction), securement of the catheter by cyanoacrylate glue, sutureless device and transparent dressing.

Results

Wireless IC-ECG was used in **85** children (age range 2 hrs – 12 y.o.: 58 patients were < 2 y.o.). Lowest weight was 1100 g.



Results (2)

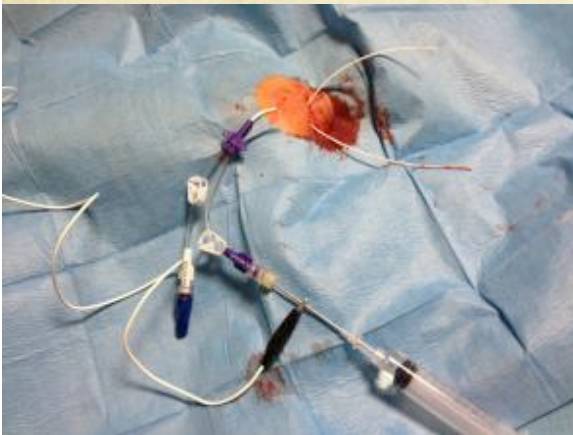
We inserted **81** non-cuffed catheters (power injectable, polyurethane, non-valved, open ended; 3Fr single lumen or 4Fr double lumen):

- **55** CICC's (in 95%, cannulation of the brachio-cephalic vein + tunneling to the infraclavicular area)
- **26** PICC's (cannulation of deep veins of the arm; in 75%, cannulation of the axillary vein at the axilla + tunneling to the arm or to the lateral thoracic area).

In **4** cases, we inserted tunneled, cuffed CICC's (5Fr single lumen) for long term therapy: all 4 were children > 6 years.

Results (3)

We had no insertion-related complications. IC-ECG was easily performed in all cases. Post-procedural confirmation of tip location was performed by echocardiography or (in a few cases) by chest x-ray: no malposition was detected.



Conclusions

Tip location with the new wireless IC-ECG device was applicable, feasible, safe and accurate in 100% of our pediatric patients, even in small neonates.



Please remember

IC-ECG is the preferred choice for tip location.

Hundreds of published papers (1949-2014) have validated the method in terms of accuracy.

Cost effectiveness

Cost-effectiveness

Low cost method

'low cost' training

Applicable even when X-Ray is contraindicated or difficult or expensive (pregnancy, morbid obesity, hospice, home care, etc.)

'real time' verification

i.v. treatment can start immediately after

Save money (cost of X-Ray, cost of repositioning)

Cost effectiveness

In its basic form: **IC-EKG is inexpensive**
(connection cables cost few euros)

Big saving comes from:

- Avoiding expensive equipment (fluoroscopy, TEE)

- Avoiding x-ray expenses (direct and indirect)

- Avoiding delay due to post-procedural chest x-ray or post-procedural TEE/TTE)

- Avoiding need for reposition (it may happen with post-procedural chest x-ray or post-procedural TEE/TTE)

How much cost-effective?

It is highly cost effective for **ports**, if associated with using US guidance and performing the procedure in a dedicated ambient and NOT in a surgical or radiological theater

UCSC data (2010): each port insertion in Day Hospital using US + EKG saves **€ 2500** if compared to insertion in operating room with fluoroscopy

It is highly cost effective for **PICCs**

Every 100 PICC insertions, **€ 7000** saved (UCSC data):

Prevention of 10% malposition - € 200 x 10 = **€ 2000**

Avoid 100 chest x-rays - € 50 x 100 = **€ 5000**

Conclusions

In adult patients, IC-EKG has been proven to be

Applicable in 91-93%

7-9% of adults may not have visible P on surface ECG

Feasible in 99% of cases

Using the saline technique and a dedicated monitor, the 'atrial' P is visible in almost all pts

Accurate in 91-99% of cases (maximal P = CAJ)

'Real' accuracy (IC-EKG vs. TEE): 99%

'Standard' accuracy (IC-EKG vs. Xray): 91-98%

In children, IC-EKG has been proven to be

Applicable in 99.4%

Almost all children have visible P on surface ECG

Feasible in 99.4% of cases

Using the saline technique and a dedicated monitor, the 'atrial' P is visible in almost all children

Accurate in 95-98% of cases (maximal P = CAJ)

Accuracy improves when using a dedicated monitor

	ICEKG	Fluoro	Chest X-ray	TTE	TEE
applicability	93%	99%	99%	100%	100%
feasibility	+++	++	++	+	+
accuracy	+++	+	++	+++	+++
precision	++	+	+	+++	+++
safety	+++	+	++	+++	++
easiness	+++	+	++	+	+
cost effectiveness	+++	+	+	++	+

Intracavitary ECG is accurate (as much as TTE/TEE), 100% safe, highly cost-effective, easy and feasible. Its only limit is that cannot be applied to all patients (in approximately 7% of patients with no evident P wave the method is not applicable).

Do we still need x-ray?

