Influence of the contraction mode on the tendon structure: rat model

Kaux JF1, Drion P2, Besançon B1, Libertiaux V3, Croisier JL1, Forthomme B1, Colige A4, Le Goff C5, Franzen R6, Defraigne JO7, Cescotto S8, Rickert M8, Crielard JM1

1. Physical Medicine Service, Department of Moiltify Sciences, University Hospital of Liège, University of Liège, Belgium. – jkaux@chuulg.ac.be
2. Animal Facility of University Hospital of Liège, Ulg GIGA-R, University of Liège, Belgium.
3. Laboratory of Connective Tissues Biology, GIGA-R, University of Liège, Belgium.
4. Department of Clinical Biology, University Hospital of Liège, University of Liège, Belgium.
5. Department of Biomedical and Preventive Sciences, GIGA-R, University of Liège, Belgium.
6. CREDEC, Laboratory of Experimental Surgery, University of Liège, Belgium.
7. Department of Orthopaedic Surgery, University of Heidelberg, Germany.

1. Introduction:
Tendinopathies are common in sport and affect both upper and lower limbs. Eccentric rehabilitation is a successful way of treating them and now is becoming the “gold treatment”. Although clinical results are very favorable, beneficial morphological and histological effects have not yet been elucidated. The aim of our experiment was to determine if any intrinsic modifications exist in a tendon trained in concentric or eccentric modes, in a rat model.

2. Methods*:
18 rats were divided into 3 groups: 6 for the control group, without physical restraint; 12 for a training of 1 hour, 3 times a week, for 5 weeks, at a speed of 17m/min (1km/h), on an inclined treadmill (Fig. 1): 6 rats running uphill at +15° for the concentric effort (group C) and 6 rats running downhill at -15° for the eccentric effort (group E). After this training period, the tricipital, patellar and Achilles tendons (Fig. 2-4) of both limbs were surgically removed in all 18 rats (Fig. 5). Tendons from five rats of each group were subjected to a tensile test up to rupture using a “cryo” jaw (Fig. 6-7). Tendons of the remaining rat of each group were subjected to a histological study [hematoxylin-eosin (HE) (Fig. 8-10); Masson’s trichrome (MT)(Fig. 11-13)].

3. Results:
Rats of group E had more developed muscles than in the 2 other groups (Fig. 14-16). The biomechanical results (Table 1) showed significant (*) changes in group E only: (1) an increase of the force (F) required to rupture the tricipital (p=0.018) and patellar (p=0.047) tendons; (2) an increase of the surface area of the section (S) of the tricipital tendon (p=0.008); (3) an improvement of the ratio between the force necessary to rupture the tricipital tendon and the body mass (F/m) of the rats (p=0.043).

No significant change was observed as far as constraint (F/S) was concerned between groups. Histologically (Fig. 8-13), tendons of group E presented, more peripheral blood vessels and a greater proportion of collagen.

4. Conclusion:
This study showed that the mechanical properties of tendon tissue are enhanced by eccentric training. Tendons become stronger, the amount of collagen increases and there is probably more interaction between collagen fibers (mechanotransduction). More studies with more samples are needed to confirm these findings.

5. References:

*All experimental procedures and protocols used in this investigation were reviewed and approved by the Institutional Animal Care and Use Committee of the University of Liège.