763

Aghyarian S[1], Manz C[1], Ortega D[1], Lund B[1], Zimmern P[2], Tibbals H[2], Eberhart R[2], Voit W[1], Smith D[1]
***1.** UT Dallas, **2.** UT Southwestern Medical Center*

BIAXIAL BIOMECHANICAL TESTING OF FRESH HUMAN ANTERIOR VAGINAL WALL PROLAPSE

Hypothesis / aims of study

We have previously performed uniaxial tensile testing on large HAVW (human anterior vaginal wall) samples [1]. However, these biomechanical measurements emphasize high strain deformations, unsuitable for the modest strains encountered by pelvic organs in daily living. We now report on testing much smaller fresh tissue samples in a shear strain configuration using dynamic mechanical analysis (DMA).

Study design, materials and methods

Following IRB approval, fresh HAVW tissue was obtained from postmenopausal women undergoing surgical treatment for advanced stage III and IV anterior wall vaginal prolapse. Anterior vaginal wall strips lateral to the midline vaginal plate, corresponding to the site of the lateral defect, were excised. Cauterization, indentation or small side cuts in the strip edges, which could promote tearing during the biomechanical studies, were avoided during harvest. All samples were at least 1 cm in width and 3 cm in length. To maintain consistency, all samples were harvested in the same orientation, using a suture placed at the distal extremity of the sample. The samples were wrapped in moist gauze to prevent drying and transported in a cooler (and maintained at 25°C and 37°C) along with a data logger to track the temperature and humidity variations. The tissue samples were then prepared for testing. For DMA analysis (METTLER TOLEDO, Model DMA/SDTA861), biopsy punches 4mm in diameter were used to cut two identical sample geometries per run as needed by the shear clamping assembly. The orientation of the tissue was noted using indelible ink marks along the longitudinal axis. The samples were placed in the DMA shear clamps and tested**.** Biaxial measurements were obtained by running tests on the sample in longitudinal and transversal orientations.

Results

Five consecutive patients were studied. DMA analysis showed anisotropy in the HAVW tissue. The storage modulus was plotted versus frequency as depicted in the theoretical diagram on Figure 1. In general, for a visco-elastic material, the modulus will increase as the frequency of the testing increases because its elastic behavior dominates over its viscous behaviour. The longitudinal orientation (solid line) had a greater storage modulus than the transversal orientation (dotted line), as shown in Figure 2 from a representative tissue sample. Note that at extremely high frequencies (above 100Hz), which are not physiologically relevant, a resonance effect was noted, and that part of the tracings was disregarded.

Figure 1

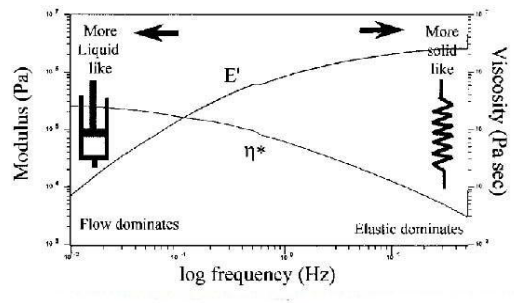
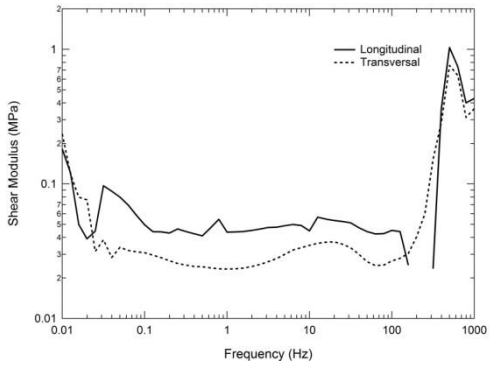


Figure 2



Interpretation of results:

Analyzing fresh human tissue samples is demanding and requires multi-specialty collaboration, along with a transport protocol allowing preservation of the samples for 30 minutes to one hour. DMA testing offers several advantages over conventional Instron uniaxial testing of samples from resting phase to ultimate tensile strength: much less tissue is required per test allowing for multiple experiments per sample, biaxial and viscoelastic properties are obtained, and lower level deformations better match pelvic straining efforts. This novel approach to fresh human tissue testing provides essential information to design more realistic finite element models of the human anterior vaginal wall.

Concluding message

To our knowledge these are the first biaxial shear measurements reported on fresh HAVW tissue. This is significant, in that at low physiological strain levels, biaxial properties better characterize tissue biomechanical properties from which more accurate finite element modeling of HAVW can be derived [3].

References
1. Neurourology and Urodynamics, 2009, 28, 325–329.
2. Polymer, 2009, 50(21): 5112-5123.
3. NeuroUrology and Urodynamics, 29:944, 2010.

Disclosures
Funding: None **Clinical Trial:** No **Subjects:** HUMAN **Ethics Committee:** Institutional Review Board of UT Southwestern Medical Center **Helsinki:** Yes **Informed Consent:** Yes