XII PICC DAY

Bologna
4 dicembre 2018

Il punto sulla tip location
Il ruolo centrale dell'ECG intracavitario, anche nel paziente con fibrillazione atriale

Antonio La Greca
Chirurgia d'Urgenza
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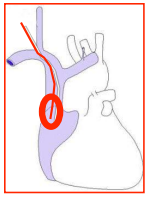
Sacro Cuore ROMA

GAVeCeLT
Gli Accessi Venosi Centrali a Lungo Termine

Gemelli
Fondazione Policlinico Universitario Agostino Gemelli IRCCS
Università Cattolica del Sacro Cuore



Tip location:
during CVC insertion !!!


Clinical Nutrition 28 (2009) 365–377

Contents lists available at ScienceDirect

Clinical Nutrition

journal homepage: http://www.elsevier.com/locate/clnu

ELSEVIER

ESPEN Guidelines on Parenteral Nutrition: Central Venous Catheters (access, care, diagnosis and therapy of complications)

Mauro Pittiruti [a], Helen Hamilton [b], Roberto Biffi [c], John MacFie [d], Marek Pertkiewicz [e]

“Ideally, the position of the tip should be checked ***during*** the procedure“

“Use methods for identifying CVAD tip location ***during*** the insertion procedure (ie, real time) due to greater accuracy, more rapid initiation of infusion therapy, and reduced costs“

Avoid complications due to malposition

Avoid costs of repositiong procedures

(2-30% without intraprocedural monitoring)

Intraprocedural tip location: IC-ECG !!!

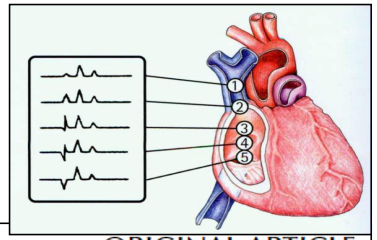
Intracavitary ECG is a well established method for verifying the position of the tip of a CVC

J Vasc Access 2011; 12 (4): 280-291
DOI: 10.5301/JVA.2011.8381

REVIEW

The electrocardiographic method for positioning the tip of central venous catheters

Mauro Pittiruti[1], Antonio La Greca[1], Giancarlo Scoppettuolo[2]



J Vasc Access 2012; 13 (3): 357-365
DOI: 10.5301/JVA.2012.9020

ORIGINAL ARTICLE

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

Mauro Pittiruti[1], Daniele Bertollo[2], Ermanno Briglia[3], Massimo Buononato[4], Giuseppe Capozzoli[5], Luigi De Simone[6], Antonio La Greca[1], Cecilia Pelagatti[7], Pier Sandro Sette[8]

JVA
ISSN 1129-7298

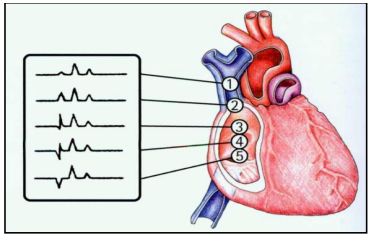
J Vasc Access 2015; 16 (2): 137-143
DOI: 10.5301/jva.5000281

ORIGINAL ARTICLE

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

Francesca Rossetti[1], Mauro Pittiruti[2], Massimo Lamperti[3], Ugo Graziano[4], Davide Celentano[5], Giuseppe Capozzoli[6]

Tip location: IC-ECG

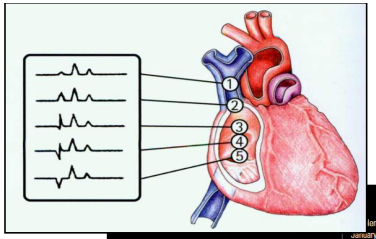


	Adults*	Children**
Accuracy	94.5%	95.8%
Feasibility	98.5%	99.3%

*The intracavitary ECG method for positioning the tip of central venous catheters: results of an Italian multicenter study. M Pittiruti et al J Vasc Access 2012;13(3):357-365

** The intracavitary ECG method for positioning the tip of central venous devices in pediatric patients: a multicenter study. F. Rossetti, M. Pittiruti et al. J Vasc Access, 2015;16(2):137-143

IC-ECG: guidelines !!!



Not only as as an alternative to X-Ray based controls ...

Clinical Nutrition 28 (2009) 365–377

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journal homepage: http://www.elsevier.com/locate/clnu

ESPEN Guidelines on Parenteral Nutrition: Central Venous Catheters (access, care, diagnosis and therapy of complications)

Mauro Pittiruti [a], Helen Hamilton [b], Roberto Biffi [c], John MacFie [d], Marek Pertkiewicz [e]

of malposition may be minimized by using a technique for intra-operative control of the position of the catheter tip (including fluoroscopy and ECG-based methods).

Ideally, the position of the tip should be checked during the procedure,[27] either by fluoroscopy or by the ECG method.[28,29] If the

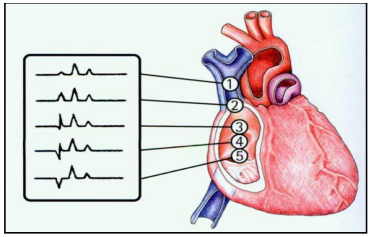
... but even as a first-choice method

E. Use methods for identifying CVAD tip location during the insertion procedure (ie, "real time") due to greater accuracy, more rapid initiation of infusion therapy, and reduced costs.

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.

Clinical Nutrition 28 (2009) 365–377

No more X-Rays



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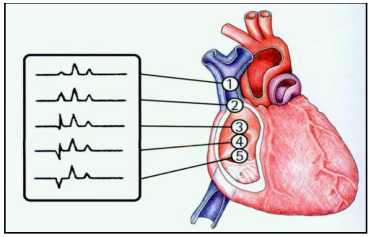
If the position has not been checked intraoperatively, a post-procedural chest X-ray should be performed to check the position of the tip

ESPEN Guidelines on Parenteral Nutrition: Central Venous Catheters (access, care, diagnosis and therapy of complications)

Mauro Pittiruti [a], Helen Hamilton [b], Roberto Biffi [c], John MacFie [d], Marek Pertkiewicz [e]

Postprocedure radiograph imaging is not necessary if alternative tip location technology confirms proper tip placement (II).

TIP LOCATION 2011-2016



Standard of care: IC-ECG …

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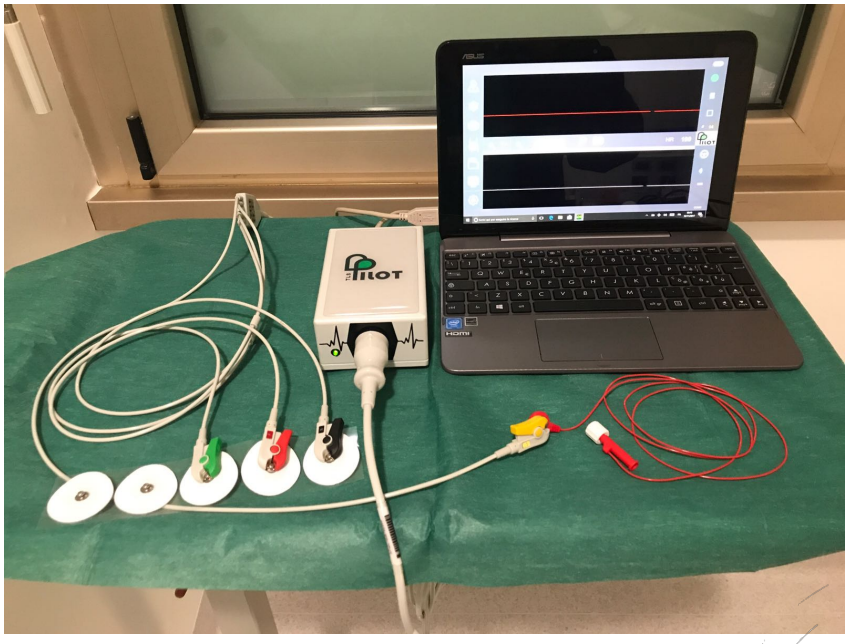
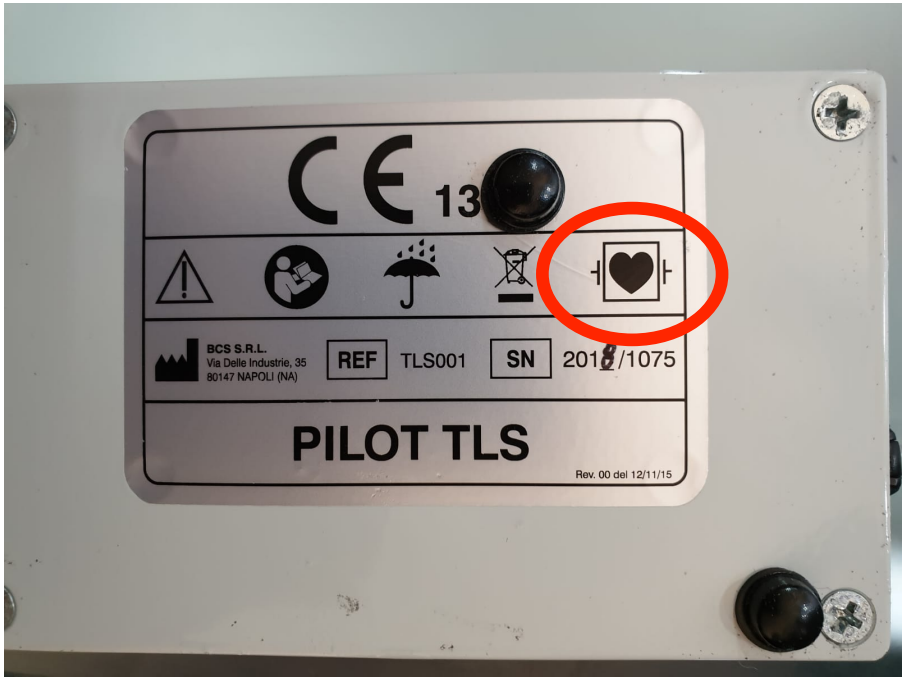
Dedicated monitors …
… improving feasibility



Electrical safety
Portable
Signal quality and target wave identification

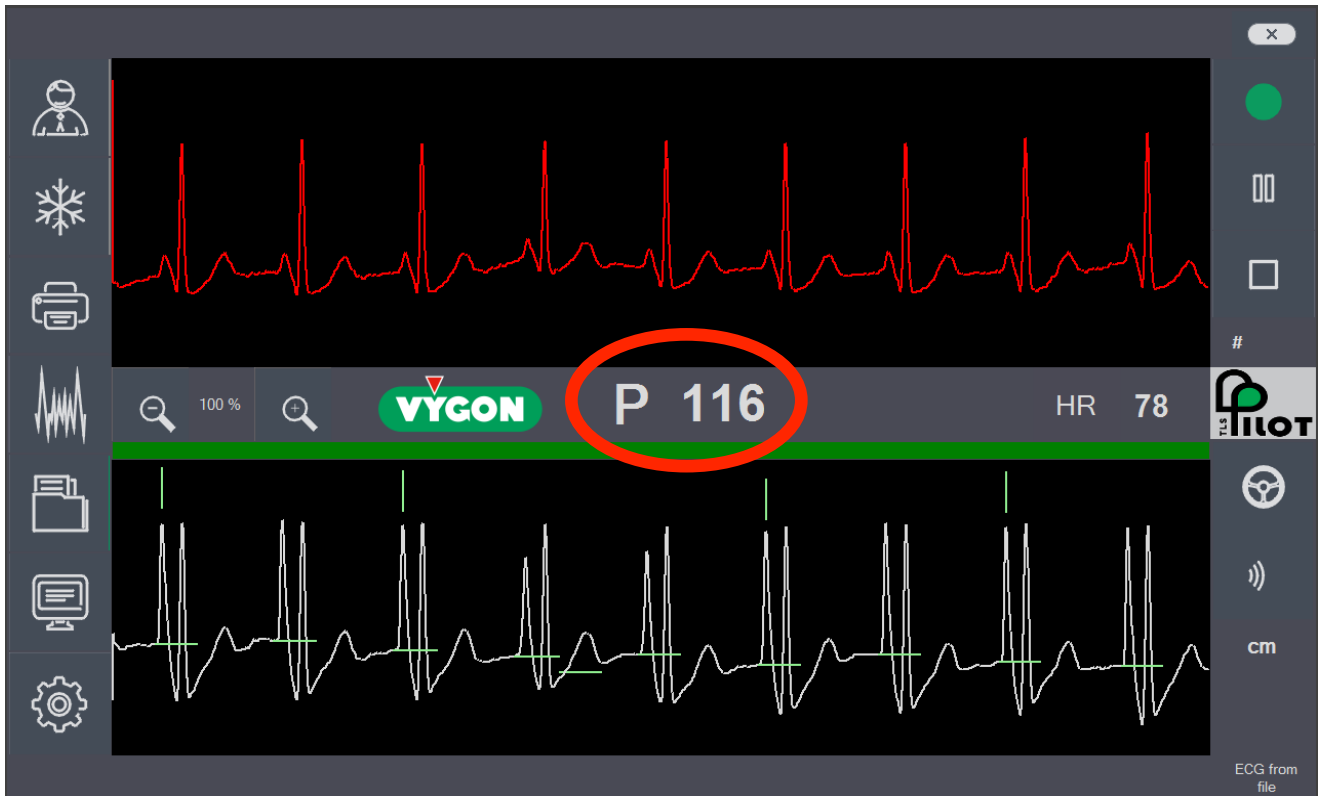
Electrical safety



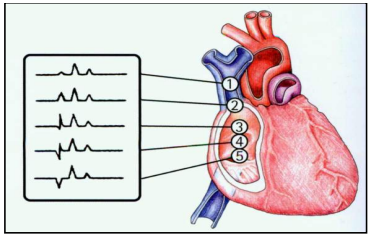
Portability

Good signal quality
Complete but user friendly dashboard
Quantitative p-wave measures

Easier target wave identification



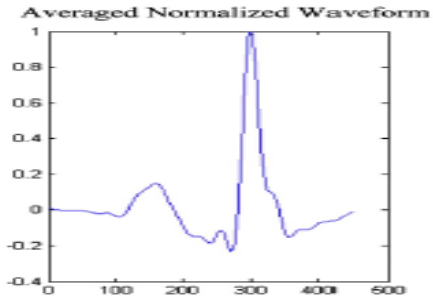
Problem …



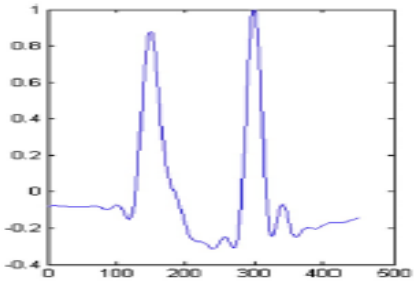
IC-ECG is based on the interpretation of changes of the p-wave during intracavitary detection of ECG:

- maximal p-wave = CAJ

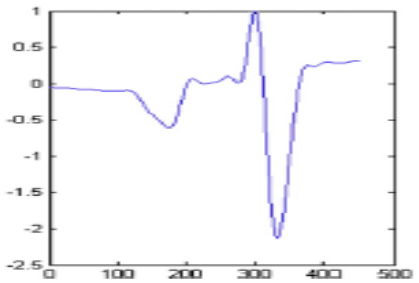
Subclavian vein



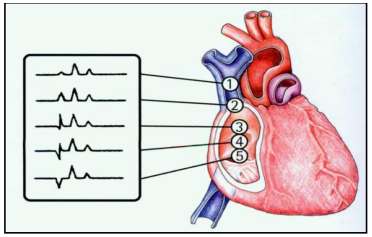
Atriocaval junction



Inferior vena cava



Problem …

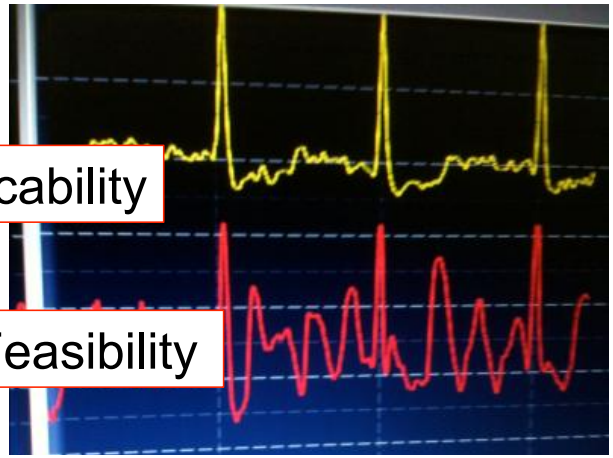


IC-ECG is based on the interpretation of changes of the p-wave during intracavitary detection of ECG:

- maximal p-wave = CAJ

Conventional IC-ECG cannot be carried out when the p-wave is:

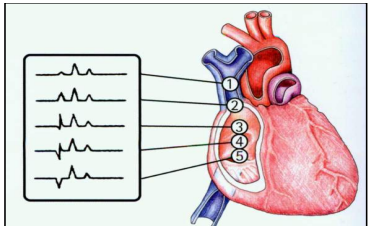
- absent (atrial fibrillation);
- abnormal (ectopic rhytms)
- hidden (active pacemakers)
- difficult to identify/evaluate (extreme tachycardia, malposition)



