LBBAP: stato dell'arte e prospettive future

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Cardiologia AOU Novara, Italy

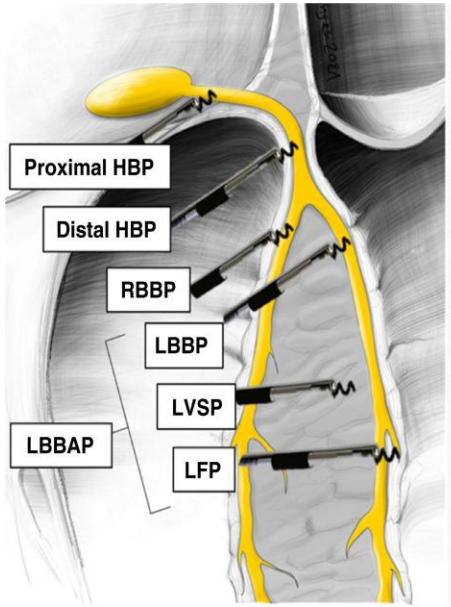
JOURNAL ARTICLE

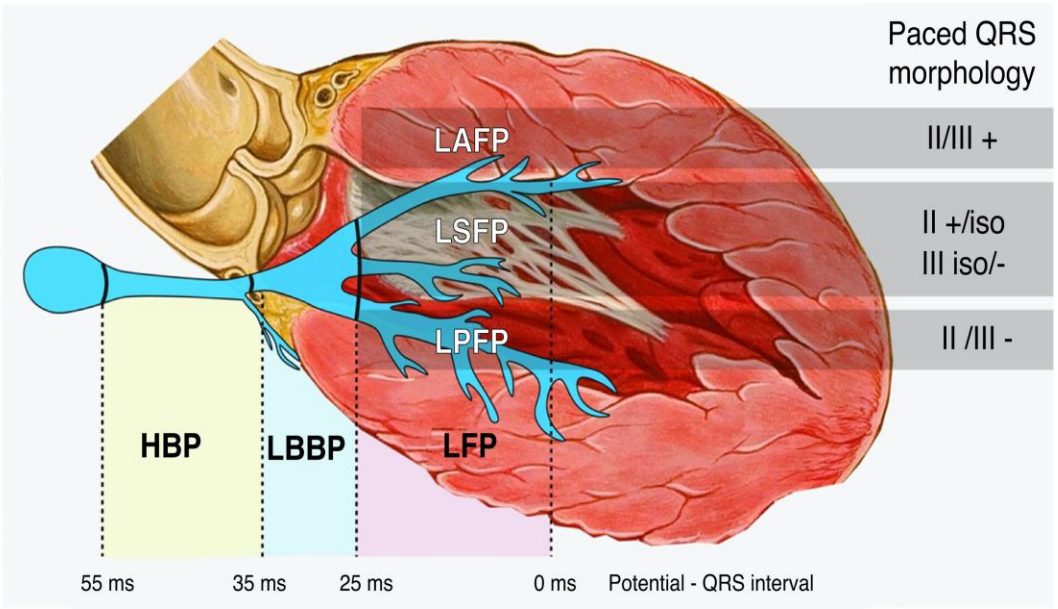
EHRA clinical consensus statement on conduction system pacing implantation: endorsed by the Asia Pacific Heart Rhythm Society (APHRS), Canadian Heart Rhythm Society (CHRS), and Latin American Heart Rhythm Society (LAHRS)

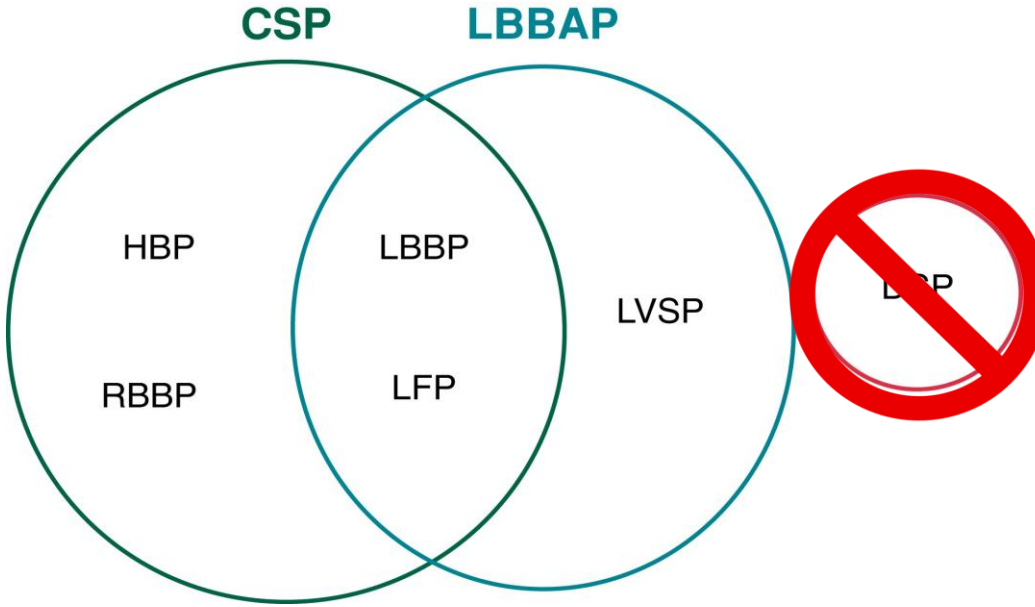
Haran Burri ✉, Marek Jastrzebski, Óscar Cano, Karol Čurila, Jan de Pooter, Weijian Huang, Carsten Israel, Jacqueline Joza, Jorge Romero, Kevin Vernooy, Pugazhendhi Vijayaraman, Zachary Whinnett, Francesco Zanon

EP Europace, Volume 25, Issue 4, April 2023, Pages 1208–1236, https://doi.org/10.1093/europace/euad043

Published: 15 April 2023 **Article history** ▾







ESC European Society of Cardiology
Europace (2025) **27**, euaf050
https://doi.org/10.1093/europace/euaf050
EHRA DOCUMENT
EHRA European Heart Rhythm Association

European Society of Cardiology (ESC) clinical consensus statement on indications for conduction system pacing, with special contribution of the European Heart Rhythm Association of the ESC and endorsed by the Asia Pacific Heart Rhythm Society, the Canadian Heart Rhythm Society, the Heart Rhythm Society, and the Latin American Heart Rhythm Society

Le varie forme di pacing determinano differenti gradi di **sincronia ventricolare**. La «perfezione» è HBP quando tutto il sistema di eccitoconduzione è intatto; un buon surrogato è **LBBAP** (selettivo o non selettivo), **più semplice, versatile e meccanicamente efficace di BiVP**

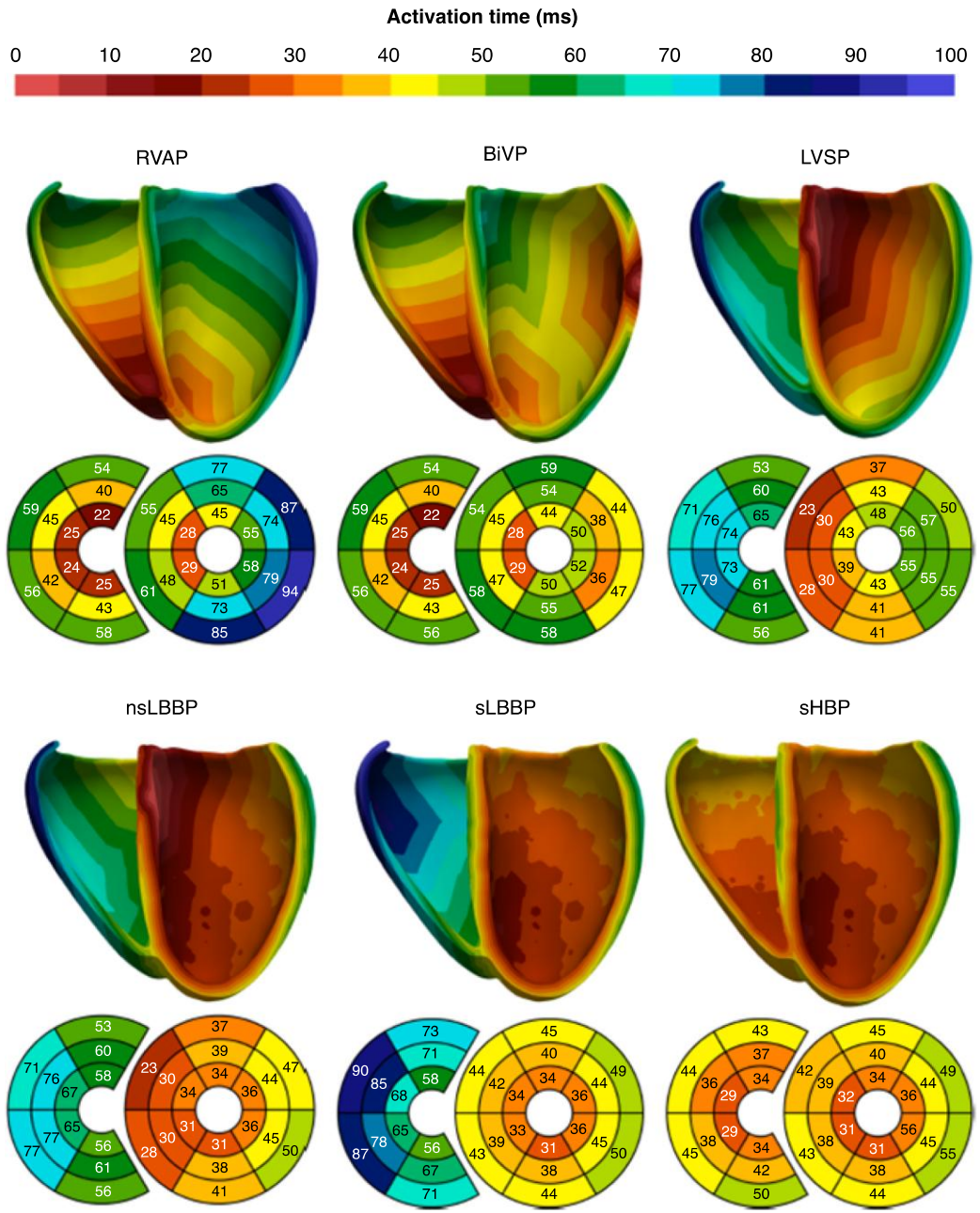


Figure 2 Computer-simulated three-dimensional activation maps following different pacing strategy and their corresponding segmental activation time in bullseye form. Reproduced with permission from Meiburg *et al.*[38]

Nei blocchi rari:

