Pacemaker Leadless: indicazione di nicchia o futuro ?

Novara 7/8 Giugno 2018

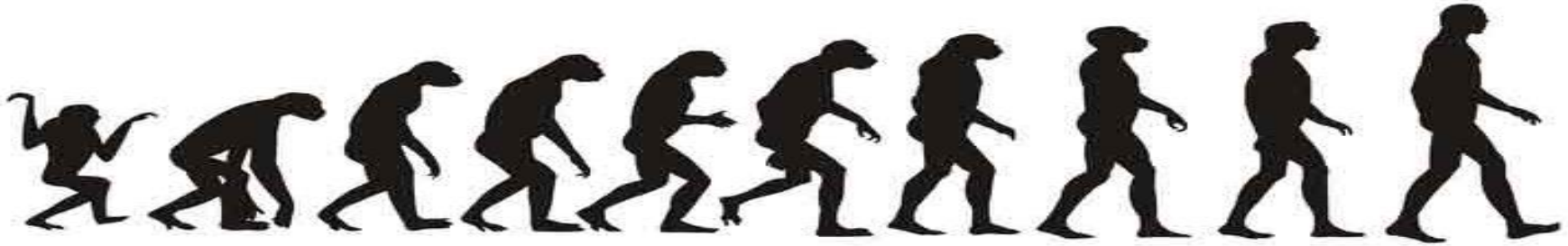
Dr. Paolo Di Donna

Cardiovascular Division

Ep Lab

Cardinal Massaia Hospital – Asti - Italy

Pacemaker's Evolution



Pacemaker's Evolution

1950-51

1st external PM
J. Hobbs
P. Zoll

1954

Demand Circuit
A. Leatham
G. Davies

1957

First Battery Operated PM
E. Bakken
W. Lillehei

1958

1st implanted device with Ni/Cad batteries
E.Elmqvist - A.Senning
A.Larsson

1958

1st wearable Devices
(Medtronic)

1960

Hg/Zn batteries

1962

1st transvenous implant
V.Parsonnet
L.Ekstrom

1970s

Improved lead desing
Tines and active screw
Nuclear generator
Titanium casing
Non-invasive progamming
Dual chamber PMs

1975

Lithium-Iodine batteries

1980s

Steroid-eluting leads
Rate responsive PM
ICD

1990s

Micro-processors-driven algorhithm and PMs
Mode switching

2000s

Biventricular pacing
RV pacing minimization
Telemonitoring

2010s

MRI conditional devices

The 11th World Survey of Cardiac Pacing and Implantable Cardioverter-Defibrillators: Calendar Year 2009–A World Society of Arrhythmia's Project

HARRY G. MOND, O.A.M., M.D.* and
ALESSANDRO PROCLEMER, M.D.†
From the *Department of Epidemiology and Preventive Medicine, Faculty of Medicine, Nursing and Health Sciences, Monash University, Melbourne, Victoria, Australia; and †Director of Cardiology Unit, Cardiothoracic Department, Azienda Ospedaliero-Universitaria, Udine, Italy

Overall, approximately 1 million pacemakers are implanted worldwide, with 26% of the total being replacement devices

Pacing Clin Electrophysiol 2011;34(8):1013–27.

Complications after cardiac implantable electronic device implantations: an analysis of a complete, nationwide cohort in Denmark

Rikke Esberg Kirkfeldt[1,2*], Jens Brock Johansen[2,3], Ellen Aagaard Nohr[4], Ole Dan Jørgensen[2,5], and Jens Cosedis Nielsen[1]

Short-term complications
often related to the procedure include pneumothorax, cardiac tamponade, lead dislodgement, and pocket hematoma.

Long-term complications
include insulation breaches, lead fractures, skin erosions, pocket infections, and septicemia.

Transvenous leads can also cause upper extremity deep vein thrombosis, venous obstruction, tricuspid valve insufficiency, and endocarditis.

The incidence of postoperative adverse events has been estimated as high as 10%

Eur Heart J 2014;35(18): 1186–94.

Risk factors for 1-year mortality among patients with cardiac implantable electronic device infection undergoing transvenous lead extraction: the impact of the infection type and the presence of vegetation on survival

Khaldoun G. Tarakji*, Oussama M. Wazni, Serge Harb, Amy Hsu, Walid Saliba and Bruce L. Wilkoff

Transvenous leads are the most vulnerable components of the system: in addition to insulation defects and fractures, which require reintervention, endocarditis can be a life-threatening complication with mortality rates of 12% to 31%.

Europace 2014;16(10):1490–5.

Clinically Significant Pocket Hematoma Increases Long-Term Risk of Device Infection

BRUISE CONTROL INFECTION Study

Vidal Essebag, MD, PhD,[a,b] Atul Verma, MD,[c] Jeff S. Healey, MD,[d] Andrew D. Krahn, MD,[e] Eli Kalfon, MD,[a,f] Benoit Coutu, MD,[g] Felix Ayala-Paredes, MD,[h] Anthony S. Tang, MD,[i,j] John Sapp, MD,[k] Marcio Sturmer, MD,[b] Arieh Keren, MD,[j] George A. Wells, PhD,[j] David H. Birnie, MD,[j] for the BRUISE CONTROL Investigators

Clinically significant pocket hematoma is an important risk factor of infection, which is associated with a greater than 7-fold increased risk of hospitalization owing to infection within 1 year after device implantation

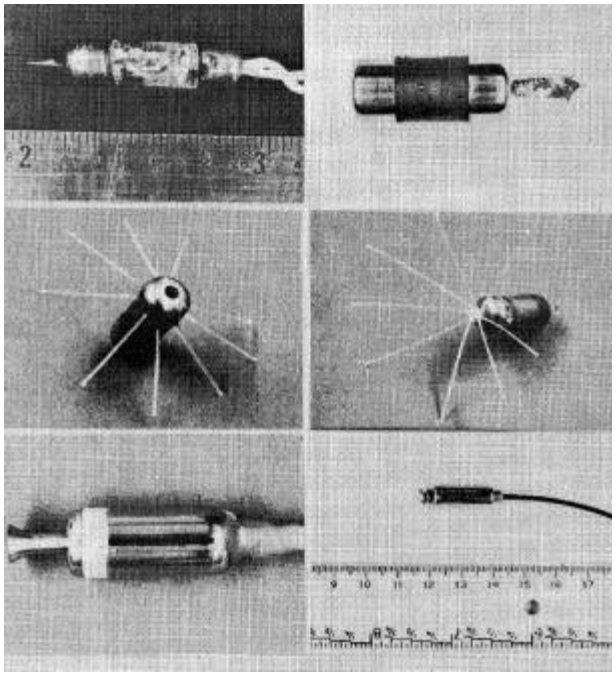
J Am Coll Cardiol 2016;67(11):1300–8.

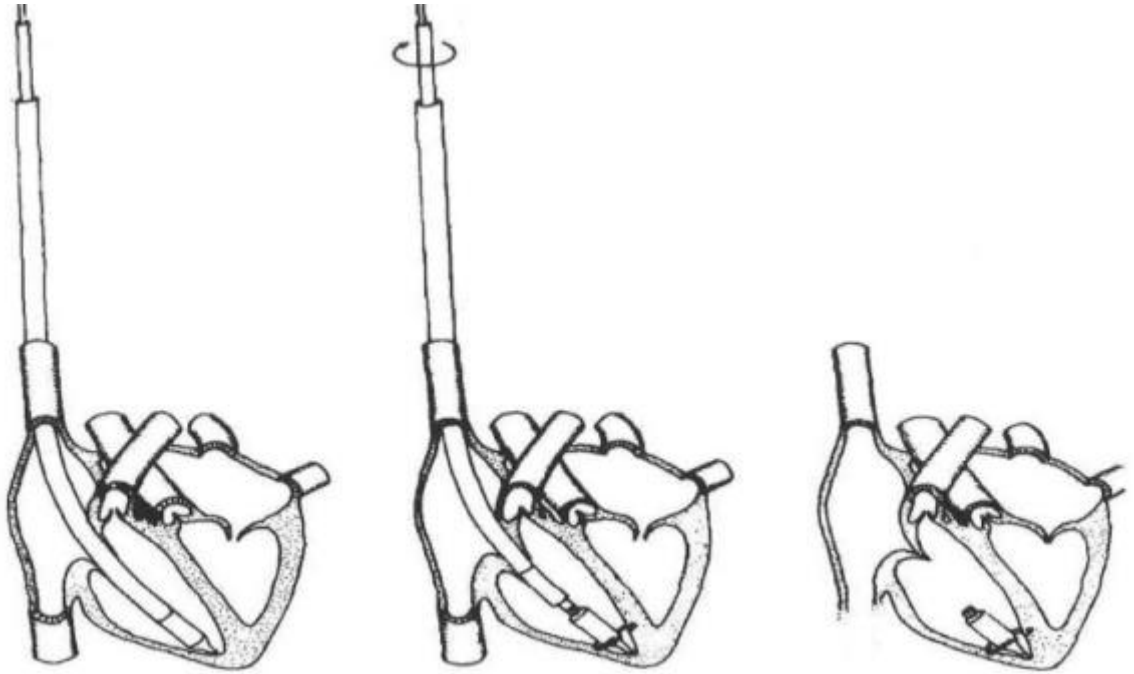
History

Special Article

Totally Self-Contained Intracardiac Pacemaker*

J. WILLIAM SPICKLER, PH.D., NED S. RASOR, PH.D.†, PAUL KEZDI, M.D.
S. N. MISRA, M.D., K. E. ROBINS, P.E., AND CHARLES LeBOEUF, P.E.





