CAN SUPPORT OF INTRACARDIAC ECHOCARDIOGRAPHY HELP TO REDUCE RADIOLOGICAL EXPOSURE WITHIN ELECTROPHYSIOLOGICAL LABORATORY?

Maines Massimiliano,

Catanzariti Domenico, Angheben Carlo

Advances in Cardiac Arrhythmias
and Great Innovations in Cardiology
Turin, 25 October 2012

Division of Cardiology, S. Maria del Carmine Hospital – Rovereto - Italy

Introduction

Intracardiac echocardiography allows to have continuous real-time images of the anatomy and cardiac events during intracardiac ablation procedures

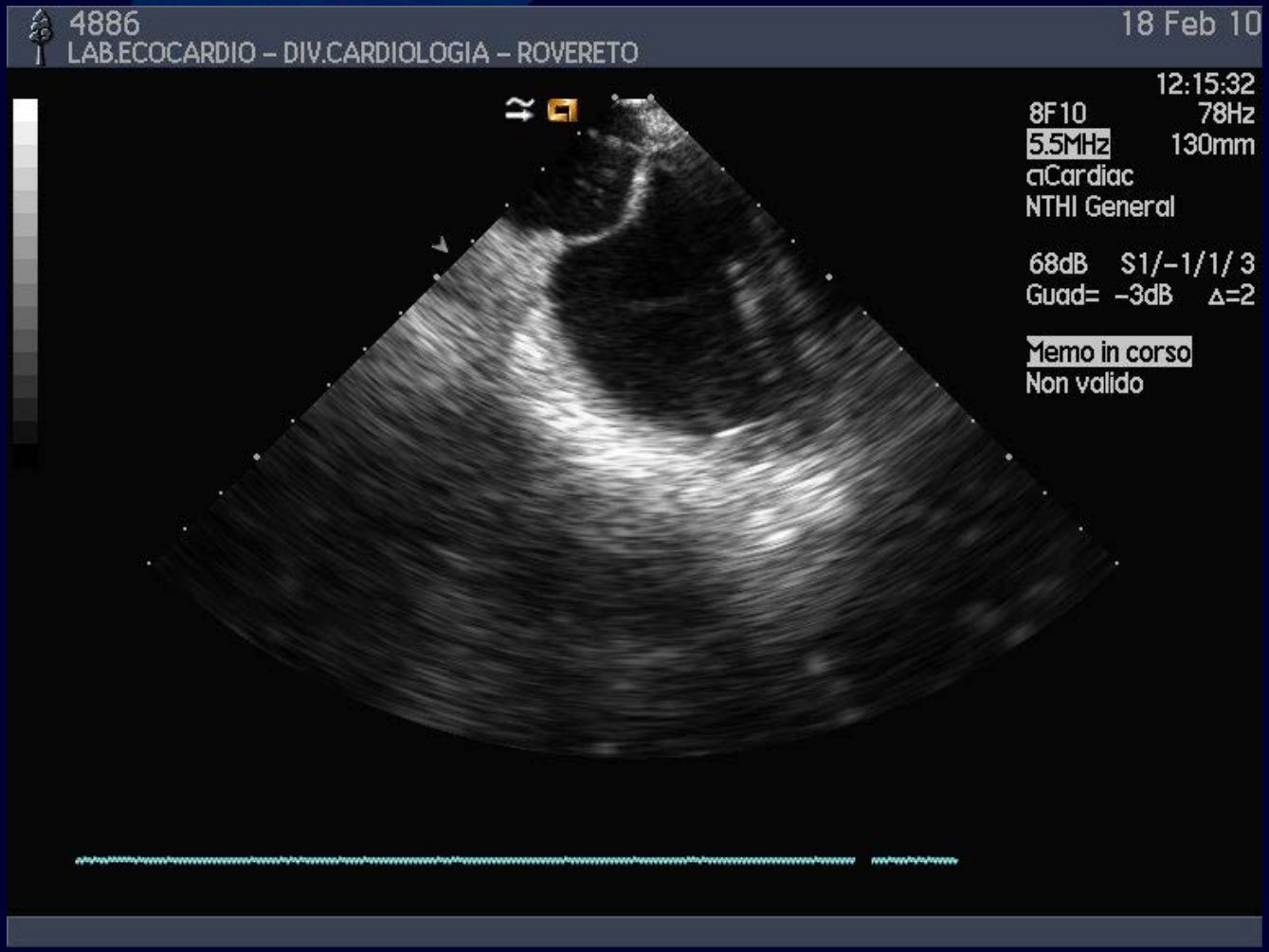

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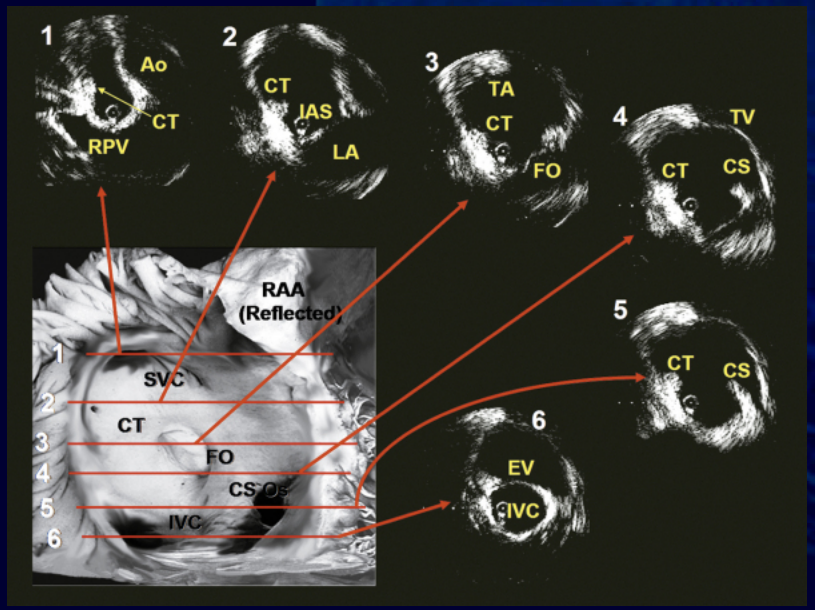
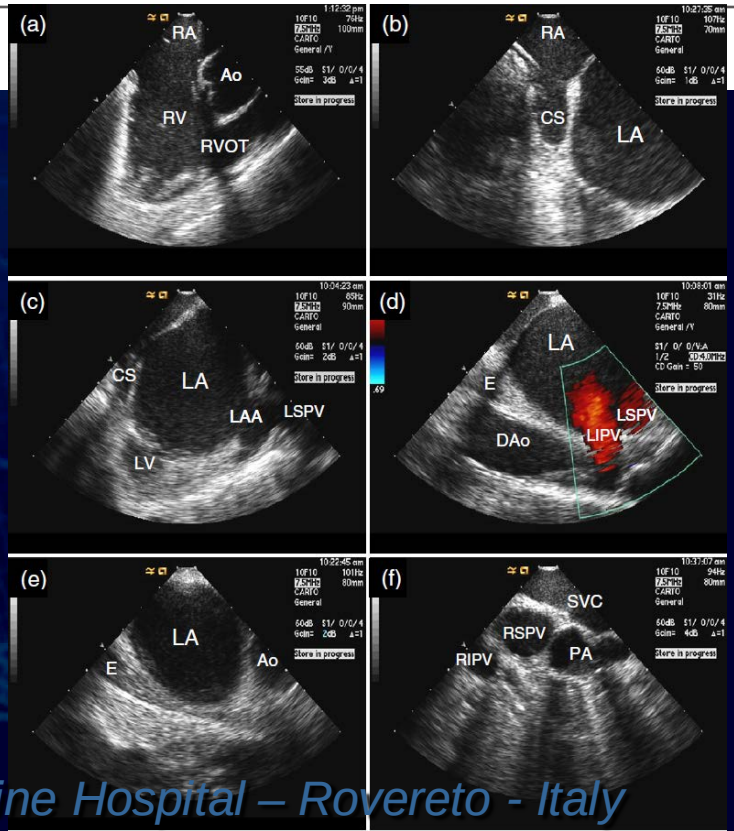
Table. Presently Available Intracardiac Imaging Devices and Their Capabilities

Device Name	Company	Features
UltraICE	Boston Scientific	9F nonsteerable rotational motor-driven grayscale only system
AcuNav	Siemens, Biosense-Webster	Side-looking 64-element phased-array 4-way steerability, 8F and 10F; grayscale, color Doppler, tissue Doppler, 3D localization with Cartosound
EP Med View Flex Catheter	St Jude Medical	Runs side-looking 64-element catheter on the Viewmate scanner, 10F introducer, 2-way flex color Doppler, grayscale, tissue Doppler 8-2 MHz
ClearICE	St Jude Medical	Derived from the hockey stick, 64-element side-looking highly steerable 4-way side-looking array with 2 sets of electrodes for integration of 3D localization with NavX; runs on the GE Vivid *i* scanner; grayscale, tissue Doppler, synchronization mapping, 2D speckle tracking
SoundStar Catheter	Biosense-Webster	This is a new catheter, just now marketed as a 10F (3.33-mm) device with integrated ultrasound array (like AcuNav) but with the CARTO magnetic sensor in the tip; this is now FDA approved; FDA 510(k) No. is K070242, May 15, 2007

3D indicates 3-dimensional; 2D, 2-dimensional; and FDA, Food and Drug Administration.



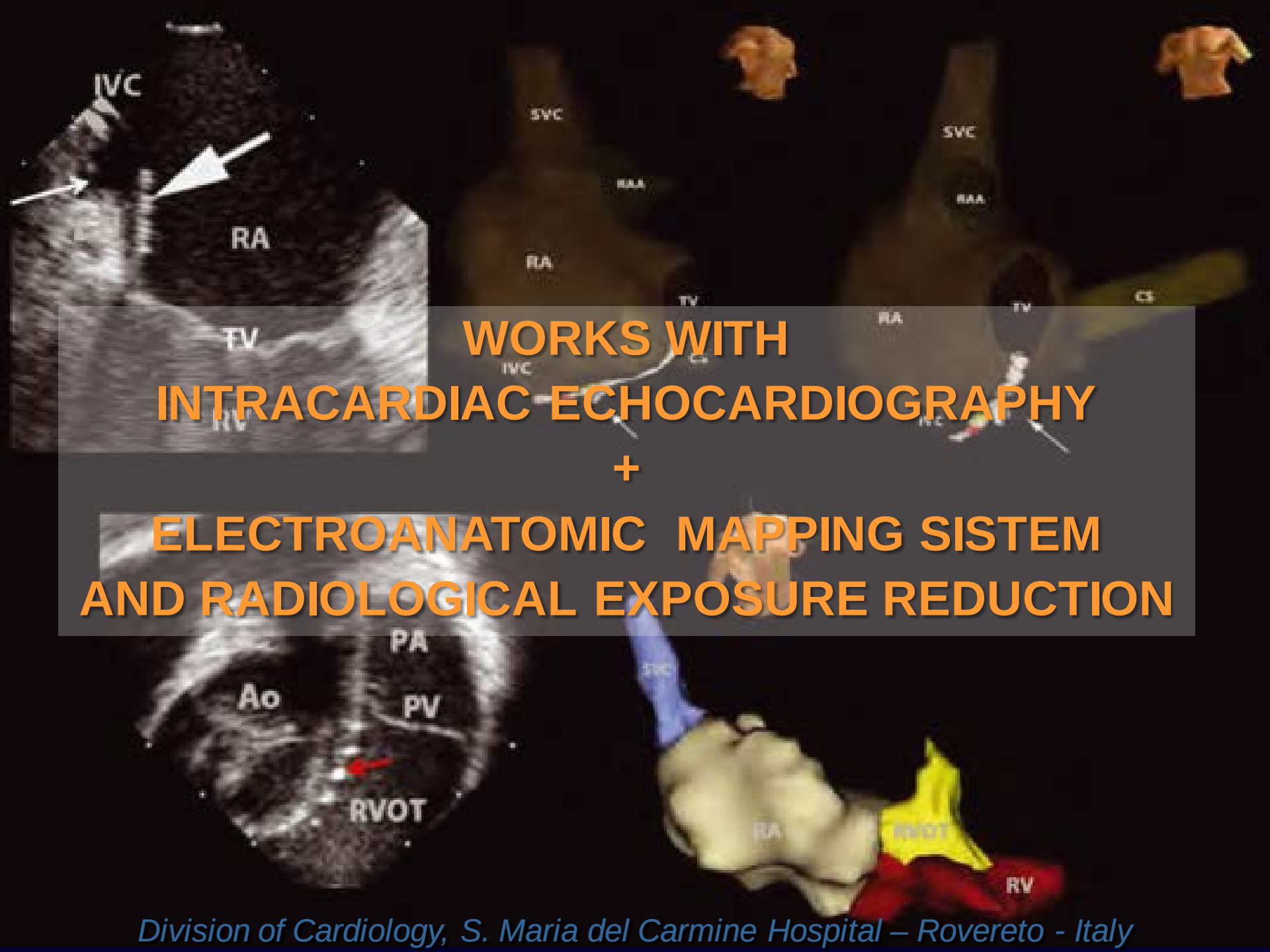


Introduction

Uses of ICE in the electrophysiology laboratory have included:

- ✓ the identification of atrial endocardial structures and the manipulation of mapping and ablation catheters in relation to these structures
- ✓ the creation and quantification of focal and continuous radiofrequency ablation (RFA) lesions
- ✓ guidance in the performance of atrial transseptal puncture
- ✓ identification and prevention of procedural complications.

REDUCTION OF RADIOLOGICAL EXPOSURE



WORKS WITH INTRACARDIAC ECHOCARDIOGRAPHY + ELECTROANATOMIC MAPPING SISTEM AND RADIOLOGICAL EXPOSURE REDUCTION

Division of Cardiology, S. Maria del Carmine Hospital – Rovereto - Italy

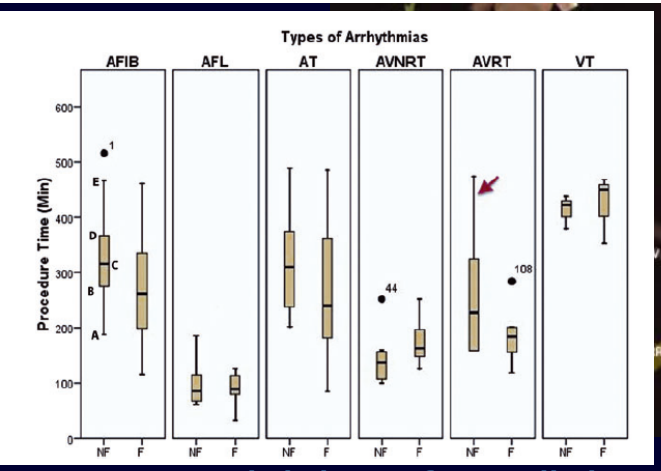
Nonfluoroscopic Catheter Ablation of Cardiac Arrhythmias in Adults: Feasibility, Safety, and Efficacy

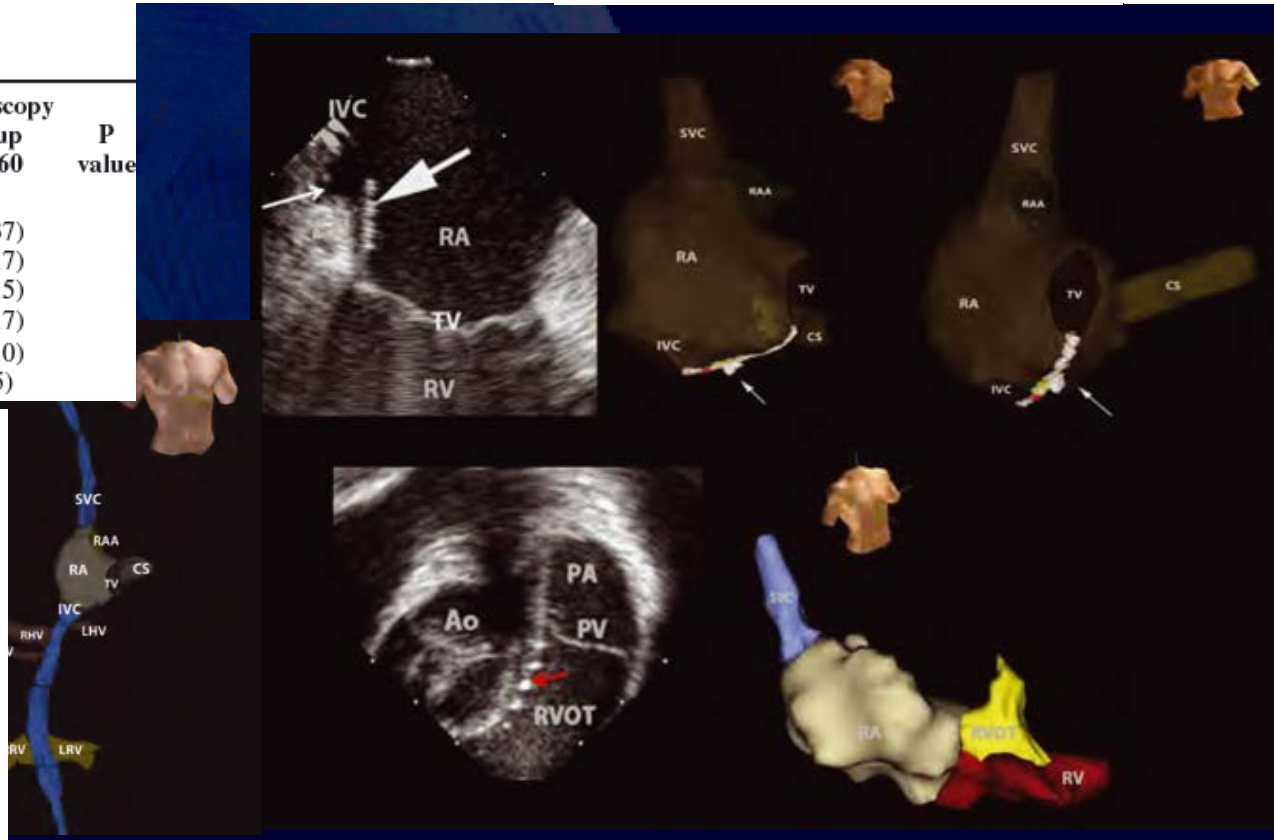
MANSOUR RAZMINIA, M.D., F.A.C.C., MARIAN F. MANANKIL, M.D., PAULA L.S. ERYAZICI, M.D., CARLOS ARRIETA-GARCIA, M.D., THEODORE WANG, M.D., F.A.C.C., OLIVER J. D'SILVA, M.D., CHRISTIAN S. LOPEZ, M.D., GEORGE J. CRYSTAL, PH.D., F.A.H.A., SABA KHAN, M.D., MIHAELA M. STANCU, M.D., MARIANNE TURNER, R.N., JOSEPH ANTHONY, R.N., TERRY A. ZHEUTLIN, M.D., F.A.C.C., and RICHARD F. KEHOE, M.D., *J Cardiovasc Electrophysiol, Vol. pp. 1-9)* 2012

