No fluoroscopy EP lab, no compromises

Navigation and 3D mapping in CRT

Massimiliano Maines, MD

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

Main limitations of the "angiographic" CRT device implantation

1. The need of prolonged radiation exposure (dangerous both for patients and physicians).
2. The need of CS angiography (with contrast liquid infusion), dangerous for patients (one-third of patients with HF have concomitant stage 3 or greater chronic kidney disease).
3. The lack of clear indications (only anatomical !) for LV lead placement >> decreasing number of CRT responder.

European Heart Journal (2013) **34**, 2281–2329
doi:10.1093/eurheartj/eht150

ESC GUIDELINES

2013 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy

The Task Force on cardiac pacing and resynchronization therapy of the European Society of Cardiology (ESC). Developed in collaboration with the European Heart Rhythm Association (EHRA).

Authors/Task Force Members: Michele Brignole (Chairperson) (Italy)*, Angelo Auricchio (Switzerland), Gonzalo Baron-Esquivias (Spain), Pierre Bordachar (France), Giuseppe Boriani (Italy), Ole-A Breithardt (Germany), John Cleland (UK), Jean-Claude Deharo (France), Victoria Delgado (Netherlands), Perry M. Elliott (UK), Bulent Gorenek (Turkey), Carsten W. Israel (Germany), Christophe Leclercq (France), Cecilia Linde (Sweden), Lluís Mont (Spain), Luigi Padeletti (Italy), Richard Sutton (UK), Panos E. Vardas (Greece)

Choice of pacing mode (and cardiac resynchronization therapy optimization)

Recommendations	Class [a]	Level [b]	Ref. [c]
1) The goal of CRT should be to achieve BiV pacing as close to 100% as possible since the survival benefit and reduction in hospitalization are strongly associated with an increasing percentage of BiV pacing.	IIa	B	67–69
2) Apical position of the LV lead should be avoided when possible.	IIa	B	70–72
3) LV lead placement may be targeted at the latest activated LV segment.	IIb	B	73

Europace
doi:10.1093/europace/eur250

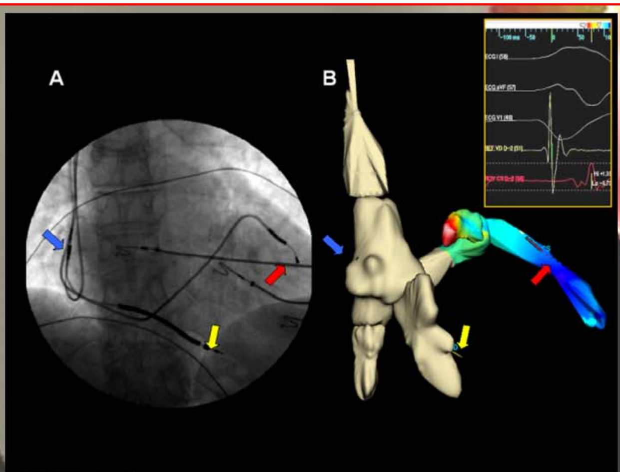
CLINICAL RESEARCH

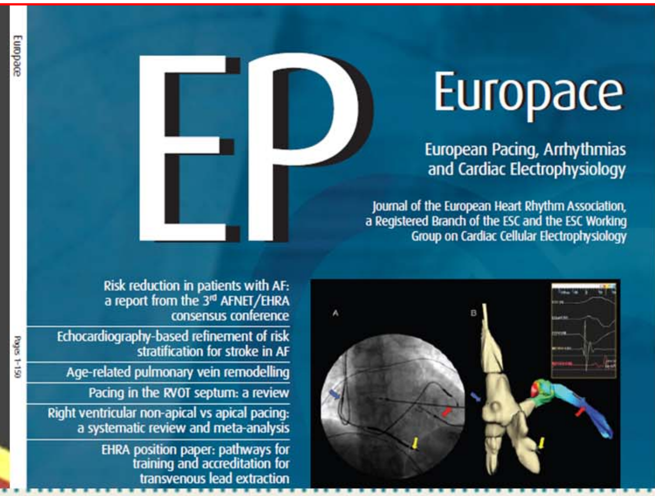
Implantation of a biventricular implantable cardioverter-defibrillator guided by an electroanatomic mapping system

Maurizio Del Greco, Massimiliano Marini*, and Roberto Bonmassari

Department of Cardiology, S. Chiara Hospital, Trento, Italy

Received 9 March 2011; accepted after revision 6 July 2011





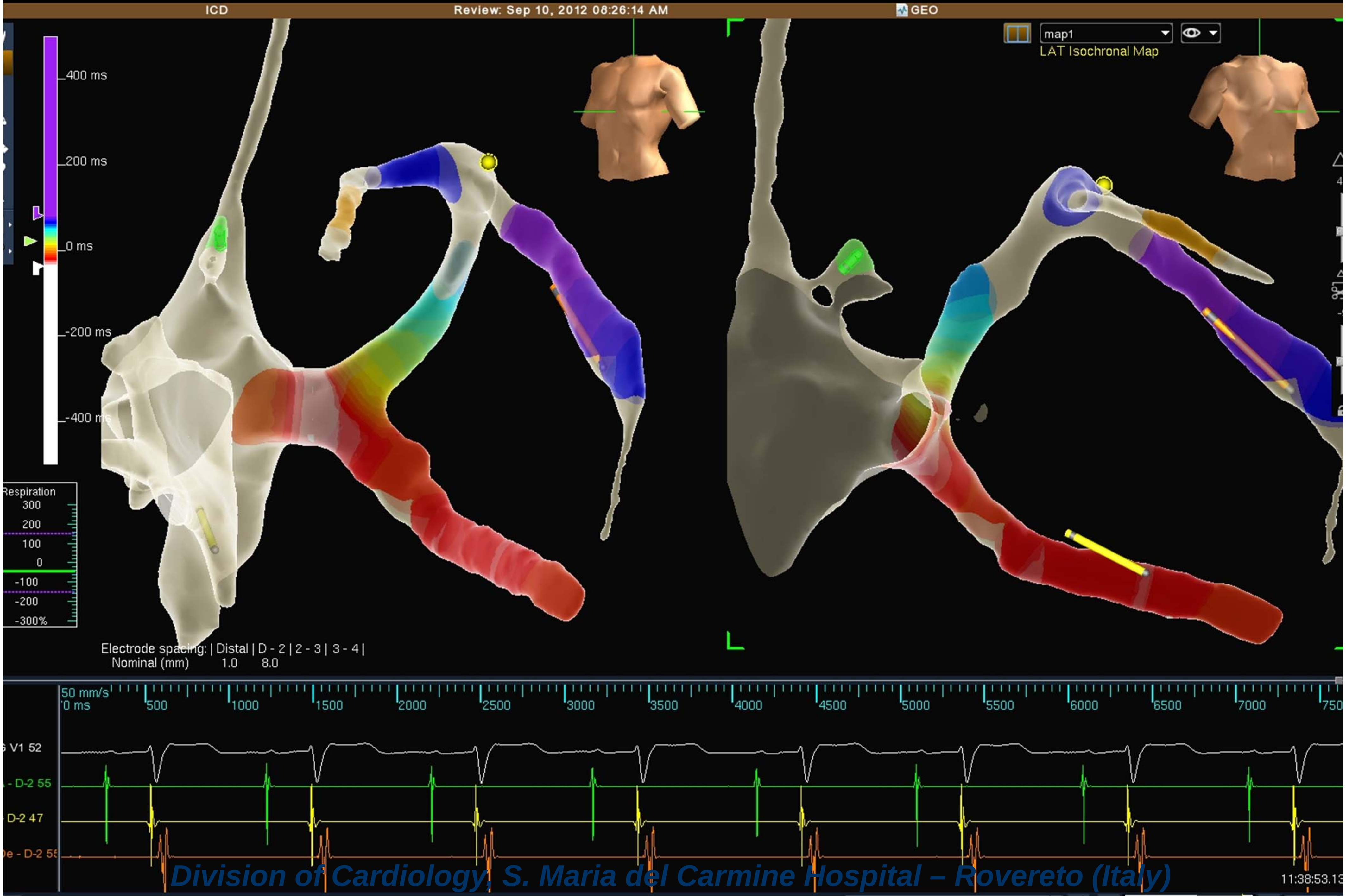
Conclusions The NavX system shows great potential during the implantation of an CRT–ICD device. It seems to be feasible, safe, and extremely beneficial in terms of a reduction in X-ray exposure. Furthermore, there is benefit of more detailed information and accuracy during the CS lead placement.

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

Navigation with diagnostic catheter

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

CS elettroanatomic map during SR



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

NavX 3.0 vs Angio

Near Zero Fluoroscopic Implantation of BIV ICD Using Electro-anatomical Mapping

ADEL MINA, M.D. and NICHOLAS WARNECKE, PA-C
From the Unity Point Health Methodist, Peoria, Illinois

Background: *Biventricular (BIV) implantable cardioverter defibrillator (ICD) implantations are traditionally performed using fluoroscopic guidance, exposing both patients and laboratory staff to the risks of radiation. Three-dimensional (3D) electro-anatomical mapping (EAM) has been used in limited reports with modest decrease in fluoroscopy time in adjunct to standard use of contrast. The purpose of this study was to evaluate the feasibility of EAM in BIV ICD implantation with near zero use of fluoroscopy and contrast.*

Methods and Results: *Retrospective analysis was performed in two patient groups (both n = 10): (1) the near zero fluoroscopy (NZF) group consisting of consecutive adult patients, in which BIV implantation was accomplished by EAM; and (2) the fluoroscopy (F) group, in which BIV implantation was additionally guided by fluoroscopy and contrast use. The same operator performed all procedures with a step-by-step approach detailed below. Complications were limited to one patient in the standard (F) group who had a pneumothorax related to difficult access with occluded collateralized subclavian vein and small hematoma with no intervention required. Another patient in the NZF group had lead revision with an extra 0.5 minutes of fluoroscopy related to microdislodgement secondary to body habitus and postural changes.*

Conclusion: *This NZF technique was feasible and effective in near elimination of contrast use, as well as in decreasing fluoroscopy exposure to as low as 0.1 minutes or near zero exposure. We also highlighted the technique in detailed step-by-step approach. It was also discovered that 3D mapping does not increase procedure time. In fact there was a tendency toward shortening the procedure time, further demonstrating the feasibility of this technique for the implantation of BIV ICD. Acute procedural success, complications, and clinical outcome were comparable in both groups. (PACE 2013; 36:1409–1416)*

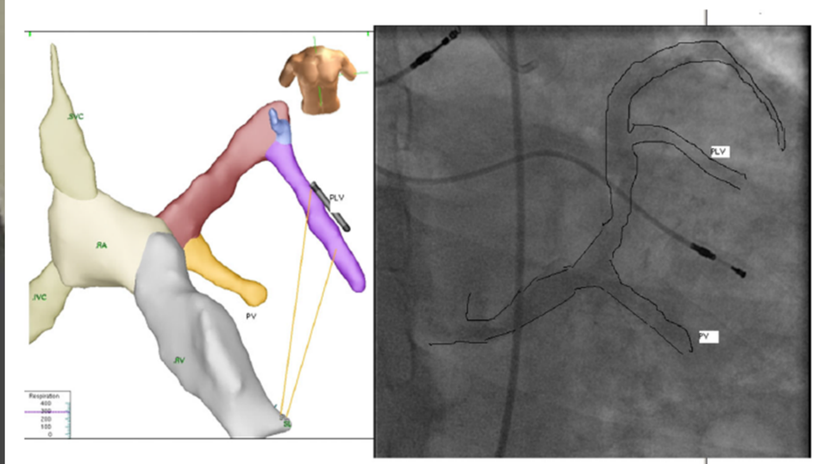
CRT, defibrillation, ICD, mapping

Table II.

Comparison of Procedure Time, Fluoroscopy Time and Amount of Contrast Used in Both Groups

	Device Type	Procedure Duration (Minutes)	Fluoro Time (Minutes)	Contrast (cc)
Standard Procedure				
Case 1	BIV ICD	182.00	26.70	100.00
Case 2	BIV ICD	257.00	19.20	150.00
Case 3	BIV ICD	141.00	7.10	75.00
Case 4	BIV ICD	265.00	8.80	75.00
Case 5	BIV ICD	130	4.5	25
Case 6	BIV ICD	107	3.5	25
Case 7	BIV ICD	108	4	5
Case 8	BIV ICD	203	19	73
Case 9	BIV ICD	170	18	42
Case 10	BIV ICD	180	9.4	20
Case 11	BIV ICD	220	29	14
Average		178.45	13.56	54.91
Near Zero Procedure				
		179.00	0.60	0.00
		211.00	2.40	0.00
		134.00	0.00	0.00
		67.00	0.00	0.00
		152	1.2	0
		137	0	0
		189	1.1	0
		120	2.9	3
		135	0.9	0
		300	6	0
		162.40	1.51	0.30
		0.53852774	0.000676966	0.000972

...efibrillator; PPM = permanent pacemaker.



RA=right atrium, RV=right ventricle, IVC=inferior venacava, SVC= superior venacava, PV=posterior vein of the left ventricle, PLV=posterio-lateral vein of the left ventricle.

