

# Analysis of P-wave Changes for Prediction of Atrial Fibrillation Episodes

Cristina Moreno<sup>1,2</sup>, Aleksei Savelev<sup>3</sup>, Pyotr Platonov<sup>4</sup>, Pablo Laguna<sup>1,2</sup>, Juan Pablo Martínez<sup>1,2</sup>

<sup>1</sup>I3A, University of Zaragoza, IIS Aragón, Zaragoza, Spain

<sup>2</sup> Centro de Investigación Biomédica en Red–BBN, Zaragoza, Spain

<sup>3</sup> St.Petersburg State University, St.Petersburg, Russia

<sup>4</sup> Department of Cardiology, Lund University Hospital, Lund, Sweden

**Introduction:** Non-invasive markers of predisposition to atrial fibrillation (AF) can help to early AF detection and treatment. We focused on the analysis of ECG signals in patients with paroxysmal AF (PxAf). We hypothesized that, in sinus rhythm, the P wave widens, becomes more rugose and with higher complexity in the vicinity of an AF episode.

**Methods:** We applied principal and periodic component analysis (PCA and  $\pi$ CA) as lineal spatial transformations and beat averaging to characterize the P wave in 5-minute segments in sinus rhythm. These segments were selected at 60, 30 and 5 min before an AF episodes, thus studying the evolution of the P wave features in the minutes previous to AF.

The studied features were: power of the  $i$ -th transform component,  $\mathcal{P}_i^\Psi$ , relative power of the second-to-first component,  $\mathcal{P}_2^{\Psi,r}$ , relative power of third-to-first plus second component,  $\mathcal{P}_3^{\Psi,r}$  and a measure of rugosity, the power of the P wave after high-pass filtering with a 30 Hz cut-off frequency,  $\mathcal{P}_i^{\Psi,HF}$ ,  $i \in \{1, 2, 3\}$ .  $\Psi \in \{PCA, \pi CA\}$ , as well as the P wave duration in the first principal and periodic component  $D_{mn}^\Psi$ .

**Results:**  $\mathcal{P}_2^{PCA}$  increased as the AF episode approached ( $p = 0.007$ ) from 60 to 30 min and  $\mathcal{P}_2^{\pi CA}$  decreased from 30 to 5 min ( $p = 0.012$ ). Moreover  $D_{mn}^{PCA}$  increased from 60 to 5 min ( $p = 0.005$ ) and  $D_{mn}^{\pi CA}$  also increased from 60 to 30 min ( $p = 0.005$ ) and from 60 to 5 min ( $p = 0.011$ ).

	60 min	30 min	5 min
$\mathcal{P}_2^{PCA}$	45.3[62.0]	47.6[65.0]	47.2[60.1]
$D_{mn}^{PCA}$	116.7[20.7]	119.1[23.1]	120.9[23.2]
$\mathcal{P}_2^{\pi CA}$	30.8[62.4]	35.8[66.6]	32.2[64.8]
$D_{mn}^{\pi CA}$	115.1[26.5]	116.7[26.3]	118.3[26.4]

Table 1. Features with significant differences, Median[IQR]

No significant differences were found in the relative power and in the high-frequency powers using either of the two processing methods.

**Conclusion:** P wave spatio-temporal features showed significant changes prior to the onset of AF episodes in PxAf, showing a more complex structure, reducing its periodicity, and enlarging its duration as AF episodes approached.