

11° CONGRESSO NAZIONALE



*Quello che le Linee
Guida Non Dicono*

Napoli
5-6 aprile 2024

Strategie innovative di stimolazione cardiaca: il punto su Left Bundle Pacing

Mario Volpicelli

LBBAP: evidenze cliniche

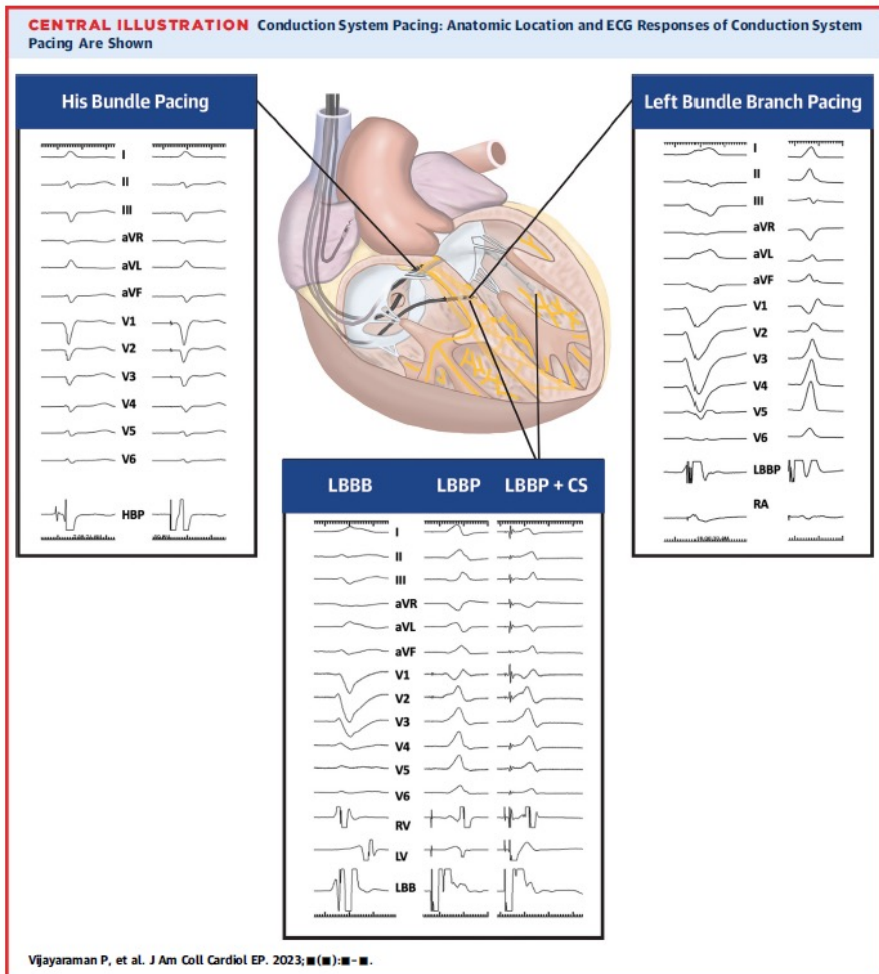
CSP comprehensive update

STATE-OF-THE-ART REVIEW

Cardiac Conduction System Pacing

A Comprehensive Update

Pugazhendhi Vijayaraman, MD,^a Mihal G. Chelu, MD, PhD,^b Karol Curila, MD, PhD, MSc,^c Gopi Dandamudi, MD,^d Bengt Herweg, MD,^e Shumpei Mori, MD, PhD,^f Marek Jastrzebski, MD, PhD,^g Parikshit S. Sharma, MD, MPH,^h Kalyanam Shivkumar, MD, PhD,ⁱ Roderick Tung, MD,^j Gaurav Upadhyay, MD,^k Kevin Vernooy, MD, PhD,^k Allan Welter-Frost, MD, MPH,^l Zachary Whinnett, MD,^m Francesco Zanon, MD,ⁿ Kenneth A. Ellenbogen, MD^o



Main comparisons of stimulation modes:

CSP vs RVP:
brady indication

CSP vs BIV for
CRT

HBP-CRT vs BIV-
CRT

HOT-CRT vs BIV-
CRT

LBBAP vs BIV

HBP-CRT vs
LBBAP-CRT

HBP with long
PR and LV
impairment

Hemodynamic
benefit with
anodal capture?