NANOSTIM™ – SJM

Awating for FDA Approval

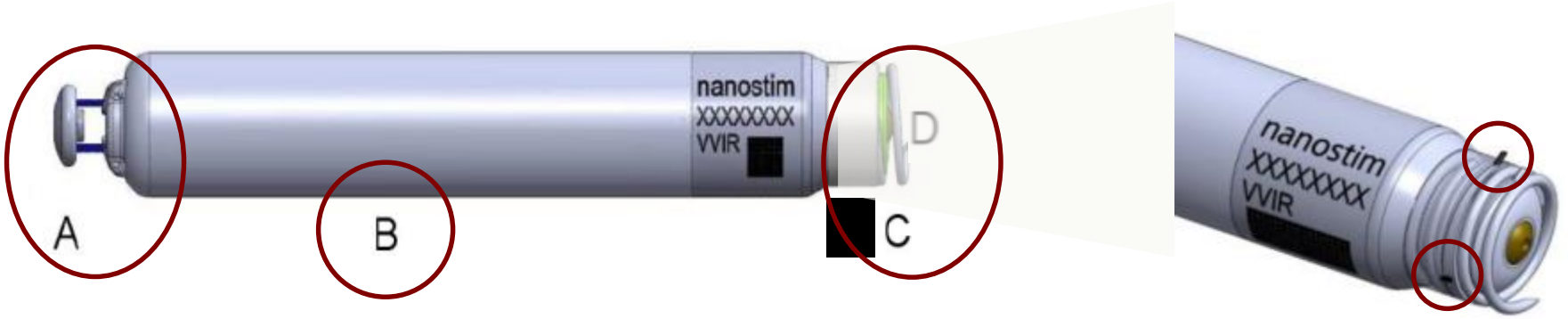
MICRA™ – MEDTRONIC

Approved CE April 2015

Nanostim™ Leadless Pacemaker

- Self-contained intracardiac device
- Length: 42 mm, maximum ∅: 6 mm
- Weight: 2 g, volume: 1 cm^3
- VVI / VVIR Pacemaker
- Temperature based rate-sensor

Nanostim™ Leadless Pacemaker



A. Docking feature for delivery, repositioning, retrieval

B. Chemical lithium battery cell

Longevity → 2.5 V, 500 Ω, 60 bpm, pacing

↗ 100%: 9.8 y

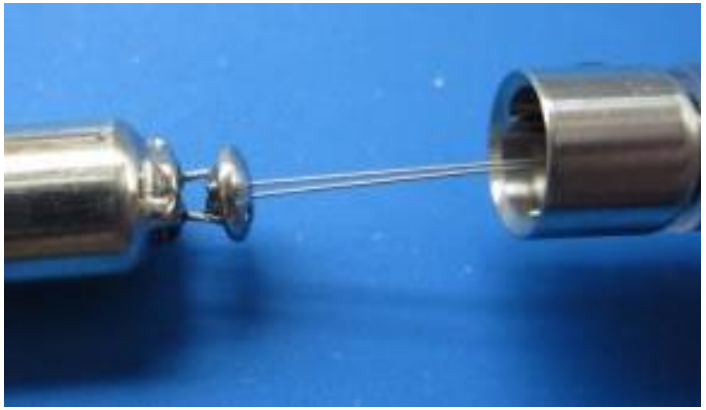
↘ 50%: 14.5 y

C. Helix provides 1^{ary} fixation, tines add 2^{ary} fixation

D. Steroid-eluting electrode tip (dexametahasone)

Nanostim™ Delivery Catheter

- Single-operator design
- 18 French introducer
- Steerable delivery catheter



- Tethered connection to maintain device during measurements

Arrhythmia/Electrophysiology

Permanent Leadless Cardiac Pacing

Results of the LEADLESS Trial

Vivek Y. Reddy, MD; Reinoud E. Knops, MD; Johannes Sperzel, MD; Marc A. Miller, MD; Jan Petru, MD; Jaroslav Simon, MD; Lucie Sediva, MD; Joris R. de Groot, MD, PhD; Fleur V.Y. Tjong, MD; Peter Jacobson, BS; Alan Ostrosff, MS; Srinivas R. Dukkipati, MD; Jacob S. Koruth, MD; Arthur A.M. Wilde, MD, PhD; Josef Kautzner, MD, PhD; Petr Neuzil, MD, PhD

Circulation 2014;129(14):1466–71.

LEADLESS Trial

- Nanostim Safety & Performance evaluation
- Prospective, non-randomized, single-arm
- Conducted at 3 investigational sites

33 Patients, mean age 76.5 y

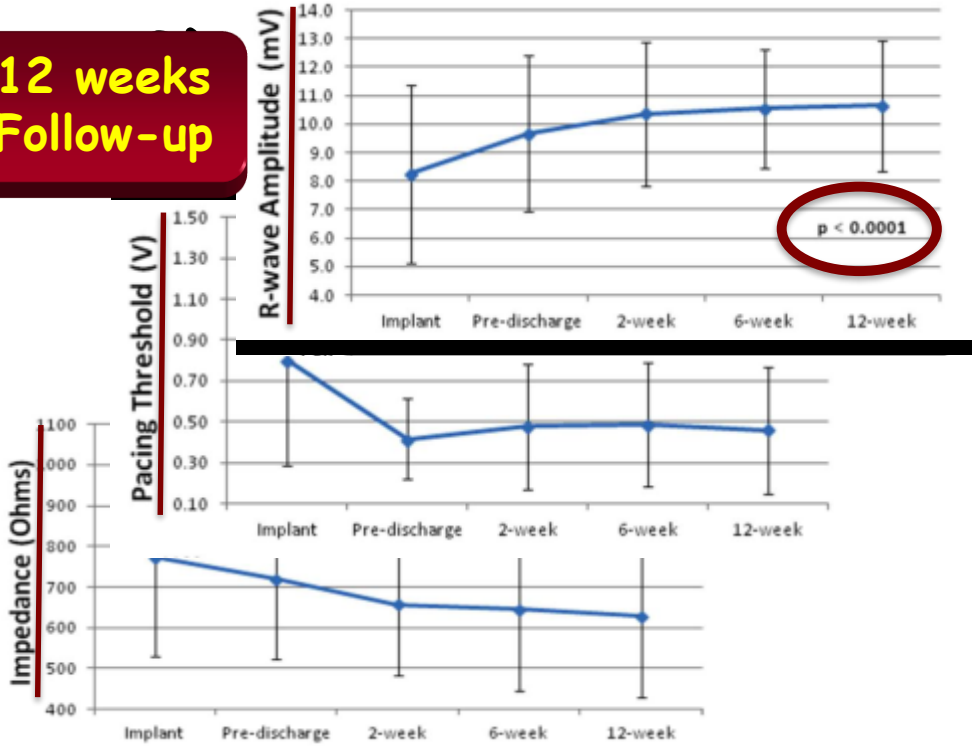
- Permanent AF with AV block 22 (67%)
- SR with 2nd/3rd degree AV block + comorb. 6 (18%)
- Sinus bradycardia with pauses/syncope 5 (15%)

Circulation. 2014;129:1466-1471

LEADLESS Trial – Procedural Outcomes

- Implantation success: 32/33 (97%)
- Procedure time: 28 min (range 11 – 74 min)
- N° catheter repositioning: mean 0.5 (range 0

12 weeks Follow-up



Complications: 2 (6%)

- 1 cardiac perforation
- 1 LV positioning

Circulation. 2014;129:1466-1471

Percutaneous Implantation of an Entirely Intracardiac Leadless Pacemaker

Vivek Y. Reddy, M.D., Derek V. Exner, M.D., M.P.H., Daniel J. Cantillon, M.D., Rahul Doshi, M.D., T. Jared Bunch, M.D., Gery F. Tomassoni, M.D., Paul A. Friedman, M.D., N.A. Mark Estes, III, M.D., John Ip, M.D., Imran Niazi, M.D., Kenneth Plunkitt, M.D., Rajesh Banker, M.D., James Porterfield, M.D., James E. Ip, M.D., and Srinivas R. Dukkipati, M.D., for the LEADLESS II Study Investigators*

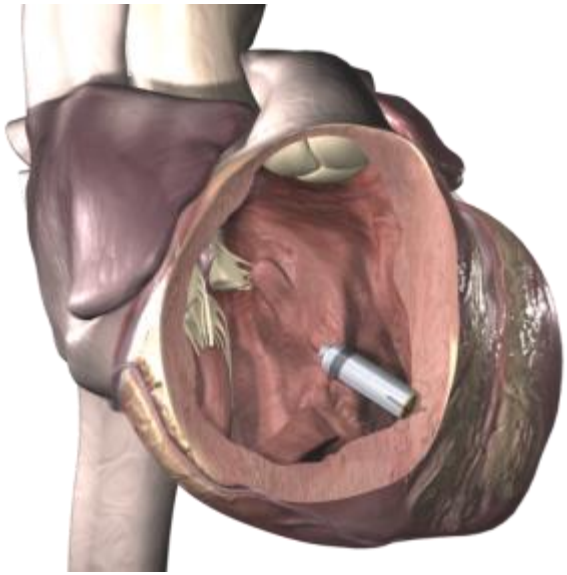
The leadless pacemaker was successfully implanted in 504 of the 526 patients in the total cohort (95.8%).

At 6 months, device-related serious adverse events were observed in 6.7% of the patients; events included device dislodgement with percutaneous retrieval (in 1.7%), cardiac perforation (in 1.3%), and pacing-threshold elevation requiring percutaneous retrieval and device replacement (in 1.3%).

Device-related serious adverse events occurred in approximately 1 in 15 patients.

