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BIAXIAL MECHANICAL PROPERTIES OF UTERO-SACRAL AND CARDINAL LIGAMENTS

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Pelvic floor disorders (PFDs) such as urinary incontinence, fecal incontinence, and pelvic organ prolapse represent a major public health concern in the United States affecting one third of adult women. These disorders are determined by structural and mechanical alterations of the pelvic organs, their supporting muscles and connective tissues that occur mainly during pregnancy, vaginal delivery, and aging. The importance of investigating the mechanical behavior of pelvic organs for the treatment of PFDs has been recognized only in the past few years [1, 2]. However, little has been done to characterize the structural and mechanical properties of the connective tissues that support pelvic organs.

This study aims at determining, for the first time, the elasticity and viscoelasticity of two major ligaments supporting the uterus and vagina: the uterosacral ligaments (USLs) and cardinal ligaments (CLs). Biaxial elastic and viscoelastic tests were performed on uterosacral and cardinal ligament complexes harvested from adult female swine using a planar biaxial system. Strain was computed by tracking the motion of markers attached to the ligaments with a video-camera system. The experimental results revealed that USLs and CLs are non-linear elastic, viscoelastic, and anisotropic.

A three-dimensional constitutive model, which is based on the Pipkin-Rogers integral series, was formulated for the USLs and CLs by following an approach similar to the one proposed by Davis and De Vita [3]. In the model, CLs and USLs are assumed to be incompressible and anisotropic. They undergo finite strains and exhibit a strain-dependent stress relaxation behavior. This combined experimental and theoretical study provides crucial information about the mechanical behavior of USLs and CLs that can potentially transform current surgical reconstruction methods and post-operative rehabilitation protocols for female pelvic floor disorders.

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