Extending the cardiovascular functional avatar with enhanced modelling of blood pressure regulation.

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**Background**: We have recently developed an integrated imaging-modelling framework for assessment of the overall cardiovascular health status of individuals called “Cardiovascular functional avatar” (Figure 1). The avatar consists of a lumped parameter model, in which the parameters are adjusted for every specific patient. By using the input from a brachial pressure cuff measurement, anatomy and dynamic flow data from 4D Flow MRI measurements, the majority of the model elements can be individualized (Casas, 2017). In addition to quantifying the functional characteristic of every element, the avatar permits the investigation of important cardiovascular parameters that are otherwise unavailable from non-invasive data, e.g., the pressure-volume curves of the heart.

![Figure 1. The schematic representation of the cardiovascular functional avatar (Casas 2017) and the output ventricular pressures, left ventricular volumes, valvular flow rates and left pressure-volume loop.](image)

In the human body, the relationship between the blood pressure, heart rate, and peripheral resistance is regulated via baroreceptors and other blood pressure regulators. The resulting effects are included in the avatars derived from a full 4D Flow MRI and blood pressure measurements. However, when changing the heart rate or peripheral resistance in an existing avatar (e.g., when what-if scenarios are explored and during treatment planning) the modeled relationship between the pressure, heart rate, and peripheral resistance might not be sufficiently accurate.

**Aim**: to include a blood pressure regulation system in the avatar to assure the validity of the method over a wide range of heart rates and blood pressures.

**Implementation**. The blood pressure regulation system will be implemented by creating a pressure regulating feedback loop from the pressure in the ascending aorta to the heart rate and peripheral resistance. The avatar blood pressure regulation will be calibrated and evaluated in full avatars created from measurement data of 10 healthy subjects before and during infusion of dobutamine (leading to a ca. 50% increase in the heart rate). These measurements will be used to develop the feedback mechanism and perform a proof-of-concept test.

**References**