To rule out pleura-pulmonary damage? **NO**

To check tip position? **NO**

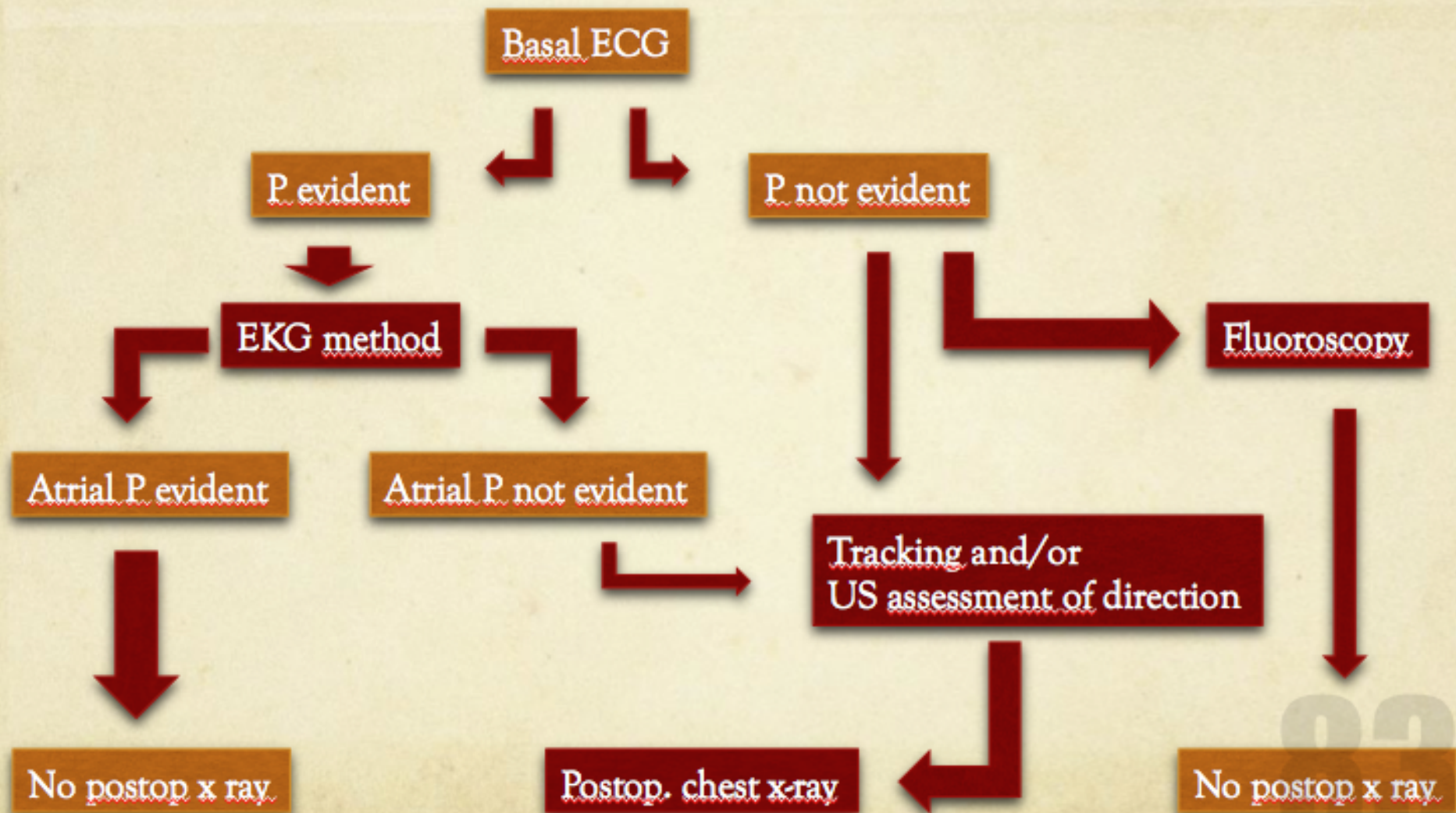
When do we need post-op. x-ray?

If IC-EKG is not applicable (no P evident on surface EKG) – **7-9 %**

If atrial P is not clearly identified during the procedure
(IC-EKG 'not feasible') - **rare**

Any time 'good common sense' suggests it (strange P patterns, resistance to progression etc.) – **rare?**

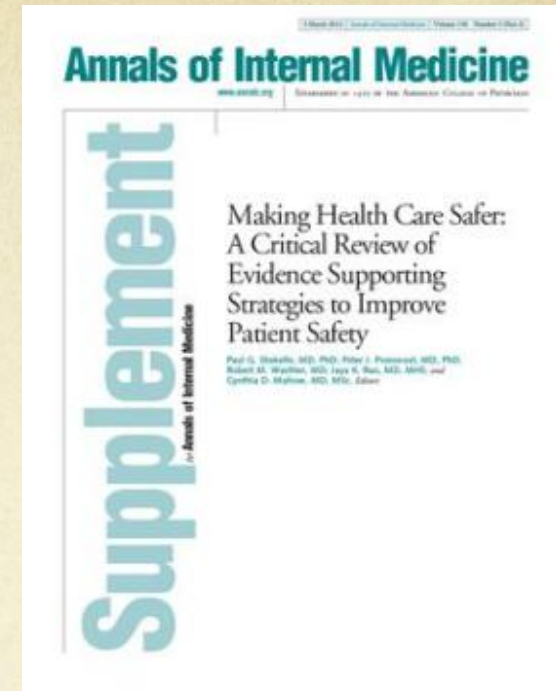
Practical decisional tree



AHRQ Recommendations



2013



Annals of Internal Medicine

SUPPLEMENT

The Top Patient Safety Strategies That Can Be Encouraged for Adoption Now

Paul G. Shekelle, MD, PhD; Peter J. Pronovost, MD, PhD; Robert M. Wachter, MD; Kathryn M. McDonald, MM; Karen Schoelles, MD, SM; Sydney M. Dy, MD, MSc; Kaveh Shojania, MD; James T. Reston, PhD, MPH; Alyce S. Adams, PhD; Peter B. Angood, MD; David W. Bates, MD, MSc; Leonard Bickman, PhD; Pascale Carayon, PhD; Sir Liam Donaldson, MBChB, MSc, MD; Naihua Duan, PhD; Donna O. Farley, PhD, MPH; Trisha Greenhalgh, BM BCH; John L. Haugom, MD; Eileen Lake, PhD, RN; Richard Lilford, PhD; Kathleen N. Lohr, PhD, MA, MPhil; Gregg S. Meyer, MD, MSc; Marlene R. Miller, MD, MSc; Duncan V. Neuhauser, PhD, MBA, MHA; Gery Ryan, PhD; Sanjay Saint, MD, MPH; Stephen M. Shortell, PhD, MPH, MBA; David P. Stevens, MD; and Kieran Walshe, PhD