TABLE 1

Baseline Patient Characteristics

Variables	Nonfluoroscopy Group n = 60	Fluoroscopy Group n = 60	P value
Type of arrhythmia [n (%)]			
Atrial fibrillation	22 (37)	22 (37)	
Atrial flutter	10 (17)	10 (17)	
Atrial tachycardia	9 (15)	9 (15)	
AVNRT§	10 (17)	10 (17)	
AVRT‖	6 (10)	6 (10)	
Ventricular tachycardia	3 (5)	3 (5)	





Catheter ablation of atrial fibrillation without the use of fluoroscopy

Vivek Y. Reddy, MD,*† Gustavo Morales, MD,‡ Humera Ahmed, BA,* Petr Neuzil, MD, PhD,† Srinivas Dukkipati, MD,* Steve Kim, BS,§ Janet Clemens, BS,§ Andre D'Avila, MD*

*From the *Cardiac Arrhythmia Service, Mount Sinai School of Medicine, New York, New York; †Homolka Hospital, Prague, Czech Republic; ‡University of Kentucky, Lexington, Kentucky; and §St. Jude Medical Inc., Minneapolis, Minnesota.*

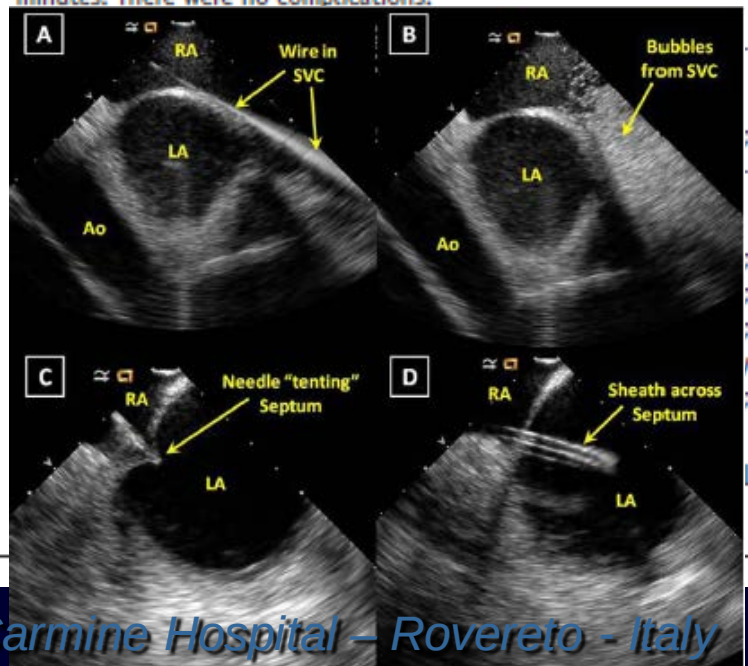
(Heart Rhythm 2010;7:1644–1653)

BACKGROUND In performing catheter ablation of paroxysmal atrial fibrillation (PAF), the advent of electroanatomical mapping (EAM) has significantly reduced fluoroscopy time. Recent advances in the ability of EAM systems to simultaneously visualize multiple catheters have allowed some operators to perform certain procedures, such as catheter ablation of supraventricular tachycardias, with zero fluoroscopy use.

OBJECTIVE The purpose of this study was to evaluate the feasibility and safety of pulmonary vein (PV) isolation with zero fluoroscopy use, using a combination of three-dimensional EAM and intracardiac echocardiography (ICE).

METHODS Using the NavX EAM system, the right atrial (RA) and coronary sinus (CS) geometries were created without fluoroscopy. Fluoroless transseptal puncture was performed under ICE guidance. Using a deflectable sheath and a multipolar catheter, the left atrial (LA) and PV anatomies were rendered and, in select cases, integrated with a three-dimensional computed tomography (CT) image. Irrigated radiofrequency ablation was performed to encircle each pair of ipsilateral PVs.

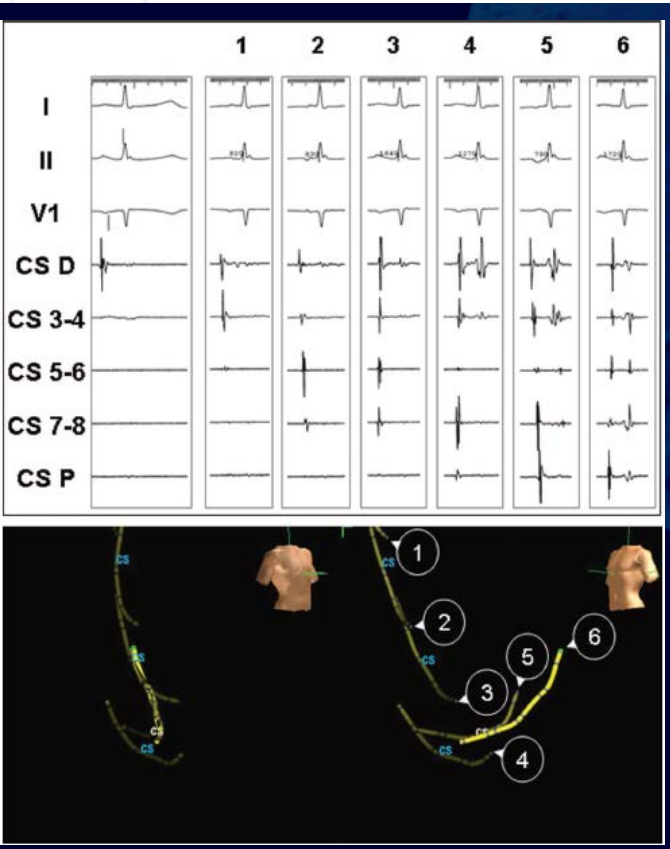
RESULTS This series included 20 consecutive PAF patients. RA/CS mapping required 5.5 ± 2.6 minutes. In all patients, single (n = 18) or dual (n = 2) transseptal access was successfully achieved. The LA-PV anatomy was rendered using either a circular (14 patients) or penta-array (six patients) catheter in 22 ± 10 minutes; CT image integration was used in 11 patients. Using 49 ± 18 ablation lesions/patient, electrical isolation was achieved in 38/39 ipsilateral PV isolating lesion sets (97%). The procedure time was 244 ± 75 minutes. There were no complications.



Catheter Ablation of Atrial Fibrillation Without Fluoroscopy Using Intracardiac Echocardiography and Electroanatomic Mapping

John D. Ferguson, MBChB, MD; Adam Helms, MD; J. Michael Mangrum, MD; Srijoy Mahapatra, MD; Pamela Mason, MD; Ken Bilchick, MD; George McDaniel, MD; David Wiggins, BS; John P. DiMarco, MD, PhD

(*Circ Arrhythm Electrophysiol.* 2009;2:611-619.)



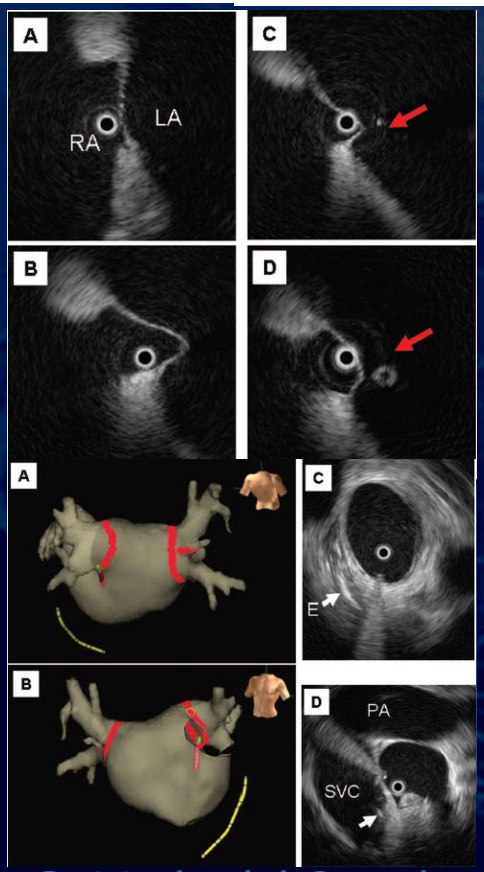


Table. Acute Procedural Outcomes of AF Ablation Without Fluoroscopy

Patients with no fluoroscopy	19/21 (90)
Procedure time, min	208 (188–221)
Coronary sinus cannulation time, min	5 (2–26)
Double transseptal time, min	26 (17–40)
Left atrial catheter manipulation time, min	103 (90–127)
Right atrial catheter manipulation time, min	16 (12–22)
Electrophysiology study time, min	14 (8–23)
Successful pulmonary vein isolation	76/76 (100)
Patients with additional ablation	
Left atrial roof	7 (33)
Mitral isthmus	4 (19)
Cavotricuspid isthmus	8 (38)
Coronary sinus	3 (14)
Complications	0

Data are presented as n/N (%) or median (range).

Different Image Integration Modalities to Guide AF Ablation: Impact on Procedural and Fluoroscopy Times

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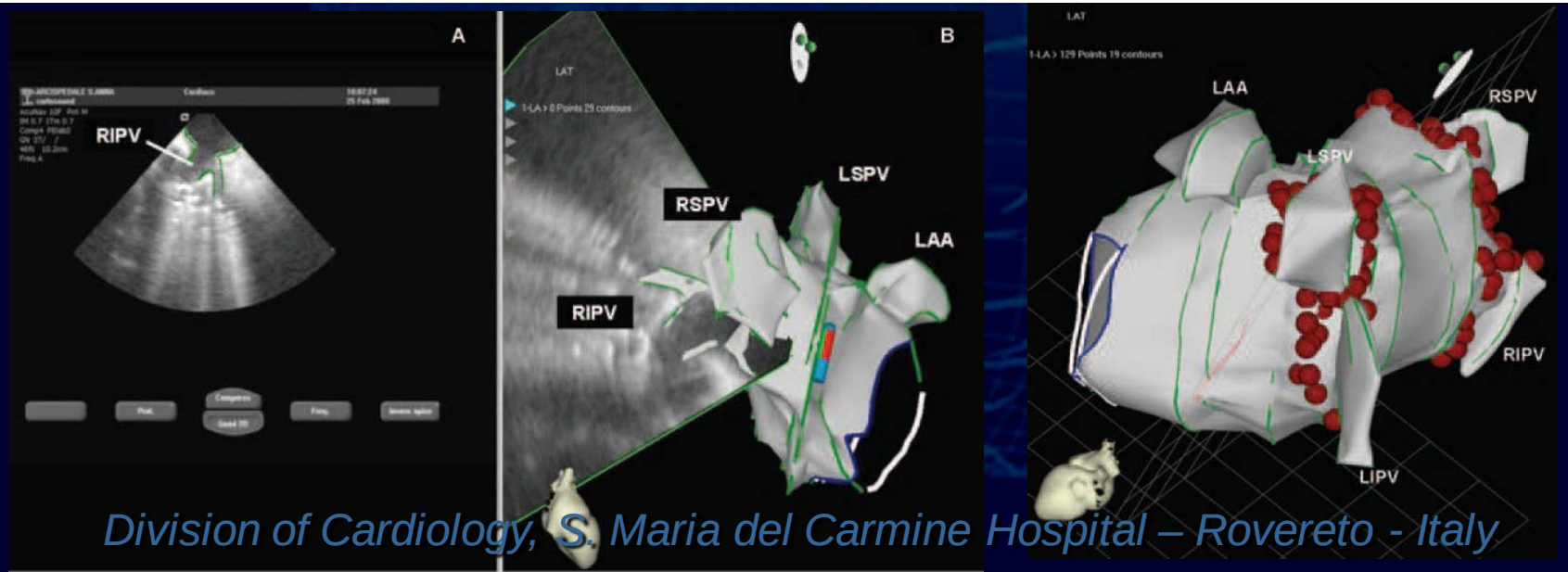
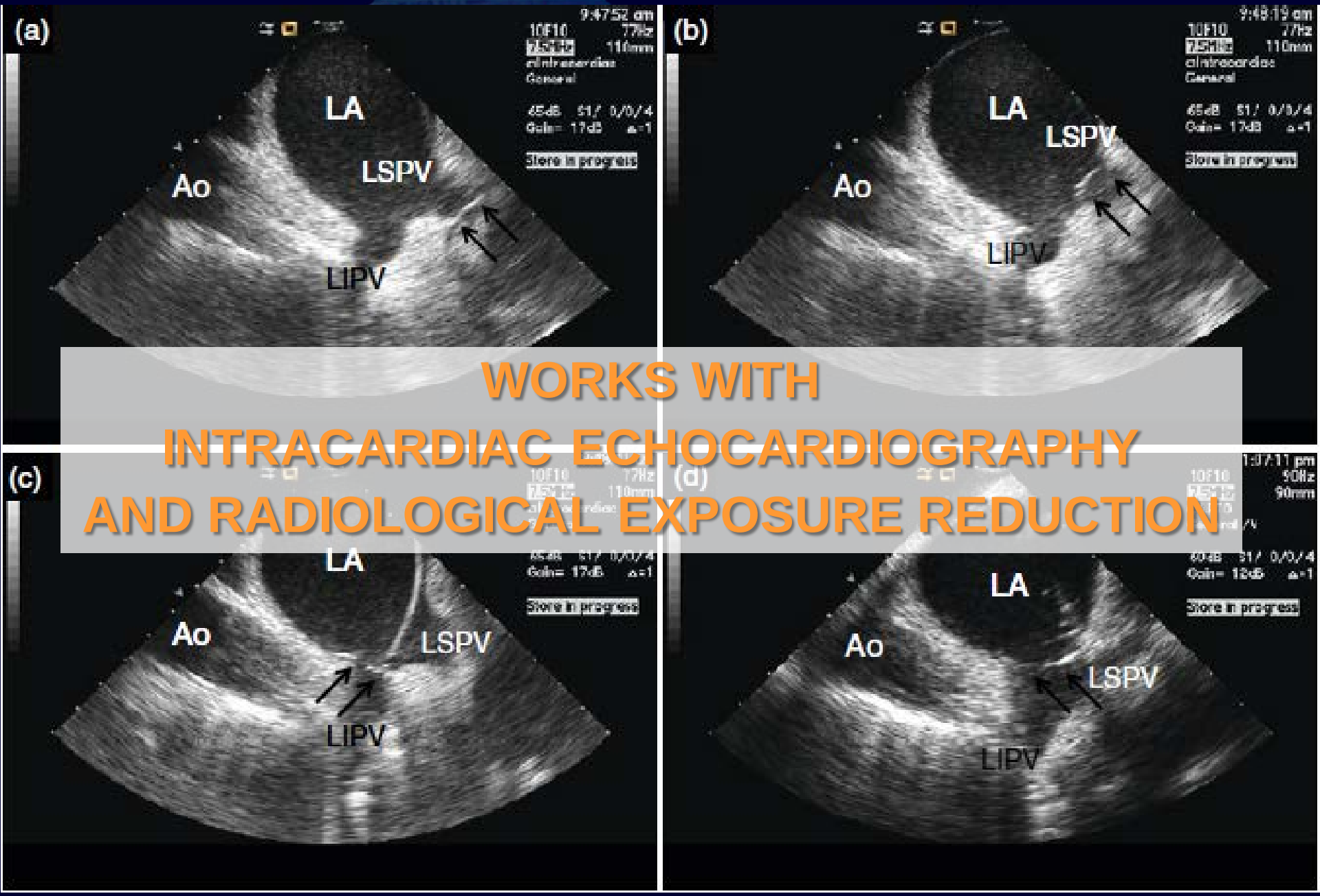
LINA MARCANTONI, M.D.,* TIZIANO TOSELLI, M.D.,* GIANFRANCQ PERCOCO. M.D..†
BIAGIO SASSONE, M.D.,§ and ROBERTO FERRARI, M.D., PH.D.* *(PACE 2011; 34:422–430)*

	Group 1 (MRI Integration)	Group 2 (ICE Integration)	Group 3 (MRI and ICE Integration)	Kruskal-Wallis Test Mann-Whitney Test with Bonferroni Correction
Total procedural time, minutes	124.7 ± 47.0 (71–214)	112.5 ± 30.4 (76–182)	108.6 ± 34.7 (74–198)	P = ns
Total fluoroscopy time, minutes	23.8 ± 6.9 (14–37)	11.0 ± 2.3 (8–15)	13.9 ± 4.2 (8–23)	P < 0.0005 Gr 1 vs Gr 2 P < 0.005 Gr 1 vs Gr 3 P < 0.005 Gr 2 vs Gr 3 P = 0.06





