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ABLAÇÃO DE TV E EXTRASSISTOLIA VENTRICULAR IDIOPÁTICAS

ABLATION OF IDIOPATHIC VT AND VPBS

Luis Carpinteiro



- Idiopathic means careful exclusion
 - Family History, ECG clues, polymorphic or bidirectional VT: channelopathy?
 - Endocrine: thyroid, pituitary
 - “Not-so-normal” ECG, non-typical or multiple morphology of VPB/VT: consider special investigations. (ARVC/D, amyloidosis, sarcoidosis)
 - Temporal distribution (SOA), exercise
 - EP Study findings – scar, pleomorphic VT
 - ... biopsy
 - “Normal” hearts may be seen in up to 10% of patients presenting with significant ventricular arrhythmias.

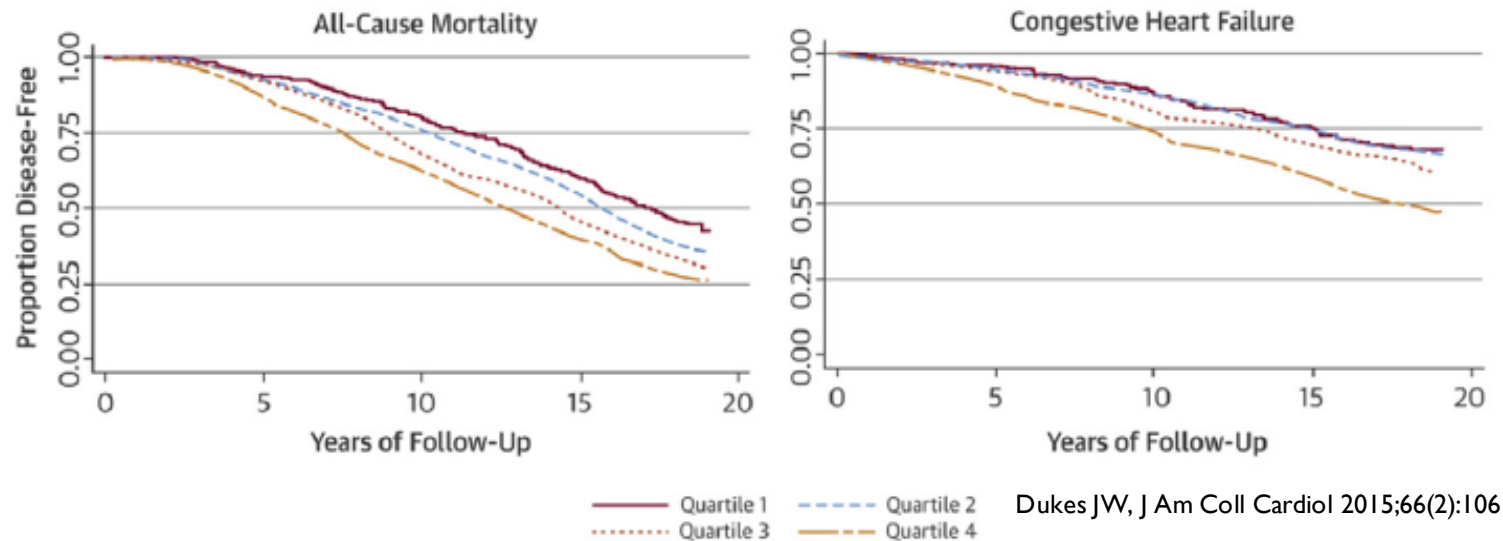


Arrhythmias Seen in Baseline 24-Hour Holter ECG Recordings in Healthy Normal Volunteers During Phase I Clinical Trials: Premature ventricular complexes (PVCs) in 43.4%, >200 PVCs per 24 hours in 3.3%, multifocal PVCs in 5.3%, nonsustained ventricular tachycardia in 0.7%.

Hingorani The Journal of Clinical Pharmacology 2016, 56(7) 885–893

Population studies, such as ARIC) and MRFIT, demonstrated a **higher prevalence** of PVCs in **men** than women, **African Americans** compared with white persons, and an increased prevalence in individuals with **hypertension**. Increasing **age** was noted to be associated with higher PVC burden with a 34% increase for each 5-year increment increase in age.

IDIOPATHIC VT AND VPBs – PREVALENCE & PROGNOSIS



Population Studies: Framingham Heart study, MRFIT, and ARIC, have demonstrated PVCs to be an independent **risk marker** for death from coronary artery disease and sudden death, and are also associated with higher risk of all-cause mortality.

Predictors of adverse events included age, diabetes and hypertension.

LENIENT INCLUSION CRITERIA...

Overall, it is not clear whether this is owing to the presence of occult structural heart disease and whether the VBPs are merely a Tell-Tale marker rather than the reason for an increase in mortality.



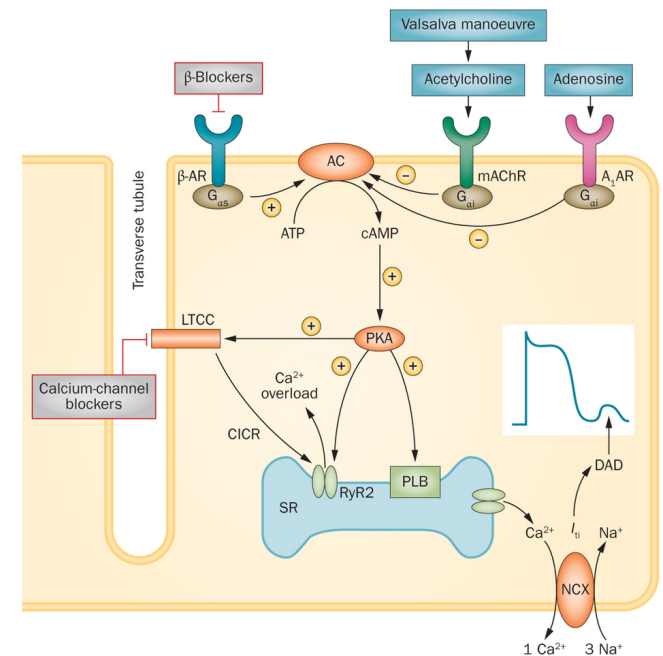
Focal

Triggered activity, AMPc dependent intracellular overload

- Adenosine sensitivity (AMPc)
- Proximity to *epicardial fat pads* (ANS mediated)
- Catecholamine sensitivity (exertion, anxiety, *vagal maneuvers* and β -blocker)
- Hormonal (female gender)
- Sensitivity to verapamil (Ca^{2+} overload)

Reentry

Functional properties (APD and RP) along Purkinje network: unidirectional block



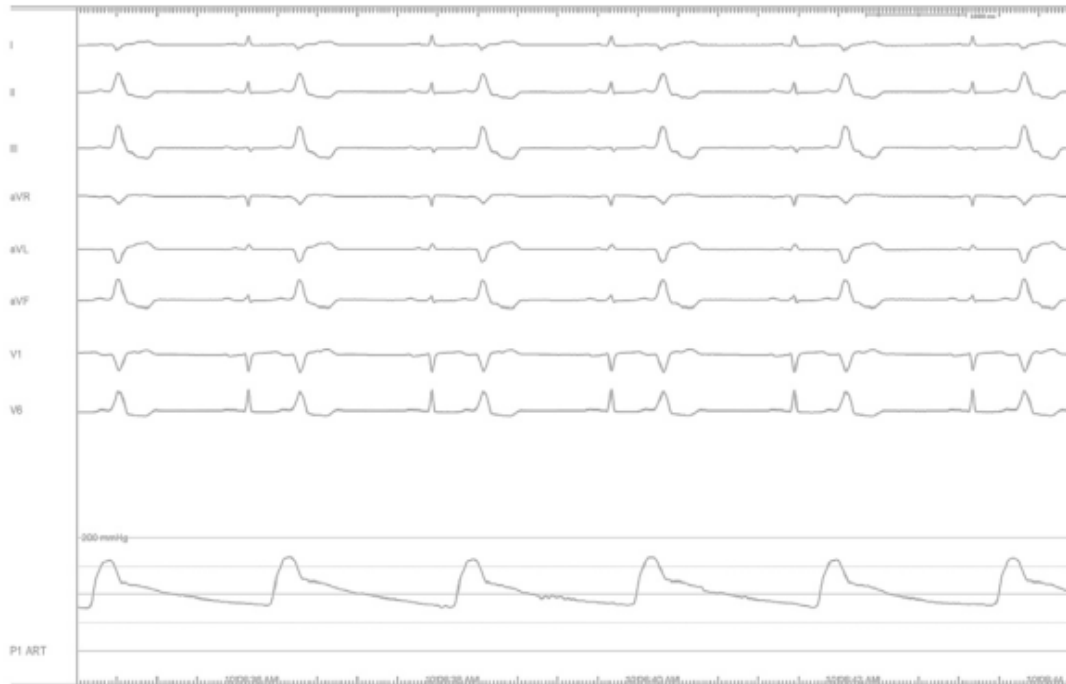


➤ **Asymptomatic**

- Low arrhythmic death risk except for subsets (Short coupled, VPB, Short cycle NSVT, Bileaflet MVP)
- High Burden asymptomatic VPB linked to DCM risk

➤ **Symptomatic**

- Palpitation (48-80%)
- Fainting / SOB / exercise intolerance (28-50%)
- Syncope (10%)
- Sudden Death – very low incidence





VPBs may be a direct cause of a reversible cardiomyopathy.

