Tachycardia Induced Cardiomyopathy(TCM) - Updates

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Tachycardia induced cardiomyopathy (TCM)

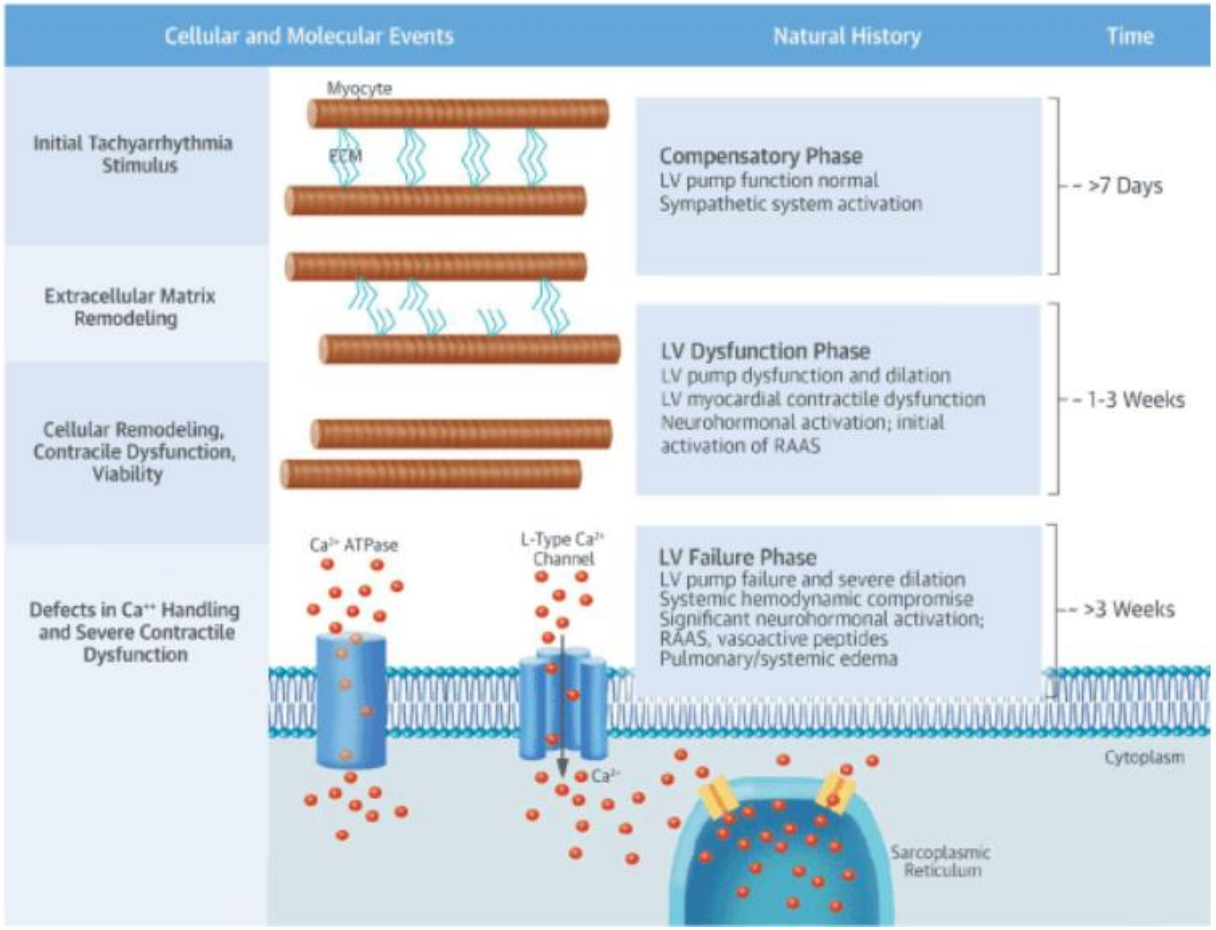
- Is a reversible cause of impaired LV function due to persistent tachycardia or very frequent ventricular premature beats (> 10%) that can lead to HF and death.

- The incidence of TCM is unknown but has been reported in all age groups, from fetuses to the elderly

- A Variety of chronic or incessant tachyarrythmias have been in the pathogenesis of TCM : AF, AFL, incessant SVT, idiopathic VT,

  Premature beats.

Pathophysiology to TCM



Experimental models with rapid pacing in animals induces cytoskeletal changes and remodeling of the extracellular matrix attributed to abnormal calcium cycling, increased catecholamines, decreased beta-1 adrenergic receptor density, oxidative stress, depletion of myocardial energy stores, and myocardial ischemia due to increased heart rate

Diagnosis

- TCM is one of the very few reversible causes of HF and dilated cardiomyopathy, and should be considered in any patient with new onset of LV dysfunction.

- The diagnosis is established by excluding other causes of cardiomyopathy, and demonstrating recovery of LV function after eradication of the arrhythmia or control of the ventricular rate.

- Typically in TCM: LVEF < 30% ,
  LVEDD < 65mm
  LVESD < 50mm

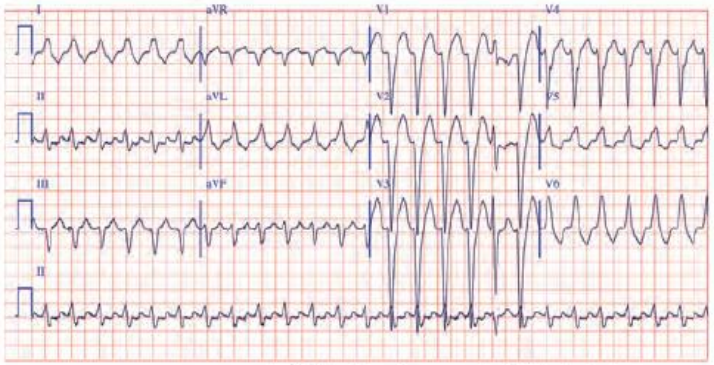
- Cardiac magnetic resonance (CMR) is advisable to exclude intrinsic structural change.