BIV vs LV
endocardial
pacing

LBBAP: evidenze cliniche

Criteri e morfologia QRS

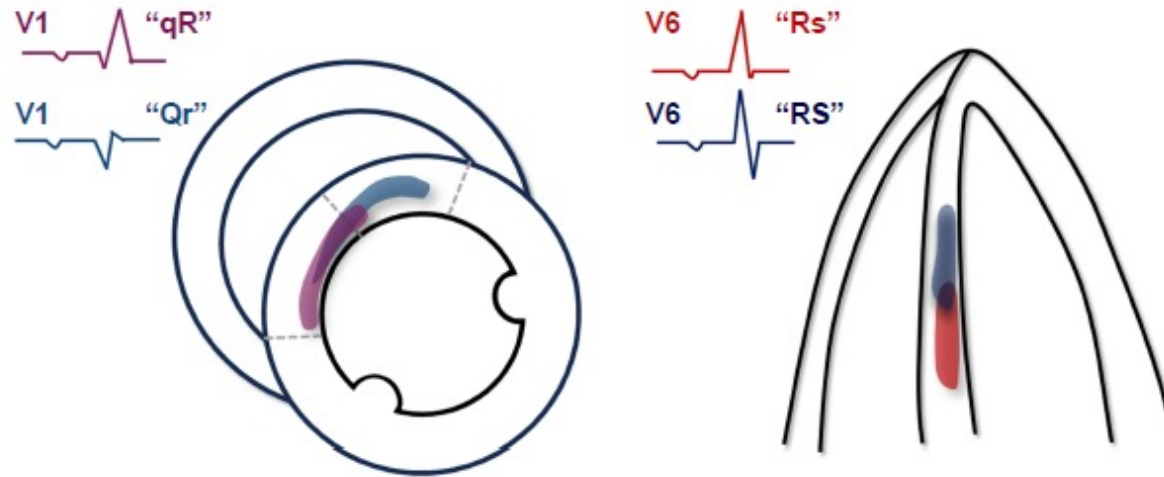


Europace (2023) 25, 1–2
European Society of Cardiology
<https://doi.org/10.1093/europace/euad284>

EDITORIAL

QRS morphologies in V1 and V6 during left bundle branch area pacing: assessing the patterns

Gaurav A. Upadhyay*



qR = more inferior location with LBBAP closer to LV endocardial surface
Qr = more anterior location and further from LV endocardial surface

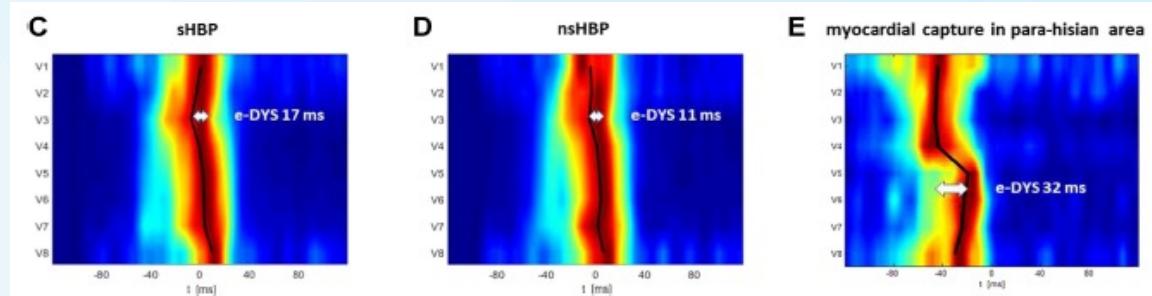
Rs = more basal lead tip location and longer V6RWPT
RS = more apical lead tip location and shorter V6RWPT

Figure 1 Evaluating paced QRS patterns in V1 and V6. Paced QRS morphology in V1 may be used to surmise lead tip location. Most lead tips in Satoh and colleagues' demonstrated lead tips at the inferior septum. A high RQ ratio (≥ 0.8) or "qR" pattern suggests that an inferior lead tip location is expected. If with Qr pattern and inferiorly directed axis, a more anterior location is expected. A deep S-wave ($>20\%$ of the total QRS) of the paced complex in V6 suggests a more apical lead location.

LBBAP: evidenze cliniche

CSP comprehensive update

Ultra High Frequency – ECG showing the electrical dyssynchrony (e-DYS) during different pacing modalities:

