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THE EFFECT OF PREGNANCY AND PARITY ON THE BIOMECHANICAL PROPERTIES OF VAGINAL TISSUE IN THE RODENT MODEL

<u>Hypothesis / aims of study</u>
Maternal birth injury at the time of vaginal delivery is the leading risk factor for the development of pelvic floor disorders later in life [1]. We hypothesized that the vagina continuously remodels throughout pregnancy to afford passage of a fetus and in the absence of injury fully recovers postpartum [2]. The objective of this study was to characterize these adaptations throughout pregnancy and recovery to the pre-pregnancy condition postpartum by quantitating the passive mechanical properties of the vagina utilizing a rodent model.

<u>Study design, materials and methods</u>
Virgin (n=8), mid-pregnant (n=7, day 15-16), late-pregnant (n=7, day 20-21), immediate postpartum (n=8, <2 hours post delivery), and 4 week postpartum (n=6) Long-Evans female rats were utilized. The vagina was isolated from the cervix, uterus, and bladder and divided into longitudinal strips. The tissue was secured in custom designed soft tissue clamps preloaded, preconditioned, and then loaded to failure in a uniaxial tensile test [3]. The mechanical properties (tangent modulus, tensile strength, ultimate strain, and strain energy density) were quantified from the resulting load to failure curve. Statistics were performed using a one-way ANOVA with a Sidak post-hoc (p=0.05).

<u>Results</u>
The tangent modulus of virgin animals (25.1±5.1 MPa) was significantly higher compared to mid-pregnant (11.7±7.7 MPa, p=0.003), late-pregnant (7.9±4.0 MPa, p<0.001), and immediate postpartum (8.5±4.7 MPa, p=0.001) animals (Figure 1). A similar trend was also observed in the tensile strength, whereas the ultimate strain, or the amount of tissue distension prior to failure, progressively increased throughout pregnancy until the time of vaginal delivery. In the immediate postpartum group the strain was 0.24±0.05 which was substantially higher than that of virgin animals 0.14±0.04 (Figure 2, p=0.007). Complete recovery was observed four weeks postpartum with no significant difference in any of the mechanical parameters relative to virgin animals.

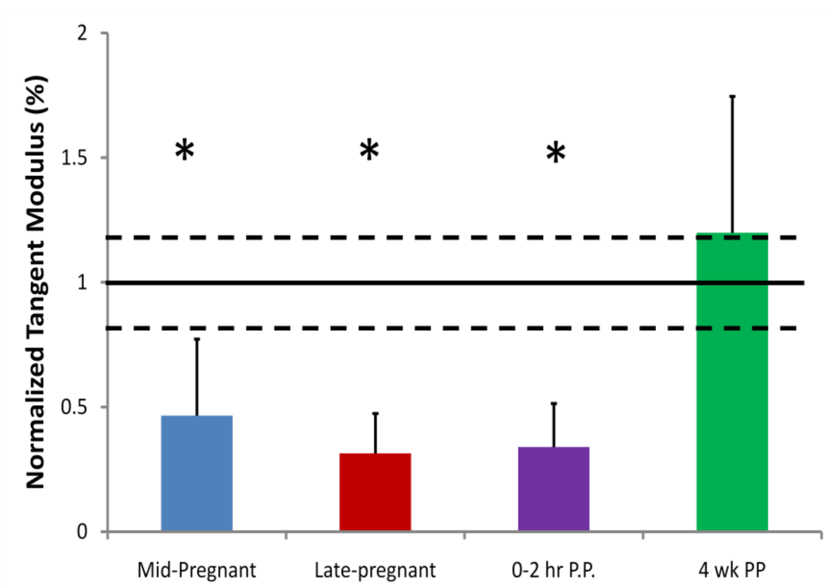

Figure 1. Tangent Modulus normalized to the mean value of virgin animals throughout pregnancy and after vaginal delivery in the rodent model. The virgin mean value is represented as the solid line, while the dashed lines represent the standard deviations, * indicates statistical significance with respect to virgin animals (p<0.05).

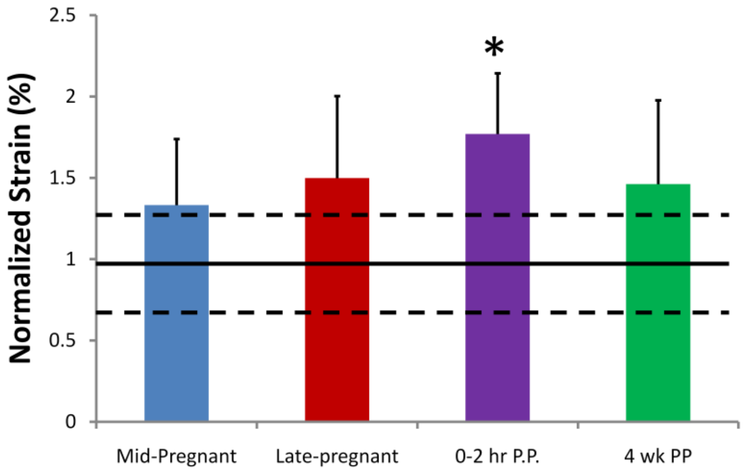

Figure 2. Strain normalized to the mean value of virgin animals throughout pregnancy and after vaginal delivery in the rodent model. The virgin mean value is represented as the solid line, while the dashed lines represent the standard deviations, * indicates statistical significance with respect to virgin animals ($p<0.05$)

Interpretation of results

This study has shown a significant decrease in the tangent modulus and tensile strength along with an increase in the ultimate strain of the vagina throughout pregnancy. These maternal adaptations are likely to increase the overall distensibility of the vagina and allow for vagina delivery with minimal injury. This process appears to be effective in the rodent model as the properties recovered to virgin levels by 4 weeks with no evidence of long term injury. In this way, the rodent is an excellent model for studying adaptations that minimize maternal injury at the time of delivery. We are currently altering or exceeding adaptations in order to better define mechanisms of maternal birth injury.

Concluding message

The vagina mechanical properties of the rodent significantly change during pregnancy up until the time of delivery and recover to pre-pregnancy values by four weeks postpartum.

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What were the subjects in the study?	**ANIMAL**
Were guidelines for care and use of laboratory animals followed or ethical committee approval obtained?	**Yes**
Name of ethics committee	**University of Pittsburgh Institutional Animal Care and Use Committee (IACUC)**