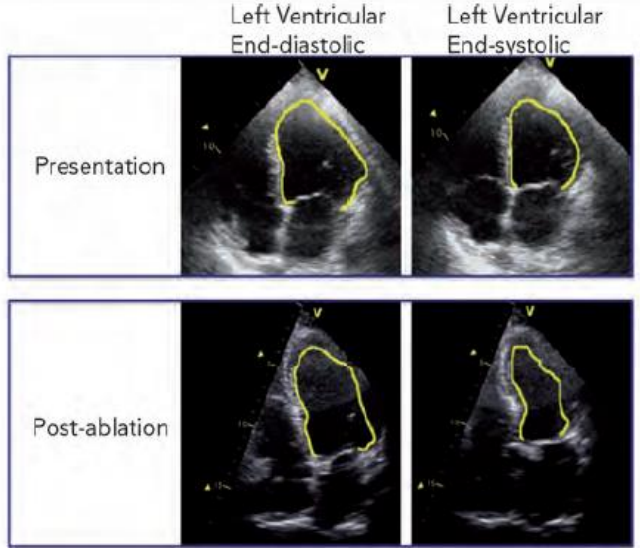
Therapy

- In TCM, LV function frequently improves after ~3 months of restoration of a normal heart rate.

- Catheter ablation is indicated when TCM

  is due to SVT





Therapy

- When the tachycardia itself cannot be ablated or controlled by medication, AV nodal ablation with either biventricular or His-bundle pacing is appropriate.

Recommendations for the therapy of supraventricular tachycardia in patients with suspected or established heart failure due to tachycardiomyopathy

Recommendation	Class[a]	Level[b]
Catheter ablation is recommended for TCM due to SVT.[196,233,418,525]	I	B
Beta-blockers (from the list with proved mortality and morbidity benefits in HFrEF) are recommended for TCM due to SVT, when catheter ablation fails or is not applicable.[567]	I	A
It is recommended that TCM is considered in a patient with reduced LV ejection fraction with an elevated heart rate (>100 b.p.m.).[557–561]	I	B
24 h (or multiday) ambulatory ECG monitoring should be considered for diagnosis of TCM by identifying subclinical or intermittent arrhythmias.[526,557,568]	IIa	B
AV nodal ablation with subsequent pacing ('ablate and pace'), either biventricular or His-bundle pacing, is recommended if the tachycardia responsible for the TCM cannot be ablated or controlled by drugs.[526,557,564,569–572]	I	C

Therapy

- Long-term medical therapy with BBx, ACEI/ARBs, is indicated before and after successful ablation

- Given the risk of recurrence of arrhythmias, long-term monitoring of patients is recommended

Premature Ventricular Complex–Induced Cardiomyopathy

- Less is known about the effects of premature ventricular contractions on LV function.

- It has been postulated that electrical activation originating within the ventricle myocardium lacking synchronous myocardial activation lead to LV function deterioration (i.e. chronic RV pacing, LBBB ,preexcitation)

- PVCs in the absence of structural disease typically originate from the right ventricular (RV) and LV perivalvular outflow tracts, inflow tracts, or papillary muscles

- Relatively long coupling interval of 360 to 420 ms.
- A burden threshold of >10% PVCs per day might produce a cardiomyopathy

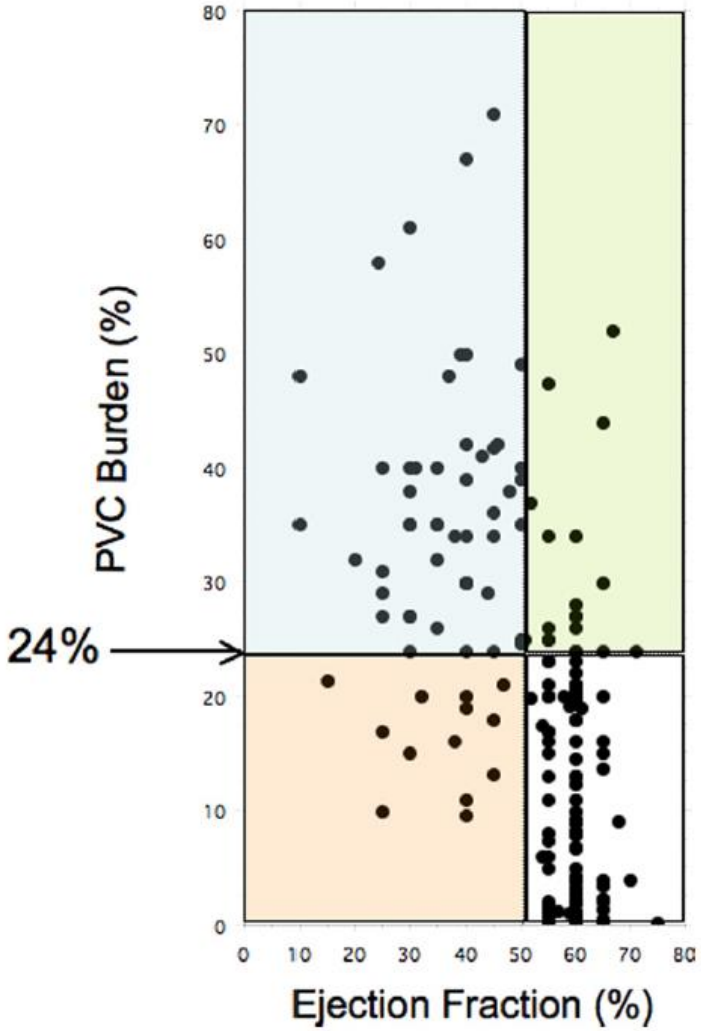


Figure 1 Scattergram indicating the relationship between PVC burden and ejection fraction. PVC = premature ventricular complex.