Un-Applicability

Un-Feasibility

Problem …



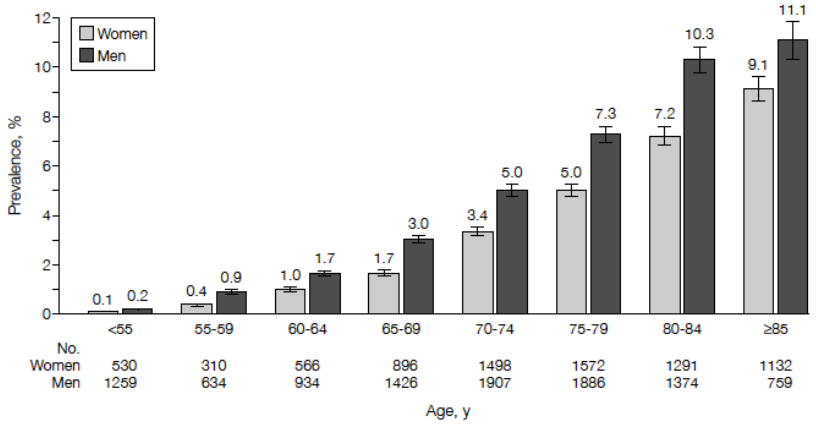
A subgroup of patients cannot benefit from IC-ECG:

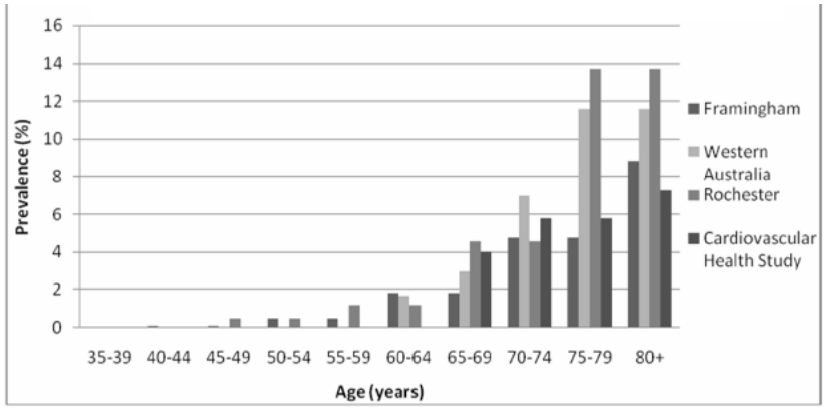
a) Patients without an evident P wave or with abnormal P on their basal surface ECG tracking

- atrial fibrillation or other morphologic abnormalities of p wave (junctional rhythms and others)
- Active atrial pace-makers

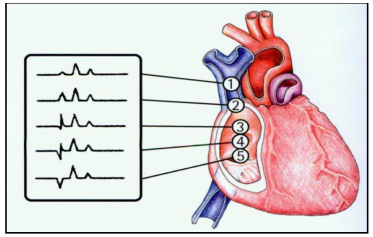
Global **applicability** (in-hospital): 91-93%

Figure 2. Prevalence of Diagnosed Atrial Fibrillation Stratified by Age and Sex





Problem …



A subgroup of patients cannot benefit from IC-ECG:

b) Difficult interpretation of a potentially detectable IC p-wave

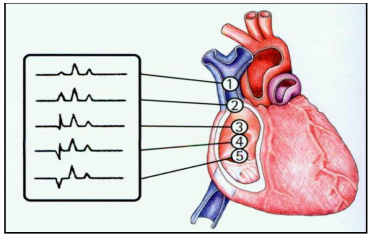
- training ? correct procedural flow
- technical problems (electrical interference, cable or monitor quality)
- tachyarrythmias ?
- trembling or non cohoperating patients

c) No p-waves variations detected despite potentially detectable IC p-wave

- refractory primary malposition
- technical problems

Global **feasibility**
(italian multicenter studies)
98.5-99.3%

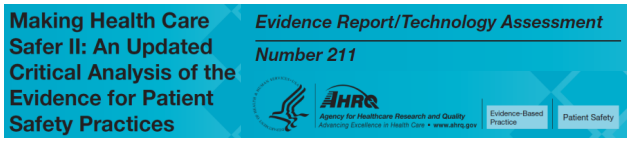
Problem …



2. Assess patient for known history of cardiac dysrhythmias and the presence of a P wave on ECG (if available) before planning to use ECG technology for placement. Contraindications to the use of ECG technology include patients with an abnormal ECG rhythm with an absence or alteration in the P wave (eg, presence of pacemakers, atrial fibrillation, extreme tachycardia). Follow manufacturers' directions for use in the appropriate patient populations.

No more X-Rays

We still want to strictly adhere to the 2013 AHRQ statement



Annals of Internal Medicine | SUPPLEMENT

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

Annals of Internal Medicine

March 2013 | Annals of Internal Medicine | Volume 158 • Number 5 (Part 2) | 365

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

Intra-procedural tip location in the IC-ECG unsuitable patients: how ?

- Introducing alternative tip location methods
- Adding further tip location and/or navigation technologies to IC-ECG
- Improving applicability of IC-ECG (modified IC-ECG)
- Integrating all the above mentioned strategies (an algorithm)

Intra-procedural tip location in the IC-ECG unsuitable patients: how ?

- Introducing alternative tip location methods

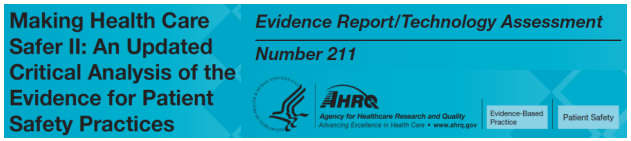
Intra-procedural tip location in the IC-ECG unsuitable patients: how ?

- Introducing alternative tip location methods
  - Fluoroscopy
  - Echocardiography
    - Trans-esophageal
    - Trans-thoracic
  - Modified IC-ECG

Intra-procedural tip location: Fluoroscopy

- Expensive
- Logistically unsustainable
- Inaccuracy of radiological landmarks
- X-Ray exposure (AHRQ 2013)

Intra-procedural tip location: Fluoroscopy



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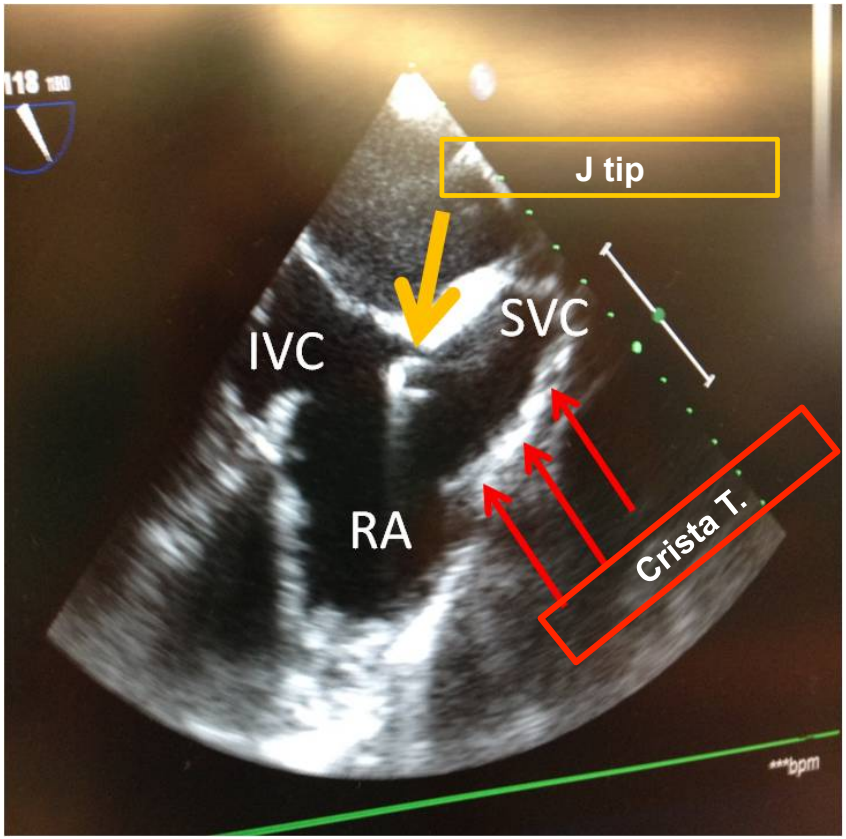
Intra-procedural tip location: Fluoroscopy

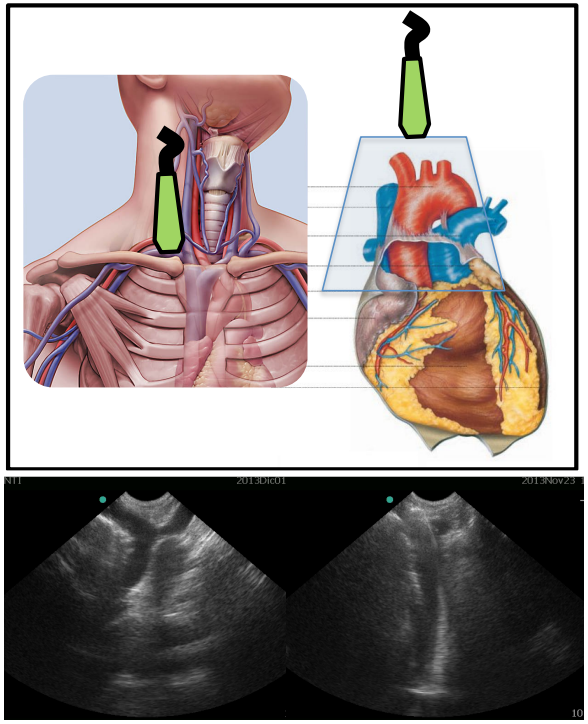
4. Avoid fluoroscopy except in the case of difficult CVAD insertions, as it requires exposure to ionizing radiation.

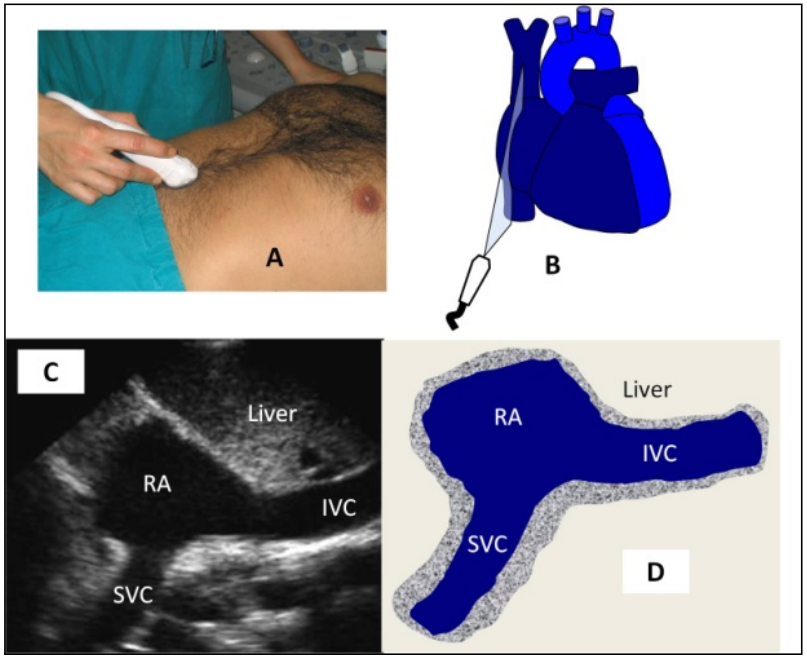
Intra-procedural tip location: Trans-Esophageal Echocardiography

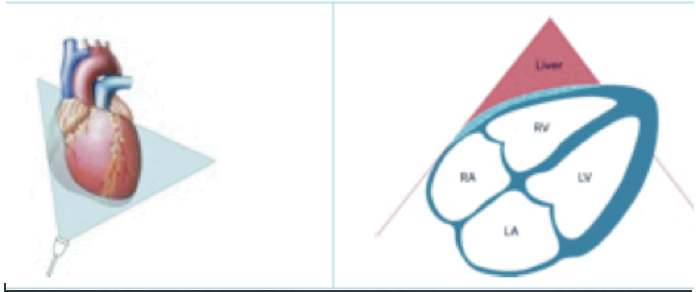
- The most accurate
- Invasive
- Specialty-based
- Only for patients under general anesthesia

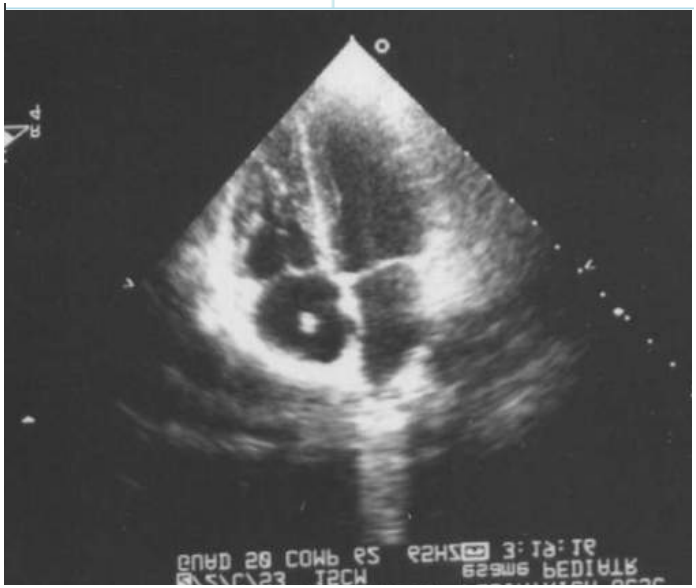


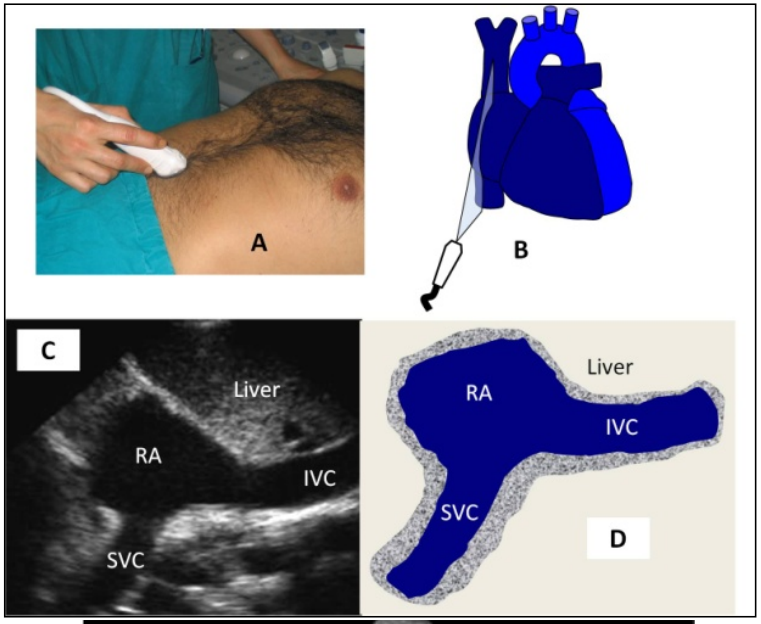
Intra-procedural tip location:
Trans-Thoracic Ecocardiography

