Inositol 1,4,5-triphosphate receptors (IP$_3$R) are tetrameric intracellular channels that mediate the release of Calcium (Ca$^{2+}$) from sarcoplasmic reticulum (SR) into the cytosol in response to IP$_3$ binding. Modulation of vascular smooth muscle cells (VSMC) contractility allows small arteries to regulate blood flow and determine peripheral vascular resistance and blood pressure levels. The level of contraction of VSMC relies on a rise in cytoplasmic Ca$^{2+}$ mediated by IP$_3$-dependent Ca$^{2+}$ release and voltage dependent Ca$^{2+}$ influx through L-type Ca$^{2+}$ (CaL) channels. Strong evidence supports a role for the vascular CaL channels in hypertension but little is known about the functional role of IP$_3$R including the modulation of IP$_3$R-Ca$^{2+}$ signaling by the vascular endothelium. The goal of this study is to elucidate the functional contribution of IP$_3$R-Ca$^{2+}$ signaling to the pathogenesis of hypertension. Our preliminary results showed that IP$_3$R are up regulated in small mesenteric arteries of two different forms of hypertensive rats. In the same arteries, activation of IP$_3$R results in accentuated vasoconstriction whereas the endothelium-derived nitric oxide exerts a tonic dilator influence. The findings of this study will greatly improve our basic understanding of the etiology of hypertension by defining the abnormalities of IP$_3$-dependent Ca$^{2+}$ signaling and contraction in VSMC and its regulation by the endothelium. This may provide critical insights into the pathogenesis of hypertension, and set the groundwork for developing novel therapeutic strategies for the treatment of hypertensive disease.