Baman TS, et al. Heart Rhythm 2010;7:865–9.

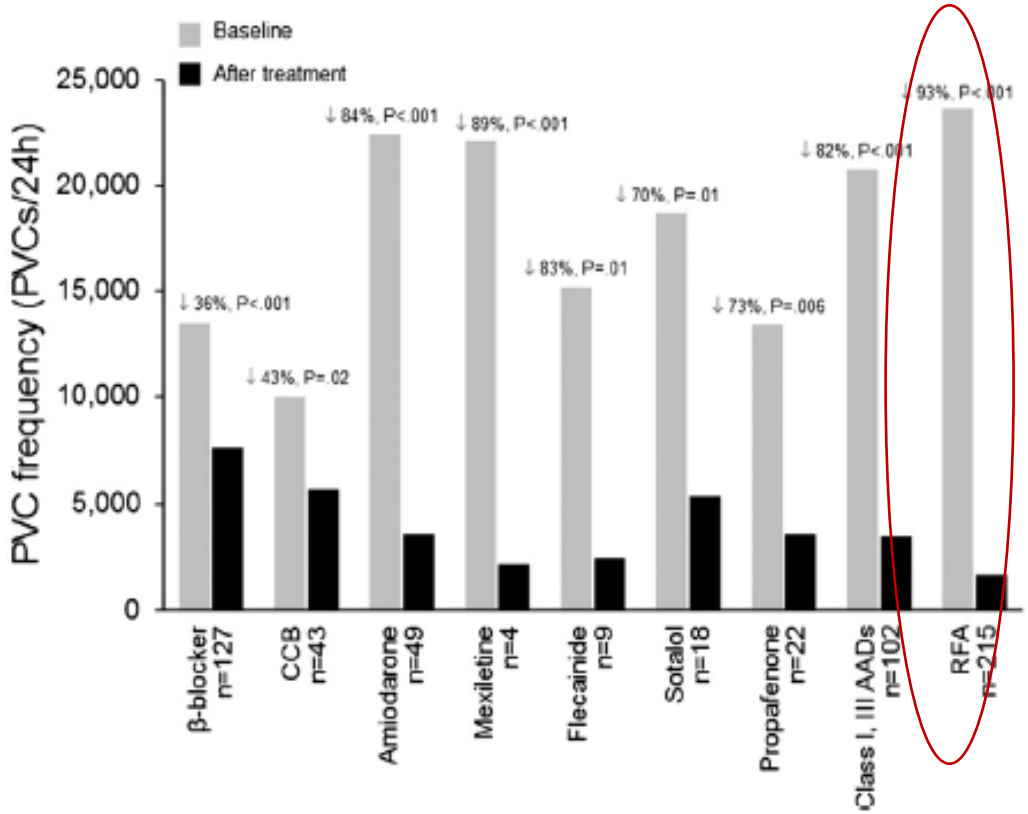
Predictors for development of TCM

- Longer PVC QRS duration (>150 ms) appear more likely to develop depressed function

- PVC QRS duration (>180 ms) marks a high risk of persistent dysfunction even.

- PVCs from the LV epicardium had the most profound effect on the degree of depression in LV function

Catheter ablation Vs. antiarrhythmic drugs in treating PVCs



The average efficacy of PVC reduction with AADs was 49% VS. 93% in RFA group.

LVEF was restored in 47% patients in the RFA group compared with 21% patients in the AAD group(P =.003)

Heart Rhythm2014;11:187–193

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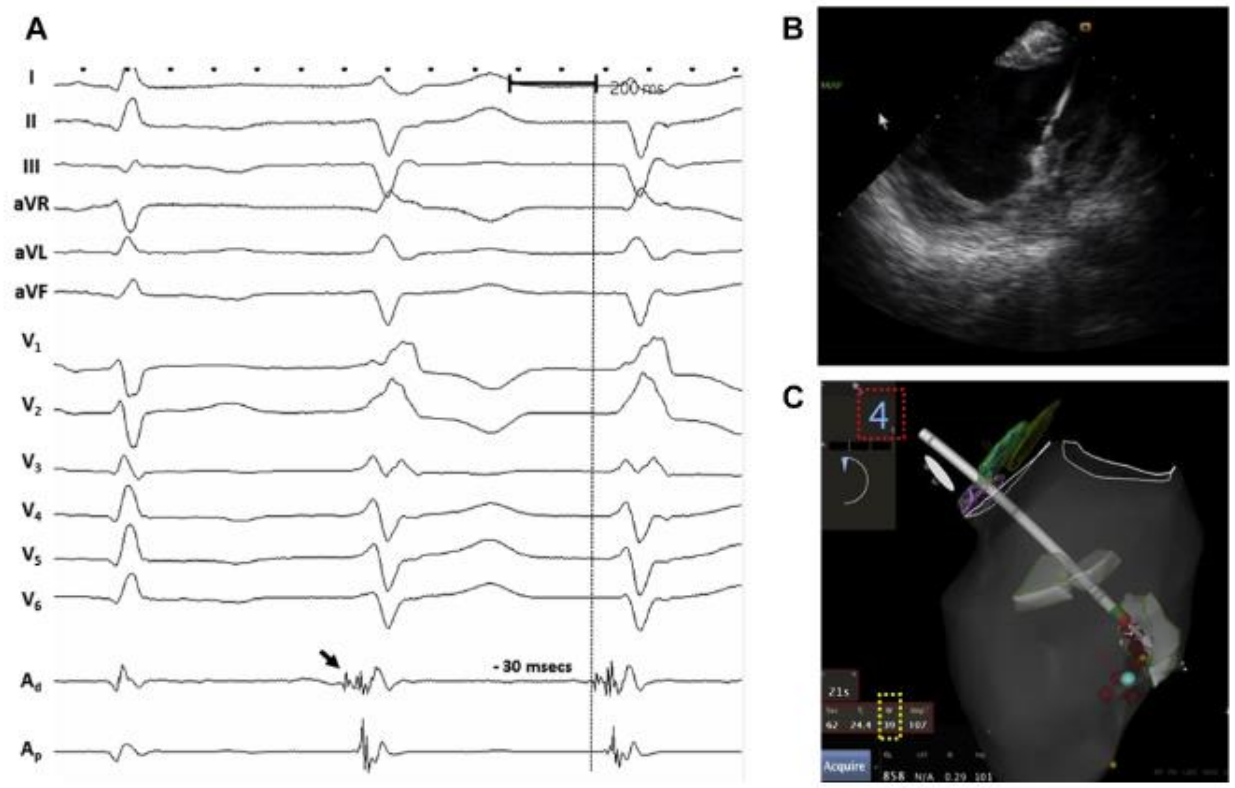
Strategies for Catheter Ablation of Left Ventricular Papillary Muscle Arrhythmias