The mechanism of this effect remains uncertain.

- Alteration of membrane ionic currents and intracellular calcium handling,
- Alteration of contractile protein expression,
- Alteration in autonomic tone,
- Hemodynamic wall stress.

An absolute burden threshold has not been established.

- Authors have reported thresholds of 16%, 24%, or 26% are more likely to contribute to cardiomyopathy; but rarely when less than 10% beats /24h.

PVC-induced cardiomyopathy prevalence varies widely

- studies with 6% to 7% of patients with frequent VPBs followed prospectively
- 38% of patients referred for catheter ablation.



➤ Arrhythmic spectrum:

- Isolated VPB (burden)
- repetitive NS VT, Sustained VT
- VPB triggered VF

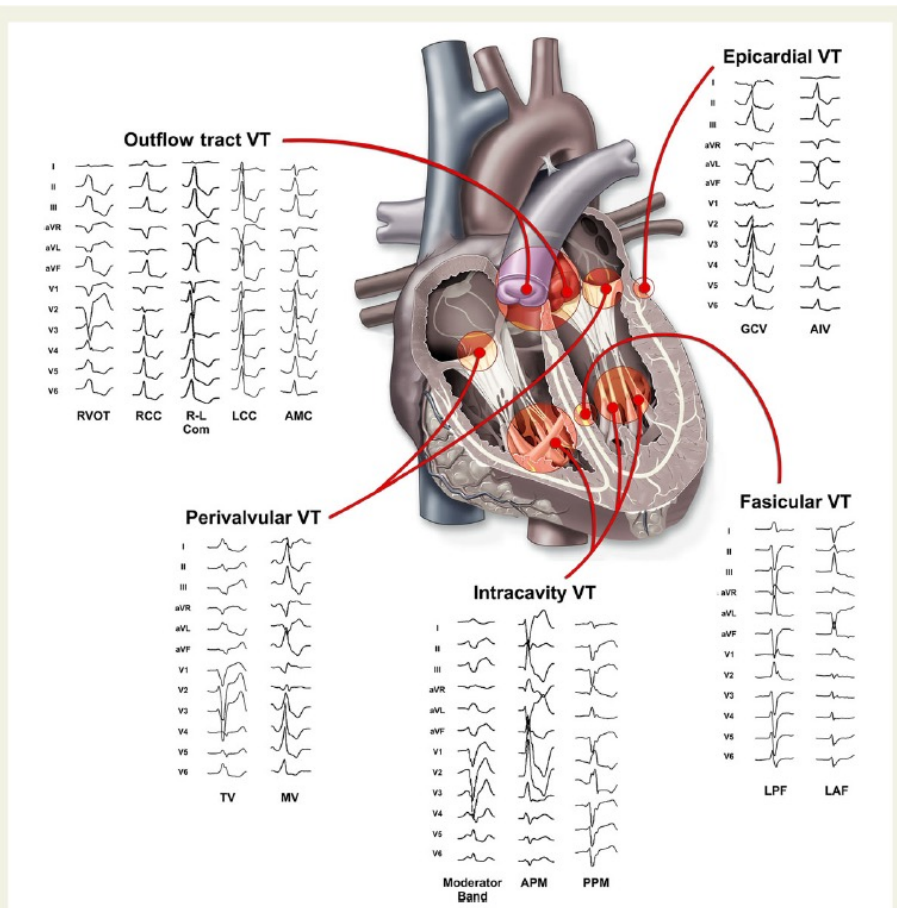
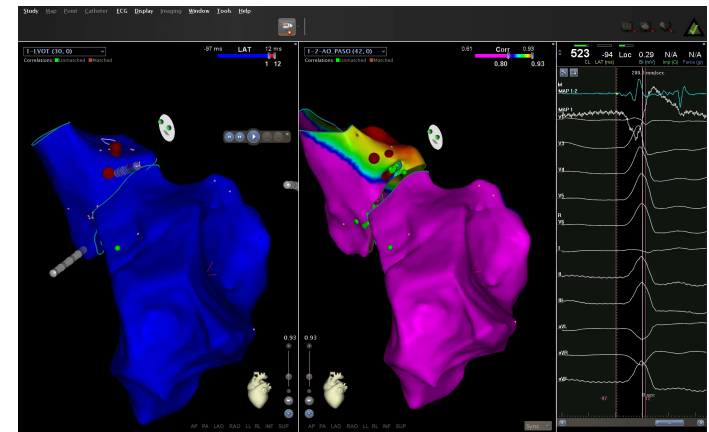


Figure 1 Twelve-lead electrocardiogram morphology of different sites of origin in idiopathic ventricular tachycardia (RVOT, right ventricular outflow tract; RCC, right coronary cusp; R-L com, right-left coronary cusp commissure; LCC, left coronary cusp; AMC, aortomitral continuity; TV, tricuspid annulus; MV, mitral annulus; APM, anterior PAP; PPM, posterior PAP; LPF, left posterior fascicle; LAF, left anterior fascicle; GCV, greater cardiac vein; AIV, anterior inter-ventricular vein).



ARRHYTHMIA SPECTRUM — II - VPB TRIGGERED VF



In patients without structural heart disease PVCs causing VF have been documented from the His-Purkinje system, right ventricular outflow tract (RVOT), right ventricular anterior wall, LV papillary muscles, or left ventricular outflow tract (LVOT).

(Van Herendael Heart Rhythm 2014;11(4):566–73. Nogami Heart Rhythm 2005;2(6):646–9. Haissaguerre Circulation 2002;106(8):962–7.)

Idiopathic or PVC induced VF is rare with an estimated incidence of 5% of all cases of resuscitated sudden death but 23% of cases in patients with preserved EF.

(Consensus statement of the joint steering committees of the unexplained cardiac arrest registry of Europe and of the idiopathic ventricular fibrillation registry of the United States. Circulation 1997;95(1):265–72.)

In series documenting outcomes after ablation the rates of recurrence after ablation range from 18% to 60% within 6 months requiring a second procedure; after second ablation all studies reported no recurrence.

Knecht J Am Coll Cardiol 2009;54(6):522–8. Van Herendael Heart Rhythm 2014;11(4):566–73. Sadek Heart Rhythm 2015;12(1):67–75.