- Numerosi studi che dimostrano la possibilità degli algoritmi di minimizzare il pacing ventricolare non necessario:

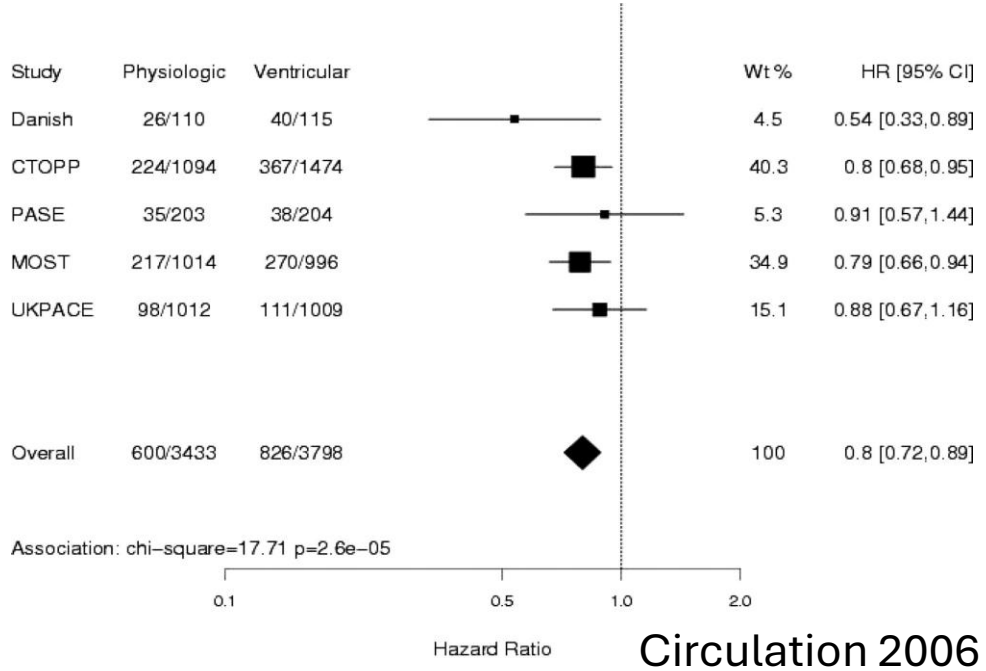
1. Riduzione degli episodi di FA
2. Riduzione della PICM
3. Riduzione del consumo di batteria

Europace (2016) 18, 739–746
doi:10.1093/europace/euv358

CLINICAL RESEARCH
Pacing and resynchronization therapy

Safety and efficiency of ventricular pacing prevention with an AAI-DDD changeover mode in patients with sinus node disease or atrioventricular block: impact on battery longevity—a sub-study of the ANSWER trial

Martin Stockburger[1,2]*, Pascal Defaye[3], Serge Boveda[4], Branislav Stancak[5], Arnaud Lazarus[6], Johann Sipötz[7], Stefano Nardi[8], Mara Rolando[9], and Javier Moreno[10,11]



Circulation 2006

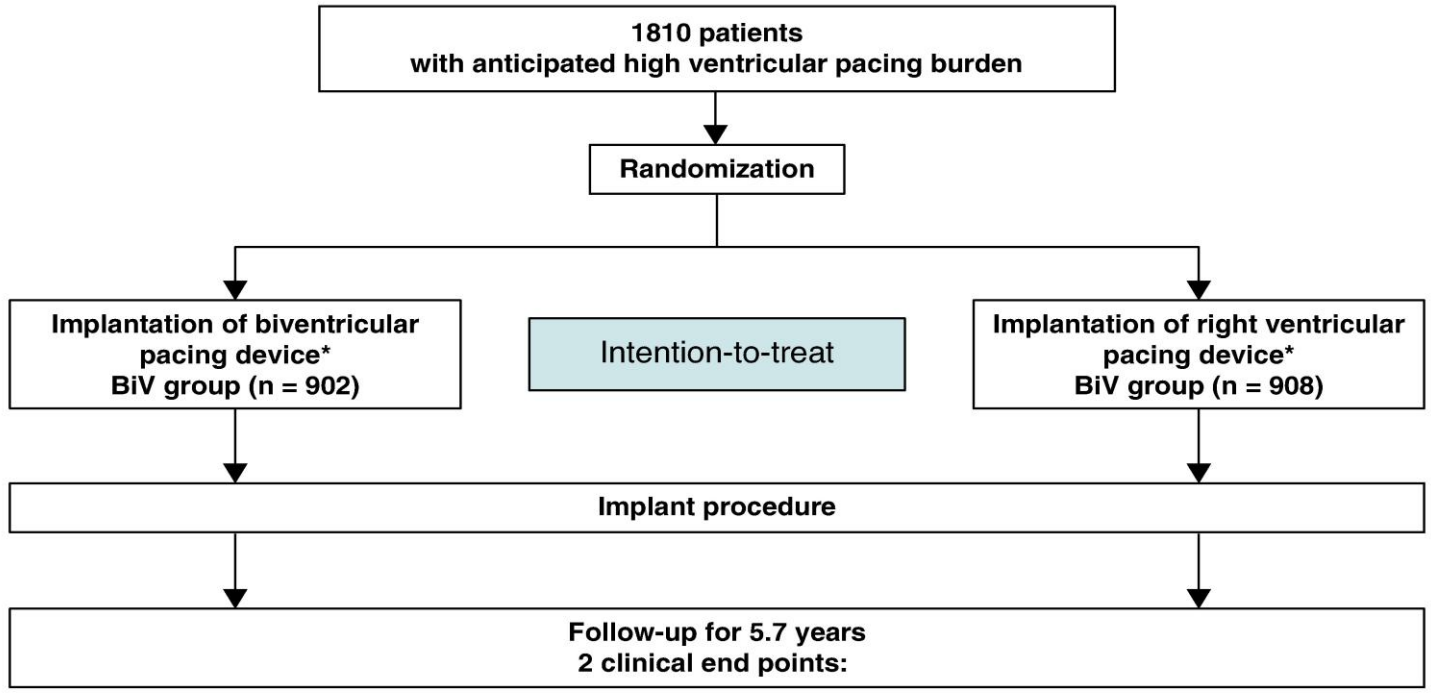
Europace 2025

Biventricular versus right ventricular pacing devices in patients anticipated to require frequent ventricular pacing (BioPace)

E qua

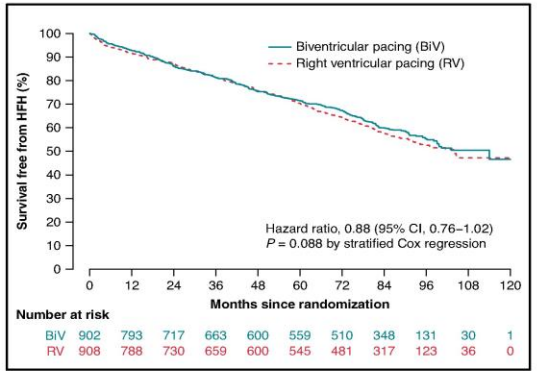
BLOCK-HF

STUDY DESIGN

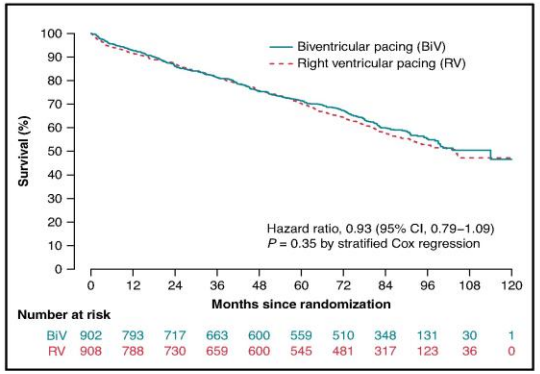


RESULTS

A Time to death or first heart failure hospitalization



B Survival time



Conclusion: Superiority of biventricular pacing device implantation over right ventricular pacing device implantation could not be proven.

* pacemaker or primary preventive implantable cardioverter defibrillator (depending on guideline recommendation)

The NEW ENGLAND JOURNAL of MEDICI

ORIGINAL ARTICLE

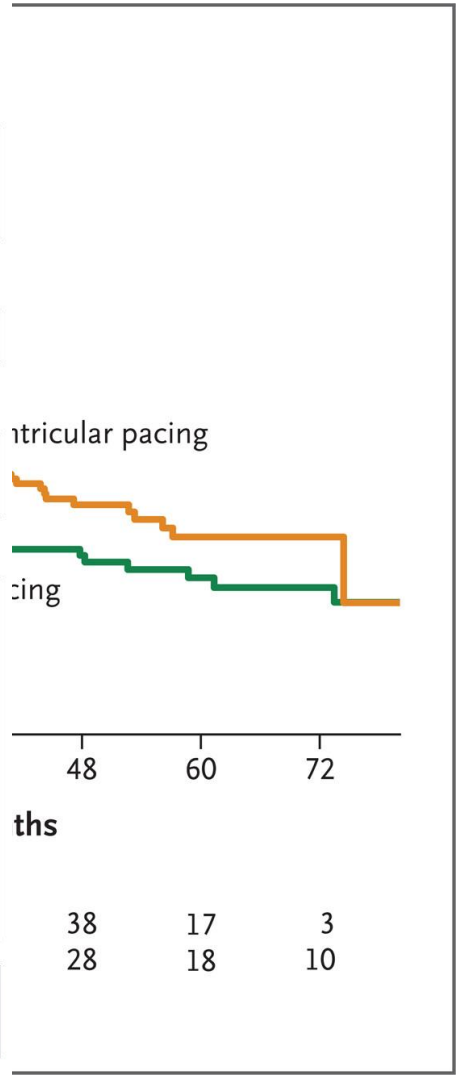
Biventricular Pacing f Systolic Dysfunction

Authors: Anne B. Curtis, M.D., Seth J. Worley, M.I Lou Sherfesee, Ph.D., Timothy Shinn, M.D., and M

Ventricular Pacing in Heart Failure Patients with A

Affiliations

Published April 25, 2013 | **N Engl J Med 2013;3**



Blocchi atrioventricolari: quale pacing?

