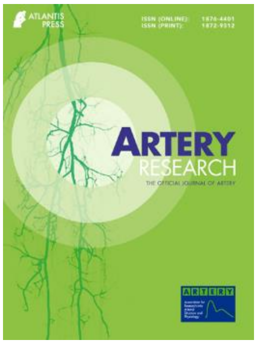

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P11.1: THE PU AND QA LOOP METHODS OVER- AND UNDERESTIMATE LOCAL CAROTID WAVE SPEED: A CONSISTENT EXPLANATION AND SOLUTION TO THE PROBLEM

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that married patients showed better levels of compliance 73.13% than single patients. patients originating from the north showed better compliance (70.45%) than those living in other regions of the Sudan. Disregard to origin most patients lived in desert environments 97.67% of those originating from the North and (66.66%)of these originating from the East).

Conclusion: Patients originating from the East showed lower compliance and therefore must be targeted for health to increase awareness

P11.1

THE PU AND QA LOOP METHODS OVER- AND UNDERESTIMATE LOCAL CAROTID WAVE SPEED: A CONSISTENT EXPLANATION AND SOLUTION TO THE PROBLEM

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Single-point methods such as the PU- and QA-loop methods are used to estimate local pulse wave velocity (PWV-PU and PWV-QA) in arteries from a combination of pressure (P), flow (Q), velocity (U) or cross-sectional area (A) waveforms. Available data indicate that the PU-loop method tends to overestimate PWV, while the QA-loop method tends to underestimate. Wave reflection has been suggested as a factor playing a role in the agreement between different methods. In this work, we (i) demonstrate the interference of wave reflection with the PU-loop method for both solitary sinusoidal waves as well as physiological waveforms; (ii) develop an operator-independent method to correct for the presence of reflections. Fluid-structure interaction simulations in a tube and carotid artery model with known mechanical properties confirm the theory. For the carotid artery model, PWV-PU severely overestimates PWV, while PWV-QA underestimates PWV. Correction (leading to an estimate termed PWV-corr) eliminates the impact of reflections. Finally, methods are applied in vivo in a subsample of the Asklepios population. Compared to PWV-PU and PWV-QA, PWV-corr leads to significantly better correlations of carotid PWV with PWV derived from carotid distensibility based on the Bramwell-Hill equation(with r^2 improving from about 0.25 to 0.91). Neither the PU-loop nor the QA-loop method provides reliable estimates of local PWV in settings where wave reflections are present - even when the PU- or QA-loops show a linear segment. They offer no alternative for the Bramwell-Hill based approach and their application should therefore be discouraged, especially for the carotid artery.

P11.2

A 1D-MODEL FOR THE SIMULATION OF THE ARTERIAL WALL DISPLACEMENT

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Background: Nowadays, a great emphasis has been placed on the modeling of the cardiovascular system. In 1d-models, the arterial diameter is generally deducted from the arterial pulse pressure by considering a stress-strain relationship. However, this assumption remains simplistic in nature since no interaction among elastic layers constituting the arterial wall is considered. Moreover, 3d-models offer generally a better description of the physiology of the arterial wall but are often too complex to be embedded in other 1d-arterial models.

Methods: In the present study, we propose a novel and simple 1d-model to simulate the arterial wall displacement in large arteries. This one relies on a system of coupled differential equations from the interactions among the elastic fibers of the arterial wall and the surrounding tissues. Thereafter, the common carotid arterial wall displacement is reproduced and compared to experimental data obtained from a high-resolution echo tracking ultrasound system in 10 patients.

Results: The model shows a distensibility of the carotid artery (5.6 10−3 mmHg−1 with the simulation) in the same range as observed for experimental data in 10 patients (4.5 10−3 mmHg−1). Moreover, the results suggest that the carotid diameter waveform cannot be directly substituted to the arterial pulse pressure as observed in other 1d-models and differs significantly during the systolic phase.

Conclusions: Subsequently, our model could give a reliable and useful tool for the simulation of the arterial wall displacement which could be easily embedded in other 1d-models treating of arterial system.

P11.3

DEVELOPMENT AND VALIDATION OF REALISTIC AORTIC PHANTOM TAILORED FOR EACH PATIENT

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The microstructure evolution of the aortic tissue in cardiovascular pathologies, such as aneurysm or arthrosclerosis, leads to an overall change of biomechanical properties. Successful treatment (e.g endovascular) of these pathologies depends on the comprehension of these properties and on the surgeon expertise.
Many investigators have created general-purpose aortic replicas called "phantoms", for the preoperative training and/or the studies of surgical and radiological processes. However, the importance of the used material properties was generally neglected. Moreover, the specific shape and the mechanical behavior of each patient's aorta were not taken into account. Our work aims to create patient-specific phantoms able to accurately mimic each individual case.
We use a mechanical model comprising both hyperelastic and viscoelastic behaviors which can be scrutinized to predict aneurysm rupture and to diagnose the atherosclerosis, respectively. To identify the model parameters, we performed steady and dynamic ex-vivo experiments. Results were used to develop a large range of materials able to replicate real healthy and pathologic aortic mechanical behavior. For that purpose, different Bluesil® silicone materials from Bluestar Silicones Company were used and suitably formulated. After adjusting the material formulation, the specific aorta shape given by medical imaging is encoded in a finite element model in order to manufacture the specific phantom by 3D prototyping. The whole process results in a quick production of a specific phantom that can be positioned in a hydro-dynamic test bench, in which physiological hemodynamic conditions can be simulated and the model parameters can be verified from ultrasound images and pressure measurements.

P11.4

INVESTIGATION OF THE ARTERIAL AGEING AND ISOLATED SYSTOLIC HYPERTENSION BY FLUID DYNAMICS-BASED MODELLING

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Arterial and left-ventricular ageing strongly affects morbidity and mortality. It is characterized by stiffening, dilation and lengthening of large arteries, microcirculation changes, and alteration of heart contracting capacity and timing. The scientific community is debating the evaluation, impact, and interaction among these fundamental processes. As fluid dynamics play a key-role, our aim is to use a physically-based model of the heart-arterial tree hemodynamics to investigate quantitatively these processes.
Our multi-scale mathematical model considers lumped descriptions of left ventricle, aortic valve dynamics and microcirculatory distal volumes, and the 1D characterization of large-to-medium arteries. Notice that model has been validated in patient-specific settings against a population of six healthy young men. In the present work, starting from parameters statistically representing a healthy young man, the ageing of both heart and arterial tree is simulated by changing the diameter, length, wall thickness and mechanical properties of large arteries, and the left-ventricular force of contraction and its activation time.
Once the main features of the ageing heart-arterial interaction are simulated, our efforts are focused to reproduce the isolated systolic hypertension (ISH) coherently with the most advanced literature data about this pathology. With the aim to elucidate the links between ISH and "healthy" ageing, the key-role of aortic stiffening and remodeling as well as the consequent early-return of reflected pressure wave and the different ventricular ejection pattern are investigated and discussed, paying attention to the physical process identification and understanding.

P11.5

CARDIAC AND VASCULAR TISSUE PROPERTIES DETERMINE THE CENTRAL BLOOD PRESSURE WAVEFORM: CONSEQUENCES FOR PULSE WAVE ANALYSIS

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Various methods exist to estimate central blood pressure (BP) waveforms from noninvasive peripheral BP measurements. Most methods consider only