Young Investigator Competition

Y1. P-wave indices predict efficacy outcomes in long-term flecainide treated patients with atrial fibrillation.

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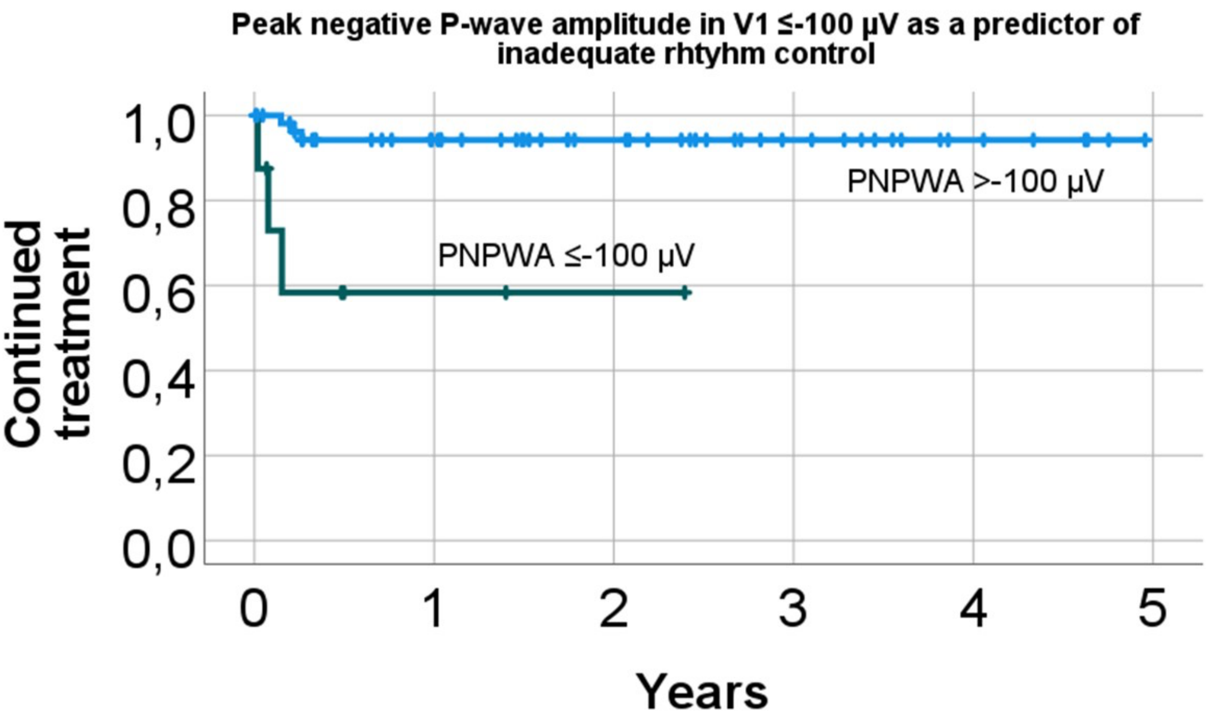
Background/Introduction: Flecainide is a commonly used efficient antiarrhythmic drug against atrial fibrillation (AF). P-wave indices reflect the atrial substrate and can predict incident AF, but their role as predictors of treatment outcomes for flecainide-treated AF patients are unknown.

Purpose: To assess if P-wave indices can predict efficacy outcomes in long-term flecainide treated AF patients.

Methods: Consecutive patients admitted for in-hospital flecainide initiation over a 5-year period were retrospectively included. Patient characteristics and baseline ECGs were collected (processed by the 12SL algorithm or manually measured). Echocardiographic measurements were collected up to 1.5 years before baseline. The study outcome was discontinuation of therapy due inadequate rhythm control (IRC). Cox regression analysis was adjusted for age, sex and left atrial volume index (LAVI).