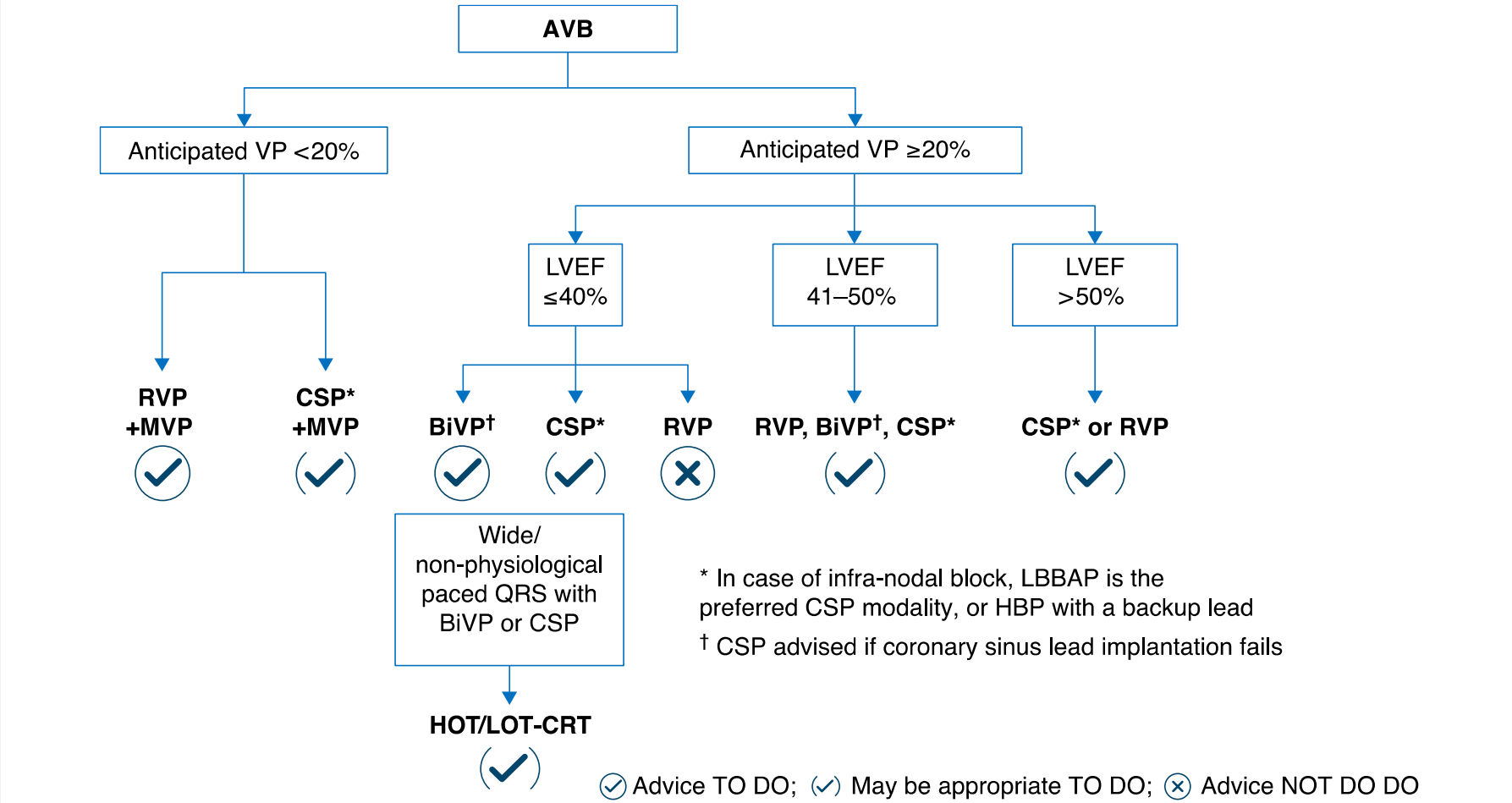
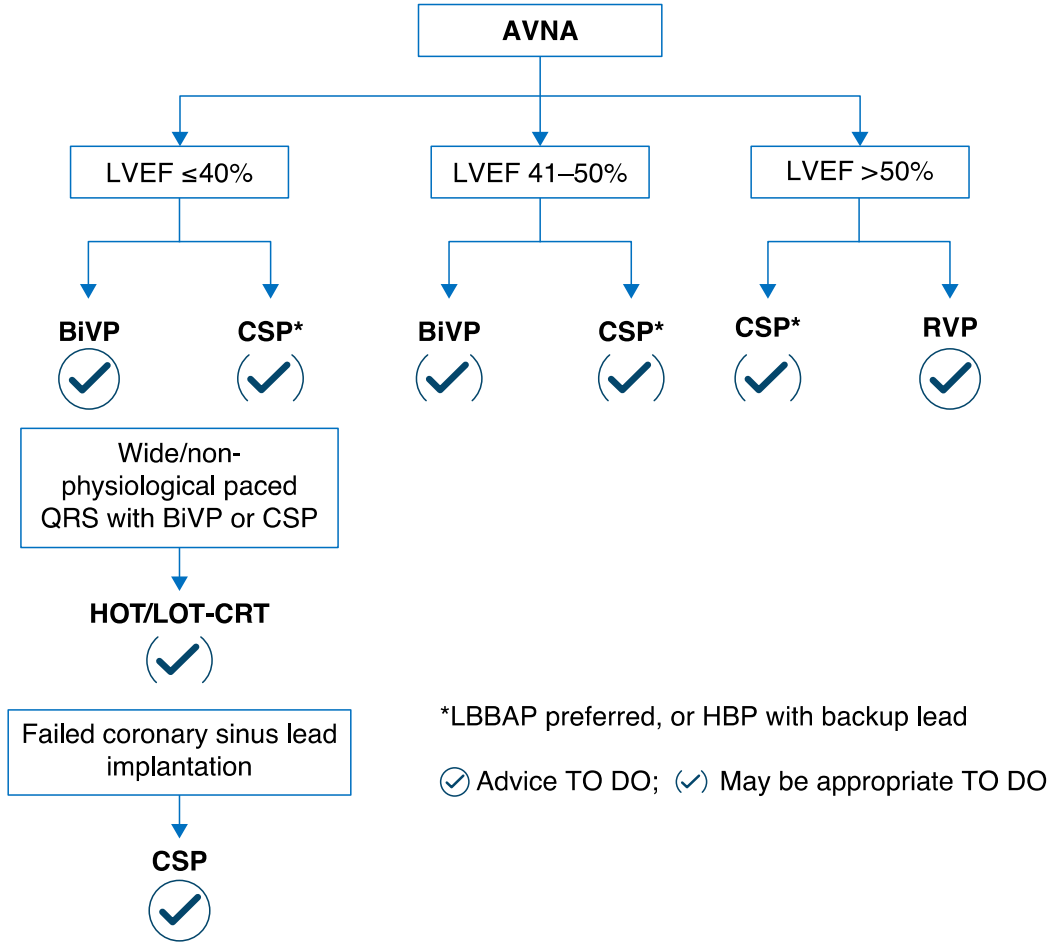


Figure 5 Summary of CSP indications in AVB. AVB, atrioventricular block; BiVP, biventricular pacing; CSP, conduction system pacing; HBP, His bundle pacing; HOT/LOT-CRT, His-optimized or left bundle-optimized cardiac resynchronization therapy; LBBAP, left bundle branch area pacing; LVEF, left ventricular ejection fraction; MVP, minimized ventricular pacing; RVP, right ventricular pacing.

