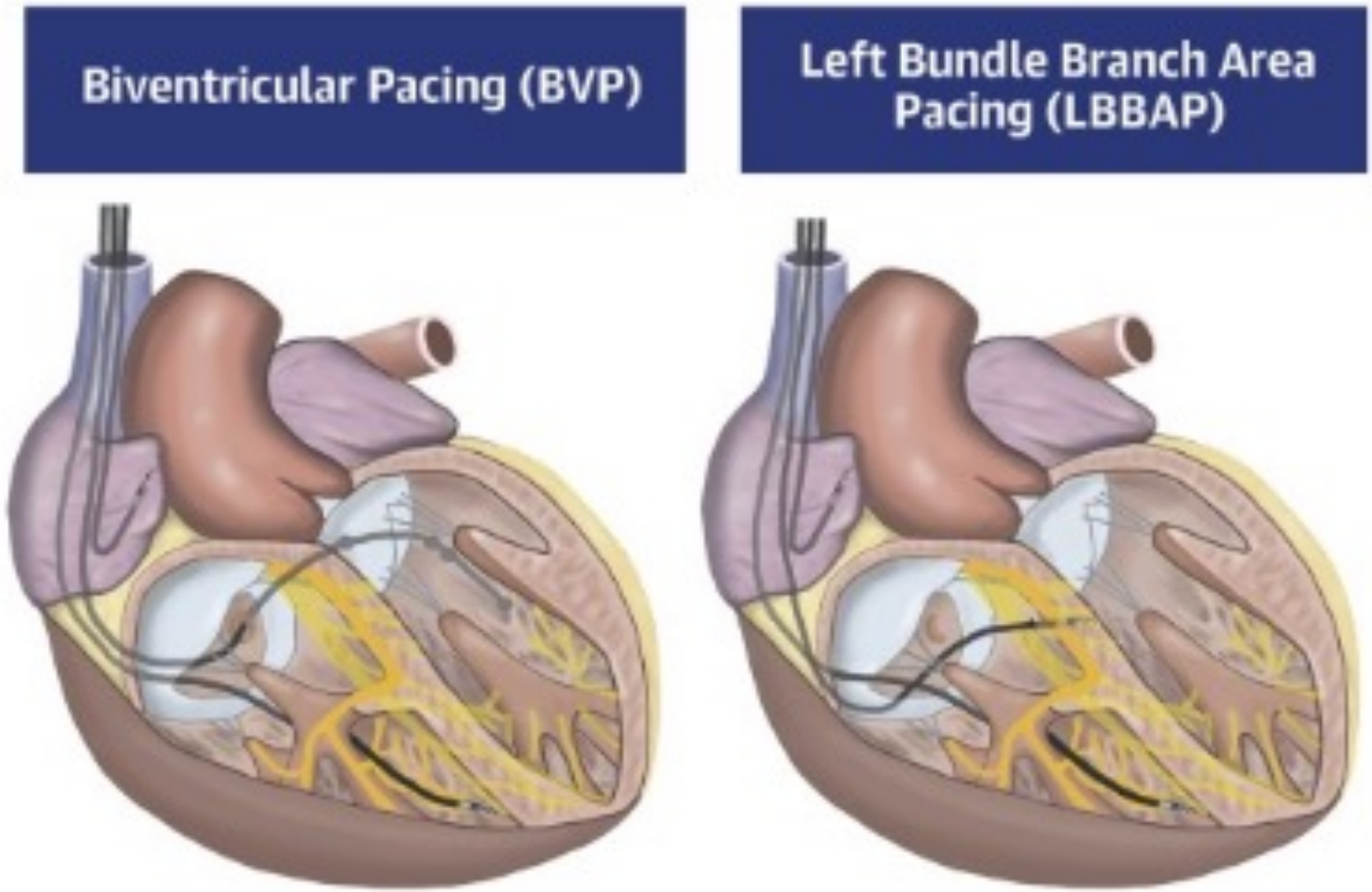
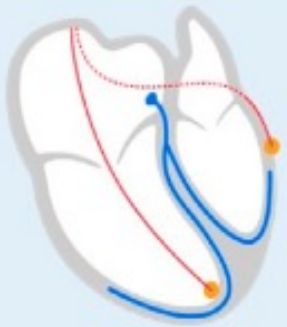
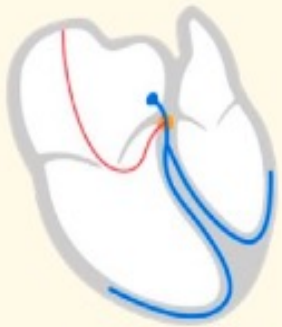
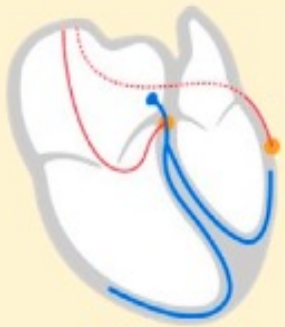
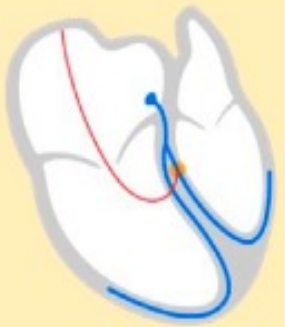
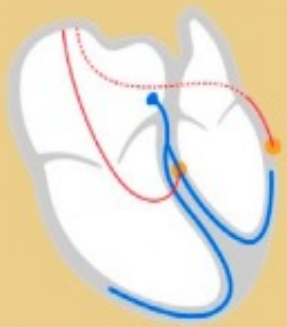
CRT’de koroner sinüs pacing vs LBBP

Dr Orçun Çiftci

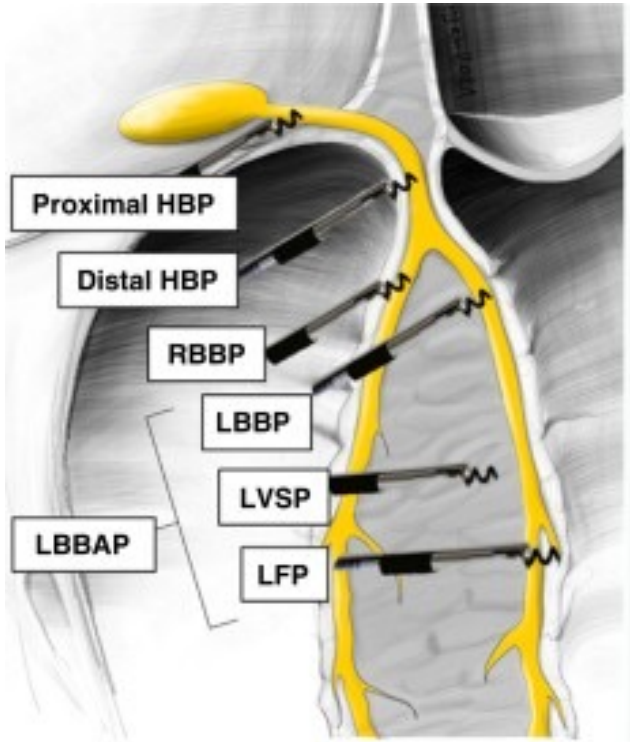
Başkent Üniversitesi Tıp Fakültesi Kardiyoloji ABD

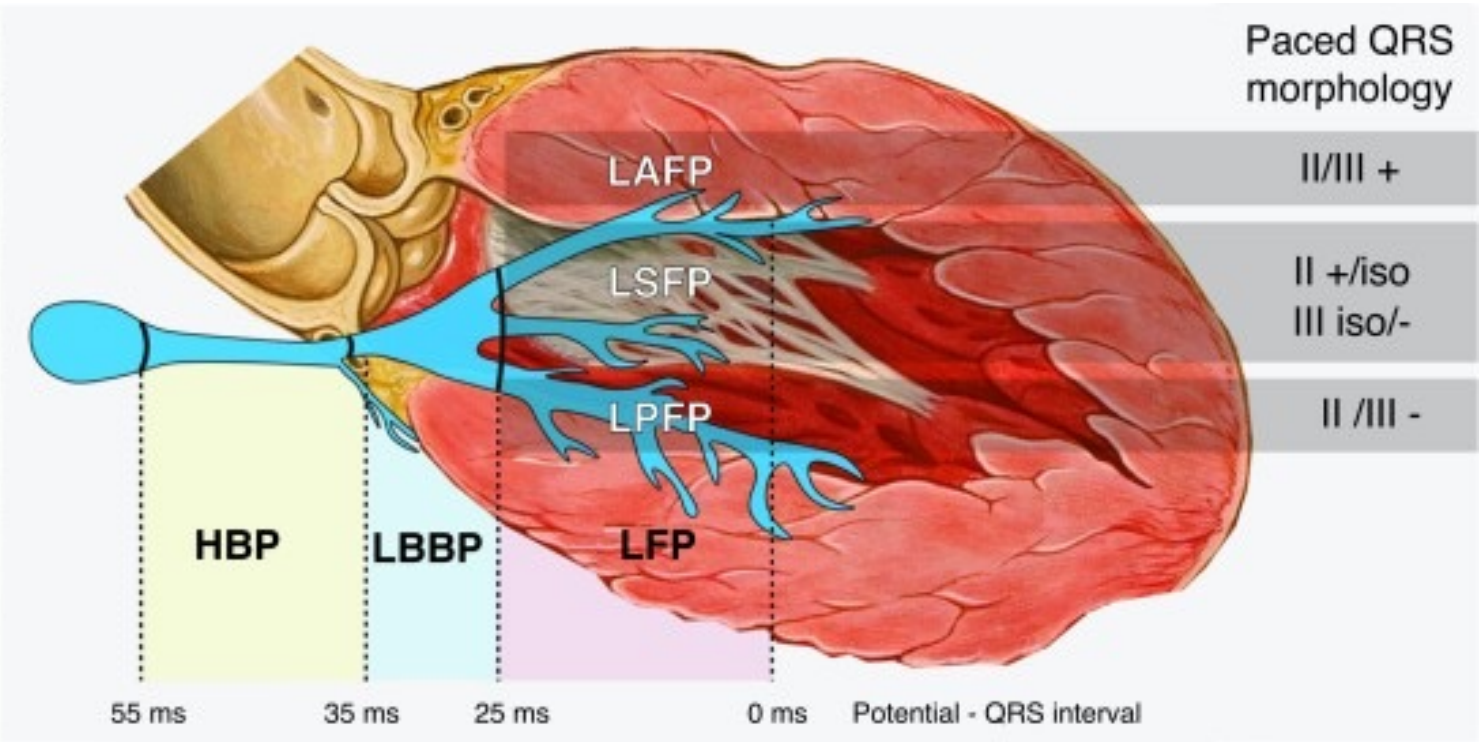

Biventricular Pacing (BVP)
Left Bundle Branch Area Pacing (LBBAP)

CRT opsiyonları

Conventional BiV pacing	Conduction System Pacing			
	HBP	***HOT-CRT***	***LBBAP***	***LOT-CRT***
				
▪ **Endocardial RV pacing** + **Epicardial LV pacing**	▪ **His bundle pacing** (between distal AV node and His bundle branching)	▪ **His bundle** + **Epicardial LV pacing**	▪ **LBB pacing** (between His bundle branching and LBB division) ▪ **LF pacing** (capture of LA, LS or LP fascicles) ▪ **LVS pacing** (left side interventricular septum, no direct activation of conduction system)	▪ **LBBAP** + **Epicardial LV pacing**
👍 • Overcomes electrical conduction delays in case of septal scar • Allows multipoint LV pacing	👍 • More physiological form of CSP	👍 • Improves electrical resynchronization in case of slow myocardial conduction	👍 • Able to correct infra-Hisian blocks • Lower capture thresholds	👍 • Improves electrical resynchronization in case of severe His-Purkinje disease or slow myocardial conduction
👎 • Non-physiological ventricular activation (from epicardium to endocardium) • Identification of optimal LV pacing site required to increase CRT response	👎 • Inability to correct infra-Hisian blocks • Electrical resynchronization affected by septal scar • High capture thresholds	👎 • High His capture thresholds • Tailored AV and VV interval programmings • DF-1 connection if ICD therapy required	👎 • Electrical resynchronization affected by septal scar	👎 • Tailored AV and VV interval programmings • DF-1 connection if ICD therapy required