Figure 1. *Side-by-side electroanatomical map with highlighted venous phase of patient coronary angiogram.*

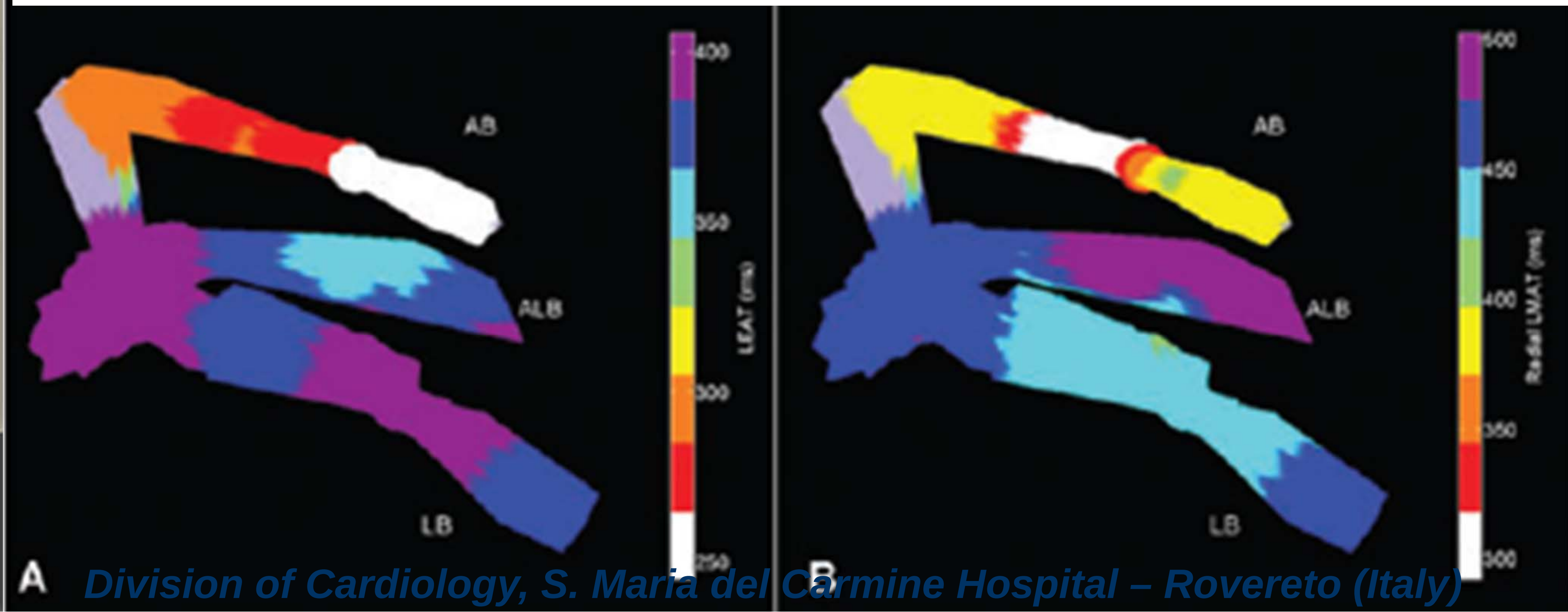
Division of Cardiology, S. Maria del Carmine Hospital – Rovereto (Italy)

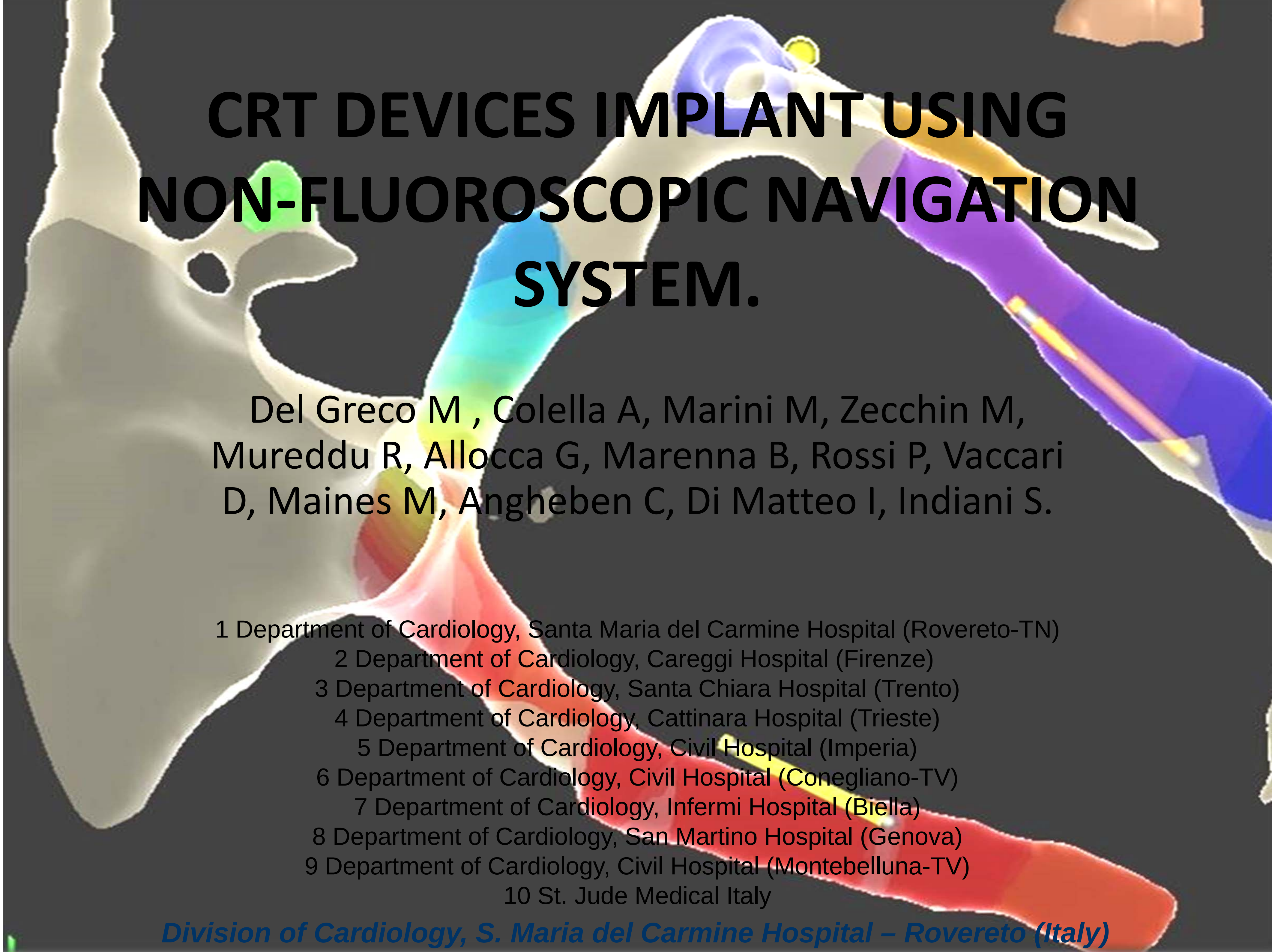
Simultaneous Electrical and Mechanical Mapping Using 3D Cardiac Mapping System: Novel Approach for Optimal Cardiac Resynchronization Therapy

KYUNGMOO RYU, PH.D.,* ANDRE D'AVILA, M.D., PH.D.,† E. KEVIN HEIST, M.D., PH.D.,† STUART P. ROSENBERG, M.S.,* JESSIE CHOU, M.S.,* MICHAEL YANG, PH.D.,* and JAGMEET P. SINGH, M.D., D.PHIL†

From the *St. Jude Medical, Sylmar, California, USA; and †Massachusetts General Hospital, Boston, Massachusetts, USA

Electrical and Mechanical Mapping During CRT. **Cardiac resynchronization therapy (CRT) restores synchrony in heart failure patients. However, a significant proportion of patients implanted with CRT devices do not realize any benefit from CRT. Placing a left ventricular (LV) lead at the sites of electrical or mechanical delay has been advocated to maximize response to CRT, but there is currently no technique described to measure mechanical delay in real-time. We describe a novel technique that can be used intraoperatively to assess mechanical and electrical activation of the coronary sinus for guidance of LV pacing site optimization during CRT implantation.** *(J Cardiovasc Electrophysiol, Vol. 21, pp. 219-222, February 2010)*





CRT DEVICES IMPLANT USING NON-FLUOROSCOPIC NAVIGATION SYSTEM.

Del Greco M , Colella A, Marini M, Zecchin M, Mureddu R, Allocca G, Marenna B, Rossi P, Vaccari D, Maines M, Angheben C, Di Matteo I, Indiani S.

1 Department of Cardiology, Santa Maria del Carmine Hospital (Rovereto-TN)
2 Department of Cardiology, Careggi Hospital (Firenze)
3 Department of Cardiology, Santa Chiara Hospital (Trento)
4 Department of Cardiology, Cattinara Hospital (Trieste)
5 Department of Cardiology, Civil Hospital (Imperia)
6 Department of Cardiology, Civil Hospital (Conegliano-TV)
7 Department of Cardiology, Infermi Hospital (Biella)
8 Department of Cardiology, San Martino Hospital (Genova)
9 Department of Cardiology, Civil Hospital (Montebelluna-TV)
10 St. Jude Medical Italy

