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Proper orthogonal decomposition analyses of high-frequency transient flow instabilities in intracranial aneurysms MUHAMMAD OWAIS KHAN, CHRISTOPHE CHNAFA, University of Toronto, KRISTIAN VALEN-SENDSTAD, Simula Research Laboratory, DAVID A. STEINMAN, University of Toronto — Treatment of incidentally detected intracranial aneurysms (IAs) can exceed the natural risk of rupture. Abnormal hemodynamic forces, derived from image-based CFD, have, therefore, been proposed to assess the risk of IA rupture. Although majority of the CFD-literature has shown laminar and stable flows in IAs, recent high-resolution CFD simulations have highlighted the presence of transient high-frequency flow instabilities, or turbulent-like flows, consistent with experimental evidence from early 70s and 80s. However, whether flows in IAs are turbulent is still not fully understood. We performed DNS of 6 patient-specific IAs exhibiting varying levels of "turbulence". Proper orthogonal decomposition (POD) eigenspectra revealed that $\sim$96% of the kinetic energy was concentrated in the first mode. Time-windowed POD showed that energy in higher modes (k>50) was dominated by contributions from deceleration phase. Velocity fields were reconstructed from the higher modes to highlight presence of distinct flow structures. We also identified presence of discrete frequency bands by applying wavelet analyses to time-velocity traces, and used novel Fourier-based hemodynamic indices to characterize the nature of these turbulent-like flows.

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