Ablate and pace



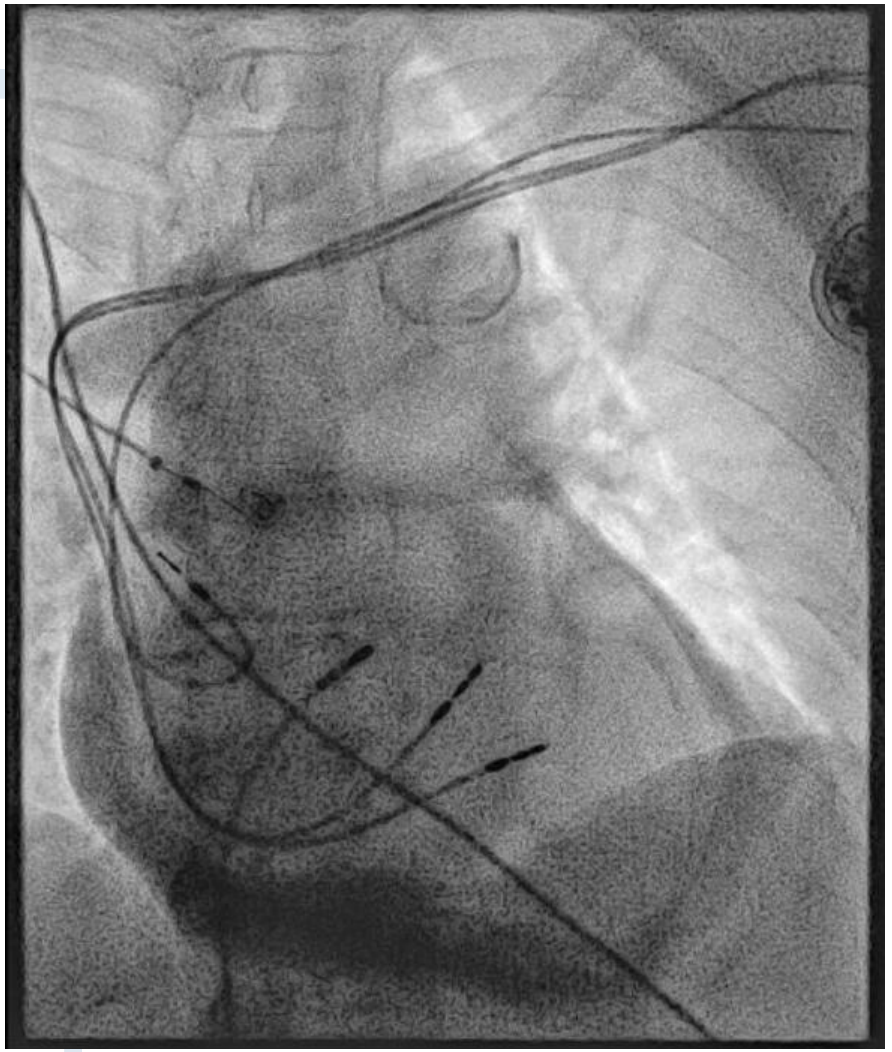


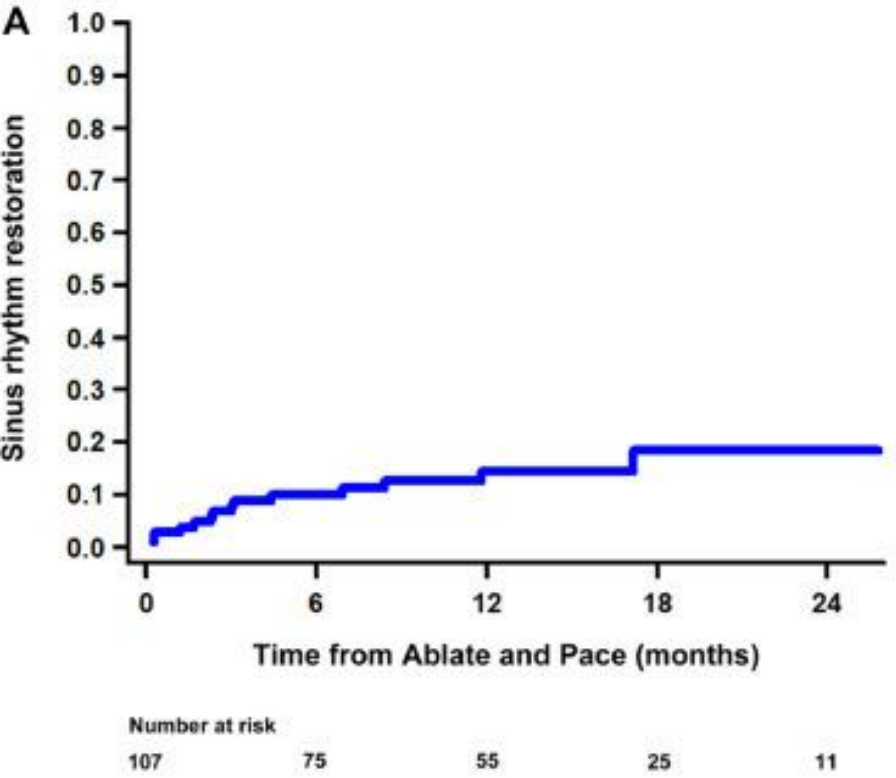
Figure 7 Indications for CSP in patients scheduled for AVNA. AVNA, atrioventricular nodal ablation; BiVP, biventricular pacing; CSP, conduction system pacing; HBP, His bundle pacing; HOT/LOT-CRT, His-optimized or left bundle-optimized cardiac resynchronization therapy; LBBAP, left bundle branch area pacing; LVEF, left ventricular ejection fraction; RVP, right ventricular pacing.

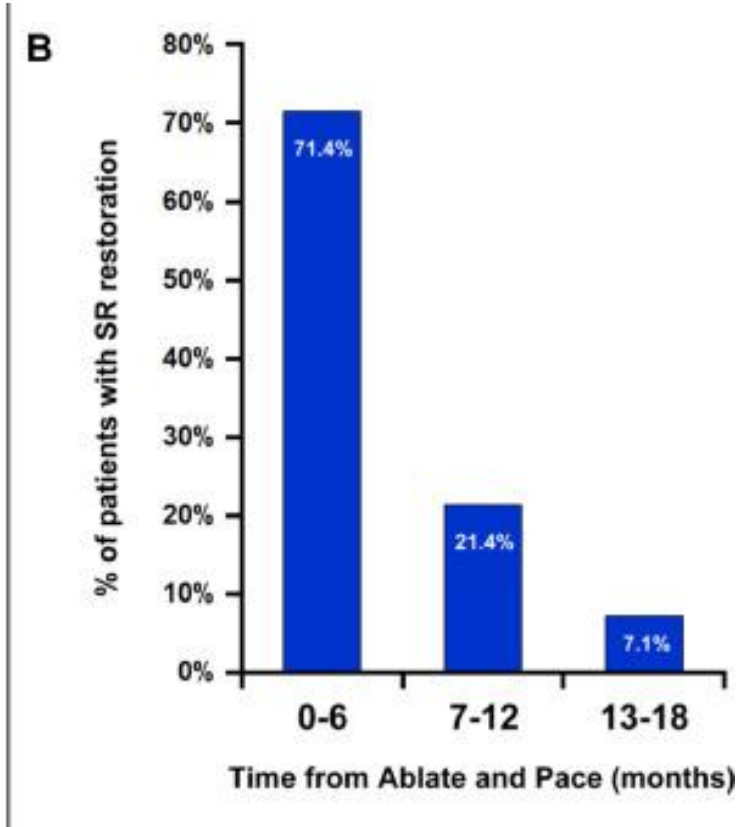
The American Journal of Cardiology
Volume 209, 15 December 2023, Pages 76-84

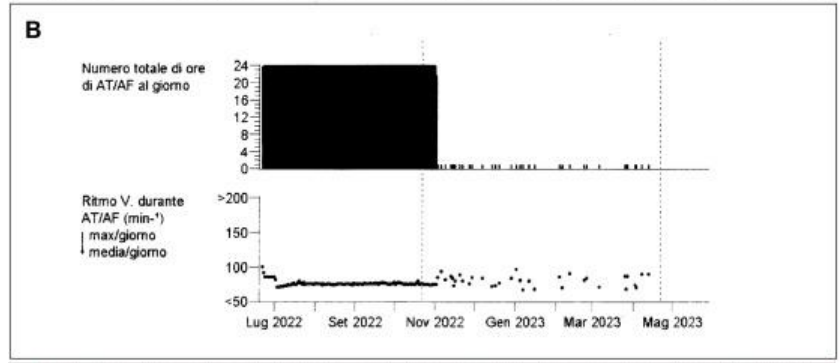
Spontaneous Sinus Rhythm Restoration in Patients With Refractory, Permanent Atrial Fibrillation Who Underwent Conduction System Pacing and Atrioventricular Junction Ablation

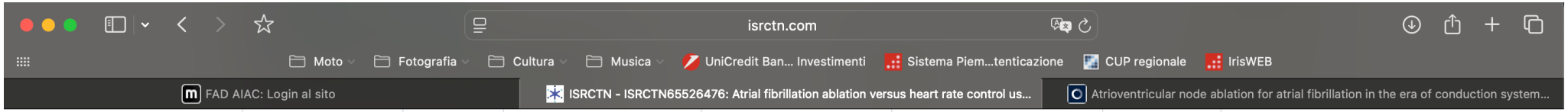
Pietro Palmisano MD [a], Antonio Parlavecchio MD [a b], Giampaolo Vetta MD [b c], Pasquale Crea MD, PhD [b], Scipione Carerj MD, PhD [b], Domenico Giovanni Della Rocca MD, PhD [b], Alessandro Guido MD [a], Michele Accogli MD [a], Giovanni Coluccia MD [a]

13% dei pazienti torna in RS









Atrial fibrillation ablation versus heart rate control using conduction system pacing with ablation of the atrioventricular node

ISRCTN	ISRCTN65526476
DOI	https://doi.org/10.1186/ISRCTN65526476
ClinicalTrials.gov number	NCT06207383
Secondary identifying numbers	SNF_2024-D0031

Submission date
25/07/2024

Registration date
05/08/2024

Last edited
06/11/2024

Recruitment status
Recruiting

Overall study status
Ongoing

Condition category
Circulatory System

- (●) Prospectively registered
- ( ) Protocol
- ( ) Statistical analysis plan
- ( ) Results
- ( ) Individual participant data
- (●) Record updated in last year

Plain English Summary

Background and study aims

Atrial fibrillation (AF) impacts heart function by causing a loss of contraction and deteriorating pump function due to the irregular and often rapid heart rate. The coexistence of AF with heart failure (HF) increases the risk of hospitalization and death. Treatment strategies involve drugs to slow down heart rate or to maintain normal rhythm, catheter intervention to maintain normal rhythm (AF ablation by pulmonary vein isolation), or implantation of a pacemaker with catheter ablation of the atrioventricular node (AVNA) to allow the pacemaker to regulate the heart rate. Conduction system pacing (CSP) involves implanting the pacemaker lead directly

Resincronizzazione per scompenso cardiaco

- *There is good evidence that in patients with sinus node dysfunction (SND), unnecessary RVP should be minimized to avoid AF and HF, particularly if systolic function is impaired or borderline.*
- *Sinus node dysfunction and AF often coexist with 40–70% of patients with SND having a history of atrial arrhythmias at the time of diagnosis. Some of these patients may later require AVNA, and in this instance, having a CSP lead from the onset may be desirable.*
- *Due to the paucity of data, it was decided not to formulate advice on this topic for the time being.*