WORKS WITH INTRACARDIAC ECHOCARDIOGRAPHY AND RADIOLOGICAL EXPOSURE REDUCTION

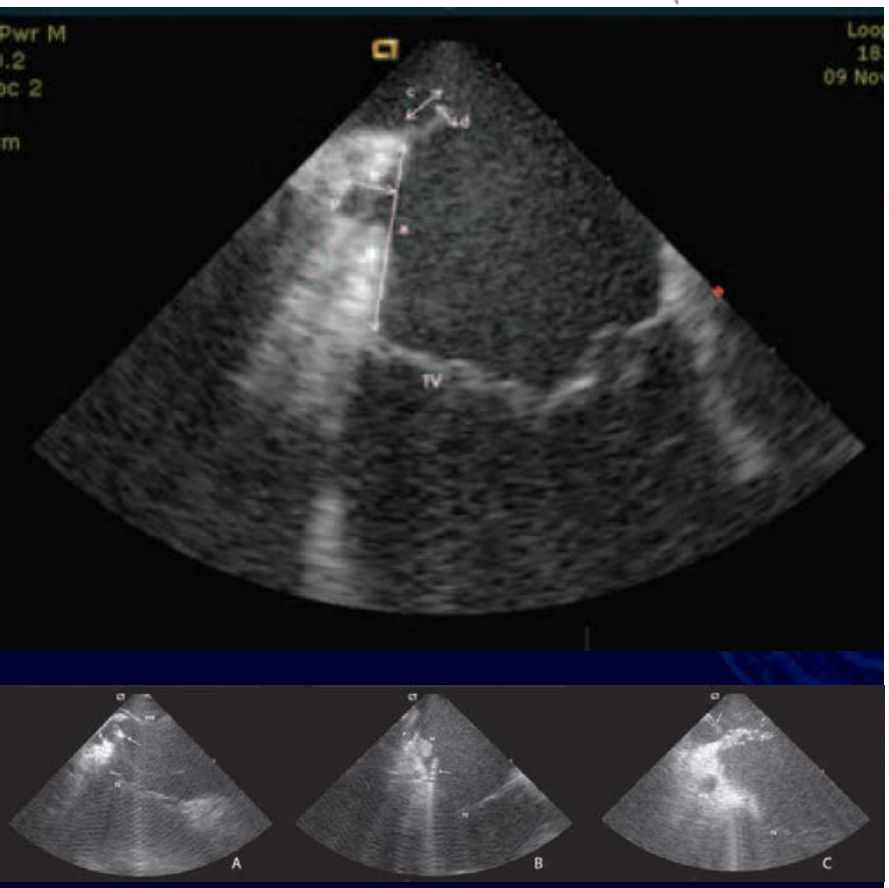
Division of Cardiology, S. Maria del Carmine Hospital – Rovereto - Italy

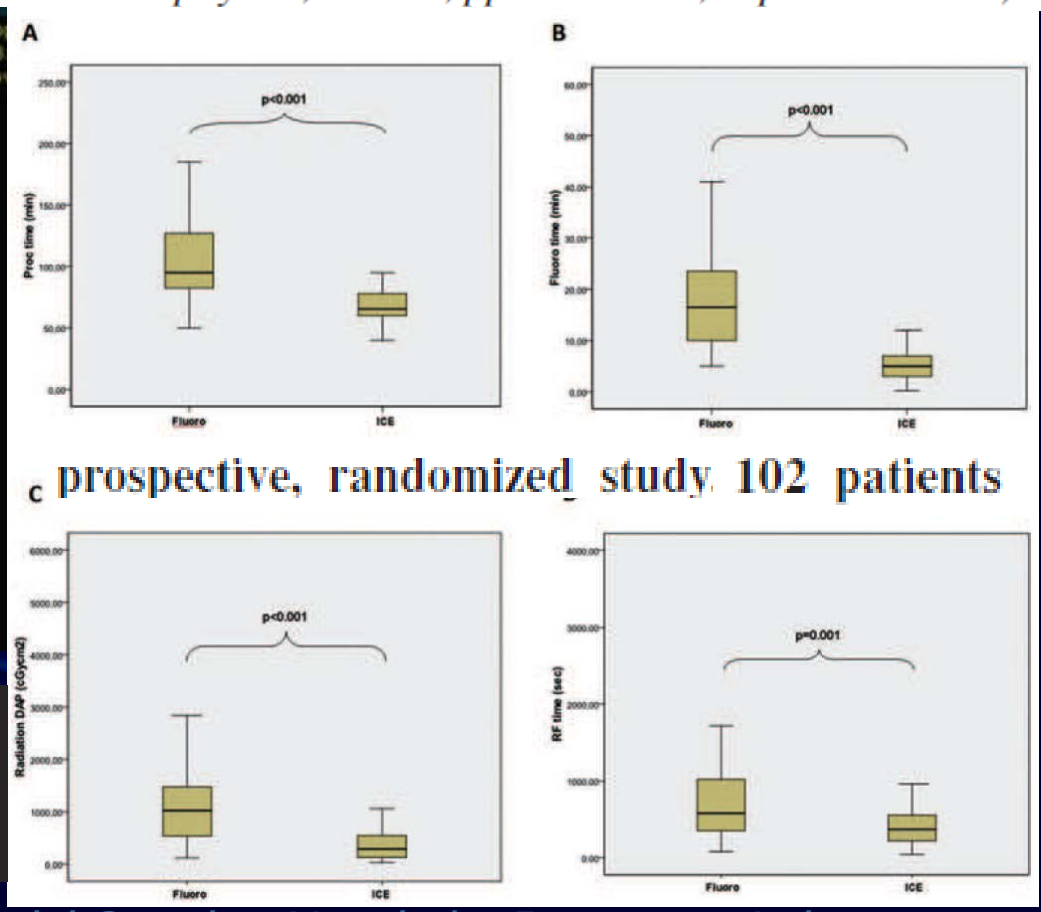
Randomized Trial of Intracardiac Echocardiography During Cavotricuspid Isthmus Ablation

GÁBOR BENCSIK, M.D., PH.D., RÓBERT PAP, M.D., PH.D., ATTILA MAKAI, M.D., PH.D., GERGELY KLAUSZ, M.D., PH.D., SZÁMI CHADAIDE, M.D., VASSIL TRAYKOV, M.D., TAMÁS FORSTER, M.D., PH.D., DSC., and LÁSZLÓ SÁGHY, M.D.

Department of Internal Medicine and Cardiology Center, University of Szeged, Szeged, Hungary

(J Cardiovasc Electrophysiol, Vol. 23, pp. 996-1000, September 2012)





prospective, randomized study 102 patients

CASE REPORT

doi:10.1093/europace/eun120

Radiofrequency catheter ablation of atrioventricular nodal reciprocating tachycardia using intracardiac echocardiography in pregnancy

Maria Grazia Bongiorni, Andrea Di Cori*, Ezio Soldati, Giulio Zucchelli, Luca Segreti, Gianluca Solarino, Raffaele De Lucia, and Mario Marzilli

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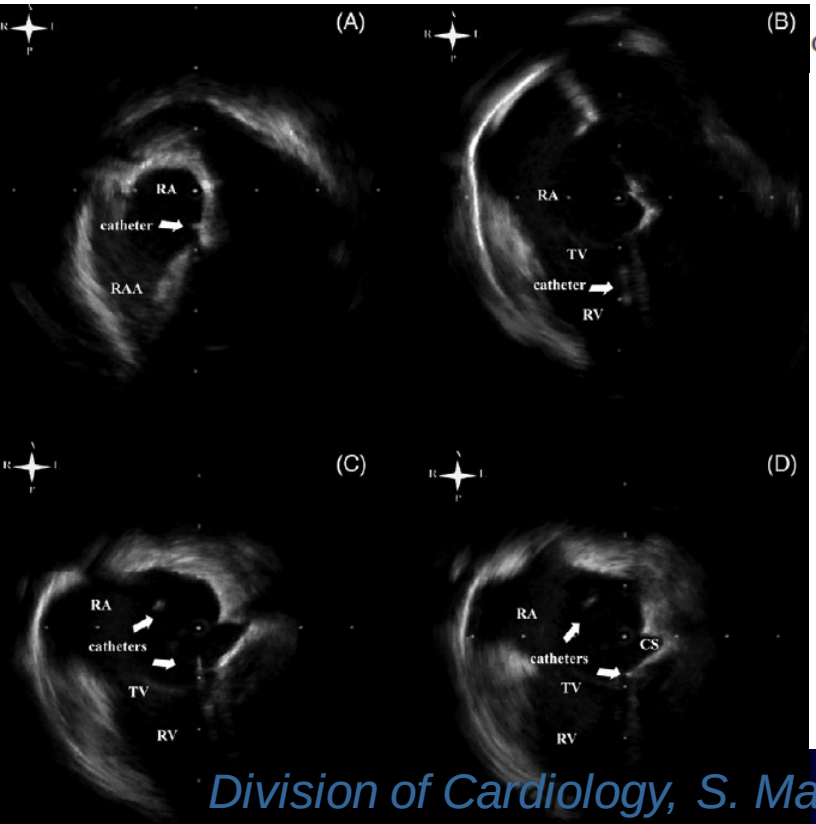
online publish-ahead-of-print 6 May 2008



Phased-Array Intracardiac Echocardiography Monitoring During Pulmonary Vein Isolation in Patients With Atrial Fibrillation

Impact on Outcome and Complications

Nassir F. Marrouche, MD; David O. Martin, MD, MPH; Oussama Wazni, MD; A. Marc Gillinov, MD; Allan Klein, MD; Mandeep Bhargava, MD; Eduardo Saad, MD; Dianna Bash, RN; Hirotsugu Yamada, MD, PhD; Wael Jaber, MD; Robert Schweikert, MD; Patrick Tchou, MD; Ahmad Abdul-Karim, MD; Walid Saliba, MD; Andrea Natale, MD

Circulation. 2003;107:2710-2716

TABLE 2. Pulmonary Vein Isolation and Follow-Up Results

	No ICE, Group 1 (n=56)	ICE Without Bubbles, Group 2 (n=107)	ICE With Bubbles, Group 3 (n=152)
No. isolated PVs, RUPV/RLPV/LUPV/LLPV	56/50/56/49	107/97/107/94	152/142/152/140
AAD	3±0.7	3.6±1.1	2.6±1.3
Fluoroscopy time, min	81±29	60±20*	59±21*
Procedure time, min	250±66	190±48*	185±65*
Mean No. RF lesions/PV (min)	14±2 (10.5±4)	10±3 (7.5±2.2)	8.5±2 (6.2±1.5)*
Follow-up, days	639±79	437±46	288±67
Recurrence of AF	19.6% (11 of 56)	16.8% (18 of 107)	9.8% (15 of 152)†
Moderate PV stenosis/PV	5% (11 of 211)	4.5% (18 of 405)	2.5% (12 of 586)
Moderate PV stenosis/patient	9% (5 of 56)	6.5% (7 of 107)	4% (5 of 152)‡

*$P<0.05$ vs group 1 applying ANOVA;

†$P=0.009$ vs group 1

‡$P<0.05$ vs group

Conclusions—Intracardiac echocardiography improves the outcome of cooled-tip PVI. Power adjustment guided by direct visualization of microbubble formation reduces the risk of PV stenosis and improves long-term cure. (***Circulation*. 2003;107:2710-2716.**)

Intracardiac Echocardiography Improves Procedural Efficiency During Cryoballoon Ablation for Atrial Fibrillation: A Pilot Study

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HARALD MARSCHANG, M.D.,* GUIDO RITSCHER, M.D.,* OLIVER TURSCHNER, M.D.,*
JOHANNES BRACHMANN, M.D., Ph.D.,* and HARALD RITTGER, M.D.*

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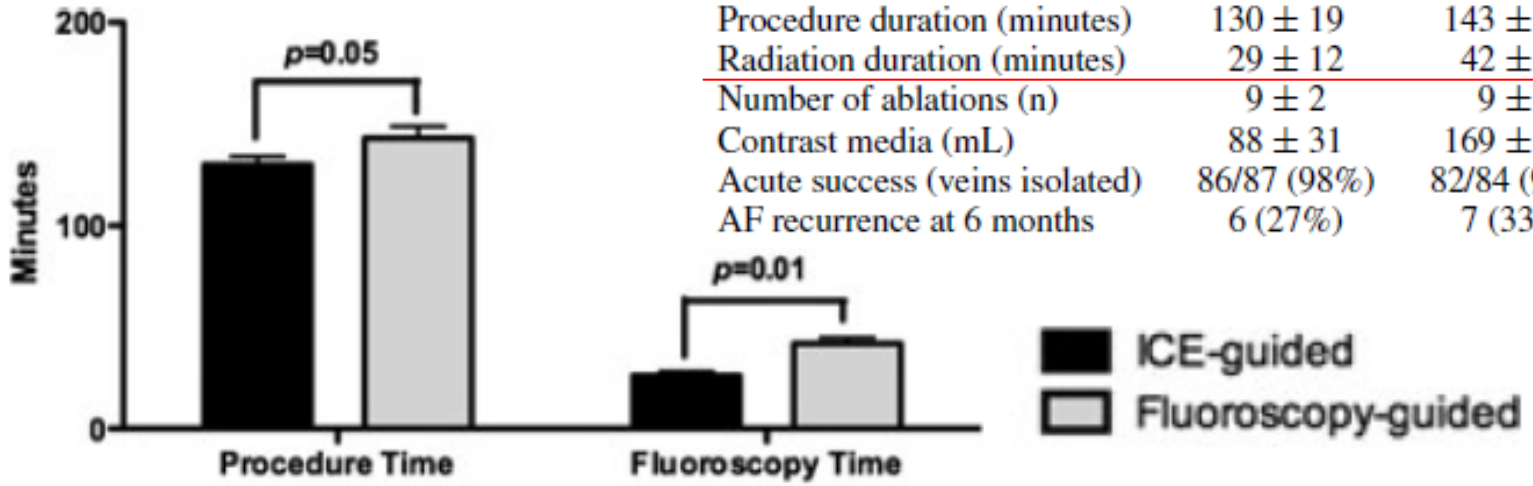
Characteristic	Group 1 (ICE) (n = 22)	Group 2 (no ICE) (n = 21)	P-value
Procedure duration (minutes)	130 ± 19	143 ± 27	0.05
Radiation duration (minutes)	29 ± 12	42 ± 13	0.01
Number of ablations (n)	9 ± 2	9 ± 2	ns
Contrast media (mL)	88 ± 31	169 ± 38	<0.001
Acute success (veins isolated)	86/87 (98%)	82/84 (97%)	ns
AF recurrence at 6 months	6 (27%)	7 (33%)	ns



Journal of Cardiovascular Electrophysiology Vol. 21, No. 11, November 2010

Indian Pacing Electrophysiol. J. 2012;12(6)
In press

Indian PACING and ELECTROPHYSIOLOGY Journal

Original Article

Usefulness of Contrast Intracardiac Echocardiography in Performing Pulmonary Vein Balloon Occlusion during Cryo-ablation for Atrial Fibrillation

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	All (n=30)	Group 1 (n=15)	Group 2 (n=15)	P
Procedure time (minutes)	138±20	152±19	127±16	P<0.05
Number of applications	11.4±3.2	10.8±2.6	12.0±3.6	P=n.s.
fluoroscopy time (minutes)	34±8	43±9	30±12	P<0.05
use of contrast (ml)	140±62	190±47	88±26	P<0.001

Uses of ICE in the electrophysiology laboratory included:

1. the identification of atrial endocardial structures and the manipulation of mapping and ablation catheters in relation to these structures
2. the creation and quantification of focal and continuous radiofrequency ablation (RFA) lesions
3. guidance in the performance of atrial transseptal puncture
4. identification and prevention of procedural complications
5. ICE and Cryoballoon Pulmonary Vein Isolation

1. Identification of right atrial structures and manipulation of mapping and ablation (A FLA)

IMAGES IN ELECTROPHYSIOLOGY

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Online publish-ahead-of-print 15 May 200

Intracardiac echocardiography for visualization of the Eustachian valve during radiofrequency ablation of typical atrial flutter

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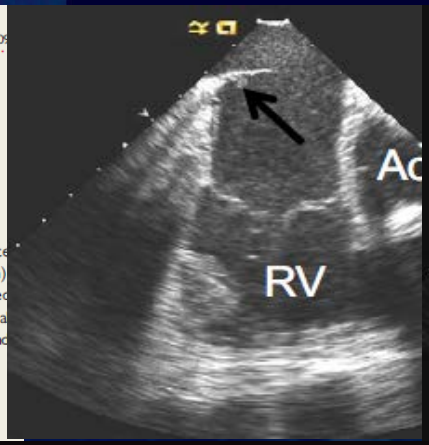
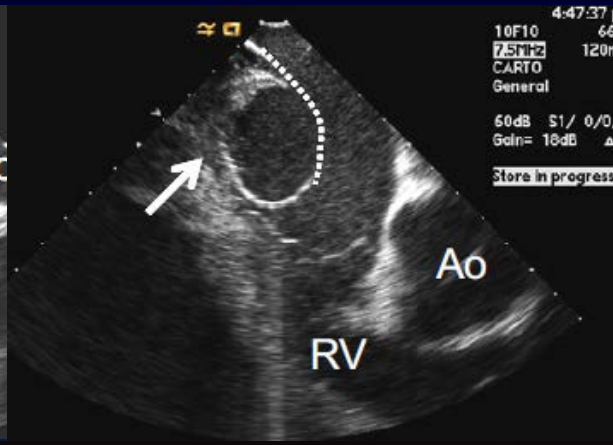
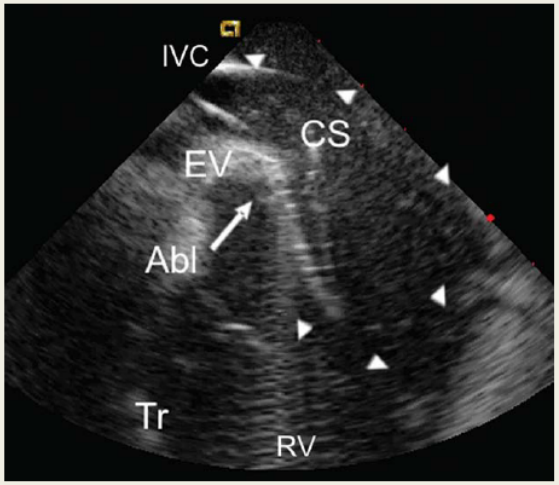
We performed a conventional, fluoroscopy-guided ablation of ongoing typical atrial flutter at the preferred isthmus site. Despite 150 min of procedure time (using a 4 mm, irrigated tip catheter with settings of 43°C, 40 W and irrigation rate of 40 mL/min) block on the isthmus was not achieved. No atrial signals were left on the line of ablation. Through the left femoral vein, we introduced an intracardiac echocardiography probe and found a highly prominent Eustachian valve (EV; see *Figure 1* and Supplementary materia online, *Movie S1*) with high-voltage atrial potential at the edge of the EV. After ablation at this point, the flutter was terminated and bidirectional block was confirmed.