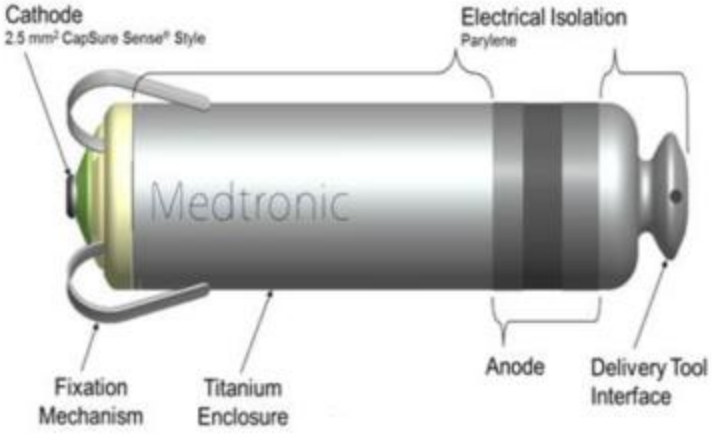
N Engl J Med 2015;373(12):1125–35.

Micra™ Transcatheter Pacing System



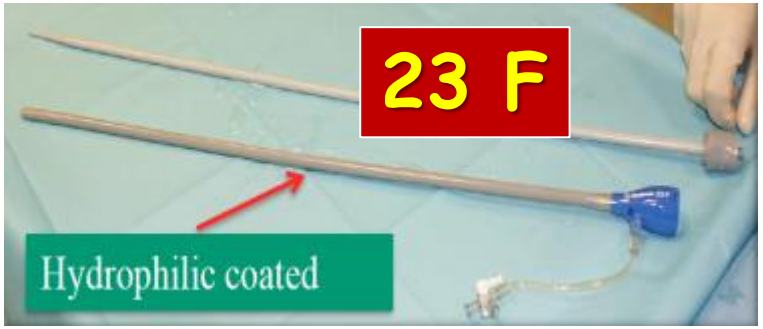
- Self-cointained intracardiac PM
- Length: 25.9 mm, max ∅: 6.7 mm
- Weight: 1.75 g, volume: 0.8 cm^3
- VVIR Pacemaker
- 3-axes accelerometer sensor

- Active fixation via 4 self-expanding nitinol tines
- Interelectrode spacing 17 mm

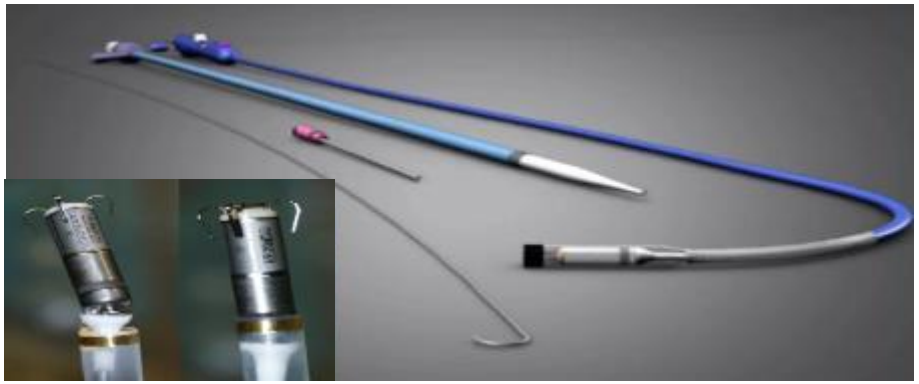


Micra™ Additional Features

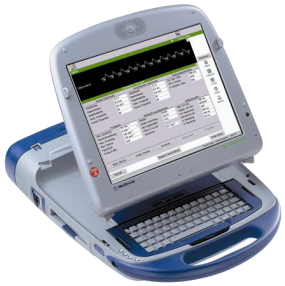
INTRODUCER



DELIVERY SYSTEM



- Communication with 2090 programmer



- Battery longevity estimates:
  - 10.1 years @ 1.5 V, 0.24 ms, 500 Ω, 100% VP

From P. Neuzil ESC 2014 - Barcelona

A Leadless Intracardiac Transcatheter Pacing System

Dwight Reynolds, M.D., Gabor Z. Duray, M.D., Ph.D., Razali Omar, M.D., Kyoko Soejima, M.D., Petr Neuzil, M.D., Shu Zhang, M.D., Calambur Narasimhan, M.D., Clemens Steinwender, M.D., Josep Brugada, M.D., Ph.D., Michael Lloyd, M.D., Paul R. Roberts, M.D., Venkata Sagi, M.D., John Hummel, M.D., Maria Grazia Bongiorni, M.D., Reinoud E. Knops, M.D., Christopher R. Ellis, M.D., Charles C. Gornick, M.D., Matthew A. Bernabei, M.D., Verla Laager, M.A., Kurt Stromberg, M.S., Eric R. Williams, B.S., J. Harrison Hudnall, B.S., and Philippe Ritter, M.D., for the Micra Transcatheter Pacing Study Group*

The device was successfully implanted in 719 of 725 patients (99.2%).

N Engl J Med 2015;374(6):533–41.

A leadless pacemaker in the real-world setting: The Micra Transcatheter Pacing System Post-Approval Registry

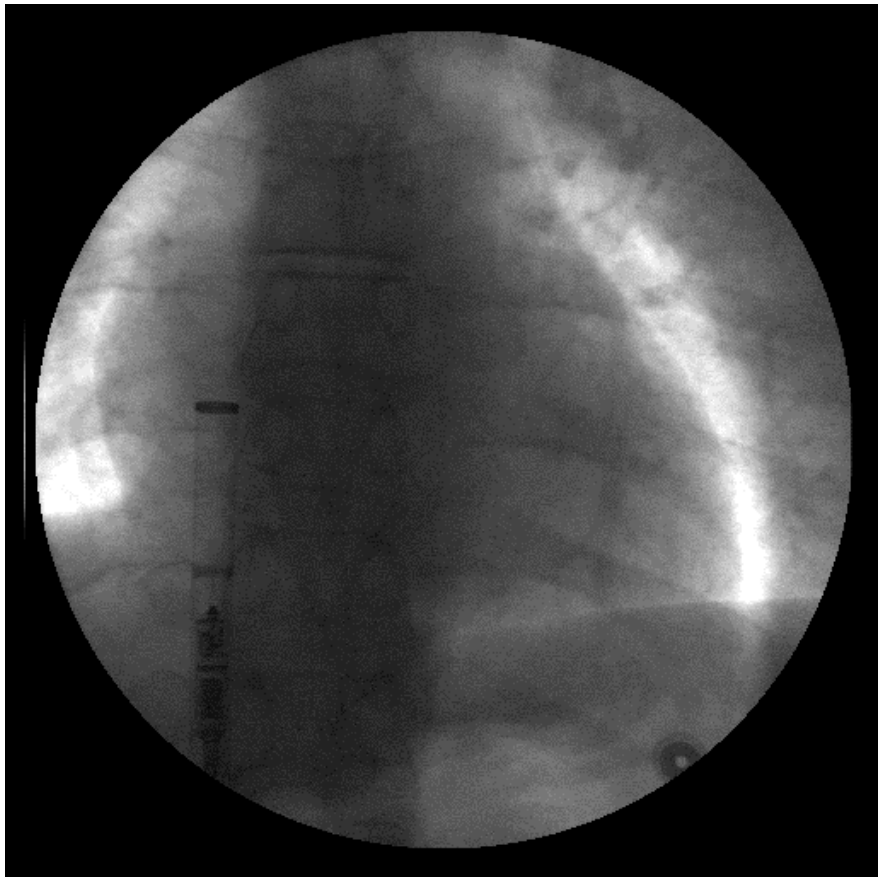
Paul R. Roberts, MD,* Nicolas Clementy, MD,† Faisal Al Samadi, MD,‡ Christophe Garweg, MD,§ Jose Luis Martinez-Sande, MD,‖ Saverio Iacopino, MD,¶ Jens Brock Johansen, MD, PhD,** Xavier Vinolas Prat, MD,†† Robert C. Kowal, MD, PhD, FHRS,‡‡§§ Didier Klug, MD, PhD,‖‖ Lluis Mont, MD, PhD,¶¶ Jan Steffel, MD, FHRS,*** Shelby Li, MD,§§ Dirk Van Osch, MPH,††† Mikhael F. El-Chami, MD, FHRS‡‡‡

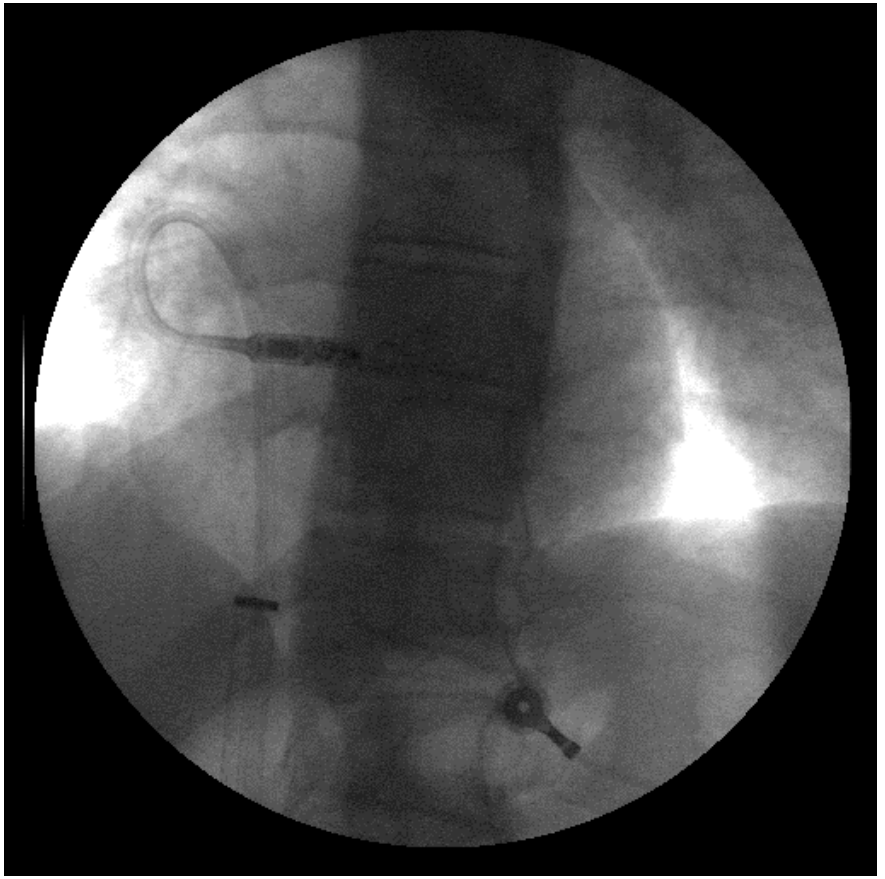
The device was successfully implanted in 792 of 795 registry patients (99.6%)

