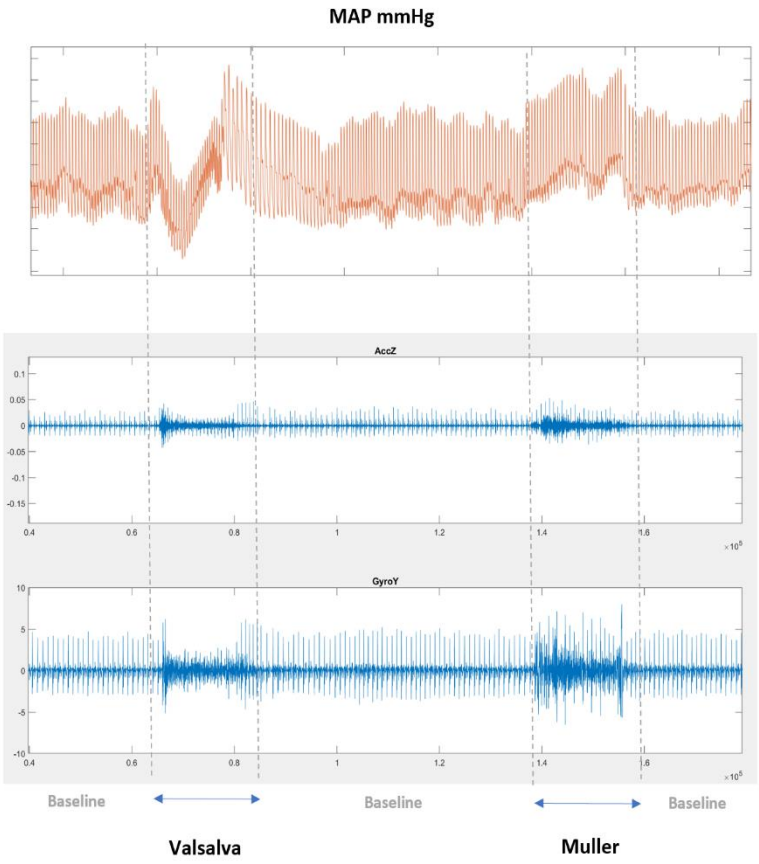
# Hemodynamic Monitoring in Response to Valsalva and Muller Maneuvers by Accelerometer and Gyroscope

Heart function monitoring by biomechanical sensors has been a clear study focus in the past decade to evaluate different cardiac conditions. This cardio-mechanical assessment includes the development of non-invasive solutions to detect cardiac abnormalities.

We studied employing Seismocardiography (SCG) and Gyrocardigraphy (GCG) to evaluate the hemodynamic changes in response to Valsalva and Muller maneuvers which are well-known mechanisms to simulate and predict different pathological conditions such as sleep apnea. Utilizing both of gyroscope and accelerometer in interpreting the maneuvers did not get much attention in the literature, especially in Muller.




A combination of 3-axis accelerometer, 3-axis gyroscope, and a single-lead ECG signals of five healthy subjects was collected during and following Valsalva and Muller maneuvers using a custom-made small device attached to the chest's wall in sternum position. Simultaneously, Mean Arterial Pressure (MAP), systole\diastole pressures, and pulse pressure were measured using the Continuous Non-Invasive Arterial Pressure (CNAP) system. The recordings were collected in the supine position and included 3 continuous measurements for each subject. Each measurement consists of a 15-minute recording of each maneuver followed by a 1-minute recovery in between each phase.

Peaks amplitudes, beats energy, and heart rate (HR) of the cardio-mechanical signals were computed and correlated with the reference CNAP measurements. The accelerometer and gyroscope's peaks amplitudes showed a strong positive correlation with the MAP in Valsalva, while in Muller correlated mostly at the beginning of the maneuver. Beats energy of both mechanical signals as well as their peaks amplitudes correlated well with the stroke volume extracted from the CNAP signal, with more increase of beat energy at the recovery phase. On the other hand, HR showed a strong inverse correlation with the MAP through the measurements.

The study outcomes can provide a new physiological understanding of how different cardiac features relate to circulatory and respiratory patterns.