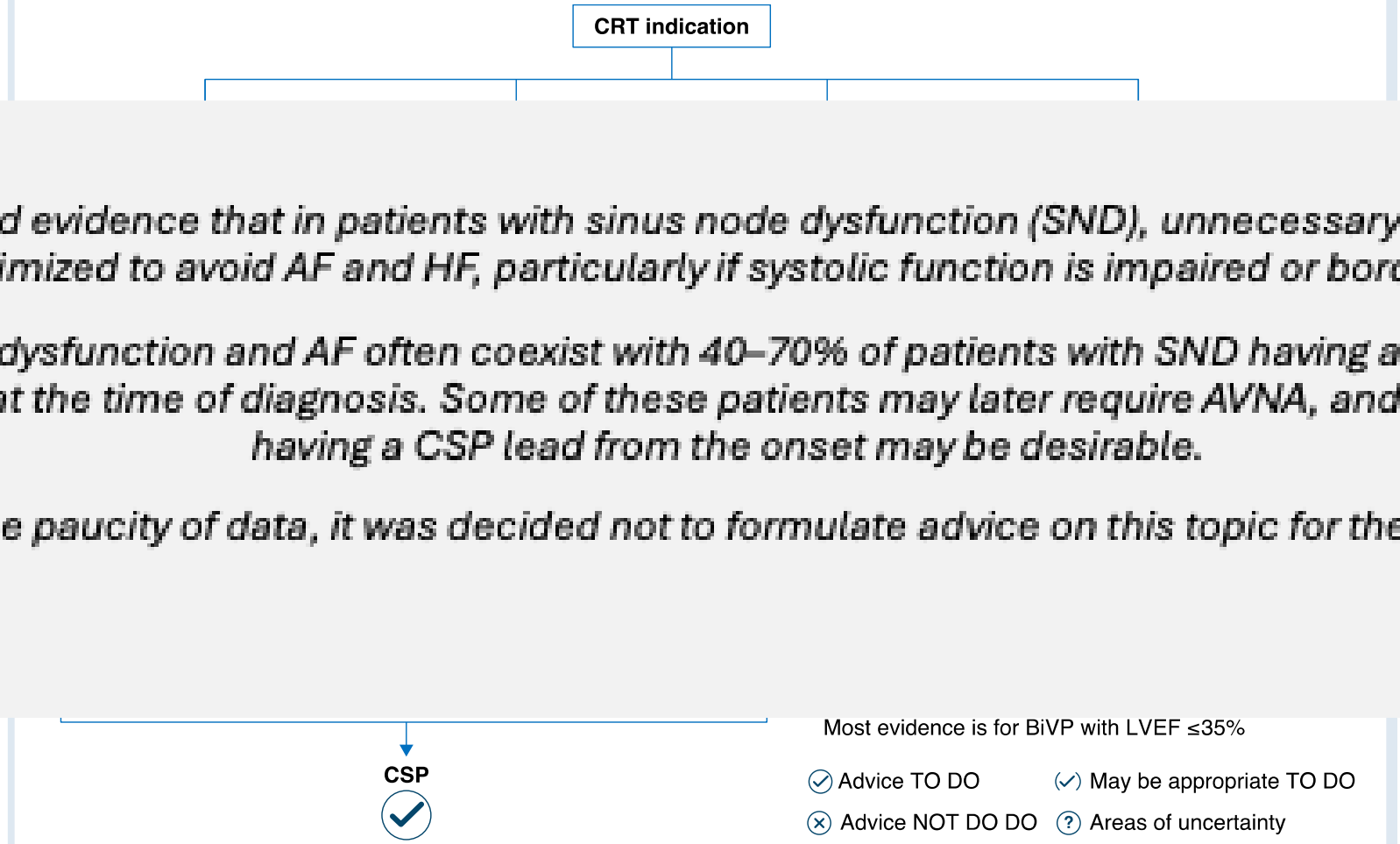
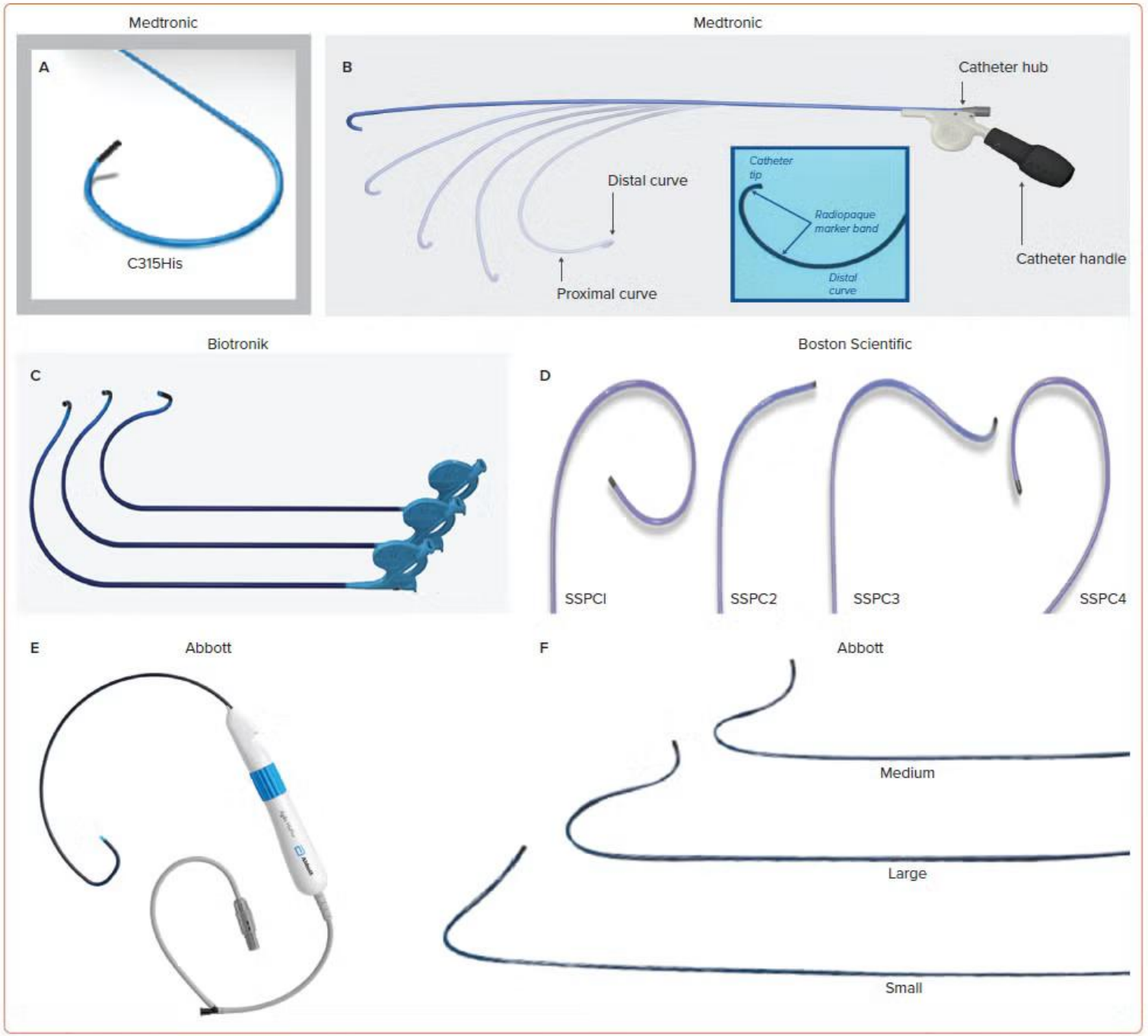


Figure 8 Indication for CSP-CRT. BiV-CRT, biventricular pacing cardiac resynchronization therapy; BiVP, biventricular pacing; CSP, conduction system pacing; HOT/LOT-CRT, His-optimized or left bundle-optimized cardiac resynchronization therapy; LBBB, left bundle branch block; LVEF, left ventricular ejection fraction; PICM, pacing-induced cardiomyopathy.



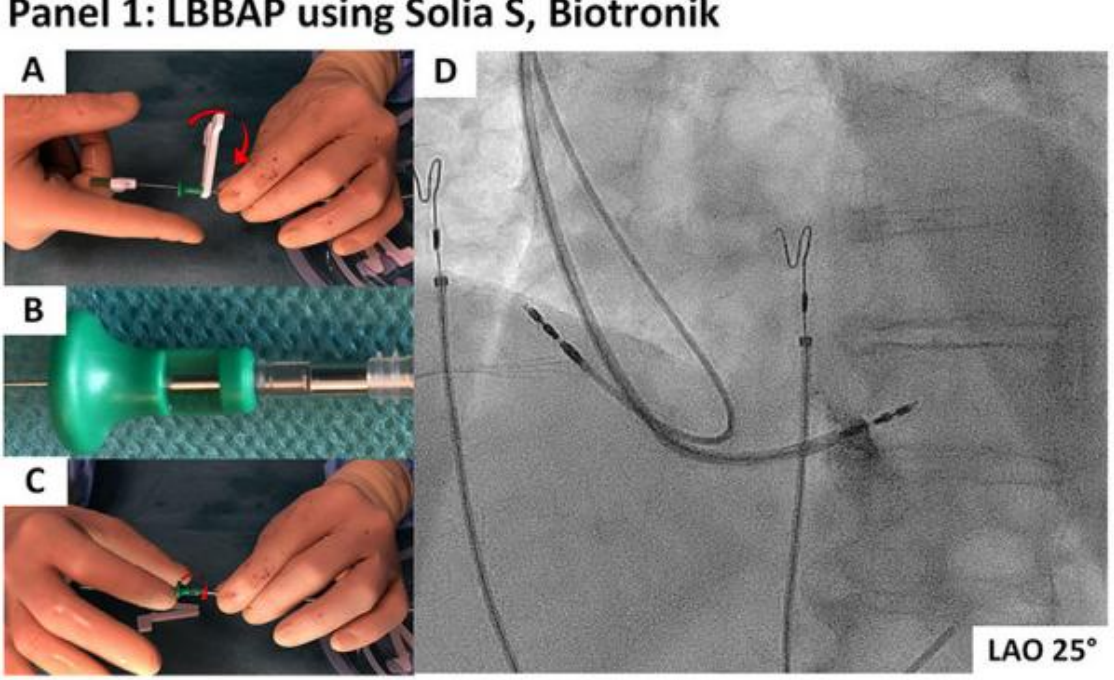
(A) Medtronic C315His; (B) Medtronic C304His steerable sheath; (C) Biotronik Selectra sheaths 40–39, 55–39 and 65–39; (D) Boston Scientific SSPC sheaths (SSPC1, SSPC2, SSPC3 and SSPC4); (E) Abbott Agilis HisPro Steerable sheath; (F) Abbott CPS Locator 3D catheters (small, large and medium). Images reproduced with permission from Abbott, Boston Scientific, Biotronik and Medtronic.

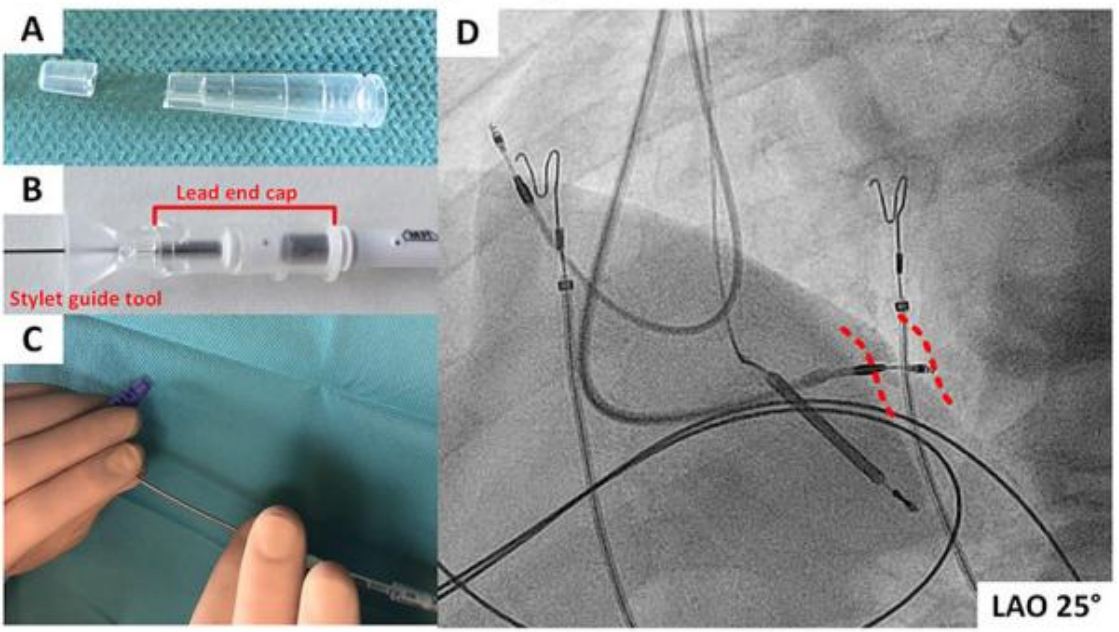
- Ormai, evoluzione verso «curve fisse»
- Tutte le principali aziende hanno delivery dedicati
- La grande differenza che persiste è tra catetere lumenless e cateteri stylet-driven