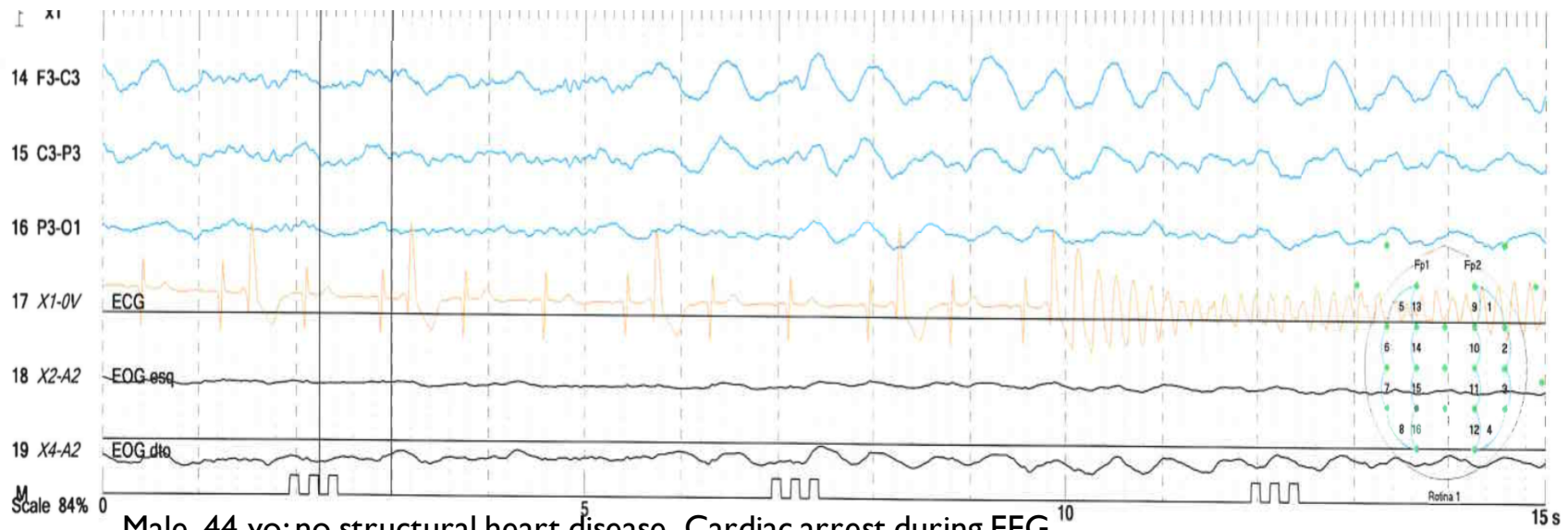




Table 2 Characteristics of idiopathic ventricular tachycardia from different locations

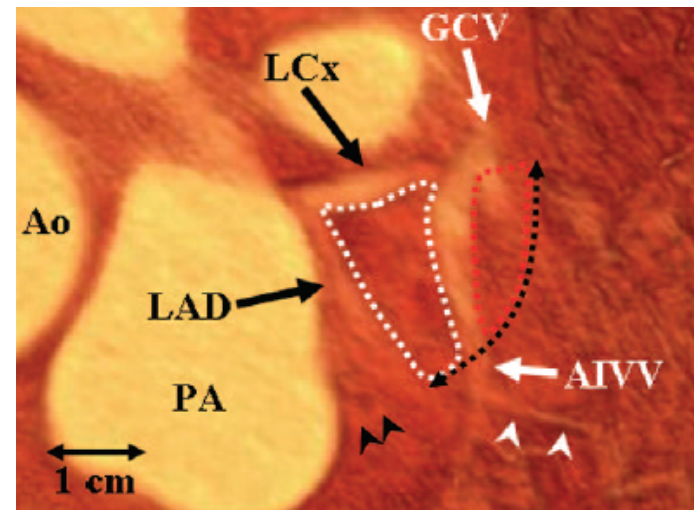
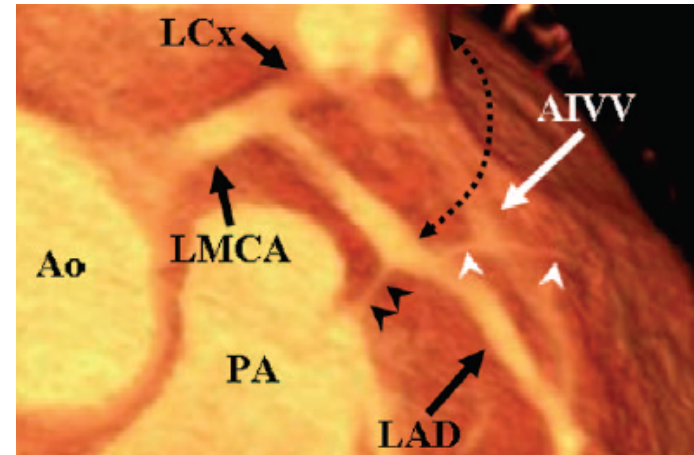
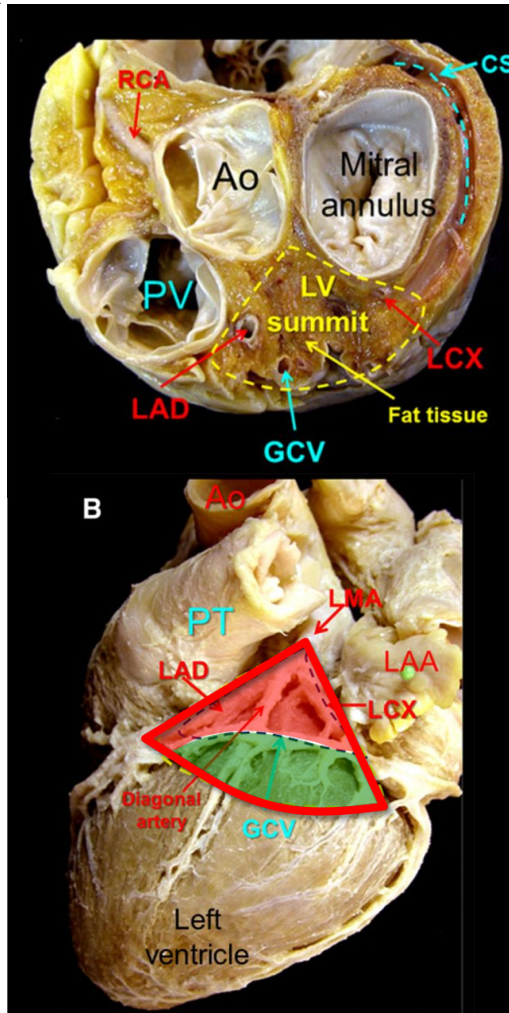
Tanawuttiwat Eur Heart J (2016) 37 (7):594-609

Sites of origin	Prevalence	Mechanism	ECG findings	Presentation	Medication therapy	Ablation target
1. Outflow tract VT						
RVOT	70–80% of idiopathic VT	DAD-related triggered activity	LBBB inferior axis Delayed R wave transition (at or after V3, or later than sinus rhythm) V2 transition ratio ^a <0.6	Exercise-induced sustained VT Incessant NSVT PVCs Tachycardia-related cardiomyopathy	Adenosine β-Blocker Verapamil/ diltiazem IA, IC, III AAD	Presystolic signal Perfect pace match with short S-QRS QS at unipolar
LVOT, aortic cusps, AMC	16% of outflow tract VT	DAD-related triggered activity	LBBB inferior axis Early R wave transition V2 transition ratio ≥0.6 Sometimes presents with >1 morphology	Same as RVOT Idiopathic VF (PVC-induced VF) (LVOT)	Adenosine β-Blocker Verapamil/ diltiazem IA, IC, III AAD	Presystolic signal Perfect pace match with short S-QRS QS at unipolar (except cusp or great vessel foci)
2. Fascicular VT						
Verapamil-sensitive VT	10–15% of idiopathic VT	Macro-reentry	Relatively narrow QRS LPF: RBBB, LAD LAF: RBBB, RAD	Same as RVOT	Verapamil	During VT: diastolic potential, anterograde Purkinje potential During sinus: diastolic potential or linear lesion at mid-inferior septum, perpendicular to the long axis of LV
Focal Purkinje VT (Propanolol-sensitive automatic VT)	Rare	Enhanced automaticity	Relatively narrow QRS. Depending on origin: LBBB (from RV distal Purkinje) or RBBB (from LV distal Purkinje)	Exercise or catecholamine related. Incessant NSVT Polymorphic/monomorphic VT Idiopathic VF (PVC-induced VF)	β-Blocker Lidocaine Adenosine	The earliest presystolic Purkinje potential
3. Intra-cavity VT						
Papillary muscle	2.4–5.2% of idiopathic VT	Enhanced automaticity vs. DAD-related triggered activity	APM: RBBB (q in V1), inferior axis PPM: RBBB (q in V1), left superior axis. RV PM: LBBB, more variable	Same as RVOT Idiopathic VF (PVC-induced VF) (LVOT)	Same as outflow tract VT, not well studied	Same as RVOT ICE can be helpful for catheter navigation and positioning. May require wide area ablation or ablation at both sides of papillary muscle
Moderator band	2.5% of idiopathic VT	Enhanced automaticity vs. DAD-related triggered activity	LBBB with pre-cordial transition later than V4 or later than sinus rhythm. Left superior axis Relatively narrow QRS	NSVT or monomorphic VT Idiopathic VF (PVC-induced VF)	Same as outflow tract VT, not well studied	Same as RVOT
4. Perivalvular VT						
Tricuspid annulus	8% of idiopathic VT	Enhanced automaticity vs. DAD-related triggered activity	LBBB R or r in lead I, R in V6 A negative component (QS, qs, Qr, or qr pattern) in lead aVR	Same as RVOT	Same as outflow tract VT, not well studied	Same as RVOT

