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ON THE MECHANICAL BEHAVIOR OF EARLY GESTATION FETAL MEMBRANES

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Improved imaging techniques and diagnostic procedures allow detecting fetal abnormalities early in pregnancy. Due to the highly invasive character of fetal surgery, it is only applied in specific cases. Although new techniques are being developed to reduce invasiveness, preterm rupture of the fetal membranes remains an important issue [1].

In this project, the deformation and fracture properties of human fetal membranes were analyzed at different gestational ages. The aim was to quantify differences in mechanical properties of fetal membranes during gestation. Additionally, we aimed to qualify term membranes as an appropriate mechanical model system for biomechanical studies of early gestation procedures. The protocols used to determine the mechanical properties of early membranes were adapted from previous investigations of the defect tolerance of term membranes [2]. Before mechanical experiments, amnion and chorion were gently separated. Mode I fracture tests were used to determine the tear resistance of each layer from early and term membranes. Uniaxial tensile tests were conducted to compare the deformation behavior of the different samples. Relevant for clinical applications, suture retention strength was measured and the so-called "critical inter-suture distance" [2] was determined. Results of all mechanical experiments were compared for two groups (early membranes, i.e. 21 to 29 weeks, and term membranes, i.e. 37 to 41 weeks) and differences assessed statistically. While some mechanical parameter displayed a dependence on gestational age, the overall defect tolerance of early membranes seems comparable to the one of term membranes.

The present work provides for the first time quantitative information on the mechanical properties of fetal membranes as early as 21 weeks of gestation, and compares their deformation and fracture behavior with term membranes. Constitutive model representations are derived from the measurements and fracture properties rationalized based on corresponding simulations of Mode I fracture experiments.

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