

Effect of A Soluble Surfactant on A Finite Sized Gas Bubble Motion in A Blood Vessel

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ABSTRACT

Detailed numerical results for the motion of a finite sized gas bubble in a blood vessel are discussed. The bubble (dispersed phase) size is such as to nearly occlude the vessel. The bulk medium is treated as a shear thinning Casson fluid and contains a soluble surfactant that adsorbs and desorbs from the interface. Three different vessel sizes, corresponding to a small artery, a large arteriole, and a small arteriole, in normal humans, are considered. The hematocrit (volume fraction of RBCs) has been taken to be 0.45. For arteriolar flow, where relevant, the Fahraeus-Lindqvist effect is taken into account. Bubble motion causes temporal and spatial gradients of shear stress at the cell surface lining the vessel wall as the bubble approaches the cell, moves over it and passes it by. Rapid reversals occur in the sign of the shear stress imparted to the cell surface during this motion. Shear stress gradients together with sign reversals are associated with a recirculation vortex at the rear of the moving bubble. The presence of the surfactant reduces the level of the shear stress gradients imparted to the cell surface as compared to an equivalent surfactant-free system. Our numerical results for bubble shapes and wall shear stresses may help explain phenomena observed in experimental studies related to gas embolism, a significant problem in cardiac surgery and decompression sickness. In this context, some experimental observations related to the problem will also be discussed.

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