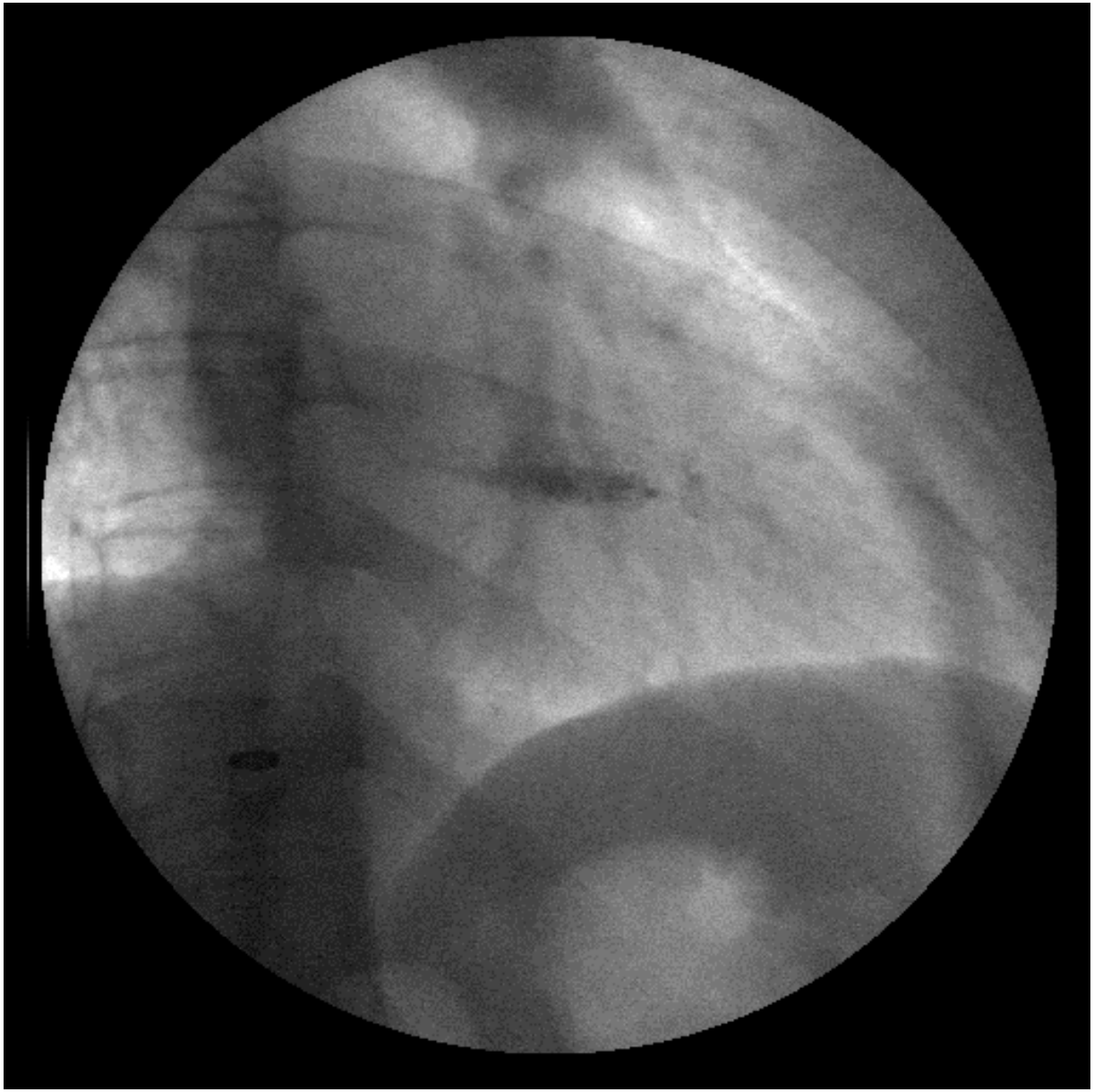
Through 30 days post implant, a total of 13 major complications occurred in 12 patients, for a major complication rate of 1.51%

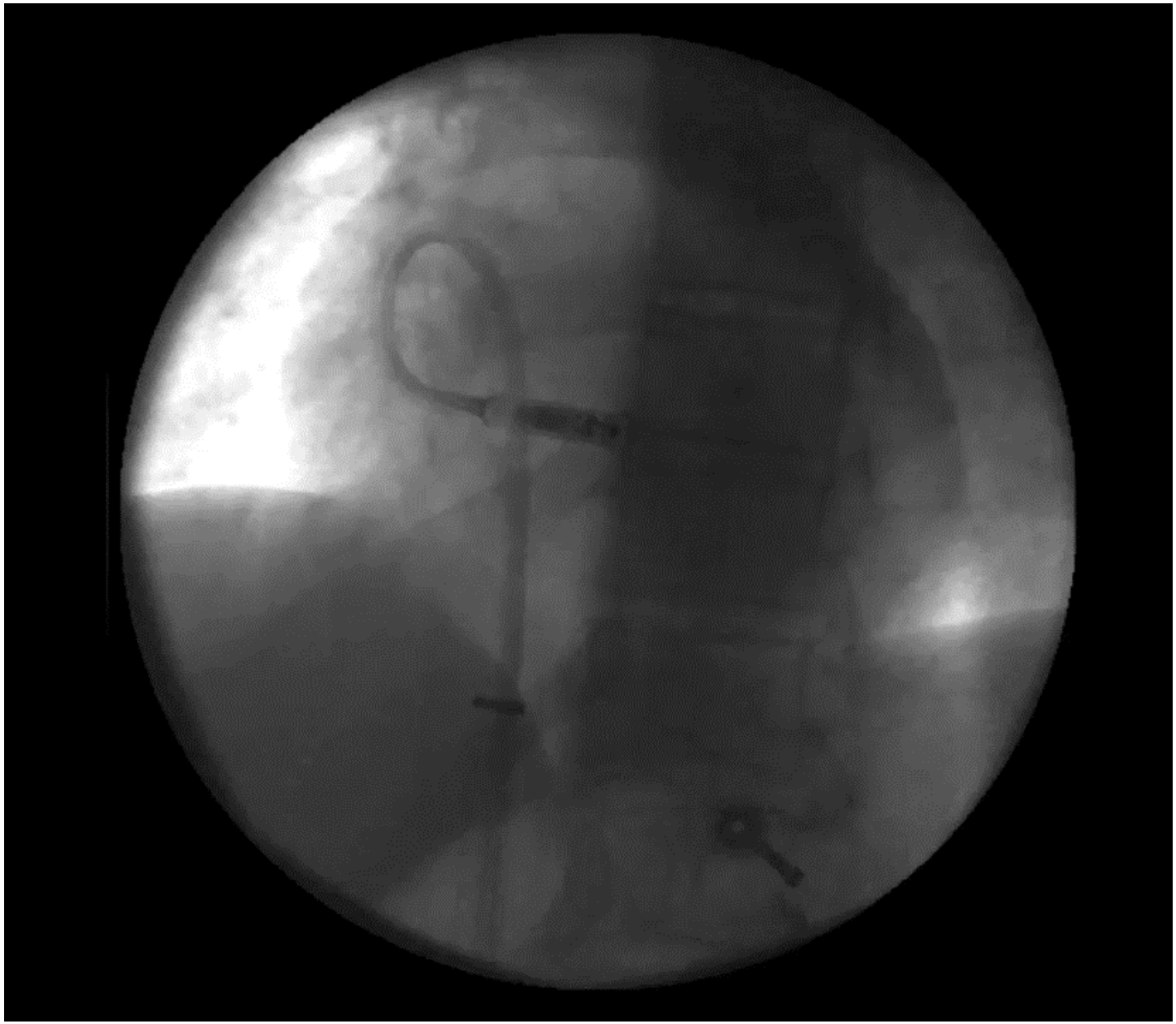
In particular, the rates of pericardial effusion, device dislodgement, and infection were low, reinforcing the positive results seen in the investigational study