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

Biella:
2 pts
Dr Maremma

Gravedona:
2 pts
Dr Chianca

Trento: 27 pts
Dr DelGreco/Dr Marini

Rovereto: 20 pts
Dr DelGreco/Maines
Angheben

Trieste: 11 pts
Dr Zecchin
Salvatori

Vercelli: 9 pts
Dr Blandino
Barbonaglia
Rametta

Conegliano:
1 pts
Dr Allocca

Imperia:
13 pts
Dr Mureddu

Montebelluna
: 2 pts
Dr Vaccari

Genova:
1 pts
Dr Rossi

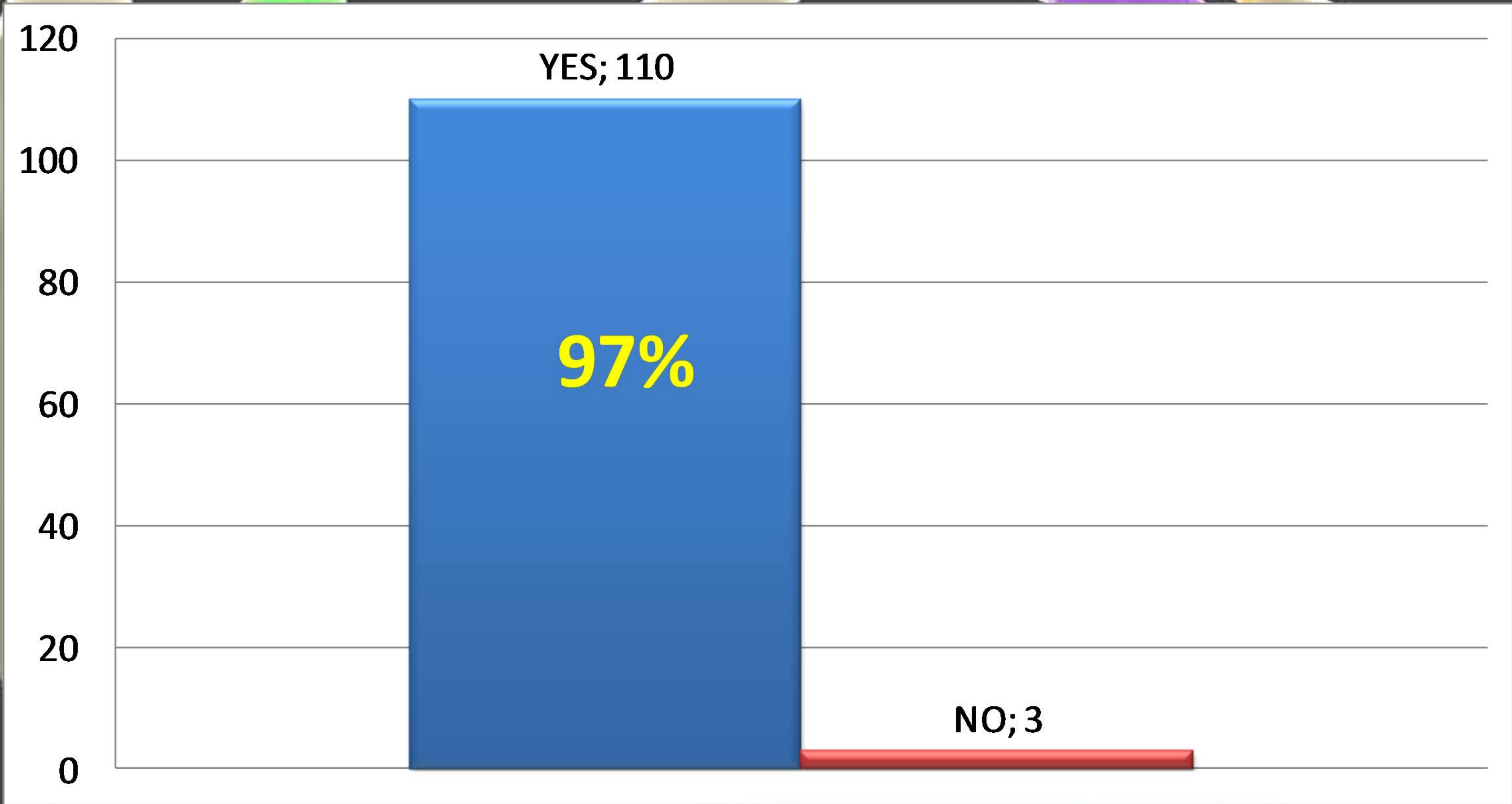
Firenze:
25 pts
Dr Colella

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

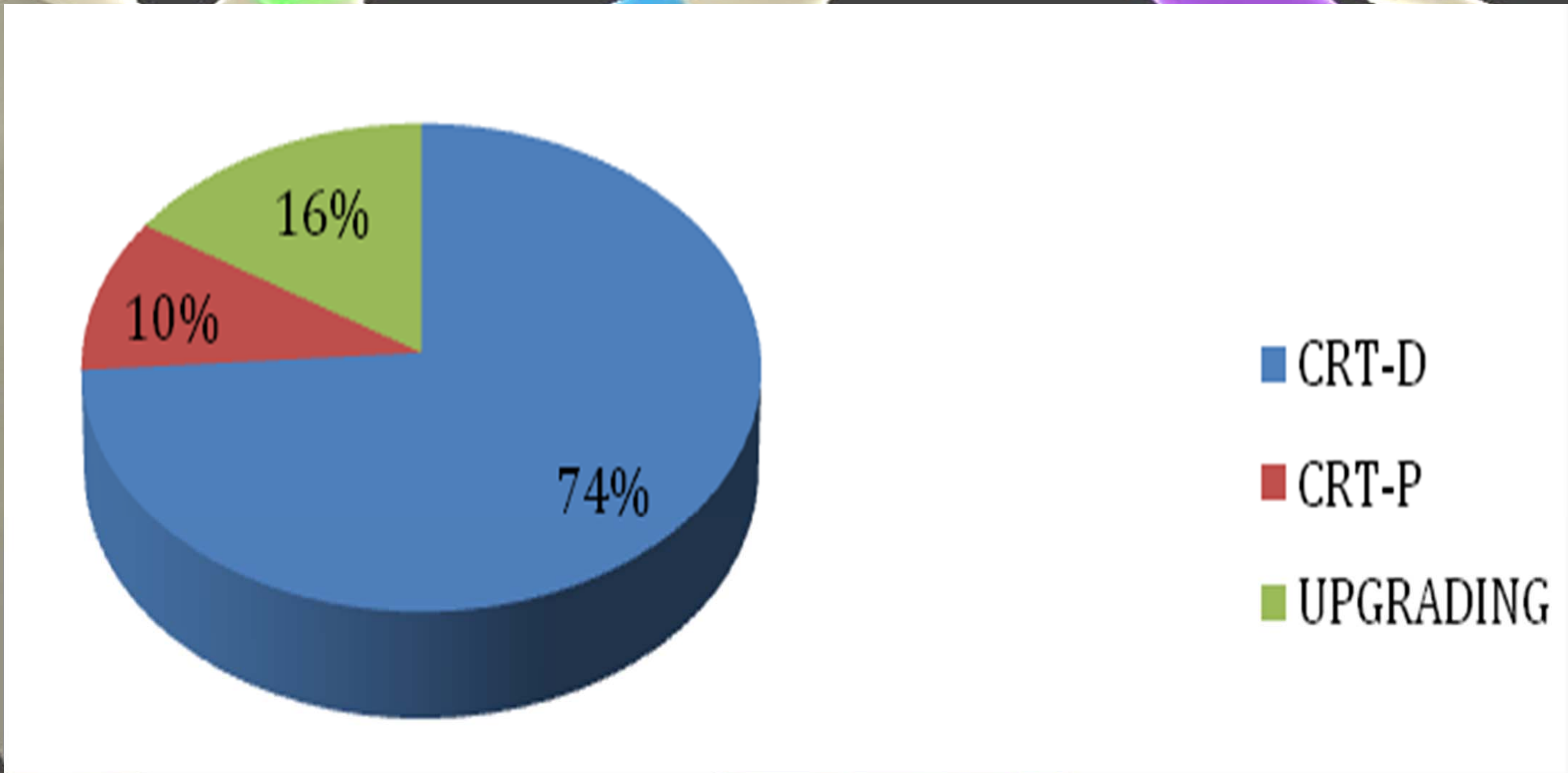
POPULATION

ENROLLED PATIENTS	**113**
CENTERS/OPERATORS	11/18
AGE	70.9 ± 8.2 anni
SEX	22 F/ 91 M
EF	29.8 ± 6 %
ETIOLOGY	
ischaemic	45,8%
non ischaemic	54,2%
CONDUCTION DELAY	
LBBB	65%
RBBB	3,7%
RBBB+AFB	5%
PM	13,8%
NO DELAY	12,5%
RYHTM	
RS	70,4%
FA	28,4%
FLA	1.2%

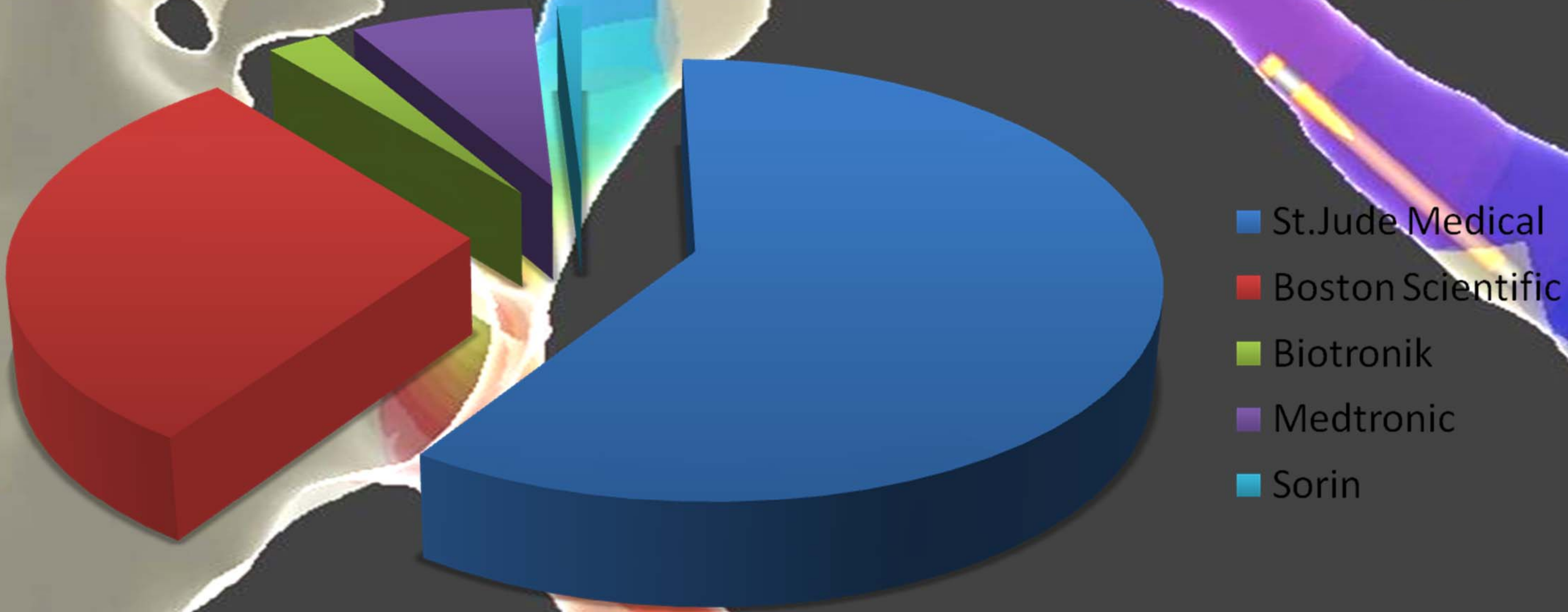
PROCEDURAL SUCCESS

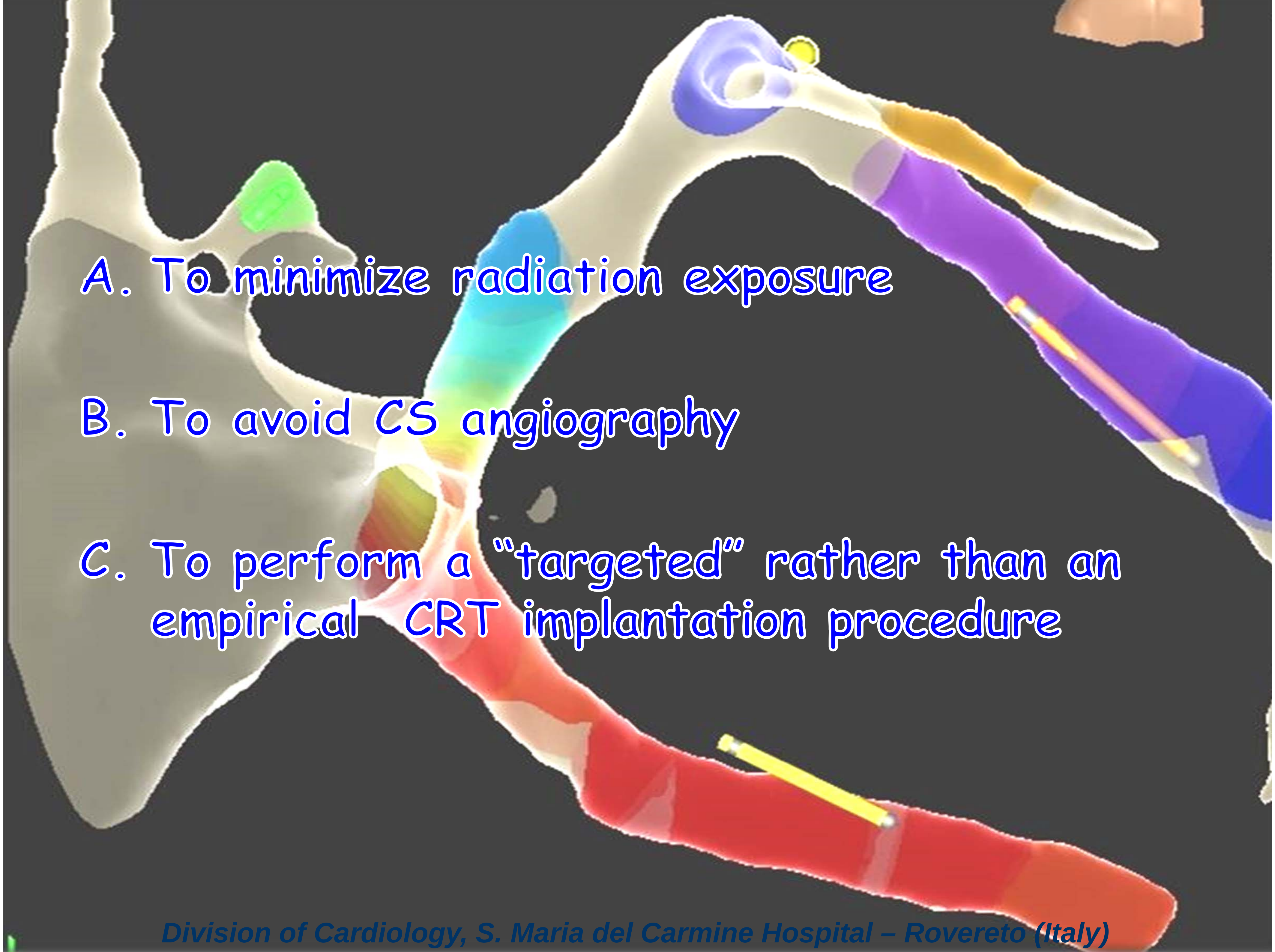


Type of implant



DEVICE BRANDS

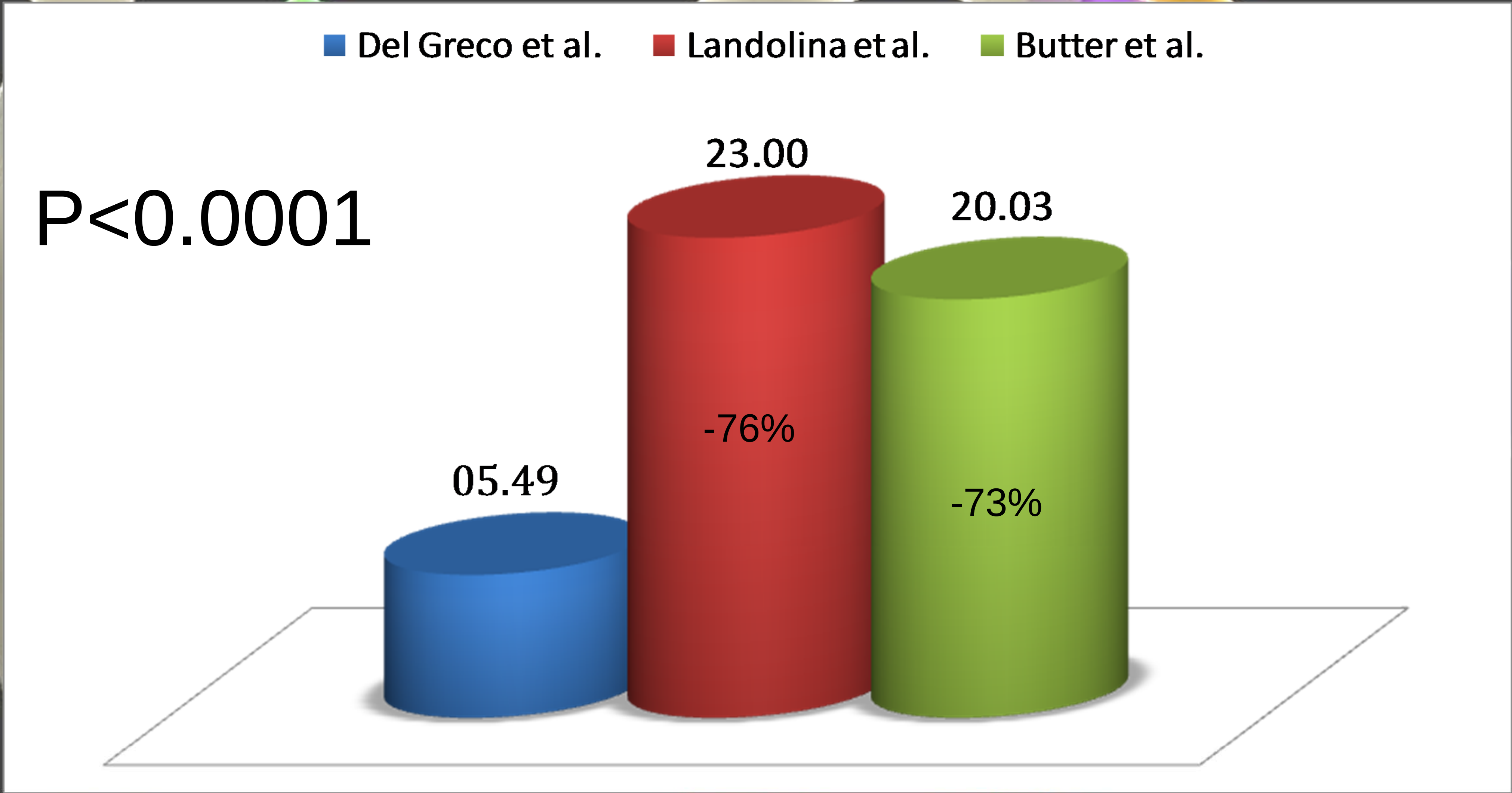



A. To minimize radiation exposure
B. To avoid CS angiography
C. To perform a “targeted” rather than an empirical CRT implantation procedure
Division of Cardiology, S. Maria del Carmine Hospital – Rovereto (Italy)