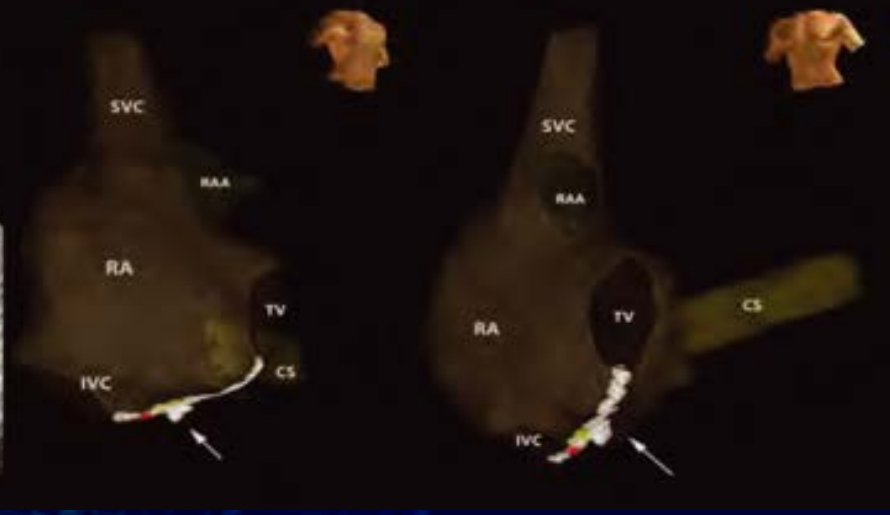
Supplementary material

Supplementary material is available at *Europace* online.

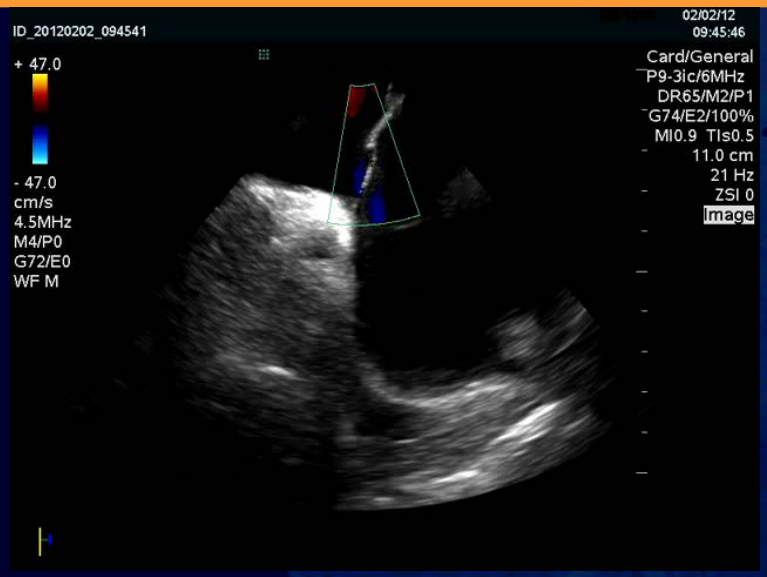


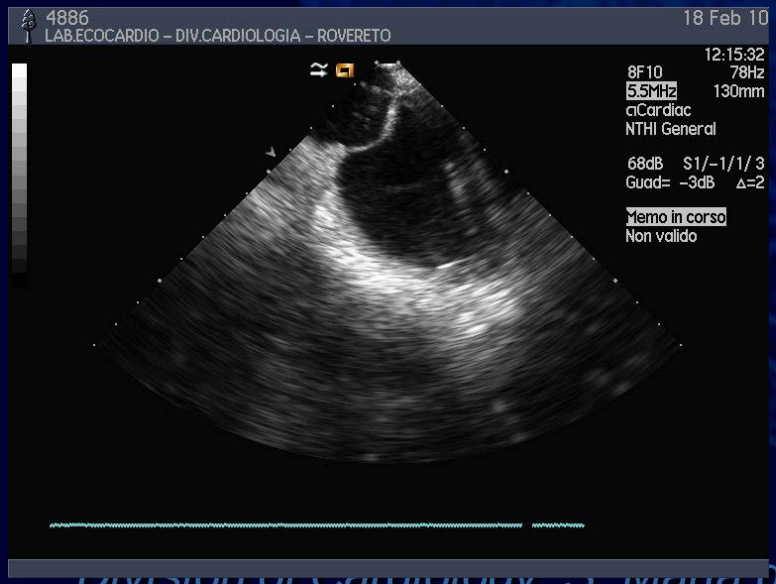






1. Identification of atrial structures and manipulation of mapping and ablation





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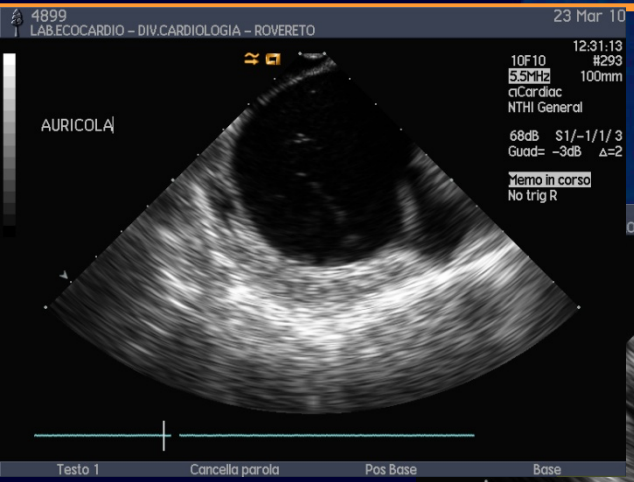

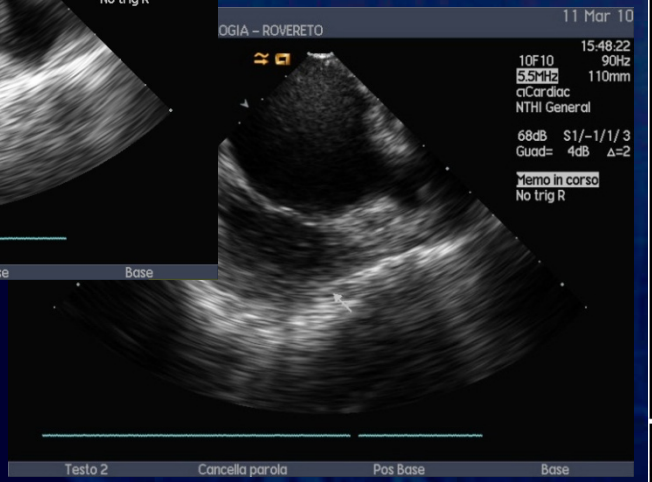

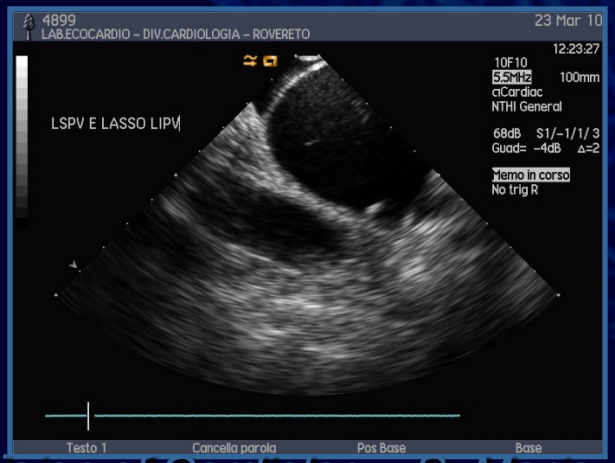

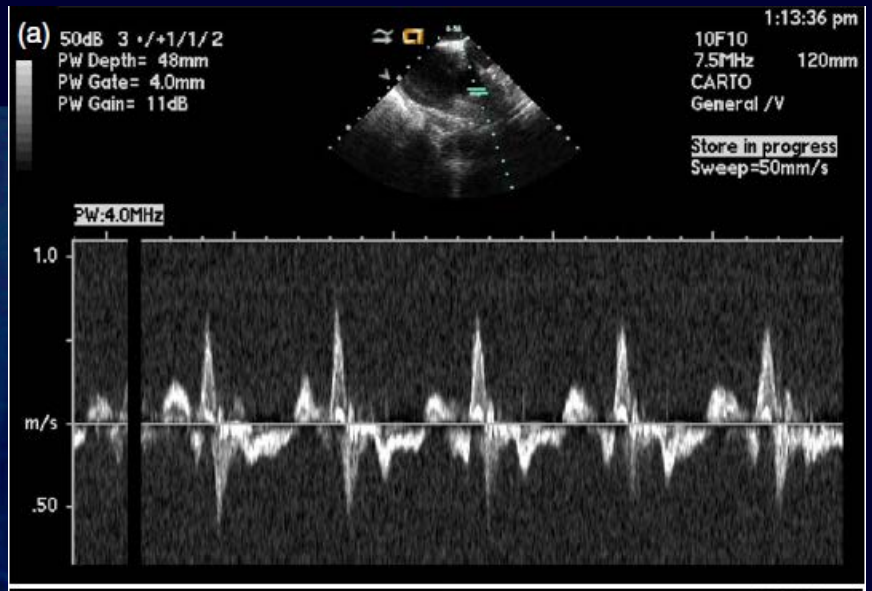

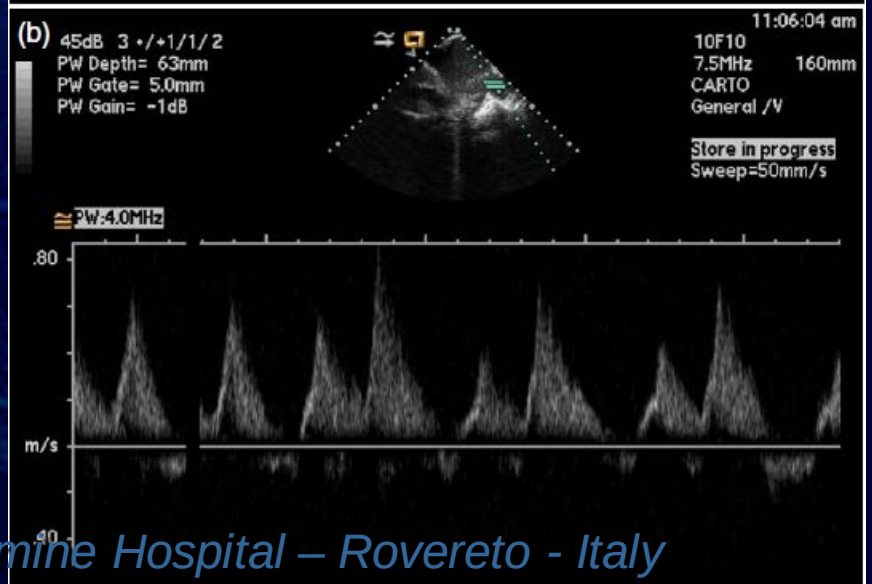

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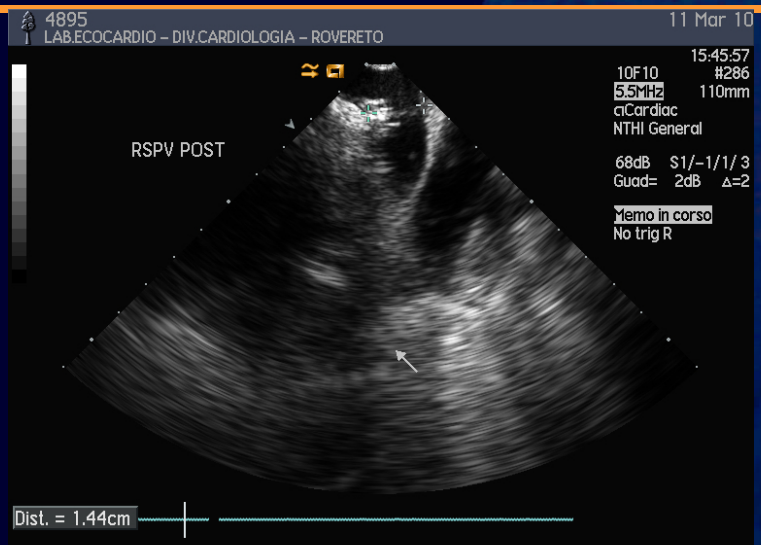
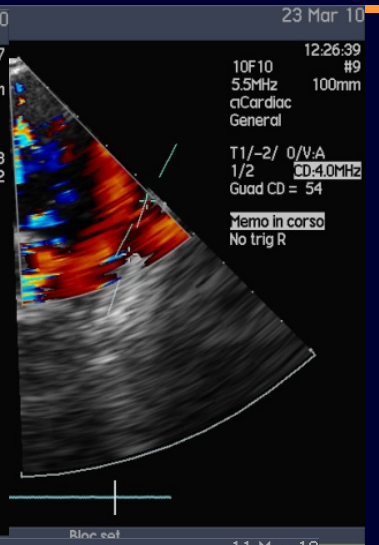
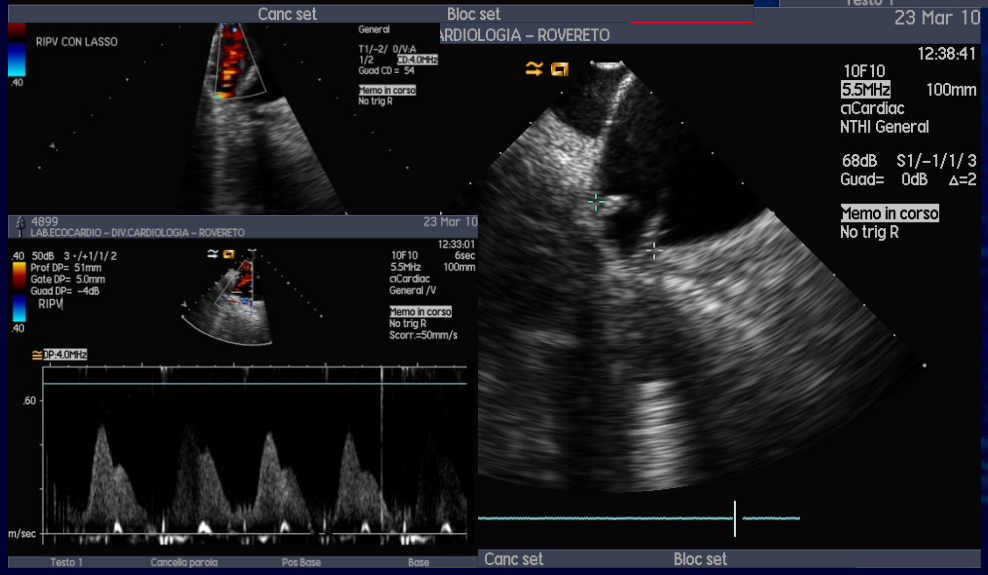






Indian Pacing Electrophysiol. J. 2012;12(6)
In press

Original Article

Indian PACING and ELECTROPHYSIOLOGY Journal

Usefulness of Contrast Intracardiac Echocardiography in Performing Pulmonary Vein Balloon Occlusion during Cryo-ablation for Atrial Fibrillation

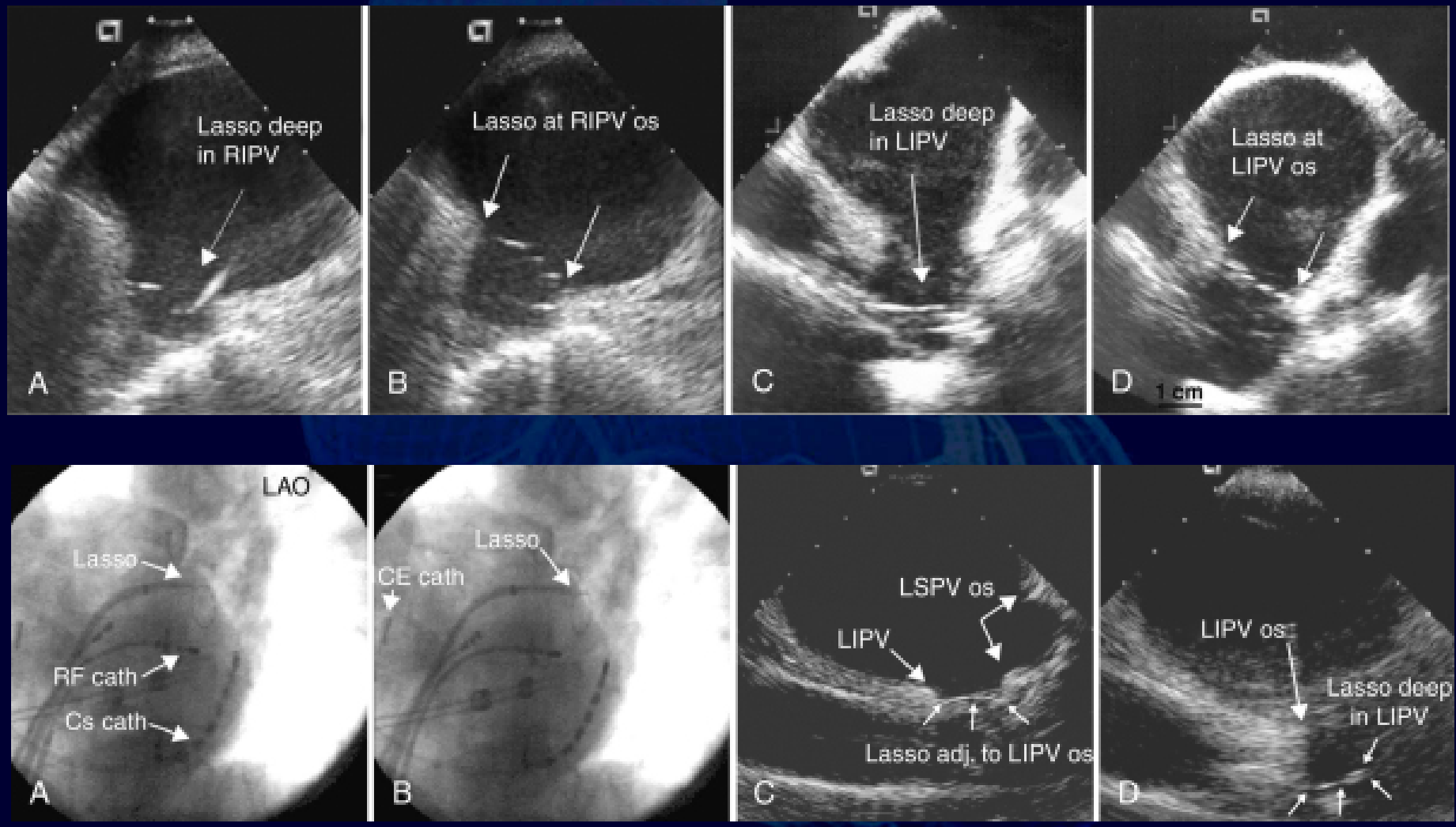
Domenico Catanzariti, MD[1], Massimiliano Maines, MD[1], Carlo Angheben, MD[1], Maurizio Centonze, MD[2], Claudio Cemin, MD[1], Giuseppe Vergara, MD[1]