Front Cardiovasc Med. 2022 Feb 21;9:844152. doi: 10.3389/fcvm.2022.844152

A Guide to Left Bundle Branch Area Pacing Using Stylet-Driven Pacing Leads

Jan De Pooter [1,*], Aurelien Wauters [2], Frederic Van Heuverswyn [1], Jean-Benoit Le polain de Waroux [3]





Performance of an Active Fixation Stylet-Driven Lead in Left Bundle Branch Area Pacing: Results from INSIGHT-LBBA

Friedman, Daniel J. et al. Heart Rhythm, 2025

Multicenter, retrospective registry of left bundle branch area implants single or dual chamber pacemakers

Prospectively Defined Endpoints

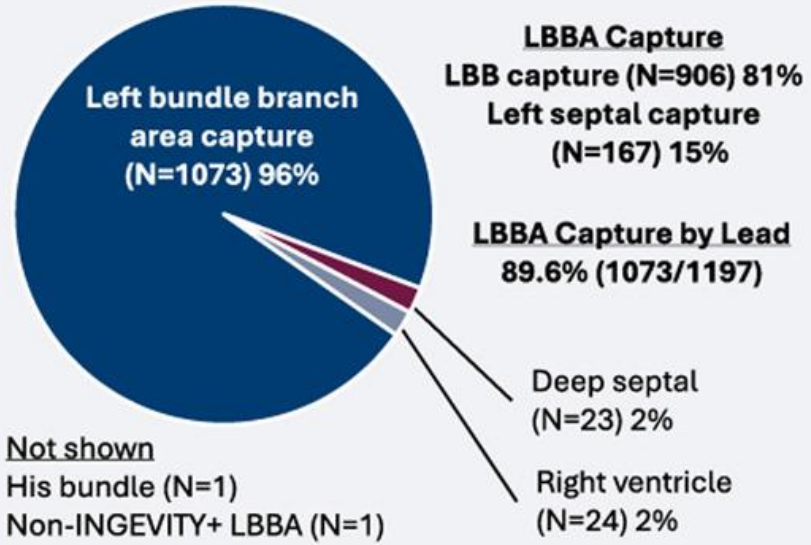
1° Effectiveness Endpoint at 3 Months

- ≥80% of pacing capture thresholds ≤ 2V @ 0.4ms pulse width
- ≥80% of R-wave sensed amplitudes ≥5mV

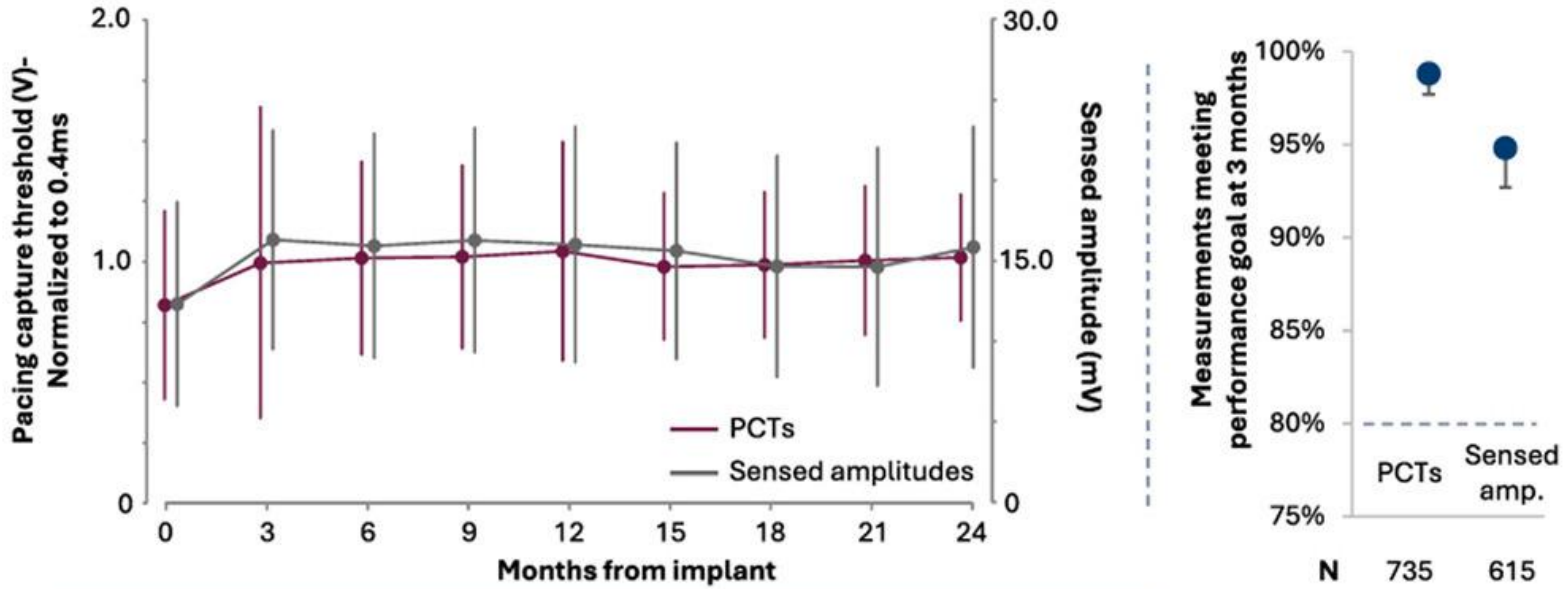
1° Safety Endpoint at 3 Months

- ≥90% lead-related complication free-rate

Implant Success by Patient (N=1122)

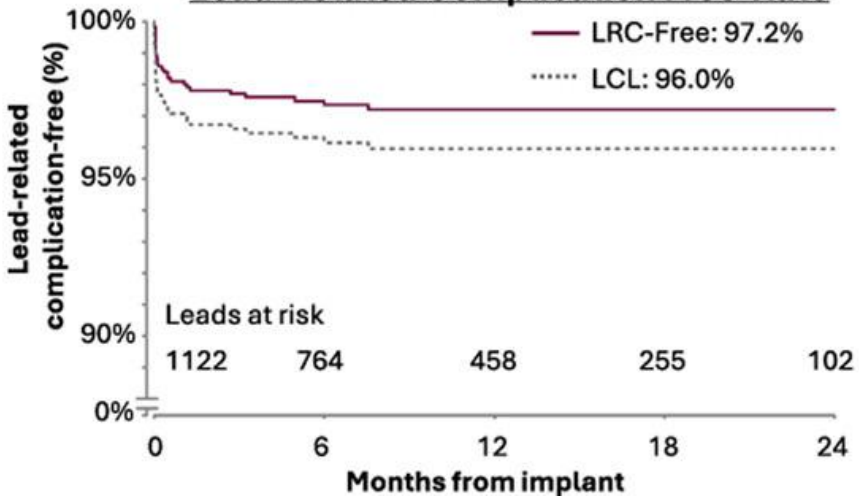


Pacing Capture Thresholds and Sensed Amplitudes Over Time



N	735	615
% in range	98.8%	94.8%
97.5% LCL	97.7%	92.7%

Lead-Related Complication Free-Rate



97.7% LRC free-rate at 3 months

External validation of lead effectiveness with 864 remote monitoring patients **clinically indistinguishable from INSIGHT**

Conclusions: Leads met all 3-month performance goals for pacing, sensing, and LRCs, with stable results through 24 months

JACC: CLINICAL ELECTROPHYSIOLOGY VOL. 11, NO. 1, 2025

PUBLISHED BY ELSEVIER

ORIGINAL RESEARCH

PACING THERAPY

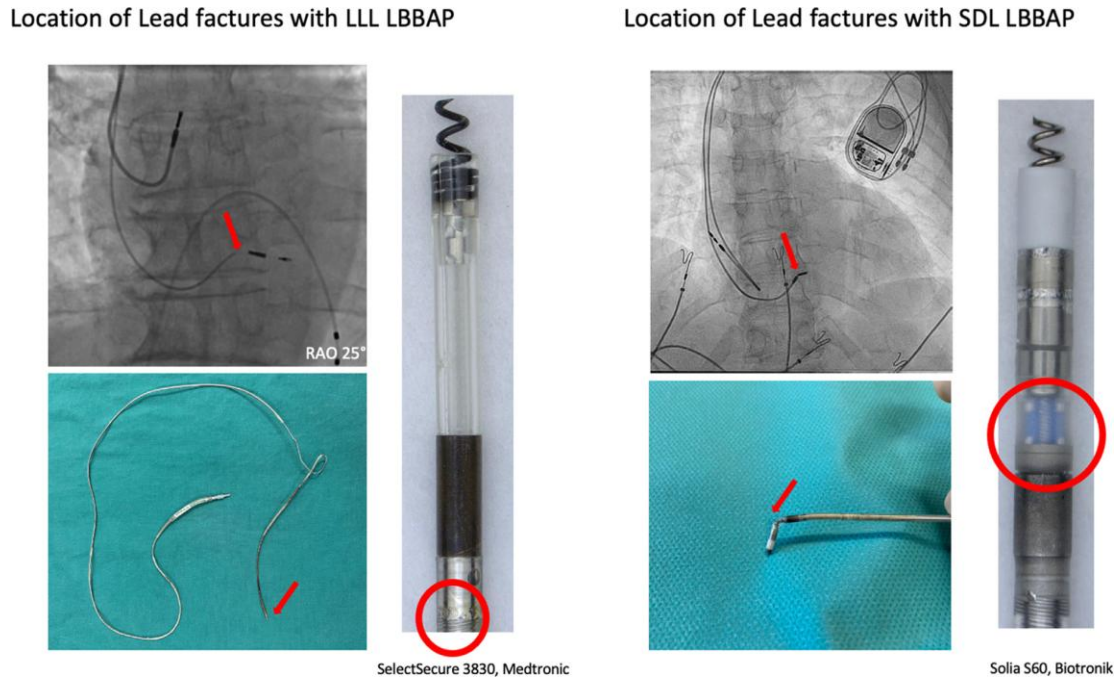
Lead Integrity and Failure Evaluation in Left Bundle Branch Area Pacing

The LIFE-LBBAP Study

Jan De Pooter, MD, PhD,[a] Alexander Breitenstein, MD, PhD,[b] Emine Özpak, MD,[a] Andreas Haeberlin, MD, PhD,[c] Daniel Hofer, MD,[d] Jean-Benoit Le Polain de Waroux, MD, PhD,[e] Aurélien Wauters, MD, PhD,[f] Tae-Hoon Kim, MD,[g] So-Ryoung Lee, MD, PhD,[h,i] Young Jun Park, MD,[j] Michael Gobitz, MD,[b] Grzegorz Kiełbasa, MD, PhD,[k] Dipen Zalavadia, MD,[l] Heli Tolppanen, MD, PhD,[m] David Žižek, MD, PhD,[n] Francesco Zanon, MD,[o] Lina Marcantoni, MD,[o] Shunmuga Sundaram Ponnusamy, MD,[p] Jarkko Karvonen, MD, PhD,[m] Oscar Cano, MD, PhD,[q] Marek Jastrzebski, MD, PhD,[k] Pugazhendhi Vijayaraman, MD, PhD,[l] Haran Burri, MD[r]