İleti sistemi pacingi





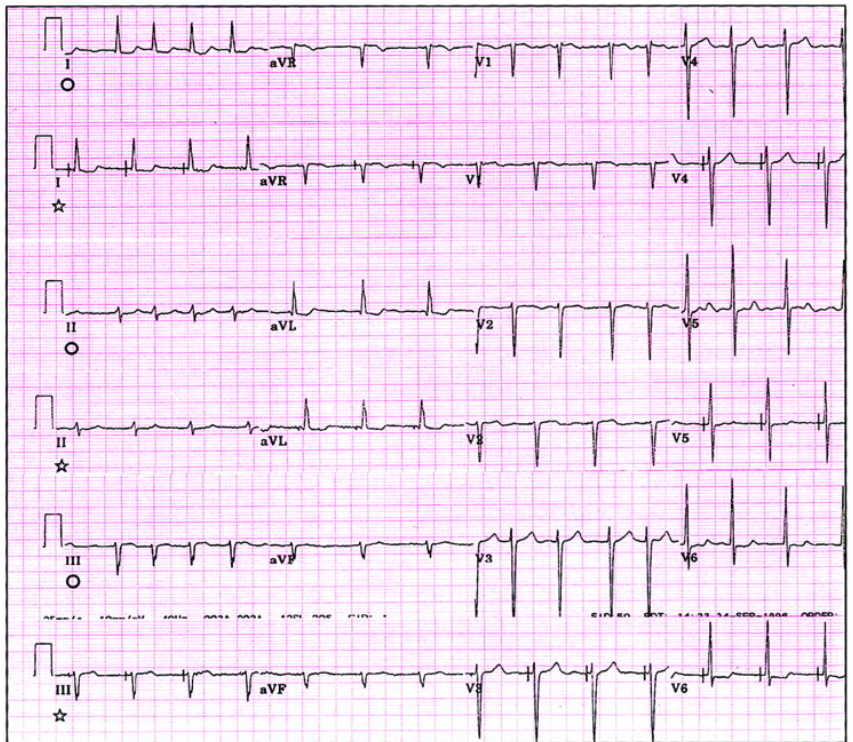
His bundle pacing

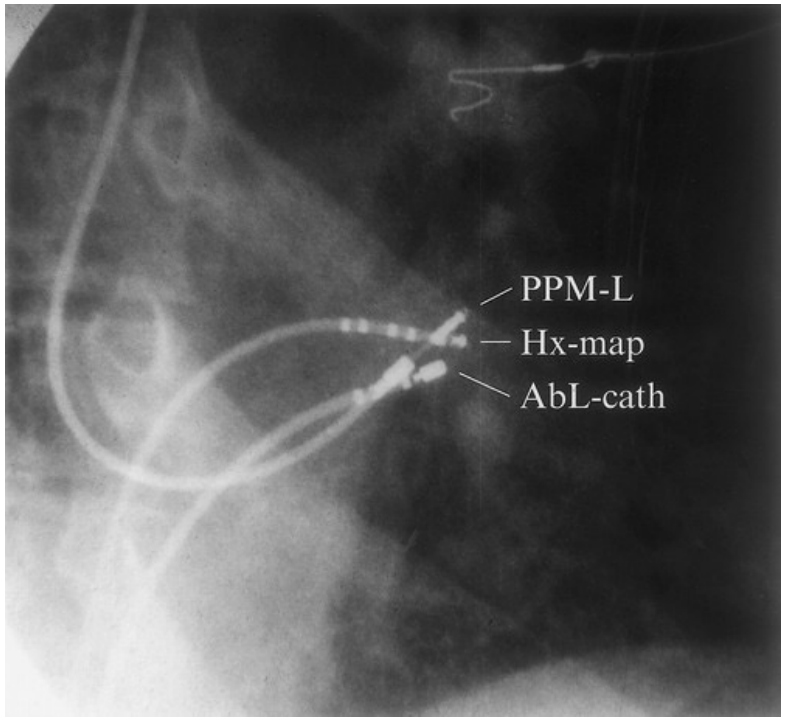
Permanent, Direct His-Bundle Pacing

A Novel Approach to Cardiac Pacing in Patients With Normal His-Purkinje Activation

Pramod Deshmukh, David A. Casavant, Mary Romanyshyn and Kathleen Anderson

Originally published 29 Feb 2000 | https://doi.org/10.1161/01.CIR.101.8.869 |
Circulation. 2000;101:869–877





His bundle pacing dezavantajları

- Uzun prosedür süresi
- His demetinin fibröz bir kılıf ile kaplı olması sonucu penetrasyon zorluğu
- Yüksek eşikler
- Düşük R dalgası
- Atrial oversensing
- Sol dal bloğu varlığında QRS normalizasyonunda başarısızlık
- Akut ve kronik dislodgement ve eşik yükselmesi

Sol dal pacing (LBBP)

ELSEVIER

Canadian Journal of Cardiology
Volume 33, Issue 12, December 2017, Pages 1736.e1-1736.e3

Case Report

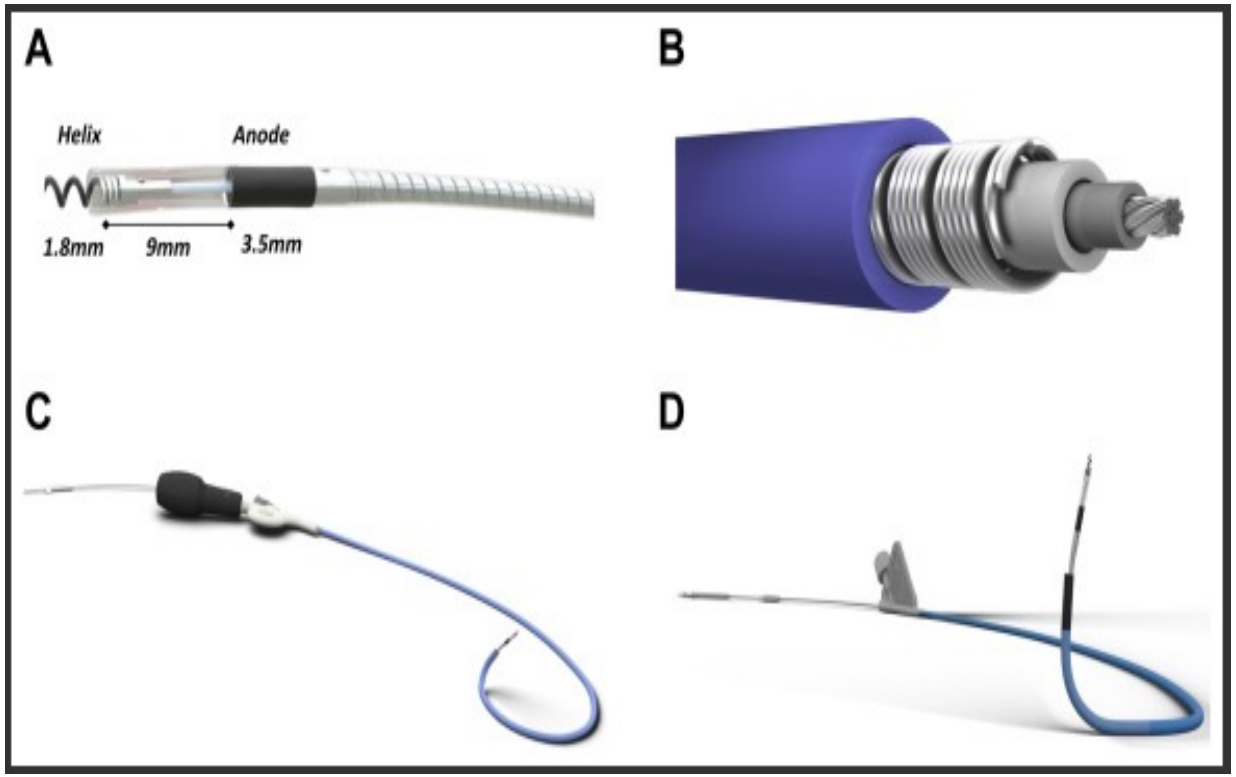
A Novel Pacing Strategy With Low and Stable Output: Pacing the Left Bundle Branch Immediately Beyond the Conduction Block

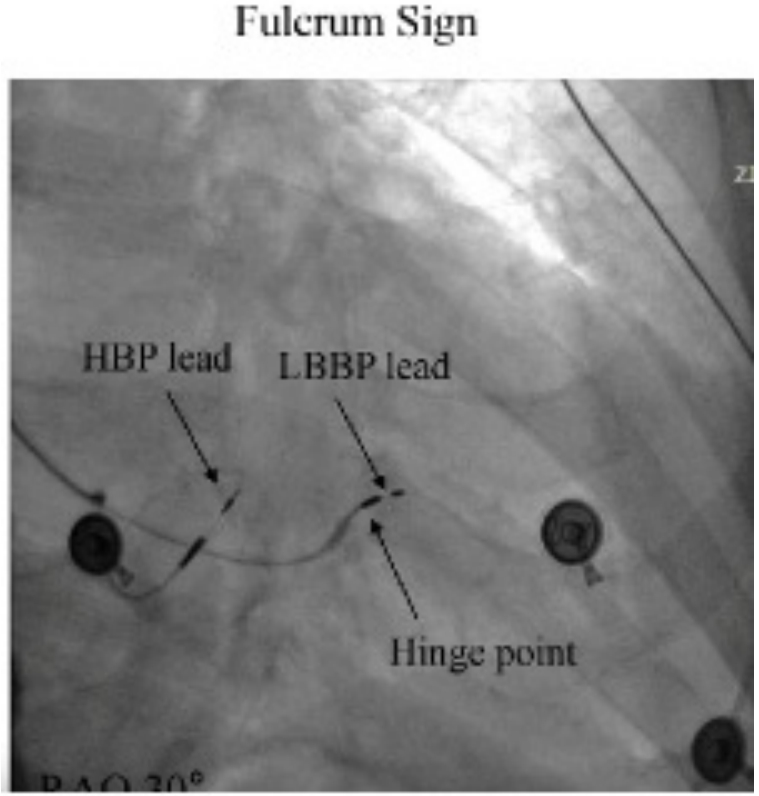
Weijian Huang MD, FHRS [a], Lan Su MD [a], Shengjie Wu MD [a], Lei Xu MD [a], Fangyi Xiao MD [a], Xiaohong Zhou MD [b], Kenneth A. Ellenbogen MD, FHRS [c]

LBBP

Medtronic SelectSecure™ model 3830 (Medtronic Inc.) : 4.1 F, lümensiz, kateter ile yerleştirilen, fiks aktif fiksasyon heliksli lead

The C315 His sheath





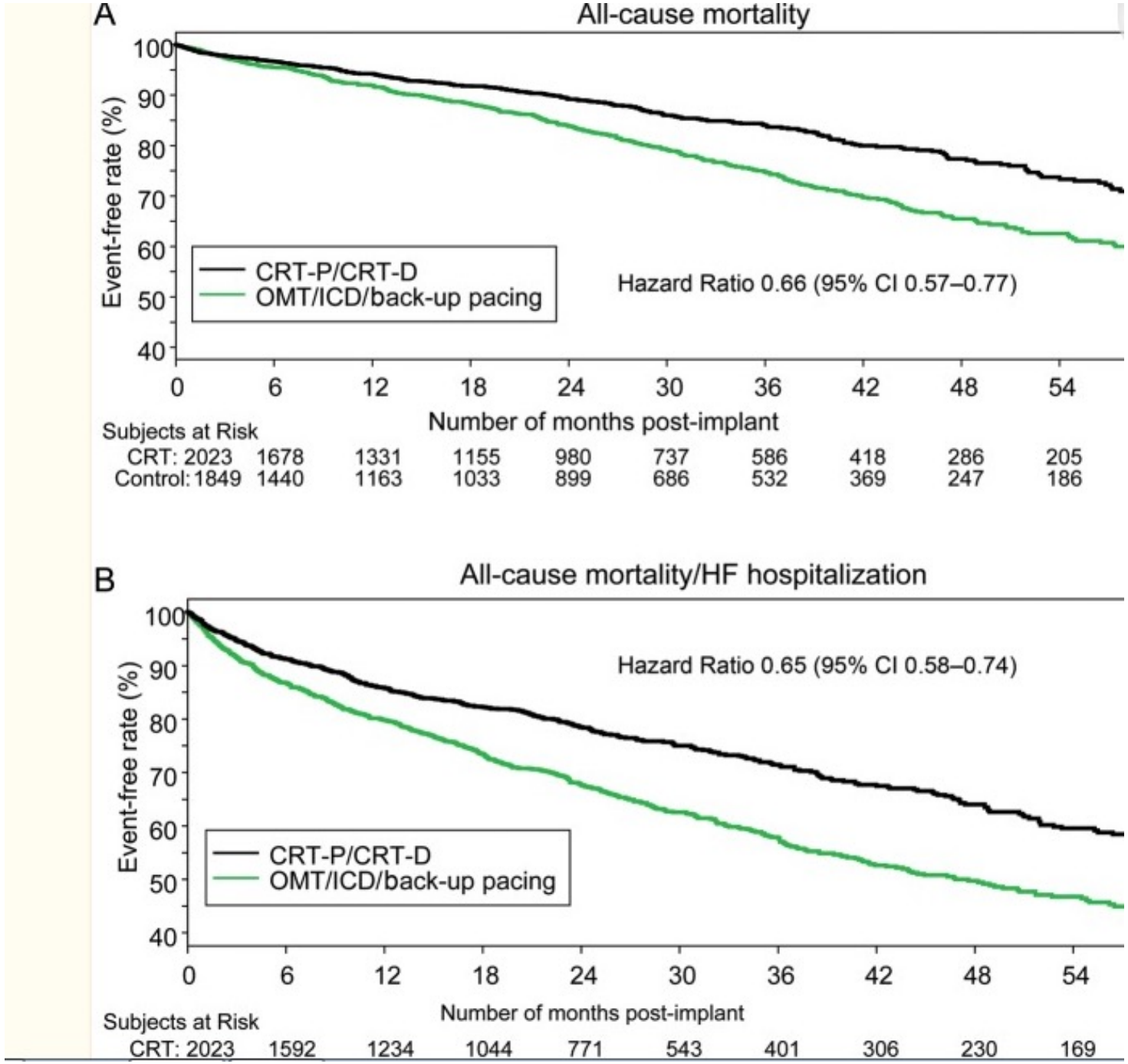
Neden CRT'de ileti sistemi pacingi ihtiyacı?