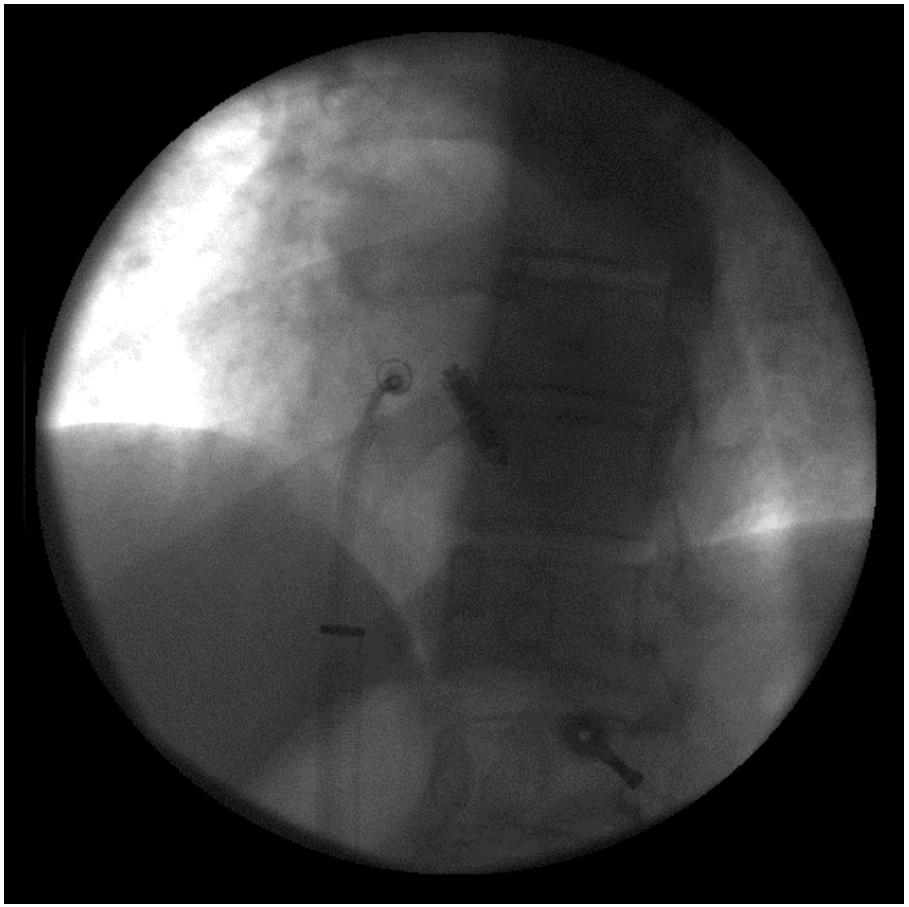
Heart Rhythm 2017;14:1375–1379

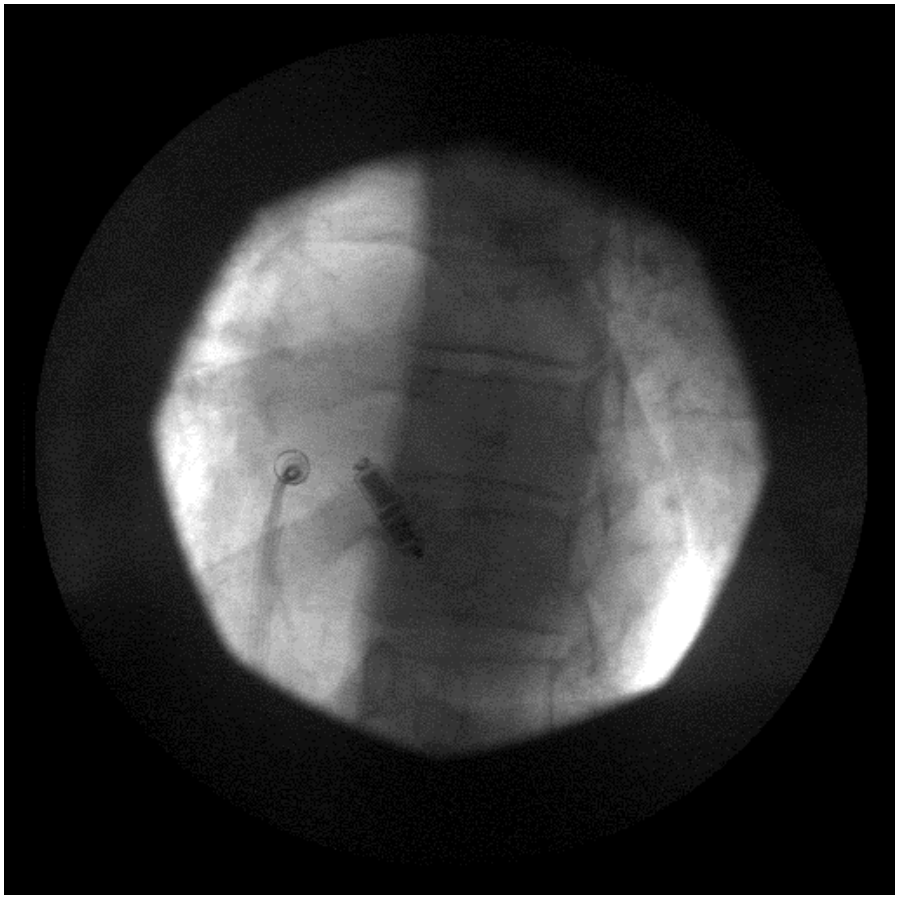


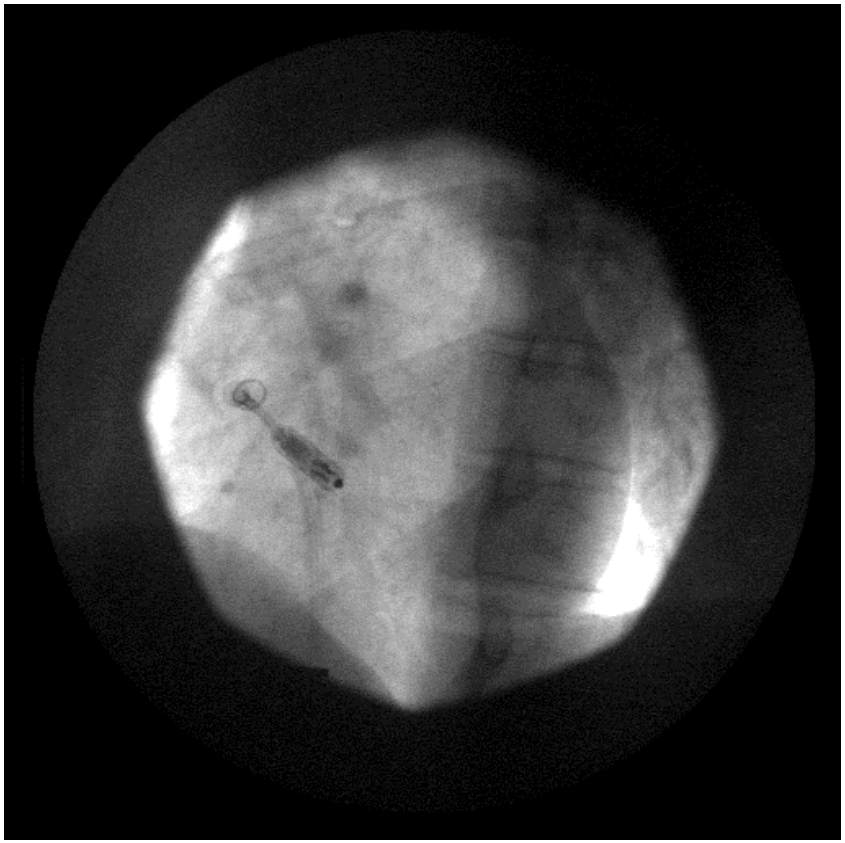


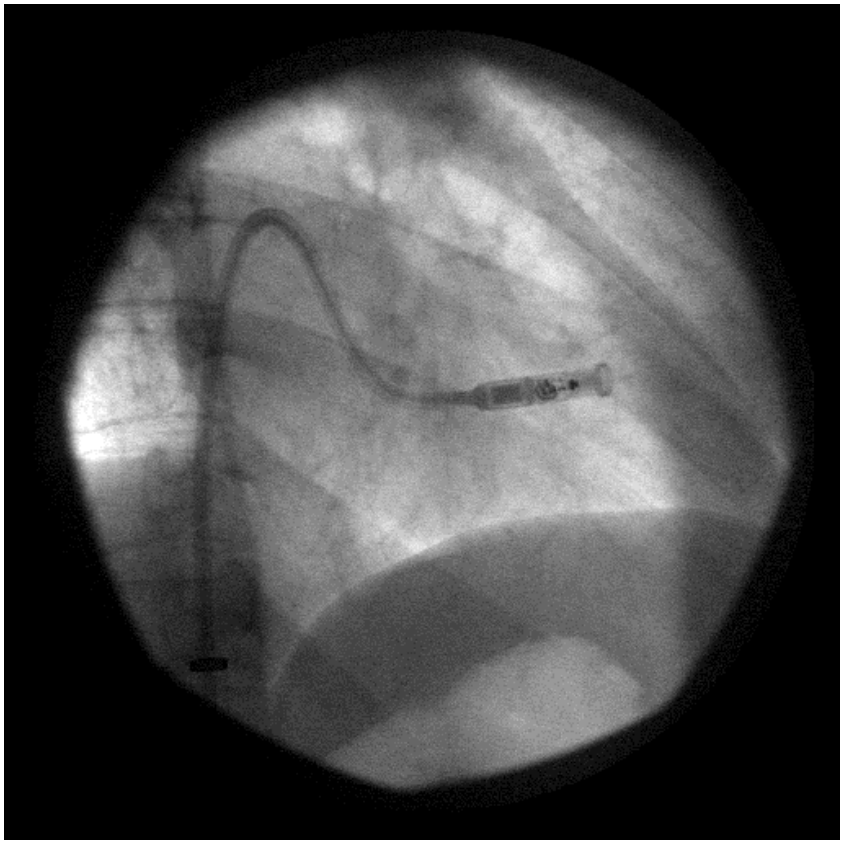


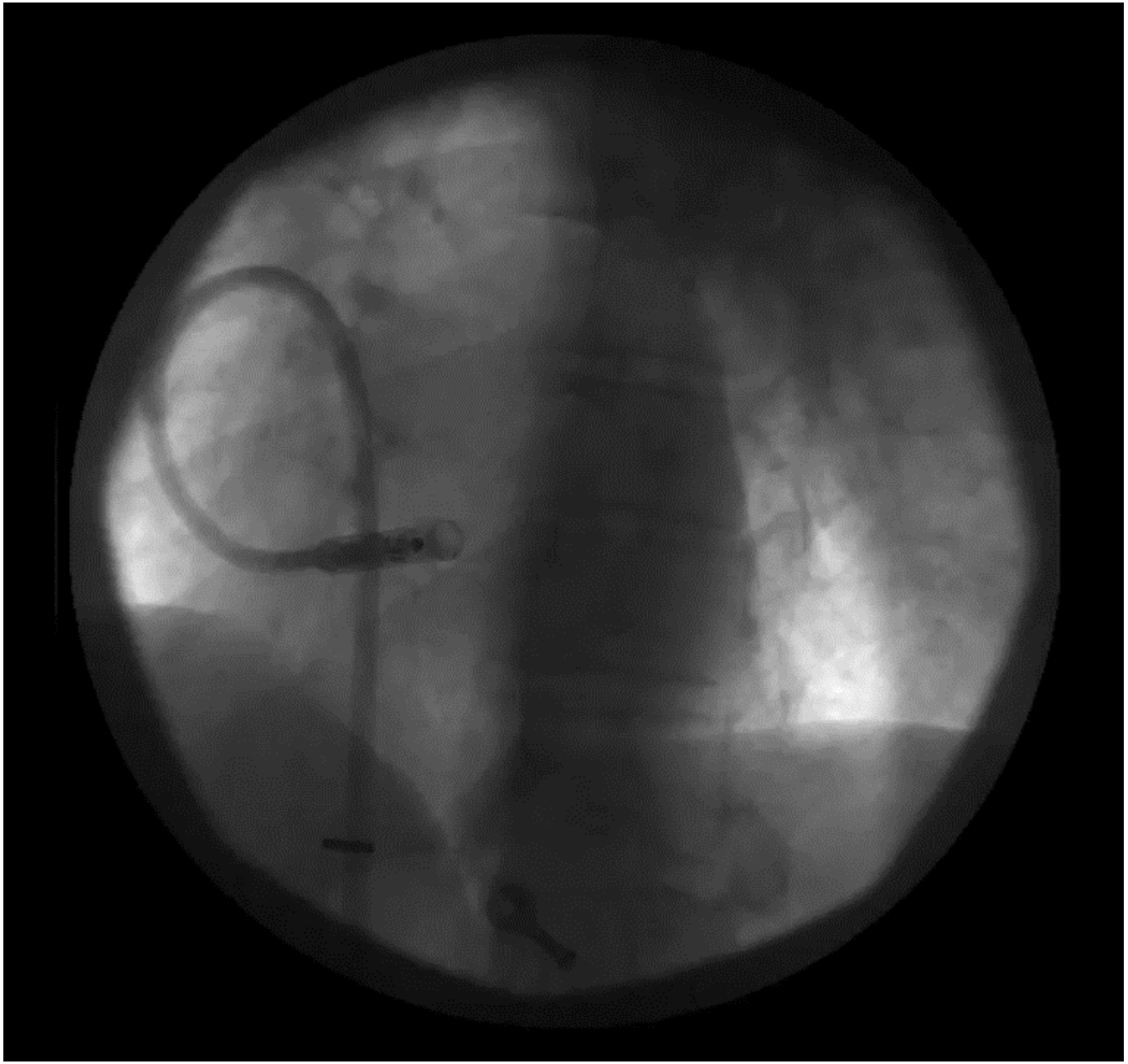


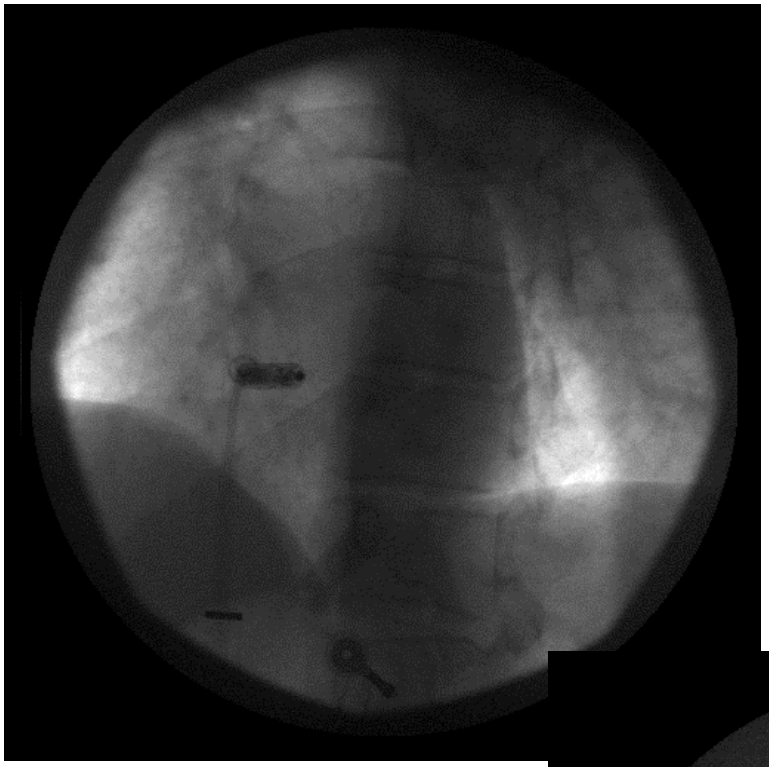


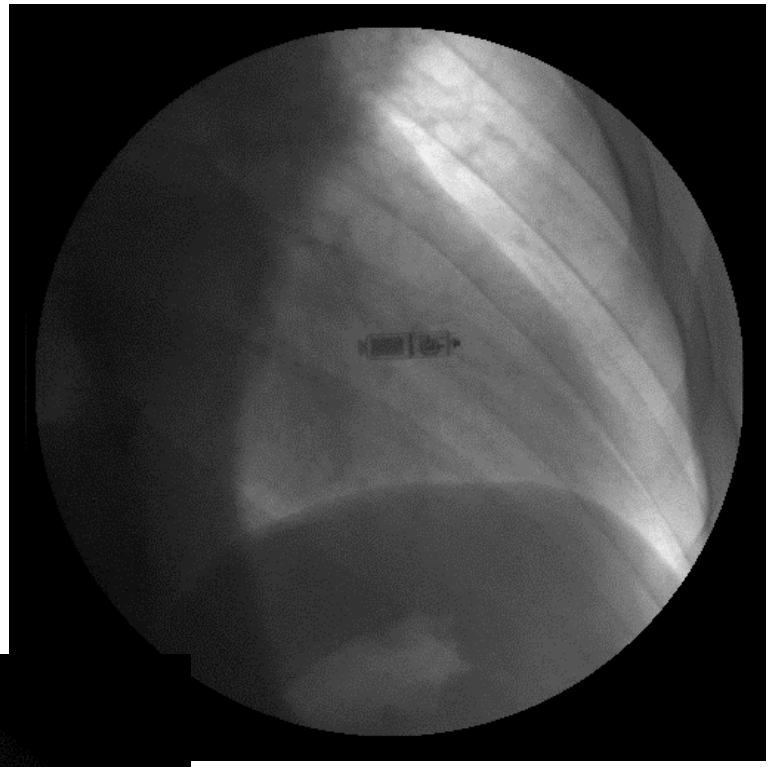


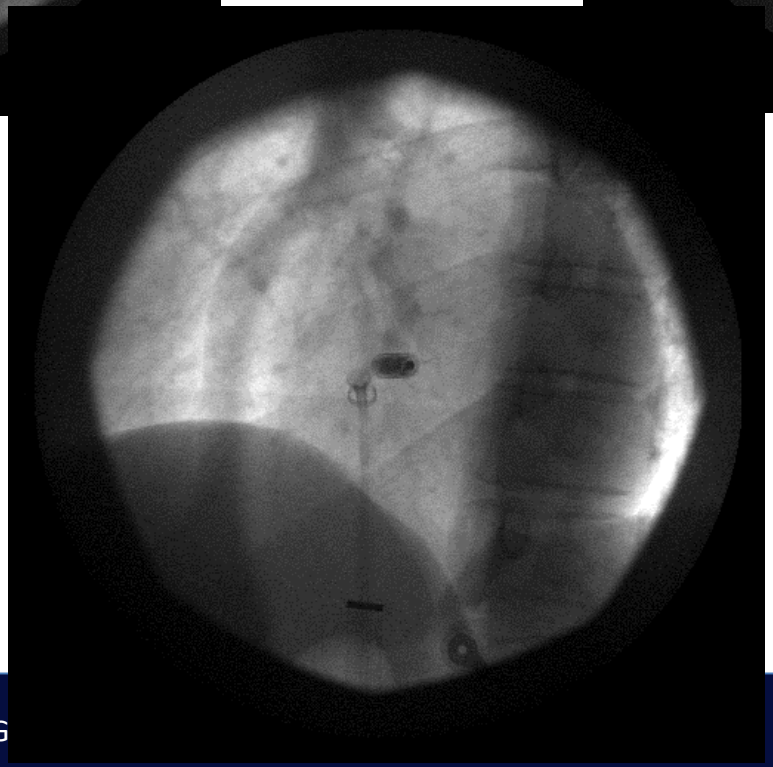


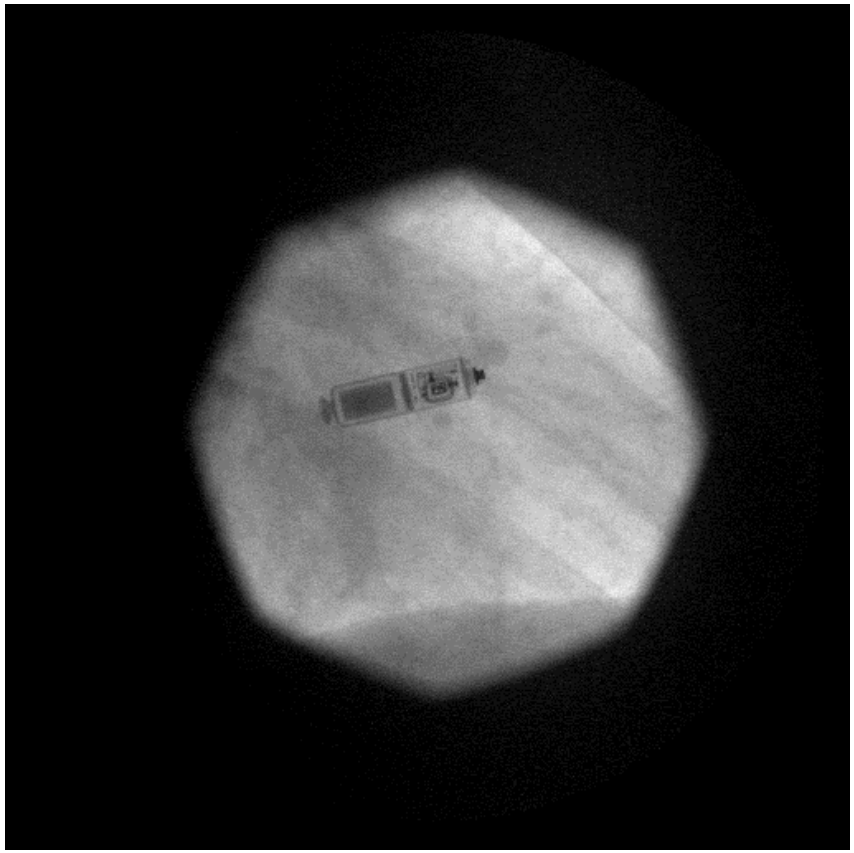