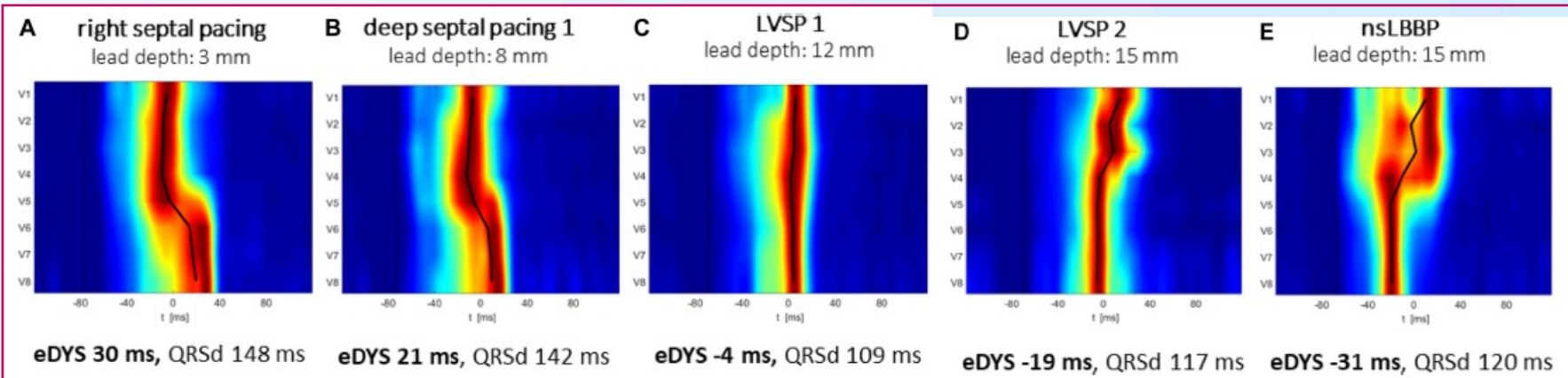


JACC: CLINICAL ELECTROPHYSIOLOGY
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STATE-OF-THE-ART REVIEW

Cardiac Conduction System Pacing A Comprehensive Update

Pugazhendhi Vijayaraman, MD,^a Mihal G. Chelu, MD, PhD,^b Karol Curila, MD, PhD, MSc,^c Gopi Dandamudi, MD,^d Bengt Herweg, MD,^e Shumpei Mori, MD, PhD,^f Marek Jastrzebski, MD, PhD,^g Parikshit S. Sharma, MD, MPH,^h Kalyanam Shivkumar, MD, PhD,ⁱ Roderick Tung, MD,^j Gaurav Upadhyay, MD,^k Kevin Vernoooy, MD, PhD,^l Allan Welter-Frost, MD, MPH,^m Zachary Whinnett, MD,ⁿ Francesco Zanon, MD,^o Kenneth A. Ellenbogen, MD^p



(A) Right septal pacing resulted in an electrical dyssynchrony (e-DYS) of 30 milliseconds caused by delayed left ventricular lateral wall activation. Left ventricular lateral wall delay and QRS duration (QRSd) were reduced when pacing at a depth of 8 mm (B), and the best interventricular synchrony with the shortest QRSd was observed at a depth of 12 mm during left ventricular septal pacing 1 (LVSP1) with a small late r in V₁ (C). Pacing at deeper positions during LVSP2 (which transitioned from nonselective left bundle branch pacing during the decremental output pacing) and nonselective left bundle branch pacing resulted in QRSd prolongation caused by the increase in left-to-right interventricular dyssynchrony with delayed right ventricular lateral wall activation (D,E).

LBBAP: evidenze cliniche

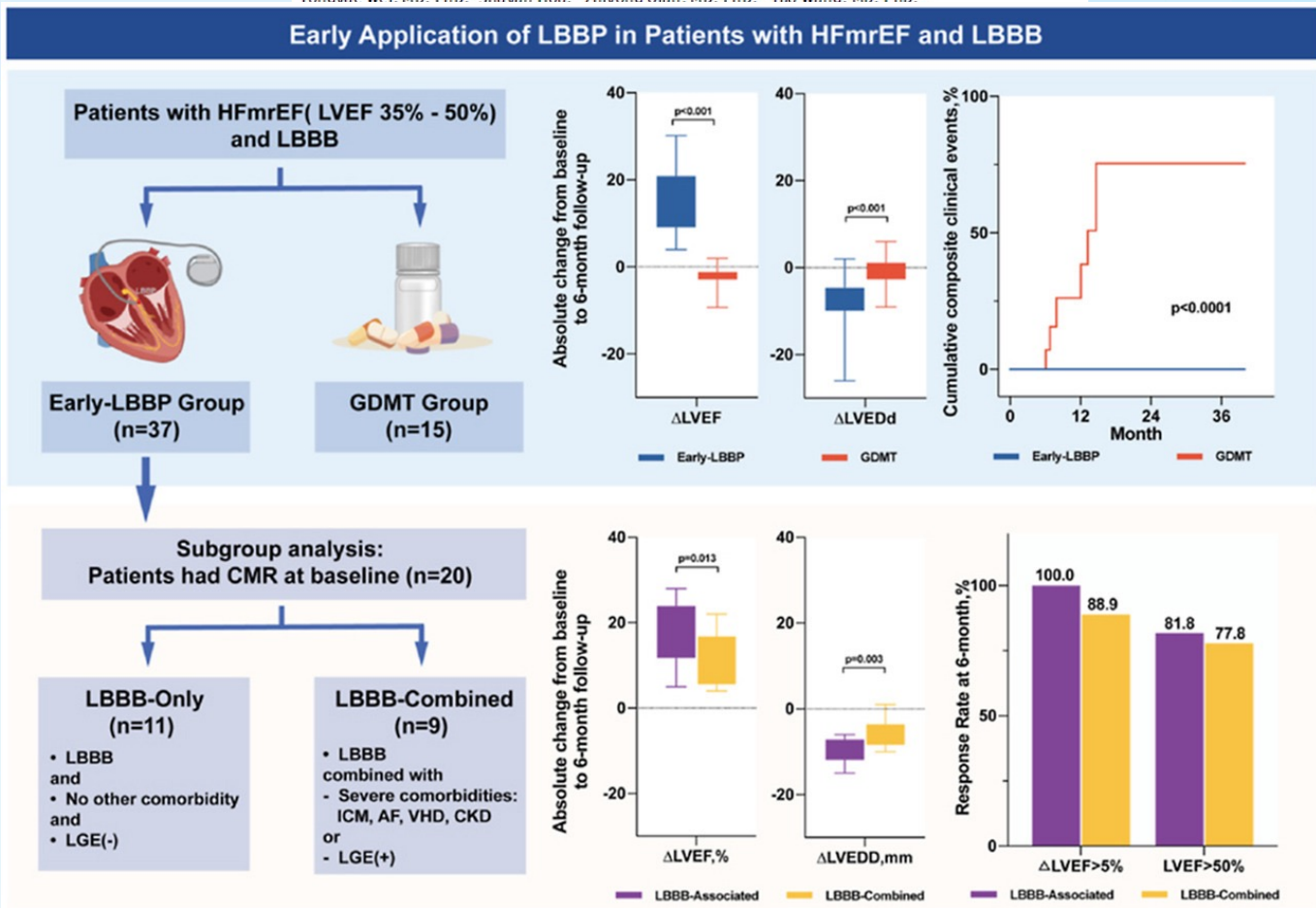
LBBAP in Heart Failure with mildly reduced EF

