In-ear pulse wave amplitude recordings during synchronized walking

Aurora Rosato[1], Seraina A. Dual[1]
1 Department of Biomedical Engineering and Health Systems, KTH Royal Institute of Technology, Stockholm, Sweden

One way to improve hemodynamic efficiency is the synchronization of the stepping with the diastolic phase of the cardiac cycle (diastolic stepping) minimizing peak pressures on the heart level. At head level, we expect maximized blood flow in diastolic and minimized blood flow in systolic stepping. This study aims to verify suggested blood flow patterns via analysis of the pulse wave (PW) amplitudes in the ear during diastolic vs systolic stepping.

Four subjects (2/2 w/m, 27± 3 years) walked at a comfortable speed on a treadmill and were guided by an auditory signal to achieve diastolic (5 min) and systolic stepping (5 min). We acquired continuous PW on the subjects' tragus by an optosensor (TCRT1000, Vishay, USA), including analog filtering at 100 Hz (GD32VF103, GigaDevice, China). To validate the in-ear measurement, we compared the PW heart rate (HR) to the HR based on the electrocardiogram (ECG) at 125 Hz from a chest strap.

Across all subjects, the PW amplitude is greater during diastolic compared to systolic stepping (20 ± 16% increase), example in Figure 1. The HRs from the optosensor are on average 0.73 ± 1.4 beats/min lower than the ECG ones. Synchronized walking modulates the PW amplitude in the ear in healthy subjects, suggesting maximized peak flows during diastolic stepping. The magnitude and the extent of the diastolic flow augmentation varies across subjects. The results of the HR analysis suggest that some beats are missing or not recognizable in the PW signal. A more stable sensor configuration should be considered in the future to increase signal robustness. Further studies will investigate the observed tendencies in more subjects to understand patient-specific variability.

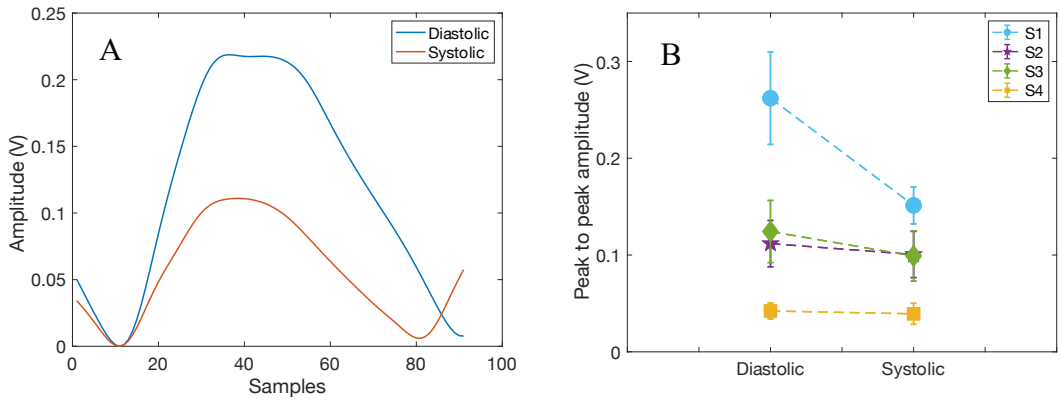

Figure 1, Mean diastolic wave and systolic, S1 (A), Mean amplitude and std, all subjects (B)