[1]Division of Cardiology, S Maria del Carmine Hospital, Rovereto (TN), Italy; [2]Department of Radiology, S Chiara Hospital, Trento, Italy

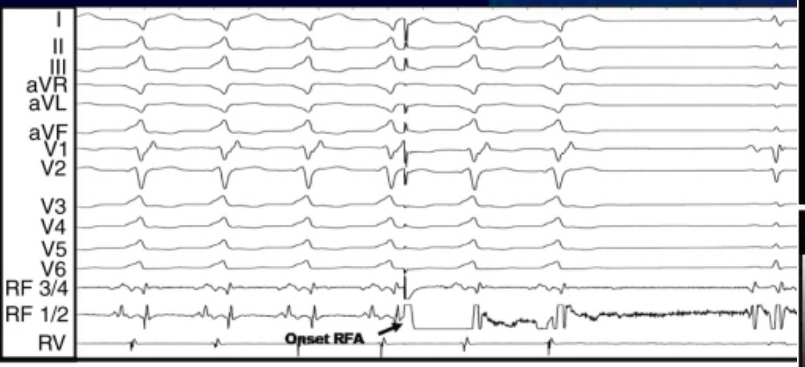
	Ø PVs MRI (mm)	Ø PVs ICE (mm)
left common trunk	25.7±5.2	23.6±1.9*
Left Superior PV	19.3±3.8	18.9±3.4*
Left Inferior PV	17.1±3.5	17.3±3.1*
Right Superior PV	20.4±2.3	19.3±3.1*
Right Inferior PV	17.3±2.4	16.8±2.4*
Right Middle PV	10	-

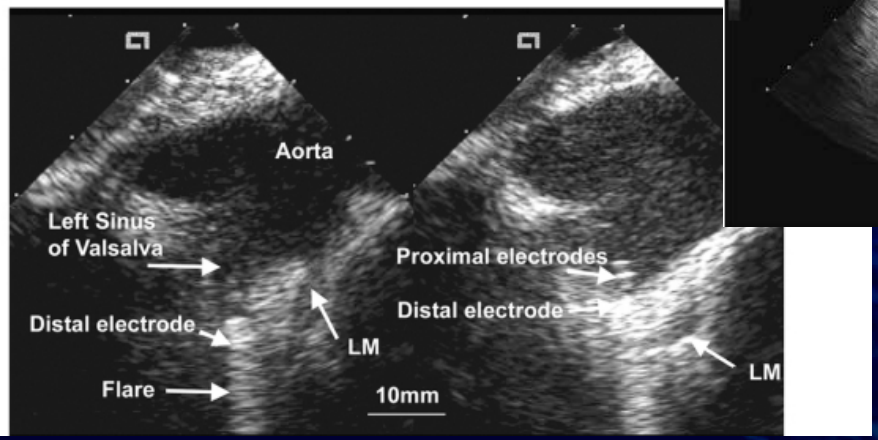
PV: pulmonary vein. ICE: intracardiac echocardiography . MRI: magnetic resonance imaging. Values are mean ± standard deviation. *P = n.s.

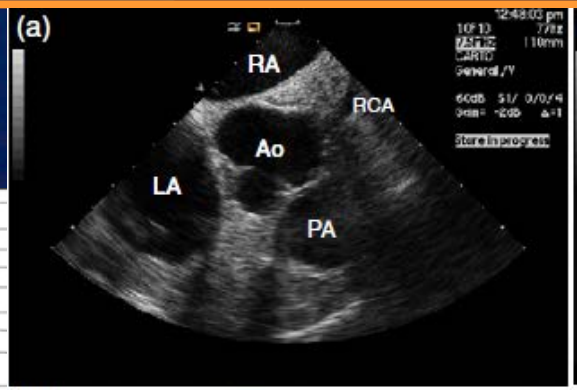
1. Identification of atrial structures and manipulation of mapping and ablation (A Fib)

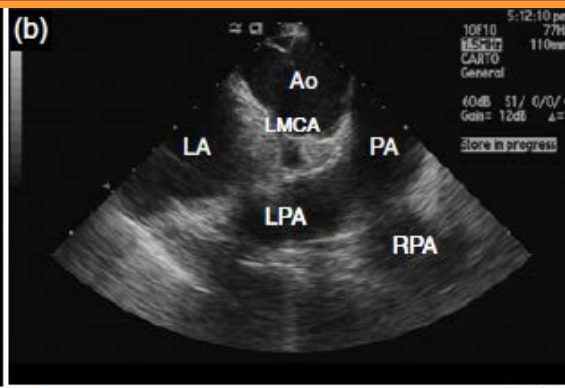


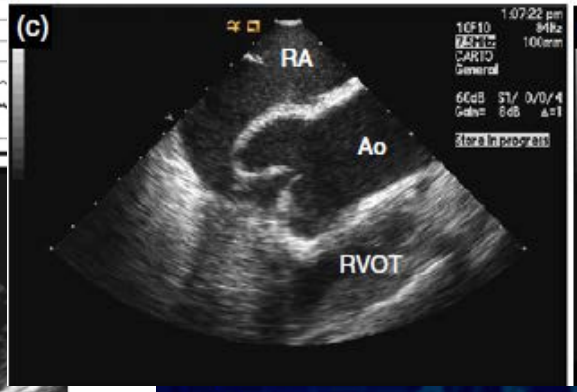
1. Identification of atrial structures and manipulation of mapping and ablation (VT)

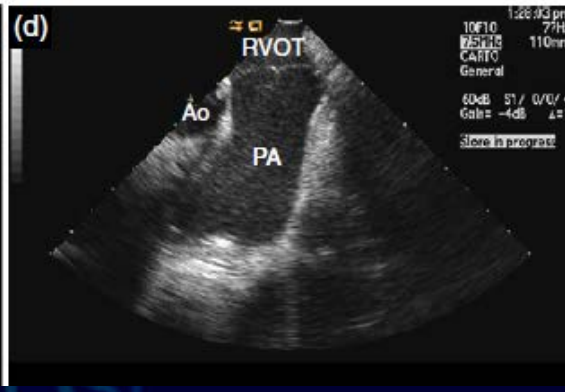












1. Identification of atrial structures and manipulation of mapping and ablation (VT)

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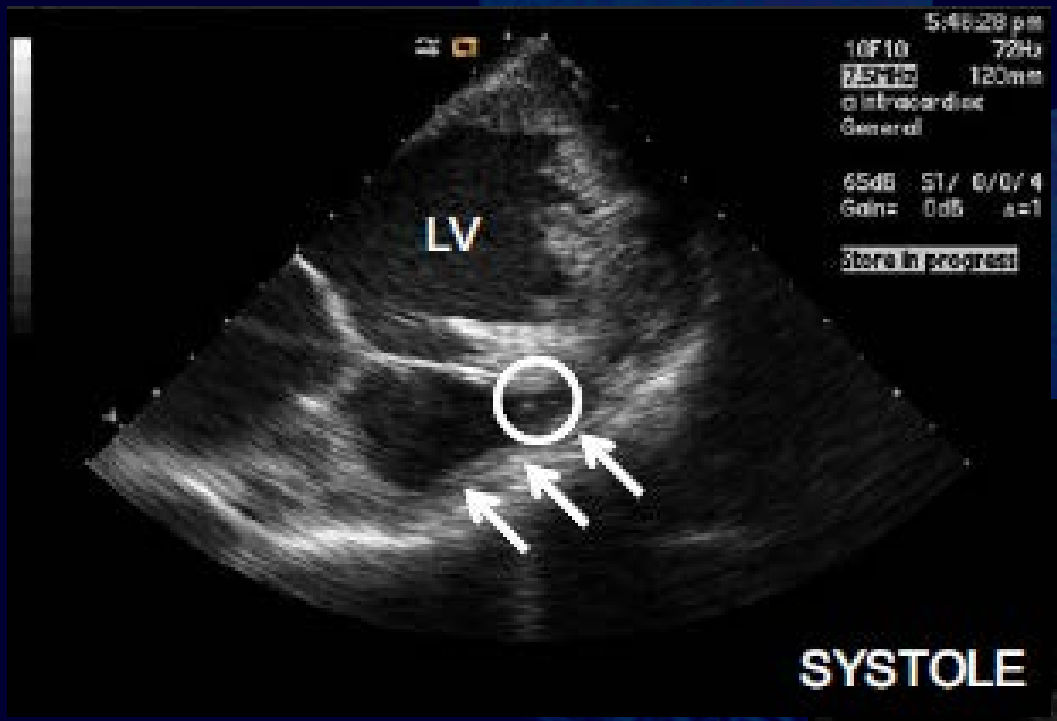
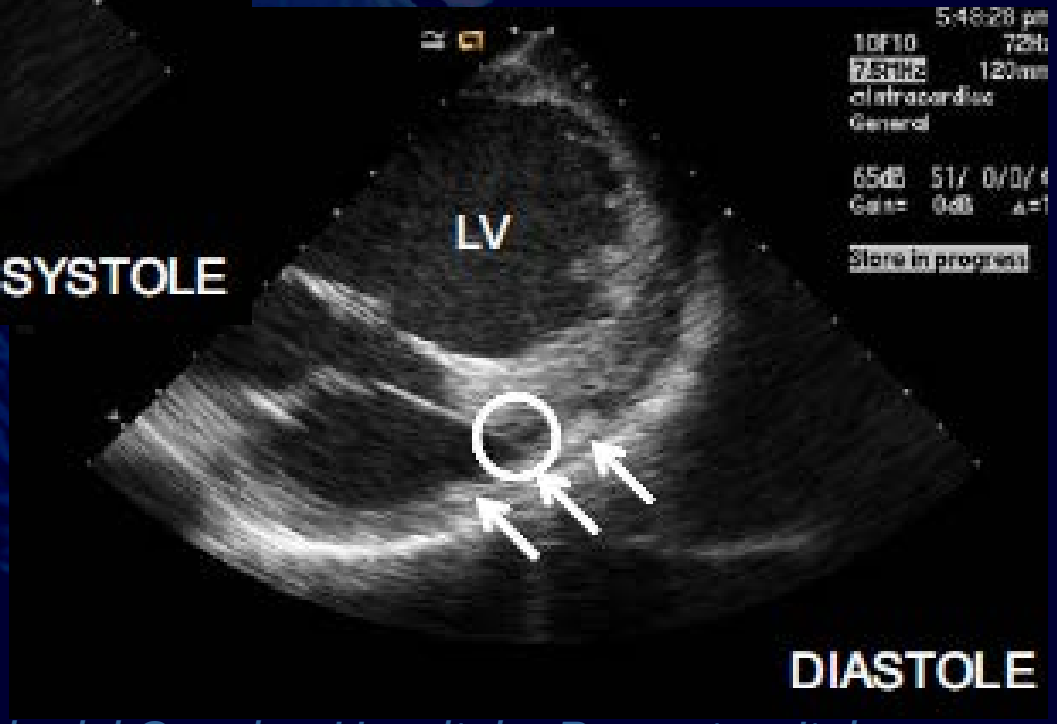
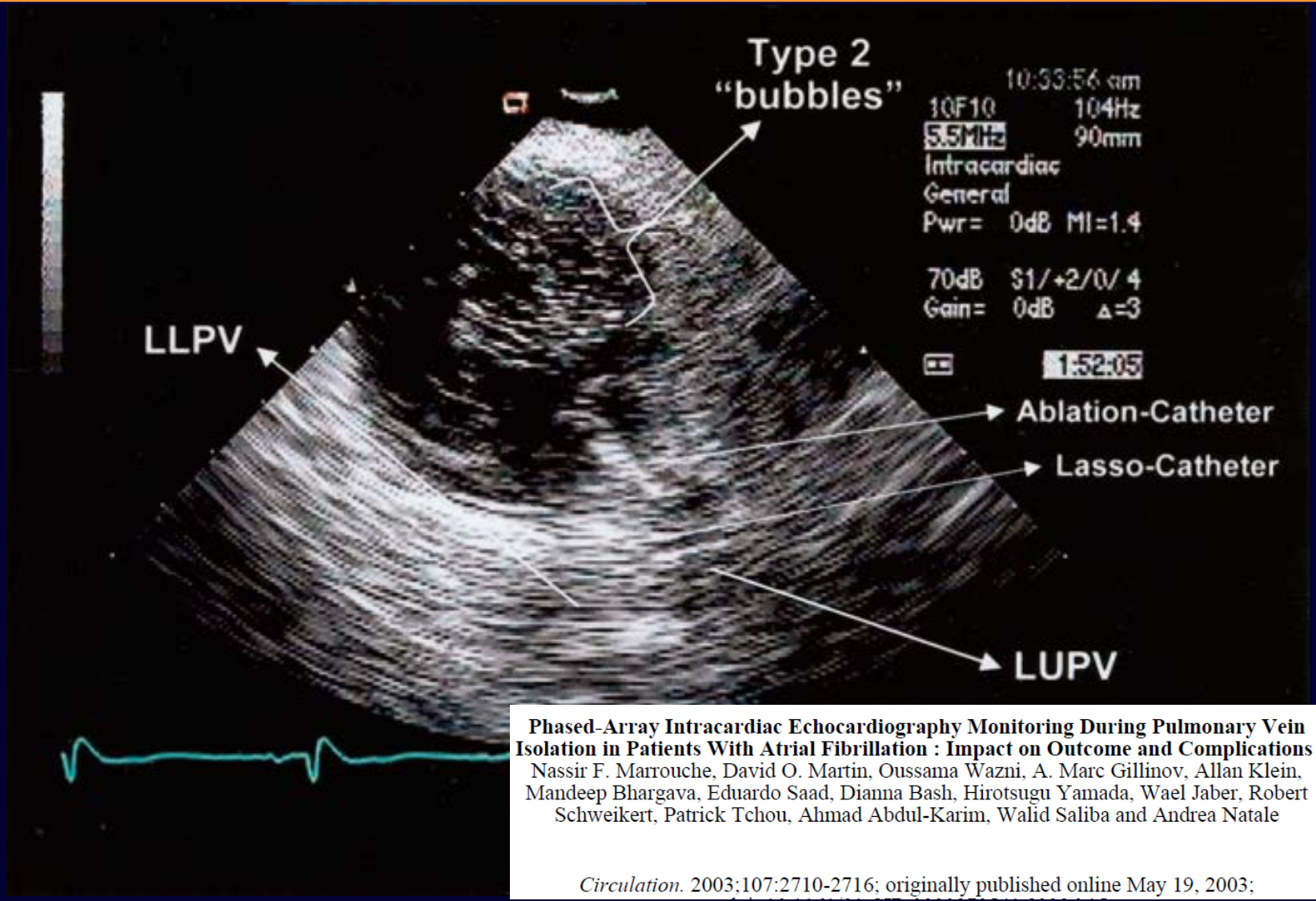




