STRESS RELAXATION OF THE LOWER LIMB TENDONS IN HORSES

Vito Burgio (1), Claudia Tuttobene (2), Mariana Rodriguez Reinoso (3), Valentina Tuveri (4), Marco Civera (5), Cecilia Surace (6)

1.Laboratory of Bioinspired Nanomechanics, DISEG, Politecnico di Torino, Italy

Introduction

Tendon injuries continue to be a major cause of premature retirement in racehorses. The flexor tendons, especially the superficial digital flexor tendon (SDFT) and the deep digital flexor tendon (DDFT) have the highest incidence according to epidemiological reports present in the literature during practice and race [1].
The anatomical architecture of equine lower limb flexor tendons and joints enable an efficient transfer of energy developed by the muscles favouring rapid locomotion. The Energy-storing tendons, such as Human Achilles tendon and horses' SDFT, are spring-like systems that permit efficient locomotion and reduce muscles workload [2]. The constitutive modelling of ligaments and tendons is important for understanding the soft tissue function, as well as the mechanisms of injury and healing [3]. The most suitable models to represent tendon and ligaments mechanical behaviour is the quasi-linear viscoelastic (QLV) model introduced by Fung [4]. In the QLV model, the stress–strain response is described as a separable function consisting of a stress or strain-dependent function (independent of time) and a time-dependent relaxation or creep function (independent of stress or strain). The time-dependent relaxation or creep function is called the reduced relaxation function (G(t)). This work is related to the T-REM3DIE (Tendon REpair MEdical DevIcE) project, whose aim is the developing of cutting-edge technologies for soft tissue repair.

Methods

The relaxation tests were performed on fresh-frozen tendon specimens, performing uniaxial tensile tests up to 3% and 6% of strain, followed by relaxation at a constant strain level for a hold time of 300 s. Specifically, three types of equine tendons were tested: the common digital extensor (ECDT), the DDFT and the SDFT. From the experimental data, stress-time curves were obtained. Then, the fitting of the models was performed and the coefficient of determination was computed (R^2). The G(t) function was defined using the Prony series and the sum of decreasing exponentials in MATLAB environment, to enable the comparison of the results obtained with other tendons and ligaments in literature. In addition, the Percent Lost Stress [5] (PLS) was computed.

Results

For both the QLV models, higher R^2 values were obtained at 3% of strain compared to 6% of strain (Figures 1-3) and lower PLS as the strain increased.

Discussion

The application of the QLV model for the characterization of the viscoelastic behaviour of the equine lower limb tendons showed promising results at each percentage of strain tested. These findings are in agreement with the literature where the QLV model was tested on other tendons and ligaments.

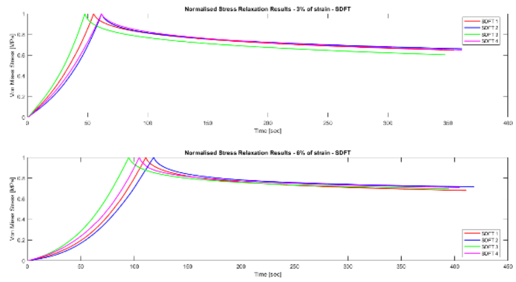

Figure 1: Normalised Stress relaxation of SDFT.

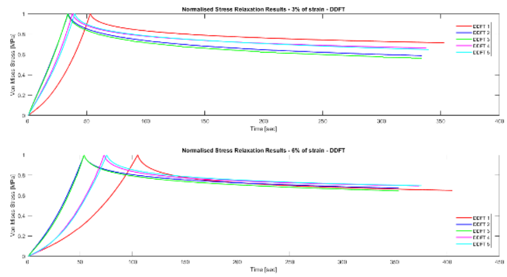

Figure 2: Normalised Stress relaxation of DDFT.

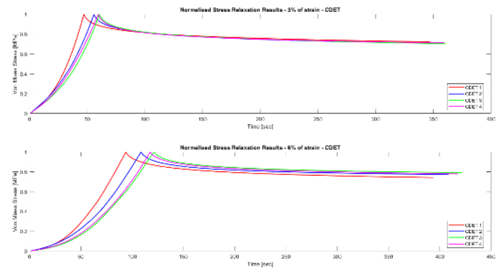

Figure 3: Normalised Stress relaxation of CDET.

References

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