An Institutional Experience

Aung N. Lin, MD,[a] Yasuhiro Shirai, MD,[a] Jackson J. Liang, DO,[a,b] Shiquan Chen, MD,[a] Arshneel Kochar, MD,[a] Matthew C. Hyman, MD, PhD,[a] Pasquale Santangeli, MD, PhD,[a] Robert D. Schaller, DO,[a] David S. Frankel, MD,[a] Jeffrey S. Arkles, MD,[a] Ramanan Kumareswaran, MD,[a] Fermin C. Garcia, MD,[a] Michael P. Riley, MD, PhD,[a] Saman Nazarian, MD, PhD,[a] David Lin, MD,[a] Erica C. Zado, PA,[a] David J. Callans, MD,[a] Francis E. Marchlinski, MD,[a] Gregory E. Supple, MD,[a] Sanjay Dixit, MD[a]

FIGURE 6 Example of PVC Ablated From PM PAP



(A) Earliest local activation precedes surface QRS complexes by 30 ms. Catheter tip is visualized on body of PAP by ICE **(B)** and CARTO sound **(C)**. The contact force at this location was only 4 g **(red interrupted square)** and so higher power (39 W; **yellow interrupted square**) was used. Abbreviations as in Figure 1.

Atrial fibrillation and TCM

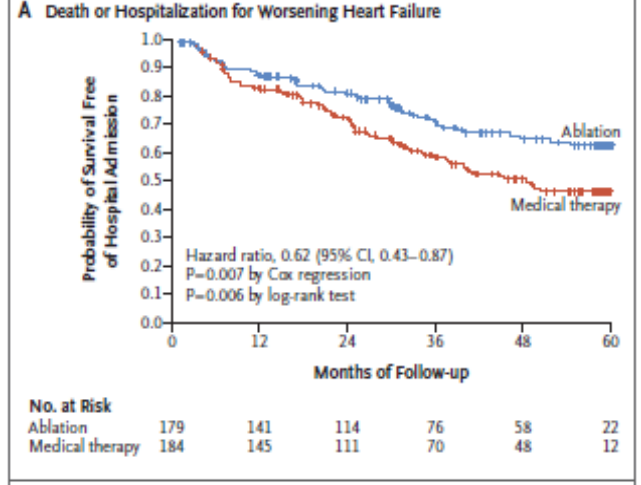
- The most rigorously studied etiology of TCM in human subjects is Persistent AF
- AF is known to increase risk of heart failure irrespective of the heart failure etiology
- Sometimes, restoration of sinus rhythm or control of ventricular rates will markedly improve or normalize left ventricular function.

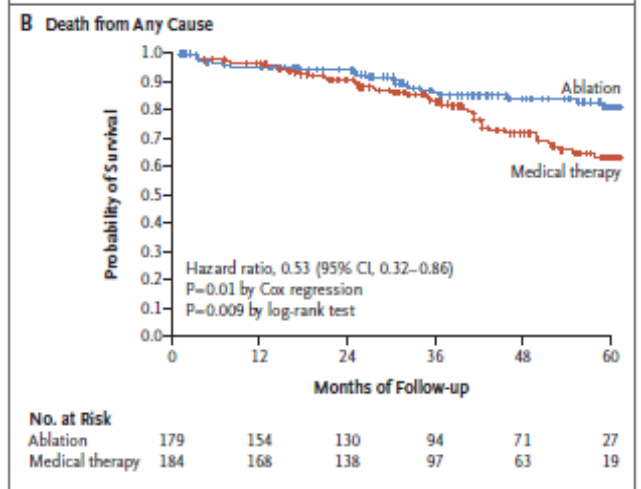
The NEW ENGLAND JOURNAL of MEDICINE

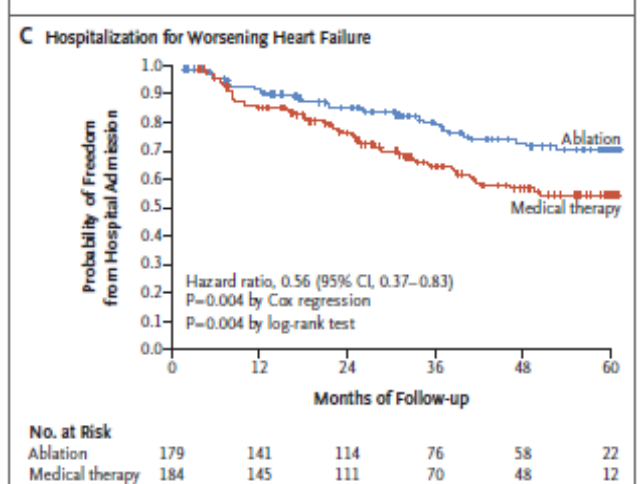
ESTABLISHED IN 1812 FEBRUARY 1, 2018 VOL. 378 NO. 5