LV Summit

Area in the epicardial triangle between LAD and Cx, partially overlapped by the RVOT / Pulmonary artery

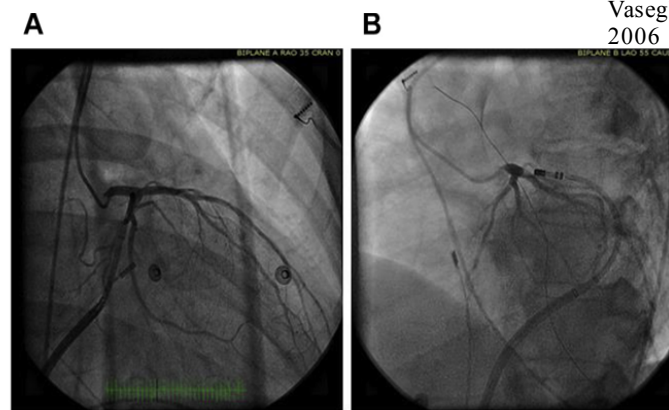
Intersected by the great cardiac / anterior IV veins—the medial part is not within reach of catheter



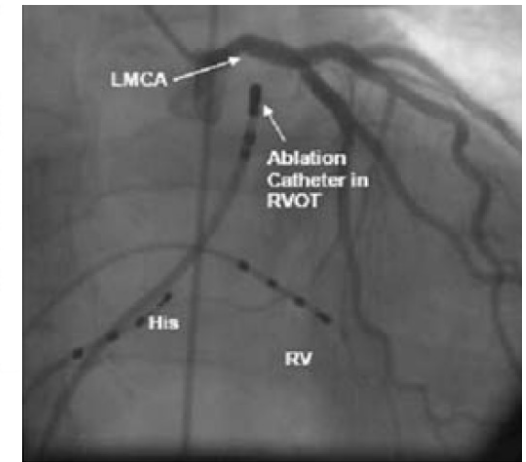
IDIOPATHIC VT AND VPBs – ANATOMICAL CONSIDERATIONS 2



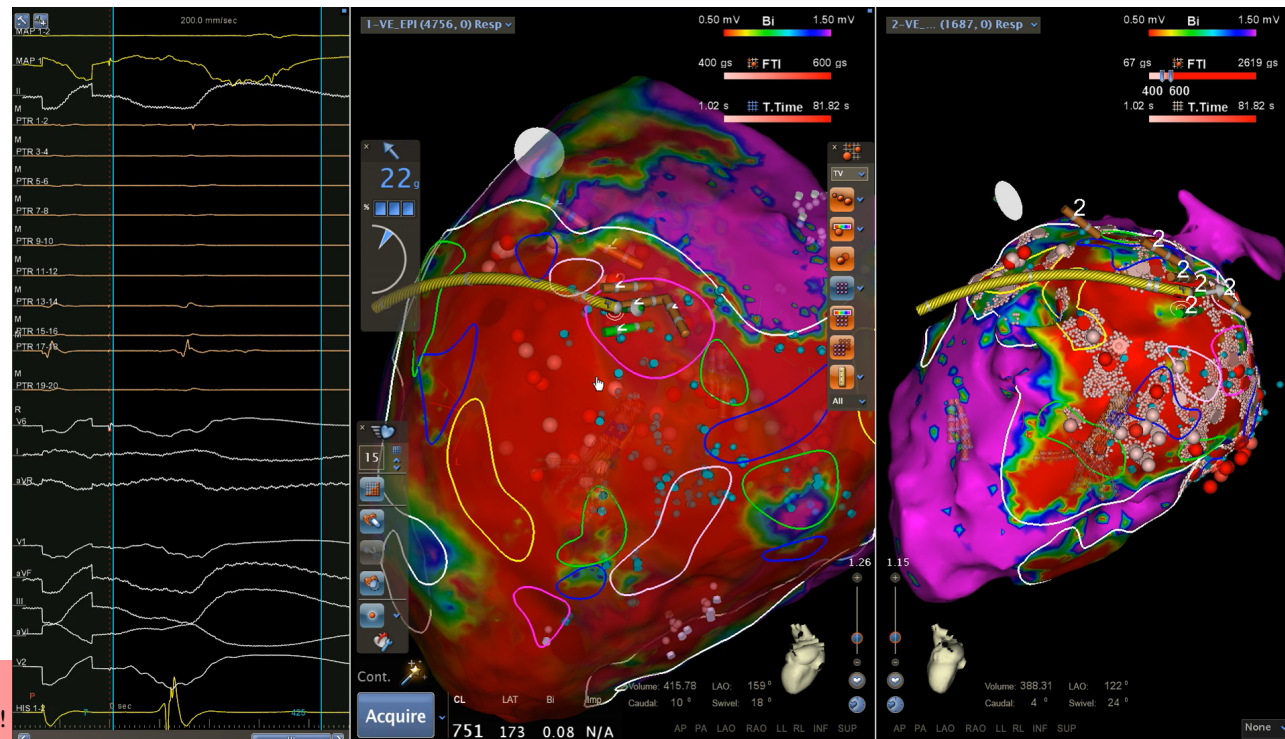
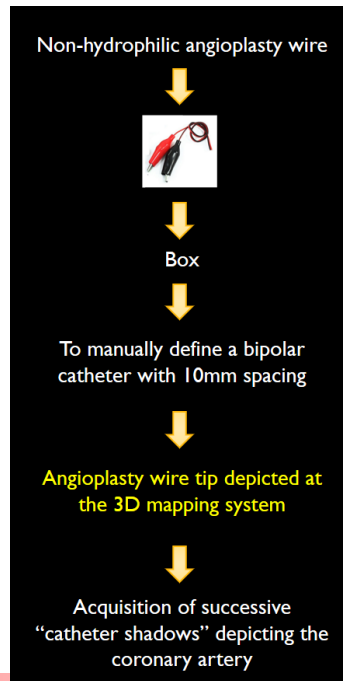
- Proximity of the area of interest to the coronary tree



Vaseghi J of Cardiovasc Electrophysiology Vol. 17, No. 6, June 2006

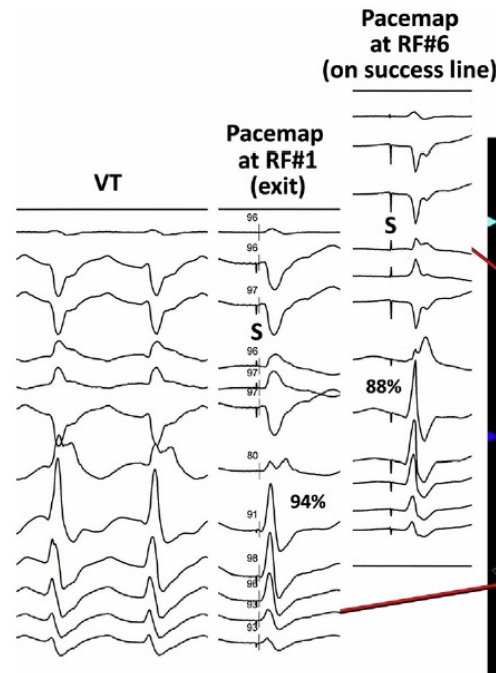


Luebbert Card Electrophysiol Clin 8(2016) 503–514



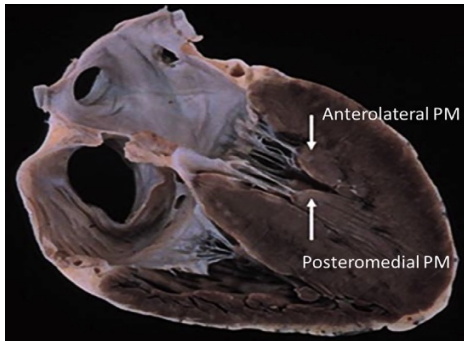
Never forget to **remove the angioplasty wire** before RF delivery – otherwise, you will cause a **myocardial infarction!**

1. Intrafascicular reentry (verapamil sensitive) >95%
2. Interfascicular reentry (rare)
3. Focal (triggered and enhanced automaticity)

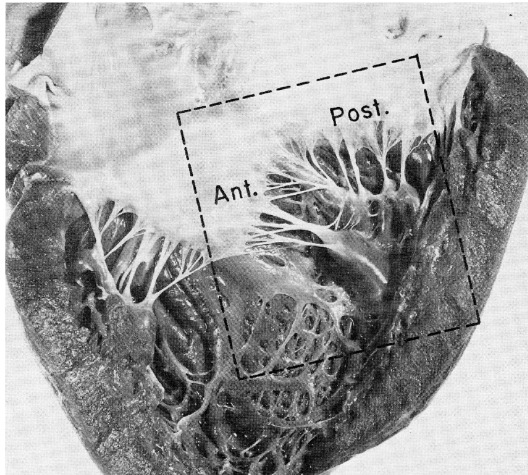


3D electroanatomical map of the left atrium. The map shows the activation sequence with a color scale from 6ms (blue) to 48ms (red). Key anatomical landmarks and labels include LAT, 1-1-VT ABL TAG > 107 Points, His, LV, and Exit. The map is overlaid with a grid. Angulation settings at the bottom are: Volume: 33.71, RAO: 47°, Caudal: 39°, and Swivel: 13°.