Table 2. Patient Safety Strategies Ready for Adoption Now

Strongly encouraged

- Preoperative checklists and anesthesia checklists to prevent operative and postoperative events
- Bundles that include checklists to prevent central line–associated bloodstream infections
- Interventions to reduce urinary catheter use, including catheter reminders, stop orders, or nurse-initiated removal protocols
- Bundles that include head-of-bed elevation, sedation vacations, oral care with chlorhexidine, and subglottic suctioning endotracheal tubes to prevent ventilator-associated pneumonia
- Hand hygiene
- The do-not-use list for hazardous abbreviations
- Multicomponent interventions to reduce pressure ulcers
- Barrier precautions to prevent health care–associated infections
- Use of real-time ultrasonography for central line placement
- Interventions to improve prophylaxis for venous thromboembolisms

Encouraged

Multicomponent interventions to reduce falls

Use of clinical pharmacists to reduce adverse drug events

Documentation of patient preferences for life-sustaining treatment

Obtaining informed consent to improve patients' understanding of the potential risks of procedures

Team training

Medication reconciliation

Practices to reduce radiation exposure from fluoroscopy and CT

The use of surgical outcome measurements and report cards, such as those from ACS NSQIP

Rapid-response systems

Use of complementary methods for detecting adverse events or medical errors to monitor for patient safety problems

Computerized provider order entry

Use of simulation exercises in patient safety efforts

Some facts (1)

FIRST FACT

A proper **tip location** methodology – preferably carried out during the procedure – is mandatory in all placements of central lines.

Some facts (2)

SECOND FACT

In adult patients, **intracavitary ECG** should be the preferred method of tip location: it is accurate, safe, easy, inexpensive, highly cost-effective and it can be applied to the vast majority of patients.

Some facts (3)

THIRD FACT

Few selected adult patients might need **intra-procedural fluoroscopy** (when IC-ECG is not applicable or feasible) and/or **post-procedural control of tip location** by chest x-ray or TTE (when intra-procedural tip location has not been carried out or it has provided dubious results).

Some facts (4)

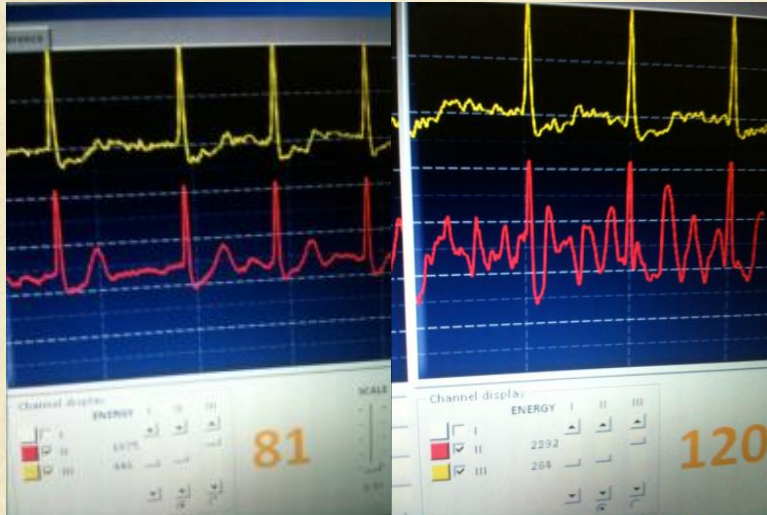
FOURTH FACT

In neonates and children, tip location of central lines can be verified with maximal safety, accuracy and cost-effectiveness by a combination of **intra-cavitary ECG** (during the procedure) and **TTE** (during or after the procedure).

Current controversies (1)

What is the best approach for tip location in the patients with no evident P wave on surface ECG (AF, etc.) ?

One option



The mean increase of the baseline electrical activity on the intracavitary ECG recorded in patients with atrial fibrillation may be used for detecting the transition of the catheter electrode from the superior vena cava to the right atrium

(Engelhardt; Pittiruti et al.)



AF – Study 1

“EKG-controlled placement of central venous catheters in patients with atrial fibrillation”

(Pittiruti, La Greca, Scoppettuolo et al. - INS 2011)

- Prospective clinical study
- Patients with atrial fibrillation candidate to a central line insertion
 - Exclusion criteria: presence of an active pacemaker
- Goal: to investigate the possibility of using the EKG technique for verifying the central position of the tip, using a dedicated device (Nautilus)

○ The cavo-atrial junction was detected by two criteria:

- (a) abrupt appearance of **high-voltage waves** when entering the right atrium and their brisk disappearance when pulling the catheter back into the vena cava superior;
- (b) sudden increase (2-fold, 5-fold) of the amount of **energy recorded** by the intracavitary electrode.

