306c How Differences in Vessel Wall Void Space between the Aorta and the Pulmonary Artery Induce Differences in Filtration and Macromolecular Transport

Zhongqing Zeng, Kung-Ming Jan, and David Rumschitzki

Atherosclerotic lesions are not equally likely in all blood vessels. Rather, they are most commonly found in big arteries, and are normally absent from the pulmonary arteries and from veins. There have been a number of structural studies and tracer experiments that reveal differences between, say, large arteries such as the aorta and smaller vessels such as the pulmonary artery. For example, Lever et al.'s (1990) study of albumin and Cr-EDTA uptake by different vessels' walls in rabbit indicated that the walls of the pulmonary artery and the vena cava have much greater void spaces for albumin than those of systemic arteries such as the aorta and the carotid artery. Recently our group has shown that the hydraulic conductivity Lp of the intact pulmonary artery in rat is an order of magnitude larger than Lp of the aorta, and Lp of the vena cava is even larger. This indicates a logical consistency of a wall with a larger void space for water displaying a much smaller resistance to transmural water flow. In addition our group injected horseradish peroxidase (HRP) as a tracer into rats and, after sacrifice, examined their vessels en face in order to see how and where the tracer penetrated the tissue. In both the aorta and the pulmonary artery, our group found that HRP entered the vessel walls in focal spots, rather than uniformly. More surprisingly, the growth of tracer spots with tracer circulation time was similar in both of these vessels despite the different lumen pressure (~100 mmHg for the aorta vs ~16 mmHg for the pulmonary artery), hydraulic conductivity (or flow resistance), wall void and macromolecular diffusion coefficient in these two vessels. We construct a two-dimensional filtration and convection-diffusion model for the pulmonary artery and use the structural and Lp data from our and from other group's experiments as a source for the model's parameters. A comparison of the solutions to this model and a similar one developed earlier by our group for the aorta reveal why, despite the above-mentioned differences, the overall transmural water flow across these two vessels' walls and the rates of growth of the HRP spots are remarkably similar in these vessels. Moreover, solution of the mass transfer problem indicates vital differences in the tracer concentration profiles that may be relevant to the understanding of why these vessels have very different susceptibilities to atherosclerosis.