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Research paper

Mechanical characterization of the softening behavior of human vaginal tissue

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ABSTRACT

The mechanical properties of vaginal tissue need to be characterized to perform accurate simulations of prolapse and other pelvic disorders that commonly affect women. This is also a fundamental step towards the improvement of therapeutic techniques such as surgery.

In this paper, the softening behavior or Mullins effect of vaginal tissue is studied by proposing an appropriate constitutive model. This effect is an important factor after the birth, since vaginal tissue has been supporting a high load distribution and therefore does not recover its original behavior. Due to the anisotropy of the tissue, the mechanical testing of vaginal tissue, consists in loading–unloading uniaxial tension tests performed along the longitudinal and transverse axes of the vagina. A directional pseudo-elastic model was used to reproduce the inelastic behavior of the tissue. The obtained results may be helpful in the design of surgical procedures with autologous tissue or smart prostheses. A good qualitative agreement has been found between the numerical and experimental results for the vaginal tissue examples, indicating that the constitutive softening model can capture the typical stress–strain behavior observed in this kind of fibrous soft tissue.

1. Introduction

Pelvic organ prolapse (POP), characterized by the loss of normal vaginal support, is widespread (43%–76%) among the female population (Barber, 2005). POP is a multifactorial problem, although obstetric complications related with vaginal birth have been pointed out as a major risk factor (Lukacz et al., 2006). There are several health problems associated with POP. Urinary incontinence (UI) and stress urinary incontinence (SUI) are counted among the most common (Jelovsek et al., 2007). Sometimes these problems lead to incapacitation, a common situation in third World countries. In

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