2. Creation and quantification of focal and continuous radiofrequency ablation lesions

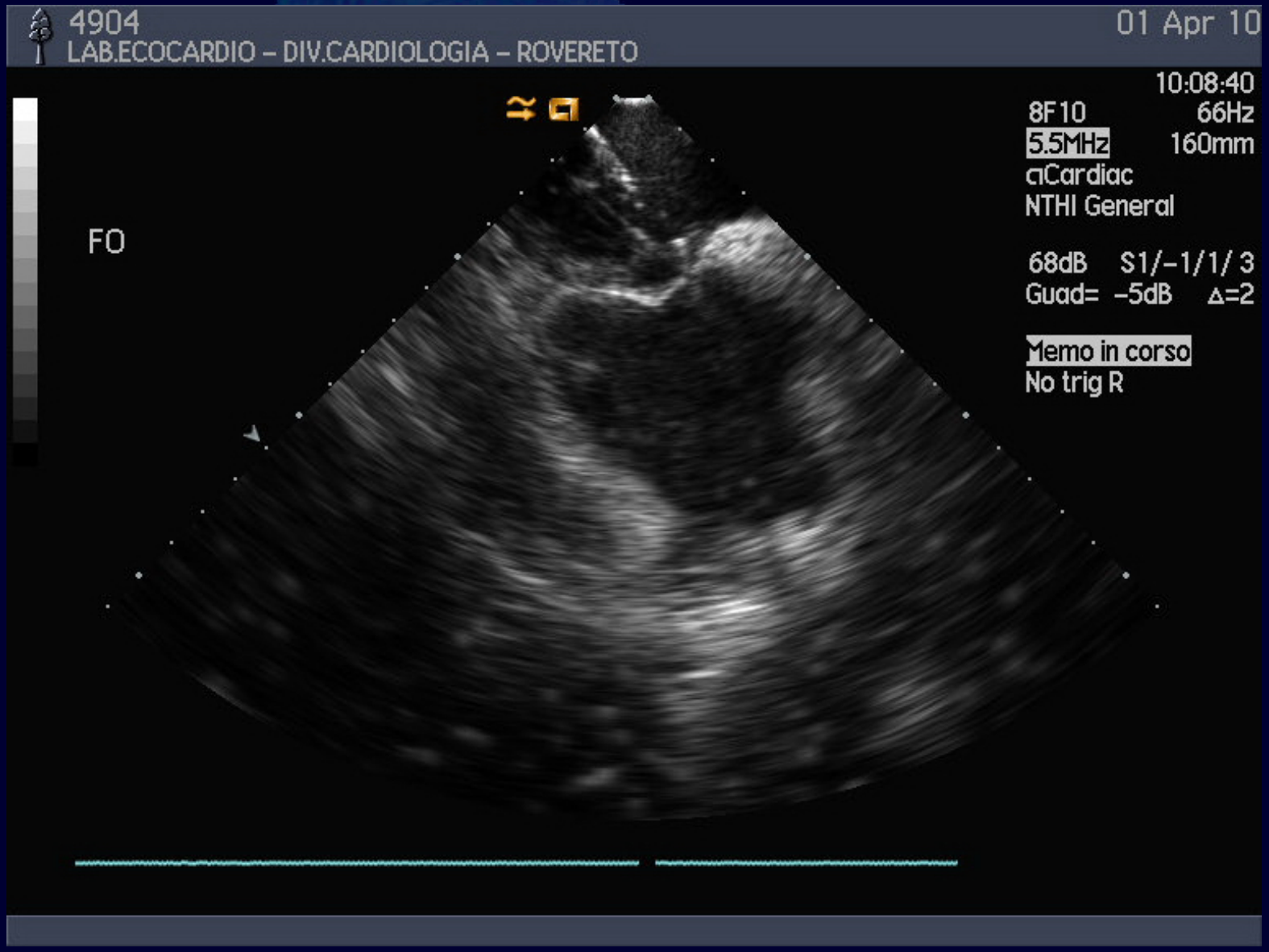


Phased-Array Intracardiac Echocardiography Monitoring During Pulmonary Vein Isolation in Patients With Atrial Fibrillation : Impact on Outcome and Complications

Nassir F. Marrouche, David O. Martin, Oussama Wazni, A. Marc Gillinov, Allan Klein, Mandeep Bhargava, Eduardo Saad, Dianna Bash, Hirotsugu Yamada, Wael Jaber, Robert Schweikert, Patrick Tchou, Ahmad Abdul-Karim, Walid Saliba and Andrea Natale

Circulation. 2003;107:2710-2716; originally published online May 19, 2003;

3. Transseptal puncture



Transseptal puncture

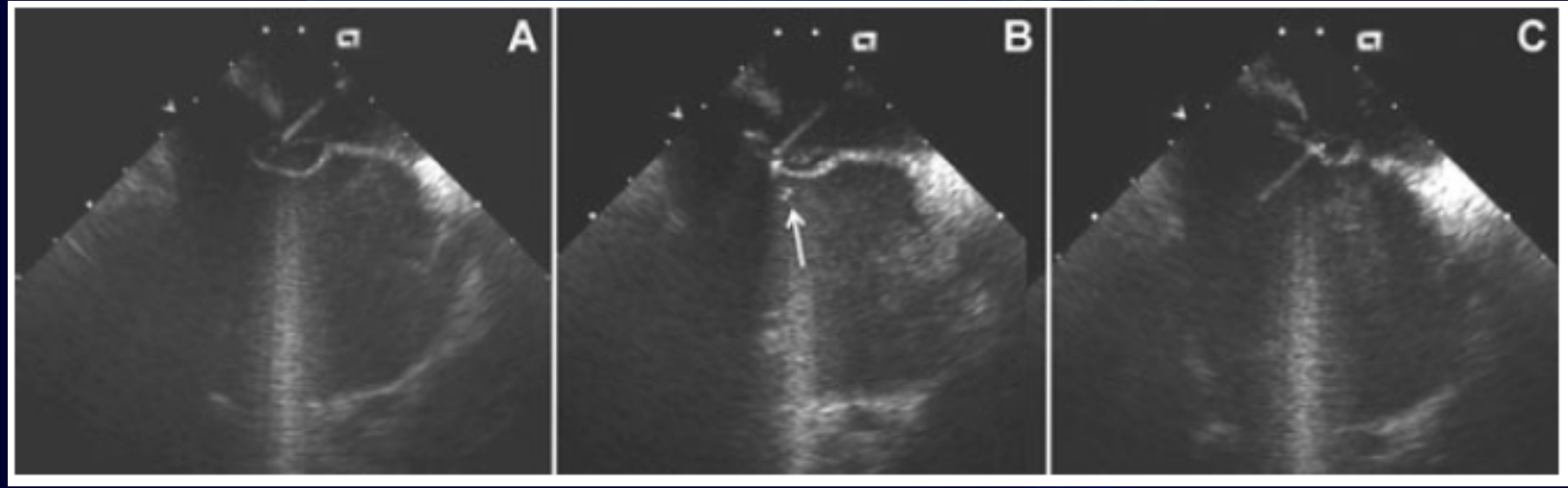
Division of Cardiology, S. Maria del Carmine Hospital – Rovereto - Italy

Troubleshooting Difficult Transseptal Catheterization

RAYMOND W. SY, M.B.B.S., GEORGE J. KLEIN, M.D., PETER LEONG-SIT, M.D., LORNE J. GULA, M.D., RAYMOND YEE, M.D., ANDREW D. KRAHN, M.D., and ALLAN C. SKANES, M.D.

From the Arrhythmia Service, University of Western Ontario, London, Ontario, Canada

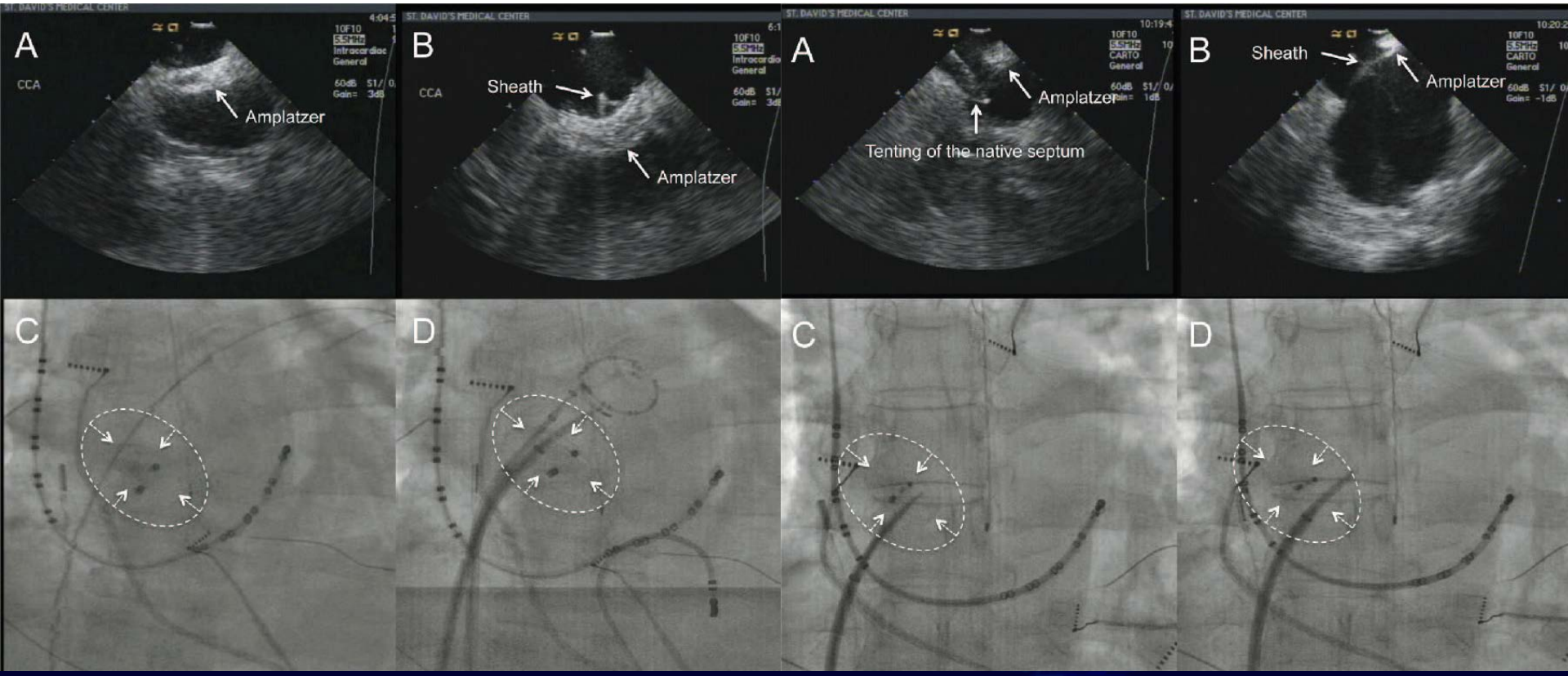
Troubleshooting Difficult Transseptal Catheterization. **Transseptal catheterization is an essential aspect of many electrophysiology studies. Difficulties may present at various stages of the procedure, especially with unique challenges posed by repeated catheterizations. More recently, technologies such as intracardiac echocardiography and radiofrequency have been employed to assist with transseptal catheterization. Integration of these tools into an organized approach for troubleshooting the difficult transseptal puncture is likely to improve procedural success and reduce the risk of serious complications such as cardiac tamponade.** *(J Cardiovasc Electrophysiol, Vol. 22, pp. 723-727, June 2011)*



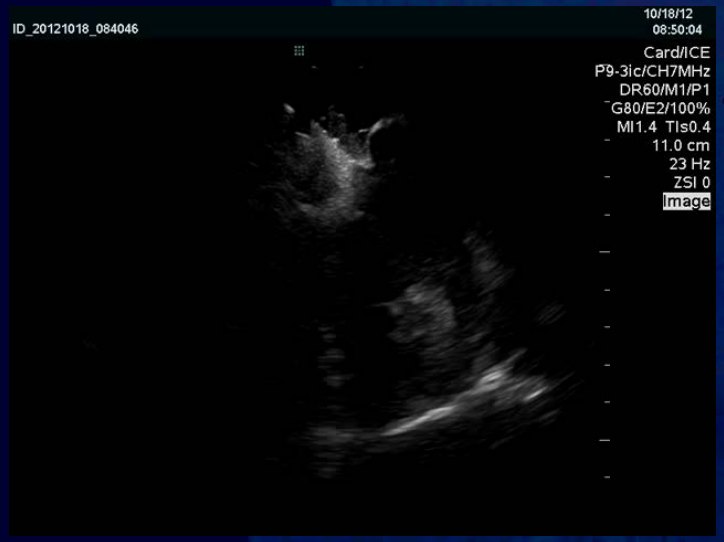
Transseptal access and atrial fibrillation ablation guided by intracardiac echocardiography in patients with atrial septal closure devices

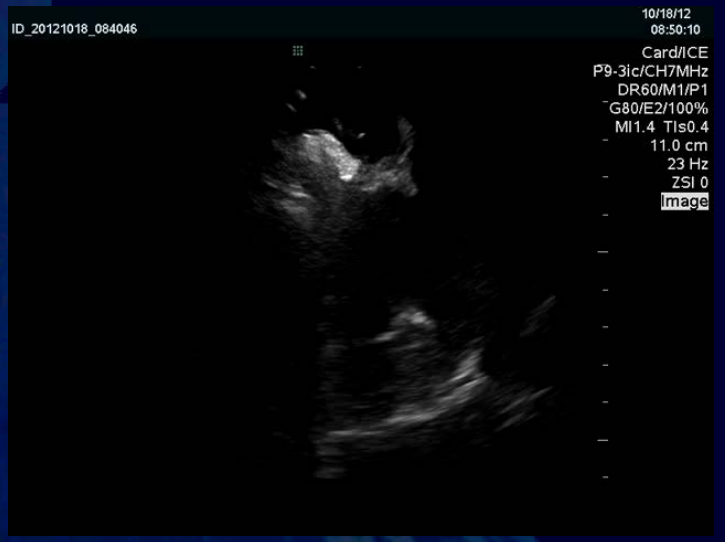
(Heart Rhythm 2011;8:1669–1675)

Pasquale Santangeli, MD,* Luigi Di Biase, MD, PhD, FHRS,*‡¶ J. David Burkhardt, MD, FACC,* Rodney Horton, MD,* Javier Sanchez, MD,* Shane Bailey, MD,* Jason D. Zagrodzky, MD,* Dhanunjaya Lakkireddy, MD,§ Rong Bai, MD, FHRS,* Prasant Mohanty, MD,* Salwa Beheiry, RN,† Richard Hongo, MD,† Andrea Natale, MD, FACC, FHRS*†¶



3. Double transseptal puncture

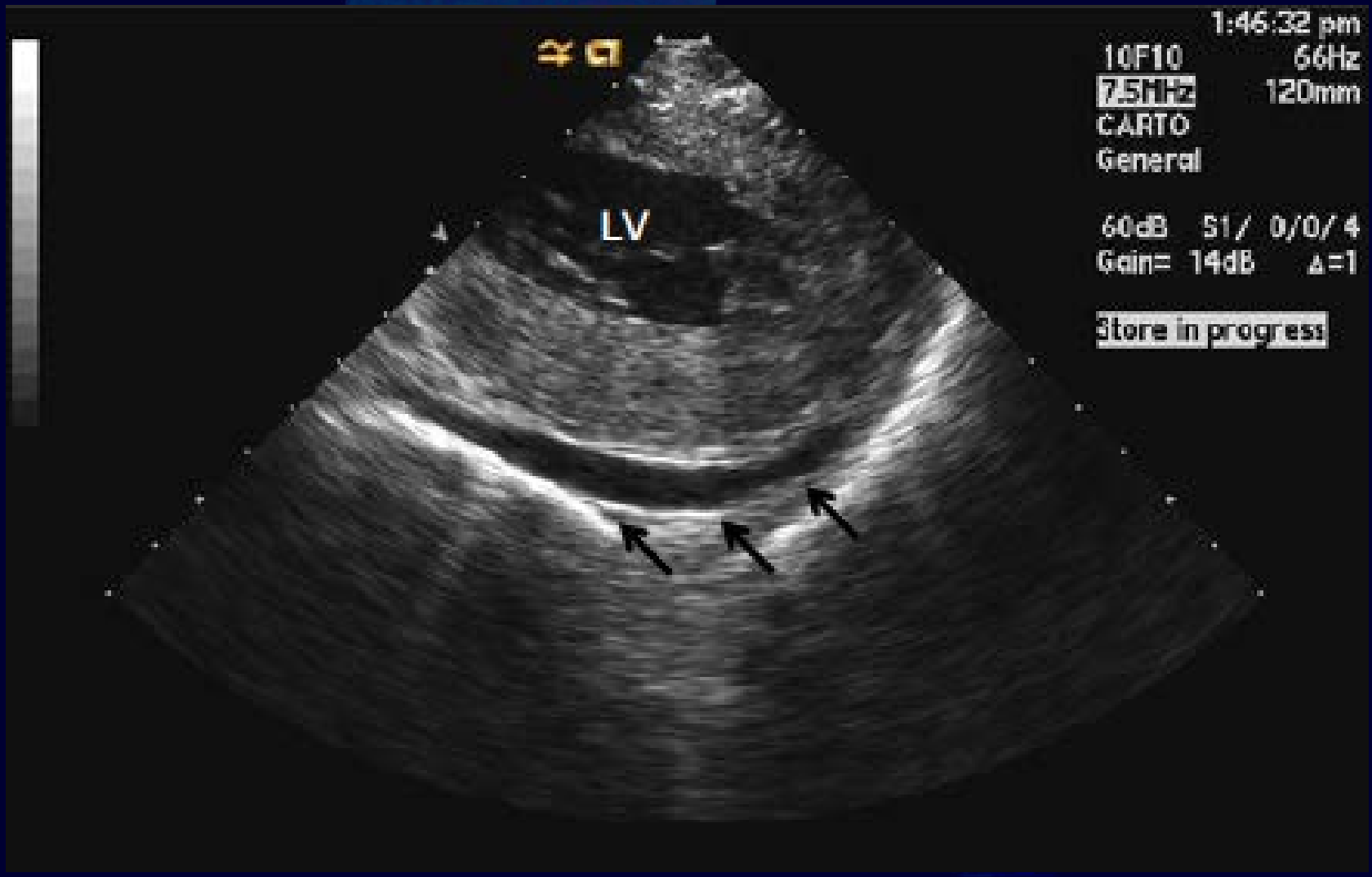




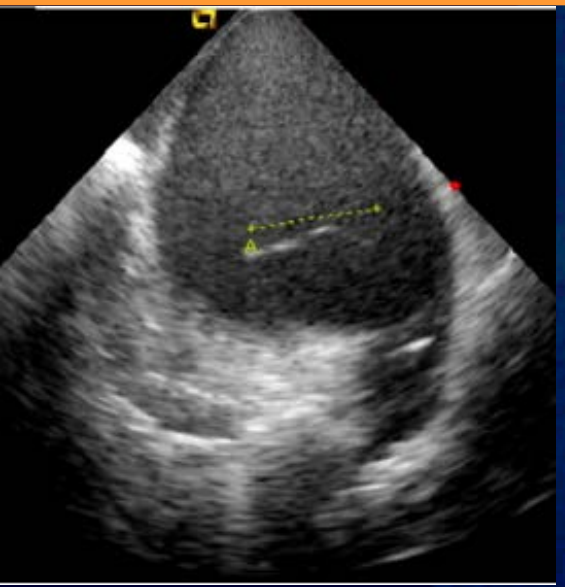
4. Identification and prevention of procedural complications