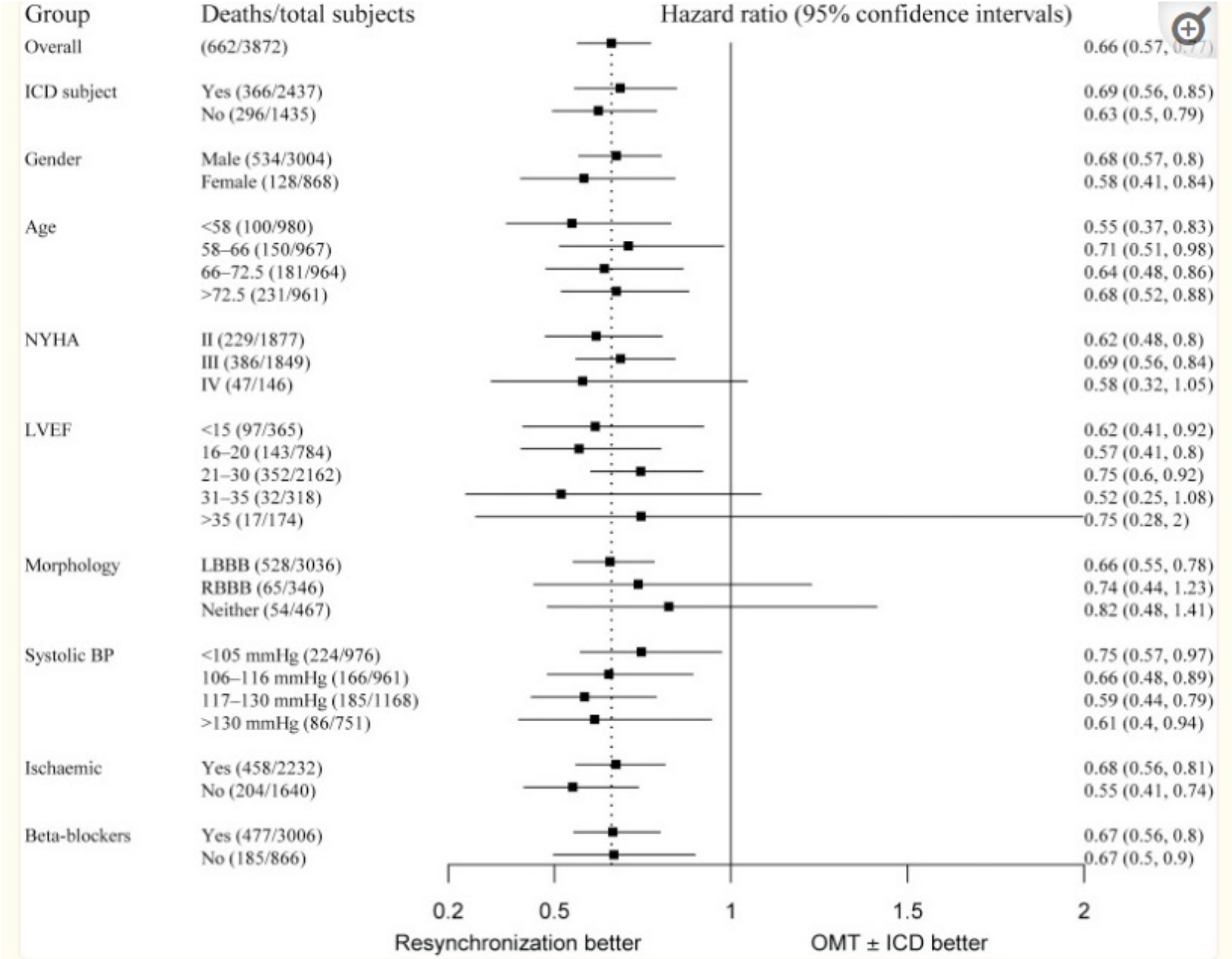
- BİVP ile non response rate (% 30-50)
- Non-fizyolojik resenkronizasyon ile repolarizasyon dispersiyonu ve QT uzaması > torsade de pointes?
- Koroner sinüs dallarının uygun anatomiye sahip olmaması, venöz kapakcık ve darlıklar, ince kalibrasyon
- Koroner sinüs perforasyonu/diseksiyonu
- Frenik sinir uyarımı, yüksek eşikler, CS lead'inde dislodgement
- Skar bölgesinden uyarının faydasız olması

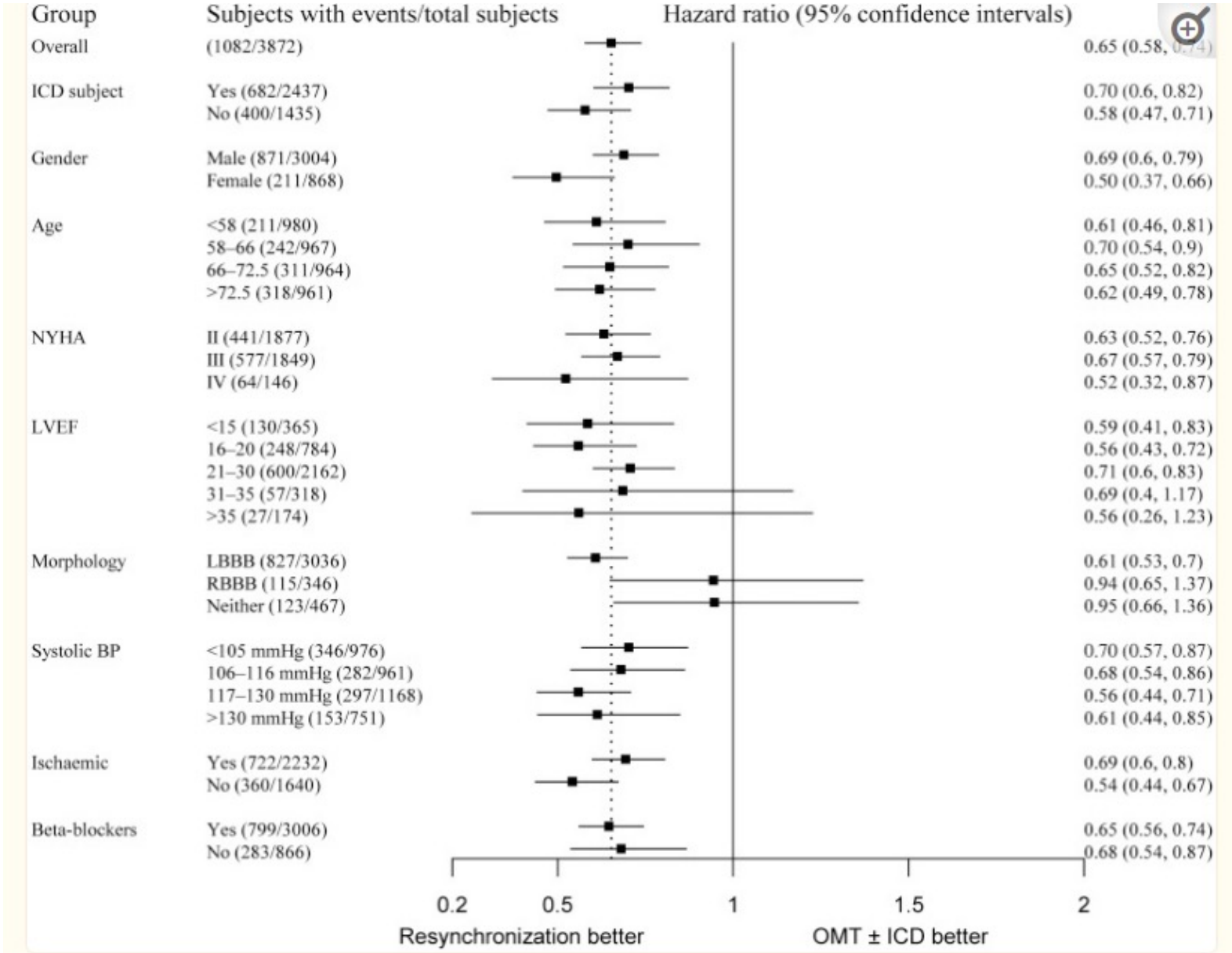
CRT için ilk tercih CSP olmalı

Koroner sinüs pacing ile ile CRT

- ***Kılavuz önerisi standard tedavi***
- **Son yıllara kadar tek** CRT metodu
- Halen **en sık kullanılan** CRT metodu
- Bilgi-tecrübe ve takip yönünden **ciddi bir birikim** oluştu


A
All-cause mortality
Event-free rate (%)
100
90
80
70
60
50
40
CRT-P/CRT-D
OMT/ICD/back-up pacing
Hazard Ratio 0.66 (95% CI 0.57–0.77)
0
6
12
18
24
30
36
42
48
54
Number of months post-implant
Subjects at Risk
CRT: 2023 1678 1331 1155 980 737 586 418 286 205
Control: 1849 1440 1163 1033 899 686 532 369 247 186
B
All-cause mortality/HF hospitalization
Event-free rate (%)
100
90
80
70
60
50
40
CRT-P/CRT-D
OMT/ICD/back-up pacing
Hazard Ratio 0.65 (95% CI 0.58–0.74)
0
6
12
18
24
30
36
42
48
54
Number of months post-implant
Subjects at Risk
CRT: 2023 1592 1234 1044 771 543 401 306 230 169


Group
Deaths/total subjects
Hazard ratio (95% confidence intervals)
Overall
(662/3872)
0.66 (0.57,
ICD subject
Yes (366/2437)
0.69 (0.56, 0.85)
No (296/1435)
0.63 (0.5, 0.79)
Gender
Male (534/3004)
0.68 (0.57, 0.8)
Female (128/868)
0.58 (0.41, 0.84)
Age
<58 (100/980)
0.55 (0.37, 0.83)
58–66 (150/967)
0.71 (0.51, 0.98)
66–72.5 (181/964)
0.64 (0.48, 0.86)
>72.5 (231/961)
0.68 (0.52, 0.88)
NYHA
II (229/1877)
0.62 (0.48, 0.8)
III (386/1849)
0.69 (0.56, 0.84)
IV (47/146)
0.58 (0.32, 1.05)
LVEF
<15 (97/365)
0.62 (0.41, 0.92)
16–20 (143/784)
0.57 (0.41, 0.8)
21–30 (352/2162)
0.75 (0.6, 0.92)
31–35 (32/318)
0.52 (0.25, 1.08)
>35 (17/174)
0.75 (0.28, 2)
Morphology
LBBB (528/3036)
0.66 (0.55, 0.78)
RBBB (65/346)
0.74 (0.44, 1.23)
Neither (54/467)
0.82 (0.48, 1.41)
Systolic BP
<105 mmHg (224/976)
0.75 (0.57, 0.97)
106–116 mmHg (166/961)
0.66 (0.48, 0.89)
117–130 mmHg (185/1168)
0.59 (0.44, 0.79)
>130 mmHg (86/751)
0.61 (0.4, 0.94)
Ischaemic
Yes (458/2232)
0.68 (0.56, 0.81)
No (204/1640)
0.55 (0.41, 0.74)
Beta-blockers
Yes (477/3006)
0.67 (0.56, 0.8)
No (185/866)
0.67 (0.5, 0.9)
0.2
0.5
1
1.5
2
Resynchronization better
OMT ± ICD better

