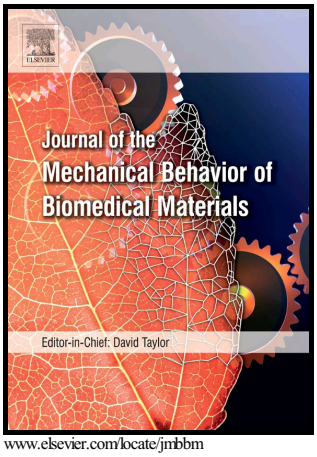
Modelling of compressible and orthotropic surgical mesh implants based on optical deformation measurement

Andreas J. Horbach, Minh Tuan Duong, Manfred Staat



www.elsevier.com/locate/jmbbm

PII: S1751-6161(17)30250-3
DOI: http://dx.doi.org/10.1016/j.jmbbm.2017.06.012
Reference: JMBBM2372

To appear in: *Journal of the Mechanical Behavior of Biomedical Materials*

Received date: 17 March 2017
Revised date: 6 June 2017
Accepted date: 9 June 2017

Cite this article as: Andreas J. Horbach, Minh Tuan Duong and Manfred Staat Modelling of compressible and orthotropic surgical mesh implants based o optical deformation measurement, *Journal of the Mechanical Behavior o Biomedical Materials,* http://dx.doi.org/10.1016/j.jmbbm.2017.06.012

Modelling of compressible and orthotropic surgical mesh implants based on optical deformation measurement

Andreas J. Horbach[a], Minh Tuan Duong[a,b], Manfred Staat[a]

[a] *Aachen University of Applied Sciences, Institute for Bioengineering, Biomechanics Lab., 52428 Jülich, Germany*
[b] *Current address: Friedrich-Alexander-University of Erlangen Nürnberg, Germany*

Abstract

There is a potential mismatch between surgical mesh implants for hernia repair of pelvic floor surgery and the host tissue because soft tissue is incompressible and meshes are compressible. Therefore, mesh and tissue may develop different stiffness over the range of deformation. In addition compressibility is related to a change of porosity of the mesh which may decrease during the deformation. Scar formation and the ingrowth of the mesh can be related to effective porosity which decreases discontinuously in uniaxial loading at a critical stretch when pore areas collapse and therefore the mesh becomes ineffective. Compressibility requires several non standard approaches which can be performed with high accuracy and local resolution by deformation measurement with digital image correlation (DIC). A compressible hyperelastic model is chosen and identified with biaxial deformation measurements. Also effective porosity of deformed meshes can be calculated on the basis of biaxial deformation. The proposed constitutive equation and the developed model of effective porosity are represented in form of principle stretch. Stretch can be measured with magnetic resonance imaging (MRI) visible meshes so that stress and effective porosity can be derived in vivo.

Keywords: polyconvex strain energy function, optical strain measurement,

Email addresses: horbach@fh-aachen.de (Andreas J. Horbach), m.staat@fh-aachen.de (Manfred Staat)
URL: https://www.ifb.fh-aachen.de/ (Manfred Staat)