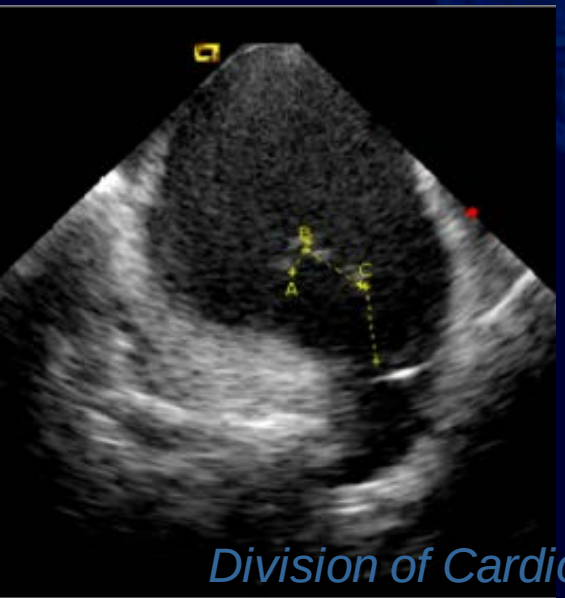
- Pericardial effusion
- Thrombus
- Atrio-esophageal fistula
- PV's stenosis
- …

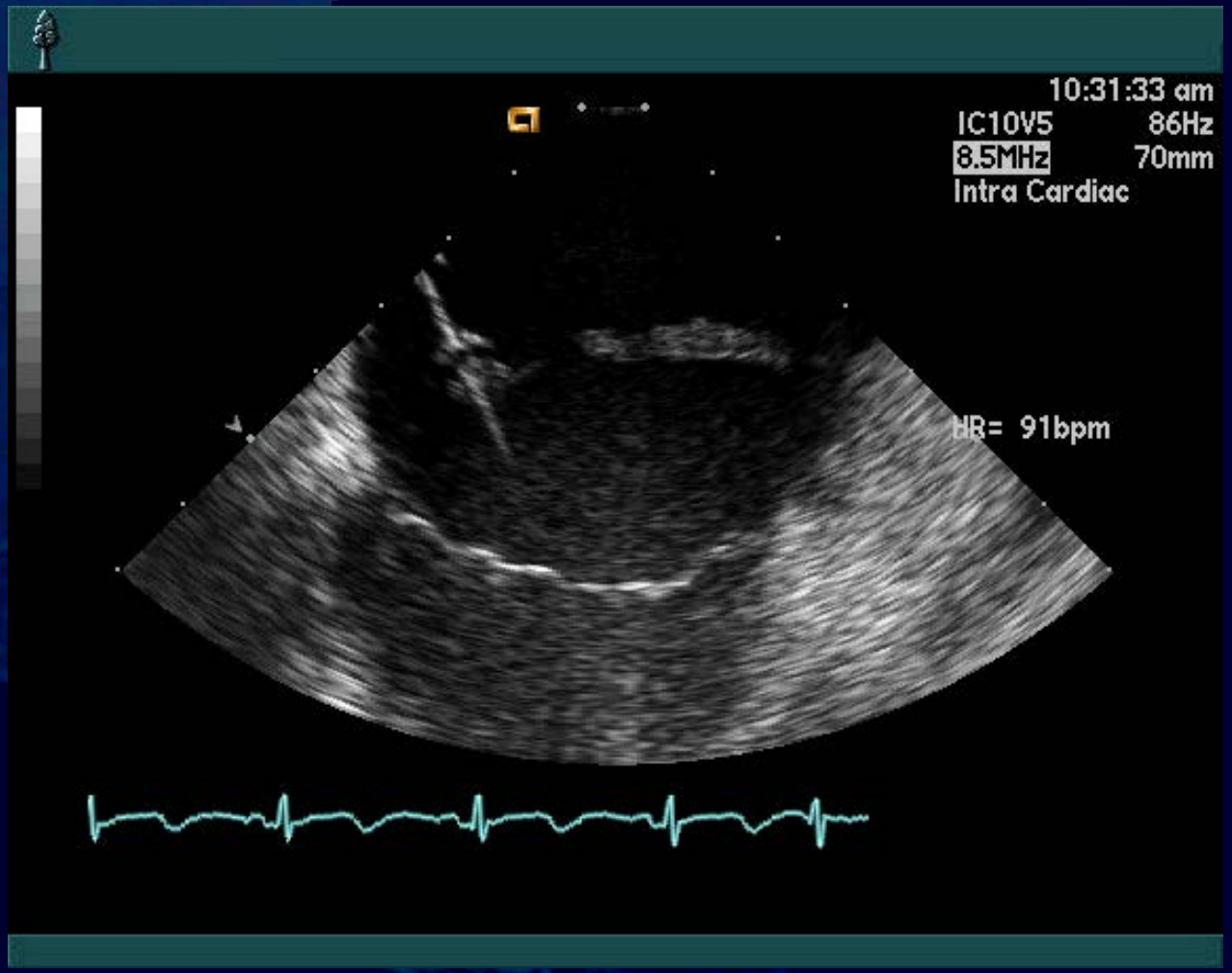
4. Identification and prevention of procedural complications: pericardial effusion



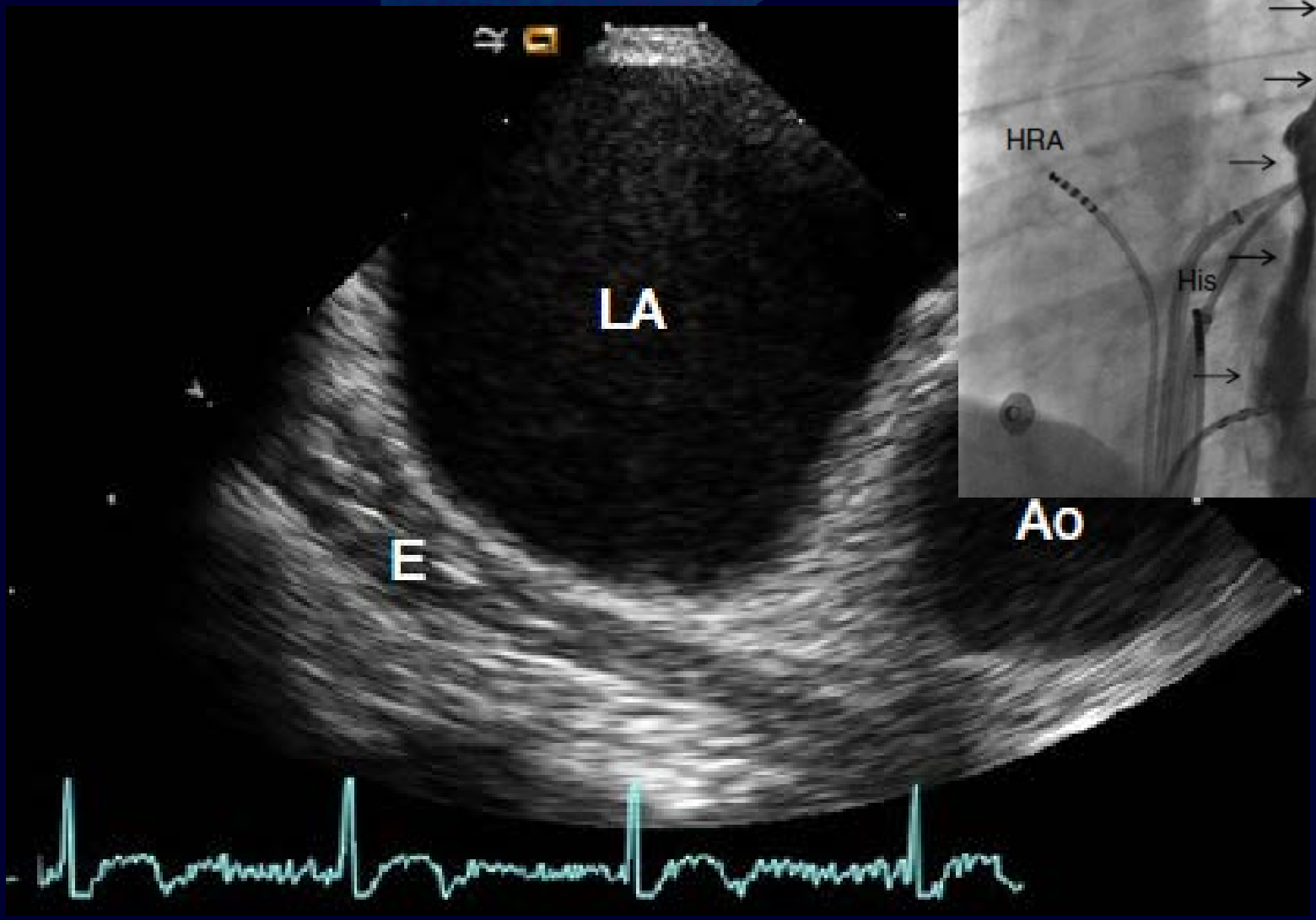
4. Identification and prevention of procedural complications: thrombus in LA



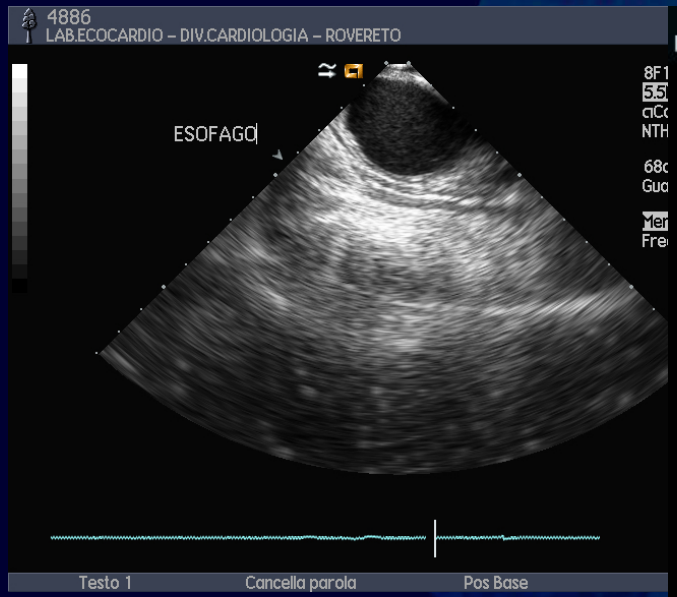




1. Identification and prevention of procedural complications: atrio-esophageal fistula



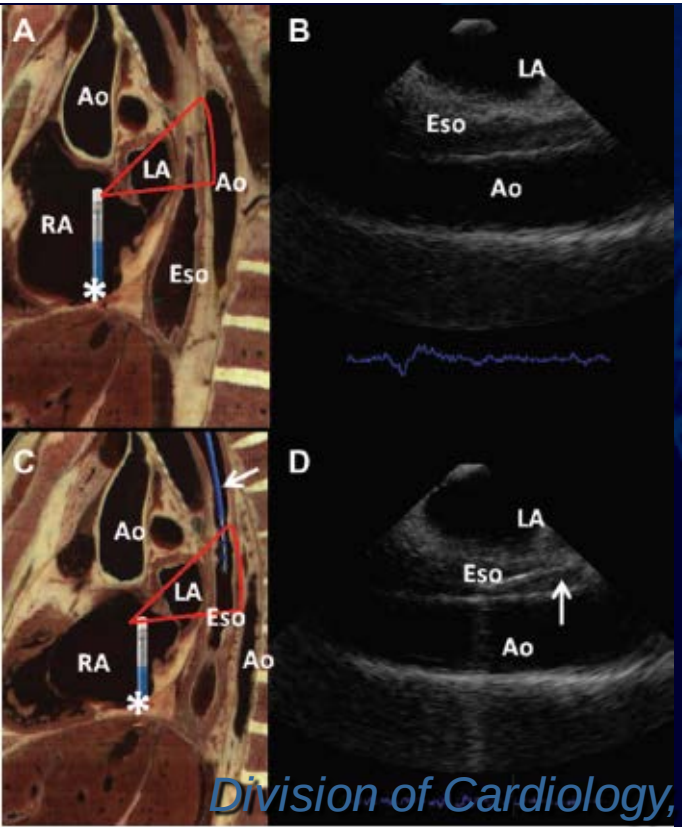
1. Identification of extracardiac structures and manipulation of mapping and ablation

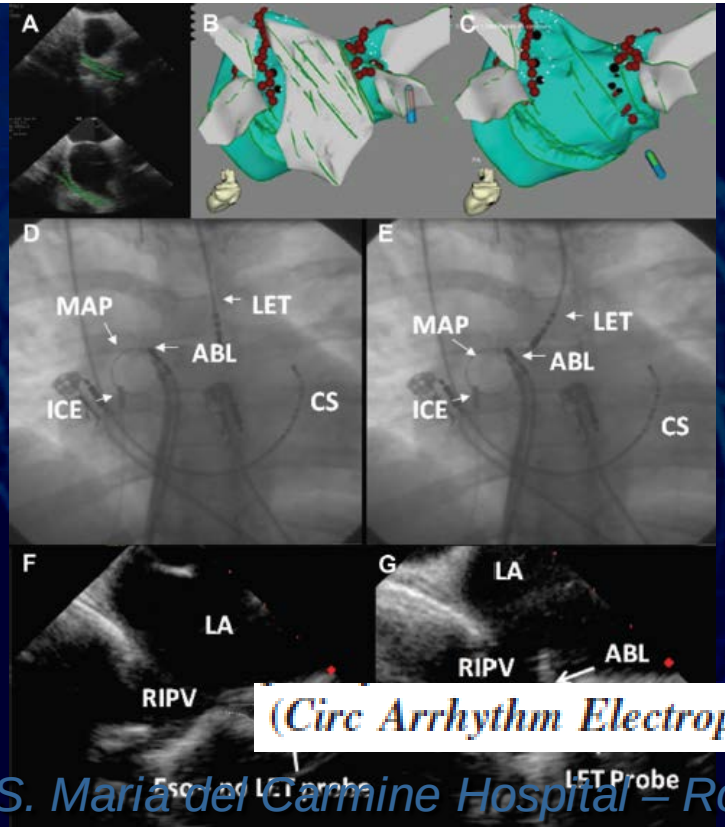


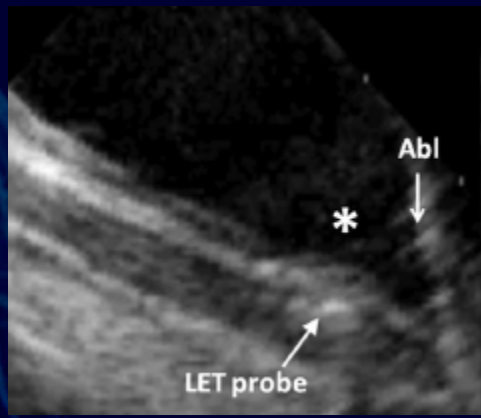
Luminal Esophageal Temperature Monitoring With a Deflectable Esophageal Temperature Probe and Intracardiac Echocardiography May Reduce Esophageal Injury During Atrial Fibrillation Ablation Procedures

Results of a Pilot Study

Luiz R. Leite, MD; Simone N. Santos, MD; Henrique Maia, MD; Benhur D. Henz, MD; Fábio Giuseppin, MD; Anderson Oliverira, MD; André R. Zanatta, MD; Ayrton K. Peres, MD; Clarissa Novakoski, MD; Jose R. Barreto, MD; Fabrício Vassalo, MD; Andre d'Avila, MD, PhD; Sheldon M. Singh, MD