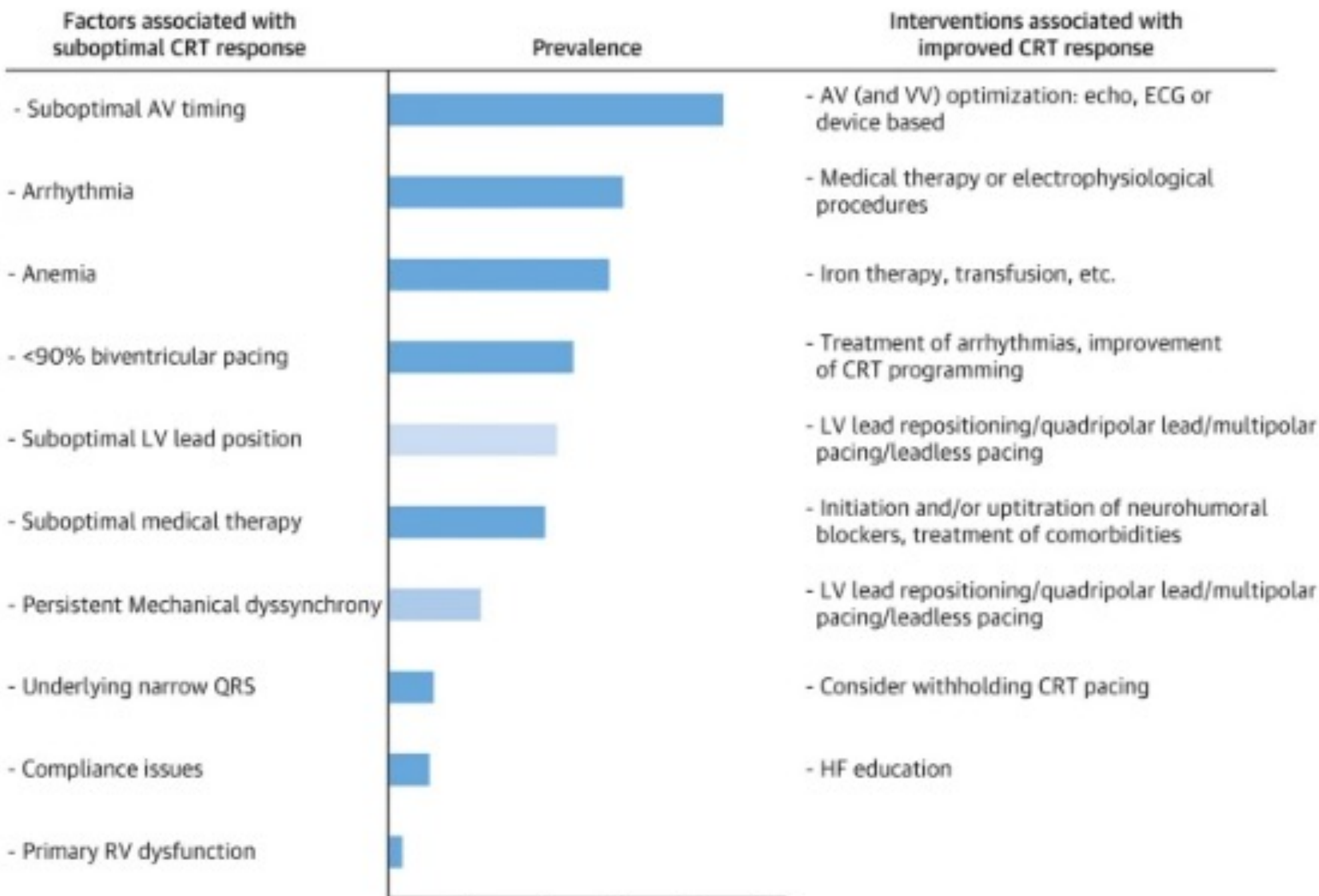

Group
Subjects with events/total subjects
Hazard ratio (95% confidence intervals)
Overall
(1082/3872)
0.65 (0.58, 0.74)
ICD subject
Yes (682/2437)
0.70 (0.6, 0.82)
No (400/1435)
0.58 (0.47, 0.71)
Gender
Male (871/3004)
0.69 (0.6, 0.79)
Female (211/868)
0.50 (0.37, 0.66)
Age
<58 (211/980)
0.61 (0.46, 0.81)
58–66 (242/967)
0.70 (0.54, 0.9)
66–72.5 (311/964)
0.65 (0.52, 0.82)
>72.5 (318/961)
0.62 (0.49, 0.78)
NYHA
II (441/1877)
0.63 (0.52, 0.76)
III (577/1849)
0.67 (0.57, 0.79)
IV (64/146)
0.52 (0.32, 0.87)
LVEF
<15 (130/365)
0.59 (0.41, 0.83)
16–20 (248/784)
0.56 (0.43, 0.72)
21–30 (600/2162)
0.71 (0.6, 0.83)
31–35 (57/318)
0.69 (0.4, 1.17)
>35 (27/174)
0.56 (0.26, 1.23)
Morphology
LBBB (827/3036)
0.61 (0.53, 0.7)
RBBB (115/346)
0.94 (0.65, 1.37)
Neither (123/467)
0.95 (0.66, 1.36)
Systolic BP
<105 mmHg (346/976)
0.70 (0.57, 0.87)
106–116 mmHg (282/961)
0.68 (0.54, 0.86)
117–130 mmHg (297/1168)
0.56 (0.44, 0.71)
>130 mmHg (153/751)
0.61 (0.44, 0.85)
Ischaemic
Yes (722/2232)
0.69 (0.6, 0.8)
No (360/1640)
0.54 (0.44, 0.67)
Beta-blockers
Yes (799/3006)
0.65 (0.56, 0.74)
No (283/866)
0.68 (0.54, 0.87)
0.2
0.5
1
1.5
2
Resynchronization better
OMT ± ICD better

Sorun ne?

- Non-response

CRT ile non-response

- % 30-50 hasta
- Universal bir tanımı yok
- Subjektif değerlendirmeler baz alınarak hesaplanırsa daha yüksek, ancak remodeling ve sonlanım noktaları baz alınırsa daha düşük
- Semptomatik iyileşme her zaman ekokardiyografik ya da fonksiyonel iyileşme ile paralel değil
- Remodelingin ne zaman değerlendirilmesi gerektiği ile ilgili de fikir birliği yok


Factors associated with suboptimal CRT response
Prevalence
Interventions associated with improved CRT response
- Suboptimal AV timing
- AV (and VV) optimization: echo, ECG or device based
- Arrhythmia
- Medical therapy or electrophysiological procedures
- Anemia
- Iron therapy, transfusion, etc.
- <90% biventricular pacing
- Treatment of arrhythmias, improvement of CRT programming
- Suboptimal LV lead position
- LV lead repositioning/quadripolar lead/multipolar pacing/leadless pacing
- Suboptimal medical therapy
- Initiation and/or uptitration of neurohumoral blockers, treatment of comorbidities
- Persistent Mechanical dyssynchrony
- LV lead repositioning/quadripolar lead/multipolar pacing/leadless pacing
- Underlying narrow QRS
- Consider withholding CRT pacing
- Compliance issues
- HF education
- Primary RV dysfunction

Non-responder oranlarını azaltma stratejileri

- Hasta seçiminin optimizasyonu
    - QRS > 150 ms + LBBB
    - Non-İskemik KMP, ciddi skar yükü olmayan hasta seçimi
    - Skar görüntüleme (MR)
    - Dissenkroninin ekokardiyografik olarak değerlendirilmesi ve en geç bölgelerin belirlenmesi
    - Elektriksel geç bölgelerin belirlenmesi
- Lead yerleşimi ve tipi
    - Postero-lateral/lateral dallar ve bazal-mid miyokardiyal segmentler
    - Apikal uyarıdan kaçınmak
    - Frenik sinir uyarımını
    - Kuadripolar (multipoint pacing)
    - Multisite pacing
    - Leadless endokardiyal LV pacing
    - Endokardiyal LV uyarımı

AV ve VV optimizasyon

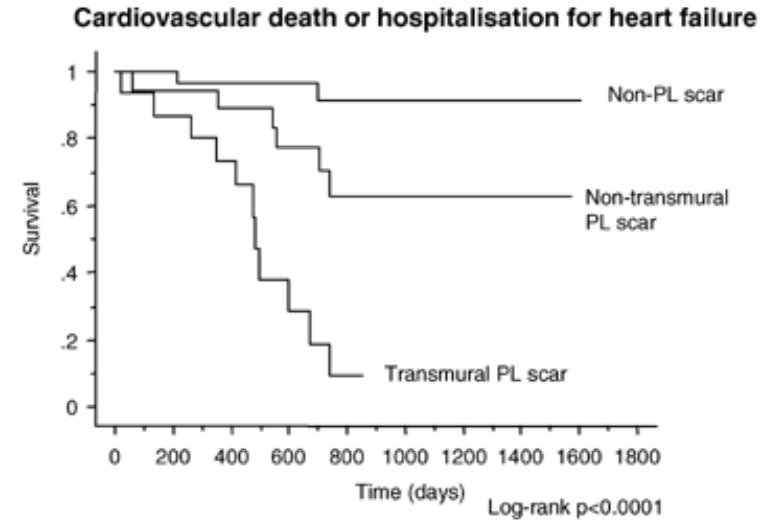
LV Pacing oranının artırılması

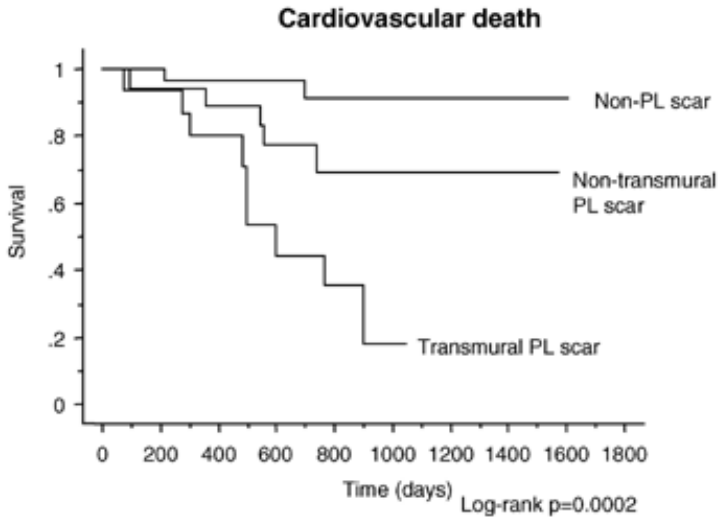
Atrial ve ventriküler aritmi yükünün azaltılması

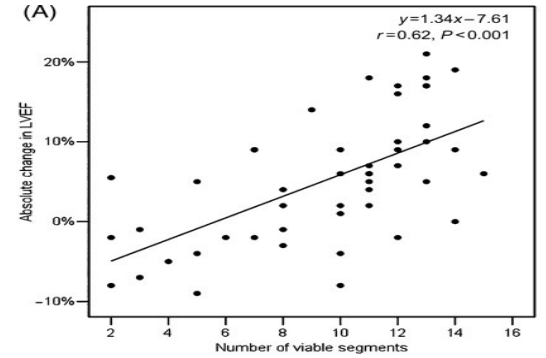
- Antiaritmik, ablasyon, AVNA

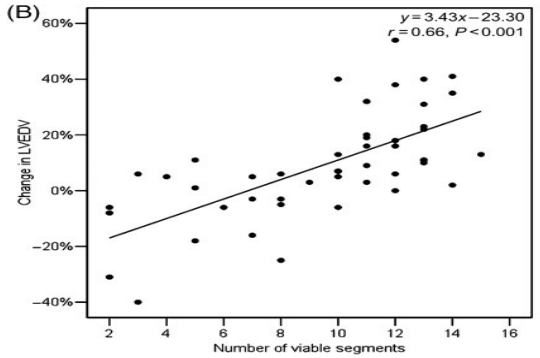
Elektriksel aktivite gecikmesi ve görüntüleme

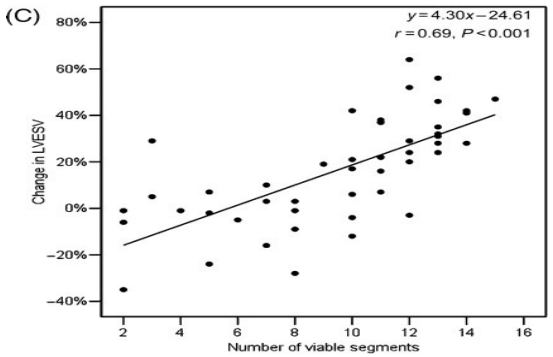
- **Gecikmiş elektriksel aktivasyonun** belirlenmesi
- Akut hemodinamik yanıt araştırması
- **Skar yükü ve lokalizasyonu** belirlenmesi
- Elektriksel ve mekanik haritalama









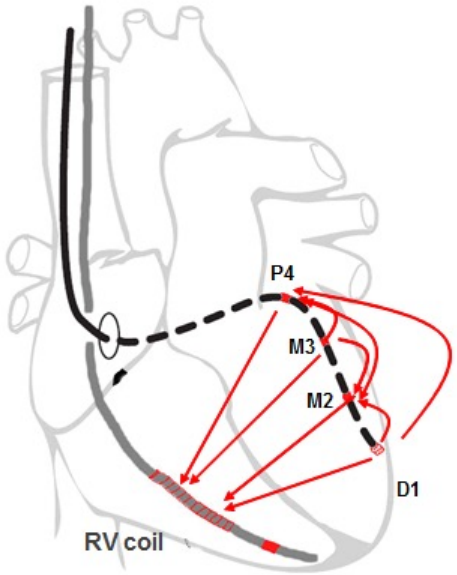


Eur Heart J, Volume 28, Issue 1, January 2007, Pages 33–41, https://doi.org/10.1093/eurheartj/ehl379

S. CHALIL , **Effect of Posterolateral Left Ventricular Scar on Mortality and Morbidity following Cardiac Resynchronization Therapy**, Circulation 2007(30) : 1201-1209

