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Myogenic Response of the Afferent Arteriole

We have formulated a mathematical model of the rat afferent arteriole (AA). Our model consists of a series of arteriolar smooth muscle cells, each of which represents ion transport, cell membrane potential, cellular contraction, gap junction coupling, and wall mechanics. Blood flow through the AA lumen is described by Poiseuille flow. Model results suggest that interacting calcium and potassium fluxes, mediated by voltage-gated and voltage-calcium-gated channels, respectively, give rise to periodic oscillations in cytoplasmic calcium concentration, myosin light chain phosphorylation, and crossbridge formation with attending muscle stress mediating vasomotion. The AA model's representation of the myogenic response is based on the hypothesis that the voltage dependence of calcium channel openings responds to transmural pressure so that vessel diameter decreases with increasing pressure. With this configuration, the results of the AA model simulations agree well with findings in the experimental literature, notably those of Steinhausen et al. (*J Physiol* 505:493, 1997), which indicated that propagated vasoconstrictive response induced by local electrical stimulation decayed more rapidly in the upstream than in the downstream flow direction. The model can be incorporated into models of integrated renal hemodynamic regulation. This research was supported in part by NIH grants DK-42091 and DK-89066, and by NSF grant DMS-0715021.