Catheter Ablation for Atrial Fibrillation with Heart Failure

Nassir F. Marrouche, M.D., Johannes Brachmann, M.D., Dietrich Andresen, M.D., Jürgen Siebels, M.D., Lucas Boersma, M.D., Luc Jordaens, M.D., Béla Merkely, M.D., Evgeny Pokushalov, M.D., Prashanthan Sanders, M.D., Jochen Proff, B.S., Heribert Schunkert, M.D., Hildegard Christ, M.D., Jürgen Vogt, M.D., and Dietmar Bänsch, M.D., for the CASTLE-AF Investigators*







The NEW ENGLAND JOURNAL of MEDICINE

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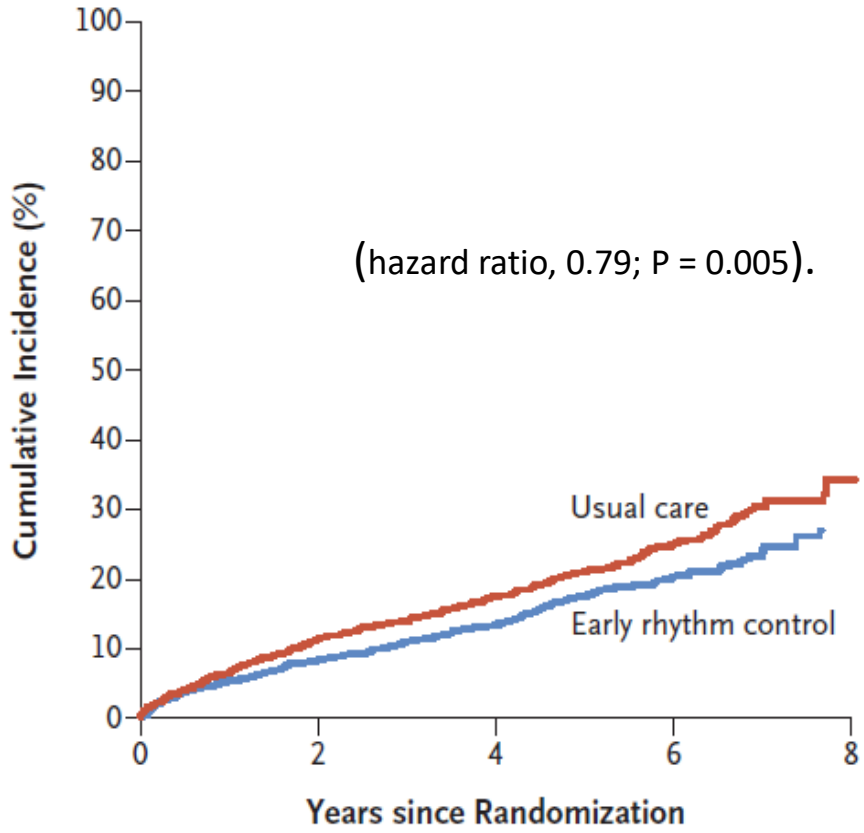
Early Rhythm-Control Therapy in Patients with Atrial Fibrillation

P. Kirchhof, A.J. Camm, A. Goette, A. Brandes, L. Eckardt, A. Elvan, T. Fetsch, I.C. van Gelder, D. Haase, L.M. Haegeli, F. Hamann, H. Heidbüchel, G. Hindricks, J. Kautzner, K.-H. Kuck, L. Mont, G.A. Ng, J. Rekosz, N. Schoen, U. Schotten, A. Suling, J. Taggeselle, S. Themistoclakis, E. Vettorazzi, P. Vardas, K. Wegscheider, S. Willems, H.J.G.M. Crijns, and G. Breithardt, for the EAST-AFNET 4 Trial Investigators*



(hazard ratio, 0.79; P = 0.005).

No. at Risk

Usual care	1394	1169	888	405	34
Early rhythm control	1395	1193	913	404	26

Figure 2. Aalen–Johansen Cumulative-Incidence Curves for the First Primary Outcome.

The first primary outcome was a composite of death from cardiovascular causes, stroke, or hospitalization with worsening of heart failure or acute coronary syndrome.

Ablate and pace –strategy for AF

Europace (2007) 9, 498–505
doi:10.1093/europace/eum091

Ablate and pace strategy for atrial fibrillation: long-term outcome of AIRCRAFT trial

Kang-Teng Lim[1], Michael J.E. Davis[1,2*], Anne Powell[1,2], Leonard Arnolda[1], Kath Moulden[1], Max Bulsara[3], and Rukshen Weerasooriya[1]

[1]*Department of Cardiology, Royal Perth Hospital, GPO Box X2213, Perth, Western Australia, Australia;* [2]*Perth Cardiovascular Institute, Hollywood Private Hospital, Nedlands, Western Australia, Australia; and* [3]*Department of Public Health, University of Western Australia, Crawley, Western Australia, Australia*

Brief report

Impact on ventricular function and quality of life of transcatheter ablation of the atrioventricular junction in chronic atrial fibrillation with a normal ventricular response

Andrea Natale MD [1], Leandro Zimerman MD, Gery Tomassoni MD, Margaret Kearney RN, Virginia Kent RN, Mary Joan Brandon RT, Keith Newby MD

Natale A, et. al. Am J Cardiol 1996;78:1431–3.

