SPACE LIFE SCIENCES SYMPOSIUM (A1)
Human Physiology in Space (2)

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THE IMPORTANCE OF TISSUE WEIGHT AND TISSUE COMPRESSIVE FORCES IN HUMAN SPACEFLIGHT

Abstract

The fluid shift and loss of hydrostatic forces that occur upon entering microgravity are often discussed as key stimuli for some of physiological changes in space. Less often discussed is the effect of tissue weight. The weight of tissues generates compressive forces that can act on the walls of veins and venules. Upon entering microgravity, tissues no longer have any weight, and so any tissue compressive forces produced by the tissues are also lost. This could remove compressive forces from the walls of veins and venules, increase vascular capacity, and increase unstressed volume (i.e. the volume of blood contained at zero distending pressure). The net effect would be a reduction in mean circulatory filling pressure, and this is likely a main contributor to the reduced central venous pressure and peripheral venous pressure seen in space. Similarly, tissue weight can affect the compliance of tissue. Studies during Gx (front to back) centrifugation show that the heart shape deforms with increased gravity, and that the size of the cardiac chambers decreases. The left ventricle becomes stiffer with transverse acceleration. This suggests that if all gravitational forces were removed, the heart may become less stiff, which could also contribute to reduced venous pressures in space. This compliance effect could apply to tissues throughout the body, including the eye and cerebrovascular system. Changes in tissue weight may also help to explain the microgravity ocular syndrome (MOS) without postulating a major increase in intracranial pressure.

But, the effects of gravity on the eye are complex, and require integrated study. In our group, we are using numerical modeling combined with physiological measurements to build a model of the eye and cerebrovascular system that includes the effects of tissue weight. This talk will describe the effects of tissue weight relevant to space physiology, including its contribution to central venous pressure changes, and potentially to the microgravity ocular syndrome. The numerical model will be described and explained, and potential applications of the model for understanding the MOS and designing countermeasures will

be discussed.