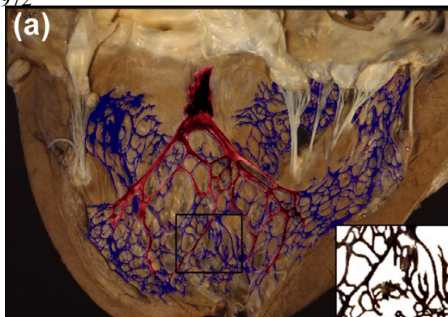
IDIOPATHIC VT AND VPBs – ANATOMICAL CONSIDERATIONS 4 - PAPILLARY MUSCLES



Abouezzeddine J Cardiovasc Electrophysiol 2010;21(3):246

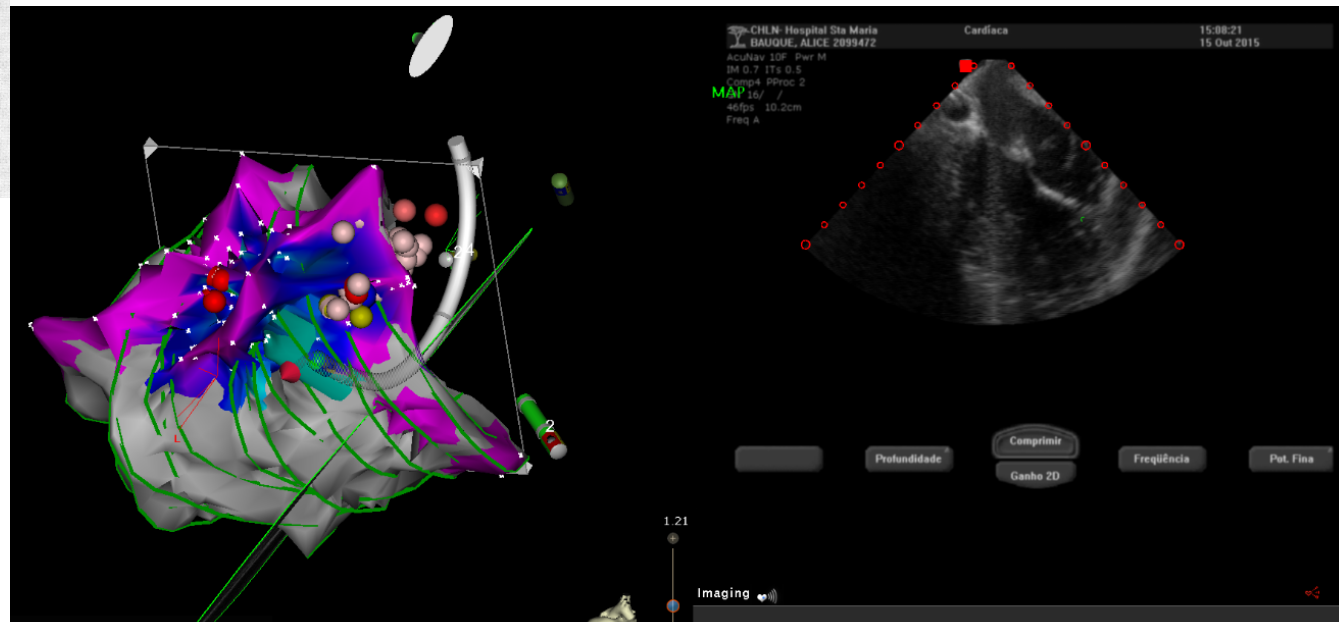


Roberts Circulation, Volume XLVI, July 1972



Cardenes Medical Image Analysis 24 (2015) 52–62

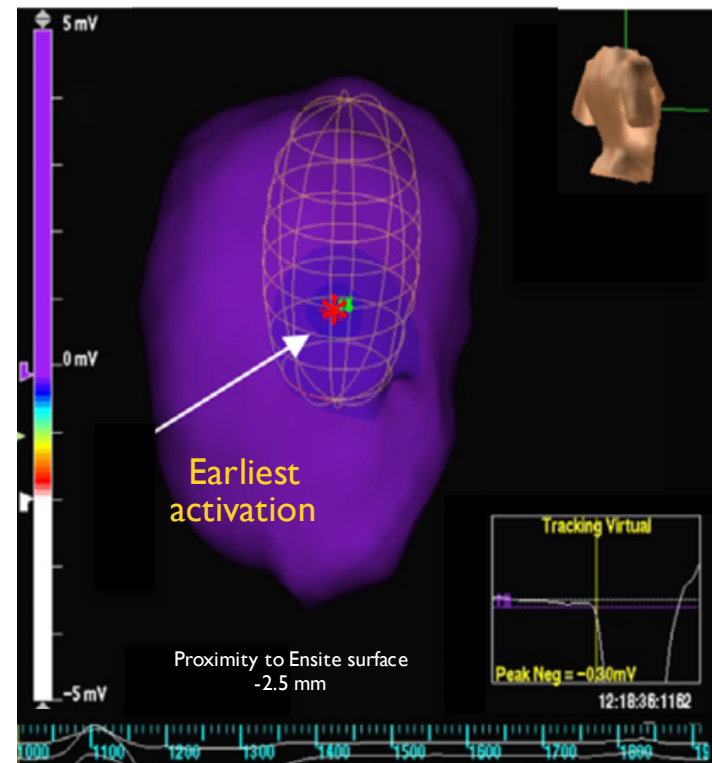
- Postero-medial Papillary muscle is the most frequent origin.
- The VPB /VT morphology may mimic the LPF-dependent fascicular tachycardia, but insensitive to Verapamil and not inducible by Pacing; Exercise and catecholamine infusion are the usual triggers.
- Earliest activation is the usual mapping technique; close proximity to Purkinje fibers may reveal a presystolic signal. This is held as a marker of successful ablation, probably by implying a superficial origin.
- Difficult catheter stability and deep myocardial sources often require several, longer or higher output RF applications, success is lower (60%, multicentre Study) and redo rate is reported 5-58%.
- Cryoablation na ICE may be the clue to success.



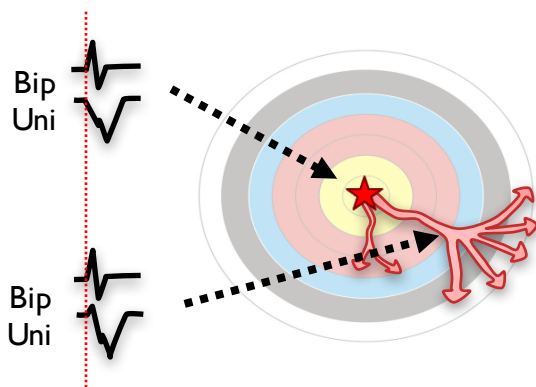


Simultaneous non-contact acquisition of unipolar virtual EGM

- **Advantages:**
- Even a single VPB produces a usable map
 - *A clear representation of break-out site as well as the earliest activation site can be obtained*