- **Dual-center study**
- **54 consecutive patients with HFmrEF (LVEF 35%–50%), LBBB, NYHA II-IV** were prospectively enrolled to:
 - 37 receive LBBP (**Early-LBBP group**) + guideline-directed medical therapy (GDMT). Divided into **LBBB-Only** or **LBBB-Combined**
 - 15 GDMT alone (**GDMT group** - at least 2 combined medications)
- **Aim:** explore the efficacy of early LBBP in patients with HFmrEF and LBBB

Early left bundle branch pacing in heart failure with mildly reduced ejection fraction and left bundle branch block

Jiaxin Zeng, MD,*¹ Chen He, MD,*^{1,2} Fengwei Zou, MD,³ Chaotong Qin, MD,*⁴ Siyuan Xue, MD,*⁵ Haojie Zhu, MD,¹ Xiaofei Li, MD,¹ Zhimin Liu, MD,¹ Yanan Wei, MD, PhD,¹ Shuyan Hou,⁶ Zhivona Qian, MD, PhD,*⁷ Yao Wang, MD, PhD,*⁸

Check for updates



Conclusion

In patients with HFmrEF and LBBB, early LBBP significantly improves cardiac function and clinical symptoms, and reverses LV remodeling compared with GDMT alone. Patients with typical LBBB could benefit significantly from LBBP despite the existence of comorbidities or positive LGE.

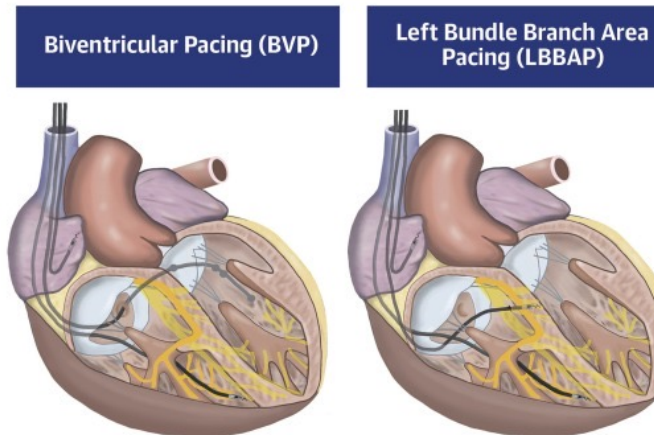
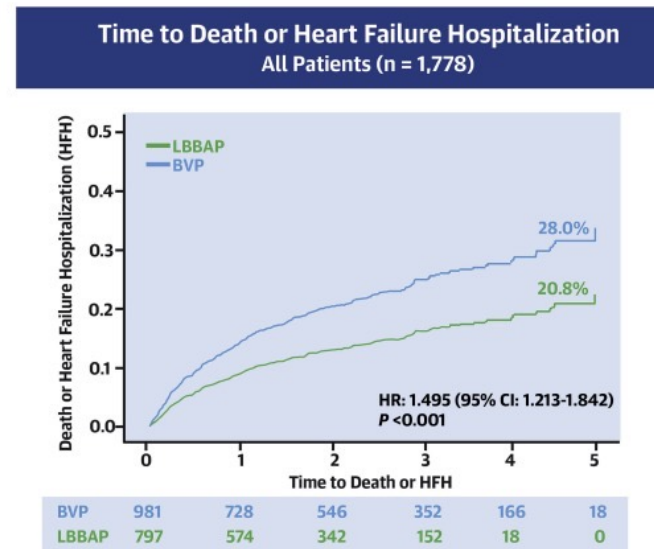
LBBAP: evidenze cliniche

LBBAP vs BIV per CRT

- 15 international centers
- 1778 patients: BVP 981, LBBAP 797
- LVEF ≤ 35% BVP or LBBAP for the first time for Class I or II indications for CRT between Jan 2018 to June 2022
- **Aim:** compare clinical outcomes between BVP and LBBAP among patients undergoing CRT.
- **Primary outcome:** composite endpoint of time to death or heart failure hospitalization (HFH).
- **Secondary outcomes:** endpoints of death, HFH, and echocardiographic changes

<https://www.sciencedirect.com/science/article/abs/pii/S0735109723055468?via%3Dihub>

CENTRAL ILLUSTRATION: Death or Heart Failure Hospitalization



Vijayaraman P, et al. J Am Coll Cardiol. 2023;82(3):228-241.