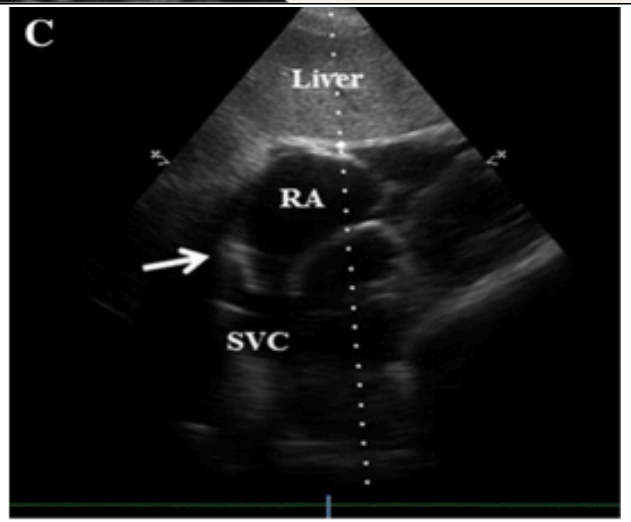


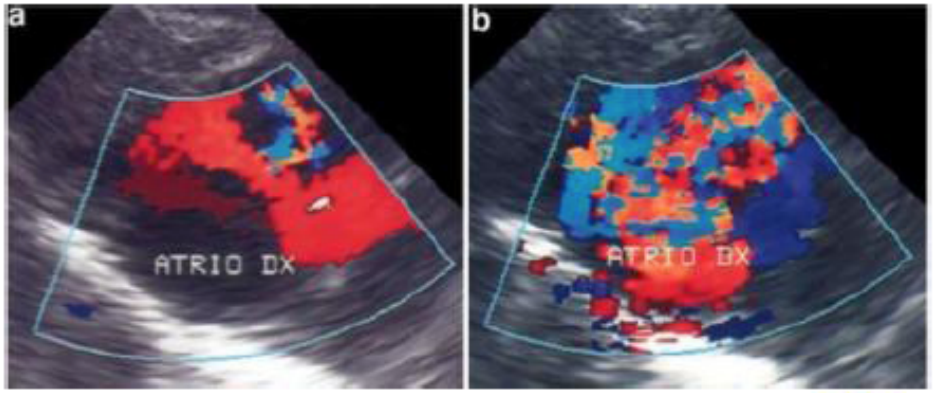


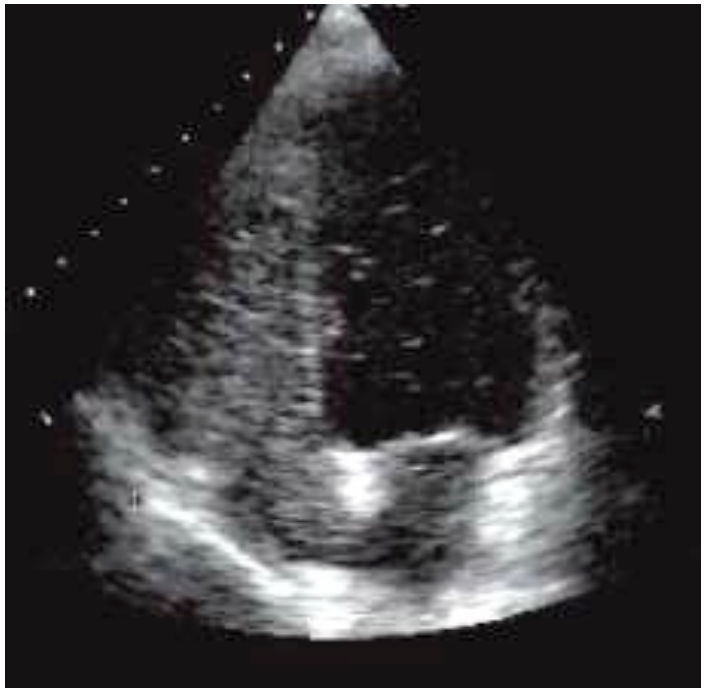

Liver
RV
RA
LV
LA




A
B
C
Liver
RA
IVC
SVC
Liver
RA
IVC
SVC
D


C
Liver
RA
SVC


a
ATRIO DX
b
ATRIO DX



Intra-procedural tip location: Trans-Thoracic Ecocardiography

Intensive Care Med (2012) 38:1105–1117
DOI 10.1007/s00134-012-2597-x

CONFERENCE REPORTS AND EXPERT PANEL

Massimo Lamperti
Andrew R. Bodenham
Mauro Pittiruti
Michael Blaivas
John G. Augoustides

International evidence-based recommendations on ultrasound-guided vascular access

Table 4 Recommendations on ultrasound vascular access in adults and cost-effectiveness

Ultrasound vascular access in adults				
Domain code	Suggested definition	Level of evidence	Degree of consensus	Strength of recommendation
D4.SD2.S1	Ultrasound guidance should be routinely used for short-term central venous access in adults	A	Very good	Strong
D4.SD2.S2	Ultrasound guidance should be routinely used for long-term central venous access in adults	A	Very good	Strong
D4.SD2.S3	PICCs should be routinely inserted at mid arm level by ultrasound guidance using micro introducer technique	A	Very good	Strong
D4.SD2.S4	Use of ultrasound guidance should be taken into consideration for any kind of peripheral intravenous line when difficult access is anticipated	B	Very good	Strong
D4.SD2.S5	Ultrasound-guided arterial catheterization improves first-pass success and should be used routinely in adults	A	Very good	Strong
D4.SD2.S6	Ultrasound can accurately detect pneumothorax and should be routinely performed after central venous catheter cannulation when the pleura could have been damaged	B	Very good	Strong
D4.SD2.S7	CEUS (contrast-enhanced ultrasound) is a valid method for detecting a central venous catheter tip in the right atrium	B	Very good	Strong
Cost-effectiveness of the use of ultrasound for vascular cannulation				
D5.S1–3	Ultrasound-guided vascular access has to be used because it results in clinical benefits and reduced overall costs of care makes it cost-effective	A	Very good	Strong

Intra-procedural tip location: Trans-Thoracic Ecocardiography

3. Use caution with ultrasound for CVAD tip location, as its use in replacing chest radiographs is controversial in all ages due to small sample sizes in available studies and lack of standardized techniques. Consider use in neonates and in emergency departments when immediate knowledge of the CVAD tip location is beneficial.

Intra-procedural tip location in the IC-ECG unsuitable patients: how ?

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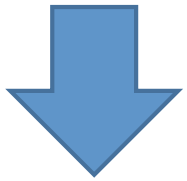
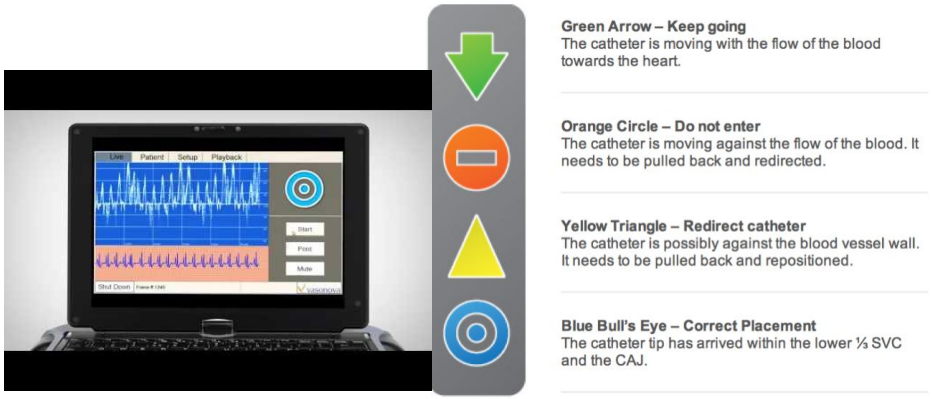


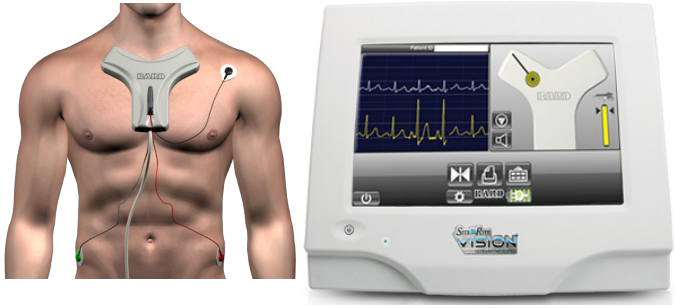
IMPROVING FEASIBILITY

Improving feasibility:
“integrated devices” (IC-ECG + navigation)

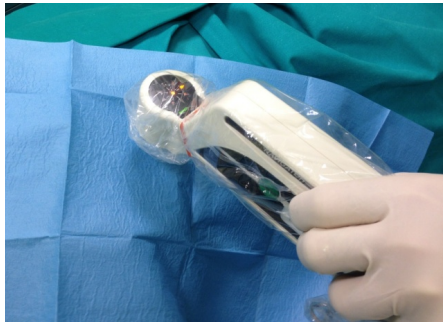
ECG + doppler



ECG
+ presso-acoustic waves



ECG
+ electromagnetic tracking



Improving feasibility: IC-ECG + navigation

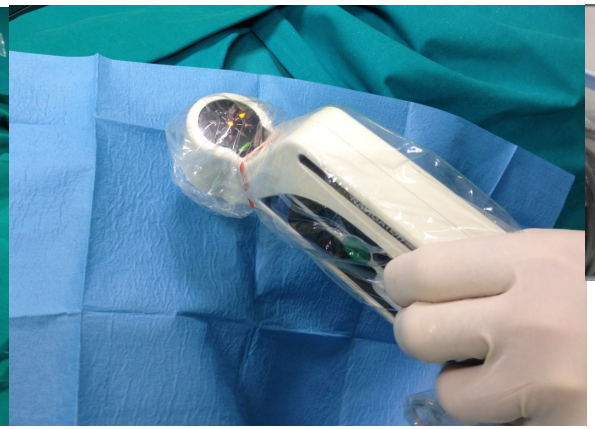
Adding a navigation system may help directing the tip towards the SVC thus obtaining the expected variations in amplitude of P wave or T-Q segment

(improve feasibility)

Improving feasibility: IC-ECG + navigation study

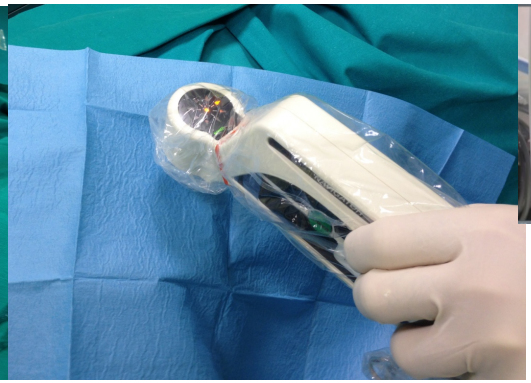
"TIP NAVIGATION + TIP LOCATION: AN ALGORITHM FOR MAXIMIZING SAFETY AND COST-EFFECTIVENESS OF CENTRAL VADs"

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

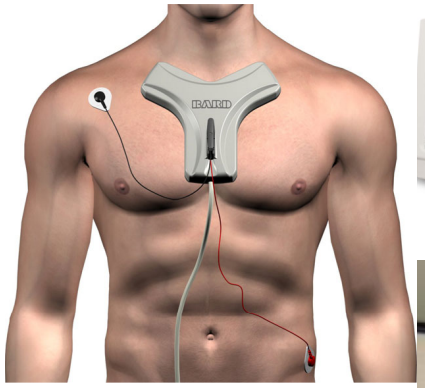


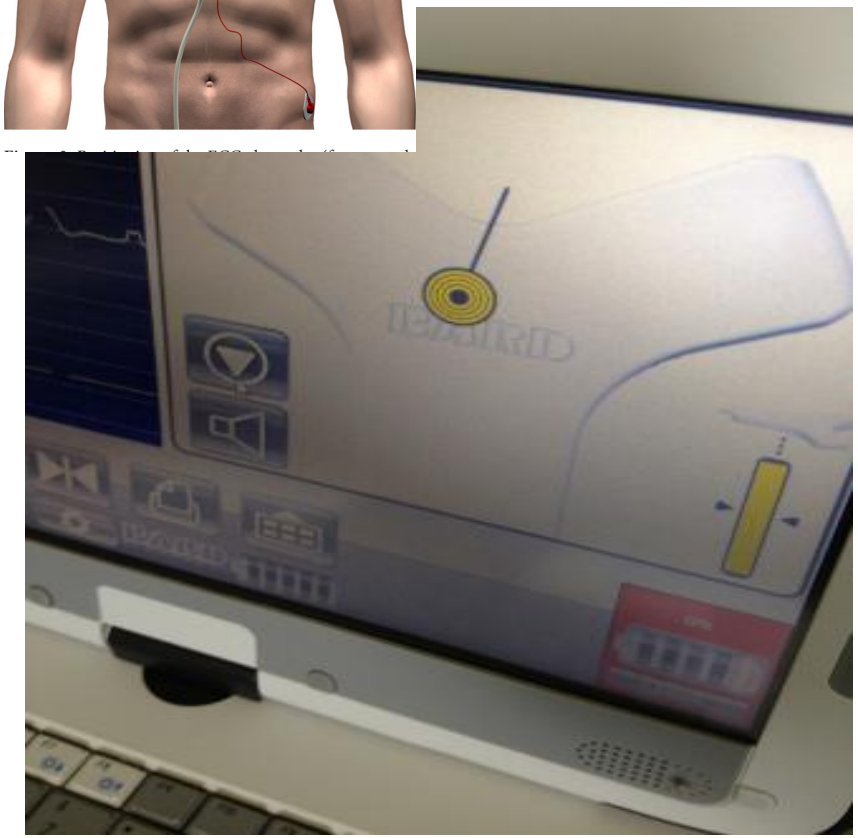
Improving feasibility: IC-ECG + navigation study

- 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.



New Sherlock (3CG)





Tip navigation by VPS Rhythm

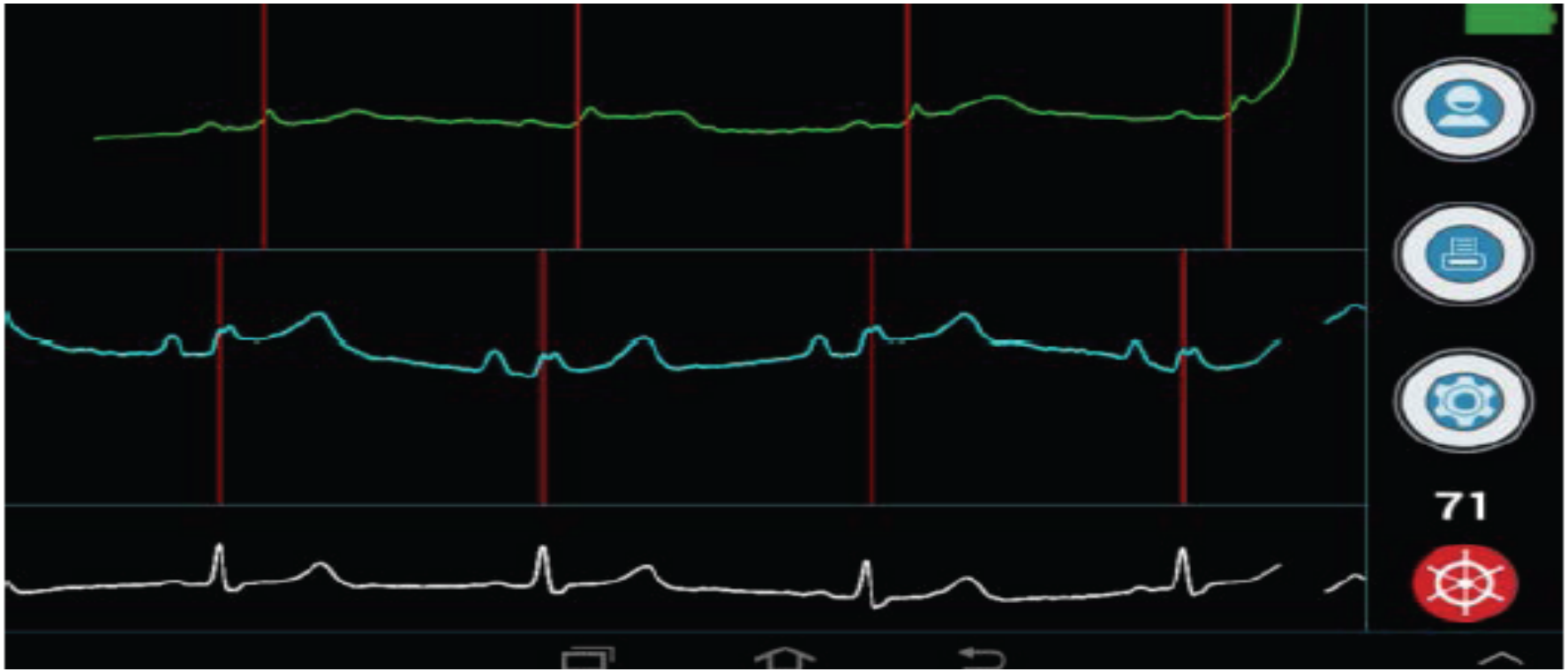
Arrow Teleflex

Improving feasibility:
IC-ECG navigation!!!