Results: Sixty-seven patients in sinus rhythm were included and followed up for a median of 1.5 years (mean age 59 ±13 years, 36% females, AF history duration median of 3.0 years, 56% had ≤34ml left atrial volume index (LAVI) and 9 % had a history of persistent AF). At end of follow up twenty patients (30%) had discontinued flecainide treatment; of these seven patients (11%) had discontinued due to IRC. P-wave duration ≥130 ms (HR=8.4, 95% CI 1.5-46), peak negative P-wave amplitude in V1 ≤-100μV (HR=10, 95% CI 2.0-50) were significantly associated with discontinuation due to IRC in the univariate analysis. However, after adjusted analysis only peak negative P-wave amplitude in V1 ≤-100μV (HRadj=28.7, 95% CI 3.13-263) remained significant.

Conclusion: Peak negative P-wave amplitude in V1 ≤-100μV was a risk factor for discontinuation due to inadequate rhythm control in long-term flecainide treated AF patients.



Y2. High-resolution in silico assessment of atrioventricular node function during atrial fibrillation

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Background: The conduction properties of the atrioventricular (AV) node play a crucial role in regulating the heart rate during atrial fibrillation (AF). Assessing short-term variations in AV nodal conduction properties could provide novel information for improved diagnosis, prognosis, and treatment optimization on an individual basis. For clinical use, assessment should be based on non-invasive data, but a natural first step is to perform the analysis on invasive measurements.

Purpose: To assess the refractory period (RP) and the conduction delay (CD) of the fast pathway (FP) and the slow pathway (SP) of the AV node with a beat-to-beat resolution for patients suffering from AF, using invasive measurements of the atria.

Methods: We propose a methodology comprising a network model of the AV node, a particle filter, and a smoothing algorithm. Together, these enable the estimation and uncertainty quantification of the RP and CD of FP and SP of the AV node for each heartbeat. The methodology was evaluated using simulated data with known ground truth as well as applied to endocardial recordings from six patients in the Intracardiac Atrial Fibrillation Database (IAFDB, open access, PhysioNet).

Results: Estimated RP and CD from the simulated data matched the ground truth values with a mean absolute error (± std) for each heartbeat of 286±220 ms for RP in FP, 82±79 ms for CD in FP, 150±148 ms for RP in SP, and 158±159 ms for CD in SP. Furthermore, the resulting RP and CD trends from the endocardial recordings for one patient are shown in Fig 1.

Conclusion: Our model-based analysis enables patient-specific assessment of AV node conduction properties with a beat-to-beat resolution, offering potential insights for personalized treatment strategies during AF. The method constitutes a novel research tool in itself and provides an important step toward non-invasive short-term AV node assessment.