- In a small series of patients with AF and a controlled ventricular response ,AV junction ablation and pacemaker implantation resulted in a significant improvement in LVEF, fractional shortening and functional capacity.

Cardiac resynchronization therapy after atrioventricular junction ablation for symptomatic atrial fibrillation: a meta-analysis

Stavros Stavrakis*, Paul Garabelli, and Dwight W. Reynolds

Table 1 Characteristics of the included studies

Trial characteristic	APAF 2011	AVAIL 2010	OPSITE 2005	PAVE 2005	MUSTIC AF 2002
No. of patients	186	153	56	184	59
Design	CRT vs. RV pacing 1 : 1	CRT vs. RV pacing 4 : 1	Three month cross-over comparison between RV pacing and CRT (phase 2)	CRT vs. RV pacing 1 : 1	Three month cross-over comparison between RV pacing and CRT
Inclusion criteria	Permanent AF undergoing AVJ ablation with or without heart failure	Persistent or permanent AF undergoing AVJ ablation with NYHA II or III	Permanent AF undergoing AVJ ablation with or without heart failure	Permanent AF undergoing AVJ ablation	LVEF < 35%, NYHA III, persistent AF requiring permanent ventricular pacing due to a slow ventricular rate, with or without AVJ ablation
Primary endpoint	Death due to HF, or hospitalization due to HF, or	Echocardiographic parameters	6 min walk distance	6 min walk distance	6 min walk distance

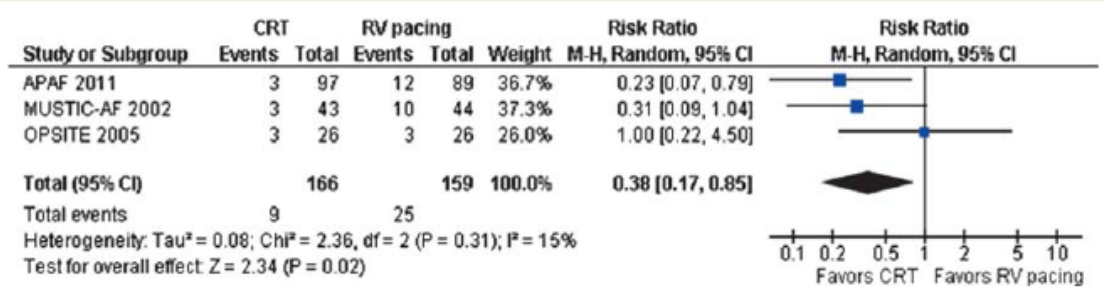


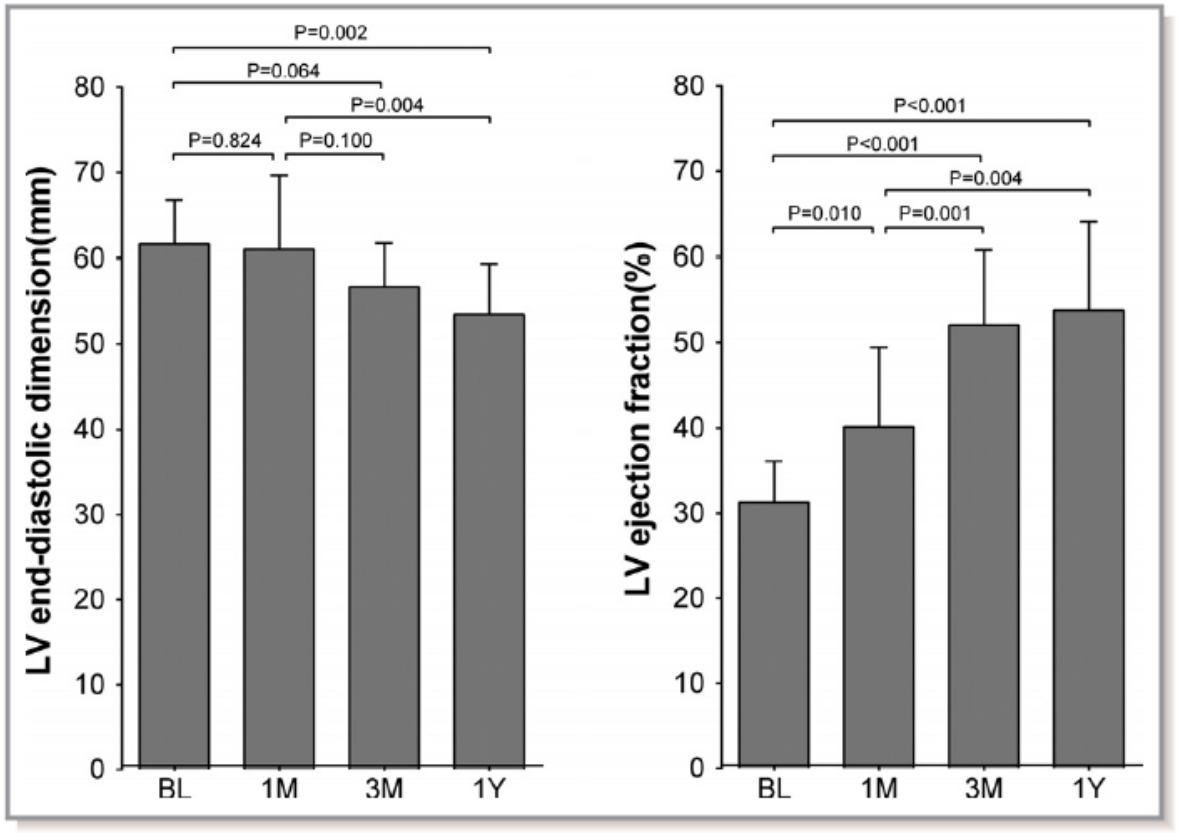
Figure 3 Forest plot of study-specific and risk hazard ratio and 95% confidence interval for the endpoint of hospitalization for heart failure among patients assigned to cardiac resynchronization therapy vs. right ventricular pacing.