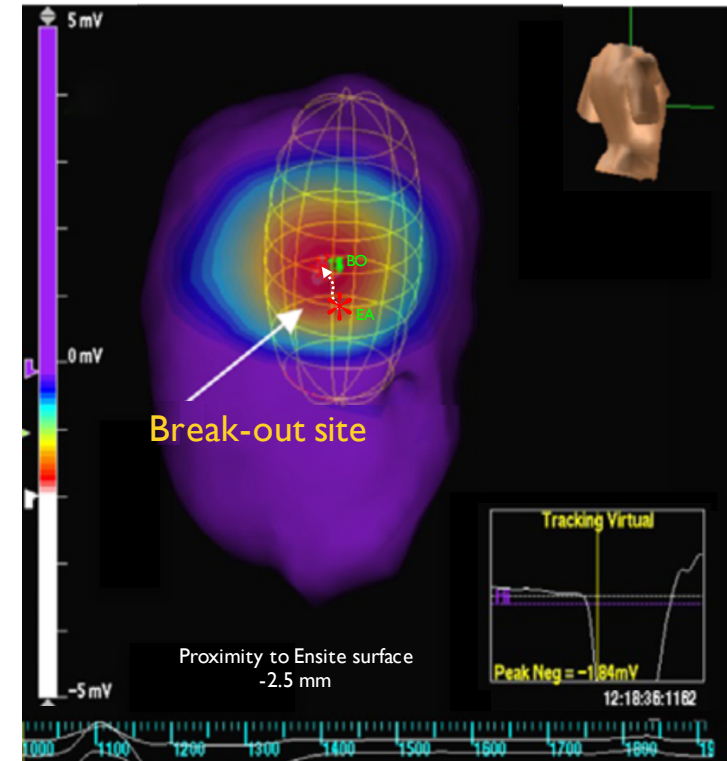
Unipolar vs. Bipolar mapping





Simultaneous non-contact acquisition of unipolar virtual EGM

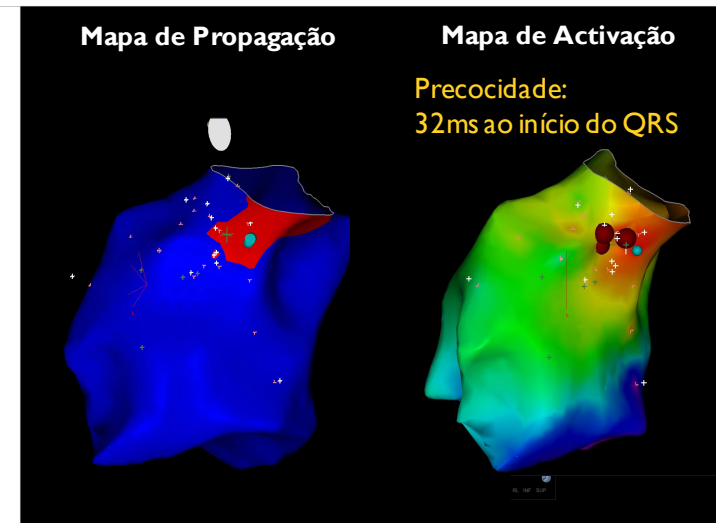
- **Advantages:**
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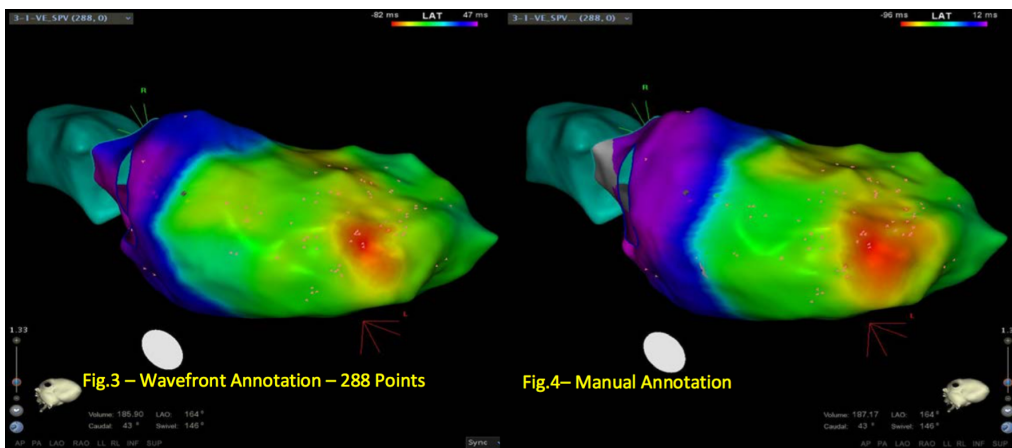


Earliest activation(LAT)

- Bipolar electrogram
 - Annotation at the onset of EGM
- Unipolar electrogram
 - Maximum downward slope (Wavefront Carto V4)
 - (not validated for VPB mapping)



Manual versus automatic annotation (Wavefront) in VPB mapping



Activation mapping is the technique of choice to pinpoint the origin of a focal arrhythmia,

But quite often hard to achieve or unfeasible in idiopathic VPB / VT

- Spontaneous VPB inhibition in 22% of patients during the procedure¹ (sedation, anesthesia, autonomic factors)
- Unpredictable, difficult induction: isoprenaline, Pacing, Ca²⁺



HSM-CHLN:

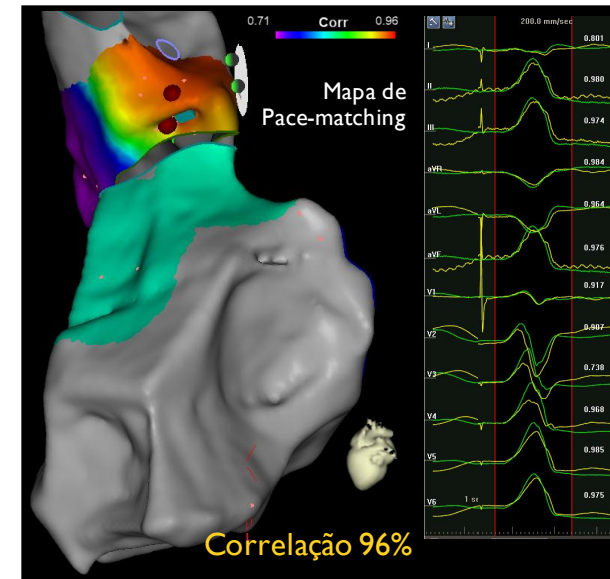
Retrospective study, 18 pts. (53 ± 15 y) iVPB / TV undergoing ablation

Activation mapping + Pace-mapping (**Carto PaSo**)

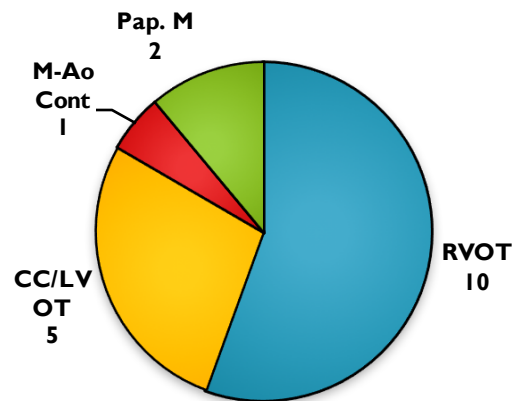
➤ “pace-matching only” was successful in 3/4 pts. with VPB inhibited during the mapping procedure.