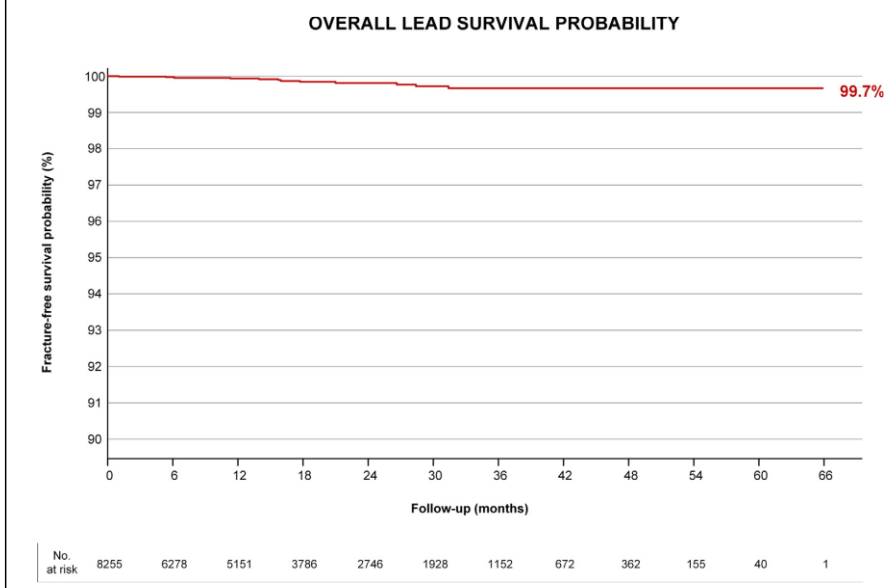
- Lead survival is high
- all lead failures attributed to conductor fractures SDLs seem to exhibit a higher susceptibility to conductor fracture compared to LLLs.
- Interelectrode segment was identified as the most susceptible site in SDLs, whereas in LLLs, fractures originated at the segment proximal to the ring electrode

FIGURE 4 Examples of LBBAP Lead Fracture



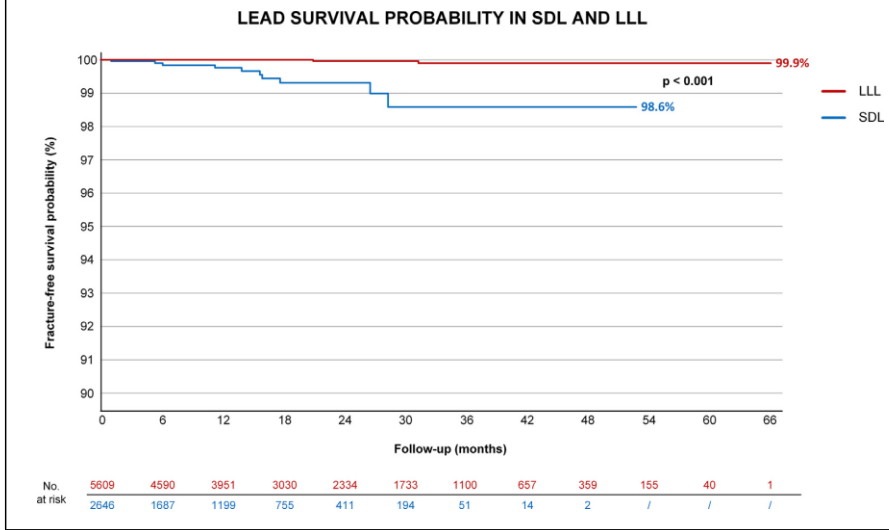
Examples of LBBAP lead fractures. (Left) LLLs presented with fractures proximal of the ring electrode. Oon extraction, the distal lead end broke proximal of the ring electrode and the distal lead fragment was retained in the septum. (Right) Fractures with SDLs originated in the interelectrode segment. Figures reproduced with permission from Rangaswamy et al.[14] RAO = right anterior oblique; other abbreviations as in Figures 1 and 2.

FIGURE 2 LBBAP Lead Survival



Kaplan-Meier curve showing overall left bundle branch area pacing (LBBAP) lead survival probability.

FIGURE 3 LBBAP Lead Survival: LLLs vs SDLs



Kaplan-Meier curve showing LLL and SDL LBBAP lead survival probability. Abbreviations as in Figures 1 and 2.

Transvenous extraction of conduction system pacing leads: An international multicenter (TECSPAM) study

Pugazhendhi Vijayaraman MD [1], Rohan S. Trivedi MD [1], Jayanthi N. Koneru MD [2], Parikshit S. Sharma MD, MPH [3], Jan De Pooter MD, PhD [4], Robert D. Schaller MD [5]

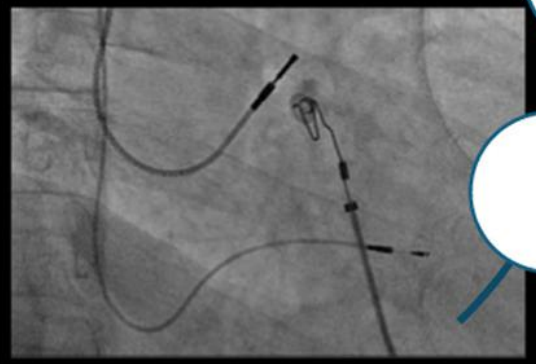
Heart Rhythm
Volume 21, Issue 10, October 2024, Pages 1953-1961

Conduction System Pacing Lead Extraction– Success 100%

Conduction System Pacing
n=341

HBP - 224 patients

LBBP - 117 patients



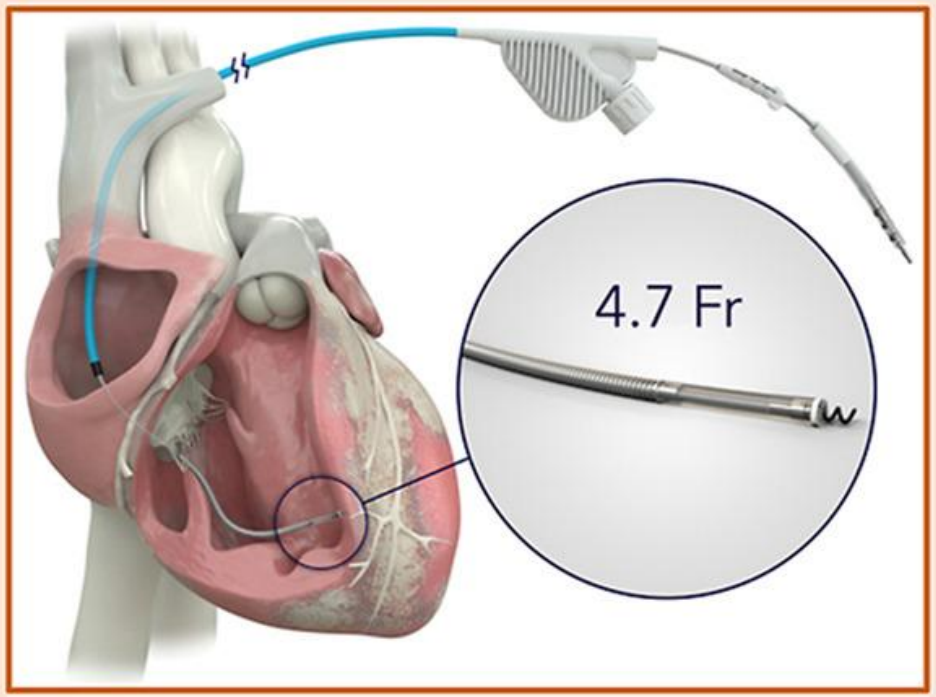
Duration of Implant 22±26 months
(Range: 0-193months)

- Manual Traction 87%
- Mechanical Tools 10%
- Laser 3%

CSP Re-implantation
rate 95%

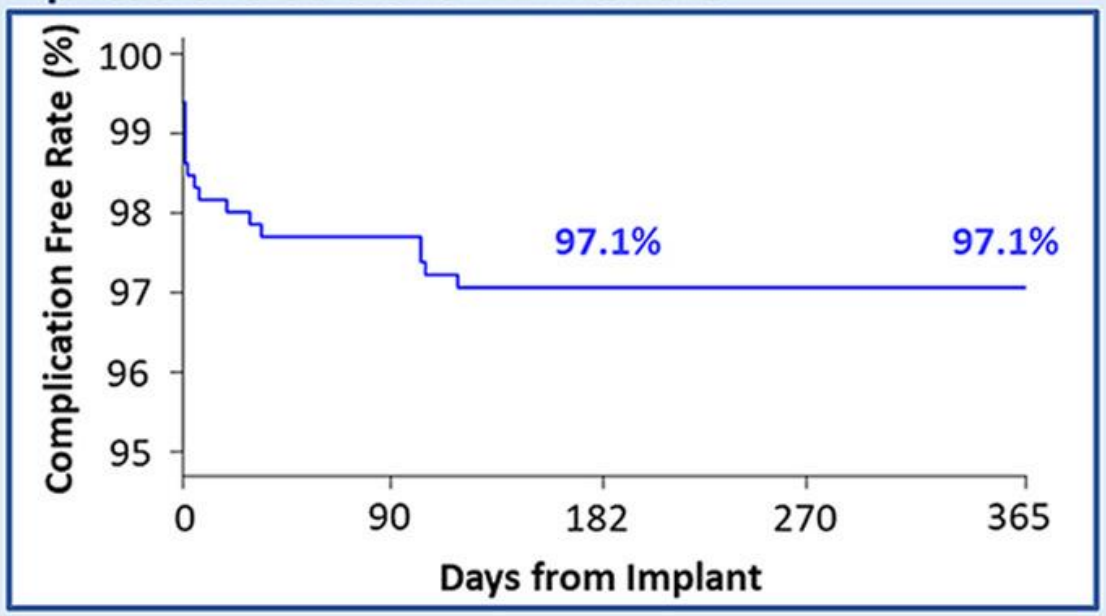
OBJECTIVE

- LEADR Pivotal trial to assess the efficacy, safety, and reliability of the OmniaSecure defibrillation lead



RESULTS

- 97.5% defibrillation success at implant
- 97.1% freedom from study lead-related major complications at 6 and 12 months



- Zero fractures & stable electricals through 12.7±4.8 mo.