Multipoint LV pacing

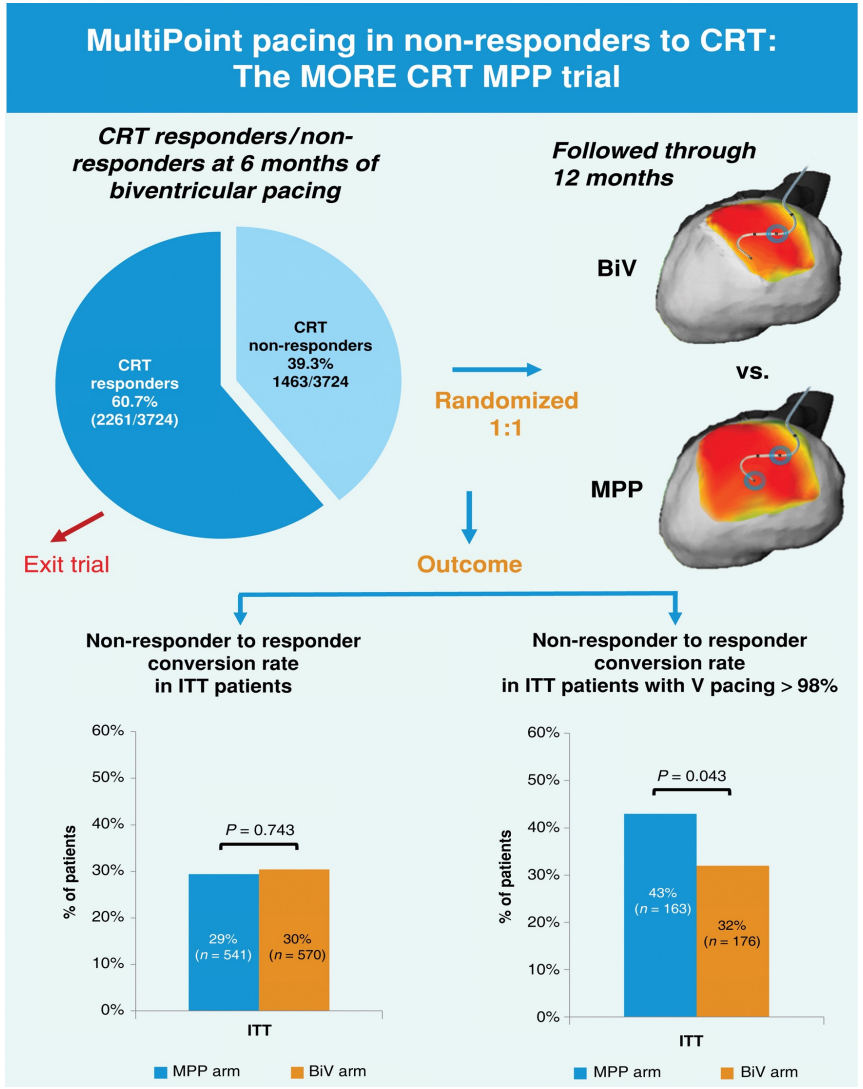
- Kuadripolar leadlerin kullanıma girmesi ile mümkün hale geldi
- Kuadripolar Lead boyunca multiple LV noktasının uyarılması sonucu daha geniş bir eksitable miyokardium capture mümkün
- Akut hemodinami ve kontraktilite üzerinde anlamlı etkiler



10 LV Configurations

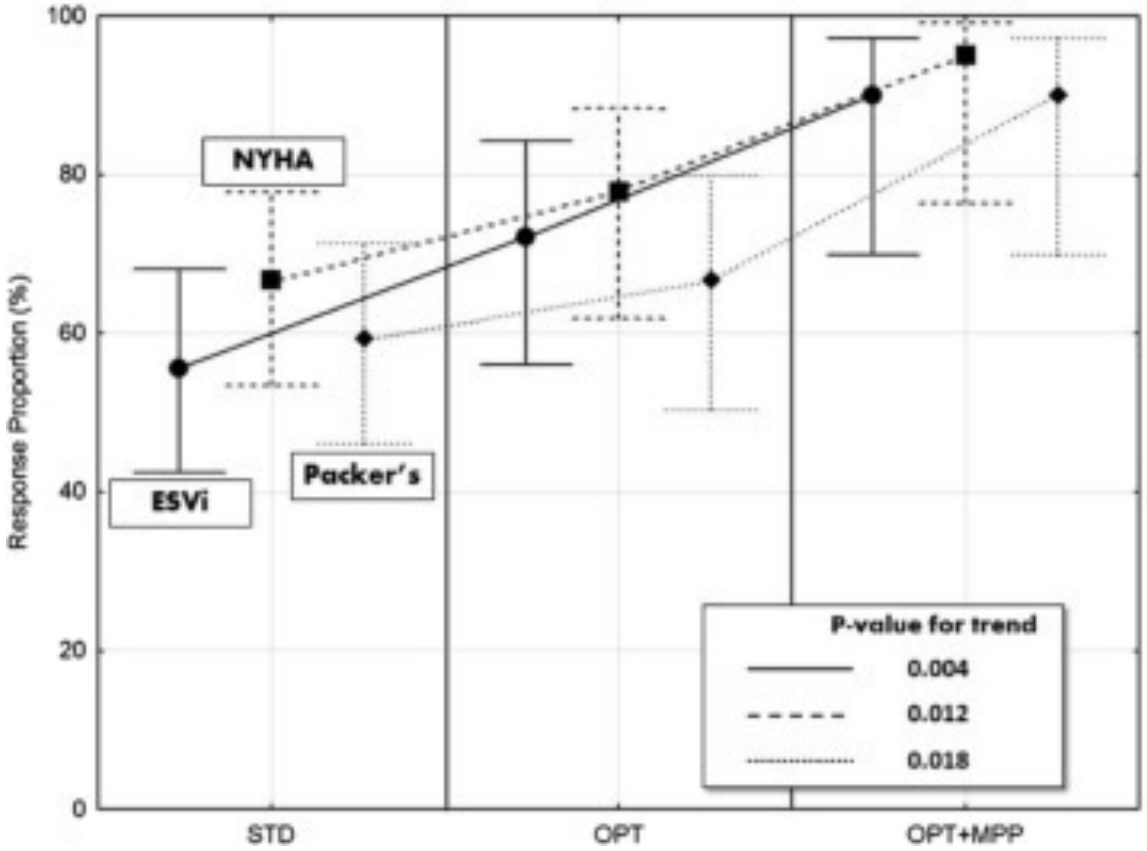
- **D1 – M2**
- **D1 – P4**
- **D1 – RV coil**
- **M2 – P4**
- **M2 – RV coil**
- **M3 – M2**
- **M3 – P4**
- **M3 – RV coil**
- **P4 – M2**
- **P4 – RV coil**

Graphical abstract



Europace, Volume 25, Issue 10, October 2023, euad294, https://doi.org/10.1093/europace/euad294

Multipoint pacing artı optimal Lead pozisyonu



MPP + optimal Lead poziasyonu ile LV volüme index ve NYHA'ya göre responder oranı sırasıyla % 90 ve 95

Zanon F. Heart Rhythm, 2016-08-01, Volume 13, Issue 8, Pages 1644-1651

LBBP

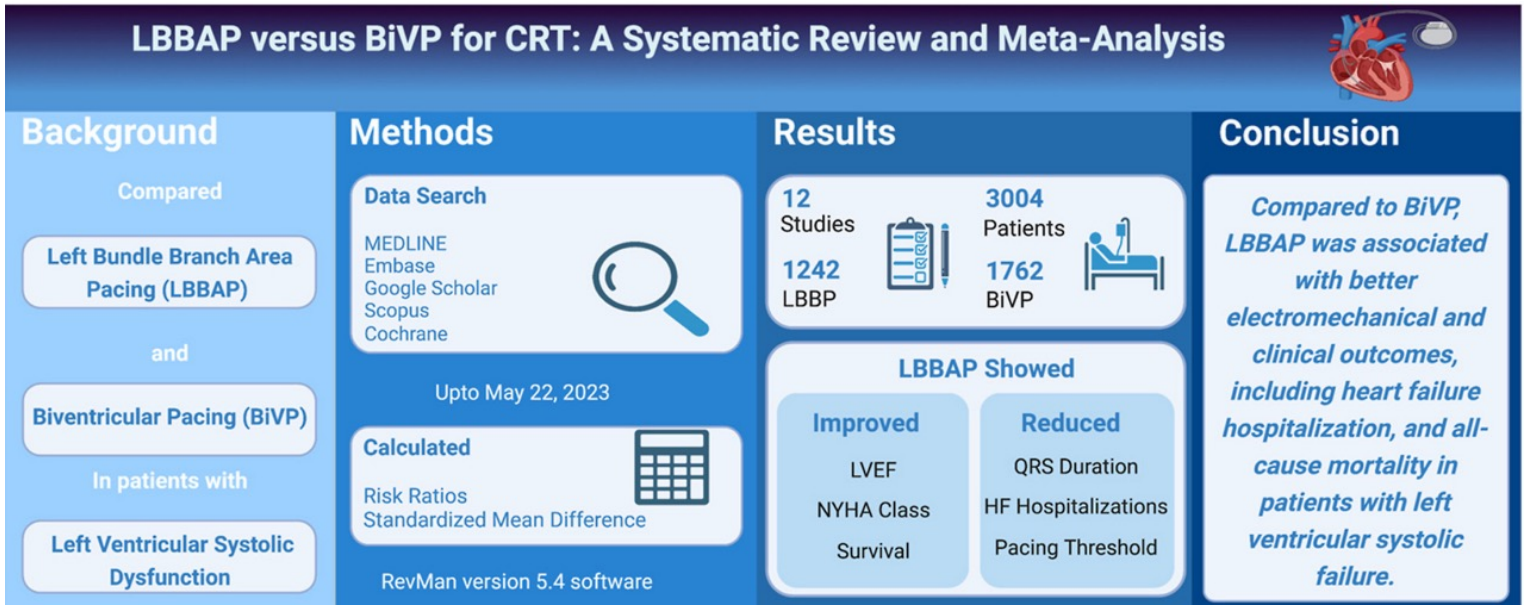
LBBB

- Başarı oranları % 89-97
- HBP’e göre daha kolay prosedür
- Non responder rate %11-15
- Komplikasyon oranları % 10’lara yakın

Left bundle branch area pacing vs biventricular pacing for cardiac resynchronization: A systematic review and meta-analysis

Amman Yousaf, MD,[*1] Soban Ahmad, MD,[†1] Joshua Peltz, MD,[†] Muhammad Junaid Ahsan, MD,[‡] Kirellos Said Abbas, MBBCh,[§] Shoaib Muhammad, MBBS,[||] Christopher Watson, MD,[†] Zain Ul Abideen Asad, MD, MS,[¶] Michael H. Kim, MD, MMM, FHRS[**]

*From the *Department of Medicine, McLaren Flint-Michigan State University, Flint, Michigan, †Department of Medicine, East Carolina University, Greenville, North Carolina, ‡Division of Cardiology, Iowa Heart Center, Des Moines, Iowa, §Department of Medicine, Alexandria University, Alexandria, Egypt, ||Department of Medicine, Gulab Devi Hospital, Lahore, Pakistan, ¶Department of Medicine, University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma, and **Department of Medicine, Creighton University and CHI Health, Omaha, Nebraska.*



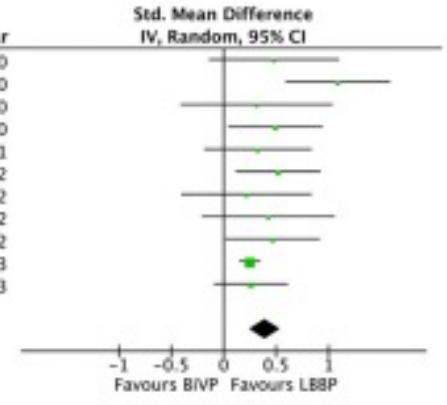
Yousaf A. Heart Rhytm O2 Nov 2023; 4 (11):671-680

First author, year	Study design	Country of origin	Total cohort	LBBAP	BiVP	Mean follow-up duration (mo)	CRT criteria used	NOS score
Guo et al, 2020[6]	Prospective	China	42	21	21	14.3	QRSd ≥150 ms, typical LBBB	8
Li et al, 2020[7]	Prospective	China	81	27	54	6	LBBB (QRSd N/A)	7
Wang et al, 2020[8]	Prospective	China	40	10	30	6	QRSd >140 ms (men) and >130 ms (women), typical LBBB	7
Wu et al, 2021[9]	Prospective	China	86	32	54	12	Typical LBBB (QRSd N/A)	8
Liu et al, 2021[15]	Prospective	China	62	27	35	6	QRSd ≥150 ms, typical LBBB	7
Chen et al, 2022[10]	Prospective	China	100	49	51	12	QRSd ≥150 ms, typical LBBB	8
Hua et al, 2022[11]	Prospective	China	41	21	20	23.71	QRSd ≥150 ms, typical LBBB	8
Wang et al, 2022[12]	RCT	China	40	20	20	6	QRSd >140 ms (men) and >130 ms (women), typical LBBB	N/A
Liang et al, 2022[13]	Retrospective	China	491	154	337	31	QRSd ≥130 ms	8
Rademakers et al, 2023[14]	Prospective	The Netherlands	80	40	40	6	QRSd ≥150 ms, typical LBBB	7
Ezzeddine et al, 2023[16]	Retrospective	United States, Spain, Canada	169	50	119	8 (LBBAP) and 10 (BiVP)	QRSd ≥120 ms	8
Vijayaraman et al, 2023[17]	Retrospective	North America, Asia, Europe	1778	797	981	33	NYHA II-IV, LVEF ≤35%, and indication for CRT or expected V-pacing >40%	8