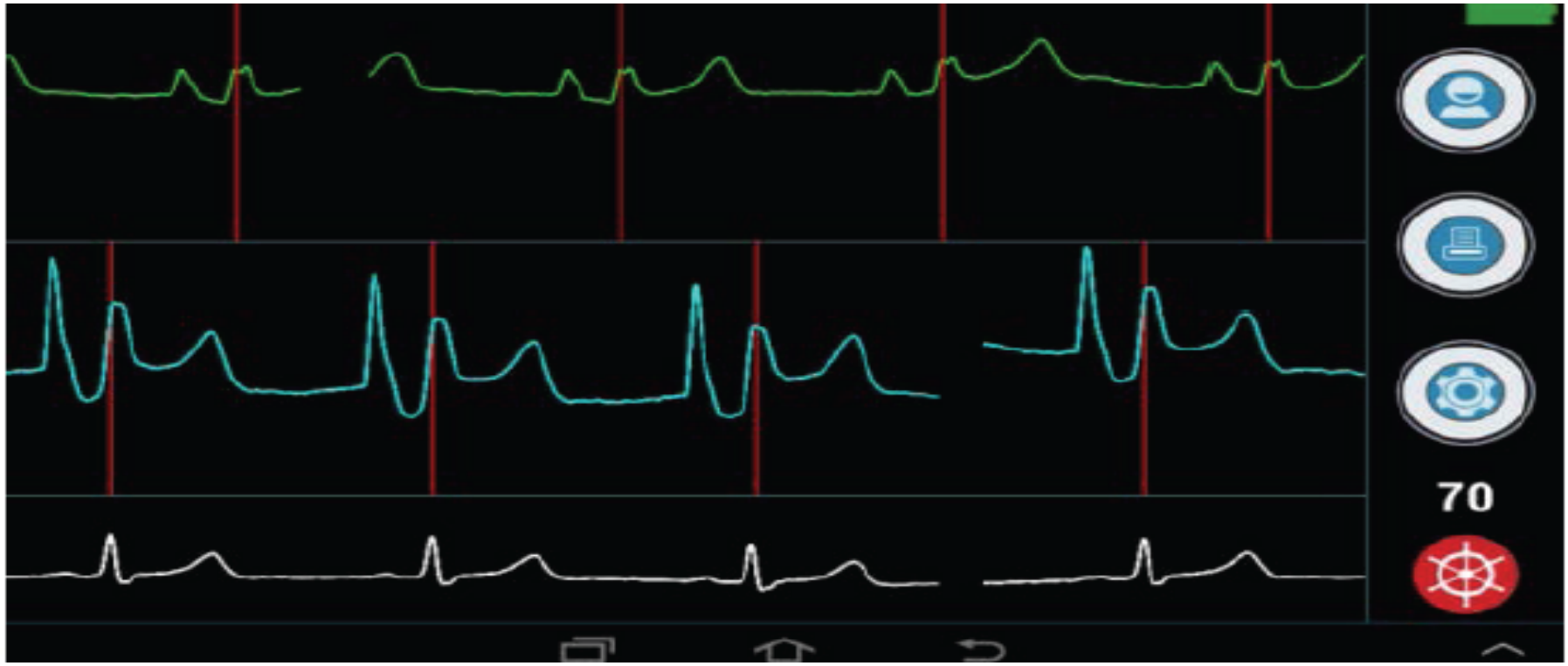
Improving feasibility:
IC-ECG navigation!!!

Improving feasibility:
IC-ECG navigation!!!

Improving feasibility:
IC-ECG navigation!!!



Improving feasibility:
IC-ECG navigation!!!

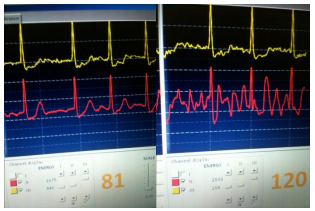


Intra-procedural tip location in the IC-ECG unsuitable patients: how ?

- Introducing alternative tip location methods
- Adding further tip location and/or navigation technologies to IC-ECG
- Improving applicability of IC-ECG (modified IC-ECG)
- Integrating all the above mentioned strategies (an algorithm)

Intra-procedural tip location in the IC-ECG unsuitable patients: how ?

- Improving applicability of IC-ECG (modified IC-ECG)



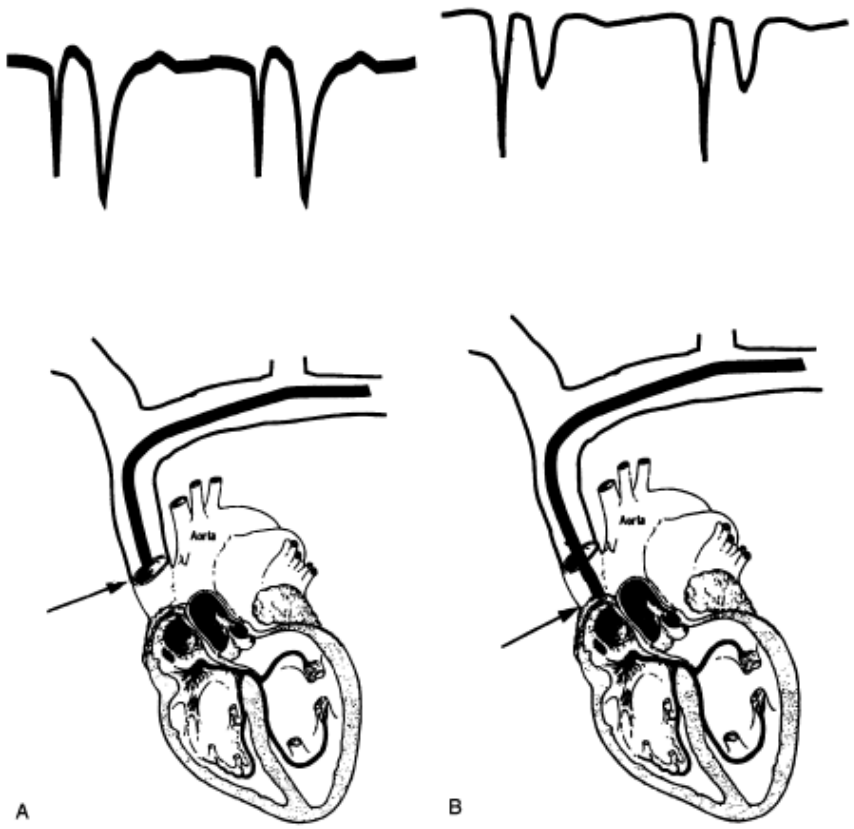
Improving applicability of IC-ECG (ectopic rhytms)

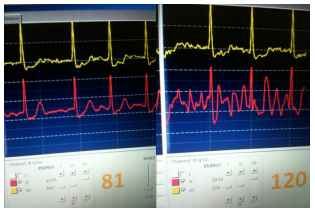
Junctional rhythms show a negative p wave on surface ECG

This negative wave increases in amplitude on IC-ECG while approaching the heart, reaching a maximum at the atrio-caval junction

These IC-ECG modification patterns are similar to those observed in sinus rhythm patients, but specular in sign

(La Greca A, personal observation)


Aorta
Aorta
A
B



Improving applicability of IC-ECG (atrial fibrillation)

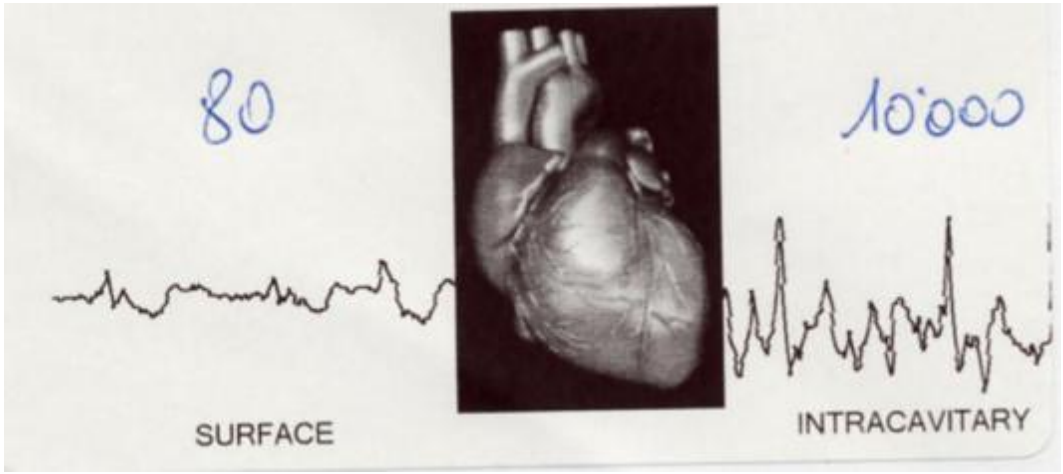
The mean increase of the baseline electrical activity on the intracavitary ECG recorded in patients with atrial fibrillation may be used for detecting the transition of the catheter electrode from the superior vena cava to the right atrium

(Engelhardt 1984; Pittiruti et al. 2011 and 2016)

Using ‘modified’ IC-ECG for tip location, evaluating the TQ tract and not the P wave

In normal atrium, CAJ = maximal P wave

In the fibrillating atrium, CAJ = maximal activity of the atrial waves (in terms of frequency and height)

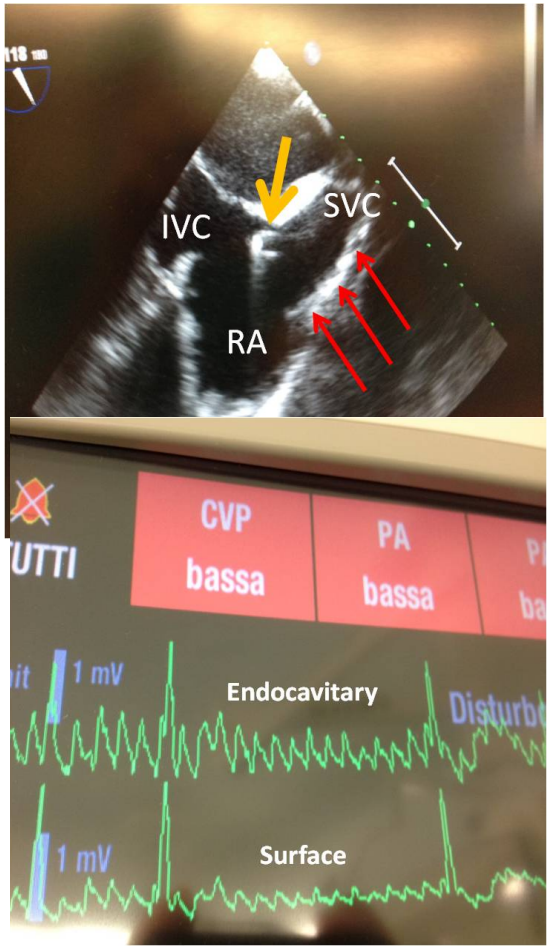


Improving applicability
FA – Study 1

"EKG-controlled placement of central venous catheters in patients with atrial fibrillation"
(Pittiruti, La Greca, Scoppettuolo et al. - INS 2011)

- 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 (4-fold, 10fold) of the amount of energy recorded by the intracavitary electrode
- Post-op. chest x-ray in all patients
- Cavo-atrial junction correctly identified in 25 pts. out of 27
- Conclusion: the 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).

Improving applicability
FA – Study 2



- Patients affected by atrial fibrillation and candidate to cardiac surgery (aorto-coronaric bypass, valvular replacement) under emodynamic monitoring via trans-esophageal echocardiography + CVAD placement in the operating room have been consecutively enrolled.
- In each patient, the TEE probe is inserted after completion of the general anesthesia procedure and adjusted to obtain the atrio-bicaval view according to the Medical Society of Echocardiography guidelines.

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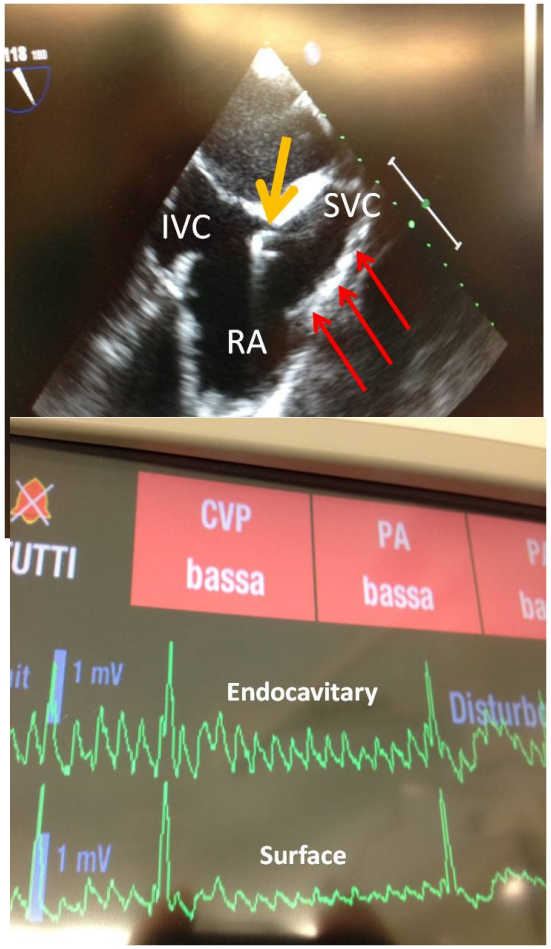
Improving applicability
FA – Study 2



- The CVAD was inserted under ultrasound and IC-ECG guidance according to our Institution standard policy.
- The CVAD 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 point defined by TEE.

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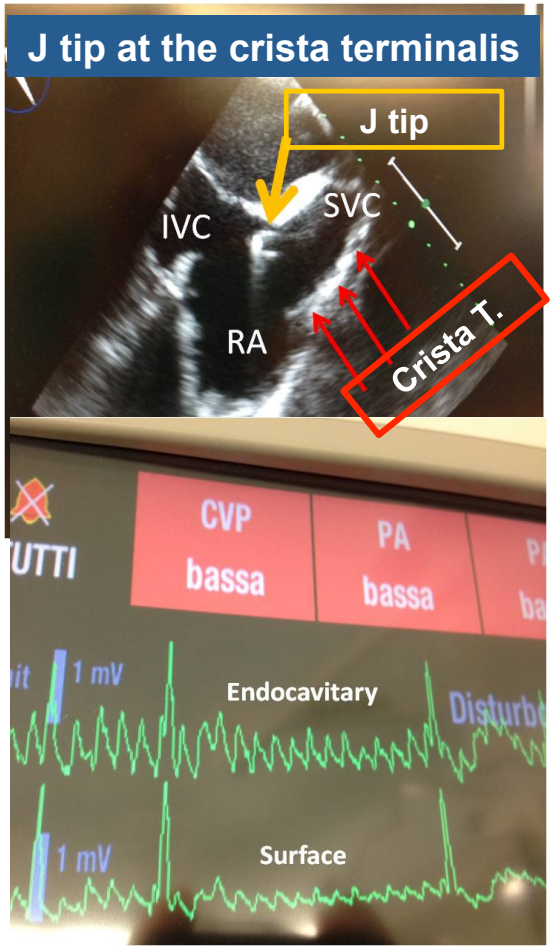
Improving applicability
FA – Study 2



- 10 consecutive patients have been enrolled and included in the analysis.
- CVAD insertion successful and uneventful in all patients.
- All CVADs inserted via the right IJV.
- Guidewire J-tip exiting the catheter and the crista terminalis clearly located by the TEE operator in all patients.

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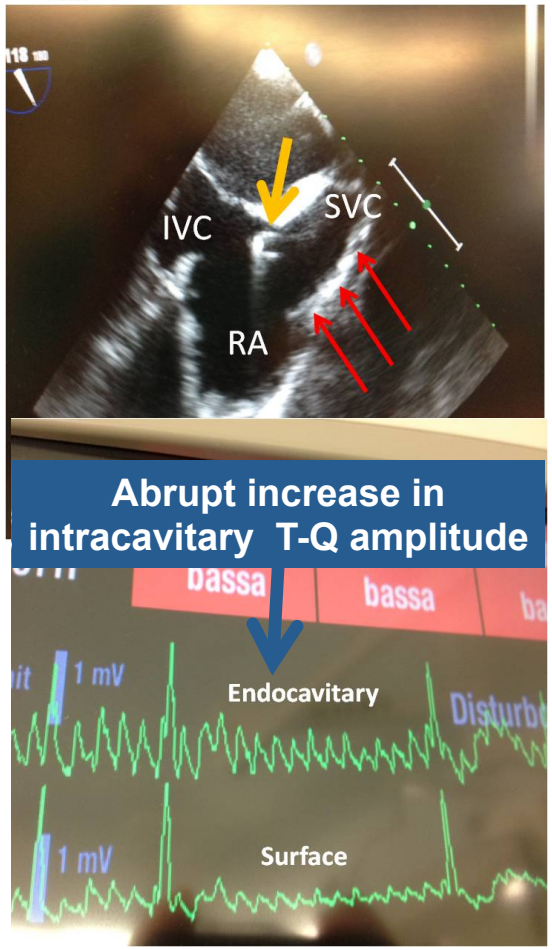
Improving applicability
FA – Study 2



- Under TEE, 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 is recorded with the J-tip placed at the crista terminalis.
- A clear reduction in amplitude is evident in the two alternative positions (SVC and deep RA) in all patients.