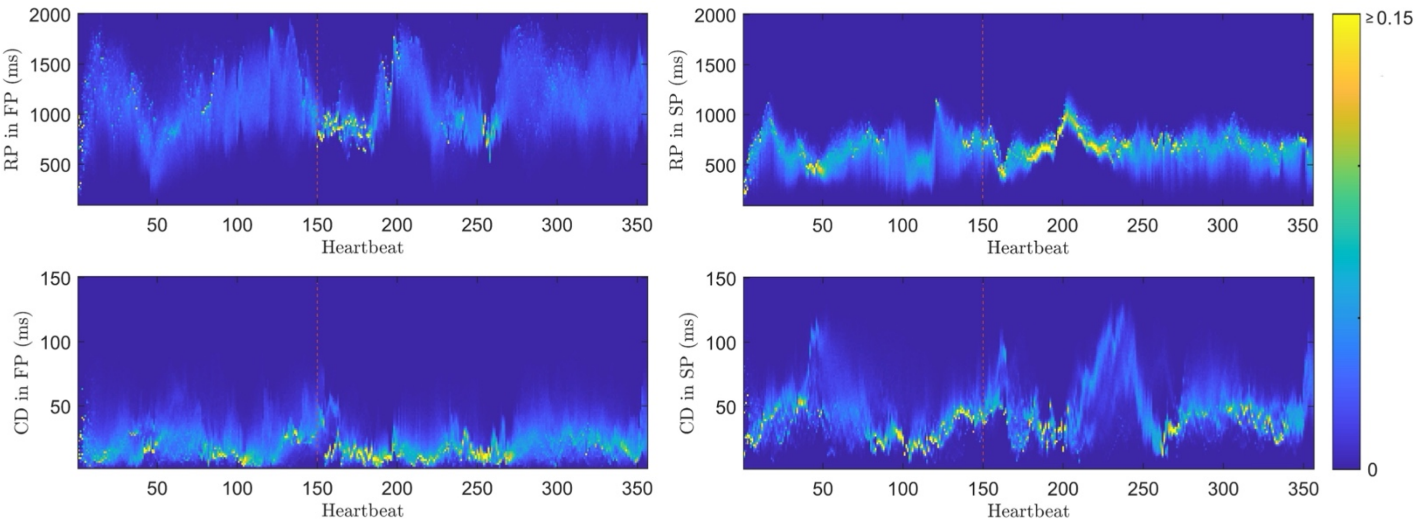

Fig 1. Estimated probability density functions (colored) of RP in FP (top left), RP in SP (top right), CD in FP (bottom left), and CD in SP (bottom right) for one patient where values ≥ 0.15 are presented with the brightest color for ease of visualization. The red dashed lines indicate time for injection of adenosine.

Y3. P-wave and F-Wave directionalities in subjects affected by paroxysmal atrial fibrillation

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Background: Vectorcardiogram (VCG) components can be used to evaluate the spatial directionality of electrocardiographic waves, being a time-spatial representation of heart vector into the three orthonormal leads (X, Y, and Z corresponding to left-right, head-feet, and back-front axes, respectively) of anatomical planes. The heart vector movements define a 3D VCG sway, that can be estimated by three ellipses, whose axes and eccentricity indicate the spatial electrocardiographic wave directionality in the anatomical planes. During atrial fibrillation (AF), F waves reflect the atrial chaotic depolarization, replacing the organized atrial depolarization pathway (P wave).

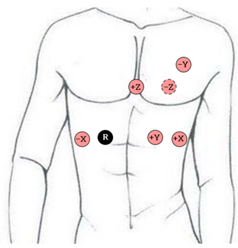
Purpose: Usually, paroxysmal AF spontaneously terminates, possibly due to the still-preserved P-wave pathway. To investigate this hypothesis, this study aimed to evaluate the similarities between the P-wave and F-wave directionality in subjects affected by paroxysmal AF.

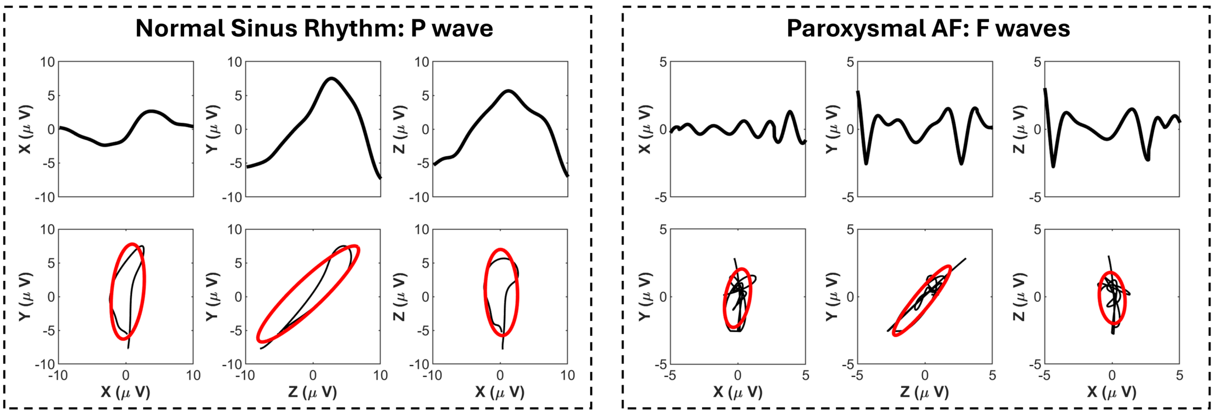
Methods: Overall, a pair of 10-second VCG were acquired from 10 subjects affected by paroxysmal AF by a clinical Holter device (sampling frequency: 200Hz), considering a pseudo-orthogonal electrode configuration. The first and the second VCG were acquired during normal sinus rhythm and paroxysmal AF, respectively. P waves of the first VCG were extracted by ECGdeli software, while F waves of the second VCG were extracted by the average subtraction algorithm. Ellipse axes and eccentricity were calculated as the root mean square of VCG components and as the ratio between axes, respectively. Not normal distributions of ellipse axes and eccentricities were quantified by 50th[25th;75th] percentiles and compared paired Wilcoxon rank-sum test.

