12. *In Vivo* Mechanical and Flow Properties of the Human Carotid

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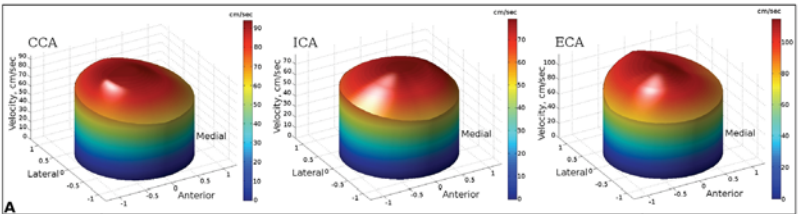
INTRODUCTION: The knowledge of the mechanical and hemodynamic properties of the human carotid bifurcation has become increasingly important in our understanding of carotid pathophysiology and the design of devices for the performance of endovascular and open procedures. However, almost all available data on carotid hemodynamics have been based on theoretical solutions and in vitro or computer-based experimental models. The quality of these models could be considerably improved by detailed knowledge of the in vivo mechanical and flow properties of the human carotid.

METHODS: Measurements were obtained before and after endarterectomy in the common (CCA), internal (ICA) and external (ECA) carotid arteries of sixteen patients. Evaluation of carotid artery hemodynamics included arterial pressure and waveforms (measured with an arterial line in the CCA) and detailed flow velocities in a standardized grid across the flow lumen of the proximal CCA, distal ICA and ECA (measured with duplex). Wall characteristics (pulsatile deformation of the artery during the cardiac cycle) were measured in the proximal CCA and distal ICA and ECA.

RESULTS: Velocity profiles in the CCA, ICA and ECA were found to be asymmetric towards the arterial centerlines (Figure A). In the CCA and ECA, velocities were higher laterally while in the ICA the velocities were higher medially. Posterior velocities were higher than anterior velocities in CCA, ICA and ECA. Pressure waveform in 13 out of 16 patients revealed narrowing of the pulse pressure by an average of 5 mm Hg after endarterectomy. Characterization of the wall properties (Figure B) demonstrated that arterial compliance is higher in CCA with mean distensibility 9.9±4.6% and lower in the ICA (5.6±2.9%) and ECA (5.3±3.4%).

CONCLUSIONS: The in vivo hemodynamics of the human carotid artery is quite complex and different from that obtained with experimental in vitro or computer-based models. Our detailed in vivo data can be used to design new models that closely replicate in vivo dynamic conditions. Such models can improve our understanding of pathophysiologic processes such as atherosclerosis and neointimal hyperplasia and be used to design and optimize vascular devices including patches and stents.



B

	Pressure, mmHg	Distensibility, %	Internal radius at systole, mm	Wall thickness at systole, mm	Wall thickness at diastole, mm
CCA	122/61±17/5	9.9±4.6	3.80±0.7	0.81±0.4	1.01±0.5
ICA		5.6±2.9	2.34±0.5	0.35±0.2	0.49±0.2
ECA		5.3±3.4	2.29±0.6	0.38±0.1	0.49±0.1

Figure A. Three-dimensional mean velocity profiles in postoperative CCA, ICA and ECA at peak systole
B. Summary of the carotid artery wall characteristics

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