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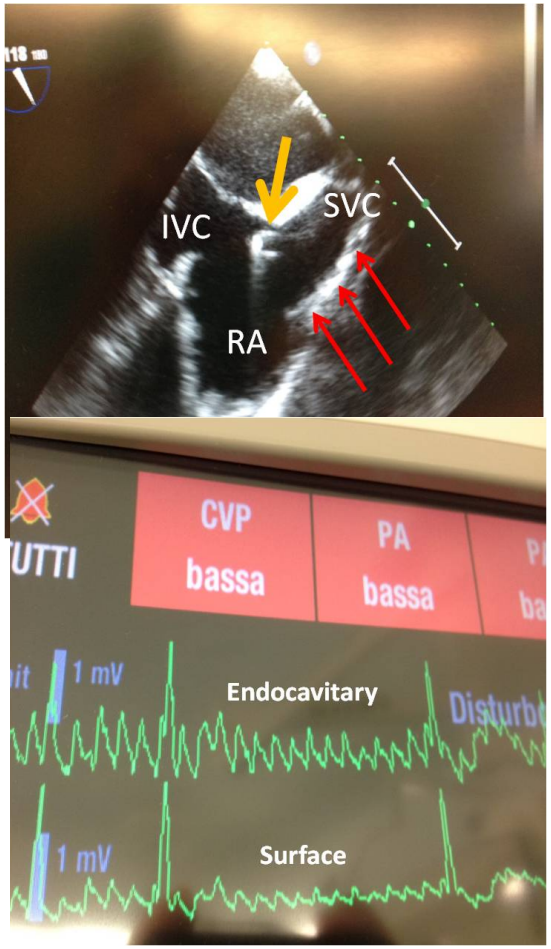
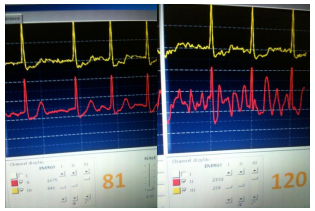
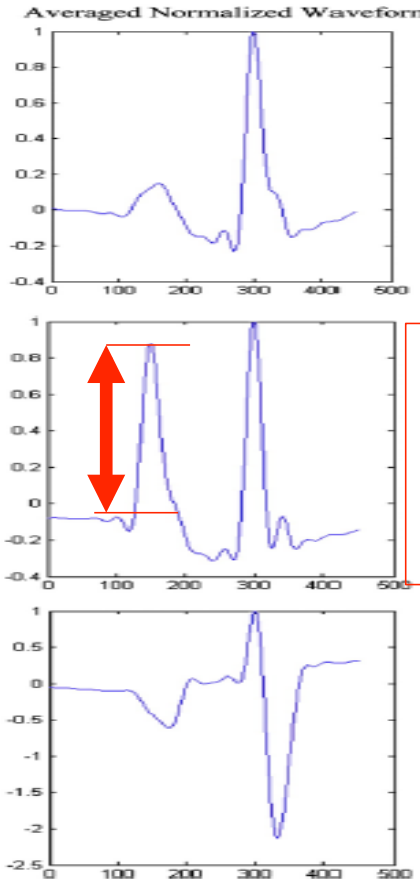
Improving applicability
FA – Study 2



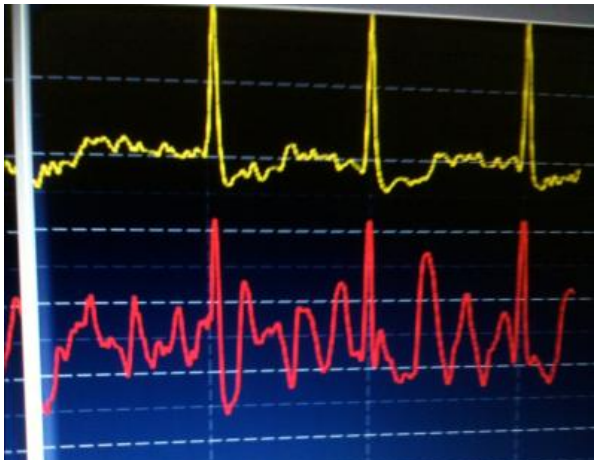
- While patients are being enrolled, further IC-ECG traces analysis is ongoing to define quantitative parameters allowing a more refined correlation between IC-ECG and tip position in FA patients (i.e.: energy et al.)

Improving applicability – FA
Which quantitative parameter ?





mm
or
mV

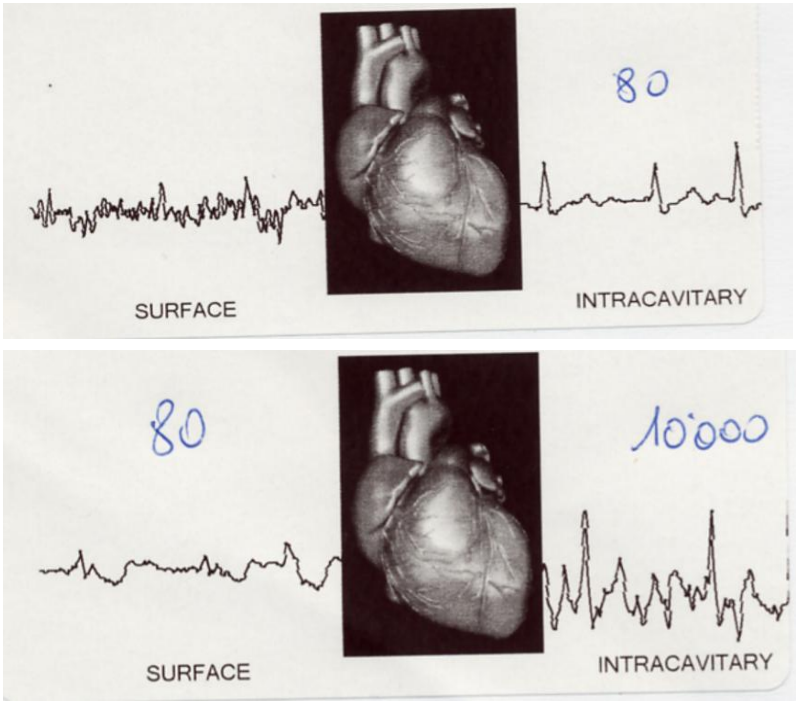


???

Improving applicability of IC-ECG (atrial fibrillation)

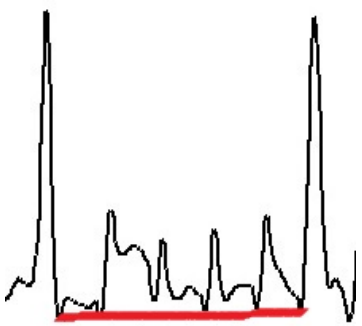
Using specialized “digital” ECG monitors

The area under the T-Q segment = atrial energy

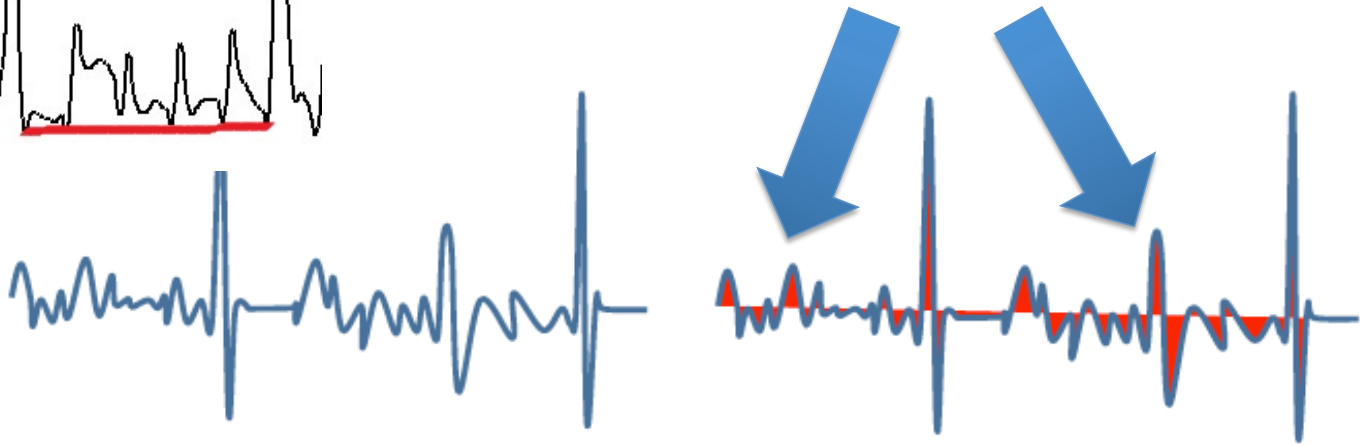


Improving applicability of IC-ECG (atrial fibrillation)

The area under the T-Q segment (atrial “energy”) might be related to the cavo-atrial junction tip location



But it is different during examination in the same tip position !!! (different duration of the T-Q segment)



Improving applicability
FA – Study 3

The mean peack-to-peack maximal voltage might be related to the cavo-atrial junction tip location (more costant in different measurements at the same tip position)

Our latest study

A modified intracavitary electrocardiographic method for detecting the location of the tip of central venous catheters in atrial fibrillation patients (JVA 2018, in press)

2018

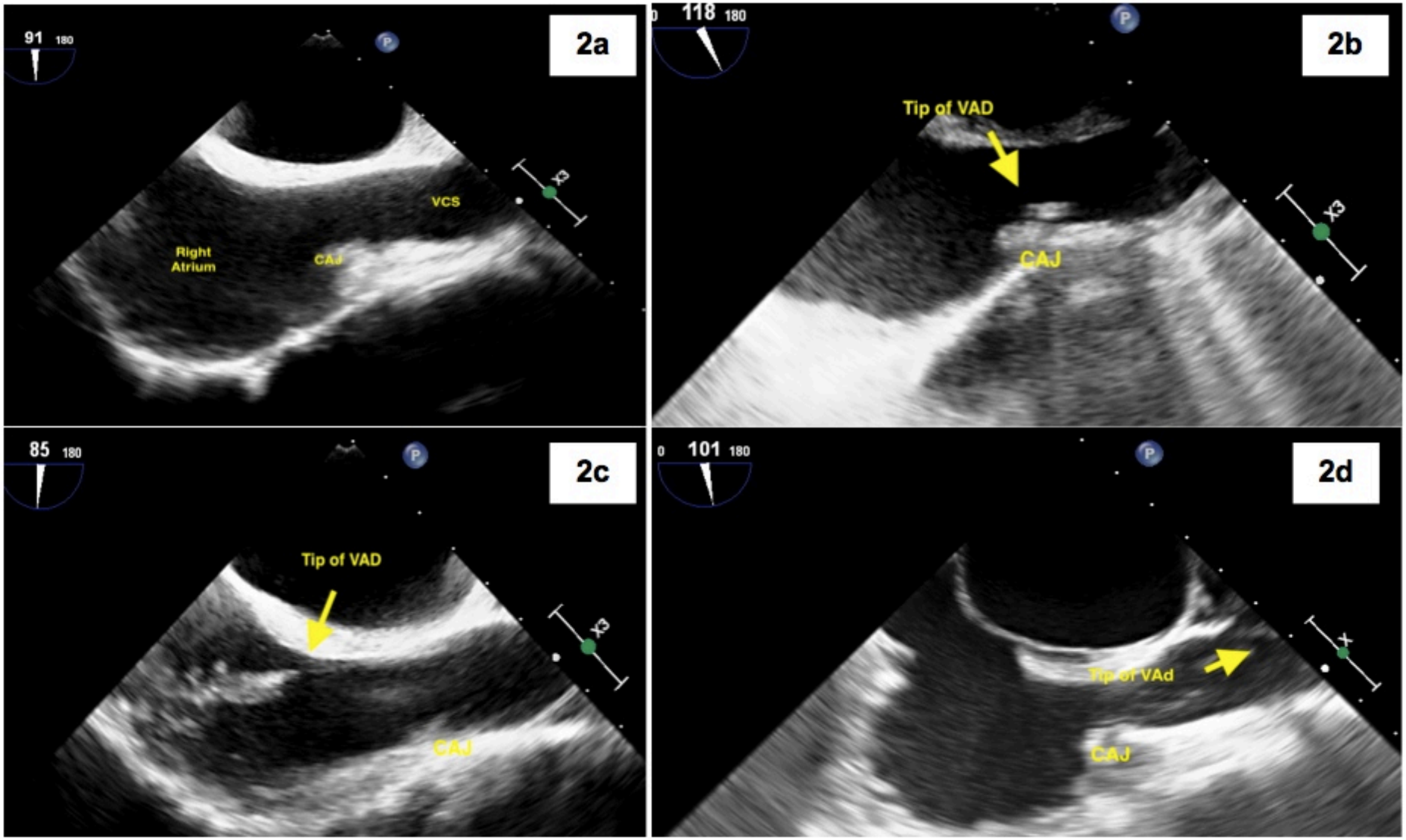
Improving applicability
FA – Study 3

- Same principles as study 2
  - IC-ECG + TEE during cardiac surgery
  - 3 tip positions under TEE (CAJ, CAJ + 2 cm, CAJ − 2 cm)
  - IC-ECG at the 3 positions
- Parameter:
  - mean value of the maximal F wave recorded in each T-Q segment during 10 cardiac cycles ***(post-recording HUMAN READING)***

Methods

18 AF patients requiring simultaneously a CVC and a trans-esophageal echocardiography (TEE).

An IC-ECG trace was recorded with the catheter tip in 3 different positions defined by TEE imaging: in the superior vena cava, 2 cm above the cavo-atrial junction (CAJ); at the CAJ; and in the right atrium, 2 cm below the CAJ.


91 180
2a
VCS
Right Atrium
CAJ
x3
0 118 180
2b
Tip of VAD
CAJ
x3
85 180
2c
Tip of VAD
CAJ
x3
0 101 180
2d
Tip of VAd
CAJ
x

Methods

Three different criteria of measurement of the *f* waves pattern in the TQ tract were used:

- the mean height of *f* waves (method A);
- the height of the highest f wave (method B);
- the difference between the highest positive peak and the lowest negative peak (method C)

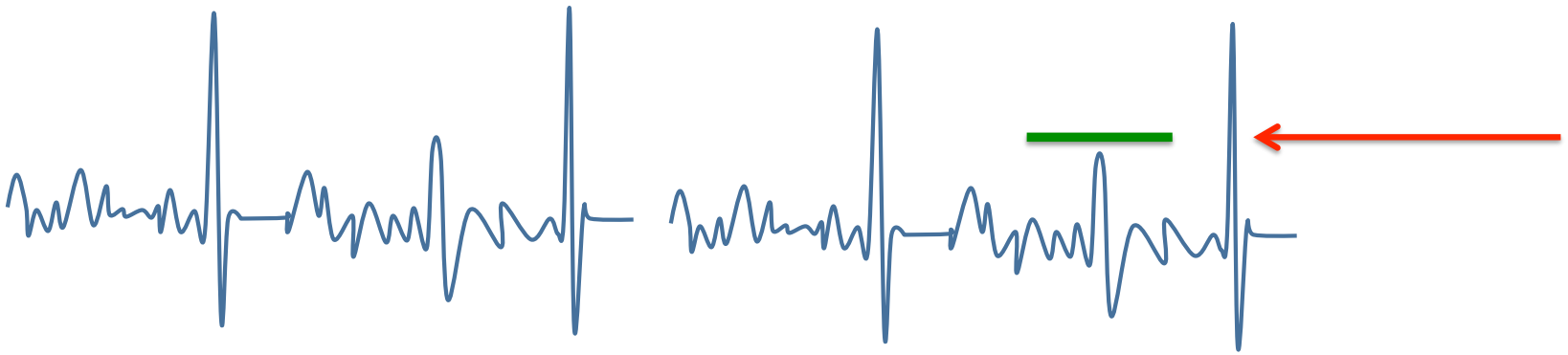
Each of the three methods of measurement was applied to ten or more consecutive QRST complexes, so to get a mean value derived from many (= or > 10) different measurements

Method A

- Measurement of the the mean height of *f* waves

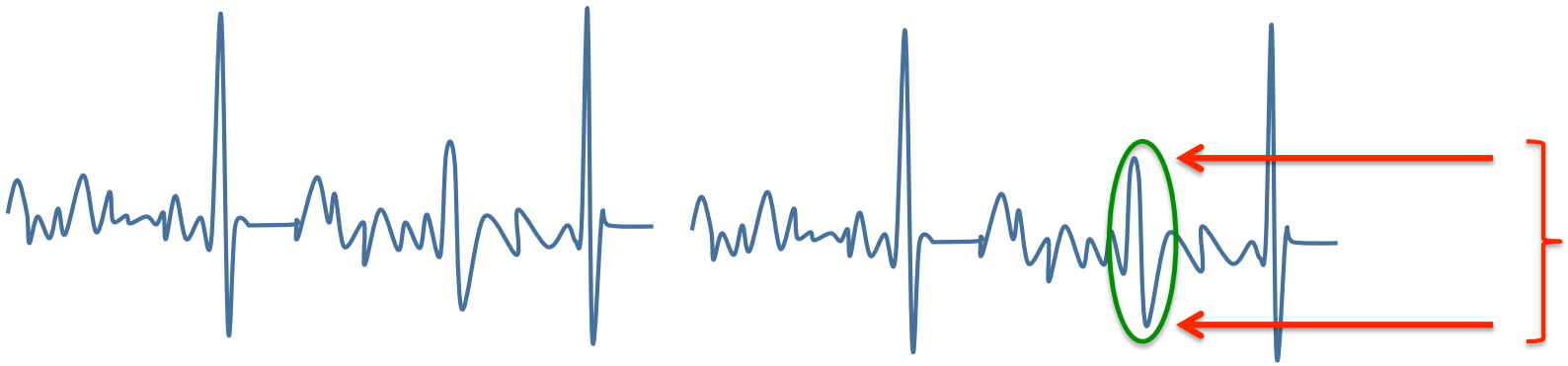
Method B

- Measurement of the height of the highest f wave



Method C

- Measurement of the widest difference between maximal positive peak and maximal negative peak



With the tip placed at the CAJ, the mean value of the *f* waves was significantly higher than in the other two positions.

