Viscoelastic Mechanical Properties of Human Abdominal Fascia

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BACKGROUND Abdominal fascia is a dense fibrous connective tissue membrane forming a sheath around the abdomen. It is highly complex tissue as composition and structure which reflect its visco-elastic material properties. The changes of its mechanical properties contribute to a development of inguinal hernia. The aim of this work is to investigate the mechanical properties of human abdominal fascia and their variations with the direction of loading and localization.

METHODS Strips were extracted from posterior wall of inguinal canal and umbilical region. The samples were oriented parallel to the main body axis and perpendicular to it. Uniaxial tensile and relaxation tests on specimens in longitudinal and transversal directions were performed using Instron type testing device. During relaxation tests the extension of the specimen was kept constant. The experimental data were represented as stress-strain and stress-time relationships.

RESULTS The stress-strain curves in longitudinal and transversal directions show that: a) maximal stress in longitudinal direction is higher than in transversal direction; b) the behaviour of the material in transversal direction is not monotonic, that is, there is a decrease of the stress after the peak, which is followed by gradual increase of the stress. The second peak is usually lower than the first one. (The left Figure)

The relaxation behaviour of abdominal fascia had a decaying exponential form with time. The results show that the relaxation process strongly depends on the initial extension. At low extension values the relaxation curves are typically decaying curves. The increased initial deformation leads to interruption of the monotonic relaxation process as if the next relaxation process begins (The right Figure). This step-wise relaxation behaviour was analytically approximated by relaxation functions which contained several relaxation spectrums.

CONCLUSION The mechanical response of abdominal fascia is essentially geometrically and physically nonlinear. It reveals orthotropic mechanical properties which depend on localization. The relaxation time spectrum is not continuous.