DEVELOPMENT AND OPTIMIZATION OF A PRESSURE MYOGRAPHY SYSTEM BASED ON AN OPEN-SOURCE DESIGN

1 Supervising staff

Antoine Nonclercq (antoine.nonclercq@ulb.be), Alain Delchambre (alain.delchambre@ulb.be), Benoit Scheid (benoit.scheid@ulb.be) Ramzi Ben Hassen (ramzi.ben.hassen@ulb.be), Cyril Tordeur (cyril.tordeur@ulb.be).

2 Context

Pressure myography is an advanced technique used in vascular research to study the physiological properties and functional responses of small arteries, veins, and other blood vessels under near-physiological conditions [1, 2]. As shown if Figure 1 this method involves isolating a small segment of a vessel, mounting it onto glass cannulas, and pressurizing it to simulate the transmural pressure experienced in vivo [3]. By maintaining these conditions, pressure myography allows researchers to measure key parameters such as vessel diameter, wall thickness, vascular resistance, and shear stress [4]. The system is particularly valuable for investigating intrinsic vascular responses like myogenic tone (the vessel's ability to constrict or dilate in response to pressure changes), flow-mediated dilation, and the effects of pharmacological agents on vascular function [5, 6]. Pressure myography is also used to evaluate structural changes in vessel walls and their intrinsic biomechanical properties under varying conditions [7, 8]. Its ability to replicate physiological pressures and flows makes it a superior alternative to traditional wire myography for studying resistance vessels that play a critical role in regulating blood flow and peripheral resistance.

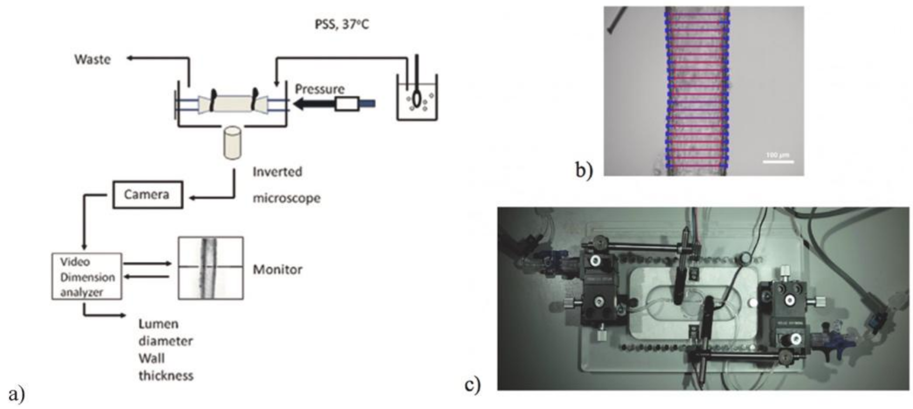

Figure 1. a) Pressure Myography Setup [8]. B) Tracking software for detecting artery diameters with the c) VasoTracker PM system [4].

Overall, pressure myography is an essential tool in cardiovascular research, offering insights into the dynamic interplay between vascular structure and function. It has applications ranging from basic physiological studies to drug development and understanding pathophysiological processes in cardiovascular diseases.

3 Work

This master thesis aims to manufacture a pressure myography system based on an existing open-source design, the VasoTracker. VasoTracker originated from a need to find a cost-effective alternative to expensive commercial systems used for studying blood vessel function. The initial VasoTracker system was a custom pressure myograph bath coupled with software designed for the live measurement of blood vessel diameter. Recognizing that other researchers might face similar challenges and benefit from our solution, researchers from the University of Strathclyde and the University of Glasgow released these tools as open-source resources.

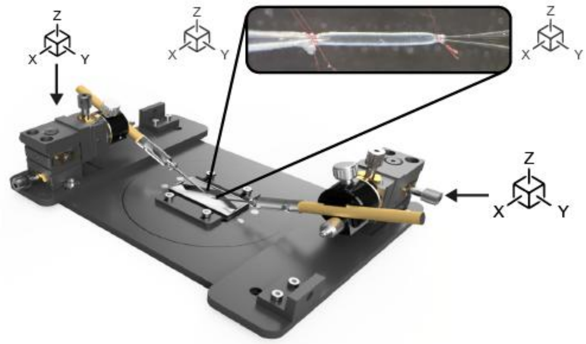

Figure 2. Illustration of the VasoTracker 2.0 with the representation of the independent XYZ positioning of both cannulae ensuring accurate and flexible manipulation of vessels.

In addition to the manufacturing process, a design optimization might be warranted to address the impossibility to analyze multiple vessels in parallel. Additionally, further work might be conducted to optimize the available design in order to reach an even more physiological condition. Upon termination of the manufacturing process, the system will be assessed on rodent arteries in a research project investigating the effects of weightlessness on central vascular structure and function.
The focus of the work evolves around the manufacturing of an open-source pressure myography system, with assessment, and room for design improvement for further work.

4 References

1. Wenceslau, C.F., et al., *Guidelines for the measurement of vascular function and structure in isolated arteries and veins.* Am J Physiol Heart Circ Physiol, 2021. **321**(1): p. H77-H111.
2. Schjorring, O.L., R. Carlsson, and U. Simonsen, *Pressure Myography to Study the Function and Structure of Isolated Small Arteries.* Methods Mol Biol, 2015. **1339**: p. 277-95.
3. Shahid, M. and E.S. Buys, *Assessing murine resistance artery function using pressure myography.* J Vis Exp, 2013(76).
4. Lawton, P.F., et al., *VasoTracker, a Low-Cost and Open Source Pressure Myograph System for Vascular Physiology.* Front Physiol, 2019. **10**: p. 99.
5. Hanson Ng, Y.Y., et al., *Asymmetric Dimethylarginine Enables Depolarizing Spikes and Vasospasm in Mesenteric and Coronary Resistance Arteries.* Hypertension, 2024. **81**(4): p. 764-775.
6. Masterova, K.S., et al., *Enhancing flow-mediated dilation analysis by optimizing an open-source software with automated edge detection.* J Appl Physiol (1985), 2024. **137**(2): p. 300-311.
7. Navindaran, K., J.S. Kang, and K. Moon, *Techniques for characterizing mechanical properties of soft tissues.* J Mech Behav Biomed Mater, 2023. **138**: p. 105575.
8. Akhtar, R., et al., *Characterizing the elastic properties of tissues.* Mater Today (Kidlington), 2011. **14**(3): p. 96-105.