ANOVA p <.001 for all

Pairwise p <.05 for each

Methods to measure the F-wave	Anatomical site	Mean ± SD (number of observations)	Pairwise comparison*
Method A	SVC	1,9 ± 0,89 (385)	SVC *vs* CAJ
	CAJ	3,33 ± 1,47 (590)	CAJ *vs* RA; CAJ *vs* SVC
	RA	2,08 ± 0,75 (376)	RA *vs* CAJ
Method B	SVC	2,11 ± 1,32 (180)	SVC *vs* CAJ
	CAJ	4,52 ± 1,87 (180)	CAJ *vs* RA; CAJ *vs* SVC
	RA	2,03 ± 0,9 (180)	RA *vs* CAJ
Method C	SVC	2,34 ± 1,39 (180)	SVC *vs* CAJ
	CAJ	5,07 ± 2,07 (180)	CAJ *vs* RA; CAJ *vs* SVC
	RA	2,32 ± 0,93 (180)	RA *vs* CAJ

Legend. SVC =superior vena cava; RA =right atrium; CAJ = cavo-atrial junction; SD =standard deviation; mm =millimeter.

* ANOVA was significantly different for all (p<0.001); each pairwise comparison was individually significant (p<.05) at post-hoc analysis (Scheffè test for all pairwise comparisons).

All three methods were effective in discriminating the tip position at the CAJ …

Different methods to measure the *f* waves	Anatomical site	AUC ± SE (95% C.I.)*	Cut-off value (mm) **
Method A	CAJ *vs* SVC	0,71±0.016 (0,68-0,74)	> 2
Method A	CAJ *vs* RA	0,7±0,016 (0,67-0,73)	> 2,5
Method B	CAJ *vs* SVC	0,84 ±0,021 (0,79-0,87)	> 2
Method B	CAJ *vs* RA	0,86 ±0,018 (0,82-0,9)	> 2,5
Method C	CAJ *vs* SVC	0,83 ±0,02 (0,78-0,86)	> 2
Method C	CAJ *vs* RA	0,85 ±0,019 (0,81-0,88)	> 3

Legend. AUC =area under curve, SE =standard error, C.I. =confidence interval, mm =millimeter, SVC = Superior Vena Cava, RA = Right Atrium, CAJ = cavo-atrial junction

* A higher value of AUC with narrow 95% confidence interval means a better discrimination between two different positions.

** The cut-off value of the height of the f wave (expressed in mm) corresponds to the one associated with maximal accuracy (minimal false positive and false negative results).

Different methods to measure the *f* waves	Anatomical site	AUC ± SE (95% C.I.)*	Cut-off value (mm) **
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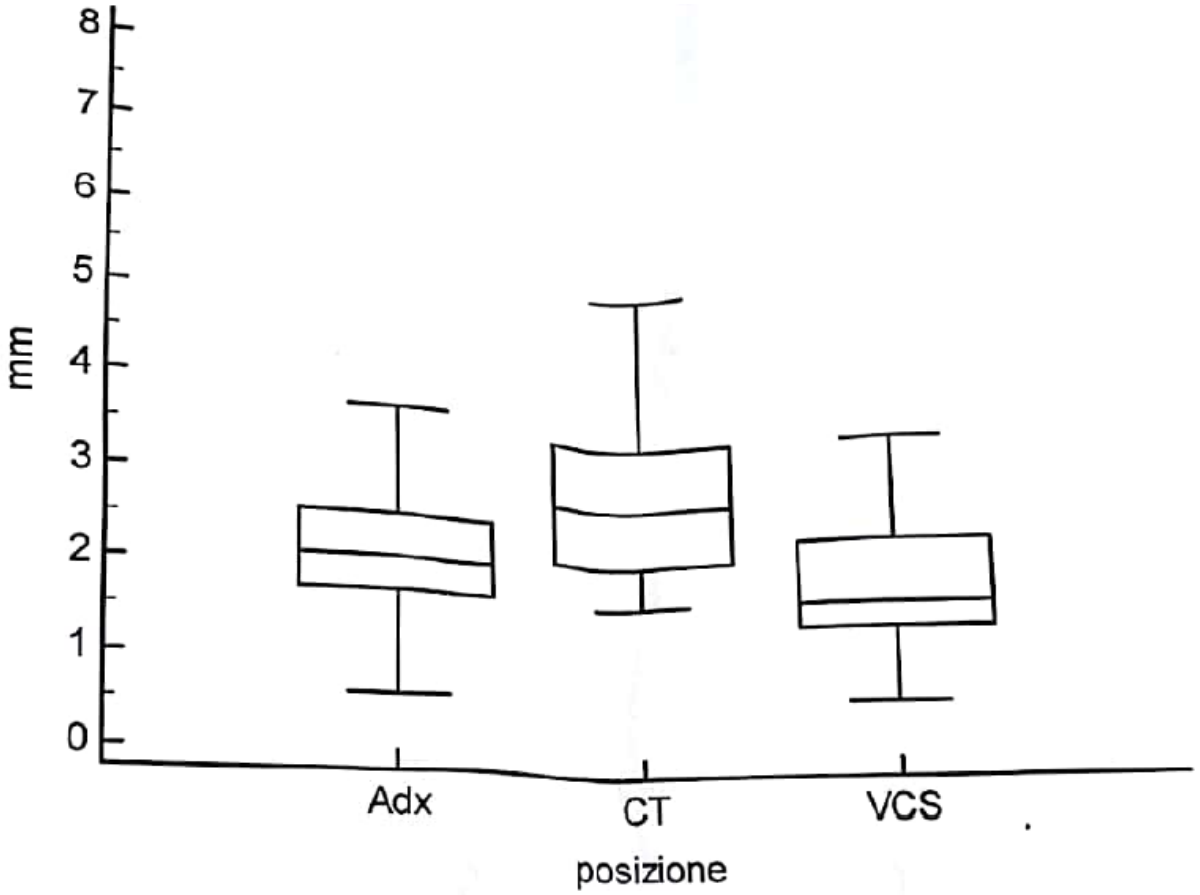
Method C	CAJ *vs* SVC	0,83 ±0,02 (0,78-0,86)	> 2
Method C	CAJ *vs* RA	0,85 ±0,019 (0,81-0,88)	> 3

… though method B proved to be the most accurate.

ROC Analysis
Higher value of AUC = better discrimination between two different positions

Improving applicability
FA – Study 3



Conclusions of the study

Our study demonstrates that a ‘modified’ IC-ECG method based not on the maximal height of the P wave but on the maximal electrical activity of the TQ tract can be safely used for detecting the location of the tip of central VADs in AF patients.

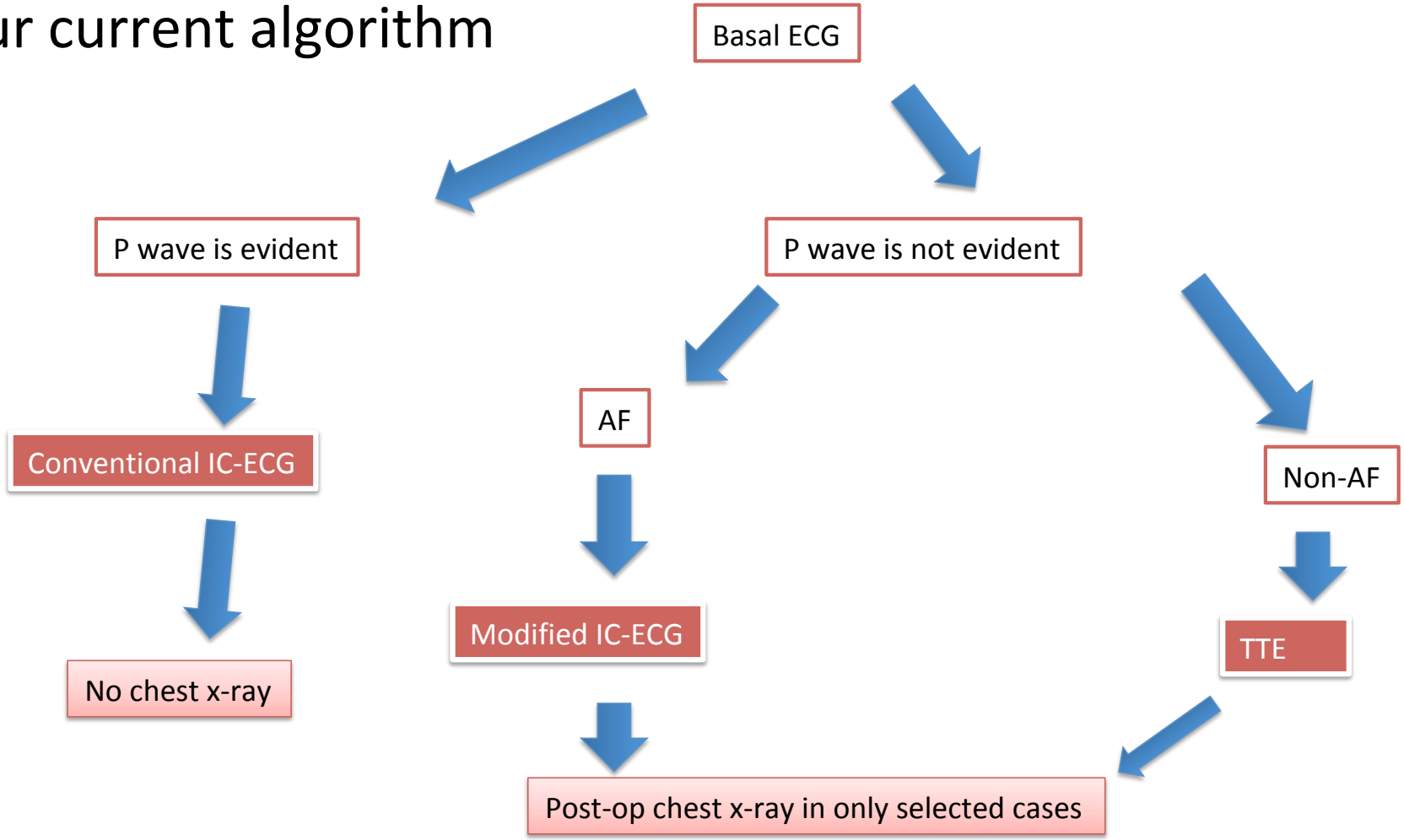
Our data also suggests that this method should replace other tip location methods currently used in AF patients, such as fluoroscopy or post-procedural chest x-ray, since such radiological techniques are less accurate, more expensive and less safe than IC-ECG.


JVA
The Journal of Vascular Access
Official Journal of the Vascular Access Society (VAS)
WICHTIG

Our current algorithm in adult patients

- If a P wave is evident on basal ECG:
  - *Conventional IC-ECG* is enough
- If a P wave is not evident:
  - In AF patients:
    - *Modified IC-ECG and/or echocardio (TTE)*
  - In non-AF patients (PM, etc.):
    - *Echocardio (TTE)*

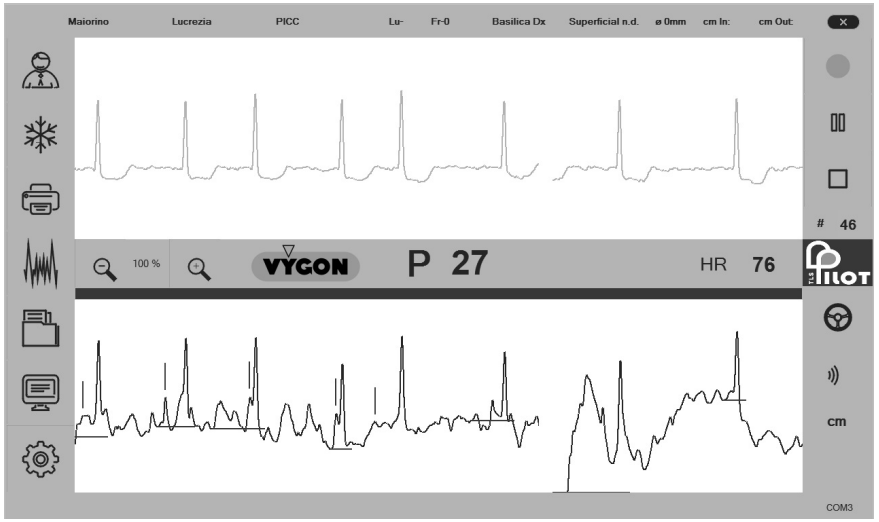
Our current algorithm



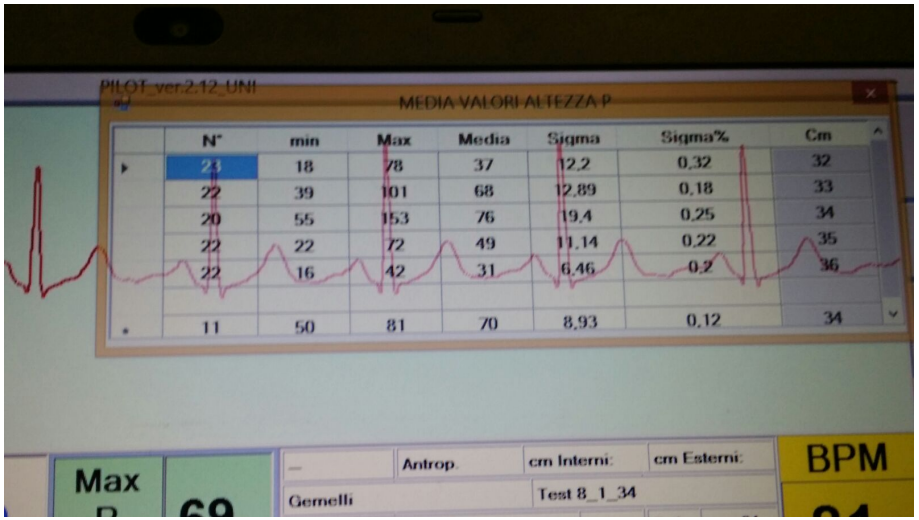
Improving applicability in FA

- Can we use quantitative parameters vs human eye in clinical practice ?
- User friendliness of quantitative parameters

Human eye

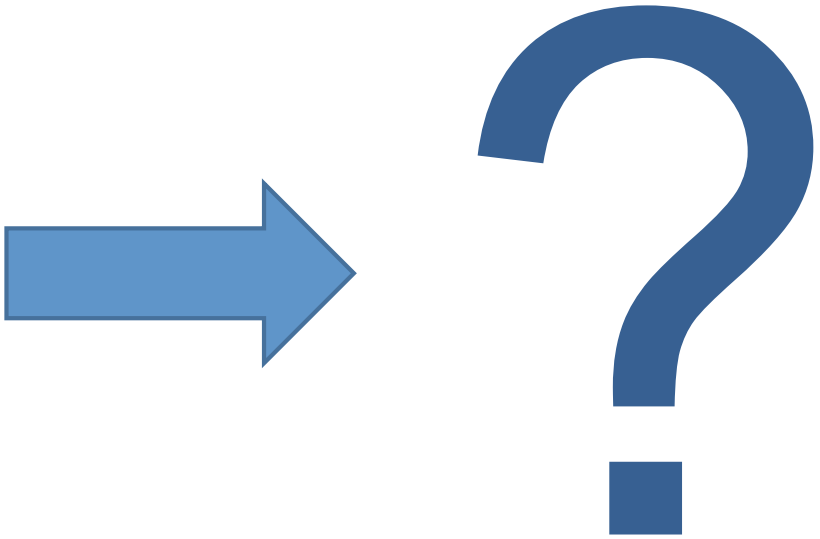


Quantitative parameters



Improving applicability in FA

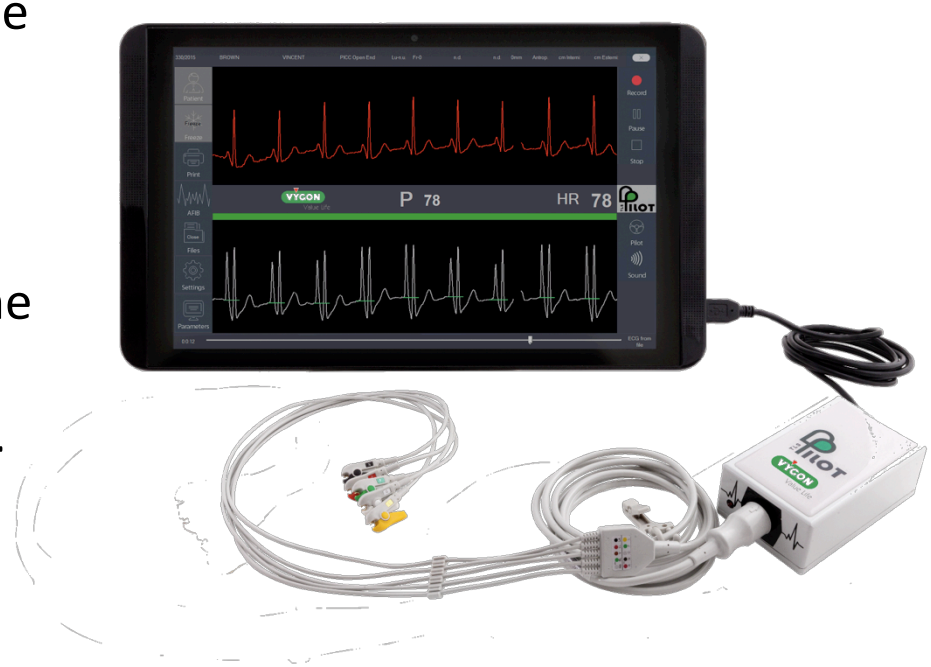
- IC-ECG in FA patients: how to introduce it into guidelines ?