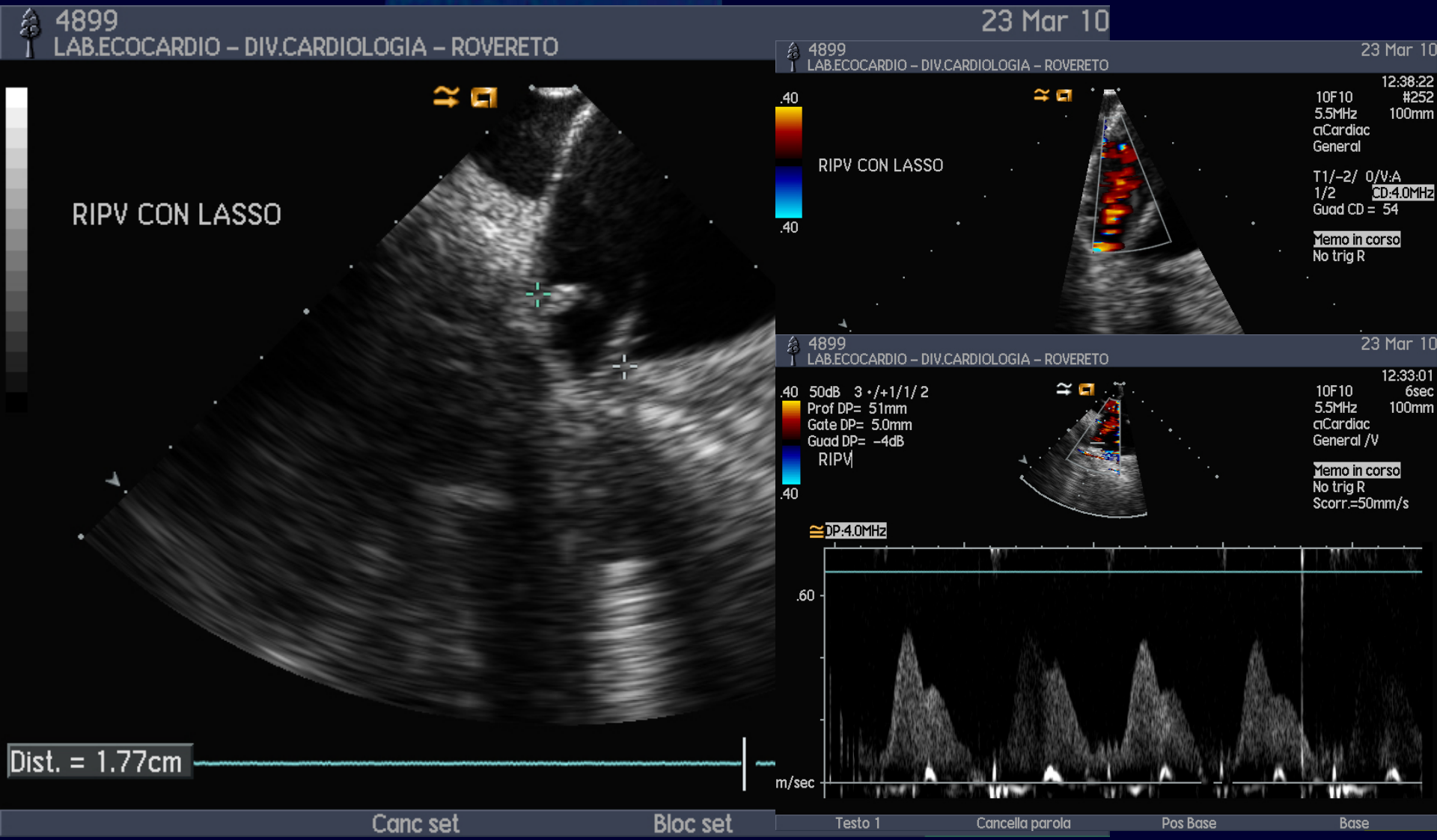




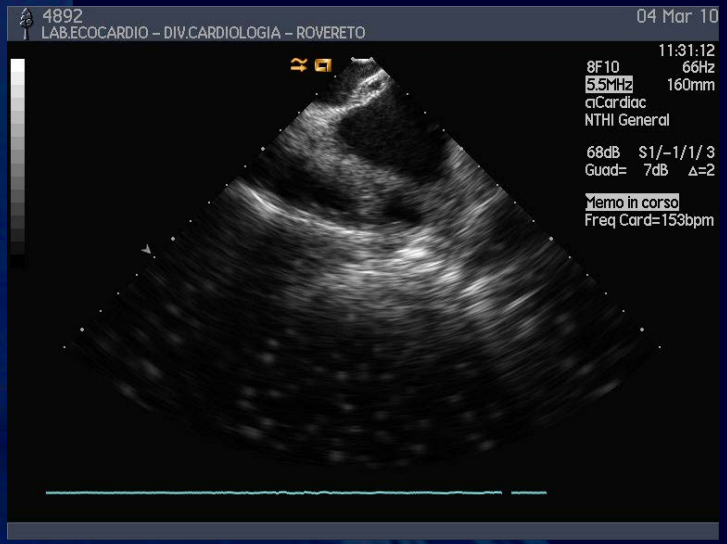


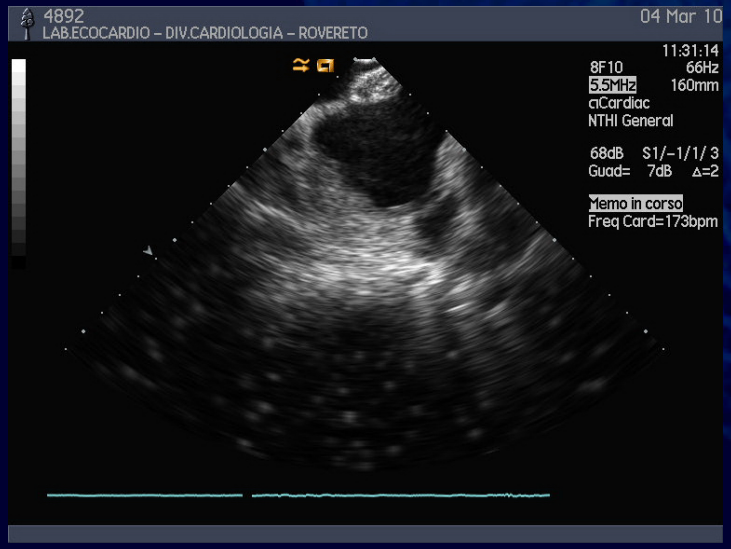
(*Circ Arrhythm Electrophysiol.* 2011;4:149-156.)

4. Identification and prevention of procedural complications: PV's stenosis

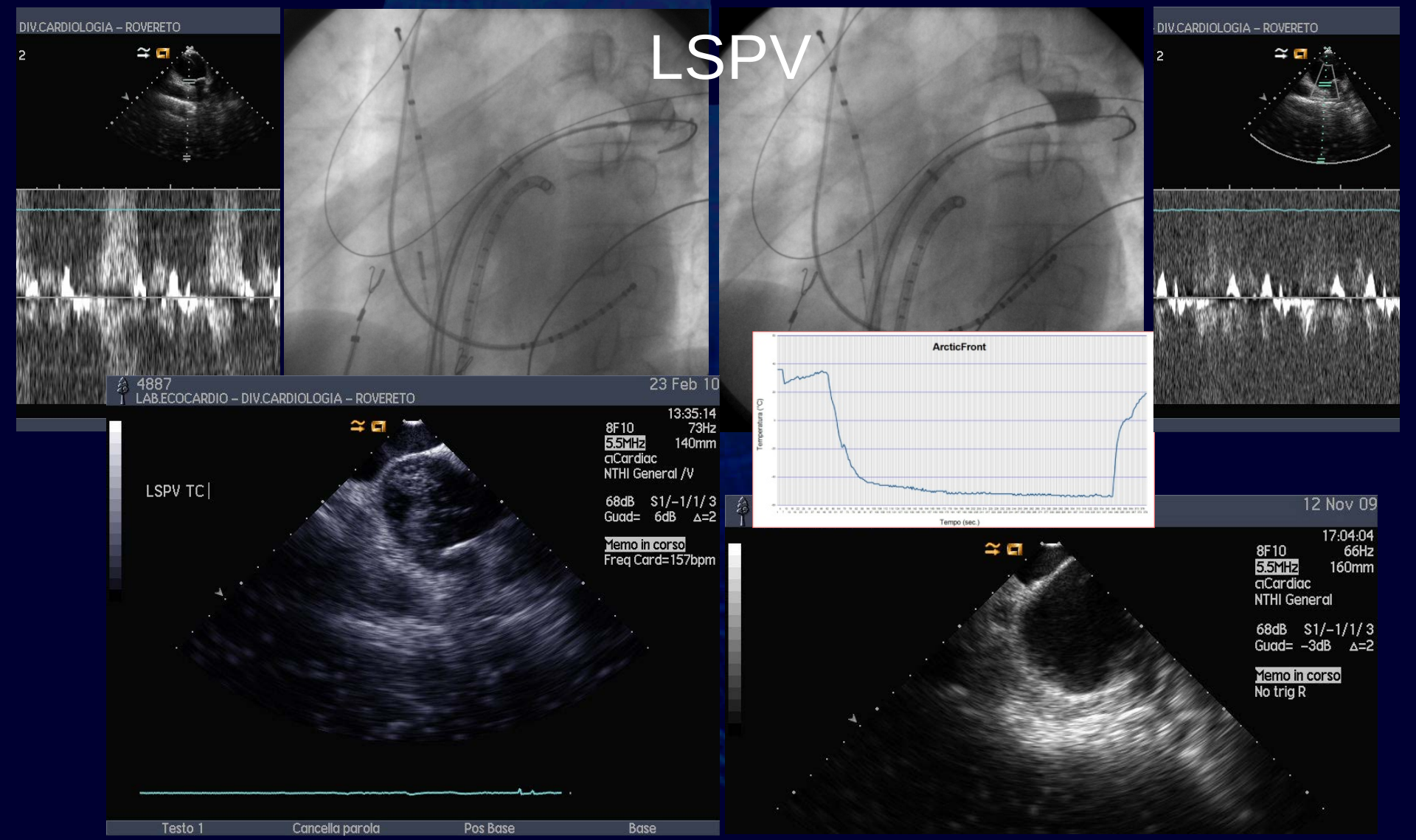


4. Identification and prevention of procedural complications: IA septum hematoma

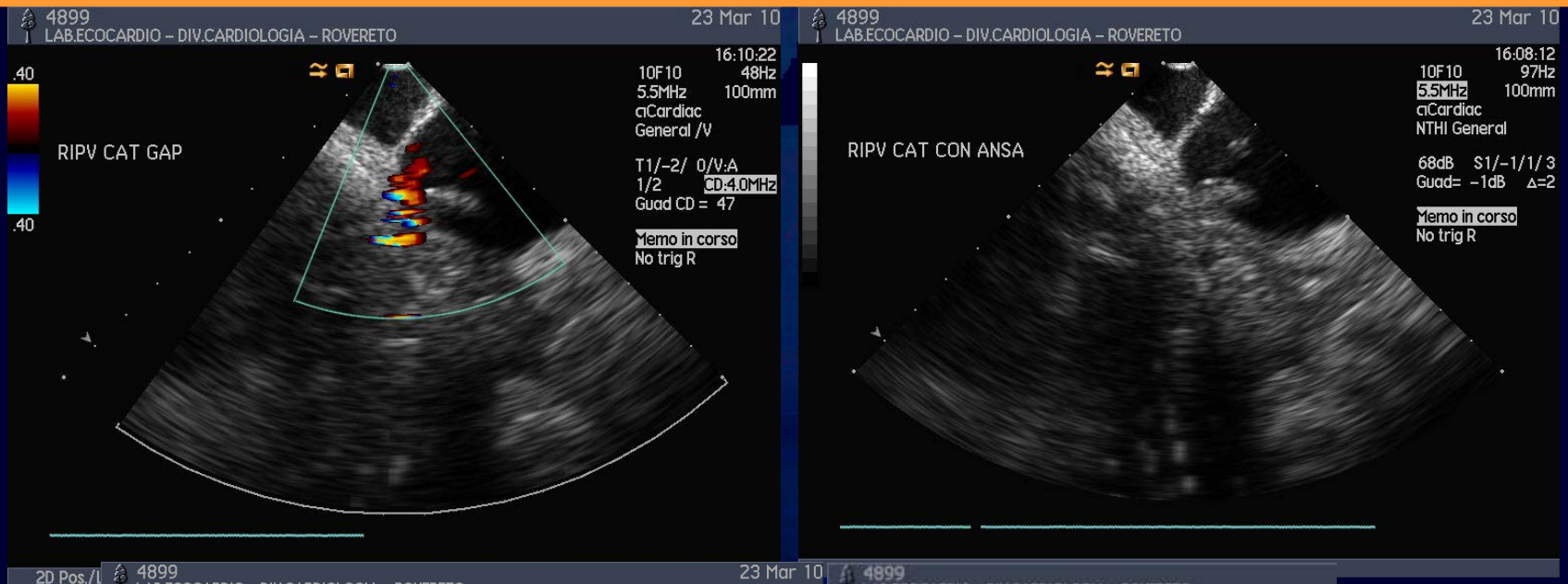


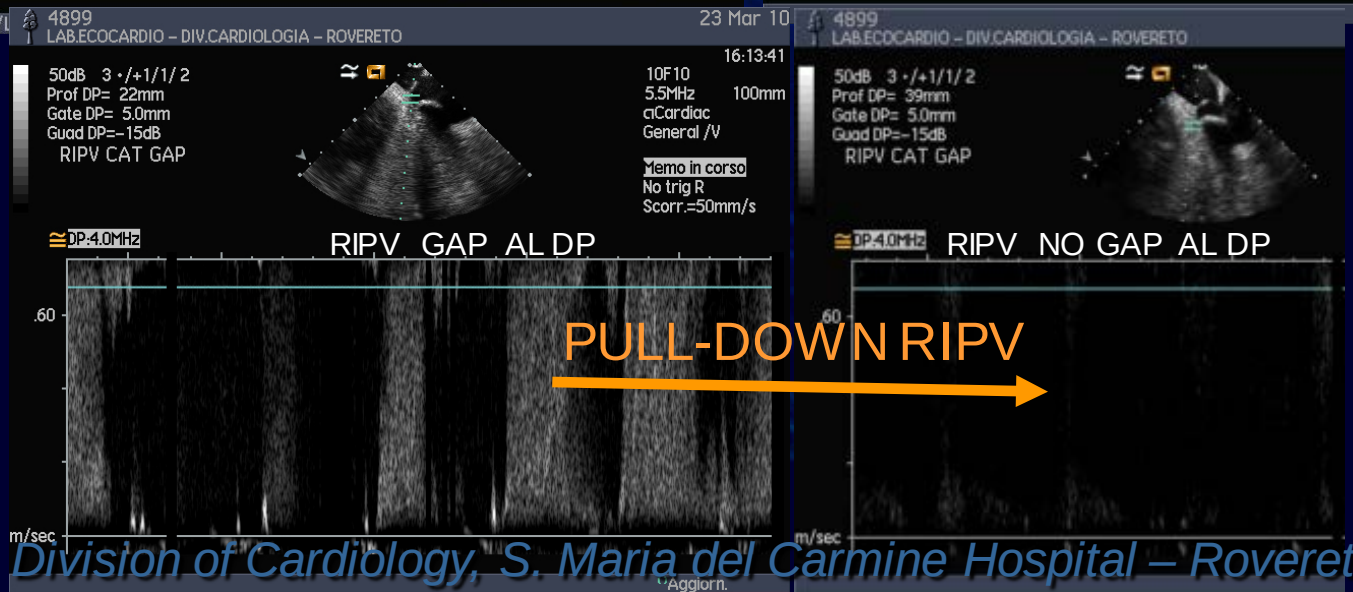


5. ICE and Cryoballoon Pulmonary Vein Isolation: gap

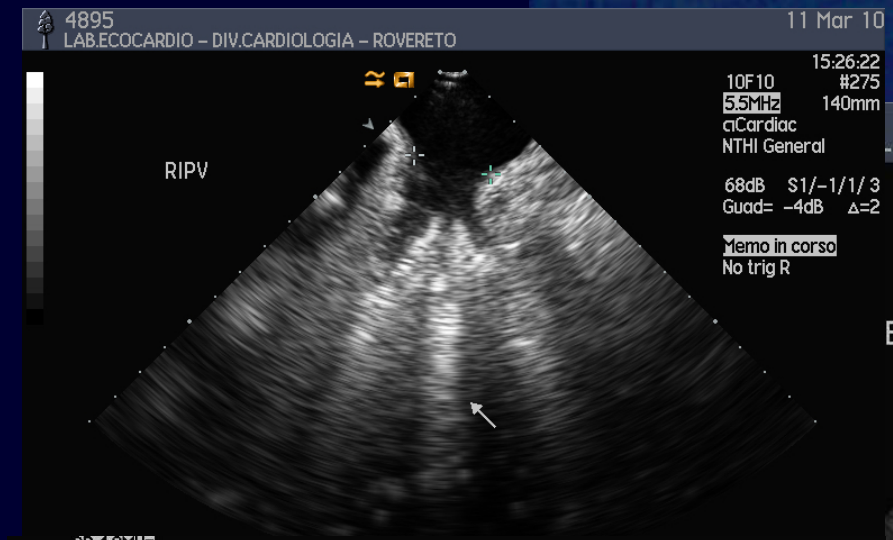


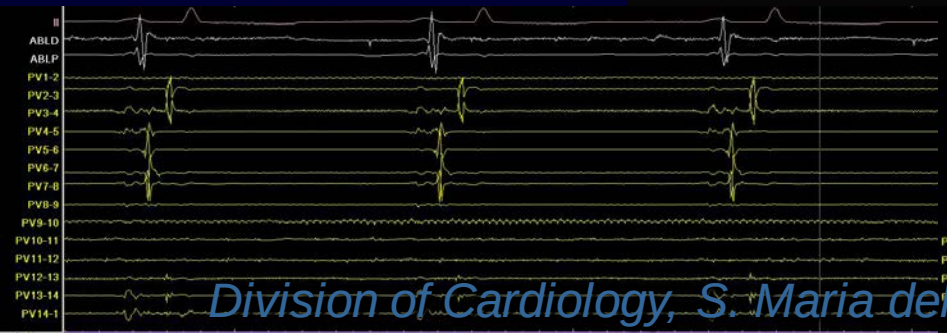
ICE and Cryoballoon Pulmonary Vein Isolation: gap

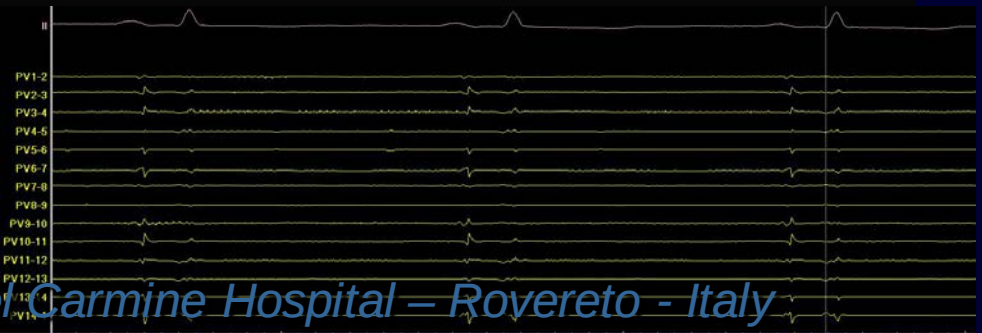




5. ICE and Cryoballoon Pulmonary Vein Isolation







Cost

Uses of ICE in the electrophysiology laboratory included:

- ✓ the identification of atrial endocardial structures and the manipulation of mapping and ablation catheters in relation to these structures
- ✓ the creation and quantification of focal and continuous radiofrequency ablation (RFA) lesions
- ✓ guidance in the performance of atrial transseptal puncture
- ✓identification and prevention of procedural complications.

Intracardiac echocardiography in complex cardiac catheter ablation procedures

Javier E. Banchs · Parag Patel · Gerald V. Naccarelli · Mario D. Gonzalez

J Interv Card Electrophysiol (2010) 28:167–184

8 Conclusions

ICE imaging by itself and integrated to the nonfluoroscopic three-dimensional mapping systems has led to a significant improvement in the precision and safety of complex catheter-based ablation procedures. Less radiation exposure, guidance during critical steps in the procedure, visual, real-time support for precise catheter placement, troubleshooting, and monitoring of complications are some of the benefits of real-time continuous ultrasound imaging.

0 X-Ray or ALARA - As Low As Reasonably Achievable ?

Division of Cardiology, S. Maria del Carmine Hospital – Rovereto - Italy