A Improvement in LVEF

Study or Subgroup	LBBP Mean	LBBP SD	LBBP Total	BiVP Mean	BiVP SD	BiVP Total	Weight	Std. Mean Difference IV, Random, 95% CI	Year
Guo et al, 2020	20.5	9.6	21	15.4	11.2	21	4.7%	0.48 [-0.13, 1.09]	2020
Li et al, 2020	15.5	6.6	27	7.8	7.2	54	6.8%	1.09 [0.60, 1.58]	2020
Wang et al, 2020	18.9	6.7	10	13	20.8	30	3.5%	0.31 [-0.41, 1.03]	2020
Wu et al, 2021	24	12.1	32	16.8	15.7	54	8.1%	0.49 [0.05, 0.94]	2020
Liu et al, 2021	17.2	9.3	27	13.7	11.5	35	6.5%	0.33 [-0.18, 0.83]	2021
Chen et al, 2022	20.9	11.8	49	15.2	10	51	9.5%	0.52 [0.12, 0.92]	2022
Hua et al, 2022	15.7	14.6	21	12.8	11.1	20	4.7%	0.22 [-0.40, 0.83]	2022
Wang et al, 2022	21.1	14.2	20	15.6	10.9	20	4.5%	0.43 [-0.20, 1.05]	2022
Rademakers et al, 2022	15.2	11.7	40	9.6	12.1	40	8.0%	0.47 [0.02, 0.91]	2022
Vijayaraman et al, 2023	13	12	797	10	12	981	32.1%	0.25 [0.16, 0.34]	2023
Ezzeddine et al, 2023	10	12.5	44	7.3	9.4	119	11.6%	0.26 [-0.09, 0.61]	2023
Total (95% CI)			**1088**			**1425**	**100.0%**	**0.40 [0.25, 0.54]**	

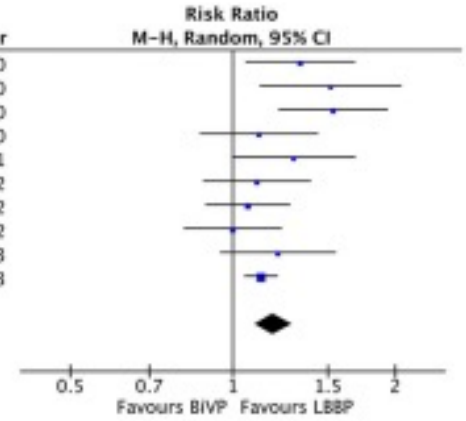
Heterogeneity: $Tau^2 = 0.01$; $Chi^2 = 13.91$, df = 10 (P = 0.18); $I^2 = 28\%$
Test for overall effect: Z = 5.44 (P < 0.00001)



B Echocardiographic response rate

Study or Subgroup	LBBP Events	LBBP Total	BiVP Events	BiVP Total	Weight	Risk Ratio M-H, Random, 95% CI	Year
Li et al, 2020	24	27	36	54	8.5%	1.33 [1.06, 1.68]	2020
Wang et al, 2020	10	10	19	30	5.8%	1.52 [1.12, 2.05]	2020
Wu et al, 2021	30	32	33	54	8.5%	1.53 [1.22, 1.93]	2020
Guo et al, 2020	19	21	17	21	7.6%	1.12 [0.87, 1.43]	2020
Liu et al, 2021	24	27	24	35	7.1%	1.30 [1.00, 1.68]	2021
Rademakers et al, 2022	25	29	28	36	8.7%	1.11 [0.88, 1.39]	2022
Chen et al, 2022	42	49	41	51	12.0%	1.07 [0.89, 1.27]	2022
Wang et al, 2022	18	20	18	20	9.9%	1.00 [0.81, 1.23]	2022
Ezzeddine et al, 2023	32	44	57	95	7.9%	1.21 [0.95, 1.55]	2023
Vijayaraman et al, 2023	492	667	495	757	23.9%	1.13 [1.05, 1.21]	2023
Total (95% CI)		**926**		**1153**	**100.0%**	**1.19 [1.10, 1.29]**	
Total events	716		768				

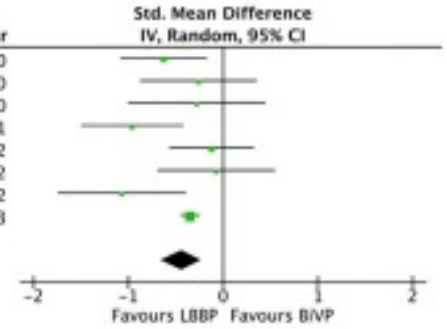
Heterogeneity: $Tau^2 = 0.01$; $Chi^2 = 14.67$, df = 9 (P = 0.10); $I^2 = 39\%$
Test for overall effect: Z = 4.22 (P < 0.0001)



C Improvement in NYHA functional class

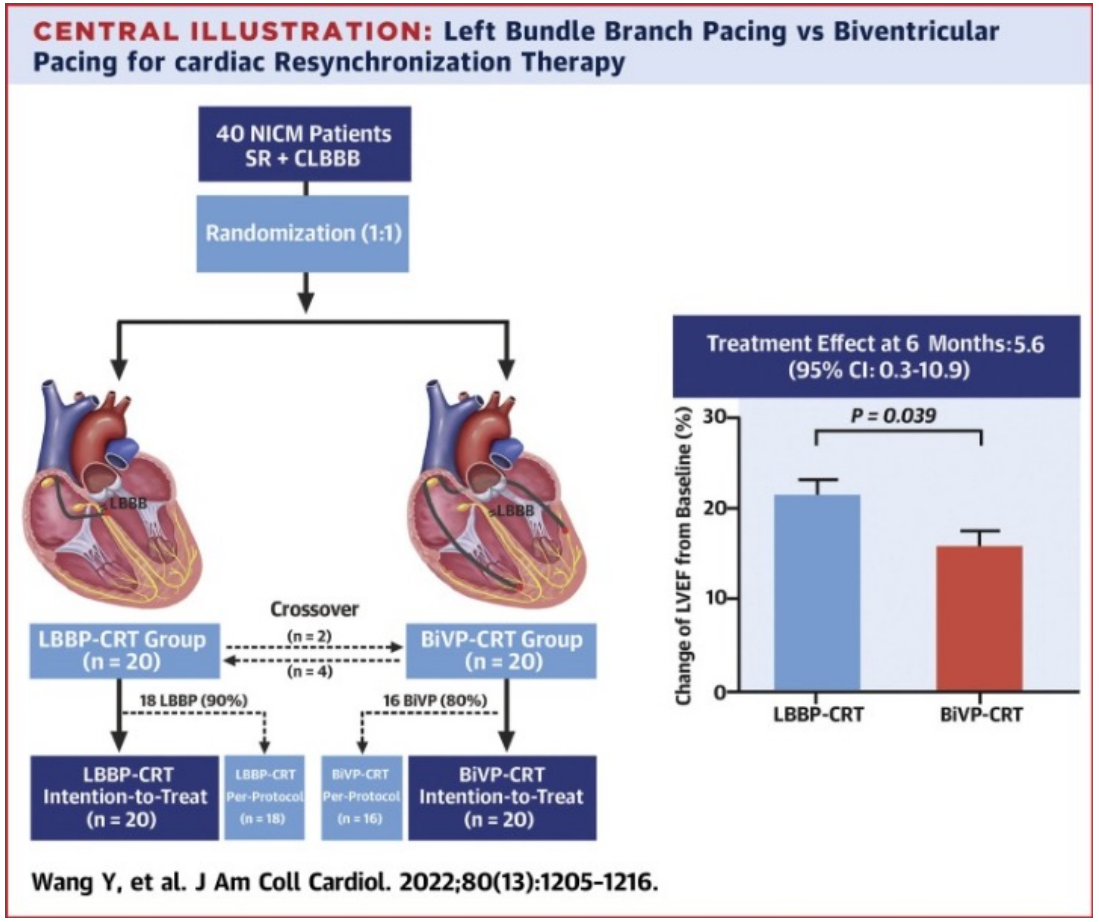
Study or Subgroup	LBBP Mean	LBBP SD	LBBP Total	BiVP Mean	BiVP SD	BiVP Total	Weight	Std. Mean Difference IV, Random, 95% CI	Year
Wu et al, 2021	-1.5	0.6	32	-0.9	1.1	54	13.2%	-0.63 [-1.08, -0.18]	2020
Guo et al, 2020	-1.7	0.8	21	-1.5	0.7	21	8.8%	-0.26 [-0.87, 0.35]	2020
Wang et al, 2020	-1.4	0.7	10	-1.2	0.7	30	6.8%	-0.28 [-1.00, 0.44]	2020
Liu et al, 2021	-1.6	0.6	27	-0.9	0.8	35	10.6%	-0.96 [-1.49, -0.43]	2021
Rademakers et al, 2022	-1.2	0.7	40	-1.1	0.9	40	13.5%	-0.12 [-0.56, 0.32]	2022
Hua et al, 2022	-1.17	0.9	21	-1.11	0.7	20	8.7%	-0.07 [-0.69, 0.54]	2022
Wang et al, 2022	-1.22	0.11	20	-1.1	0.11	20	7.7%	-1.07 [-1.74, -0.40]	2022
Vijayaraman et al, 2023	-0.8	0.8	797	-0.5	0.9	981	30.7%	-0.35 [-0.44, -0.26]	2023
Total (95% CI)			**968**			**1201**	**100.0%**	**-0.44 [-0.65, -0.23]**	

Heterogeneity: $Tau^2 = 0.04$; $Chi^2 = 12.71$, df = 7 (P = 0.08); $I^2 = 45\%$
Test for overall effect: Z = 4.08 (P < 0.0001)



LBBP ile ilgili belirsizlikler

- LBBP yeni bir teknik, uzun dönem sonuçlara ait takip verisi yok
- Non-response rate?
- KY hastalarında veriler gözlemsel çalışmalardan ve bu nedenle selection bias'e açık, sadece 1 adet randomize çalışma
- Septal skar olan hastalarda LBBP etkinlik?
- AV tam blok hastalarında sağ ventrikül dissenkronisi?
- Selektif LBBP ile stimüle sağ dal bloğu paterni ile potansiyel interventriküler dissenkroni?
- Distal sol dal ya da dalcık bloklarında senkronizasyon
- Diffüz intraventriküler iletim gecikmesinde senkronizasyon?



- Sonuçlar NIKMP hastalarına sınırlı
- Primer son noktalar kardiyovasküler olaylar ya da mortaliteyi kapsamıyor
- Örneklem küçük, power yalnızca LVEF'deki değişimleri belirlemeye yeterli, birçok p değeri sınıra yakın
- Takip görece kısa

Sağ dal bloğu olan hastalarda LBBP?

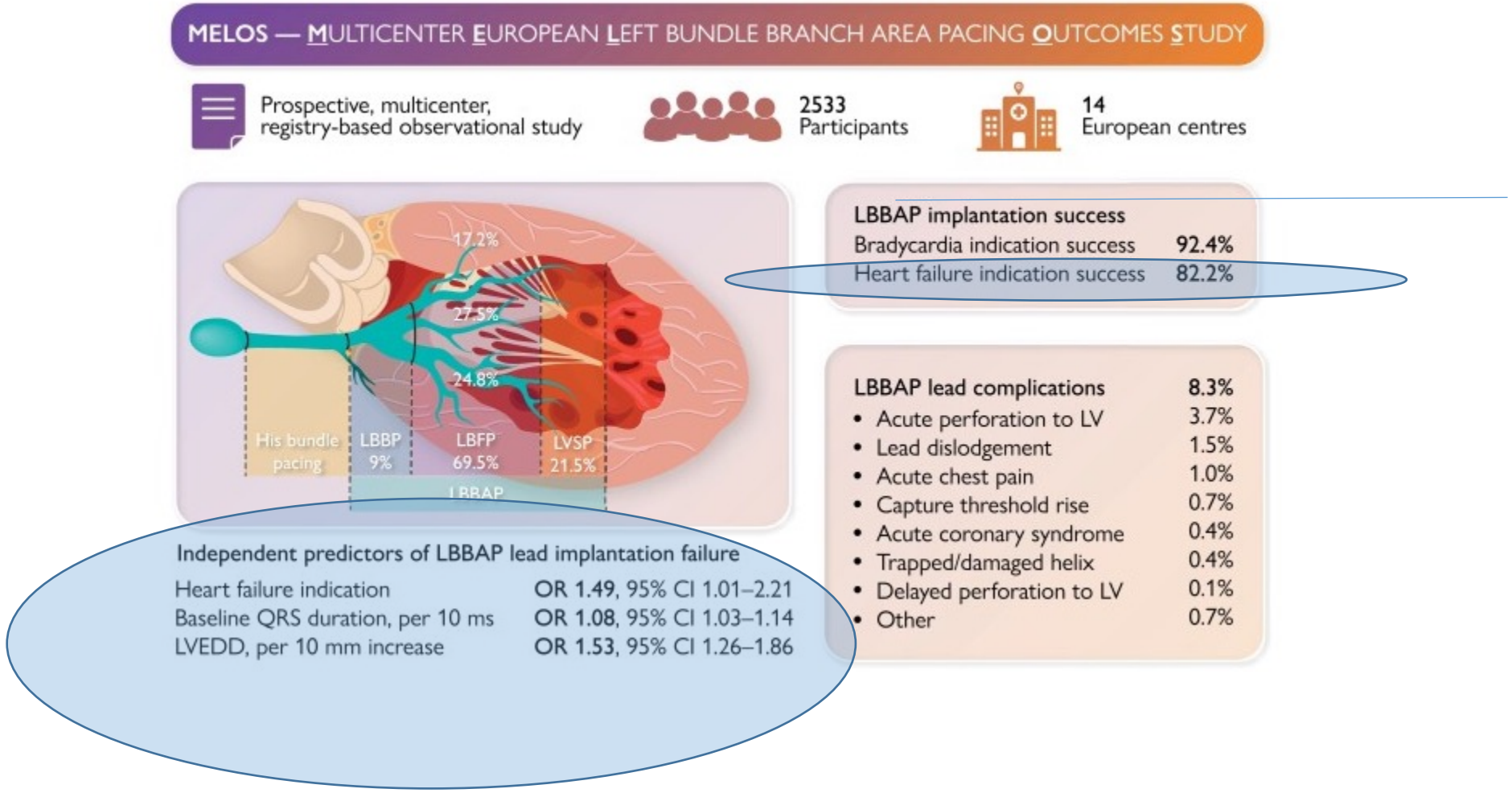
- Yüksek outputlu bipolar pacing ile Ring (anodal) capture ya da yüksek outputlu unipolar pacing ile komşuluk yolu ile sağ dalınyakalndığına ve RBBB'nin düzeltildiğine yönelik veriler var
- İleri çalışmalara ve sonlanım noktalarına bakmak lazım
- RBBB veya non-LBBB olan ve QRS'i ileri derece geniş hastalarda BİVP şu anda daha önde görünüyor

Distal iletim gecikmesi olan hastalarda LBBP?