SVC
pattern

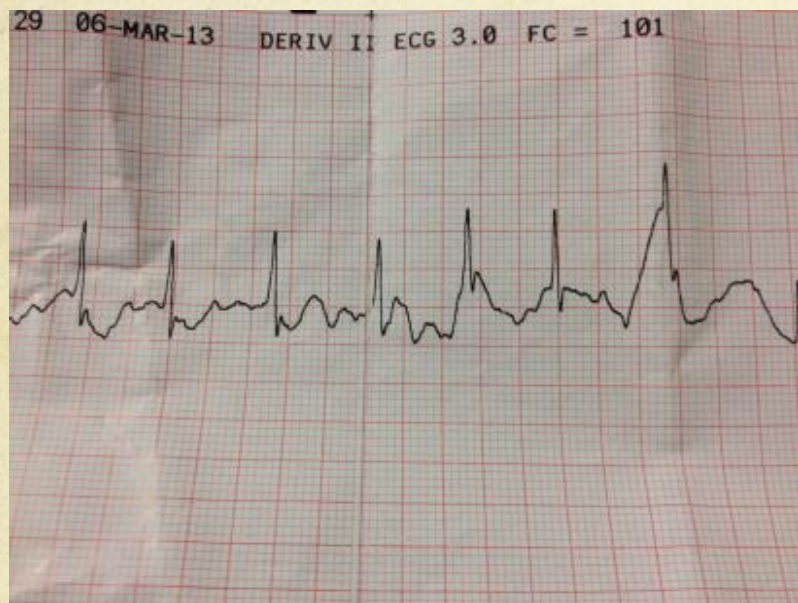


Right Atrium
pattern

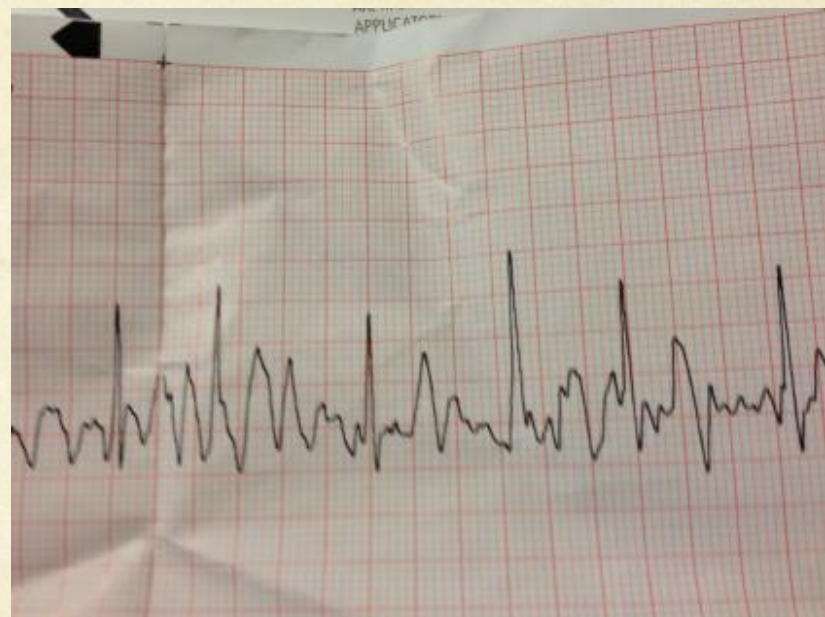


Energy
recorded

SVC pattern



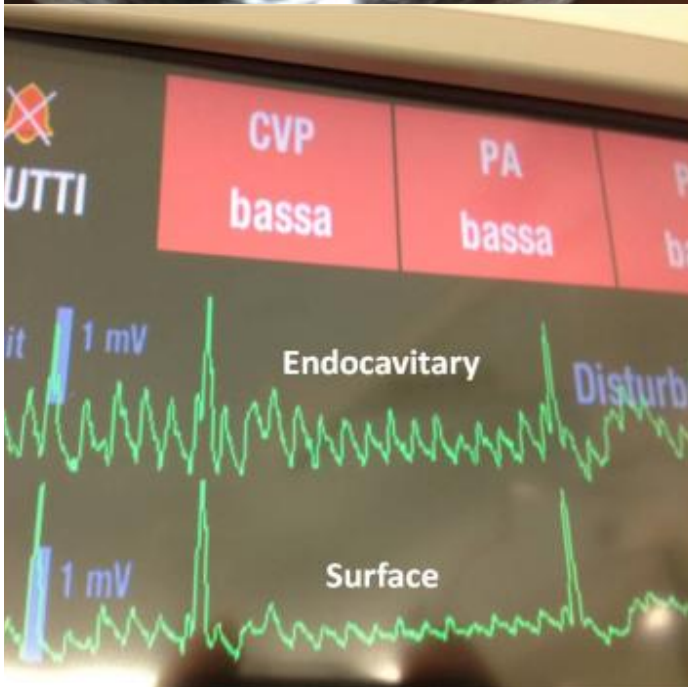
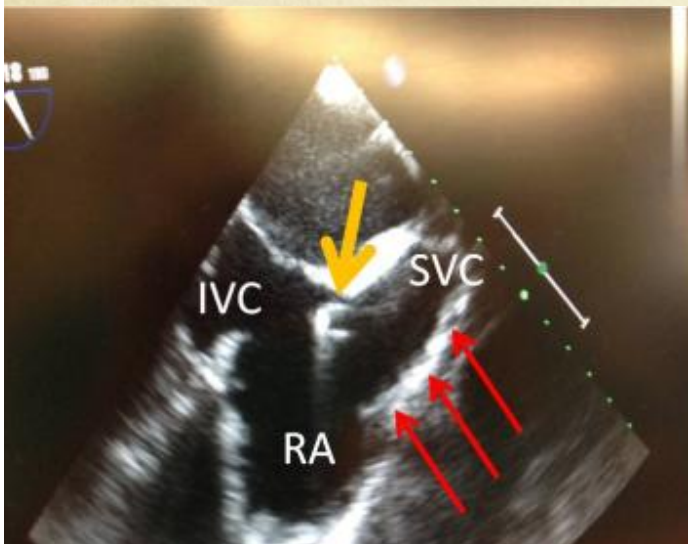
Right Atrium pattern



- The cavo-atrial junction was correctly identified in 25 patients out of 27, as proven by the radiological control.
- In two patients, the ECG pattern was seriously deranged and no clear intra-cavitary ECG tracking could be obtained.