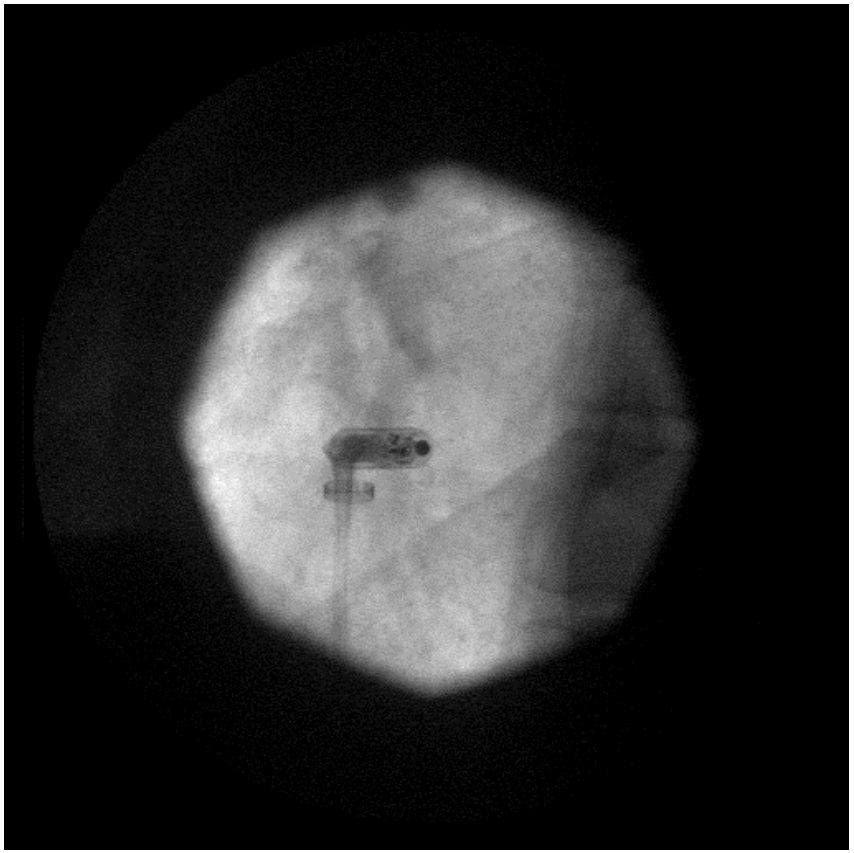












MICRA post approval registry (closed March 2018 mean f-up duration 6.8 ±6.9 m (range0-30m)

1817 implant attempts 300 implanting physicians 179 sites 23 countries

99.1% implant success

Major complication rate 2.7%

14 pericardial effusions (0.44%) 8 requiring drainage, 2 surgical repair

1 dislodgement (0.06%)

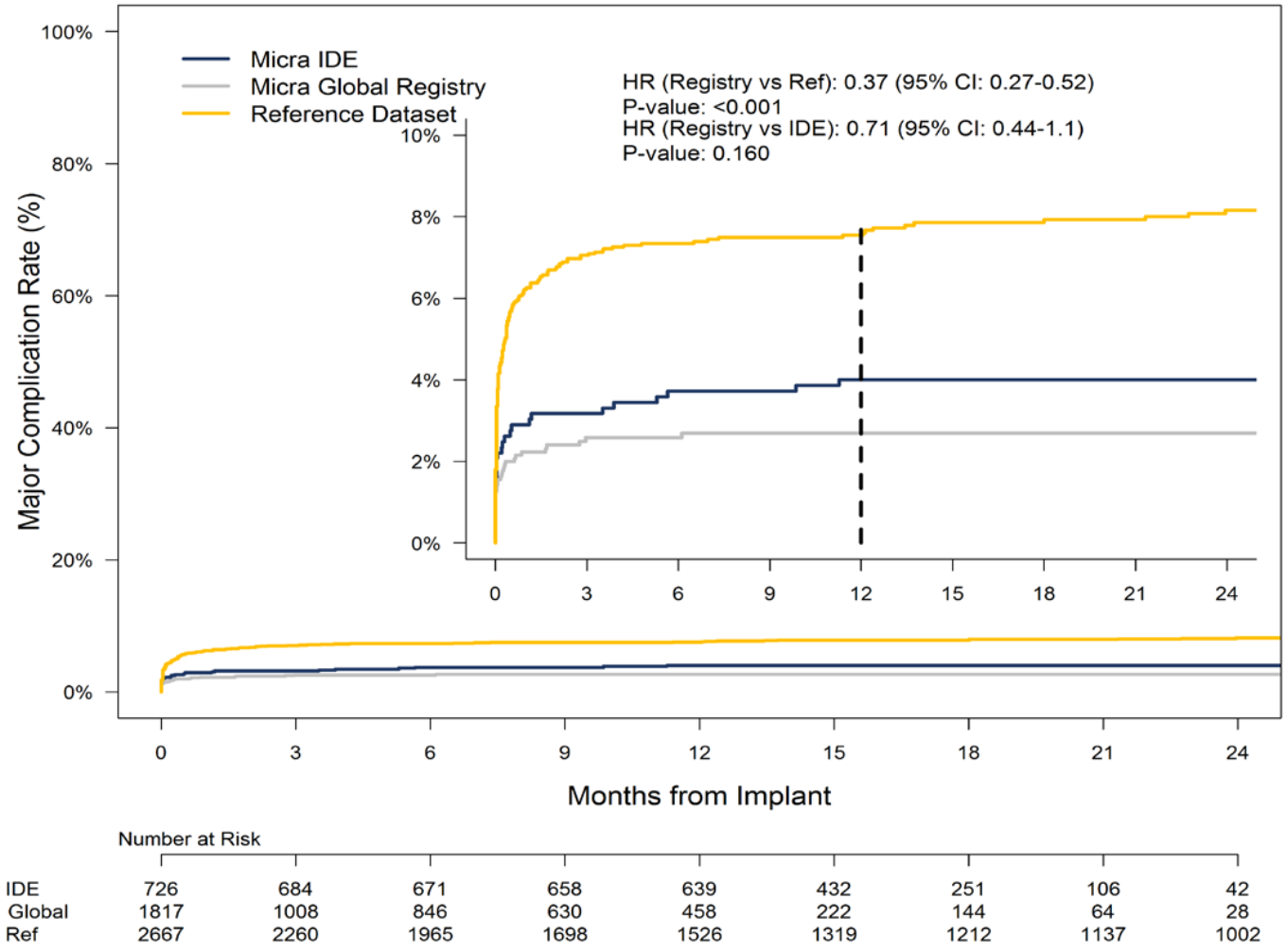
