Vascular Aging Using Infrasonic Hemodynography Embedded Into Everyday Earbuds

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Motivation

Physiological aging and cardiovascular risk factors lead to structural and functional alterations in large arteries. Aortic stiffness is the best predictor of cardiovascular morbidity and mortality. Invasive measurements of arterial stiffness are not feasible in routine clinical use.

About MindMics

MindMics is pioneering the field of **in-ear infrasonic hemodynography** (IH). The low-frequency infrasonic waves (< 20 Hz) are below the human audible range. The body constantly generates infrasonic waves from muscular contraction, blood circulation, and respiration. MindMics technology integrates into standard earbuds to enable non-invasive monitoring of human audiom.

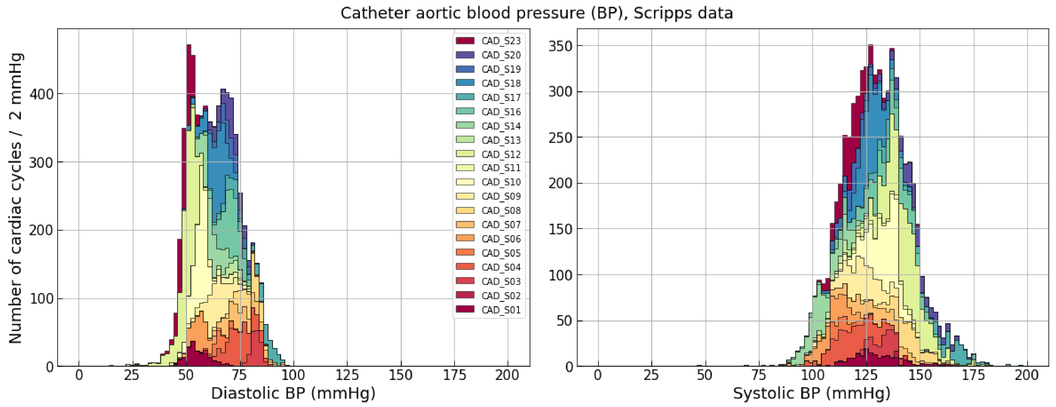
Project Objectives

We plan to use data collected from our clinical studies at Scripps Health to develop algorithms to understand and quantify aortic stiffness. Increased aortic stiffness is largely a product of aging and unhealthy lifestyle habits. We will further conduct studies to investigate accuracy of algorithms in healthy individuals at rest and after performing various breathing exercises. Adding aortic stiffness as a proxy for vascular age into the next releases of the MindMics product would empower people by giving them tools and knowledge to control their inner aging in an actionable and convenient way.

Pilot Project Highlights

Aim 1: Preparation of data banks for analysis
Duration: 2 months (12/1/2022 - 1/31/2023)

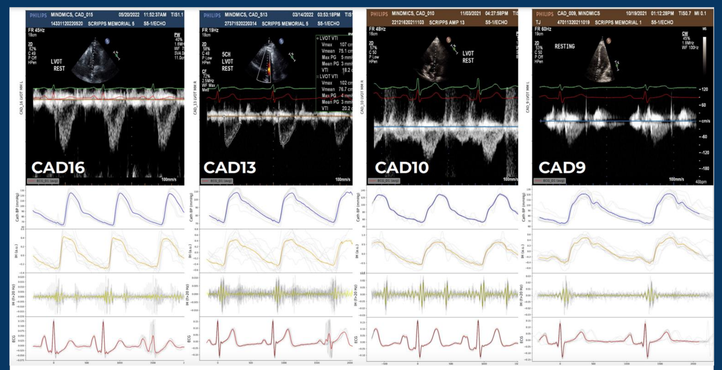
- Create a reference database of arterial stiffness based on echocardiogram and cardiac catheter data collected during clinical study at Scripps Health (patients recruited before the start of this project in ClinicalTrials.gov Identifier: NCT04636892);



Aim 2: Pulse wave decomposition for feature extraction to correlate with aortic stiffness

Aim 3: Subject study design and data collection including testing breathing protocols to lower aortic stiffness

Aim 4: Data analysis to search for most efficient protocol in lowering aortic stiffness



Exemplary Wiggers diagrams showing synchronized mechanical (echocardiogram on top, LVOT), hemodynamic (catheter in blue and MindMics in orange and yellow), and electrical (ECG in red) waveforms for selected Scripps patients.

Implications

MindMics could provide an inner vascular age estimated based on arterial stiffness paired with actionable tools to empower people to make better decisions about their lifestyles and improve their health outcomes. Moreover, long term data collection through MindMics technology, which will be soon acquired from a large population, would enable us to study aging and understand what factors have an impact and what techniques could be used to stop or even reverse the process of vascular aging and lower the chances of cardiovascular diseases, the #1 killer in the US and globally.

Bibliography

Gilliam, F.R., Ciesielski, R., Shahinyan, K. et al. In-ear infrasonic hemodynography with a digital health device for cardiovascular monitoring using the human audiome. npj Digit. Med. 5, 189 (2022). https://doi.org/10.1038/s41746-022-00725-3

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