- The intra-cavitary EKG method for verifying the position of the tip of central venous access devices can be applied in most patients with atrial fibrillation, with high accuracy (no false positives; few false negatives).

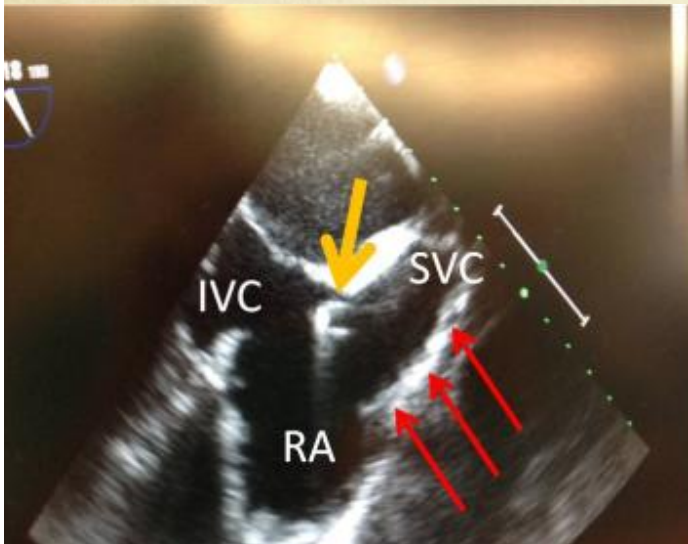
AF – Study 2



- Patients affected by atrial fibrillation and candidate to cardiac surgery (aorto-coronary bypass, valvular replacement) under hemodynamic monitoring via transesophageal echocardiography + CVAD placement in the operating room have been consecutively enrolled.
- In each patient, the TEE probe was inserted after completion of the general anesthesia procedure and adjusted to obtain the atrio-bicaval view

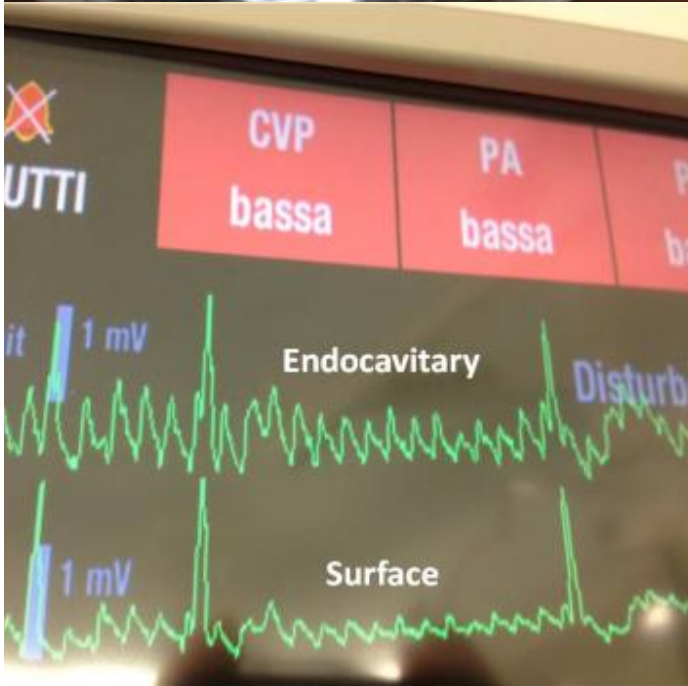


AF – Study 2



CVCs were inserted under ultrasound and IC-ECG guidance according to our Institution standard policy.

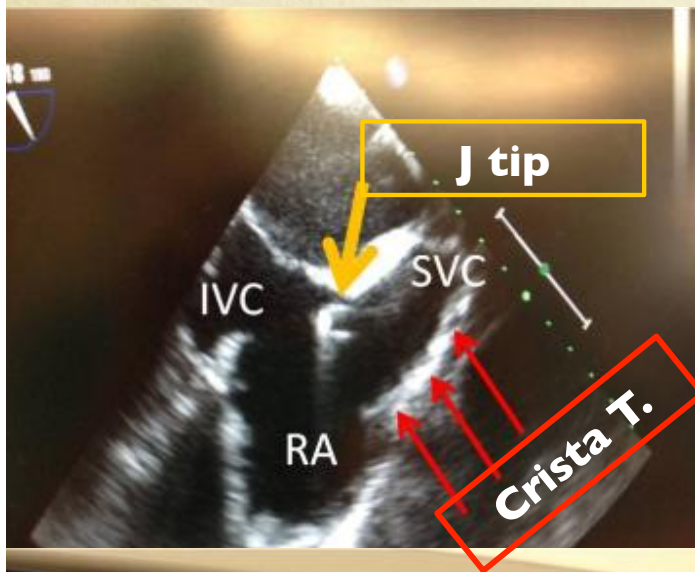
The CVC tip was placed at the CAJ as defined with regard to the crista terminalis, the anatomical and US landmark of the CAJ and then threaded 2 cm below and pulled 2 cm above it always under TEE guidance.



