Submission for FRC, preferably for **POSTER** presentation

# Fascial Strain Hardening Correlates with Matrix Hydration Changes

Robert Schleip PhD[1], Werner Klingler MD[2].
Depts. of [1]Physiology and [2]Anesthesiology, University of Ulm, Einstein-Allee 11, D-89081 Ulm, Germany, phone: +49-731-500-23250, fax: +49-731-500-23260, email: robert.schleip@uni-ulm.de; www. fasciaresearch.de

BACKGROUND Strain hardening as an increase in tissue stiffness due to isometric stretch and subsequent rest has been occasionally described for ligaments, tendons and fascia [1, 2]. The extrapolation of this tissue behavior as well as the involved tissue dynamics are unclear.

METHODS Mechanographic in vitro testing of strips of mice dorsal fascia were conducted with a 4% strain applied for 15 min followed by 30 min of subsequent rest (n=18). Control tissues, made unviable with repetitive deep freezing and rapid thawing, were used for comparison.
Pieces of porcine lumbar fascia were examined for accompanying changes in tissue water content in response to this protocol (n=24), as well as the influence of a hypotone solution vs. sotone bath solution on tissue stiffness.

RESULTS The mechanical challenge resulted in an increase in tensional stiffness in fresh fascia as well as in unviable control tissues. Given a sufficiently long resting period (>20 min), higher levels of tissue hydration were observed than before the stretch, with a slow return toward the original hydration values over the following one to two hours. An increase in tissue hydration (hypotone solution) correlates positively with an increase in tissue stiffness.

CONCLUSIONS Strain hardening as a temporary stiffness increase is a reproducible tissue response in vitro. This response is not dependent on cellular viability and therefore not due to cellular contraction, yet it does correlate with an enhanced matrix hydration [3, 4]. Given a comparable occurrence of this behavior in vivo, clinical application of suitable preconditioning routines for injury prevention of fascia and ligaments in sports medicine and occupational medicine could be explored.

REFERENCES

[1] Yahia, L.H., Pigeon, P., DesRosiers, E.A., Viscoelastic properties of the human lumbodorsal fascia.. J. Biomed. Eng. 1993; 15: 425-429.

[2] Viidik, A: Elasticity and tensile strength of the anterior cruciate ligament in rabbits as influenced by training. Acta Phyiol. Scand. 1968: 74, 372-380.

[3] Thornton, G.M., Shrive, N.G., Frank, C.B.,. Altering ligament water content affects ligament pre-stress and creep behavior. J. Orthop. Res. 2001; 19: 845-851.

[4] Hoffman, A.H., Robichaud, D.R. 2nd, Duquett, J.J., Grigg, P., 2005. Determining the effect of hydration upon the properties of ligaments using pseudo Gaussian stress stimuli. J. Biomech. 2005: 38, 1636-1642.