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Chronic Hypertension, Aquaporin and Hydraulic Conductivity: A Perspective on Pathological Connections

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Abstract : Numerous studies examine aquaporins' role in osmotic water transport in various systems but virtually none focus on aquaporins' role in hydrostatically-driven water transport involving mammalian cells save for our laboratory's recent study of aortic endothelial cells. Here we investigate aquaporin-1 expression and function in the aortic endothelium in two high-renin rat models of hypertension, the spontaneously hypertensive genomically altered Wystar-Kyoto rat variant and Sprague-Dawley rats made hypertensive by two kidney, one clip Goldblatt surgery. We measured aquaporin-1 expression in aortic endothelial cells from whole rat aortas by quantitative immunohistochemistry, and function by measuring the pressure driven hydraulic conductivities of excised rat aortas with both intact and denuded endothelia on the same vessel. We use them to calculate the effective intimal hydraulic conductivity, which is a combination of endothelial and subendothelial components. We observed well-correlated enhancements in aquaporin-1 expression and function in both hypertensive rat models as well as in aortas from normotensive rats whose expression was upregulated by 2h forskolin treatment. Upregulated aquaporin-1 expression and function may be a response to hypertension that critically determines conduit artery vessel wall viability and long-term susceptibility to atherosclerosis. Numerous studies examine aquaporins' role in osmotic water transport in various systems but virtually none focus on aquaporins' role in hydrostatically-driven water transport involving mammalian cells save for our laboratory's recent study of aortic endothelial cells. Here we investigate aquaporin-1 expression and function in the aortic endothelium in two high-renin rat models of hypertension, the spontaneously hypertensive genomically altered Wystar-Kyoto rat variant and Sprague-Dawley rats made hypertensive by two kidney, one clip Goldblatt surgery. We measured aquaporin-1 expression in aortic endothelial cells from whole rat aortas by quantitative immunohistochemistry, and function by measuring the pressure driven hydraulic conductivities of excised rat aortas with both intact and denuded endothelia on the same vessel. We use them to calculate the effective intimal hydraulic conductivity, which is a combination of endothelial and subendothelial components. We observed well-correlated enhancements in aquaporin-1 expression and function in both hypertensive rat models as well as in aortas from normotensive rats whose expression was upregulated by 2h forskolin treatment. Upregulated aquaporin-1 expression and function may be a response to hypertension that critically determines conduit artery vessel wall viability and long-term susceptibility to atherosclerosis.

Keywords : acute hypertension, aquaporin-1, hydraulic conductivity, hydrostatic pressure, aortic endothelial cells, transcellular flow
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