Original Investigation
Comparison of Left Bundle Branch Area Pacing and Biventricular Pacing in Candidates for Resynchronization Therapy

Pugazhendhi Vijayaraman MD,^a Parikshit S. Sharma MD, MPH,^b Oscar Cano MD, PhD,^c Shunmuga Sundaram Ponnusamy MD, DM,^d Bengt Herweg MD,^e Francesco Zanon MD,^f Marek Jastrzebski MD, PhD,^g Jianguang Zou MD,^h Mihail G. Chelu MD, PhD,ⁱ Kevin Vernooy MD, PhD,^j Zachary I. Whinnett MD, PhD,^k Girish M. Nair MBBS, MSc,^l Manuel Molina-Lerma MD,^m Karol Curila MD, PhD,ⁿ Dipen Zalavadia MD,^o Abdul Haseeb MD,^o Cicely Dye MD,^o Sharath C. Vipparthi MD,^o Ryan Brunetti MD,^o Pawel Moskal MD,^o...Kenneth A. Ellenbogen MD,^o

BIV 28%

LBBAP 20.8 %

Conclusions

LBBAP improved clinical outcomes compared with BVP in patients with CRT indications and may be a reasonable alternative to BVP.

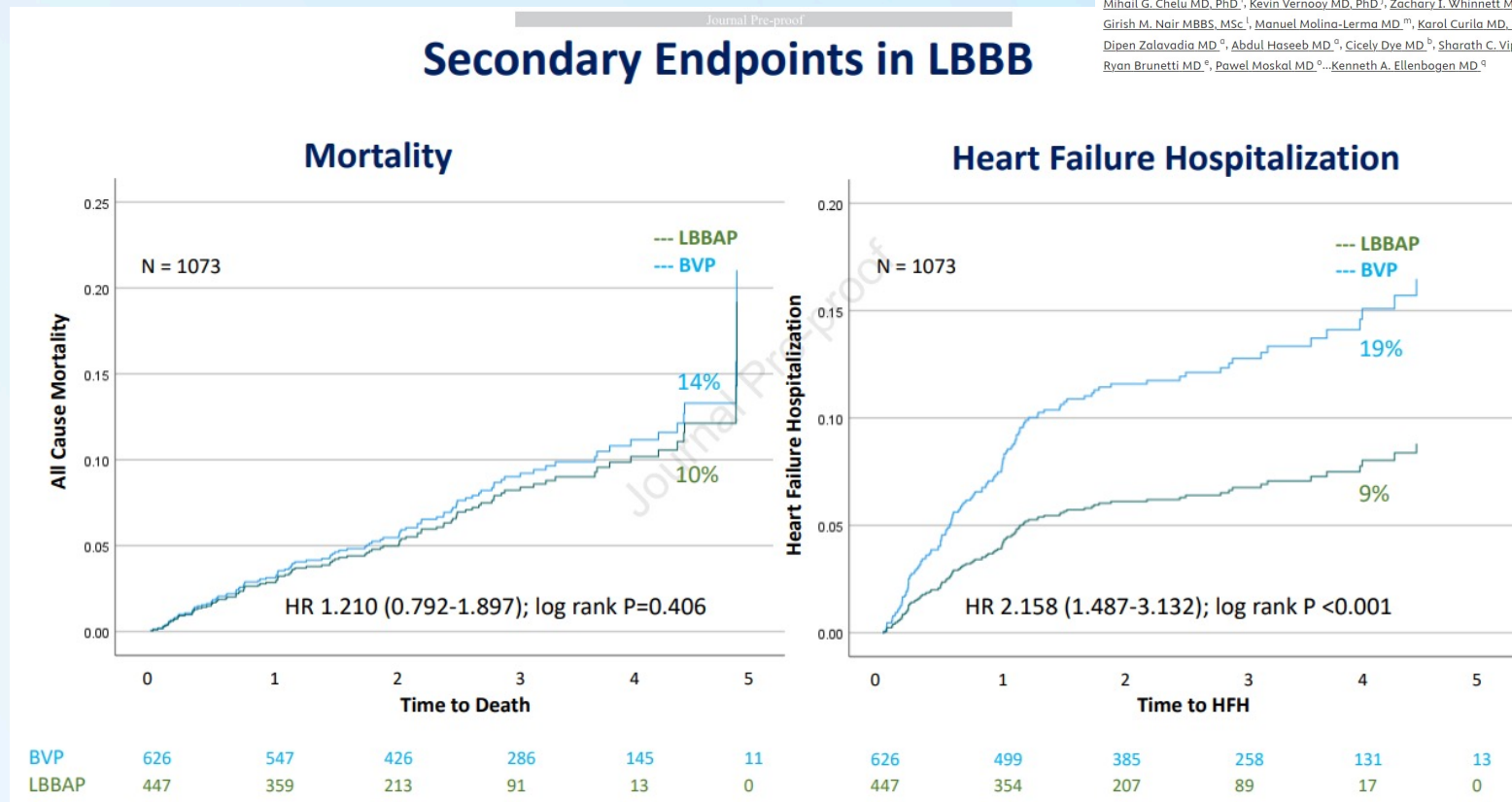
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LBBAP: evidenze cliniche

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Conclusions

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LBBAP: evidenze cliniche

LBBAP vs BIV nel rischio aritmico

- 15 international centers
- 1778 patients: BVP 981, LBBAP 797 → Propensity Score matched 707 with BVP to 707 with LBBAP (n = 1414).
- LVEF≤35% BVP or LBBAP for the first time for Class I or II indications for CRT between Jan 2018 to June 2022
- **Aim:** asses the incidence of VT/VF and new-onset AF among patients with no prior history of AF. Time to sustained VT/VF and time to new-on
- **Primary outcome:** time to sustained ventricular tachycardia or ventricular fibrillation (VT/VF) and new onset AF (lasting >30 seconds) among propensity score matched patients undergoing BVP compared with LBBAP.
- **Secondary outcomes:** overall incidence of ventricular arrhythmias including non-sustained VT (≥10 beats at ≥150 bpm), anti-tachycardia pacing (ATP), ICD shocks, VT storm, VT ablation, duration of AF lasting >30 sec, >6 min, and AF >24 hours, cardioversion, AF ablation and AV node ablation.

