ECG-Based Unsupervised Clustering in Coronary Artery Disease Associates with Ventricular Arrhythmia

Josseline Madrid*, Patricia B Munroe, Stefan van Duijvenboden, Julia Ramírez, Ana Mincholé

University of Zaragoza
Zaragoza, Spain

Aims: Coronary Artery Disease (CAD) is one of the leading causes of life-threatening ventricular arrhythmias (LTVAs) leading to sudden cardiac death. The presence of CAD slows ventricular conduction heterogeneously across individuals, manifesting as different QRS morphologies. This study aimed to identify distinct clusters of CAD individuals based on QRS morphology using unsupervised learning, and, investigate their association with LTVA risk.

Methods: An average heartbeat was derived from 10-second ECGs (lead I) from 1,458 individuals diagnosed with CAD in the UK Biobank study. QRS morphology was mathematically characterized by a combination of Hermite functions, as well as standard biomarkers, such as QRS amplitude, slopes, and duration. An unsupervised clustering algorithm based on 3-nearest neighbours was used to classify each individual into 3 distinct clusters. LTVA risk was defined as LTVA mortality or admission to hospital with a LTVA diagnosis 6-months before or after the CAD diagnosis. Statistical nonparametric tests (chi-square test) were performed to evaluate the association of each of the clusters with LTVA risk.

Results of K-means Clustering

Clusters (N=1458)	LTVA Ratio	*P*
Cluster 1 (N=564)	6.38 %	0.005*
Cluster 2 (N=652)	3.22 %	0.049
Cluster 3 (N= 242)	3.31 %	0.342

Results: There were a total of 65 LTVA events in the population. The unsupervised algorithm was able to distinguish 3 distinct clusters of QRS-related morphological features in CAD, which significantly differed in terms of LTVA events rate (see table). Cluster 1, which included the highest rate of LTVA events (6.38%), was characterized by lower QRS amplitude and down slopes, and a wider QRS than clusters 2 and 3.

Conclusions: Our analysis has identified in an unsupervised manner CAD individuals at risk of LTVA using information from the QRS morphology. Further studies will investigate the contribution of additional LTVA risk factors in CAD.