
Strain-dependent relaxation time of viscoelastic soft tissues

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Abstract

Perineal tears occur in about 80 % of vaginal deliveries. During childbirth, the descent of the infant causes repeated stretching of the perineal body. The tissues of the perineum undergo significant elongation, with the stretch maintained until the next pushing effort, which induces an even greater level of stretch-reaching up to 400% elongation. This sequence of stretching and relaxation is repeated several times, potentially causing tissue failure and leading to perineal lacerations, which may result in pelvic floor disorders.

Conservative techniques exist to alleviate perineal stretch, such as maneuvers or episiotomy. The latter involves a controlled incision in the perineal body. However, these techniques can sometimes cause more harm than the natural occurrence of tearing, particularly if the risk of deep lacerations during delivery is overestimated. Therefore, it is crucial to develop a non-destructive method for assessing perineal damage to support physicians in making informed decisions during childbirth.

To address this, the mechanical response of the perineal body to repeated elongation-relaxation loads was investigated via cyclic pure-shear testing conducted *ex vivo* on porcine perineum. Analysis of the relaxation phase using Zener model identification revealed that the relaxation times continuously decreased with increased stretching until a discontinuity occurred. This discontinuity appeared to precede visible structural damage (tears) in the sample.

These findings demonstrate the evolution of the viscoelastic response of the perineal tissue during cyclic loading. Furthermore, non-invasive techniques such as relaxed indentation or suction testing are currently used *in vivo* for the assessment of properties relative to the viscoelasticity of soft materials. As such, the results presented in this study, combined with the existing techniques, are promising for the future development of real-time assessments of the mechanical state of the perineum during childbirth.

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