Arrhythmic Risk In Biventricular Pacing Compared with Left Bundle Branch Area Pacing: Results From The International LBBAP Collaborative Study (I-CLAS)

Bengt Herweg, Parikshit S. Sharma, Oscar Cano, Shunmuga Sundaram Ponnusamy, Francesco Zanon, Marek Jastrzebski, JIangang Zou, Mihail G. Chelu, Kevin Vernooy, Zachary I. Whinnett, Girish M. Nair, Manuel Molina-Lerma, Karol Curila, Dipen Zalavadia, Cicely Dye, Sharath C. Vipparthy, Ryan Brunetti, Mishal Mumtaz, Pawel Moskal, Andrew M. Leong, Antonius van Stipdonk, Jerin George, Yusuf K. Qadeer, Jeffrey Kolominsky, Mehrdad Golian, Ramez Morcos, Lina Marcantoni, Faiz A. Subzposh, Kenneth A. Ellenbogen and Pugazhendhi Vijayaraman [See fewer authors](#)

Originally published 11 Nov 2023 | <https://doi.org/10.1161/CIRCULATIONAHA.123.067465> | Circulation. 2023;0

Conclusions: LBBAP was associated with lower incidence of sustained VT/VF and new-onset AF compared with BVP. This difference remained significant after adjustment for differences in baseline characteristics between patients with BVP and LBBAP. Physiologic resynchronization by LBBAP may be associated with lower risk of arrhythmias compared with BVP.

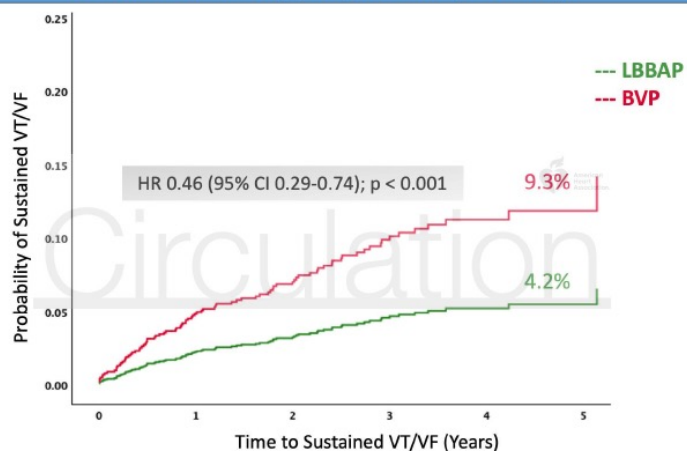
LBBAP: evidenze cliniche

LBBAP vs BIV nel rischio aritmico

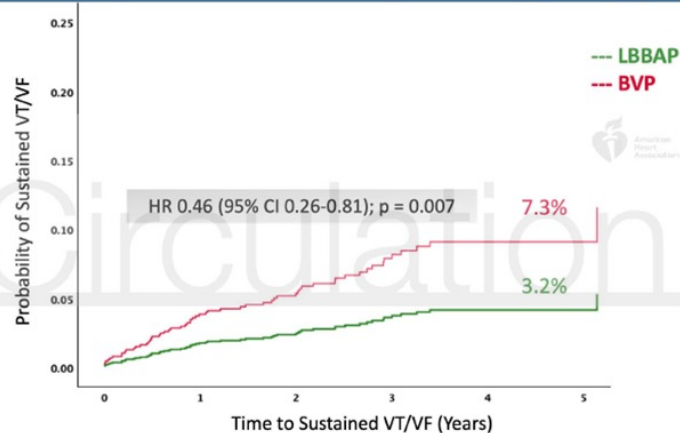
Discussion

This large international, multicenter, retrospective, observational study shows a decreased incidence of ventricular arrhythmias as well as new onset AF in patients undergoing CRT by LBBAP compared with BVP. The lower incidence of sustained VT/VF in the LBBAP group translated into a substantial reduction in ICD therapies. The incidence of non-sustained VT and VT storm was similarly decreased in the LBBAP vs. BVP patients. The incidence of AF lasting >30 seconds, >6 minutes or >24 hours was also reduced in patients undergoing LBBAP compared with BVP. These observations suggest that physiologic pacing and more effective CRT by LBBAP may promote remodeling that provides a less arrhythmogenic substrate compared with BVP.

