ABSTRACT FACE PAGE

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11. **Is this the research presented in this abstract supported by IMAG MSM-related U01 funding? No**
12. **If the Presenting Author is a trainee, who is the trainee's primary research advisor? __Kristin Myers____**

TRAINEE POSTER AND ORAL PRESENTATION COMPETITONS:

New to the meeting this year, we are holding *both* a trainee poster competition and a trainee oral presentation competition! If the presenting author is a trainee (i.e., a student at any level or a post doctoral trainee), he/she may enter his/her abstract in the trainee poster competition, the trainee oral presentation competition, or both competitions. Trainees may also submit more than one abstract to the meeting and enter more than one abstract in these competitions. Prizes will be given to the presenters of the top-ranked trainee oral presentation and the top-ranked trainee poster (judged during the meeting by the Program Committee).

13. **If the Presenting author is a trainee, would the Presenting Author like to enter his/her abstract in the Trainee Poster Competition*? Yes**

*Note: Trainees who enter the poster competition are expected to stand by their poster during the scheduled poster sessions and present them to the judges.

14. **If the Presenting author is a trainee, would the Presenting Author like to enter his/her abstract in the Trainee Oral Presentation Competition**? Yes**

**Note: The Program Committee will select the top four abstracts from trainees who elect to enter their abstract into the trainee oral presentation competition, these four trainees will be notified by Feb. 17th, and they will deliver their oral presentations (which will be judged) on the second day of the meeting after lunch.

TENSILE AND COMPRESSIVE ANISOTROPIC AND TIME DEPENDENT MATERIAL PROPERTIES OF HUMAN CERVICAL TISSUE

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INTRODUCTION: The mechanical properties of the cervix are believed to be related to preterm birth. The cervix is a soft collagenous tissue exhibiting anisotropic, visco- and poro-elasticity, and tension-compression asymmetry. In this study, we mechanically tested human cervical tissue using both indentation and uniaxial tensile tests to formulate a material constitutive model that can capture the nonlinear, time-dependent, anisotropic material response of the cervix.

METHODS: 4 nonpregnant (NP) and 2 pregnant (PG) human cervices were collected with an IRB-approved protocol. Slices were cut from each cervix along the axial direction and stored in -80ºC until the time of mechanical testing (for details see [1]). Ramp-hold mechanical loading profiles were conducted in both spherical indentation and uniaxial tension (Fig. 1c&d). For both tests, the force-time-deformation response was recorded (Fig. 1a&b) and the strain was calculated by a digital image correlation system (Correlated Solutions V2.6). For each sample, spherical indentation was performed first via the protocol in [1] (Fig. 1a&c). After indentation, two tensile strips were cut from each slice perpendicular and parallel to the principal fiber direction. The change of width (*w*) and thickness (*t*) was discerned by a custom U-Net based deep learning code. Sample-specific FEA models were created using a custom Matlab code and were calculated using FEBio (V2.9, url: febio.org) to simulate both experiments. A fibrous reactive viscoelastic constitutive framework (see FEBio user manual v2.8) was used to fit the experimental data, where the elastic part was modelled as a fibrous composite (described in [1]) and the viscous part was modelled using a "relaxation-power-distortion" relaxation function. A custom genetic algorithm based inverse finite element analysis routine was conducted to fit the experimental force responses.

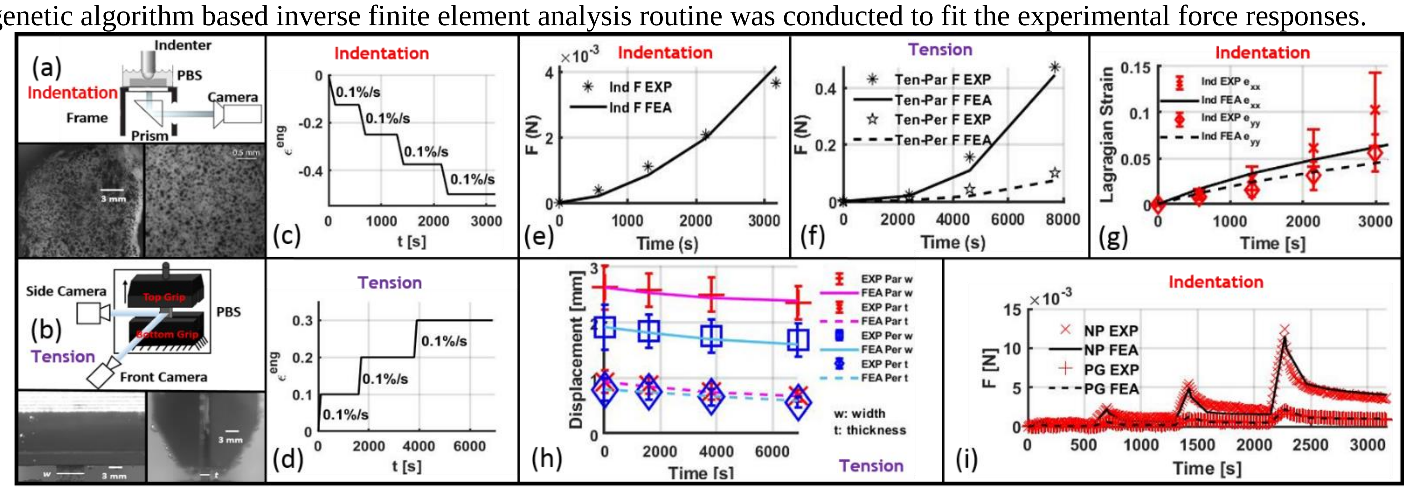

Figure 1: Experiment setup of (a) indentation and (b) uniaxial tensile test and the loading profiles (c) and (d). Representative fitted equilibrium force response of (e) indentation and (f) uniaxial tensile test. Predicted and experimental (g) strain of the indenter spot and (h) shape deformation of uniaxial tensile test. (i) Representative best-fit indentation viscoelastic force response of the non-pregnant and pregnant samples.

RESULTS: The elastic parameters E=1.2±1.0kPa, ξ=210±116kPa for nonpregnant samples, are found significantly different ($p<0.05$, one way ANOVA) from pregnant samples (E=0.05±0.02kPa, ξ=4.5±3.5kPa), illustrating the cervix remodeled to be softer during pregnancy. Other elastic parameters are ν=0.43±0.2, b=1.2±0.8, α=1.5±0.7. The viscous parameters are E_v=5.5±3.5kPa, ξ_v=50±35kPa, τ_0=51±21s, τ_1=10±9s for nonpregnant samples and E_v=1.1±0.5kPa, ξ_v=8.9±6.3kPa, τ_0=56±11s, τ_1=13±3s for pregnant samples.

CONCLUSIONS: Representative results (Fig. 1e&f) show that both the equilibrium compressive and tensile mechanical behavior of the cervical tissue could be captured well by the proposed model. The strain under the indenter spot is predicted lower (30~50% off) using this model (Fig. 1g). But the shape deformation of the uniaxial test was predicted well (Fig. 1h). The nonlinear viscoelastic model could approximately describe the indentation experiment well (Fig. 1i). Our future studies will address these time-dependent mechanisms by including poroelastic and other viscoelastic effects.

REFERENCES:

1. Shi, L et al, 2019, J. BioMech. Eng. 141.9.