➤ **Best pace-matching correlation in effective ablation cases:**

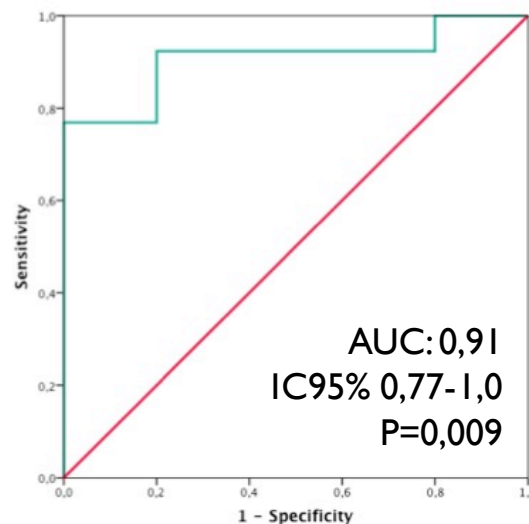
97 (95-98) versus 92 (92-93); $P=0,007$



iVPB/VT origin



PaSo correlation coefficient versus ablation success



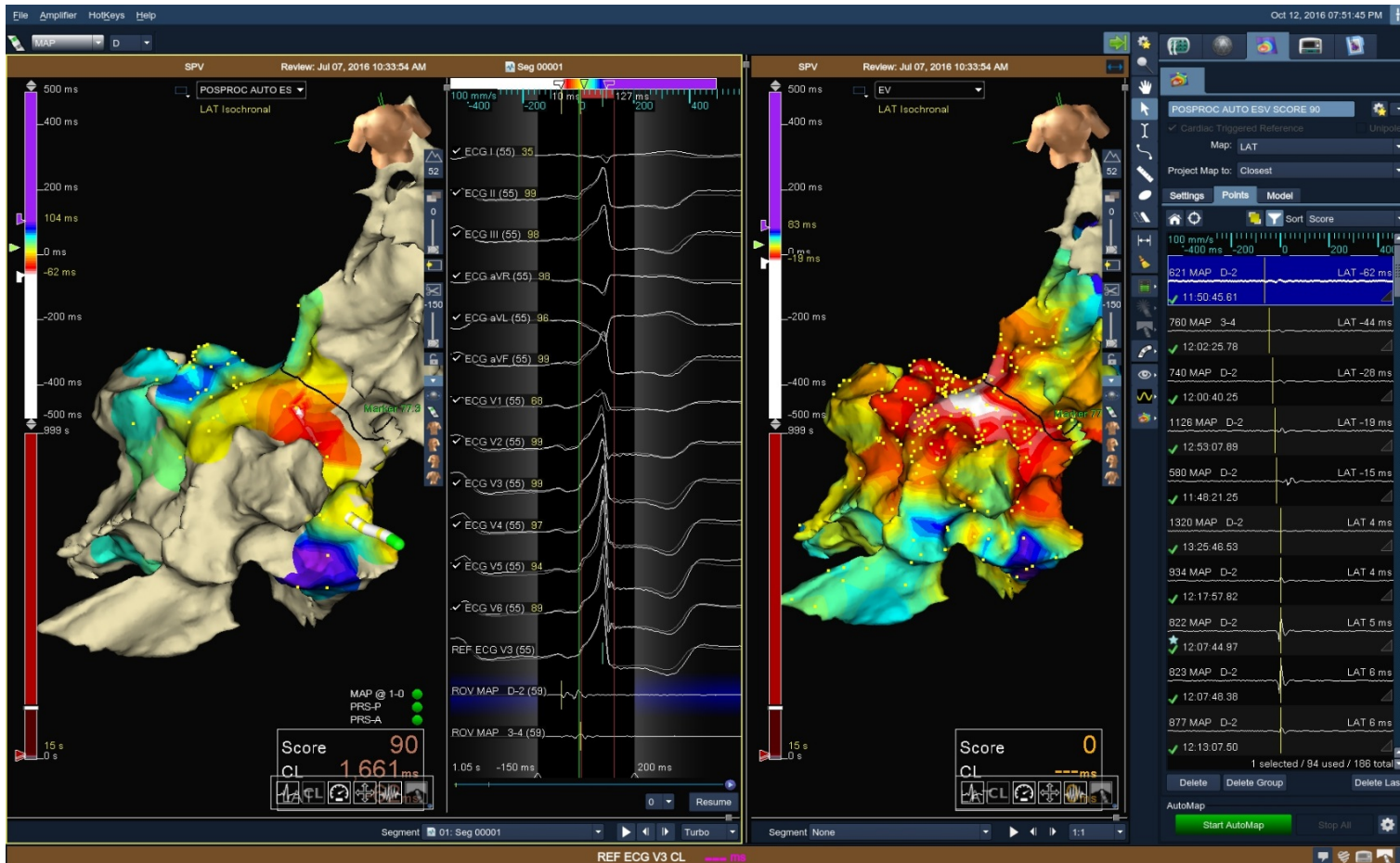
Correlação de pace-matching $\geq 95\%$ was predictive of success



NavX Ensite

Template matching: automated scoring of pace-mapped beats to define na
área of interest

TurboMap allow reconstruction of activation mapping using
multielectrode cateter recording and infrequent VPB



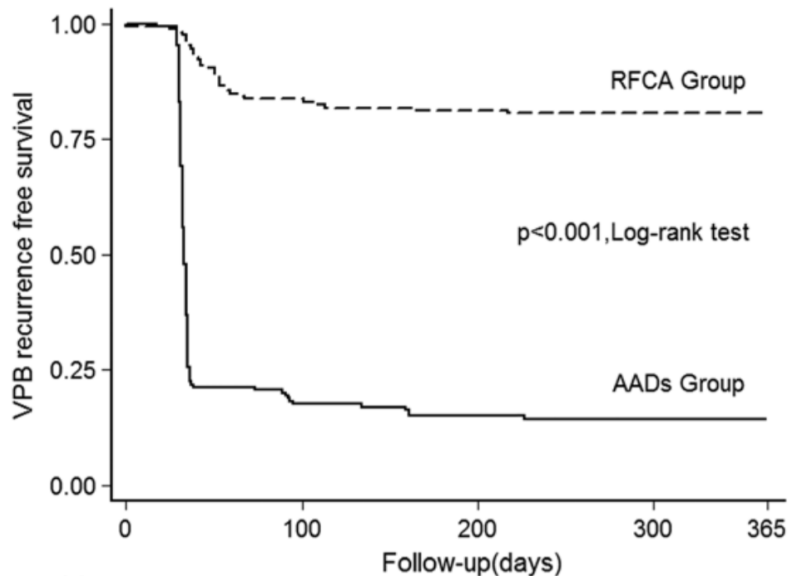


Randomised controlled trial

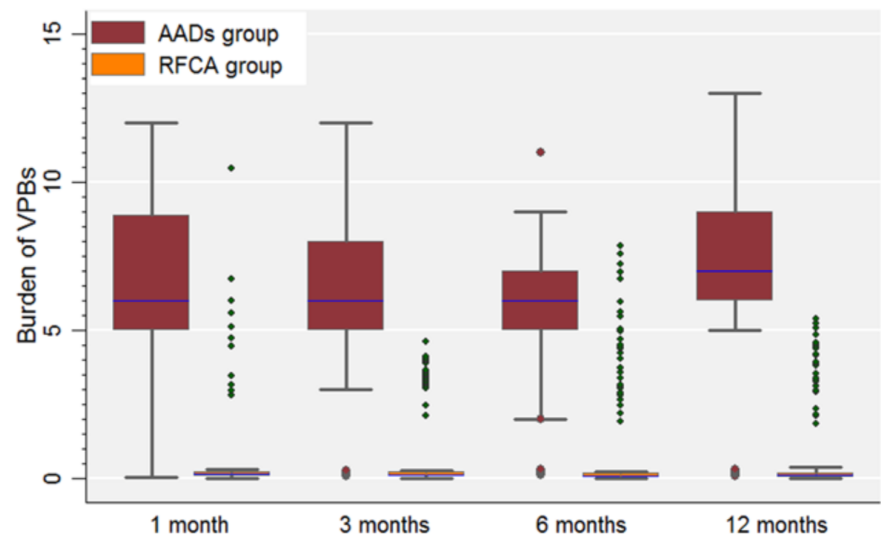
- 330 pts. With idiopathic, frequent VPB (>6000/24h) with LBB / Inferior axis on ECG, suggestive of RVOT origin

AAD Propafenone or metoprolol
Ablation

Success: >80% 24 h burden drop



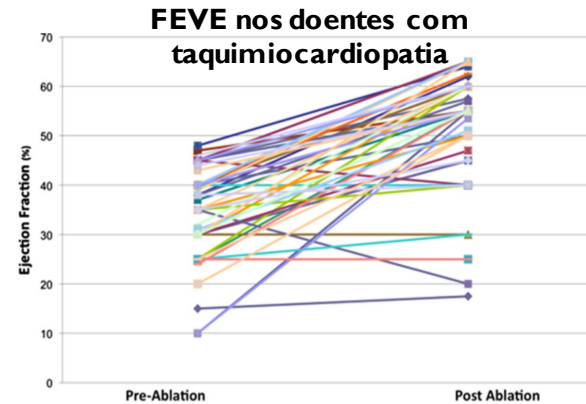
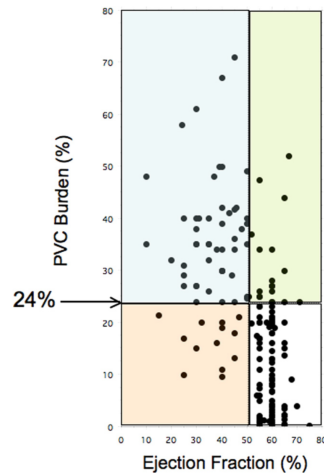
24 h burden



Complications: Ablation 3 (1,8%) – vascular access
AAD 10 (6,0%) – brady (4,2%) e symptomatic hypotension (1,8%)



174 pts with “idiopathic” frequent VPB underwent ablation
LVEF <50% : 32,8%



Baman TS. Heart Rhythm. 2010;7:865-9

Ablation of frequent PVC in patients meeting criteria for primary prevention ICD implant: safety of withholding the implant.