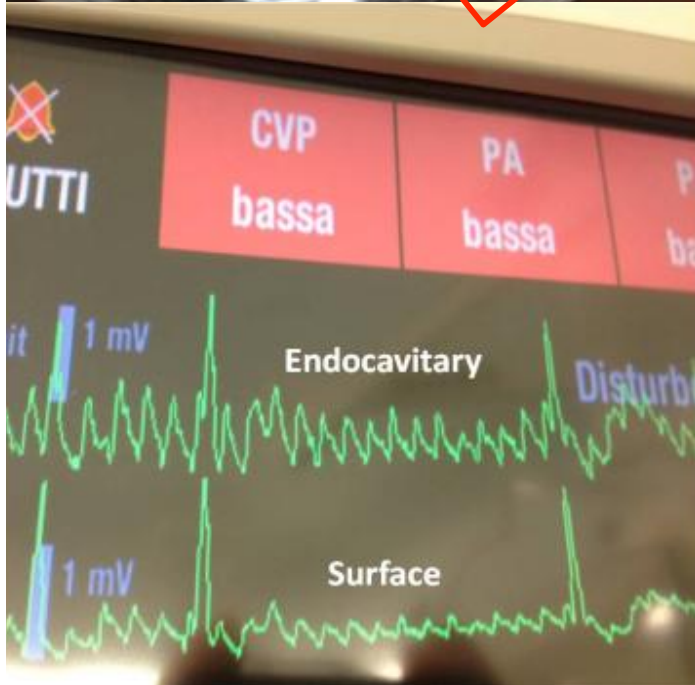
The IC-ECG traces corresponding to the three US-based tip positions were saved for subsequent analysis and the catheter was left in situ at the site defined by TEE.



AF – Study 2



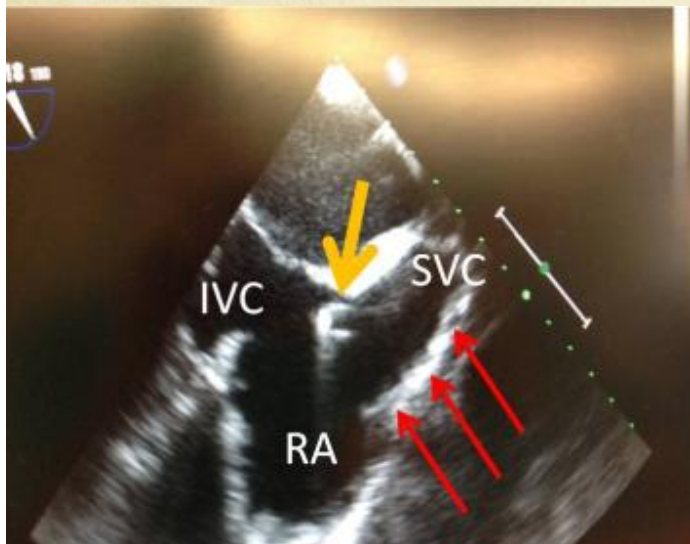
Guidewire J-tip and the crista terminalis can be clearly located by the TEE operator in all patients.



**J tip at the
crista
terminalis**



AF – Study 2



**Abrupt
increase in
intracavitary
T-Q amplitude**

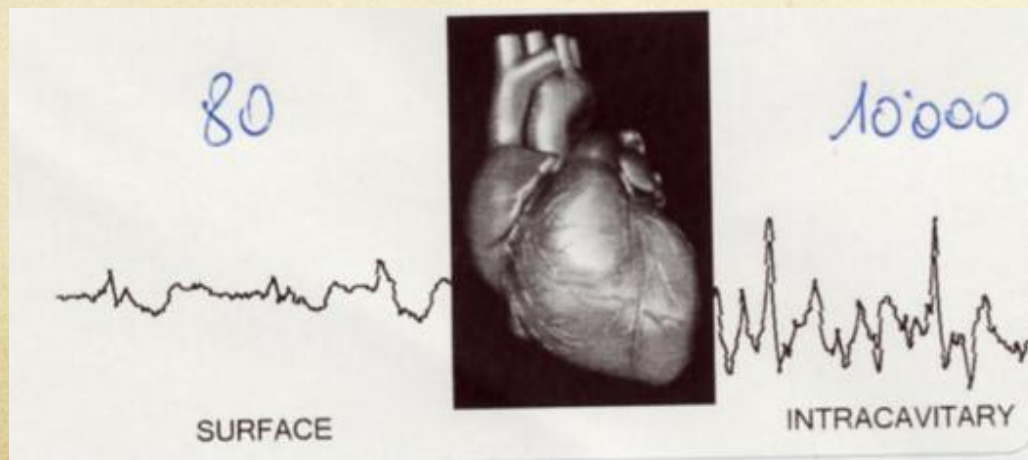
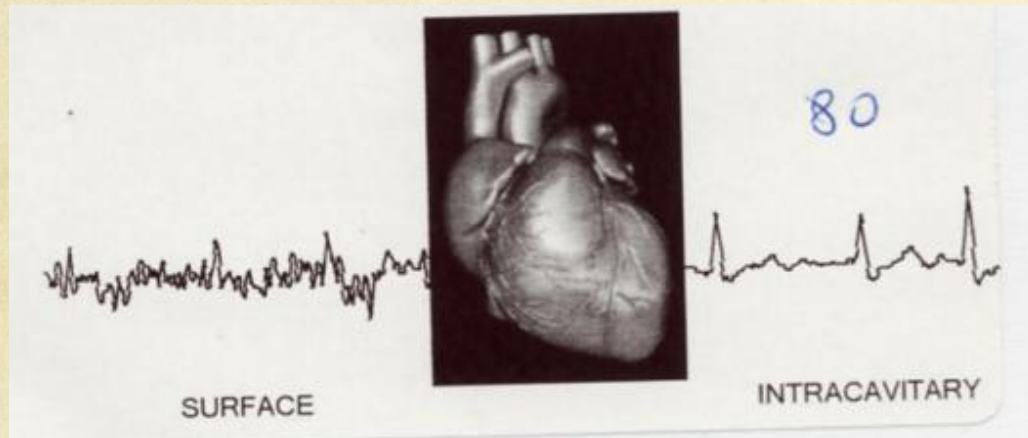