PROCEDURAL DATA

	Geometric mean	CI 95%
Fluoro Time (sec)	351.3	284.1-434.3
DAP $cGy*cm^2$	2600	1815-3724
Procedure Time (min)	123.3	114.6-132.6

FLUOROSCOPY TIME (min)



LANDOLINA ET AL. *Circulation. 2011;123:2526-2535*

BUTTER ET AL. *PACE 2010; 33:1003–1012*

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

Radiation Exposure of Patient and Physician during Implantation and Upgrade of Cardiac Resynchronization Devices

CHRISTIAN BUTTER, M.D.,* THOMAS SCHAU, M.D.,* JUERGEN MEYHOEFER, M.D.,* KLAUS NEUMANN, M.D.,† HANS H. MINDEN, M.D.,* and JOERG ENGELHARDT, PH.D.‡

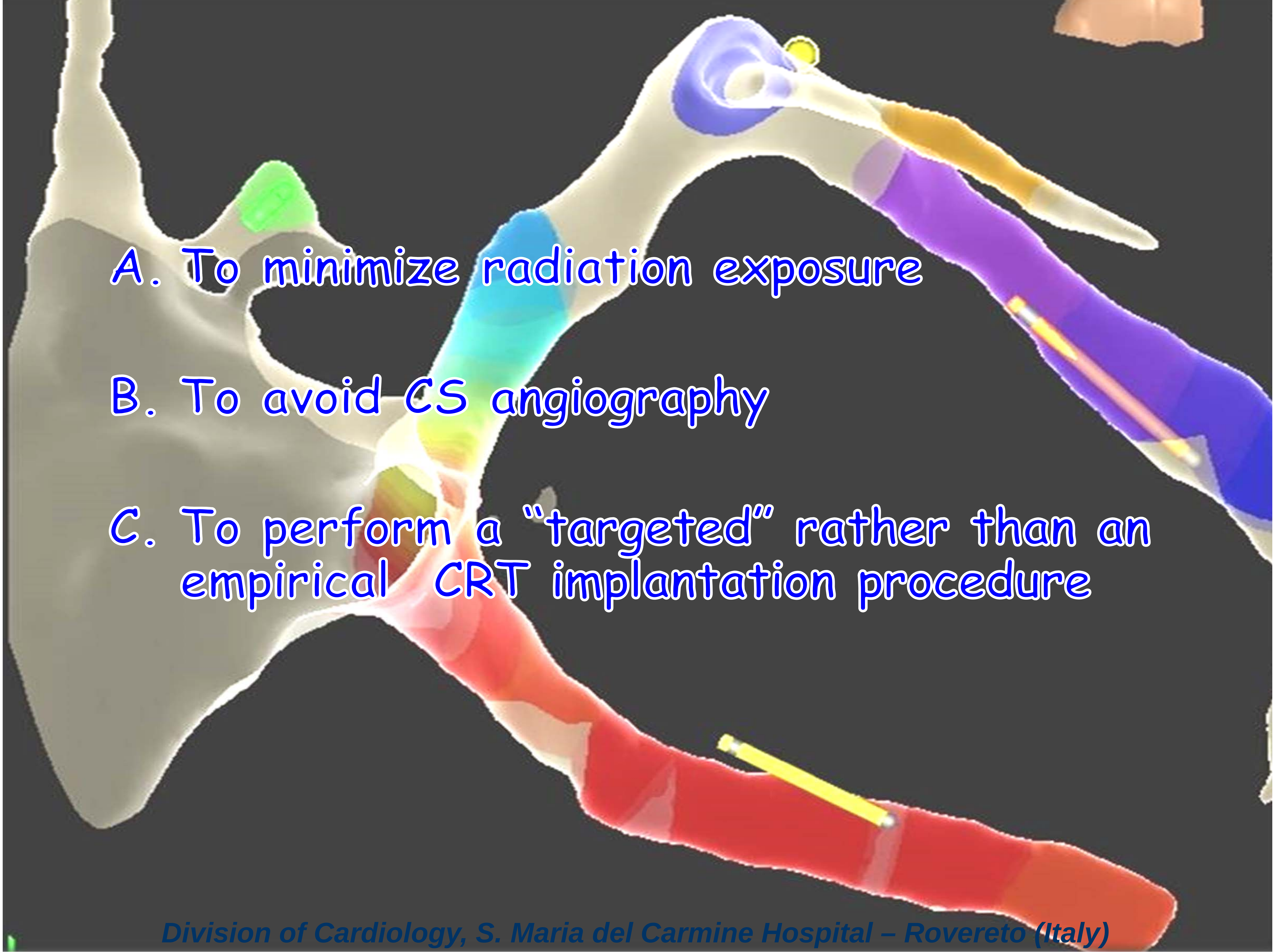
From the *Heart Center Brandenburg, Department of Cardiology, Bernau/Berlin, Germany; †Heart Center Brandenburg, Department of Radiology, Bernau/Berlin, Germany; and ‡Landesanstalt für Personendosimetrie und Strahlenschutzausbildung Mecklenburg-Vorpommern (Institute for Dosimetry and Radiation Protection of the Federal State of Mecklenburg-West Pomerania), Berlin, Germany

Background: *Cardiac resynchronization therapy (CRT) is often associated with extended fluoroscopic exposure during placement of the devices. The objective of this study was to measure the radiation exposure sustained by different parts of the body of patients and operators during fluoroscopically guided cardiac resynchronization device implantation.*

Methods: *Dosimetry data were prospectively recorded in a series of 104 consecutive patients, who underwent resynchronization device implantation or upgrade in our cardiac catheterization laboratory. Five Chipstrate dosimeters were fixed to the patient's skin around the thorax (right and left paravertebral, right and left parasternal, and sternal positions), one dosimeter was attached to the forehead, and one to the pubis. The operator was equipped with one dosimeter on the forehead at eye level and a ring dosimeter was worn on the right hand.*

Results: *Based on the maximum radiation dose of 9.2 mSv measured at the operator's hand in a single implantation session, it might be recommended to conservatively limit the number of implantations to four per month (an annual limit value of 500 mSv). At a mean dose of 1.2 mSv, this number can be increased sevenfold.*

Conclusion: *In patients, incipient deterministic radiation effects can theoretically be observed at dose area product >400 Gy•cm², a dose applied in 2.9% of CRT implantation procedures. Special follow-up programs are considered necessary for these patients and for operators, as the latter may be exposed over many years given the unknown long-term impact of chronic radiation exposure and the nature of current complex electrophysiology and device procedures.* *(PACE 2010; 33:1003–1012)*

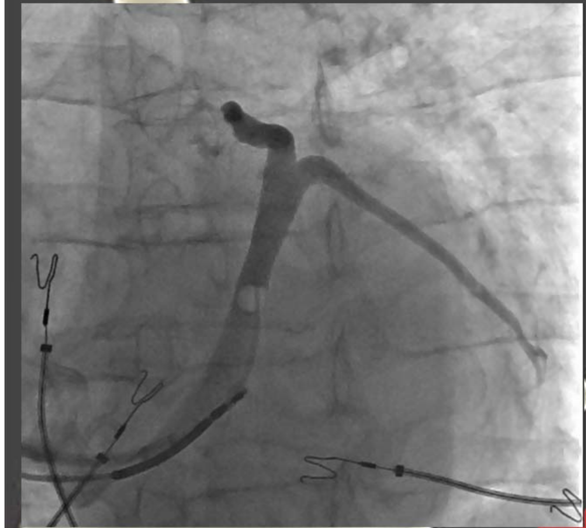


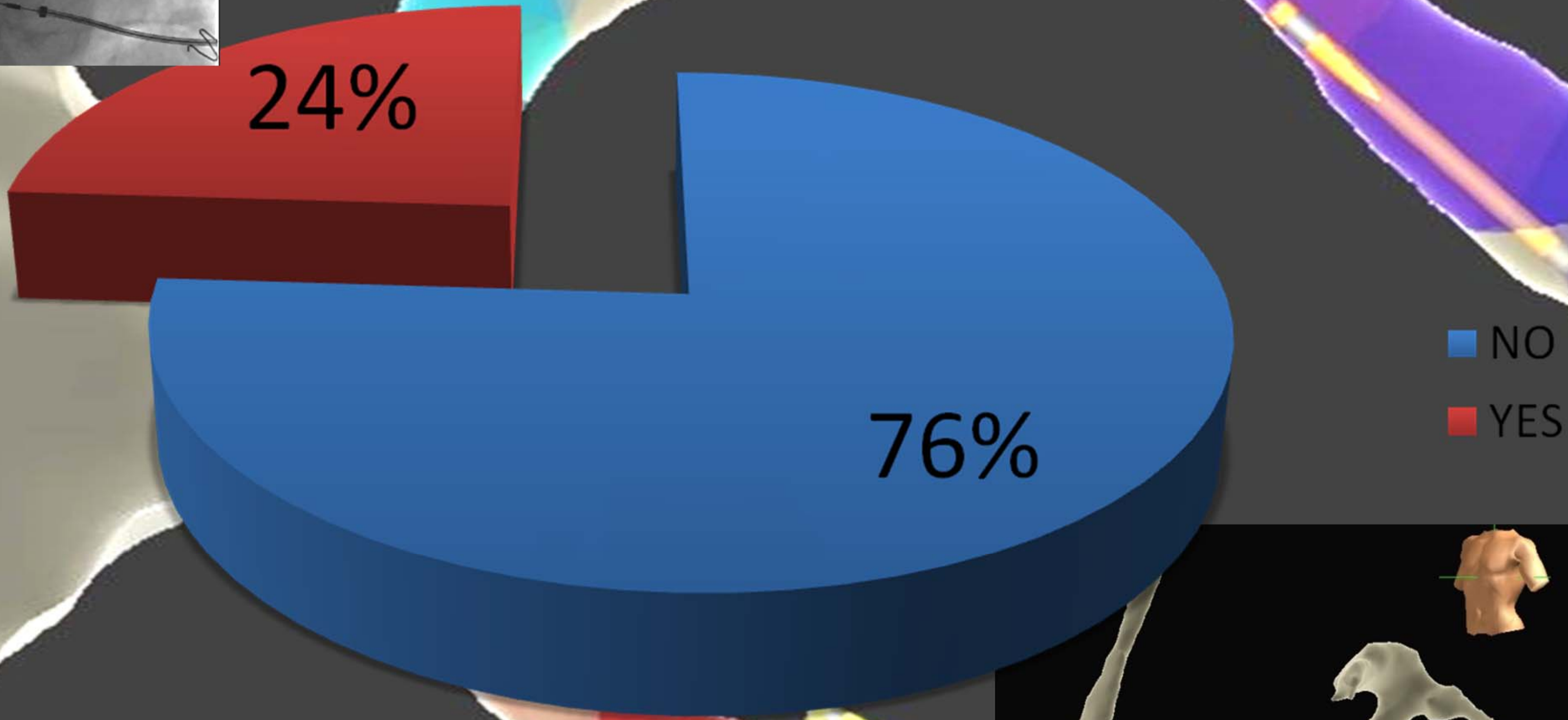
A. To minimize radiation exposure

B. To avoid CS angiography

C. To perform a "targeted" rather than an empirical CRT implantation procedure

CS ANGIOGRAPHY





C. To avoid CS angiography

- Multiple studies have demonstrated that nearly one-third of patients with HF have concomitant stage 3 or greater chronic kidney disease.

Cannizzaro et al JACC 2011

Contrast nephropathy post cardiac resynchronization therapy: An under-recognized complication with important morbidity

Peter J. Cowburn, Harshna Patel, Rebecca R. Pipes, John D. Parker*

Abstract

Objectives: The aim of the study was to define the incidence of contrast nephropathy in patients undergoing cardiac resynchronization therapy (CRT).