- After successful ablation when followed out to 1 year 64% recovered EF to the extent that they would no longer qualify for ICD for primary prevention.
- There were no sudden deaths or malignant arrhythmias observed in this group.

Penela D, Acosta J, Aguinaga L, et al. Heart Rhythm 2015;12(12):2434–42.

After successful ablation (80% reduction VPB burden) most patients demonstrate recovery in EF within 4 months, 32% delayed resolution with an average of 12 months.

Yokokawa Heart Rhythm 2013;10(2):172–5

In a comparison of VPB ablation with medical therapy, the likelihood of recovery of EF was 82% in the ablation group with no improvement in EF in the medical group

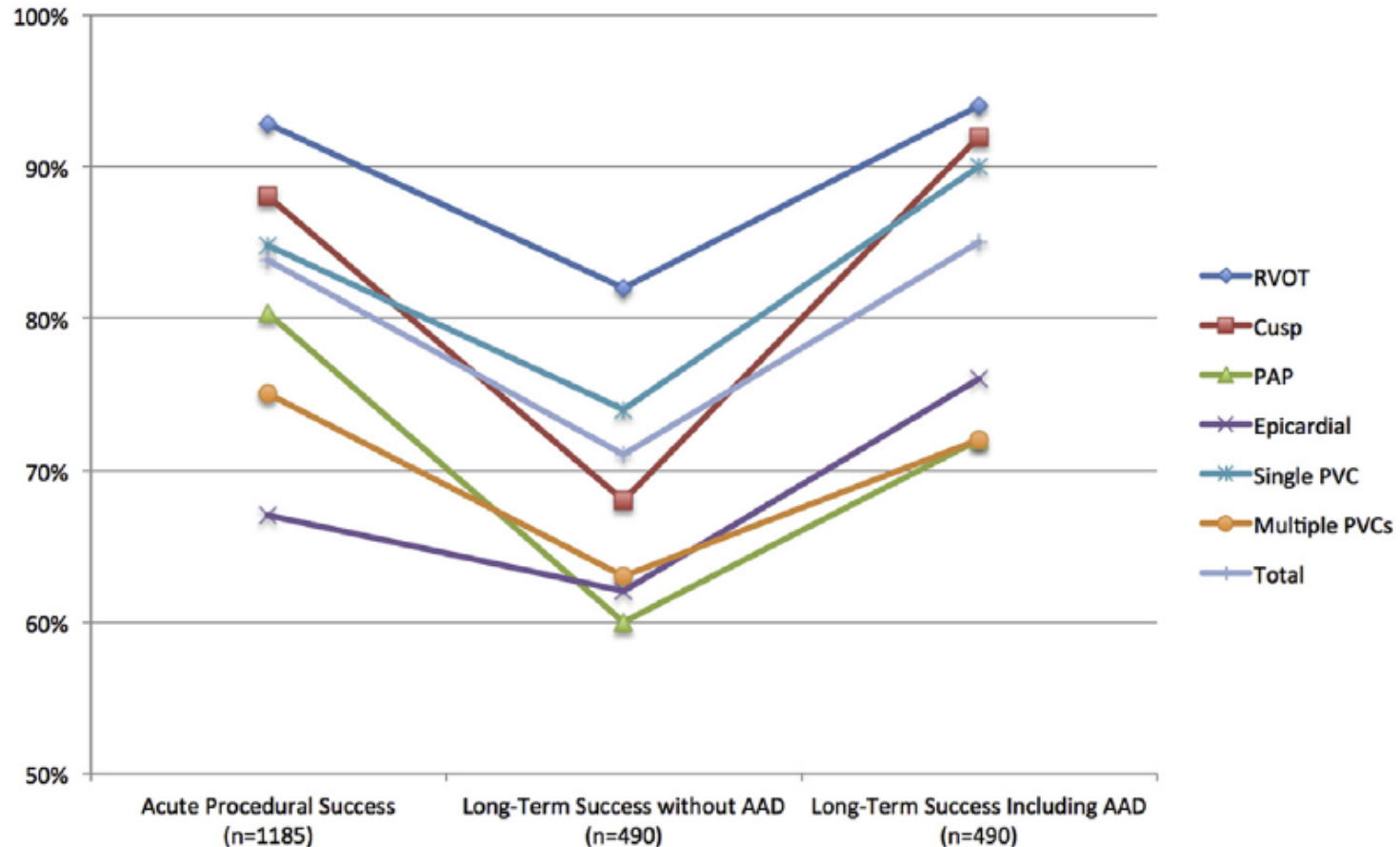
Bogun Heart Rhythm 2007;4(7):863–7

IDIOPATHIC VT AND VPBs – ABLATION RESULTS



FIGURE 1 Acute and Long-Term Ablation Success

Latchamsetty JACC: CLINICAL ELECTROPHYSIOLOGY VOL. 1, NO. 3, 2015



From several publications: factors for success were operator experience, site of origin, epicardial origin, reproducible VPB / inducibility during intervention

IDIOPATHIC VT AND VPBs – THE GUIDELINES



2015 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death

Treatment of outflow tract ventricular tachycardia

Recommendations	Class ^a	Level ^b	Ref. ^c
Catheter ablation of RVOT VT/PVC is recommended in symptomatic patients and/or in patients with a failure of anti-arrhythmic drug therapy (e.g. beta-blocker) or in patients with a decline in LV function due to RVOT-PVC burden.	I	B	525–528
Catheter ablation of LVOT/aortic cusp/epicardial VT/PVC by experienced operators after failure of one or more sodium channel blockers (class IC agents) or in patients not wanting long-term anti-arrhythmic drug therapy should be considered in symptomatic patients.	IIa	B	195, 531–533

Treatment to prevent recurrence of idiopathic ventricular tachycardia

Recommendations	Class ^a	Level ^b	Ref. ^c
Catheter ablation by experienced operators is recommended as a first-line treatment in symptomatic patients with idiopathic left VTs.	I	B	346, 347, 563–575
When catheter ablation is not available or desired, treatment with beta-blockers, verapamil or sodium channel blockers (class IC agents) is recommended in symptomatic patients with idiopathic left VT.	I	C	This panel of expert
Treatment with beta-blockers, verapamil or sodium channel blockers (class IC agents) is recommended in symptomatic patients with papillary muscle tachycardia.	I	C	This panel of experts
Treatment with beta-blockers, verapamil or sodium channel blockers (class IC agents) is recommended in symptomatic patients with mitral and tricuspid annular tachycardia.	I	C	This panel of experts
Catheter ablation under echo guidance by experienced operators after failure of one or more sodium channel blockers (class IC agents) or in patients refusing long-term anti-arrhythmic drug therapy should be considered in symptomatic patients with papillary muscle tachycardia.	IIa	B	576–578
Catheter ablation by experienced operators after failure of one or more sodium channel blockers (class IC agents) or in patients not wanting long-term anti-arrhythmic drug should be considered in symptomatic patients with mitral and tricuspid annular tachycardia.	IIa	B	534, 579–581

Treatment of idiopathic ventricular fibrillation

Recommendations	Class ^a	Level ^b	Ref. ^c
ICD implantation is recommended in survivors of idiopathic VF.	I	B	154, 583
Catheter ablation of PVCs triggering recurrent VF leading to ICD interventions is recommended when performed by experienced operators.	I	B	467, 584–587
Catheter ablation of PVCs leading to electrical storm is recommended when performed by experienced operators.	I	B	467, 584–587

TAKE-HOME MESSAGES

- VPBs are quite common in the general population, even NSVT is not exceptional. Casting a prognostic value still faces many confounding factors;
- When brought to medical attention, “Idiopathic” is a label of careful exclusion;
- Coping, and (if necessary) drugs not so often thought of as “AAD” might be the first choice;
- Heavily symptomatic patients, groups selected by VPB burden / LVEF compromise or high-risk markers are suitable for ablation;
- The planning of the ablation procedure starts with careful ECG analysis: clinical documentation is critical;
- The origin of the arrhythmia, center experience and availability of special techniques are critical for success.

