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A dynamic model of intracranial saccular aneurysms

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Intracranial Saccular Aneurysms (ISAs) are associated with both frequent and significant morbidity and mortality. A mathematical model of ISAs is presented which is derived based upon a hyperelastic thin-walled sphere as well as wave physics. The interrelationships of blood pressure, the time rate change of blood pressure, compliance, and aneurysmal blood flow are discussed with respect to the physical properties of ISAs. In addition, the intra-aneurysmal presence of turbulence as well as wall shear stress is also examined. By utilizing the product of compliance and characteristic impedance, a time constant is derived which may explain the phenomena of incomplete emptying; this may occur in some larger ISAs. Furthermore, the potential influence of these physical characteristics, on aneurysmal rupture and other associated pathology, is additionally investigated. The clinical application of this model also supports the adjunct benefits of temporary cardiac arrest, as compared to controlled hypotension, in the operative management of ISAs. Moreover, this model also justifies the selective use of anticoagulants to prevent aneurysmal-associated clot formation and related thrombo-embolic complications; particularly during endovascular procedures. The potential benefit of acute as well as chronic control of diastolic hypertension, in this patient population, is also substantiated. The results of this study may play a possible role in further development of patient-specific models, risk stratification, and decision making regarding operative vs. medical management of ISAs.

Biography

Glen Atlas is a Professor in the Department of Anesthesiology at Rutgers New Jersey Medical School and is an Adjunct Clinical Professor in the Department of Chemistry, Chemical Biology and Biomedical Engineering at Stevens Institute of Technology. He is also an Adjunct Member of the graduate Faculty at Rutgers University Department of Biomedical Engineering.

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