Background: CRT is a promising new treatment for advanced heart failure. It is a technically demanding procedure with a recognized failure/complication rate. Contrast nephropathy is a well-recognized complication of coronary angiography/intervention, but has not been described following CRT.

Methods: We performed a retrospective chart review of patients who had undergone CRT at Mount Sinai Hospital, a tertiary referral center for heart failure management, to define the incidence of contrast nephropathy in patients undergoing CRT. Contrast nephropathy was defined as the occurrence of a 25% or greater increase in serum creatinine within 48 h after contrast administration.

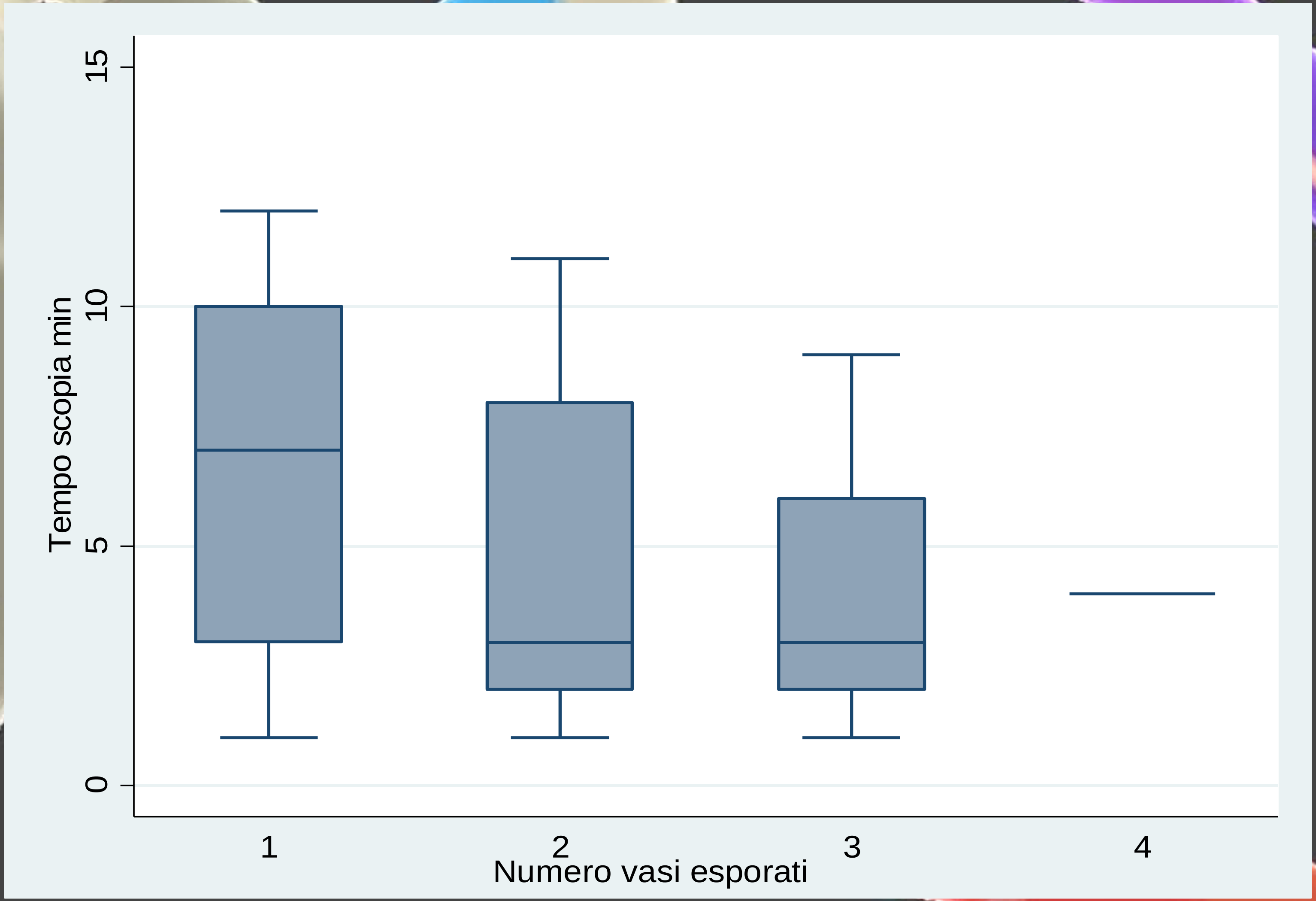
Results: Sixty-eight patients underwent a total of seventy-three procedures between October 1st 2000 and December 31st 2003. Ten patients (14%) developed contrast nephropathy. Three of these patients (4%) required hemofiltration and one died. Patients with creatinine ≥200 μmol/l (2.26mg/dl) were more likely to develop contrast nephropathy than those with creatinine <200 μmol/l (6/14 patients [43%] v 4/59 patients [7%], $p<0.01$). The mean length of hospital stay post-procedure in patients developing contrast nephropathy was 19±18 (SD) days versus 4±5 days for those patients with stable renal function ($p<0.01$).

Conclusions: Contrast nephropathy is a frequent, but under-recognized complication of CRT with important morbidity/mortality. The extended hospital stay associated with contrast nephropathy has important clinical and health care implications. Patients and physicians need to be aware of this potential risk.

whilst in the right ventricle. Another option is to use EP electrode catheters to identify the coronary sinus without the use of contrast. When patients are undergoing

The European Journal of Heart Failure (2005)

The median number of coronary sinus vassel esplorated was 2.02±0.84

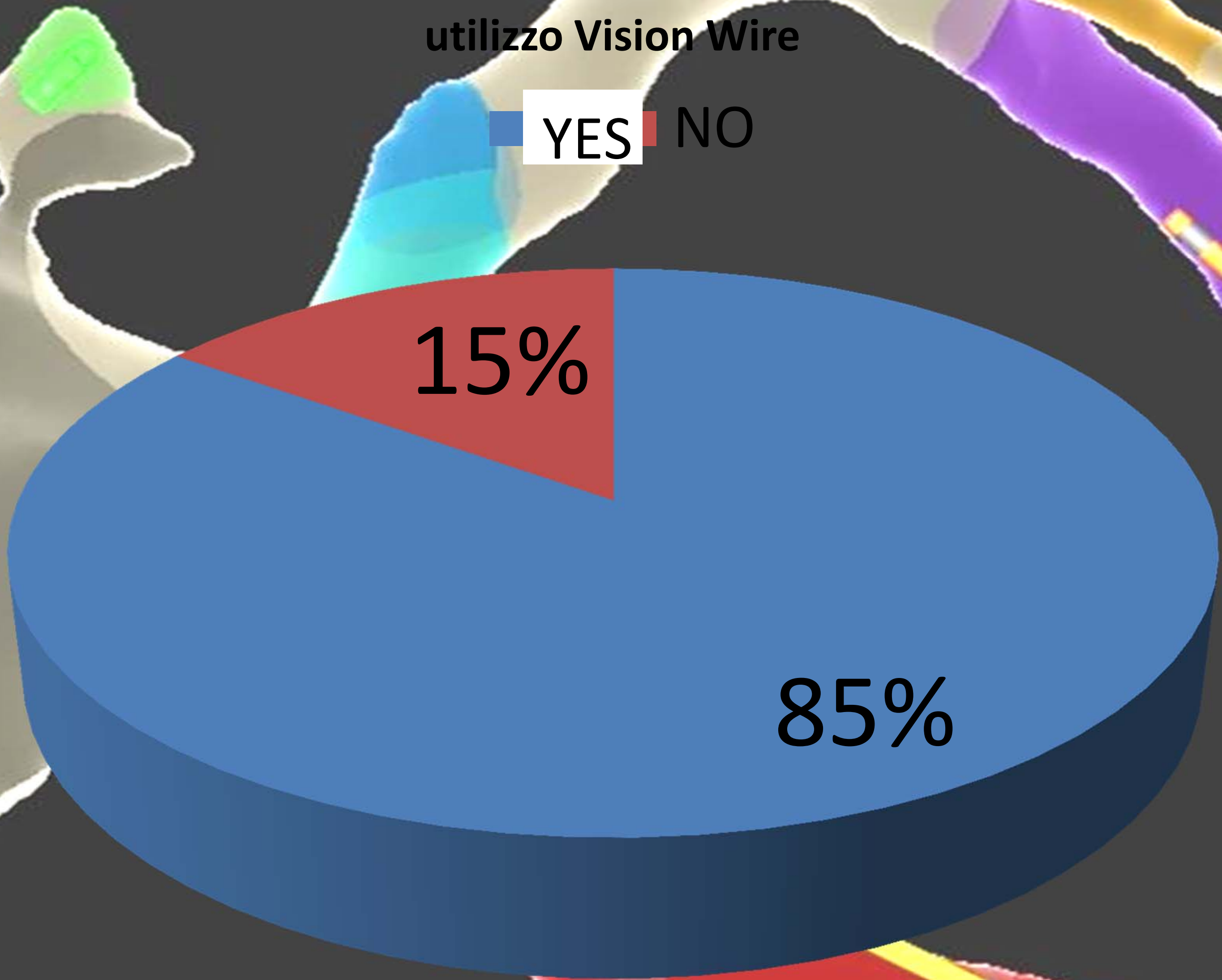


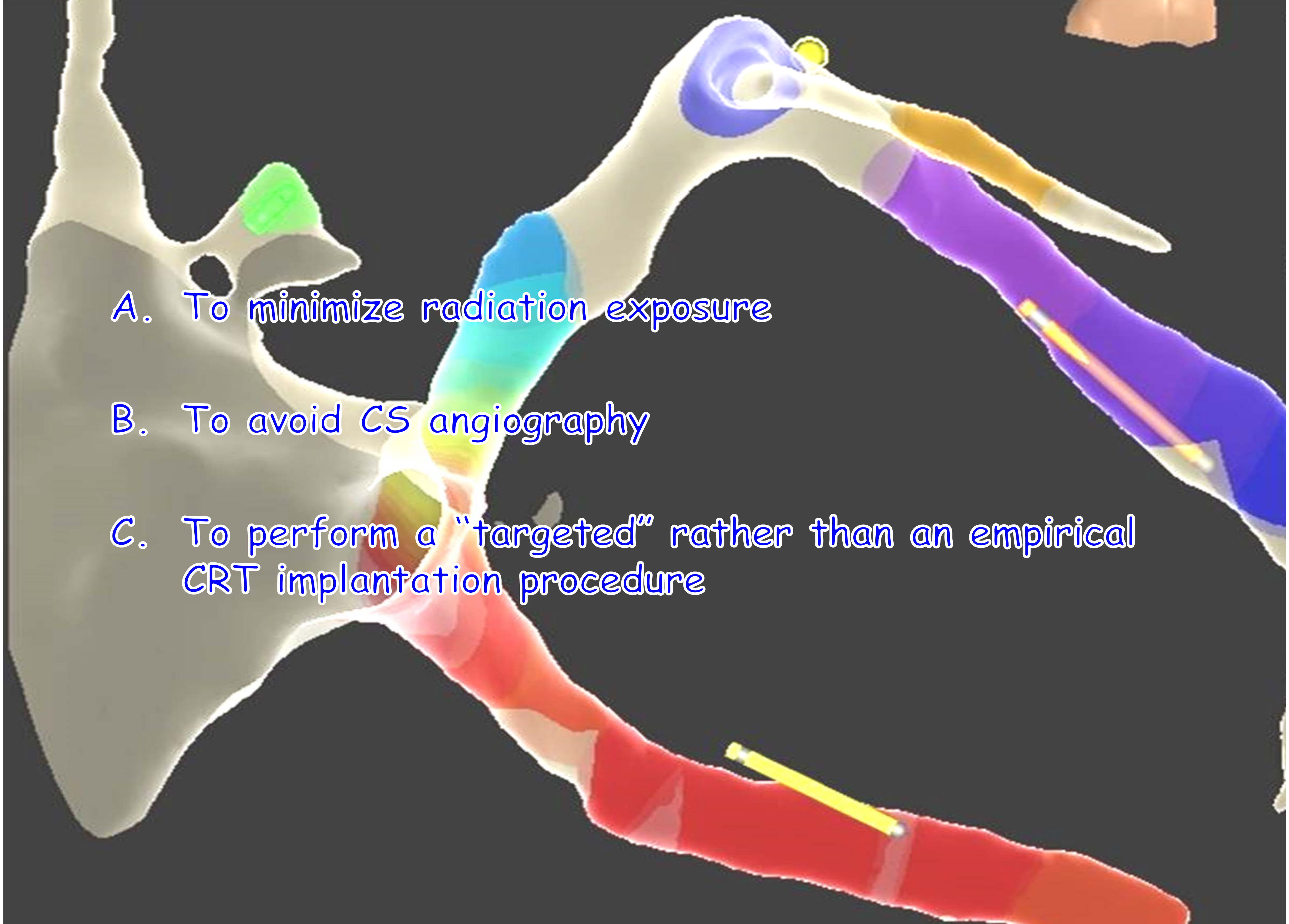
Division of Cardiology, S. Maria del Carmine Hospital – Rovereto (Italy)