- Distal LBB, LV purkinje ağı ya da miyokardiyumda ileti gecikmesi durumunda LBBP fizyolojik aktivasyonu düzeltme kabiliyeti azalıyor
- Hastaların önemli bir kısmında sadece sol ventriküler septal miyokardiyal capture oluşabiliyor, bu da LV lateral duvar aktivasyonunda küçük ancak potansiyel olarak önemli bir non-fizyolojik gecikme meydana getirebilir.

Kalp yetersizliğinde LBBP ile ilgili belirsizlikler

- Bu hastalarda septal fibrozis implantasyon başarısını düşürüyor
- LV ve QRS genişledikçe implantasyon başarısı azalıyor
- Dedicated implant ekipmanının ve LBBP implantasyon prosedürünün geliştirilmesi gerekli
- Septal fibrozis durumunda daha proksimal veya distalden pace? Koroner sinüs pacing?



Jastrzebski et al. Eur Heart J. 2022 Oct 21; 43(40): 4161–4173.

Variables	Unsuccessful LBBAP N=36	Successful LBBAP N=305	p Value
Age (years); Mean ± SD	70.8 ± 10.7	72.2 ± 12.1	0.53
Males (%)	28 (78%)	159 (52%)	0.004*
Hypertension	26 (72%)	182 (60%)	0.20
Diabetes Mellitus	16 (44%)	85 (28%)	0.05
Coronary Artery Disease	14 (39%)	92 (30%)	0.34
Coronary Artery Bypass Surgery	6 (17%)	31 (10%)	0.25
Valvular Heart Surgery	4 (11%)	46 (15%)	0.80
Left Ventricular Dysfunction (EF<50%)	17 (47%)	61 (20%)	0.001*
QRS Duration (ms); Mean ± SD	135.7 ± 41	115 ± 29	<0.001*
QRS Duration ≥150 ms	13 (37%)	38 (13%)	0.001*
Right Bundle Branch Block	8 (23%)	69 (23%)	1
Left Bundle Branch Block	8 (23%)	31 (10%)	0.047
Intra Ventricular Conduction Delay	4 (11%)	16 (5%)	0.14

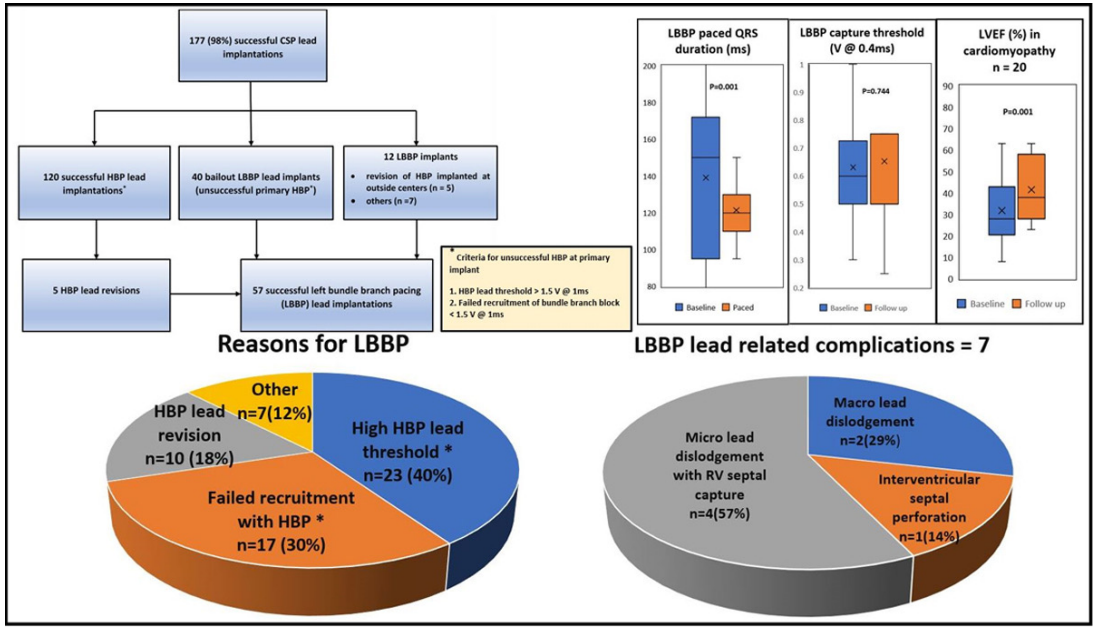
Sadala SK. JACC: Clin Electrophysiol, 2020: 6-14; 1773-1782

TABLE 1 Baseline Characteristics

	All Patients (N = 325)	Successful LBBP (n = 277)	Unsuccessful LBBP (n = 48)	p Value
Age	71 ± 12	70 ± 13	75 ± 8	0.03
Female	113 (35)	101 (36)	12 (25)	0.07
Medical history				
HTN	224 (69)	188 (68)	36 (75)	0.11
DM	113 (35)	100 (36)	13 (27)	0.08
CAD	161 (50)	126 (46)	35 (73)	0.01
AF	184 (57)	166 (60)	18 (38)	0.01
Ischemic cardiomyopathy	144 (44)	114 (41)	30 (63)	0.01
Baseline NYHA functional class III or IV	209 (64)	184 (68)	25 (52)	0.24
Baseline NYHA functional class	2.7 ± 0.7	2.7 ± 0.7	2.5 ± 0.7	0.92
Echocardiographic parameters				
LVEF	32 ± 12	33 ± 10	27 ± 10	0.06
LVEDD, mm	57 ± 10	56 ± 9	61 ± 9	0.03
LVESV, ml	115 ± 70	114 ± 68	124 ± 81	0.45
LVEDV, ml	170 ± 86	169 ± 84	175 ± 90	0.18
LA volume index, ml/m^2	58 ± 22	58 ± 23	59 ± 16	0.92
IVSD, mm	11.6 ± 3	11.4 ± 2	14 ± 3	0.04
Electrocardiographic parameters				
Baseline QRS duration, ms	154 ± 32	152 ± 32	169 ± 35	0.02
Baseline QRS duration >150 ms	198 (61)	168 (62)	30 (63)	0.86
LBBB	126 (39)	116 (42)	10 (21)	0.02
RBBB	54 (17)	48 (17)	6 (13)	0.81
IVCD	49 (15)	32 (12)	17 (35)	0.02
RV paced	48 (14.5)	36 (13)	12 (25)	0.06
Narrow	48 (14.5)	45 (16)	3 (6)	0.62

(Vijayaraman et al. J Am Coll Cardiol EP 2021;7:135–47)

Lead ile ilgili potansiyel sorunlar



- Lead kırığı
- Microdislodgement
- Macrodislodgement
- Septal rüptür
  - Akut
  - Geç
- Koroner yaralanma

Ravi V, Hanifin JL, Larsen T, Huang HD, Trohman RG, Sharma PS. Pros and Cons of Left Bundle Branch Pacing: A Single-Center Experience. Circ Arrhythm Electrophysiol. 2020 Dec;13(12):e008874. doi: 10.1161/CIRCEP.120.008874. Epub 2020 Nov 16. PMID: 33198496.

Lead kırığı

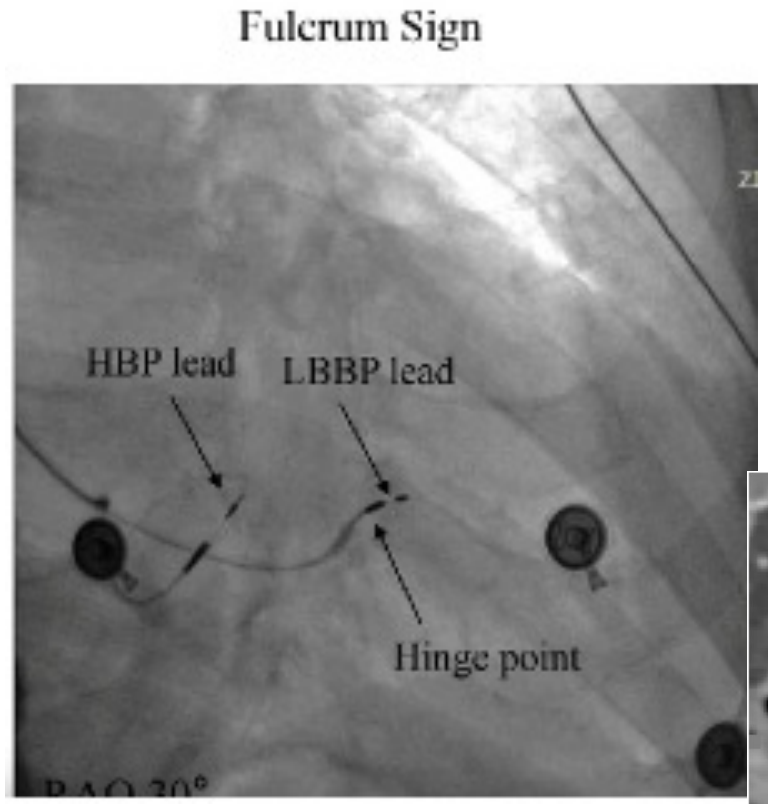
Fulcrum işareti: lead septuma dayandığında ring bölgesinde oluşan destek noktası

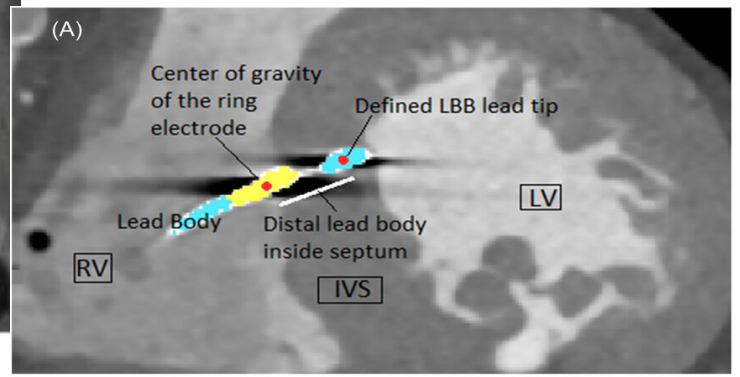
Septumda derine ilerlemek için lead üzerinde ekstra mekanik stres uygulanıyor

Kondüktör kırığı riski!

