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Aortic Valve Mechanical Properties Are Regulated by the Cellular Components of the Valve

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Objectives:

Little is known about endothelium-dependent regulation of valve tone and function. The aim of this study was to evaluate the effects of endogenous mediators on the mechanical properties of aortic valve leaflets and to investigate the influence of the endothelium.

Method:

Normal and de-endothelialized porcine aortic valve leaflets were evaluated using a biaxial micromechanical testing apparatus to measure Young's modulus of the aortic valve in response to serotonin [5-HT 10^{-8} to 10^{-5} M, with and without N-Nitro-L-Arginine-Methyl Ester (L-NAME), an NO synthase inhibitor], endothelin-1 [ET-1 10^{-10} to 10^{-8} M, with and without cytochalasin B (CyB), an actin polymerization inhibitor], sodium nitroprusside (SNP; 10^{-8} to 10^{-6} M) and KCl (90mM).

Results:

Under physiological loading conditions, aortic cusp relaxations to 5-HT were reversed by L-NAME and endothelial denudation ($p < 0.05$). Valve cusps contracted in response to ET-1 and KCl versus control ($p < 0.05$). Addition of CyB completely inhibited contractile responses to ET-1 ($p < 0.05$). 5-HT and SNP induced a reduction in the elastic modulus of the tissue in both radial and circumferential axes ($p < 0.05$). Conversely, addition of ET-1 or KCl caused an increase in the elastic modulus of the tissue in both axes ($p < 0.05$). CyB caused a decrease in basal valve tone and suppression of elastic modulus responses to ET-1. L-NAME and endothelial denudation caused a significant increase in elastic modulus.

Conclusions:

These data demonstrate a significant role for endothelium-dependent regulation of aortic valve mechanical properties and suggest the valve cell cytoskeleton is a key mediator of valve stiffness. These findings underline the importance of cellular integrity for optimal valve function.