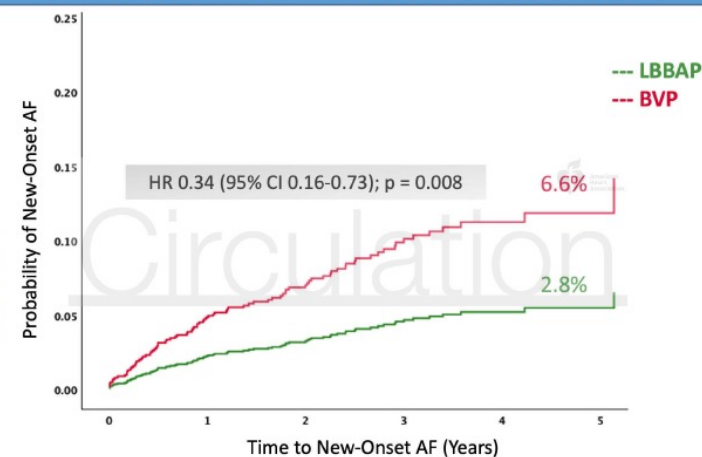
Time to sustained ventricular tachycardia / ventricular fibrillation among all patients (N=1414)





Time to sustained ventricular tachycardia / ventricular fibrillation in patients with no prior history of VT/VF or antiarrhythmic drug therapy (N=1194)



Time to new new-onset atrial fibrillation in patients without prior history of atrial fibrillation (N=890)



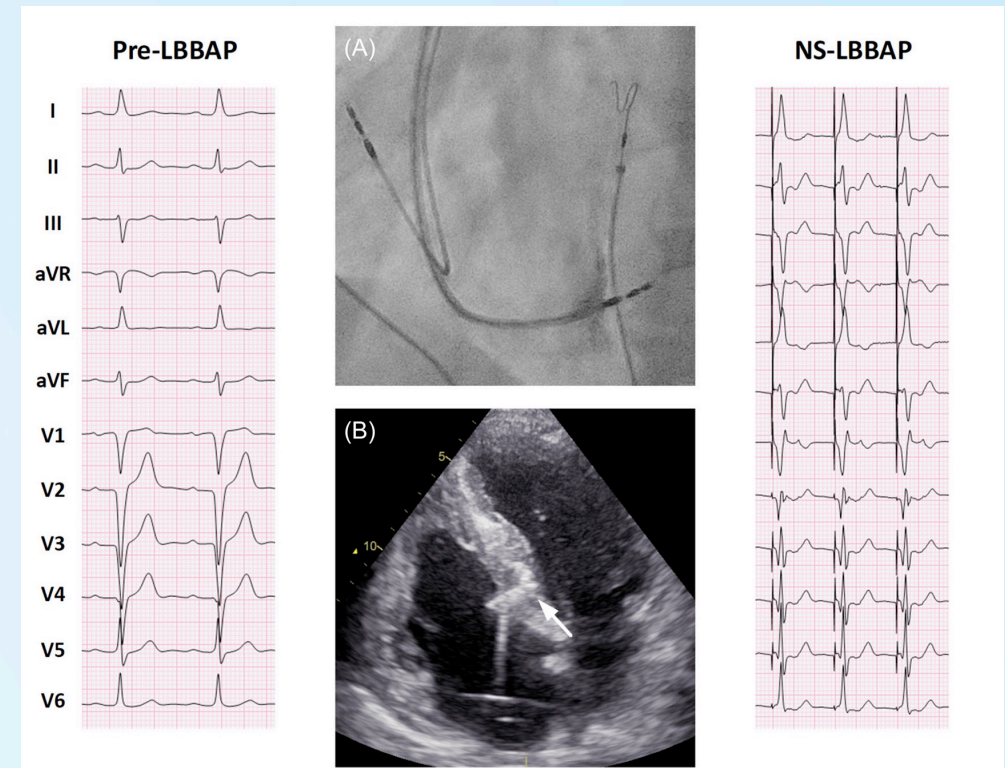
Feasibility and safety of left bundle branch area pacing in patients with septal hypertrophy

Emine Özpak MD  | Frederic Van Heuverswyn MD | Frank Timmermans MD, PhD | Jan De Pooter MD, PhD 

LBBAP: evidenze cliniche

LBBAP in septal hypertrophy

- 17 patients with Hypertrophic septum (Left Ventricular Septal Hypertrophy)
- Aim: compare clinical outcomes among 17 LVSH patient for LBBAP
- Primary outcome: feasibility, success rate.
- **88% success rate** with 53% of proven LBB capture
- **Septal thickness it not a limitation.**
- **Mean implant depth is 17,2 mm.**



Left bundle branch area pacing in patients with septal hypertrophy is feasible and safe. Stylet-driven leads facilitate deep septal lead position resulting in successful LBBAP with electrophysiological properties comparable to patients without septal hypertrophy.

LBBAP: la nostra esperienza

Database CSP PO S. Maria della Pietà-Nola

Baseline patient characteristics

- A total of 120 patients underwent CSP implantation between October 2022 and January 2024 (median age 73 [65-81] years, male 67.5%).