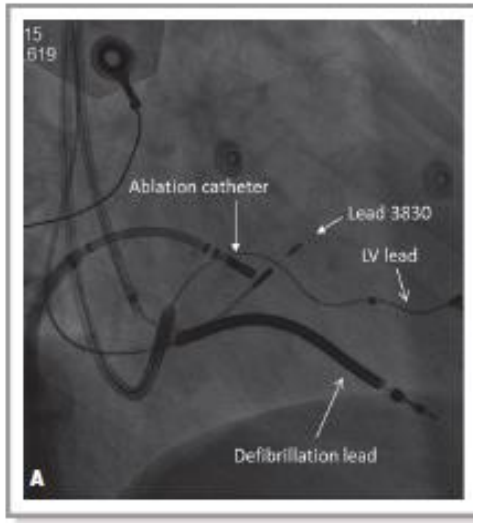
"Cardiac resynchronization therapy may be superior to RV pacing in patients undergoing AVJ ablation for AF"

Europace (2012) 14, 1490–1497

Benefits of Permanent His Bundle Pacing Combined With Atrioventricular Node Ablation in Atrial Fibrillation Patients With Heart Failure With Both Preserved and Reduced Left Ventricular Ejection Fraction

Weijian Huang, MD; Lan Su, MD; Shengjie Wu, MD; Lei Xu, MD; Fangyi Xiao, MD; Xiaohong Zhou, MD; Kenneth A. Ellenbogen, MD





Medications Before and 1 Year After HBP

	Baseline	After HBP	*P* Value
All patients (N=42)			
Diuretics	38 (90.5)	23 (54.8)	<0.001
β-Blockers	40 (95.2)	32 (76.2)	0.011
ACE inhibitors	36 (85.7)	38 (90.5)	0.480
Digoxin	20 (47.6)	2 (4.8)	<0.001
HFpEF patients (N=22)			
Diuretics	18 (81.8)	9 (40.9)	0.003
β-Blockers	21 (95.5)	14 (63.6)	0.020
ACE inhibitors	20 (90.9)	19 (86.4)	0.564
Digoxin	7 (31.8)	1 (4.5)	0.034
HFrEF patients (N=20)			
Diuretics	20 (100.0)	14 (70.0)	0.014
β-Blockers	19 (95.0)	18 (90.0)	0.317
ACE inhibitors	16 (80.0)	19 (95.0)	0.180
Digoxin	13 (65.0)	1 (5.0)	<0.001

Permanent HBP post–atrioventricular node ablation significantly improved echocardiographic measurements and New York Heart Association classification and reduced diuretics use for heart failure management in atrial fibrillation patients with narrow QRS who suffered from heart failure with preserved or reduced ejection fraction

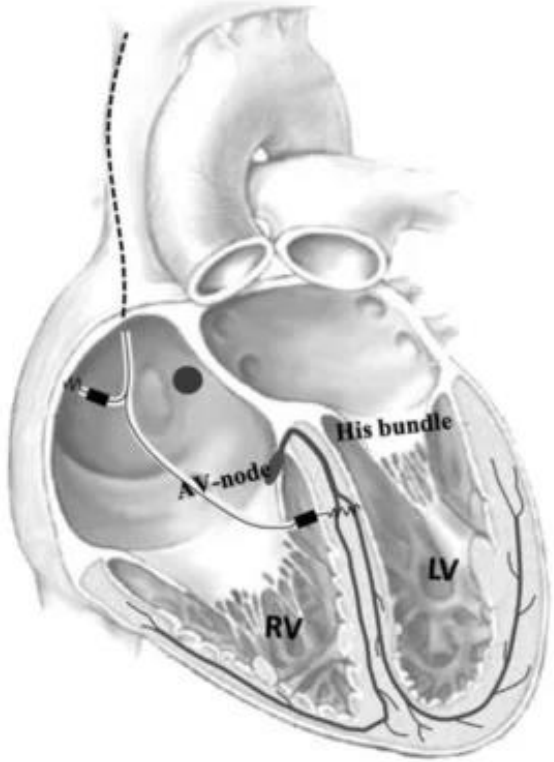
J Am Heart Assoc. 2017;6

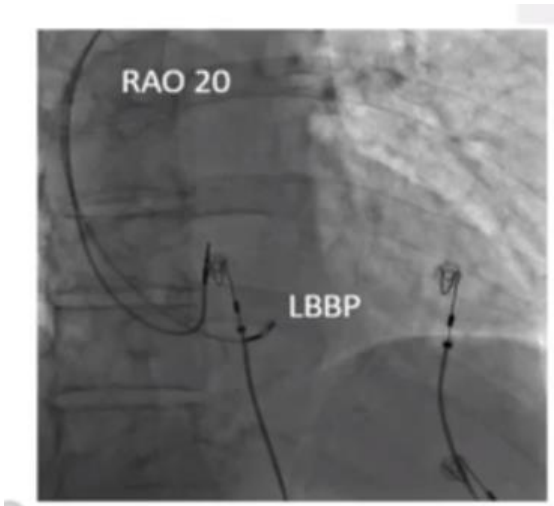
Left bundle branch area pacing

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] and Kenneth A. Ellenbogen, MD, FHRS[c]





Huang, Can J Cardio 2017

Atrioventricular junction ablation in patients with conduction system pacing leads: A comparison of His-bundle vs left bundle branch area pacing leads