3 procedure-related infections (0.17%) Treated with antibiotics w/o need for Micra removal, none device-related

5 procedure-related deaths (0.28%) **Pulmonary edema; retroperitoneal hemorrhage; septic shock secondary to cardiac tamponade; cardiac failure; cardiac perforation**

No major complications due to battery or telemetry issues

Chami M HRS 2018

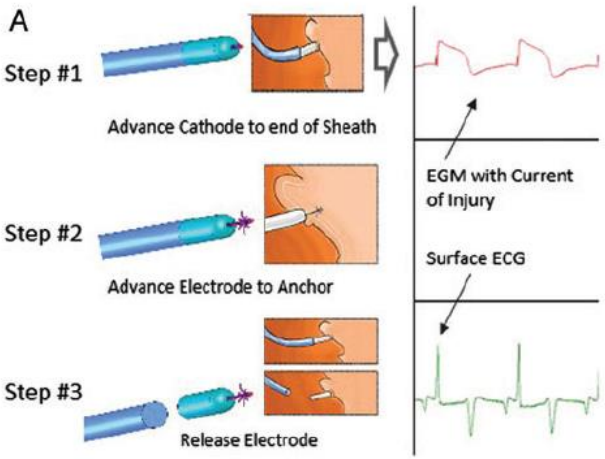
Global Registry Confirms Long-term Safety Profile