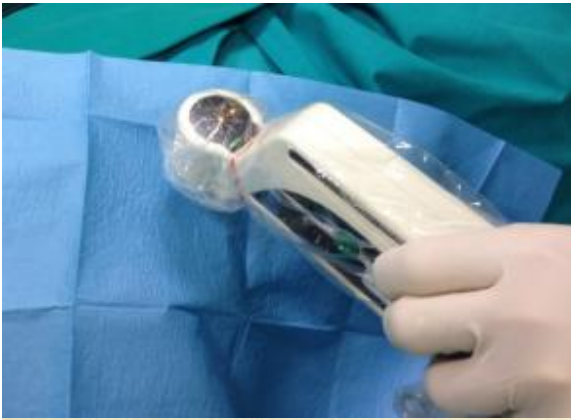
- An abrupt increase in the mean intracavitary amplitude of the asynchronous atrial electrical activity (i.e. the T-Q segment on the ECG trace) as compared to the surface trace was recorded with the J-tip placed at the crista terminalis.
- A clear reduction in amplitude was evident in the two alternative positions in all patients.

Another option

Analyzing the waves.....

The area under the T-Q segment = atrial energy



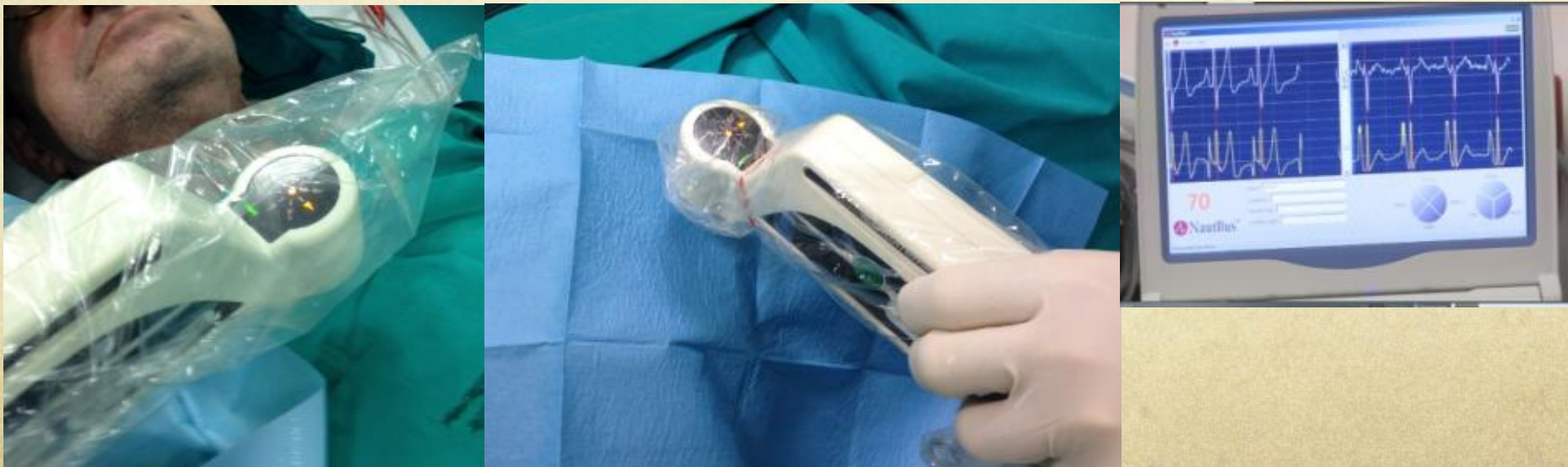


Another possible option

Adding a navigation system may help directing the tip towards the SVC thus obtaining the expected variations in amplitude of P wave or T-Q segment