Her ne kadar 10 yıllık lead kırık oranı tahmini % 0.02 hesaplanmış ve mevcut RV lead'lerinden farklı olmasa da, ve kısa-orta dönem sonuçlar kırık riskinin artmadığına işaret etse de mevcut lead septuma girşiteki destek noktasındaki mekanik strese dayanmak için üretilmemiş ve bu nedenle henüz uzun dönemli lead performansı ve güvenilirlik verisi de elimizde yok

İnfektif endokardit durumunda ekstraktibilite ile ilgili veri yok





Cardiovasc electrophysiol, Volume: 34, Issue: 3, Pages: 718-725, First published: 04 February 2023, DOI: (10.1111/jce.15843)

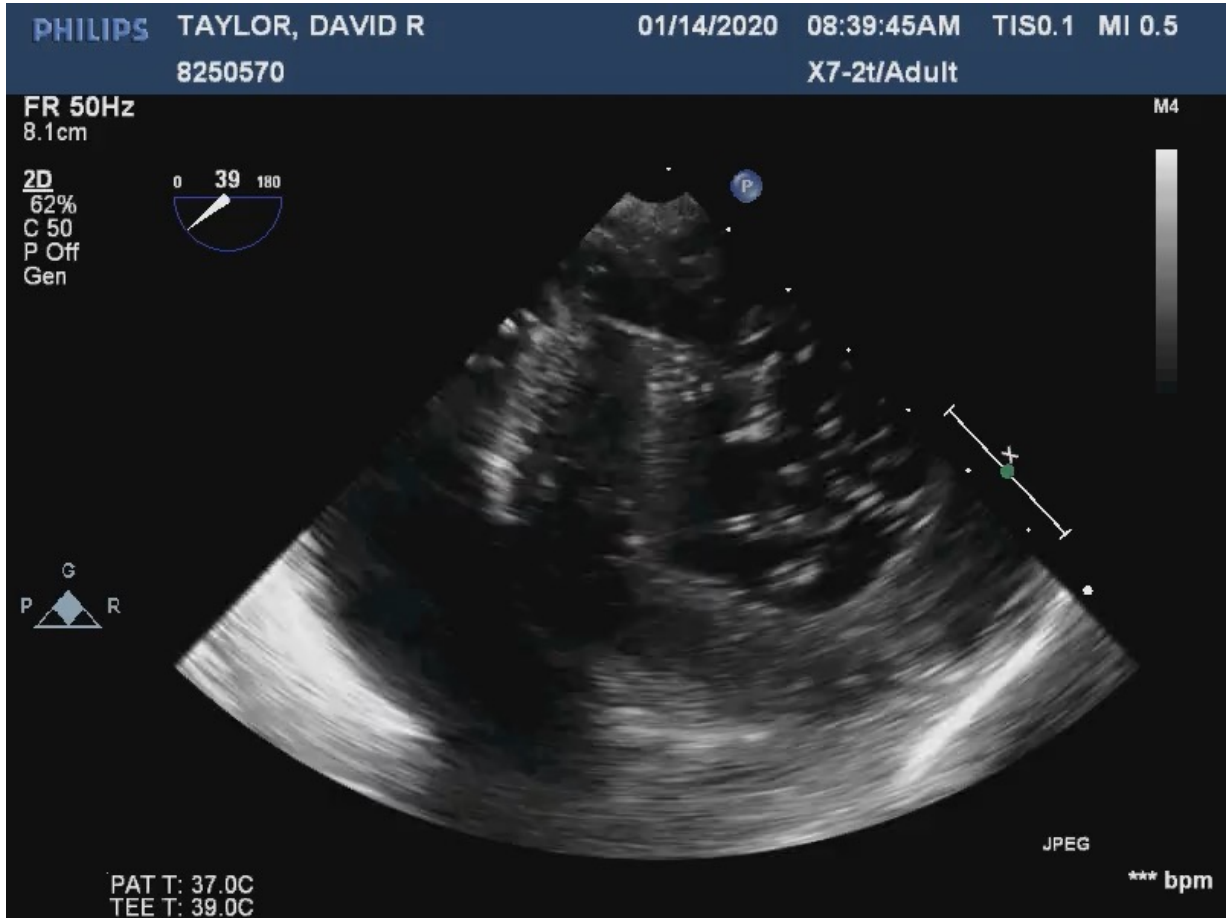
Microdislodgement ve sağ ventriküler septal capture

- Normal LVEF ve/veya düşük pacing yükü olanlarda sorun olmayabilir
- Ancak düşük LVEF ve/veya yüksek pacing yükü olanlarda, bazalde LBBB olanlarda potansiyel problem, bunlarda lead revizyonu gerekli

Prosedürel komplikasyonlar

- Ortalama 10-15%
- Natürü gereği en büyük kaygı ***septum ve septumdan geçen vasküler yapılar***la ilgili kaygılar
- Septal perforatörler ye da LAD'nin kendisinde yaralanma, okülüzyon
- **Göğüs ağrısı, ST elevasyonu ya da troponin yüksekliği** % 1
- **AKS** oranı % 0.4 > genellikle benign seyirli
  - Septal perforatör oklüzyonu (septal ST elevasyonu)
  - Koroner arter spazmı (yaygın ST elevasyonları)
- **LV kavitesine akut perforasyon** % 0.3-6.0. Genellikle ciddi duruma yol açmıyor ancak lead'in farklı bir yere vidalanması elzem

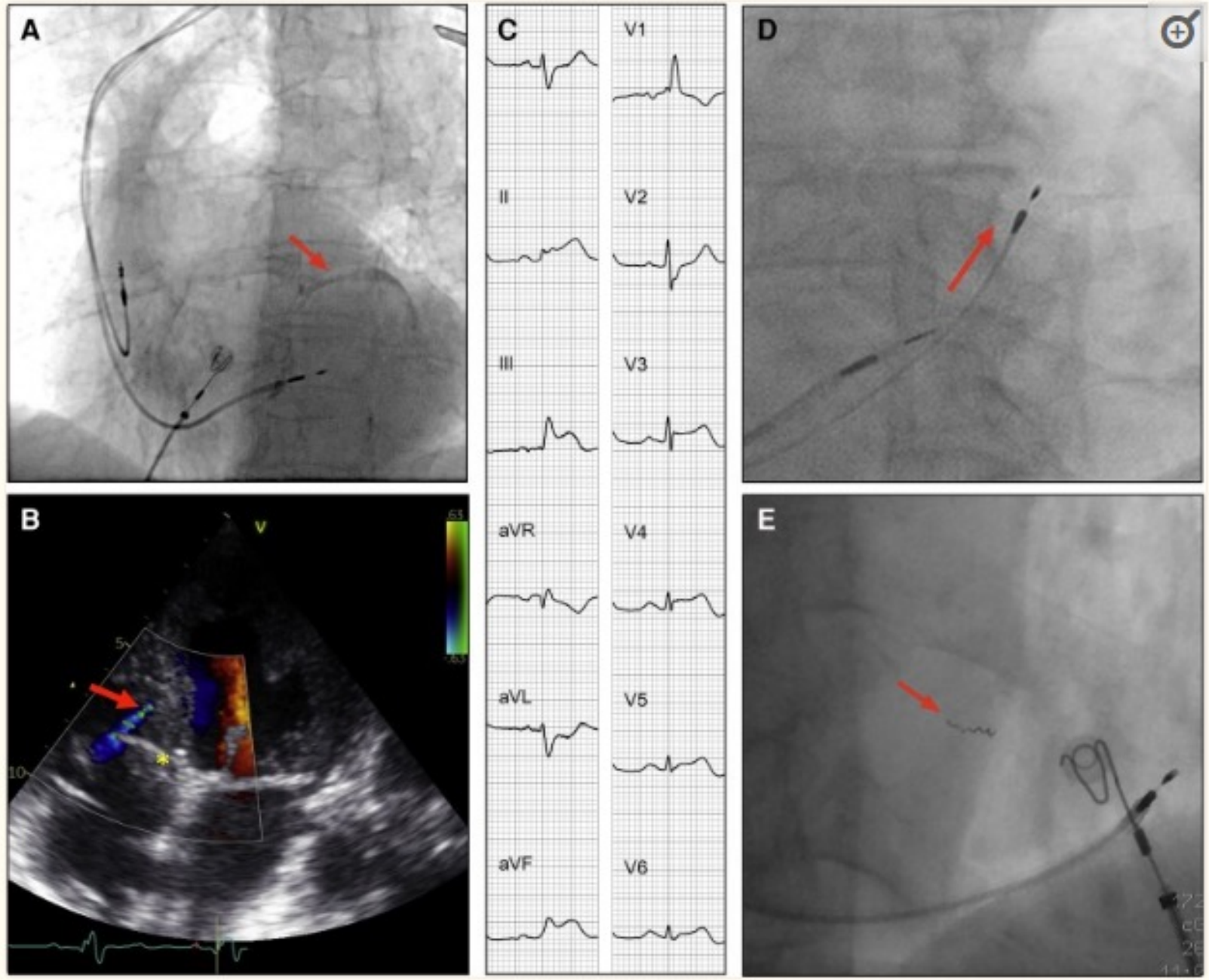
LV kavitesine geç perforasyon % 0.1-0.4, potansiyel olarak ciddi bir durum, stroke veya periferik embolizme yol açabilir. Lead repozisyonu gerekli



Ravi V, Hanifin JL, Larsen T, Huang HD, Trohman RG, Sharma PS. Pros and Cons of Left Bundle Branch Pacing: A Single-Center Experience. Circ Arrhythm Electrophysiol. 2020 Dec;13(12):e008874. doi: 10.1161/CIRCEP.120.008874. Epub 2020 Nov 16. PMID: 33198496.

MELOS

Complications attributed to the transseptal route of the pacing lead	
Intraprocedural perforation into the LV cavity	93 (3.67%)
Delayed perforation into the LV cavity	2 (0.08%)
Acute chest pain	25 (0.98%)
Acute ST-segment elevation in multiple leads	6 (0.24%)
Acute coronary syndrome [c]	11 (0.43%)
Coronary vein fistula	7 (0.28%)
Coronary artery fistula	2 (0.08%)
Painful pacing/chest pain	4 (0.16%)
LBBAP lead unscrewable/trapped/damaged helix	11 (0.43%)
LBBAP lead dislodgement	38 (1.5%)
Threshold rise to an absolute value > 2 V	17 (0.67%)
Threshold rise > 1 V from baseline	18 (0.71%)
Threshold rise leading to re-intervention	4 (0.16%)
Stroke/TIA	0 (0)
Summary	209 (8.25%)



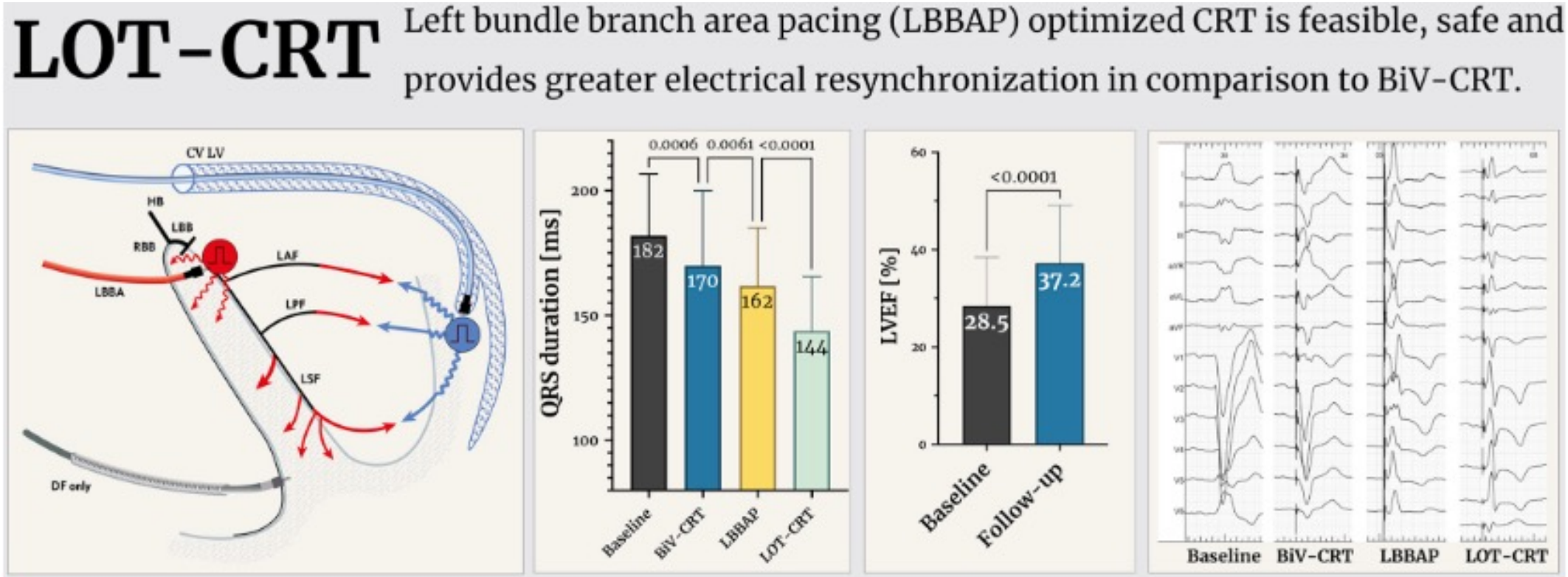
JACC Clin Elecrtrophysiol. 2020; 6: 1337–1338.

Sonuç olarak

- Randomize kontrollü çalışma datası gelene
- Özellikle kalp yetersizliği, septal fibrozis ve dilate LV'si olan hastalarda prosedürel başarının artana
- Non-response rate ve ilişkili faktörler belirlenene
- Uzun dönemli sonlanımlar bildirilene
- Sağ dal bloğu ve distal iletim bloğunda LBBP yeri aydınlatılana kadar
- Komplikasyonların natürünün ve sıklığının aydınlatılması ve yönetimleri konusunun yerleşmesine kadar

Koroner sinüs pacing ilk tercih olmalı, prosedür feasible, başarılı, veya optimal değilse ya da hasta non-responder ise LBBP tercih edilmeli.

LOT-CRT


LOT-CRT
Left bundle branch area pacing (LBBAP) optimized CRT is feasible, safe and provides greater electrical resynchronization in comparison to BiV-CRT.
CV LV
HB
LBB
RBB
LBBA
LAF
LPF
LSF
DF only
QRS duration [ms]
0.0006
0.0061
<0.0001
182
170
162
144
Baseline
BiV-CRT
LBBAP
LOT-CRT
LVEF [%]
<0.0001
28.5
37.2
Baseline
Follow-up
Baseline
BiV-CRT
LBBAP
LOT-CRT