Results

The changes in blood pressure and arterial wall properties were measured using the MIXED procedure of the SAS® System. The repeated measures analysis showed a significant decrease in diastolic blood pressure (p=0.03) and marked increase in pulse pressure (p=0.04) in the celiprolol group compared to the control group. The wall-to-lumen ratio and Young's elastic modulus also increased significantly in the celiprolol group. The circumferential wall stress did not change in both groups. Radial internal diameter, wall cross-sectional area, and wall-to-lumen ratio decreased significantly in the control group but not in the celiprolol group.

Conclusions

Celiprolol induced a moderate dilation and an important augmentation of elasticity of the radial artery with no change in radial blood pressure. The results proposed the pleiotropic effect of celiprolol in small-sized muscular arteries.

I034

MECHANICAL MODELING OF IN VIVO HUMAN CAROTID ARTERIES FROM NON-INVASIVE CLINICAL DATA, APPLICATION TO NORMAL SUBJECTS

I. MASSON 1,2,3, H. BEAUSSIER 1, P. BOUTOUYRIE 1, S. LAURENT 1, J. HUMFRAY 4, M. ZIDI 2
1 HEGP Service de Pharmacologie & Inserm UMRS 970, Paris, France
2 CNRS UMR 7054, Université Paris 12, Crétteil, France
3 CNRS UMR 7190, Institut Jean Le Rond d'Alembert, Université Pierre et Marie Curie, Paris, France
4 Department of Biomedical Engineering, Texas A&M University, Houston, USA

Background — For mechanical modeling, in vivo data are relatively incomplete in comparison to in vitro results. However, identification of mechanical properties from clinical data can be used to predict wall stress fields, which can play an important role in understanding better pathological evolutions.

Aim — Demonstrate the feasibility of material identification and stress computation from clinical data for normal subjects.

Methods — In vivo human common carotid arteries (CCAs) were explored non-invasively for 16 normal subjects. During several cardiac cycles, medial diameter, intimal-medial thickness, and blood pressure were measured by high-resolution echotracking (Art. Lab®) and applanation tonometry (SphygmoCor®), respectively. To study the wall mechanical behavior, the CCA was assumed to be a 3D hollow cylinder subjected to dynamical intraluminal pressure and perivascular constraints. We also assumed that the arterial wall is made of hyperelastic, fibrous, and incompressible material with smooth muscle activity and residual stresses. We included wall mechanical contributions by microconstituents: elastin-dominated matrix, collagen fibers, and vascular smooth muscle (VSM). We solved the in vivo boundary value problem semi-analytically to compute the intraluminal pressure during a cardiac cycle. Minimizing the difference between computed and measured inner pressures over the cardiac cycle provided the identification of optimal model parameters employing a nonlinear regression.

Results — The fit-to-data gave very good results and was possible in all cases. There was a convergence of parameters for major constituents such as collagen, elastin, and VSM tone. Age was correlated with collagen content and residual stresses. The predicted radial, circumferential, and axial stretches and stresses within the wall during the cardiac cycle were sensitive.

Conclusion — We were able to reproduce the evolution of inner blood pressure identifying experimentally unknown geometric and material properties directly from in vivo human data, in order to compute wall stresses and stretches over a cardiac cycle. We can extend the proposed approach to pathological cases such as hypertension.