ABSTRACT FACE PAGE

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11. **Is this the research presented in this abstract supported by IMAG MSM-related U01 funding? Yes or 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 or No**

*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 or No**

**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.

BIOMECHANICS OF CERVICAL FUNNELING IN HIGH-RISK PREGNANCIES

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BACKGROUND: There is currently no accurate way to predict preterm birth (PTB), though it is believed that mechanical failure of reproductive tissue may be a cause [1,2]. Cervical insufficiency (CI) is cervical tissue failure, and cervical funneling is used as clinical evidence of CI with an associated higher risk of PTB [1,3]. Identifying the mechanisms of cervical funneling will improve understanding of PTB. Computational models are a suitable method to explore the mechanics of CI and cervical funneling. Previous computational research has shown cervical funnel shape progression but has not distinguished the mechanisms through which it occurs [4]. Our goal is to ascertain the biomechanics of cervical funneling through parametric patient-specific computational models of high-risk pregnancies.

METHODS: Ultrasounds and cervical aspiration measurements were obtained from 5 pregnant women at high-risk for PTB at Columbia University Medical Center. The parametric measurements from ultrasounds were collected as outlined in Westervelt et al., and patient-specific models were built [5]. Cervical aspiration stiffness was collected by trained doctors using the Pregnolia System (Pregnolia, Schlieren, Switzerland). The patient-specific cervical material properties were determined using inverse finite element analysis (FEA) for a passive fiber composite material [6]. Additional models with "normal" cervical stiffness were built to assess how anatomical differences affect loading [7]. The material models of the uterus and fetal membrane were based on existing literature, and the abdomen was considered to be nearly incompressible neo-Hookean [8,9]. Quarter model geometries were used to decrease computational time. The boundary conditions applied were as follows: fetal membranes sliding on the uterine wall and cervix, the uterus tied to the abdomen, the cervix sliding along the abdomen and vaginal canal, and the entire outside surface fixed. A gestational intrauterine pressure of 1kPa was applied to the inner membrane surface. FEBio (v2.8.5) was used for model simulations.

RESULTS: Cervical funneling occurs in all five of the high-risk patient-specific FEA models. In the simulation, cervical funneling is initiated through thinning of the lower uterine segment followed by compression of the cervix by the fetal membrane and the opening of the internal os. In the set of models with patient-specific geometry and the same cervical properties, cervical stretch varied substantially as did location of maximum stretch (Fig. 1).

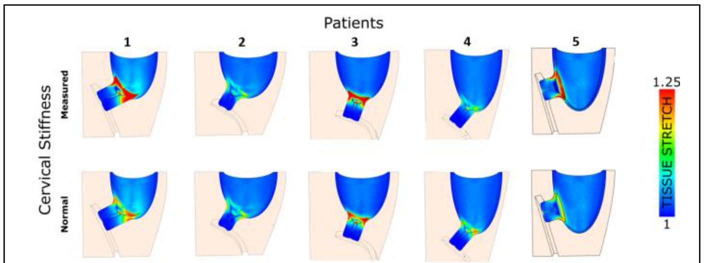

Figure 1: Stretch results from FEA models for both measured and "normal" cervical stiffnesses.

CONCLUSIONS: The computational simulations of cervical funneling accurately capture the funnel shape in some patients, but not all. Patients with measured cervical stiffness softer than "normal" have greater tissue stretch (1, 3, and 5). For patients with stiffer cervices than "normal" (2 and 4), the tissue stretch is increased in the "normal" cervical stiffness models. Between the FEA models with the same "normal" cervical stiffness, differences are observed in cervical stretch value and location of maximum cervical stretch showing that patient anatomy influences cervical loading. Therefore, both cervical stiffness and patient anatomy are important in understanding the mechanics of cervical funneling. This work also shows that lower uterine segment thinning could be a precursor to cervical funnel initiation and could be used as a biomechanical marker for PTB prediction.

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