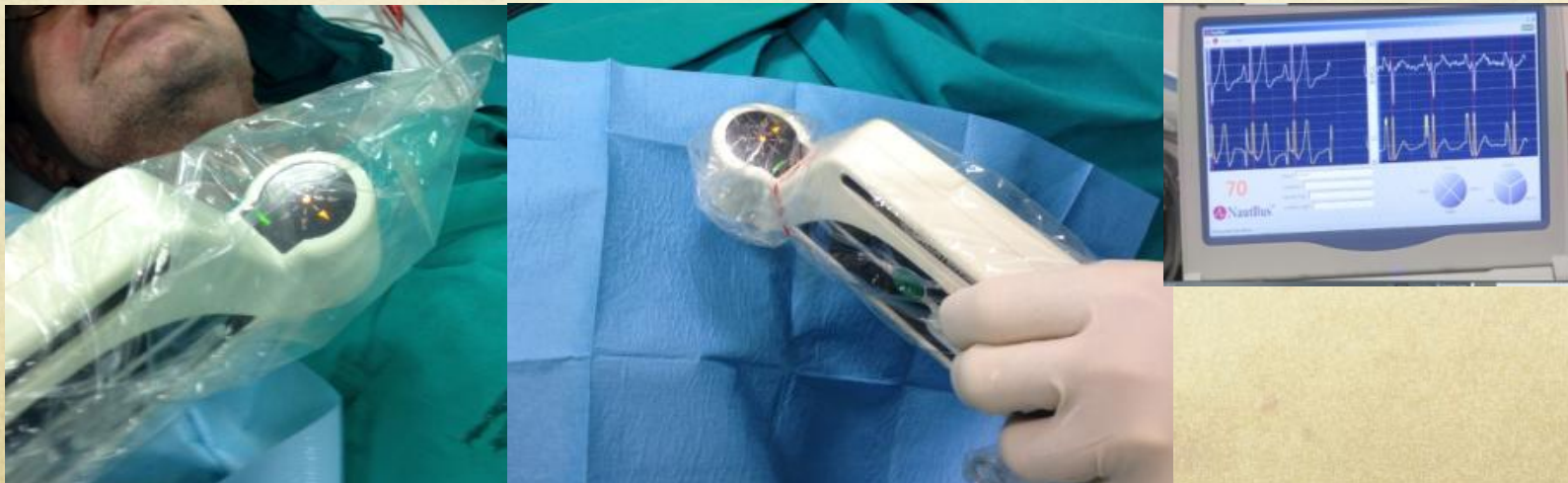
“TIP NAVIGATION + TIP LOCATION: AN ALGORITHM FOR MAXIMIZING SAFETY AND COST-EFFECTIVENESS OF CENTRAL VADs”

- 30 patients consecutively studied during PICC placement
- Navigator (Corpak) as tip navigation system
- Intracavitary ECG method for tip location.



The tip navigation device was successfully used in all patients, making the procedure easier and faster.

In all patients, the correct tip location as evaluated by the intracavitary ECG method corresponded to the electromagnetic detection of the tip below the third intercostal space, with the tip properly directed downward.



AF – one more option ?

Vasonova VPS

Is it useful for tip location in AF?

- No published data on peer-reviewed journals
- Reported success on 5 pts with AF (JAVA, 2014)
- More studies are needed; in particular, a clinical study of doppler alone in AF is highly needed (doppler navigation technology has never been validated separately from IC-ECG)

AF – future options ?

Konings MK et al. - New electric method for correct positioning of PICC - June 14, 2014

Correct positioning of peripherally inserted central venous catheters using a new electric method

Maurits K Konings, Leonard J van Schelven, Ronald C Meijer, Albert H Westra, Roland A Snijder, Anton J van Bortel

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The Netherlands

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MK, LS, AW, and RS are with the dept. of Medical Technology, and RM is with the dept. of Thoracic Surgery, University Medical Center Utrecht, Utrecht, the Netherlands. AB is with Infu-In, Bilthoven, the Netherlands

AF – maybe the best option..

ULTRASOUND:

TTE +/- CEUS

Avoid X-Ray in IC-ECG definitively
unsuitable patients: ULTRASOUND



Ultrasonic Examination

AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 164 2001

An Alternative to Chest Radiography after Central Venous Catheter Insertion?

ERIC MAURY,
Service de Réanimation

Negative assessment:
IJV & SCV (supraclavicular view), RA (subcostal view)

Jerome Bedel

Negative assessment:
**RA (subcostal view) +
predictive length**

**Guidewire localization by transthoracic
echocardiography during central venous
catheter insertion: a periprocedural method
to evaluate catheter placement**

Intensive Care Med (2013) 39:1932–1937

**Ultrasound localization of central vein catheter and detection of
postprocedural pneumothorax: An alternative to chest radiography***

Crit Care Med 2010 Vol. 38, No. 2

Antonella Vezzani,
Mario Mergoni, M

“Positive” assessment:
**Saline + air bubbles in linear flow appearing within 2 seconds
(subcostal view)**



“I have used ultrasound by visualizing all 4 central vessels and RA with agitated saline injection (CEUS) to confirm placement in SVC along with pulmonary US to exclude pneumothorax. However, I do not routinely use this in all patients but in selected cases (such as AF)”

**Jason T Nomura MD, RDMS, posted
on April 11, 2010 in Emergency &
Critical Care Ultrasound
Community Discussions,
www.aiumcommunities.org**



Current controversies (2)

Which protocol/algorithm for tip location and tip navigation is associated with the maximal cost-effectiveness ?

This cannot be determined yet.

Our current algorithm

1) P wave evident:

- tip location by IC-ECG (peak of P wave = CAJ);
- tip navigation by ultrasound (when using a standard ECG monitor) or by ECG-based navigation (when using Delta)

Our current algorithm

2) P wave absent:

- in AF: tip navigation by NAV, with approximated tip location (third intercostal space on the right parasternal line) + tip location by IC-ECG (abrupt change in amplitude of TQ)
- in APM or other arrhythmias: tip navigation by NAV, for approximated tip location (see above) + confirmation by TTE (intra-procedural) or chest X-Ray (post-procedural).

Final remarks

- 1) use an **intra-procedural tip location** method whenever possible (preferably based on IC-ECG)
- 2) When adopting a tip navigation method as an add-on to tip location, **consider its cost-effectiveness** (which is still under debate for many devices)
- 3) The most cost-effective method of tip location for **AF patients** is still uncertain

Our Vascular Team....