Correlayion between fluoroscopy time and number of vassel explored

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

Vision Wire





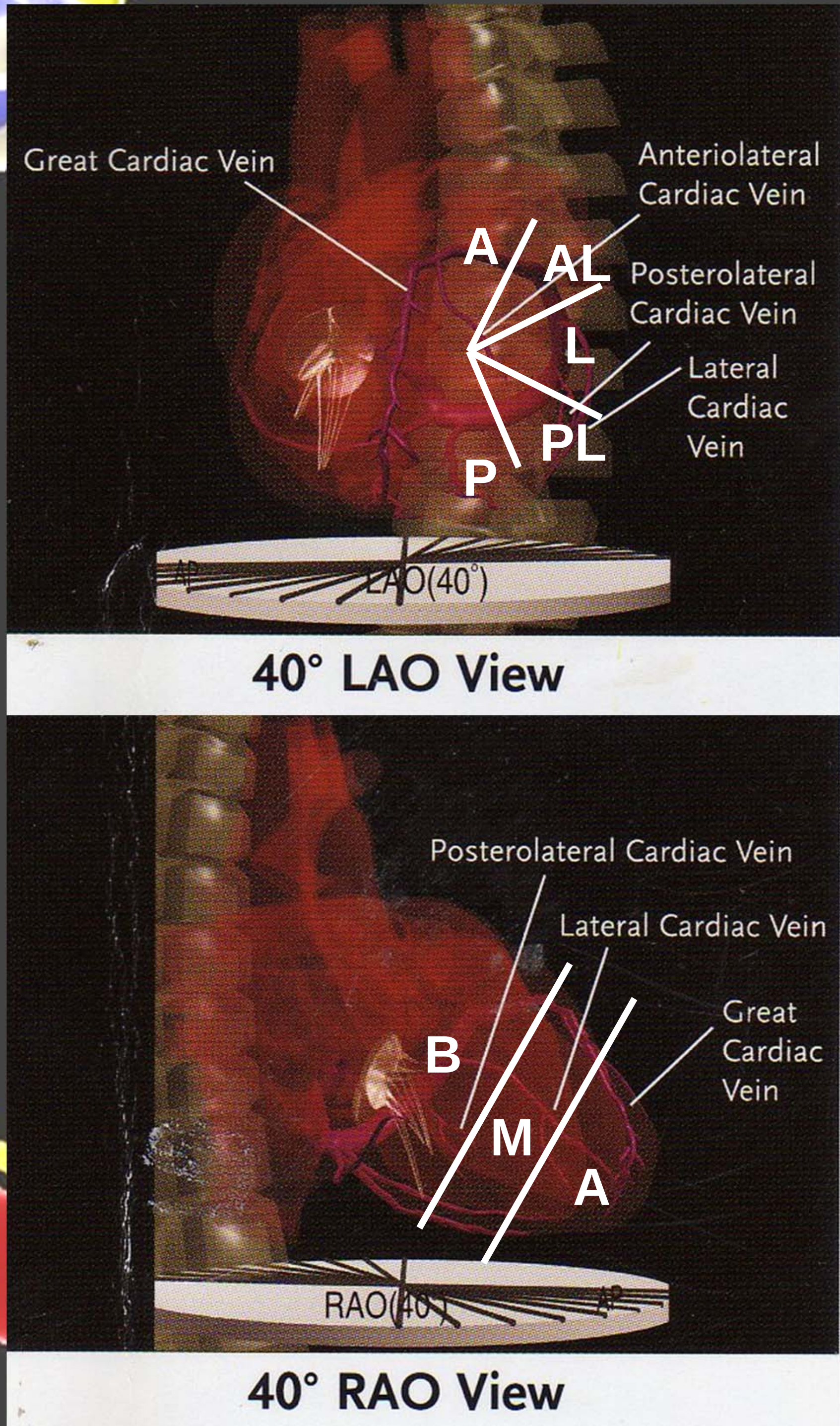
A. To minimize radiation exposure

B. To avoid CS angiography

C. To perform a "targeted" rather than an empirical CRT implantation procedure

More delayed activation

LAO	Latest activation during sinus rhythm - % of patients	Latest activation during RV pacing* - % of patients
Anterior	**5**	12
Antero-lateral	**7**	0
Lateral	**63**	50
Postero-Lateral	**23**	38
Posterior	**2**	0
RAO		
Basal	**55**	38
Medium	**38**	31
Apical	**7**	31



40° LAO View

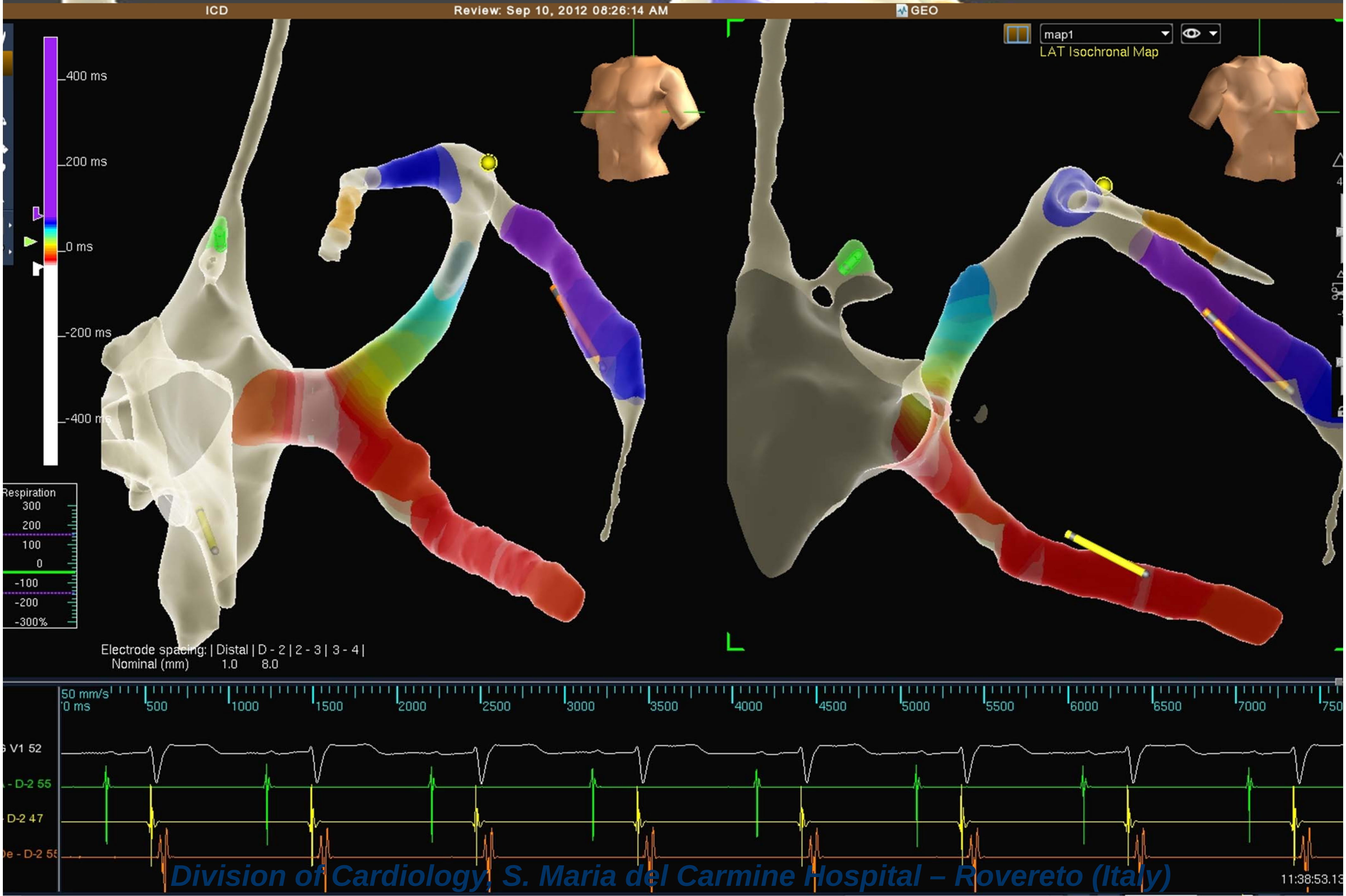
40° RAO View

* Position of the catheter in right ventricle was septal in 74% and apical in 26 % of the patients

CS elettroanatomic map during SR

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

CS elettroanatomic map during SR

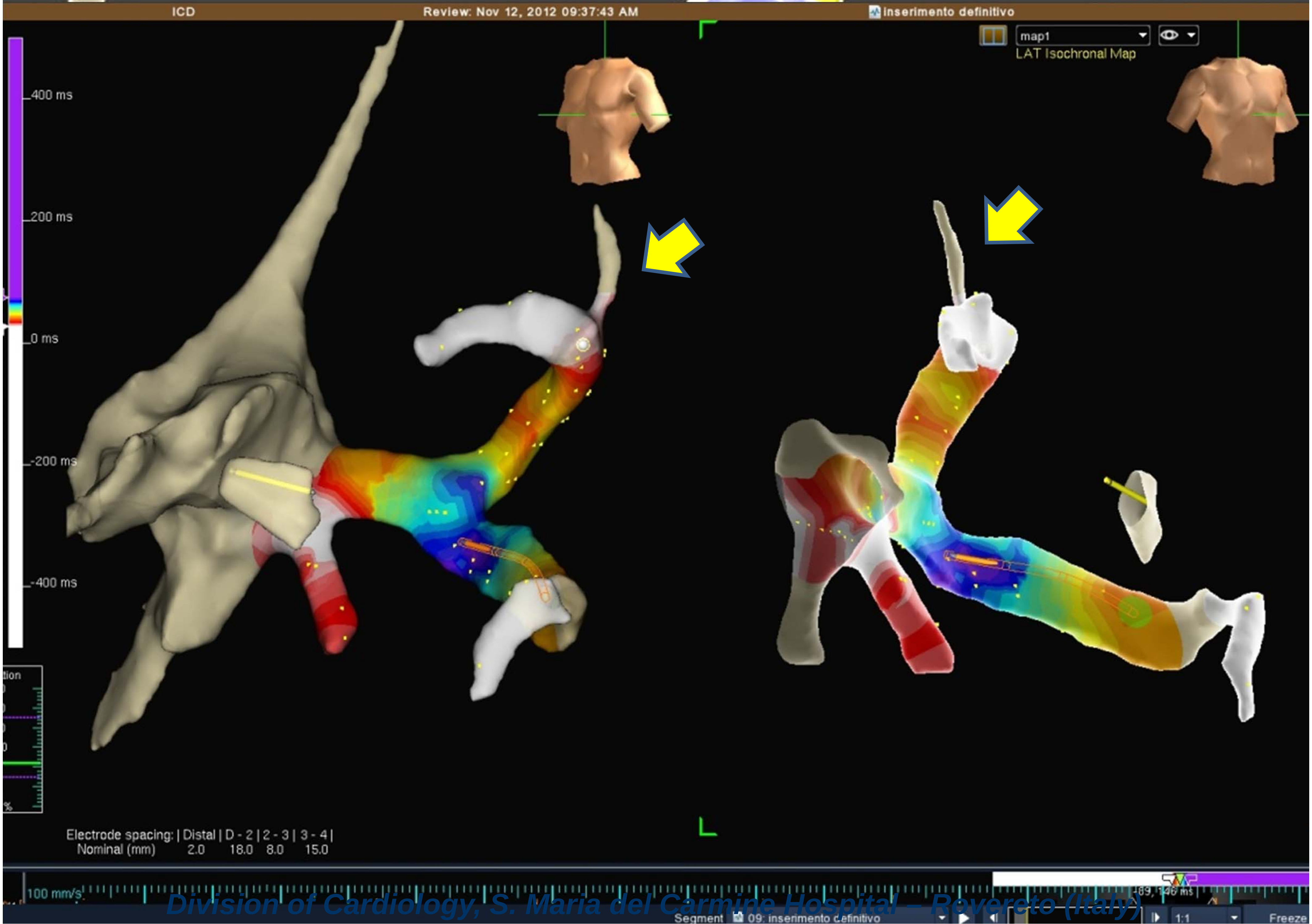


Division of Cardiology, S. Maria del Carmine Hospital – Rovereto (Italy)