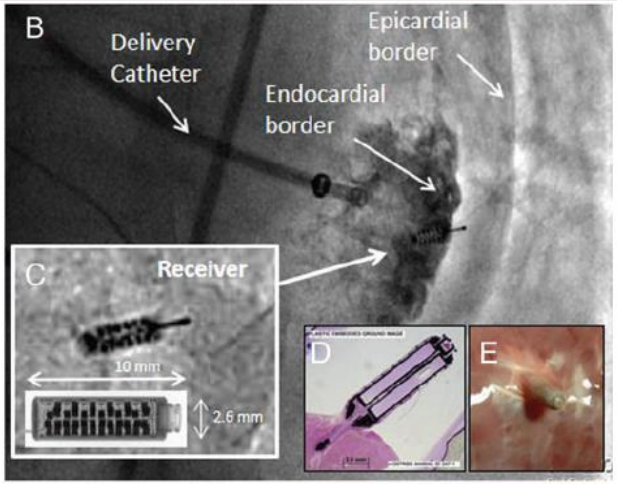


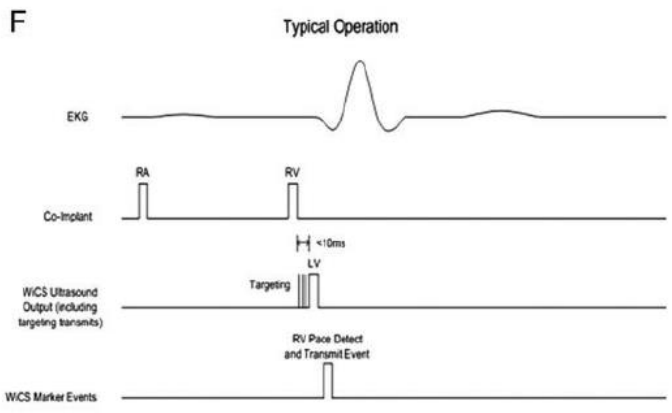
63% reduction in risk for major complications through 12 months relative to transvenous pacemakers

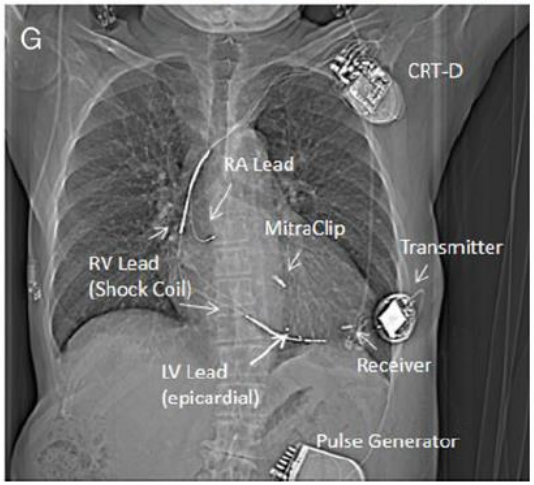
Chami M HRS 2018

Wireless Stimulation Endocardially for CRT (Wise-CRT) study









Where?

30% no reponder pts

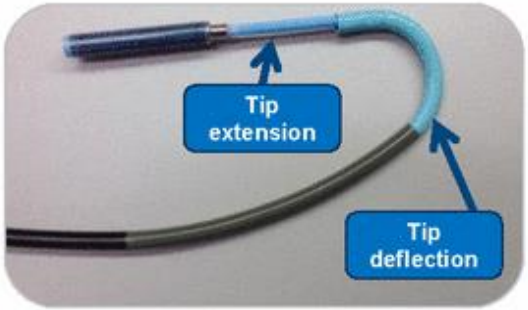
Alternative solution to overcome any limitation related to Cs venous anatomy and lead stability

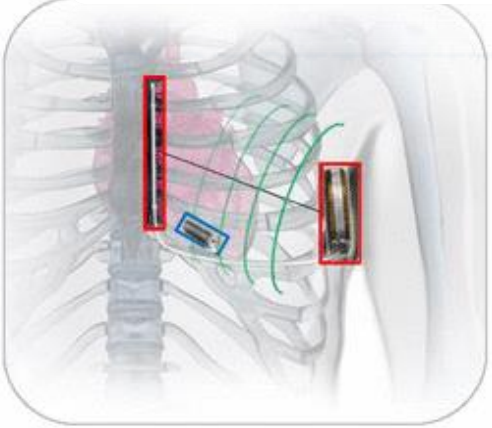
Auricchio A et al Europace 2014

Other Manufacturers

SORIN GROUP

Boston Scientific





Program Goals

- Paired with S-ICD™ (ATP)
- Single chamber
- Dual chamber & CRT applications pending

Key Features

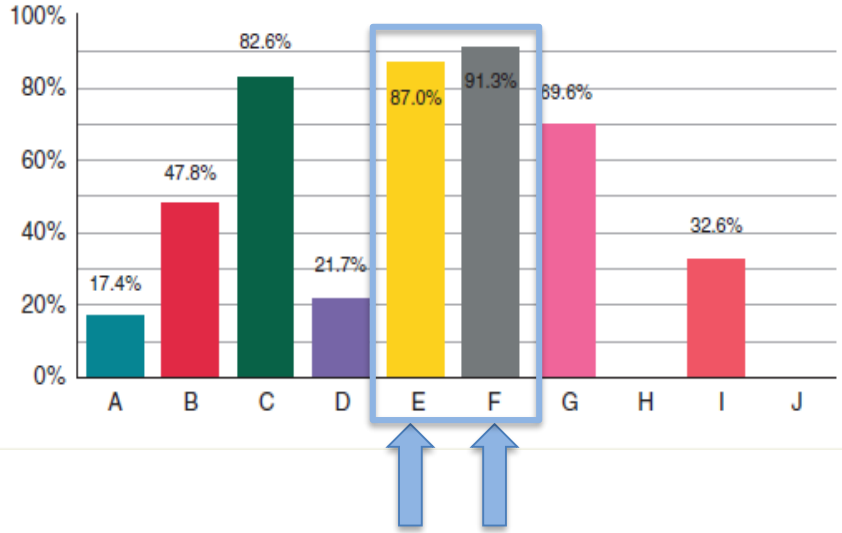
- Fixation / rate response
- Delivery system with atraumatic tip
- Communication (S-ICD)

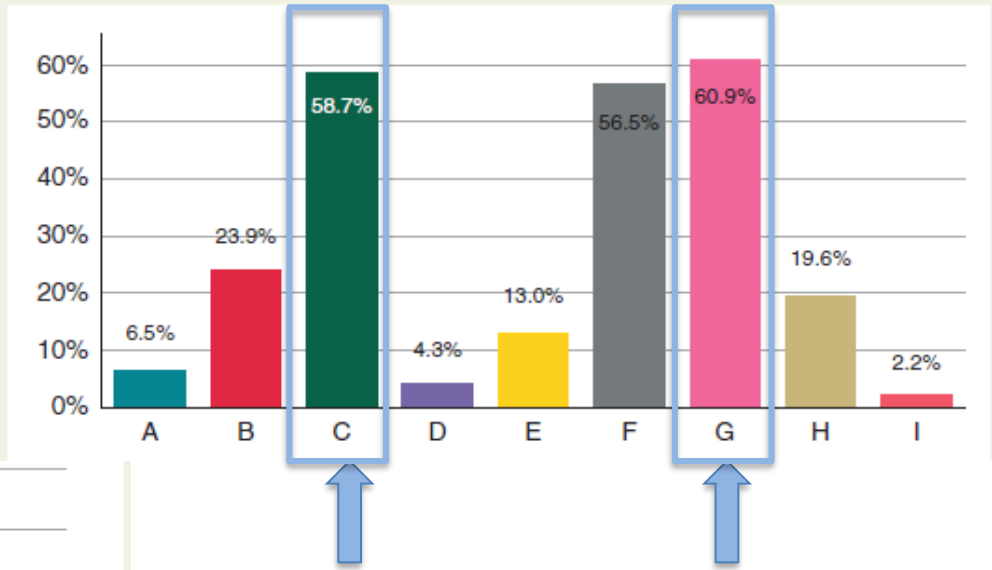
Status

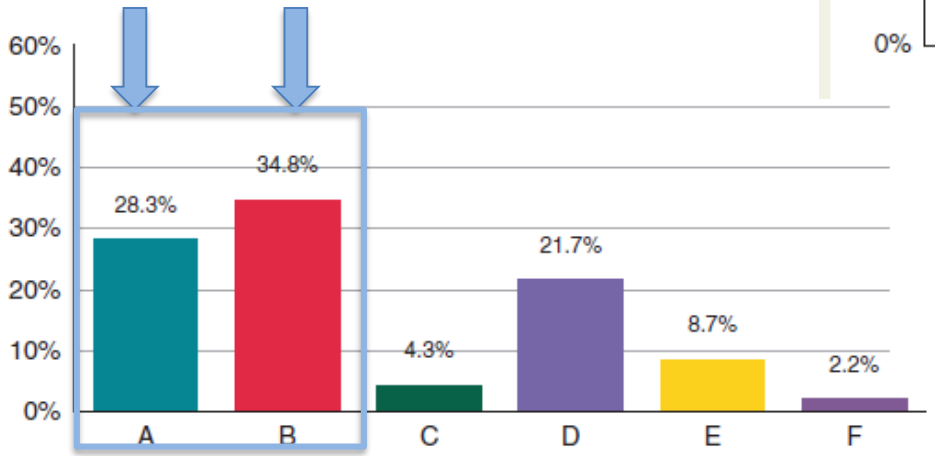
- Development phase
- Clinical planning

S-ICD™ System & VVIR development complete 2016E

Use of leadless pacemakers in Europe: results of the European Heart Rhythm Association survey







Boveda S Europace 2018

Leadless PM - Conclusions

Leadless right ventricular pacing has been proved feasible, with advantages for selected patients in terms of lead failure and infective complications

Most common procedure related adverse events include risk of cardiac perforation and vascular access complications

Leadless PM
Limitations and Open Questions

Leadless pacing is currently limited to single right ventricular pacing (20% PM candidates)
Dual chamber Pacing? CRT?

Very Long-term reliability data are lacking

How patients should be managed at the time of elective battery replacement?