Estimation of Cardiac Time Intervals from the Mechanical Activity of the Heart using Machine Learning

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Aim- Pre-ejection period (PEP) and total systolic time (TST) are hemodynamic indices which provide vital information about left ventricular performance. PEP and TST are defined as the time interval between the onset of Q wave in an Electrocardiogram (ECG) and the opening and closure of the aortic valve, respectively. In this study, we suggested a method for estimating PEP and TST using the features extracted from the mechanical activity of the heart without finding the fiducial points associated with the opening and closure of heart valves.

Database- We recorded seismocardiogram (SCG) and gyrocardiogram (GCG) signals from 50 healthy subjects using a 3-axial micro-electro-mechanical joint accelerometer-gyroscope sensor.

Method- For each axis of the SCG and GCG signals, 18 features were extracted per cardiac cycle. Several multivariate regression models were implemented using the features from multiple combinations of SCG and GCG. The trained models were validated using the Leave-one-out-subject method against measurements from tissue Doppler imaging (TDI) as the reference.

Result- The model that was fitted over the SCG z-axis features provided the most accurate estimates for PEP and TST intervals with the root mean square error of 9.5 and 17.2 milliseconds, respectively.

Conclusion- The estimation of cardiac time intervals using SCG and GCG investigated in this study broadens the potential of SCG and GCG in the monitoring of cardiovascular performance. As these technologies yield themselves to wearable applications, they could be used outside of hospital/clinical settings to detect the potential abnormalities and malfunctions of the cardiovascular system.