- Evidence base + chance of widespreading

Widespreading: pre-requisites

- **QUANTITATIVE** analysis might represent the scientific basis for validating IC-ECG in FA patients
- This should be **USER FRIENDLY**
- The **MANUAL QUANTITATIVE** analysis of the TQ tract is difficult and time-consuming.
- The Pilot provides **automatically and REAL-TIME** the measurement of the widest difference between maximal positive peak and maximal negative peak (method C).



Improving applicability
FA – Study 4 and 5

The highest T-Q activity is related to the cavo-atrial junction tip location
(more costant in different measurements at the same tip position)

Using specialized “digital” ECG monitors

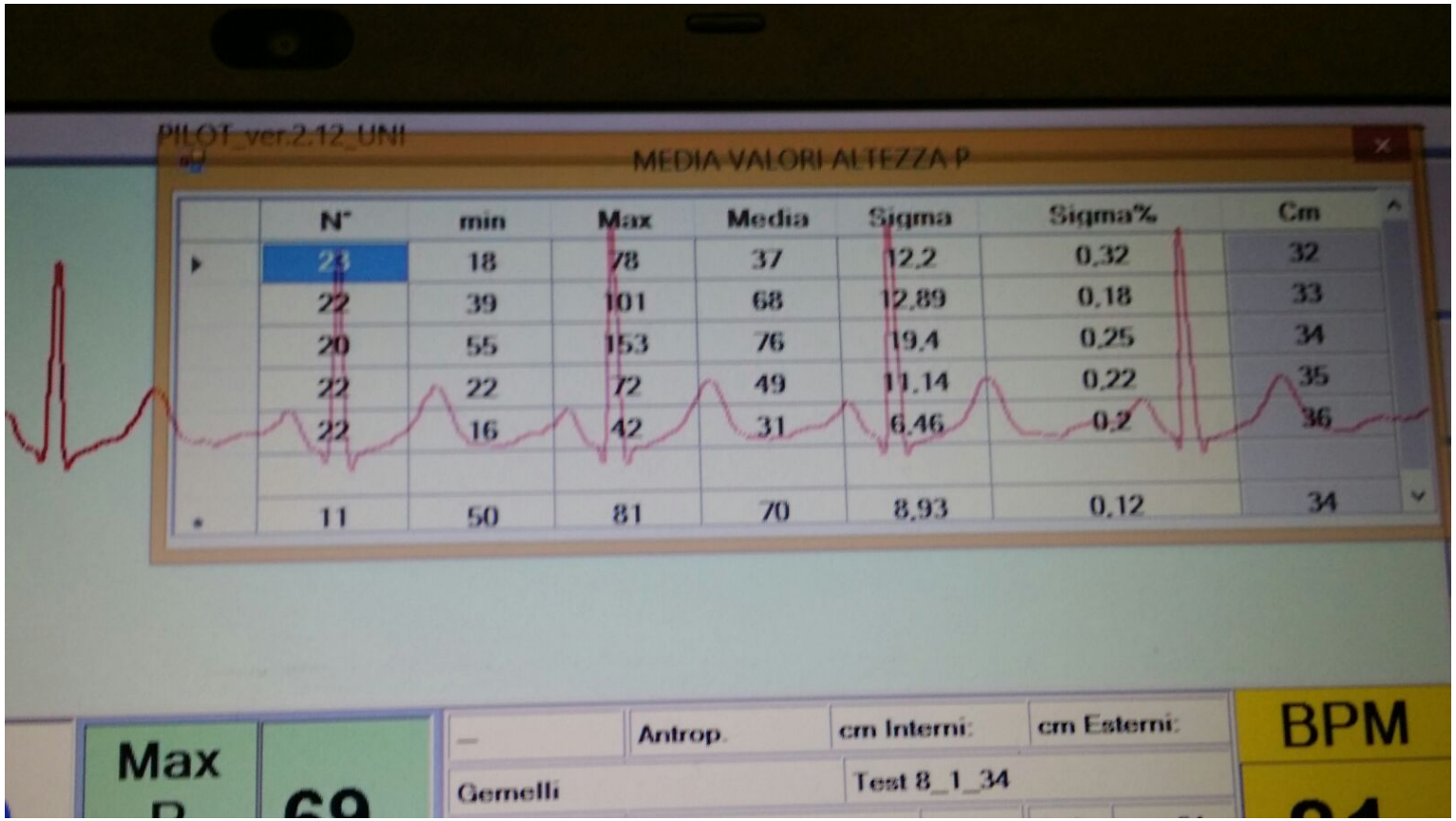
to calculate this mean value ***DURING THE PROCEDURE***
and on more than 20 cycles instead of 10

REAL TIME !!!

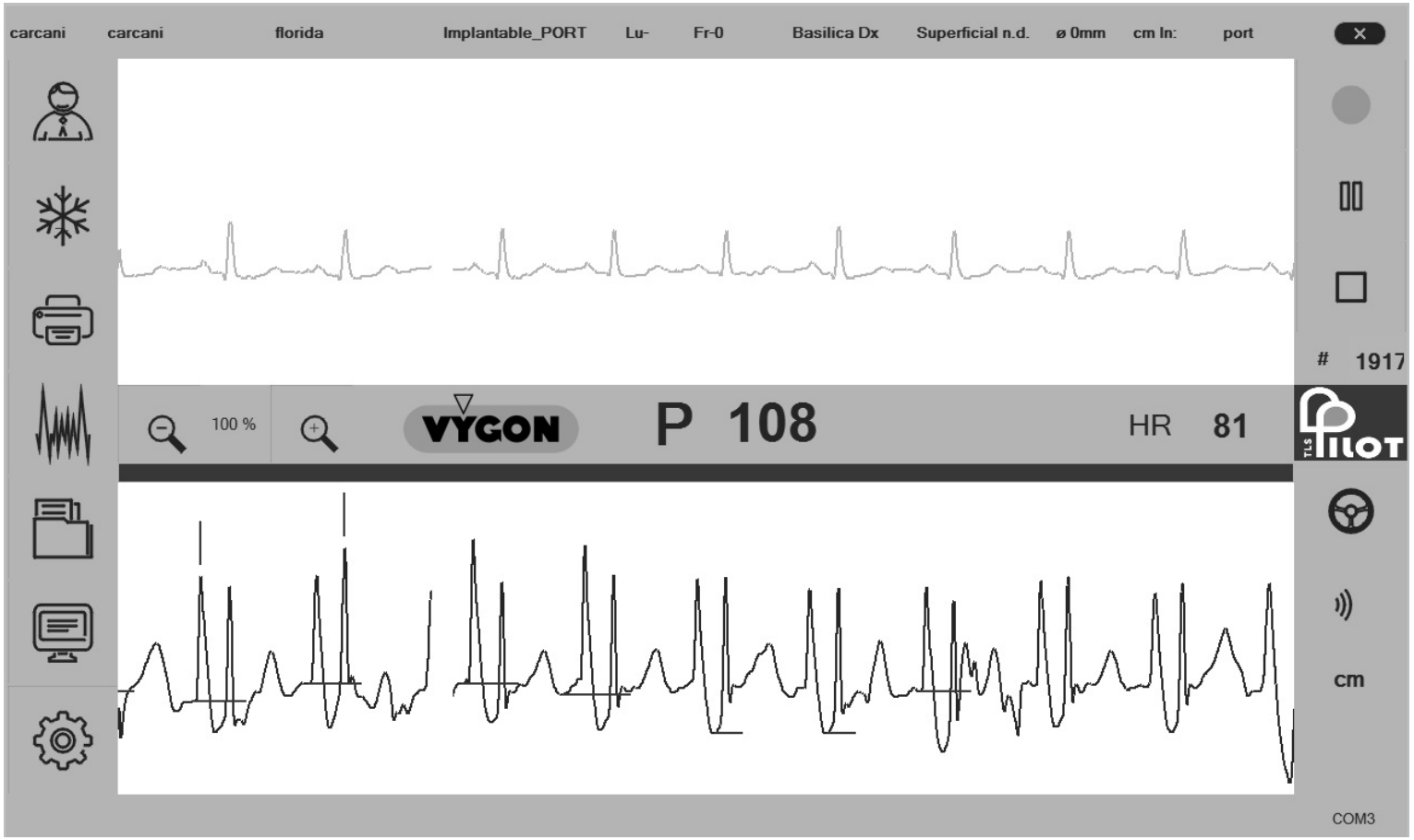
OLD PILOT


PILOT_ver.2.12_UNI
Anagrafica
Fibrillante
Freeze
Stampa
Ecografo
Filtro Rumore
Quota Zero
5
Secondi Quadro
6
0
Guadagno
2
P
87
Max P
98
Reset
Antrop.
cm Interni:
cm Esterni:
Gemelli
Test 2
Port_Open_Tip
Lu-1
Fr-6
cm -
Basilica
Dx
6mm
BPM
63
Soglie
Zoom
R
Rivedi Esame
Beep
Dati estesi
NAV
Set E C G
Zero ECG
QRS
QRS val
COM5
ECG Live
Lista Max_P: 109-99-94-112-112-84-74-81-198-58-58-

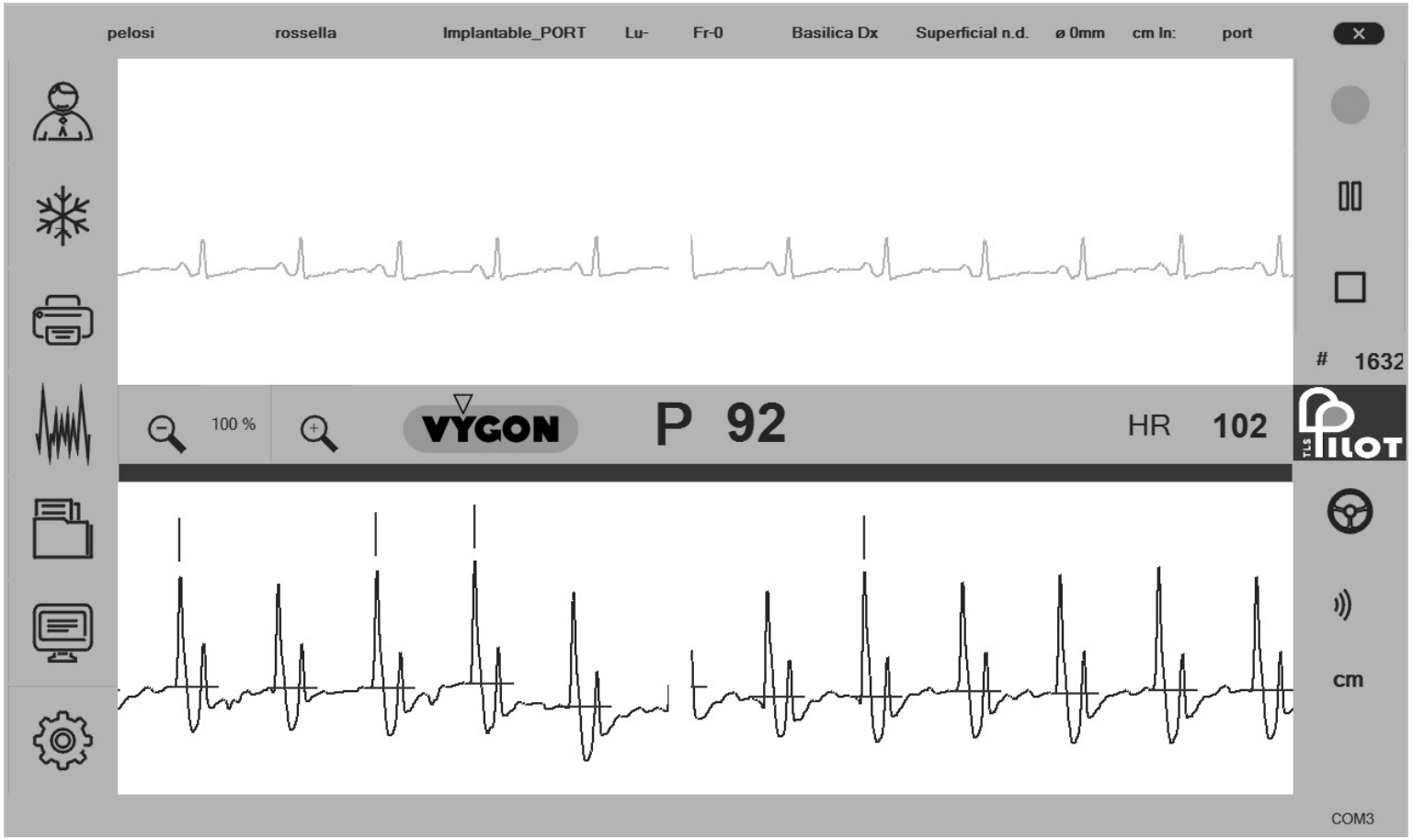
OLD PILOT


PILOT_ver.2.12_UNI
MEDIA VALORI ALTEZZA P
N° min Max Media Sigma Sigma% Cm
23 18 78 37 12,2 0,32 32
22 39 101 68 12,89 0,18 33
20 55 153 76 19,4 0,25 34
22 22 72 49 11,14 0,22 35
22 16 42 31 6,46 0,2 36
11 50 81 70 8,93 0,12 34
Max
69
Antrop.
cm Interni:
cm Esterni:
Gemelli
Test 8_1_34
BPM

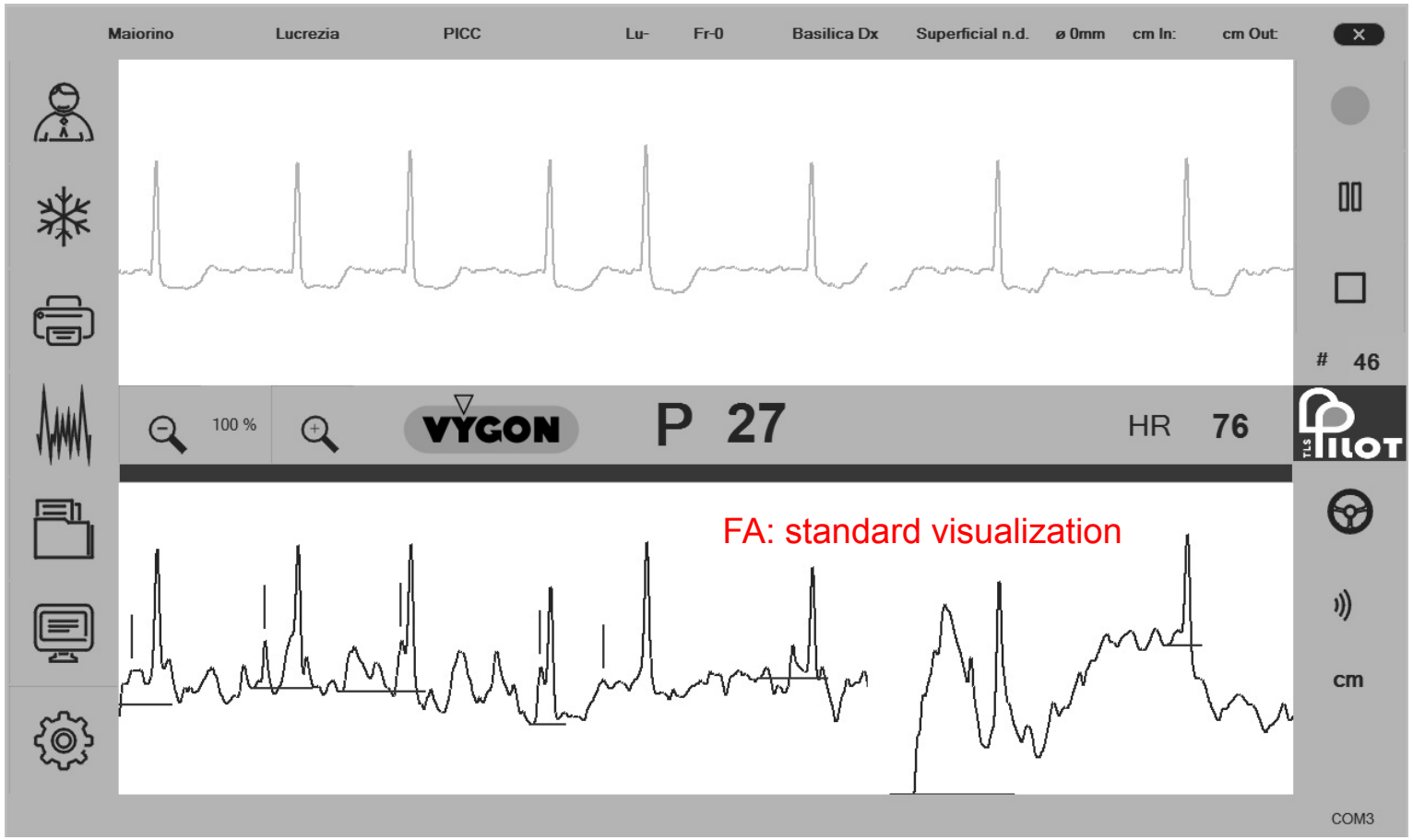
NEW PILOT


carcani
carcani
florida
Implantable_PORT
Lu-
Fr-0
Basilica Dx
Superficial n.d.
ø 0mm
cm In:
port
100 %
VYGON
P 108
HR 81
1917
cm
COM3