	Total (N=120)
Sex, male	81/120 (67.5)
Age (years)	73 (65-81)
Body mass index (Kg/m ²)	26.9 (25.0-28.9)
NYHA functional class	
I	39/101 (39)
II	54/101 (53)
III	7/101 (7)
IV	1/101(1)
Medical history	
Cardiomyopathy	
None	47/113 (41.6)
Ischemic	40/113 (35.4)
Dilated	18/113 (16.5)
Other	4/113 (3.5)
Valvular	1/113 (1)
Pre-implant ECG	
Sinus rhythm	77/111 (69.4)
AF	32/111(28.8)
Other	2/111 (1.8)
AV Block I*	26/111 (23.6)
AV Block II*	3/111 (2.7)
AV Block III*	25/111 (22.7)
QRS duration (ms)	138 (108-163)
QRS morphology	
Normal	36/113 (31.8)
LBBB	30/113 (26.5)
RBBB	18/113 (15.9)
RBBB + LAFB	13/113 (11.5)
Intraventricular conduction defect	12/113 (10.6)
Left anterior fascicular block	4/113 (3.5)
Echocardiography	
LVEF (%)	40 (30-55)
LVEDD (mm)	55 (47-61.55)
LVEDV (ml)	131 (109.5-205)
LVESV (ml)	75 (35-80)
IV septum thickness (mm)	12 (11-13)
PAPs (mmHg)	35 (35-45)
TAPSE (mm)	19 (17-21)
Mitral regurgitation	
1	26/58 (44.8)
2	25/58 (43.1)
3	7/58 (12.1)
Tricuspid regurgitation	
1	31/51 (60.8.5)
2	12/51 (23.5)
3	8/51 (15.7)

LBBAP: la nostra esperienza

Database CSP PO S. Maria della Pietà-Nola

Pacing indications

- Leading indication included heart failure (47,9%), intrinsic AV block (28,2%), atrial fibrillation with bradycardia (7,7%)

	Total (n=117)
Pacing indication	
CRT (heart failure)	56/117 (47.9)
Intrinsic AV block	33/117 (28.2)
Atrial fibrillation with bradycardia	9/117 (7.7)
AV node ablation	7/117 (6.0)
Sinus node dysfunction	5/117 (4.3)
Vasovagal syncope	3/117 (2.6)
Sinus node dysfunction + AV block	3/117 (2.6)
CRT after LV lead failure	1/117 (0.8)
Post-TAVI AV block	0/117 (0)

Data are shown as median (interquartile range) and N (%) for categorical variables.

LBBAP: la nostra esperienza

Database CSP PO S. Maria della Pietà-Nola

Procedural characteristics

- Final 12-lead ECG assessment revealed LBBAP capture in 84.9% patients, HBP in 7.9% (selective 9.3%, non-selective 4.2%) resulting in a 93% CSP lead implantation success rate

	Total (n=117)
Device type	
Pacemaker	2/119 (1.7)
CRT-D	64/119 (53.8)
CRT-P	53/119 (44.5)
Number of CSP delivery sheaths used during the procedure	
1	96/115 (83.5)
2	18/115 (15.6)
3	1/1115 (0.9)
CSP implant success	117/119 (98.30)
Vascular access for CSP lead	
Left subclavian	89/90 (98.9)
Left cephalic	1/90 (1.1)
Successful delivery sheath brand	
Biotronik	96/109 (88.1)
Medtronic	11/109 (10.1)
Boston Scientific	2/109 (1.8)
Abbott	0/109 (0)
CSP lead type	
Stylet driven	106/115 (92.2)
Lumenless	9/115 (7.8)
CSP lead brand	
Biotronik	67/118 (56.8)
Medtronic	13/118 (11.0)
Boston Scientific	12/118 (10.2)
Abbott	26/118 (22.0)
Visible HB/LBB signal	
"w" pattern in V1 before fixation	57/114 (50.0)
Fixation beats during screwing	97/98 (99.0)
Millimeters of lead penetration into septum (mm)	75/113 (66.4)
10 (10-13)	
Final CSP capture	
LBBAP	101/119 (84.9)
Selective HBP	11/119 (9.3)
Non-Selective HBP	5/119 (4.2)
No CSP capture	2/119(1.7)
LBBAP capture subtypes	
LBBP	40/98 (40.8)
LPFP	25/98 (25.5)
LSFP	9/98 (9.2)
LAFP	14/98 (14.3)
LVSP	9/98 (9.2)
Unknown	1/98 (1.2)
ECG	
Paced QRS duration (msec)	120 (108-86)
R' in V1	69/98 (70.4)
Stimulus to V6 R wave peak (LVAT) (msec)	76 (66-84)
V6-V1 interpeak interval (msec)	40 (26-52)
Electrical parameters	
Bipolar R-wave amplitude (V)	9.5 (7.3-11.5)
CSP pacing threshold (V) @ <=0.5ms	0.7 (0.6-0.9)
CSP pacing threshold (V) @ >0.5ms	0.7 (0.6-0.9)
Impedance (ohm)	
Unipolar	611 (519-834)
Bipolar	46/86 (535)
40/86 (4.6.5)	
Fluoroscopic time (min)	
8 (5.3-12)	
Procedure duration (min)	
60 (55-70)	

CONCLUSIONI

- Le linee guida attuali sono obsolete
Parola chiave «Left Bundle Branch Area Pacing» su pubmed:
 - Dal 1975 alle ultime linee guida ESC (2021): 350 risultati
 - Dalle ultime linee guida ESC (2021) ad oggi: 345 risultati
- LBBAP è il futuro della resincronizzazione cardiaca
Risultati degli studi finora:
 - LBBAP > BivP
 - Nel LBBB: LBBAP precoce > GDMT
- Evidenze ad oggi su BivP: esperienza pluridecennale, materiali dedicati
- Evidenze ad oggi su LBBAP: esperienza iniziale, materiali non dedicati
- Gli studi randomizzati in corso potranno consolidare le evidenze attuali