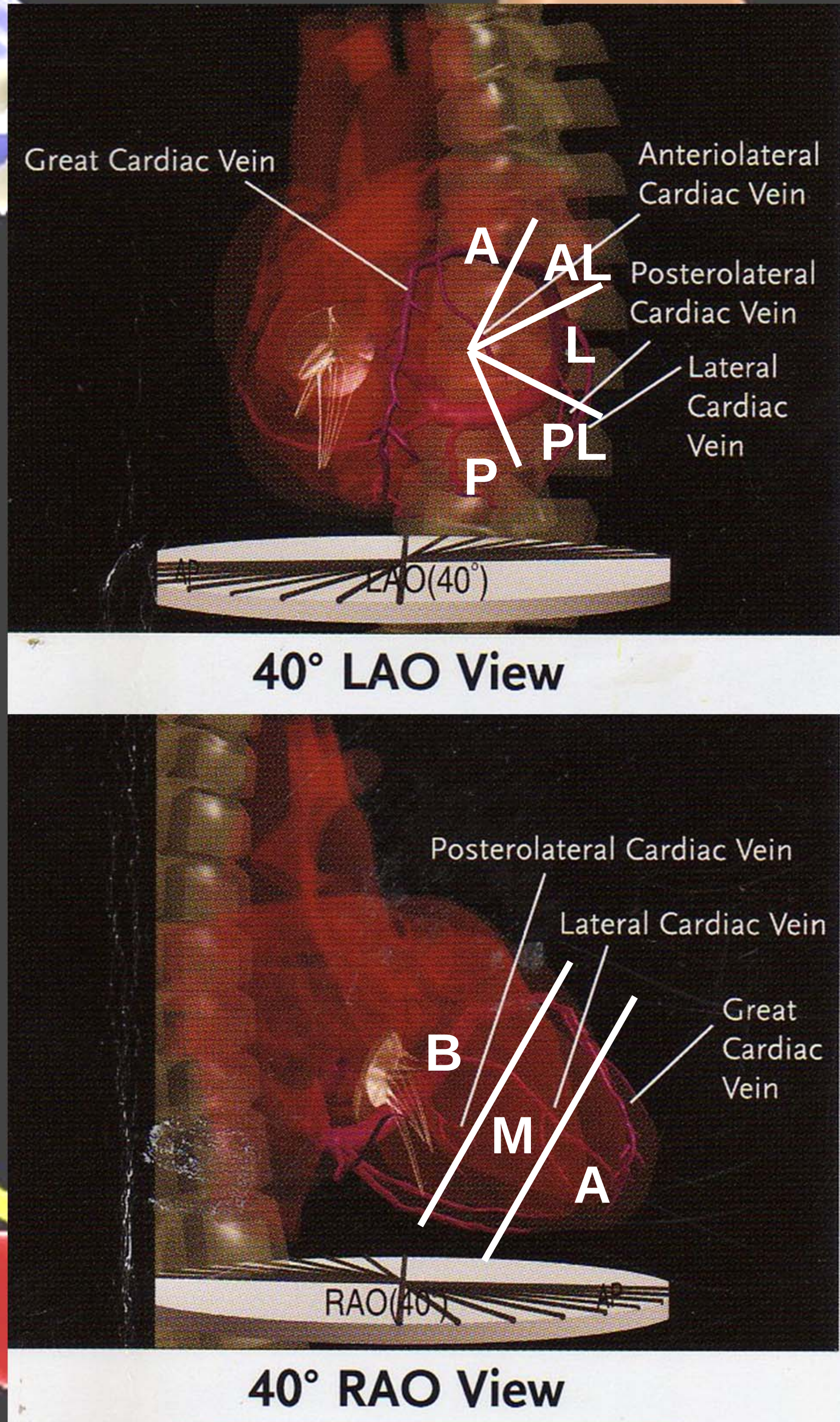
LV pacing configuration: Left tip > Right ring

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

Vein of Marshall



LAO	Latest activation during SR - % of patients	Latest activation during RV p p* - % of patients	Final position of LV lead % of patients
Anterior	5	12	9
Antero-lateral	7	0	16
Lateral	63	50	39
Postero-Lateral	23	38	31
Posterior	2	0	5
RAO			
Basal	55	38	16
Medium	38	31	68
Apical	7	31	16



* Position of the catheter in right ventricle was septal in 74% and apical in 26 % of the patients

EUROPEAN SOCIETY OF CARDIOLOGY®
Europace
doi:10.1093/europace/euu221

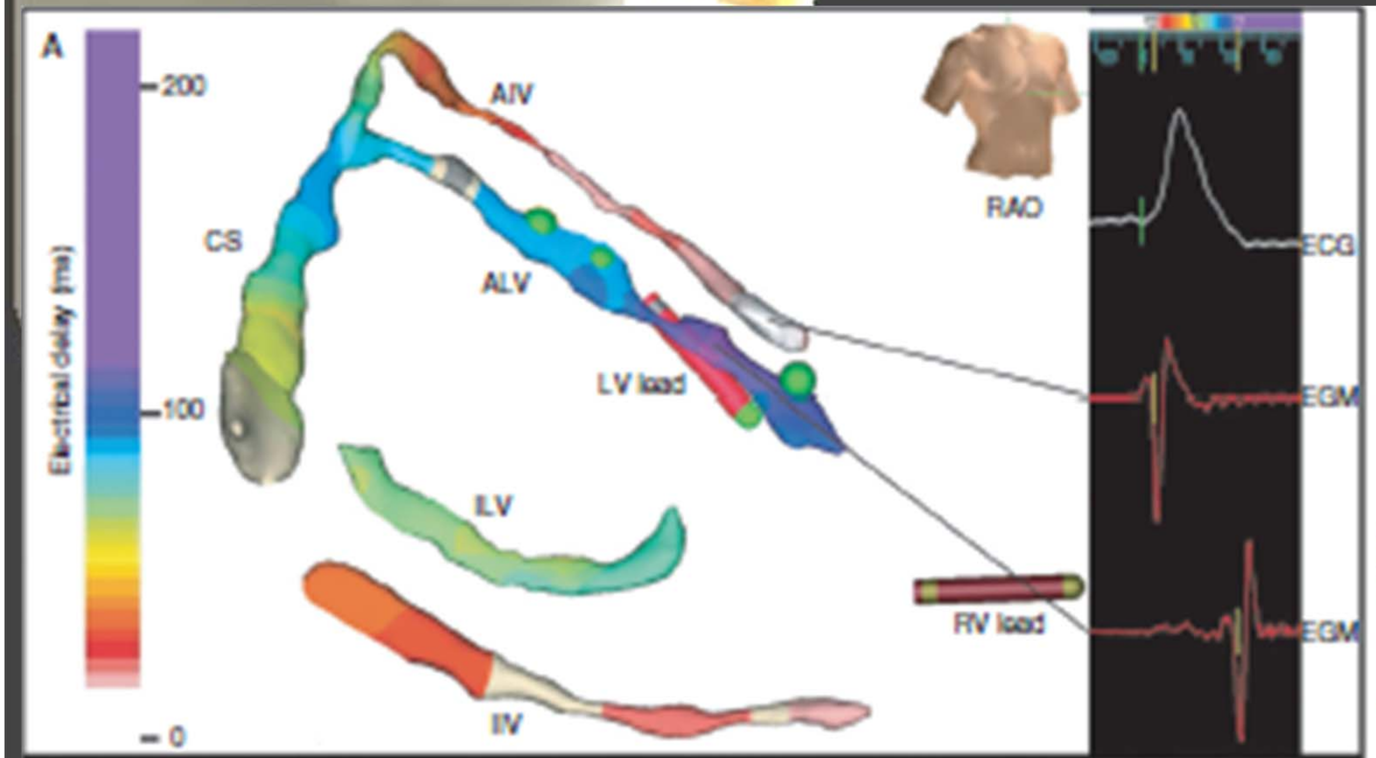
CLINICAL RESEARCH

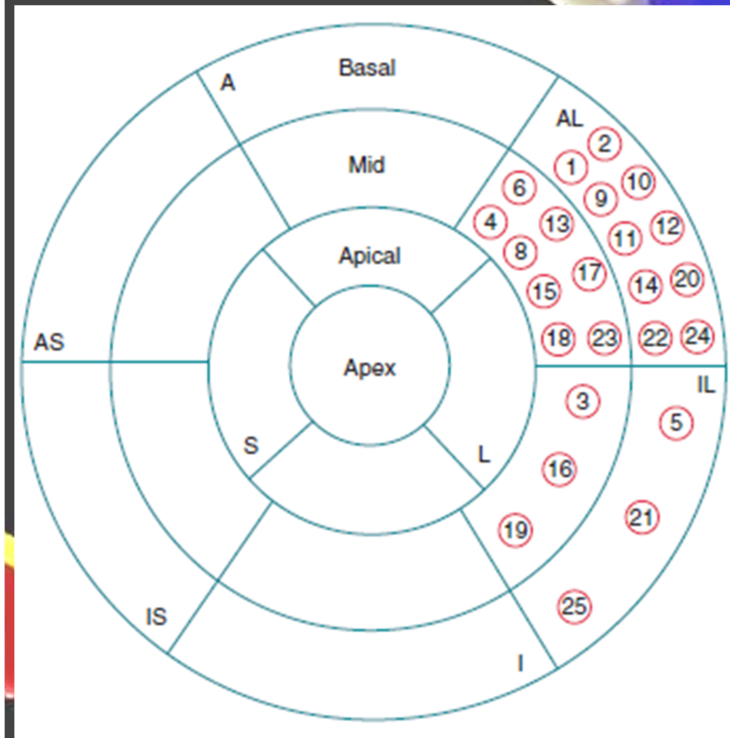
Left ventricular lead placement in the latest activated region guided by coronary venous electroanatomic mapping

Masih Mafi Rad[1]*, Yuri Blaauw[1], Trang Dinh[1], Laurent Pison[1], Harry J. Crijns[1], Frits W. Prinzen[2], and Kevin Vernooy[1]

[1]Department of Cardiology, Maastricht University Medical Center, P. Debeyelaan 25, PO Box 5800, 6202 AZ Maastricht, The Netherlands; and
[2]Department of Physiology, Cardiovascular Research Institute Maastricht, PO Box 616, Maastricht 6200 MD, The Netherlands

Received 10 October 2013; accepted after revision 22 July 2014





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

J Interv Card Electrophysiol (2014) 41:147–153
DOI 10.1007/s10840-014-9932-9

Three-dimensional electroanatomic mapping of the coronary veins during cardiac resynchronization therapy implant: feasibility and possible applications

Imran Niazi · Kyungmoo Ryu · Richard Hood · Indrajit Choudhuri · Masood Akhtar

Methods Patients (n=32; NYHA III, LVEF <35 %, QRSd >120 ms) underwent NavX™ mapping during CRT implant. Left bundle branch block (LBBB) was present during sinus rhythm in group A (n=17), whereas LBBB was induced by permanent RV apical pacing in group B (n=15). Following coronary sinus (CS) cannulation, a coil tip 0.014-in. guidewire was introduced into all available CS branches as a mapping electrode. Each patient's unipolar activation map was successfully constructed within 10 min, using the onset of surface QRS as reference.
Results LV activation patterns were complex and varied in both groups. Earliest activation was usually apical, but latest activation was more heterogenous. The lateral or posterolateral branches were the sites of latest activation in 47 % of group A and 73 % of group B. An LV lead positioned conventionally by a physician blinded to the mapping data was concordant with the latest activated segment in 18 % of group A and none of group B patients.

Patient	Earliest activated branch	Latest activated branch	LV lead final location	Total mapped activation time (ms)	QRS duration (ms)
1	Distal A	Distal MCV	Distal PL	80	163
2	Mid A	Mid MCV	Distal MCV	80	124
3	Distal A	Mid A	Mid A	50	131
4	Basal A	Distal A	Mid L	23	120
5	Distal AL	Basal PL	Distal PL	64	170
6	Basal A	Distal PL	Distal PL	71	136
7	Distal A	Mid-Basal L	Distal L	114	154
8	Basal A	Basal L	Distal L	52	190
9	Distal L	Basal A	Mid L	148	188
10	Distal MCV	Distal A	Distal PL	50	142
11	Distal PL	Basal AL	Distal PL	84	150
12	Distal A	Mid L	Mid L	101	132
13	Distal AL	Basal L	Distal AL	67	140
14	Distal MCV	Basal PL	Distal PL	150	164
15	Distal AL	Basal AL	Mid PL	139	188
16	Distal MCV	Basal L	Mid L	69	192
17	Distal MCV	Basal A	Distal L	118	134

Determination of the Longest Intrapatient Left Ventricular Electrical Delay May Predict Acute Hemodynamic Improvement in Patients After Cardiac Resynchronization Therapy

Francesco Zanon, MD, FESC, FHRS; Enrico Baracca, MD; Gianni Pastore, MD; Chiara Fraccaro, MD, PhD; Loris Roncon, MD; Silvio Aggio, MD; Franco Noventa, MD; Alberto Mazza, MD, PhD; Frits Prinzen, PhD

Background—One of the reasons for patient nonresponse to cardiac resynchronization therapy is a suboptimal left ventricular (LV) pacing site. LV electric delay (Q-LV interval) has been indicated as a prognostic parameter of cardiac resynchronization therapy response. This study evaluates the LV delay for the optimization of the LV pacing site.

Methods and Results—Thirty-two consecutive patients (23 men; mean age, 71±11 years; LV ejection fraction, 30±6%; 18 with ischemic cardiomyopathy; QRS, 181±25 ms; all mean±SD) underwent cardiac resynchronization therapy device implantation. All available tributary veins of the coronary sinus were tested, and the Q-LV interval was measured at each pacing site. The hemodynamic effects of pacing at different sites were evaluated by invasive measurement of LV dP/dt_{max} at baseline and during pacing. Overall, 2.9±0.8 different veins and 6.4±2.3 pacing sites were tested. In 31 of 32 (96.8%) patients, the highest LV dP/dt_{max} coincided with the maximum Q-LV interval. Q-LV interval correlated with the increase in LV dP/dt_{max} in all patients at each site (AR1 $\rho=0.98$; $P<0.001$). A Q-LV value >95 ms corresponded to a >10% in LV dP/dt_{max}. An inverse correlation between paced QRS duration and improvement in LV dP/dt_{max} was seen in 24 patients (75%).