Ajay Pillai, MD,* Jeffrey Kolominsky, MD,* Jayanthi N. Koneru, MD,* Jordana Kron, MD,* Richard K. Shepard, MD,* Gautham Kalahasty, MD,* Weijian Huang, MD,† Atul Verma, MD, FHRS,‡ Kenneth A. Ellenbogen, MD, FHRS*

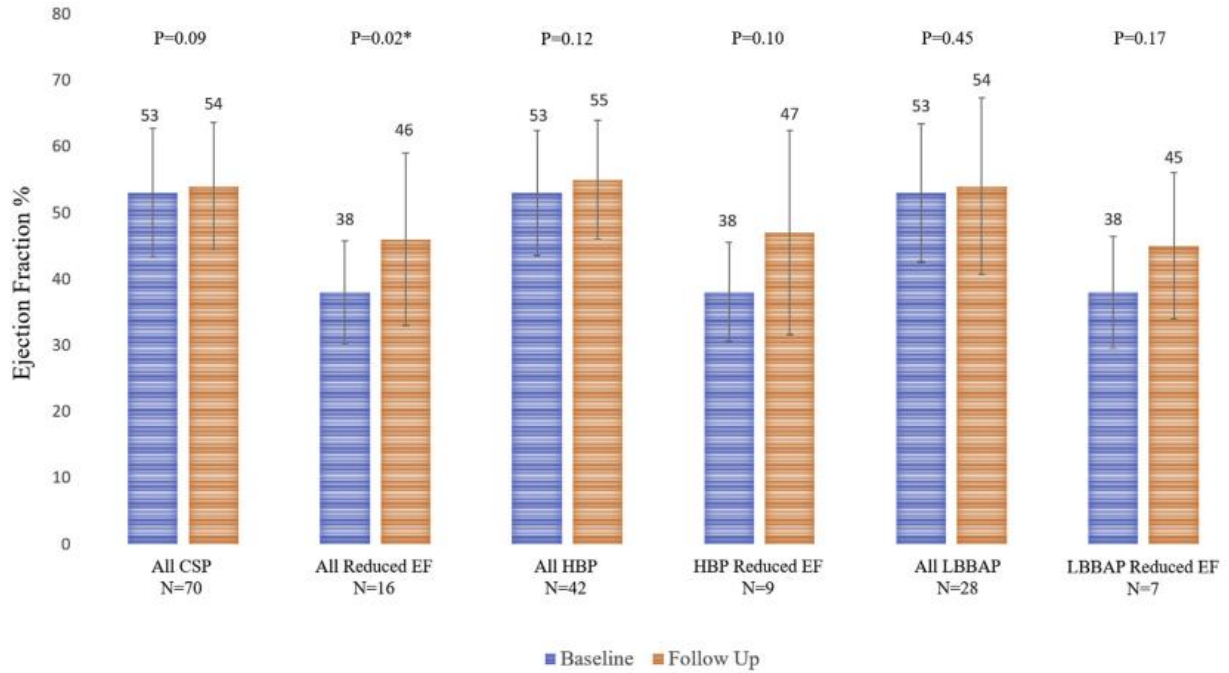


Figure 4 Echocardiographic data pre- and post-atrioventricular junction ablation in the overall cohort, His-bundle pacing (HBP) group, and left bundle branch area pacing (LBBAP) group. CSP = conduction system pacing; EF = ejection fraction.

LBBAP lead is associated with higher success rate, lower complication rate, and shorter procedural and fluoroscopy durations compared to those with HBP lead

Heart Rhythm 2022 in press

2019 ESC Guidelines for the management of patients with supraventricular tachycardia

The Task Force for the management of patients with supraventricular tachycardia of the European Society of Cardiology (ESC)

Recommendations for the therapy of supraventricular tachycardia in patients with suspected or established heart failure due to tachycardiomyopathy

AV nodal ablation with subsequent pacing ('ablate and pace'), either biventricular or His-bundle pacing, is recommended if the tachycardia responsible for the TCM cannot be ablated or controlled by drugs.[526,557,564,569–572]	I	C

European Heart Journal (2020) 41, 655-720

Recommendations for using His bundle pacing (1)

Recommendations	Class	Level
In patients treated with HBP, device programming tailored to specific requirements of HBP is recommended.	I	C
In CRT candidates in whom coronary sinus lead implantation is unsuccessful, HBP should be considered as a treatment option along with other techniques such as surgical epicardial lead.	IIa	B
In patients treated with HBP, implantation of a RV lead used as "backup" for pacing should be considered in specific situations (e.g. pacemaker-dependency, high-grade AVB, infra-nodal block, high pacing threshold, planned AVJ ablation) or for sensing in case of issues with detection (e.g. risk of ventricular undersensing or oversensing of atrial/His potentials).	IIa	C

AVB = atrioventricular block; AVJ = atrioventricular junction; CRT = cardiac resynchronization therapy; HBP = His bundle pacing; LVEF = left ventricular ejection fraction; RV = right ventricular.

2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy
(European Heart Journal 2021 – doi:10.1093/eurheartj/ehab364)

Conclusion:

- TCM is a reversible cause of HF.
- TCM requires the demonstration of improved LV function with suppression of tachycardia.
- TCM should be suspected in all patients with DCMP of undetermined etiology and tachycardia faster than 100 or 110 beats/min for early detection and treatment for these patients.
- TCM should be considered as a possible diagnosis even in patients with HF of other established causes because they may have the superimposed reversible component of TCM.
- Strategies of tachyarrhythmia management can be antiarrhythmic drugs, catheter ablation or rate control.
- Catheter ablation should be considered for tachyarrhythmias which can be curable with ablation.
- CSP with either HBP or LBBAP preserves LVEF with refractory atrial fibrillation post AVJ ablation