CONCLUSION

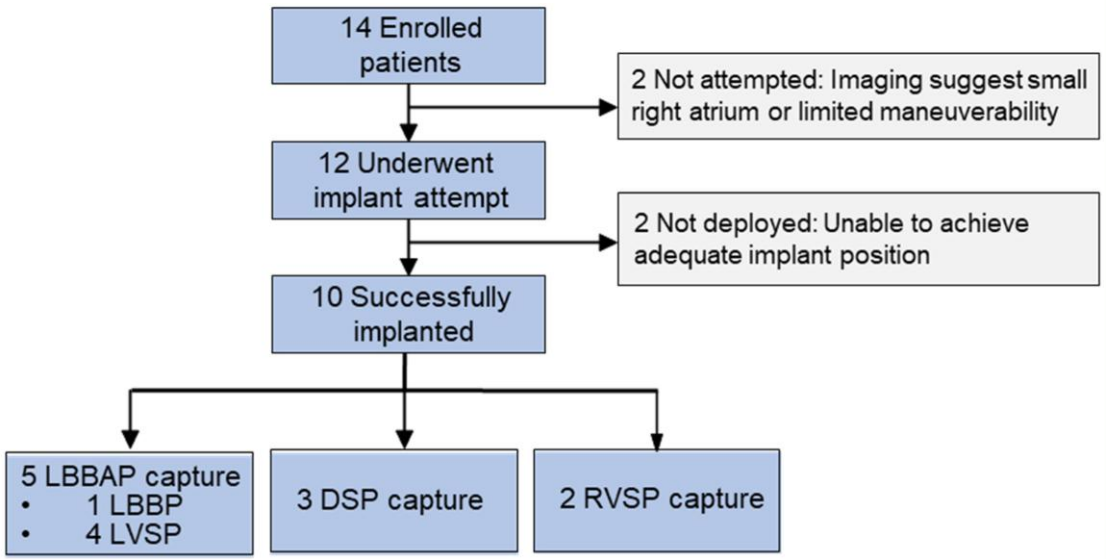
The LEADR trial demonstrated that the OmniaSecure lead met its safety and efficacy endpoints.

Heart Rhythm
Volume 22, Issue 8, August 2025, Pages 2010-2017

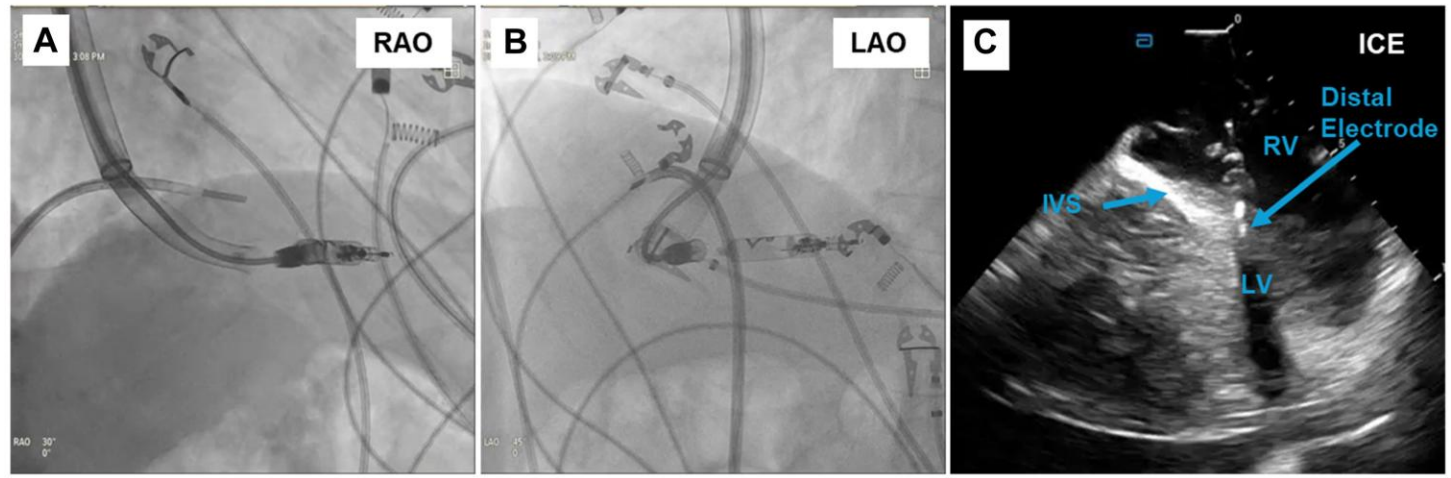
Physiological Pacing

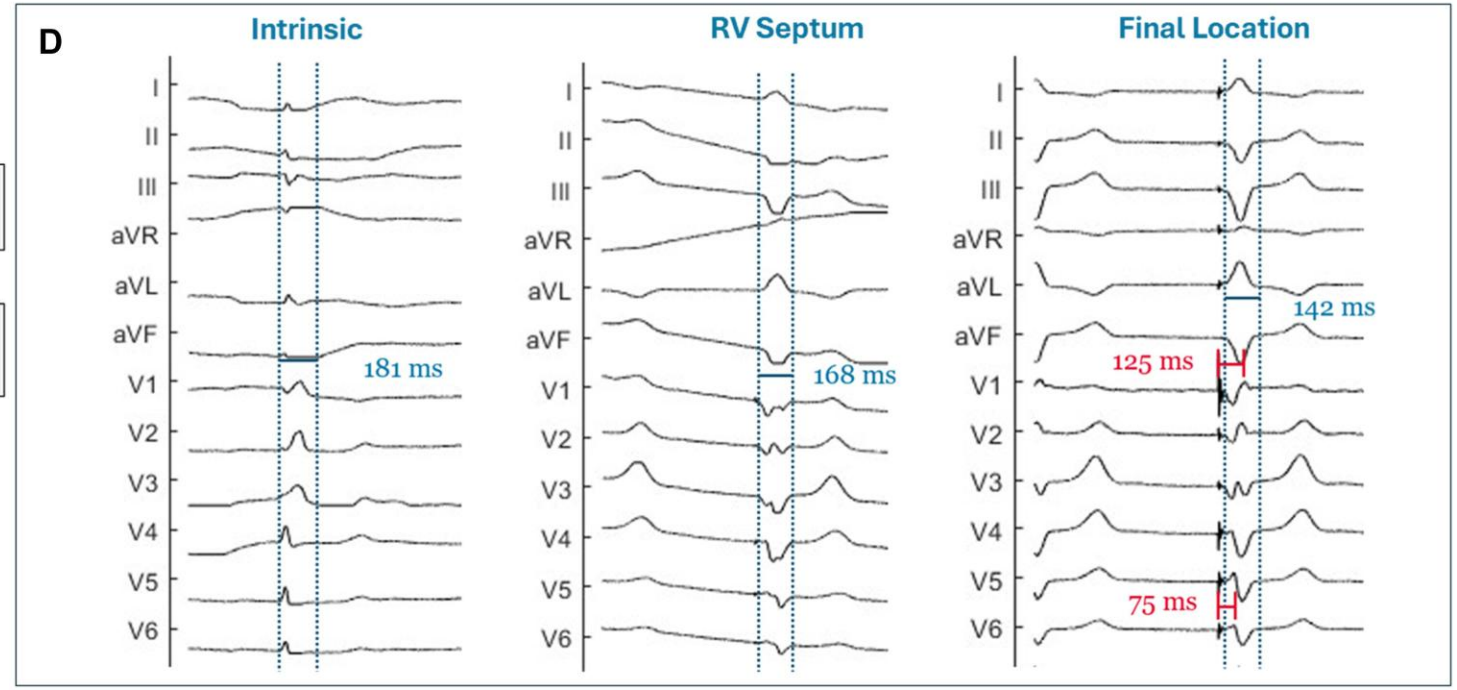
First-in-human study of a leadless pacemaker system for left bundle branch area pacing

Vivek Y. Reddy MD [1 2], Devi G. Nair MD, FHRS [3], Shephal K. Doshi MD [4], Rahul N. Doshi MD, FHRS [5], Milan Chovanec MD [2], Leonard Ganz MD, FHRS [6], Leyla Sabet PhD [6], Chunlan Jiang PhD [6], Petr Neuzil MD, PhD [2]



Pt #4





Due ulteriori grandi campi di sviluppo:

tool di supporto agli impianti e follow-up: analisi automatica delle variazioni-misure del QRS da PSA/poligrafo, tecnologie di teleassistenza, ecc

NETWORK di tutoraggio

Conduction System Pacing Italian Network Group (C-SING)

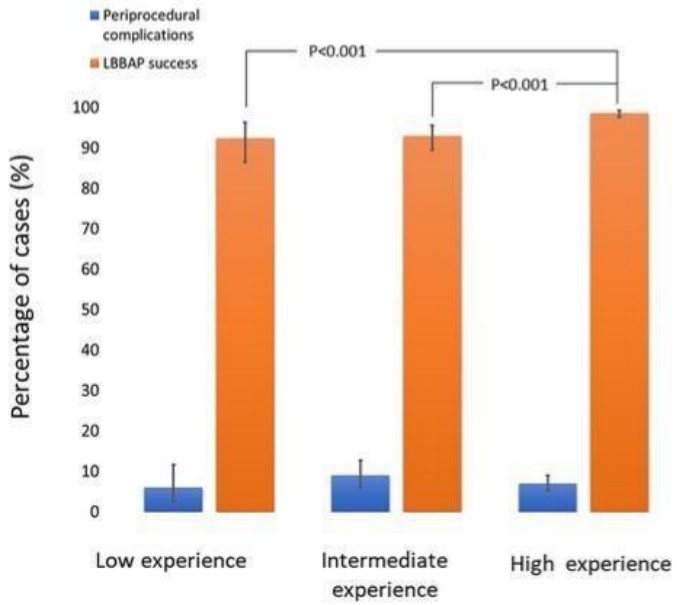
independent, prospective, observational study

1250 LBBAP procedures

28 Italian sites

Operator LBBAP experience

10.6% Low
25.0% Intermediate
64.4% High



LBBAP lead implantation success rate **96.6%**

Median fluoroscopy time **6.2 minutes**

Periprocedural complications **6.2%**

Stable LBBAP capture and low complication rate (**2.1%**) during follow-up

- Better outcomes for high- vs low-experience operators with reduced fluoroscopy time (**5.9 min vs 9.0 min, p=0.005**) and an **86%** lower risk of lead implantation failure
- Complication rates not affected by operator experience

Dell'Era G, Palmisano P, Bertini M, et al, Real-world adoption of left bundle branch area pacing: Insights from the Conduction-System pacing Italian Network Group (C-SING). Int J Cardiol. 2025 Feb 15;421:132879.