Conclusions—Pacing the LV at the latest activated site is highly predictive of the maximum increase in contractility, expressed as LV dP/dt_{max}. A positive correlation between Q-LV interval and hemodynamic improvement was found in all patients at every pacing site, a value of 95 ms corresponding to an increase in LV dP/dt_{max} of ≥10%. (***Circ Arrhythm Electrophysiol*. 2014;7:377-383.**)

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

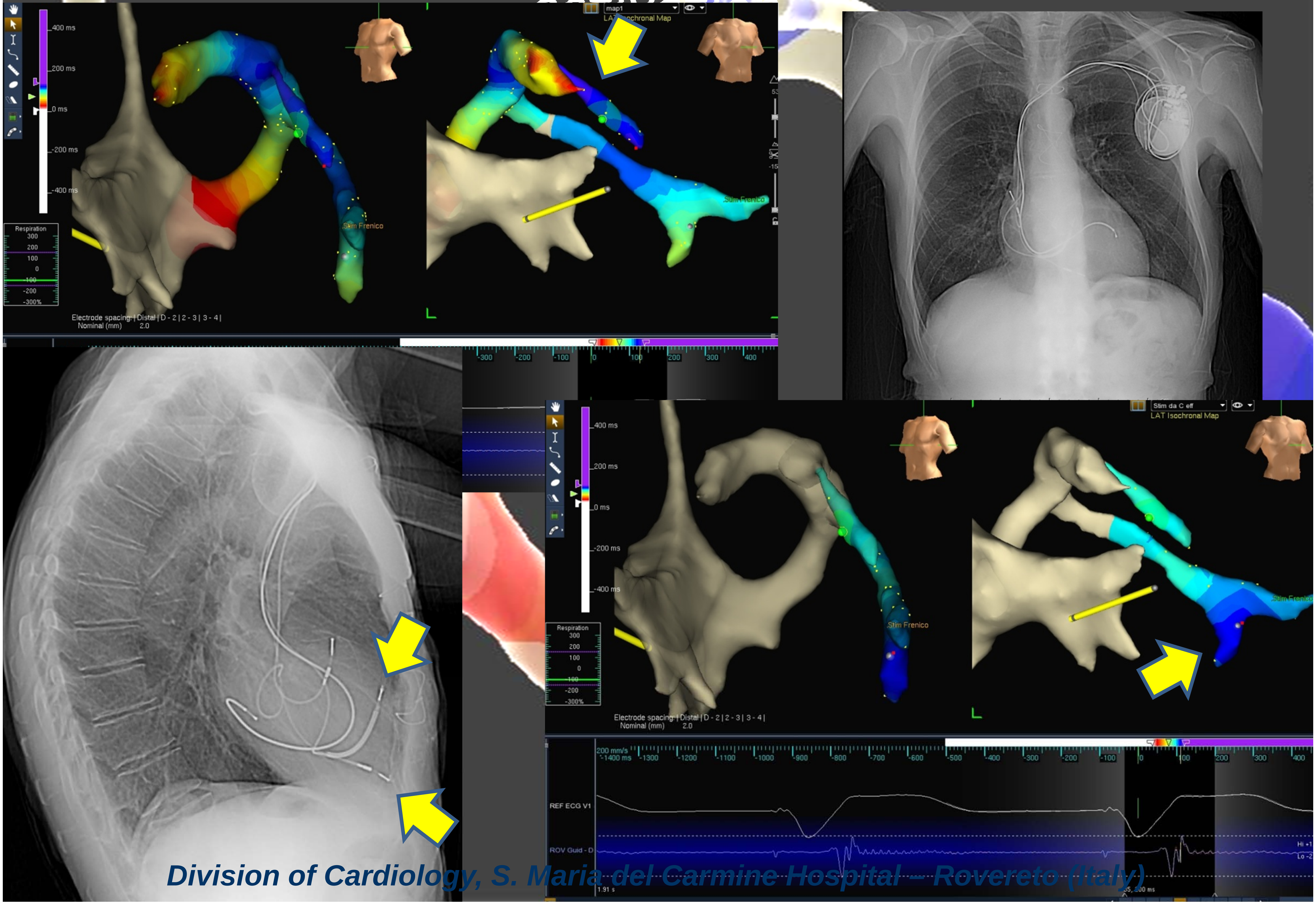
EUROPEAN SOCIETY OF CARDIOLOGY®

ESC GUIDELINES

Choice of pacing mode (and cardiac resynchronization therapy optimization)

Recommendations	Class [a]	Level [b]	Ref. [c]
1) The goal of CRT should be to achieve BiV pacing as close to 100% as possible since the survival benefit and reduction in hospitalization are strongly associated with an increasing percentage of BiV pacing.	IIa	B	67–69
2) Apical position of the LV lead should be avoided when possible.	IIa	B	70–72
3) LV lead placement may be targeted at the latest activated LV segment.	IIb	B	73

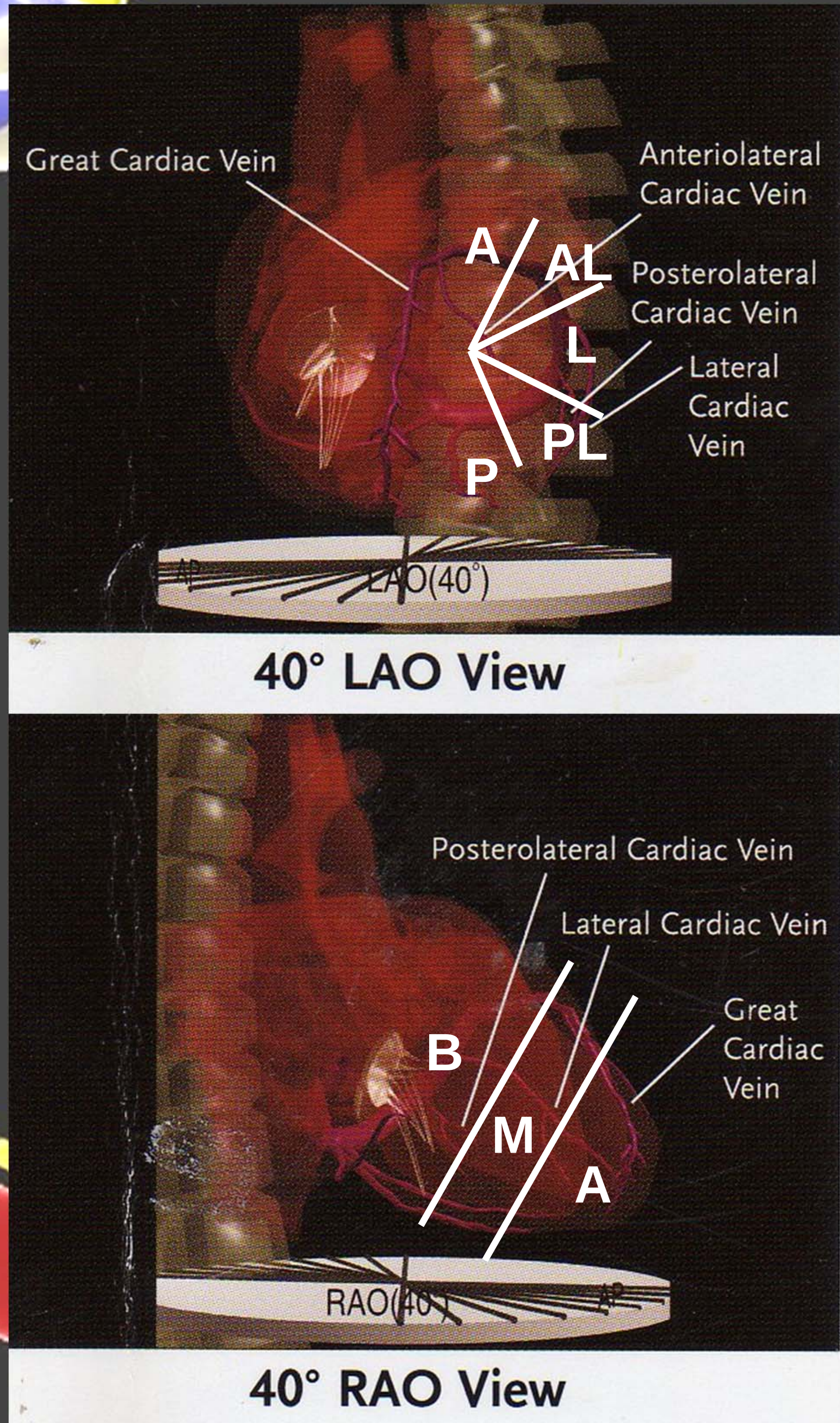
Effects on RV pacing site on the CS



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

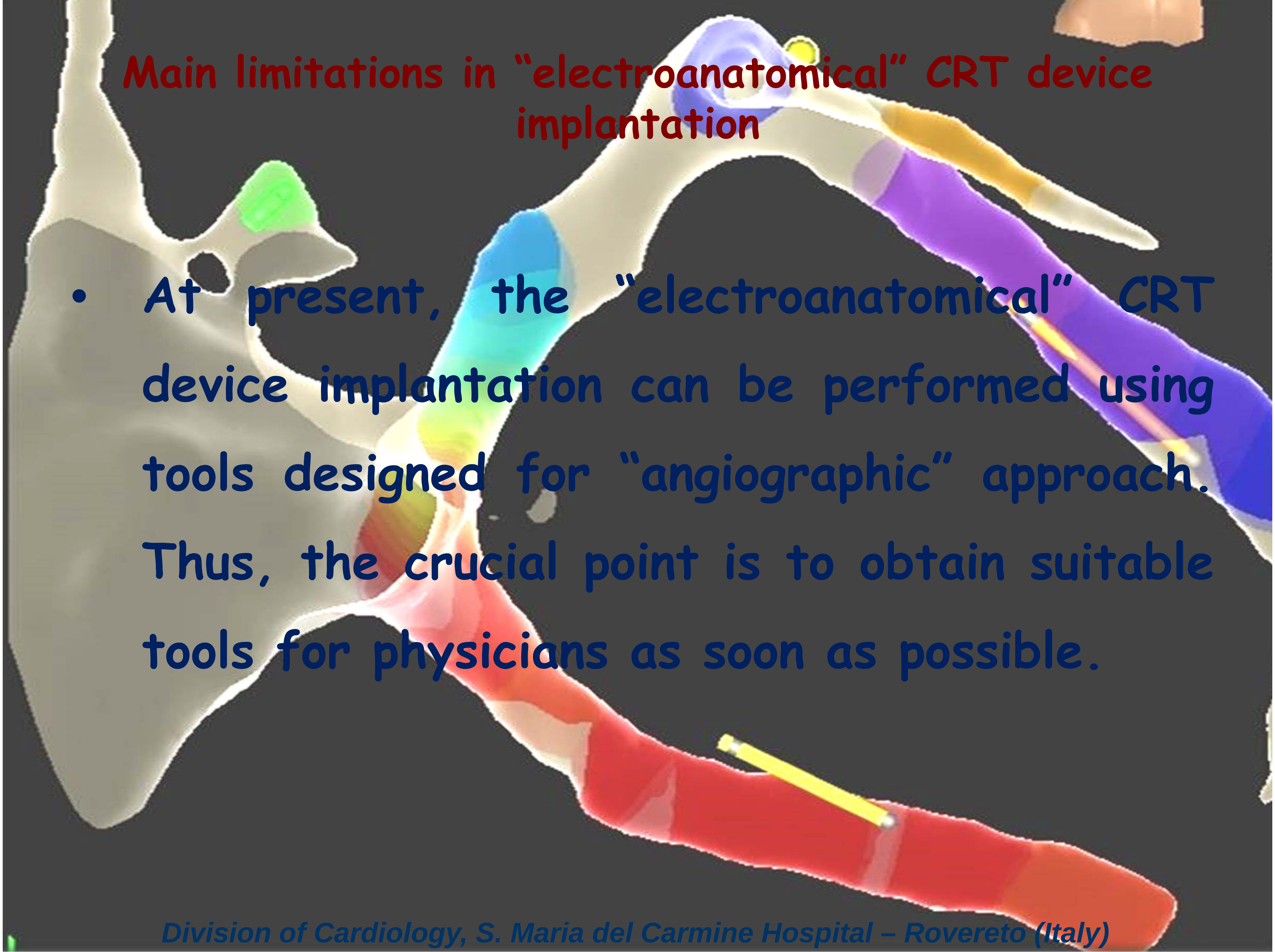
Final position of the LV lead

LAO	% of patients
anterior	14
Antero-lateral	16
Lateral	34
Postero-lateral	31
Posterior	5
RAO	
Basal	16
Medium	68
Apical	16



Conclusions

1. The "electroanatomical" CRT device implantation dramatically reduce radiation exposure (> 70 %).
2. The "electroanatomical" CRT device implantation allows to overcome the problem of the contrast liquid infusion for CS visualization.
3. The "electroanatomical" CRT device implantation provide the possibility to guide (with very high precision) the left ventricular lead toward the position with the most delayed ventricular activation. On the basis of previous studies this approach could increase the number of CRT responders.



Main limitations in "electroanatomical" CRT device implantation

- At present, the "electroanatomical" CRT device implantation can be performed using tools designed for "angiographic" approach. Thus, the crucial point is to obtain suitable tools for physicians as soon as possible.

Main Technical Limitations (Nichols Peter, 2013)

- ✓ **<u>The sheath</u>** (called delivery system) is not connectable with the NavX system and therefore is not visible during the procedure of CS mapping. The movements of the catheter or of the wire could often pull back the sheath causing the exit from the CS. That's why, in the meantime this part must be performed under fluoroscopy.
- ✓ **<u>The mapping catheter</u>** (a standard EP 5F deflectable catheters) which were tested have resulted to be too stiff (and often too large) for the non-fluoroscopic mapping of the CS branches. The VisionWire partially overcomes these limitations however it is not deflectable and it does not provide information on the vessel caliber either.
- ✓ **<u>The connecting cables</u>**: because all the catheters, leads and wires remain connected with the NavX during the whole procedure (to monitor the position), many cables tend to cross the operative field and cause a problem with the manipulation and risk of error of connection or contact.

massimiliano.maines@apss.tn.it

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