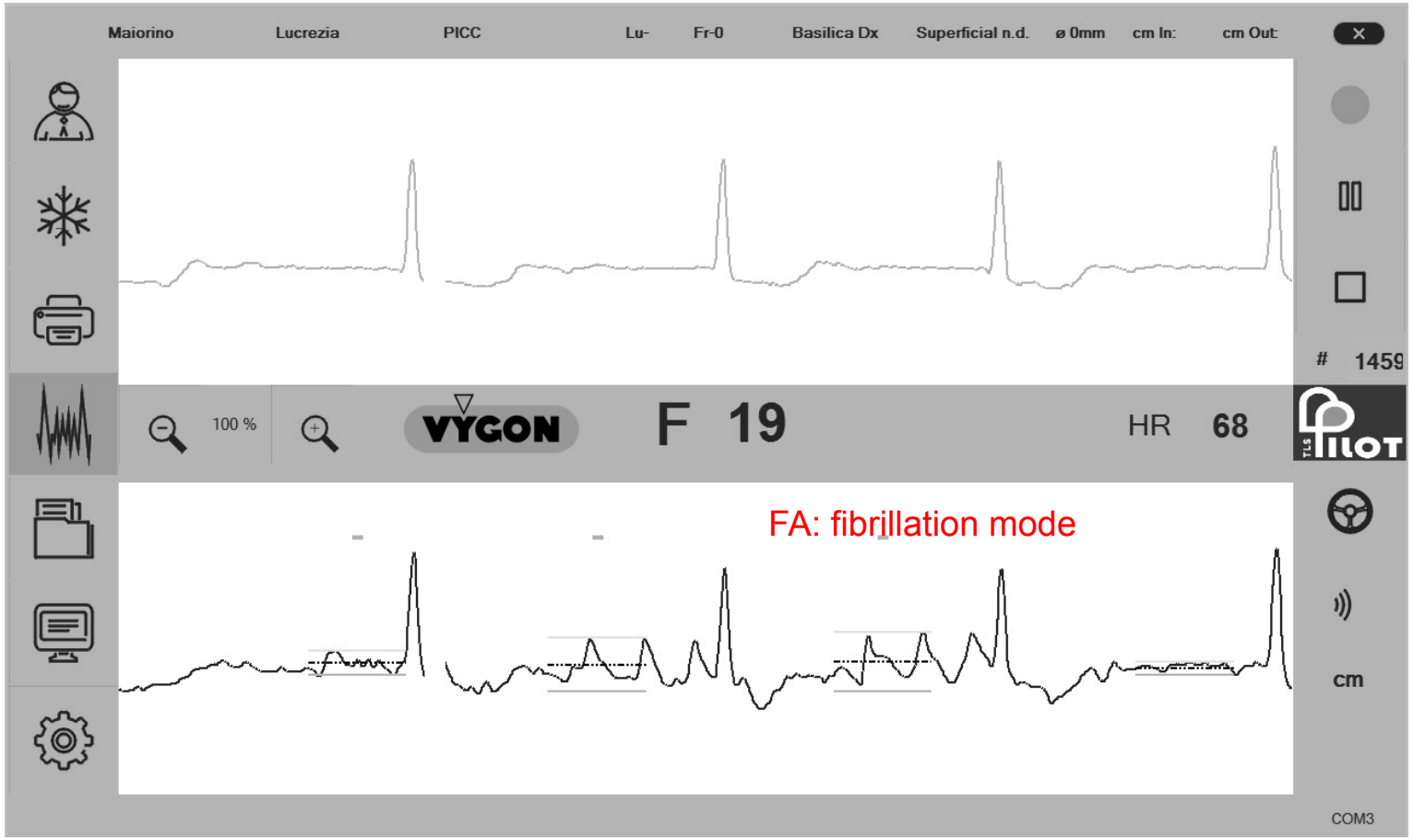
NEW PILOT


pelosi
rossella
Implantable_PORT
Lu-
Fr-0
Basilica Dx
Superficial n.d.
ø 0mm
cm In:
port
100 %
VYGON
P 92
HR 102
1632
cm
COM3

NEW PILOT

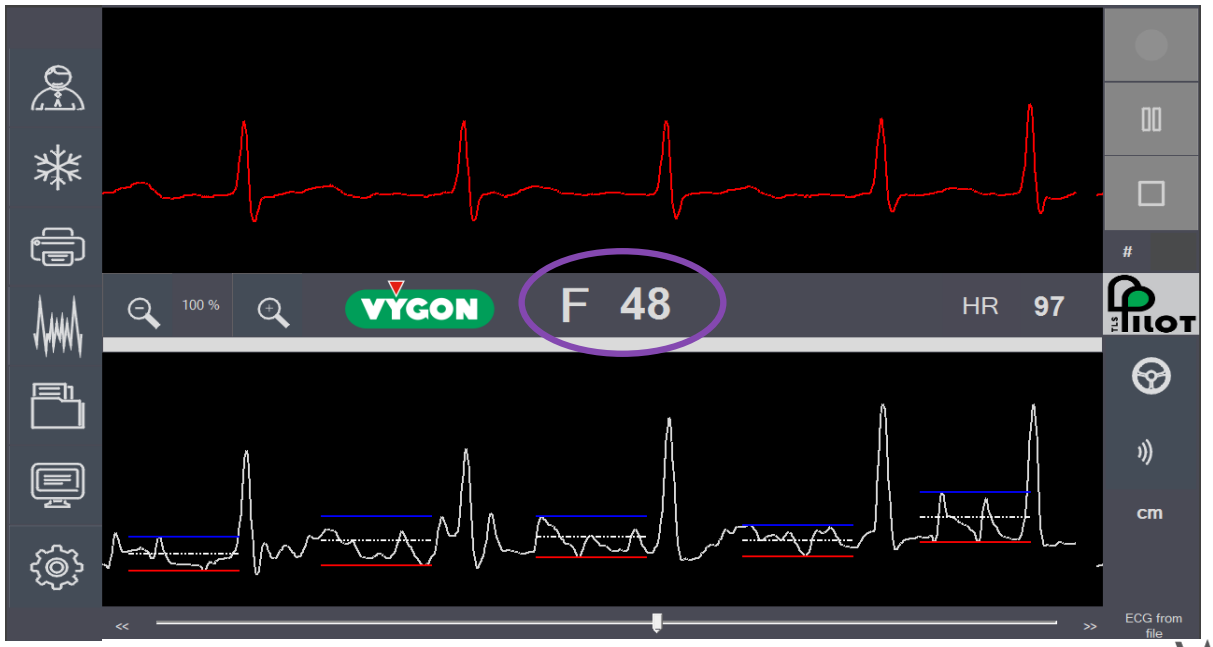

Maiorino
Lucrezia
PICC
Lu-
Fr-0
Basilica Dx
Superficial n.d.
ø 0mm
cm In:
cm Out:
100 %
VYGON
P 27
HR 76
46
FA: standard visualization
cm
COM3

PILOT

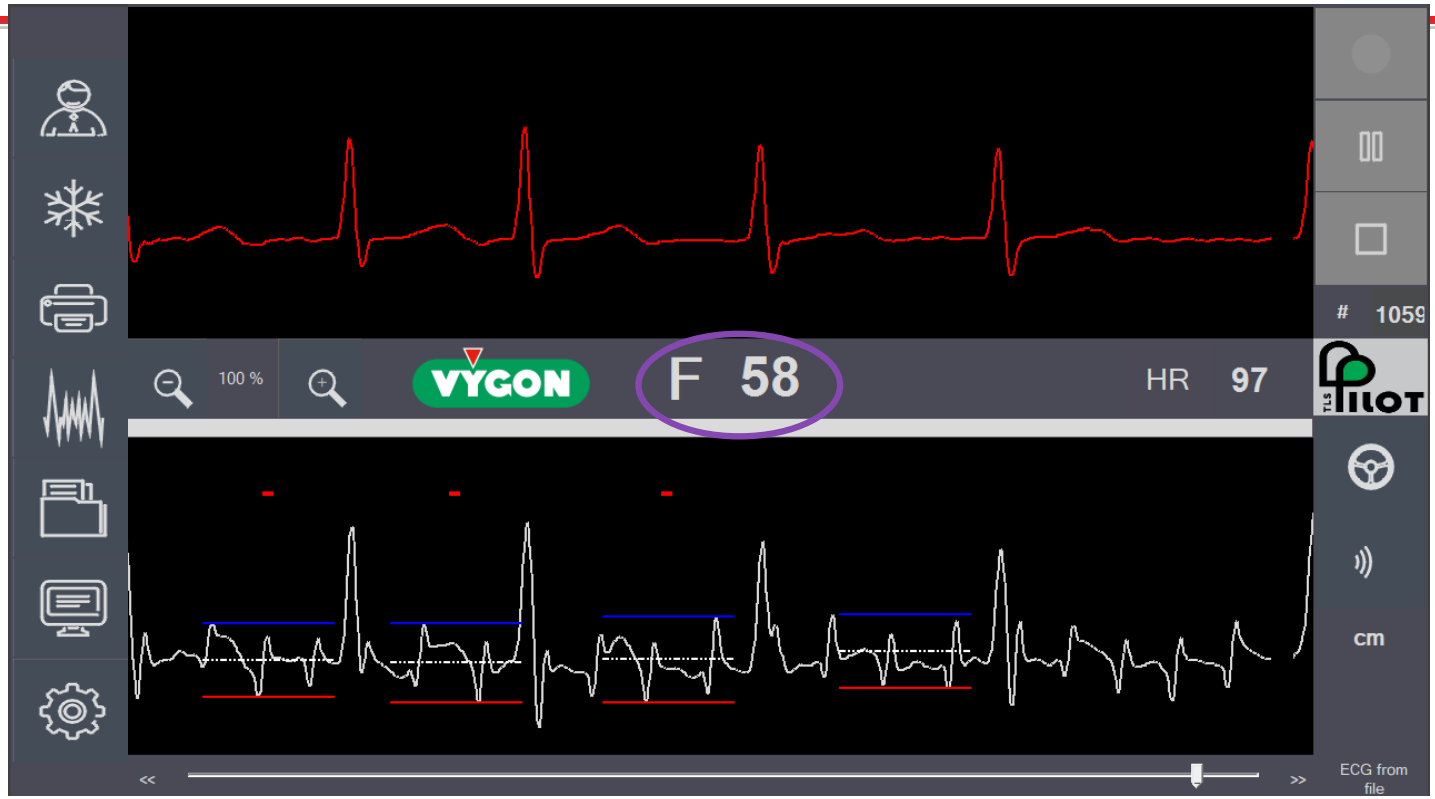

Maiorino
Lucrezia
PICC
Lu-
Fr-0
Basilica Dx
Superficial n.d.
ø 0mm
cm In:
cm Out:
1459
100 %
VYGON
F 19
HR 68
FA: fibrillation mode
cm
COM3

Modalità AFIB

- L’assenza di una vera e propria onda P non permette di utilizzare la procedura standard; nel paziente fibrillante è possible osservare il valore del parametro F
- F è Massimo in corrispondenza dela giunzione CA.



Modalità AFIB

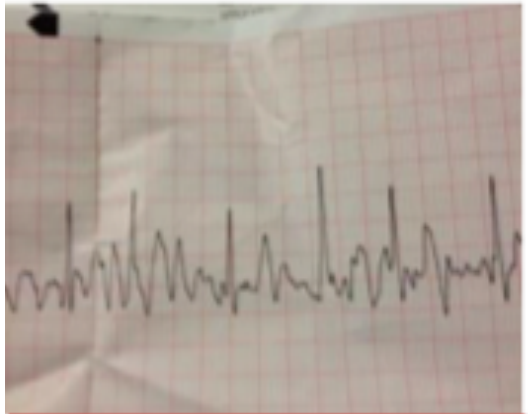


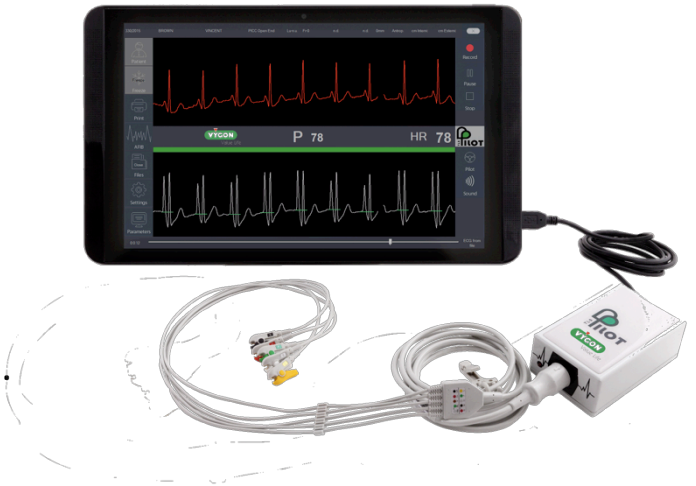
Modalità AFIB

Improving applicability
FA – Study 4

SUMMARY: Comparison data provided by Pilot algorithm vs manual measures (FA Study 3)
OBJECTIVE: match Pilot / manual measures (peak to peak) in identifying CAJ
PAZIENTI IN STUDIO: tutti i pazienti con fibrillazione striale che necessitano di un catetere venoso centrale (PICC, port, PICC-port, etc.); la presenza di fibrillazione atriale in atto viene confermata dal monitoraggio ECG all'inizio della manovra.
N. PATIENTS: 20
AMBIENTE: Oncology (General and Gyn) DH
METHODOLOGY: tip location by IC-ECG (saline column) :

- Identification of CAJ by Pilot algorithm (values + morfology)
- Standard ECG monitor: printing in 3 positions (CAJ as identified by Pilot, 2 cm over, 2 cm below)
- Manual measures on the printed traces: match Pilot/manual for CAJ.

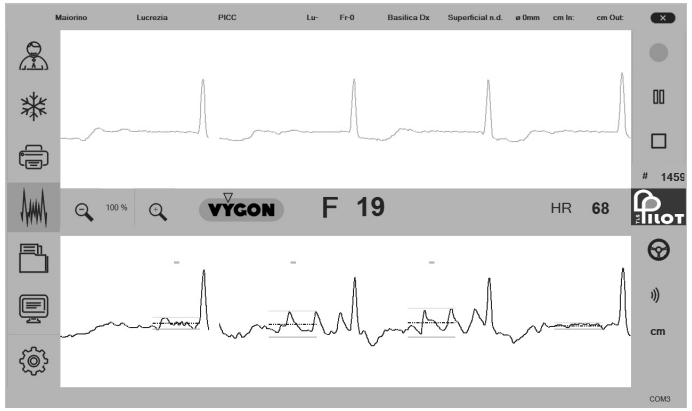


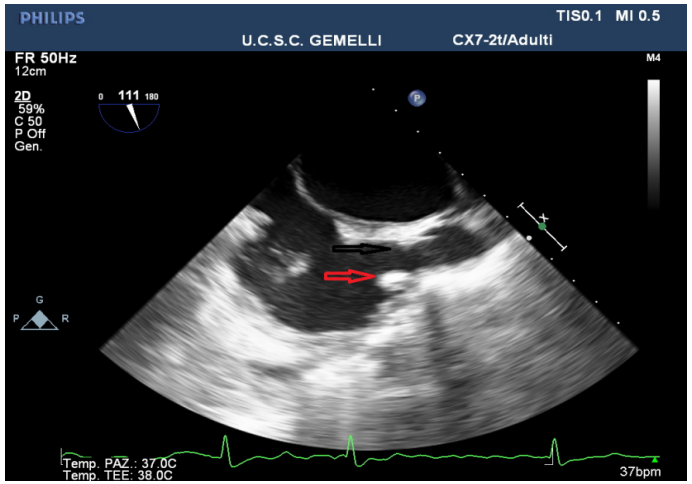


Improving applicability
FA – Study 5

Comparison PILOT vs TEE
OBIETTIVO: PILOT accuracy in identifying CAJ in FA pts
POPULATION: FA pts candidate to cardiac surgery under TEE monitoring and needing a CVC.
N. PATIENTS: 20
SETTING: Cardio surgical OR
METHODOLOGY:

- TEE probe placed; CVC insertion under Pilot
- posizionamento di sonda TEE; posizionamento del CVC usando il Pilot;
- CAJ identification under Pilot algorithm:
- TEE measurement of distance tip – CAJ





So, can we improve IC-ECG results ?

… yes, we can !

Gemelli

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Università Cattolica del Sacro Cuore

GAVeCeLT
Gli Accessi Venosi Centrali a Lungo Termine