Results: Overall, 89 VCG beats of normal sinus rhythm and 116 beats of paroxysmal AF were analyzed. The median value of axes and eccentricities of paroxysmal AF are not statistically different (P-value>0.05) than normal sinus rhythm.

Conclusions: VCG F-wave directionality in paroxysmal AF seems to be similar to the VCG P-wave directionality, suggesting the maintenance of the atrial depolarization pathway in subjects with self-terminating AF.

	Axis (μV)			Eccentricity		
	X (Right-Left)	Y (Head-Feet)	Z (Back-Front)	X-Y Plane (Frontal)	X-Z Plane (Transverse)	Y-Z Plane (Sagittal)
Paroxysmal AF	8.64 [7.62;10.27]	9.01 [6.93;15.49]	7.07 [4.10;9.63]	0.91 [0.86;0.95]	0.95 [0.86;0.97]	0.89 [0.86;0.94]
Normal Sinus Rhythm	11.79 [6.02;20.31]	11.08 [9.47;18.43]	6.02 [4.65;8.96]	0.95 [0.93;0.98]	0.92 [0.86;0.99]	0.87 [0.84;0.97]
P-value	0.49	0.63	0.63	0.75	0.83	0.57





Examples of the directionality of P wave and F waves of the same subject.

Y4. Implantable device utilization in real-life patients with heart failure: experience from The HARVEST-Malmö Study

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Background: Cardiac resynchronization therapy (CRT) and implantable cardiac defibrillators (ICD) have significantly enhanced outcomes in heart failure (HF), however underuse of device therapy has been reported.

Purpose: To compare clinical characteristics and long-term outcomes between HF patients with device (CRT/ICD) and those who, although meeting eligibility criteria, did not receive a device.

Methods: During hospital admission due to HF, 128 consecutive patients were prospectively enrolled. Eligibility for primary prevention device implant was defined as preexisting HF with EF <35% despite optimal medical therapy. Clinical characteristics were compared between patients with CRT or ICD (n=52) and eligible non-CRT/ICD recipients (n=76). Multivariable Cox regression assessed the risk of non-implantation for mortality and HF-related re-hospitalization

Results: During the median follow-up time (death: 34 (11-53) months, HF hospitalization: (2-32) months), 80 (63%) patients died and 82 (64%) were re- admitted for HF. The CRT/ICD recipient group was younger compared to the non-recipient group (70 vs 74 years; p=0.033). CRT/ICD-recipients had lower mean systolic (116 vs 129 mmHg; p=0.004) and diastolic (71 vs 78 mmHg, p=0.001) blood pressure, but a higher utilization of spironolactone (33% vs. 8%; p<0.001) compared to non-recipients. Beta blockers (38% vs. 57%, p=0.632) and ACE/ARBs (92% vs. 90%, p=0.589) did not differ between the groups. Re-hospitalization due to HF was more common among CRT/ICD-recipients (79% vs 53%, p=0.004). CRT/ICD-recipients had higher risk of re-hospitalization due to HF (HR:1.92, 95%CI: 1.10-3.35), but not of all-cause mortality (HR:0.87, 95%CI:0.50-1.49).

Conclusions: In this study, we observed high mortality rates in HF patients, regardless of device therapy use. Eligible non-recipients, compared to CRT/ICD recipients, were older with higher blood pressure and lower mineralocorticoid therapy prevalence but similar in other aspects. Our findings suggest a potential bias towards increased hospital admissions among CRT/ICD patient