

# EVIDENCE OF IMBALANCED ADAPTATION BETWEEN MUSCLE AND TENDON IN ADOLESCENT ATHLETES

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## Introduction

Muscle strength and tendon properties influence athletic performance [Arampatzis, 2006] and relate to the risk of injury [Arya, 2010]. Imbalances in the time course of adaptation within the muscle-tendon unit might increase the risk of tendon injury. In adolescent athletes both environmental mechanical stimuli and maturation affect the adaptation process of muscle and tendon [O'Brien, 2010], which may induce a critical phase of tissue plasticity. Supporting clinical evidence shows that earliest manifestations of overload tendon injuries concern adolescent athletes [Cook, 2000]. Our purpose in a set of investigations was to provide information about quadriceps femoris muscle strength and patellar tendon properties as well as about the course of adaptation of muscle and tendon in adolescent athletes.

## Methods

Twenty adolescent (15.9±0.6 years, 10 female [A<sub>F</sub>] / 10 male [A<sub>M</sub>]) and 18 middle-aged elite volleyball athletes (46.9±0.6 years, 10 female [MA<sub>F</sub>] / 8 male [MA<sub>M</sub>]) participated in magnet resonance imaging and ultrasound-dynamometry sessions to determine quadriceps femoris muscle strength and patellar tendon mechanical and morphological properties. In a longitudinal study with a subsample of adolescent athletes we currently monitor changes in muscle strength and tendon properties every three months for two years to investigate the time course of adaptation.

## Results

As expected, male athletes showed higher muscle strength ( $p < 0.05$ ) compared to female ones (M: 346.3±47.4 Nm; F: 231.9±42.9 Nm), however we didn't find a significant age effect ( $p > 0.05$ ) indicating similar muscle strength between adolescent and middle-aged athletes (A: 305.1±67.7 Nm; MA: 281.4±79.6 Nm). The CSA<sub>PT</sub> was significantly smaller and the tendon stress during the maximal contractions was significantly higher in adolescent com-

pared to the middle-aged group and female compared to male athletes, respectively (figure 1). Preliminary individual data show imbalances between the time course of adaptation of quadriceps femoris muscle strength and patellar tendon stiffness in the adolescents, resulting in episodes of high tendon strain during maximal contractions.

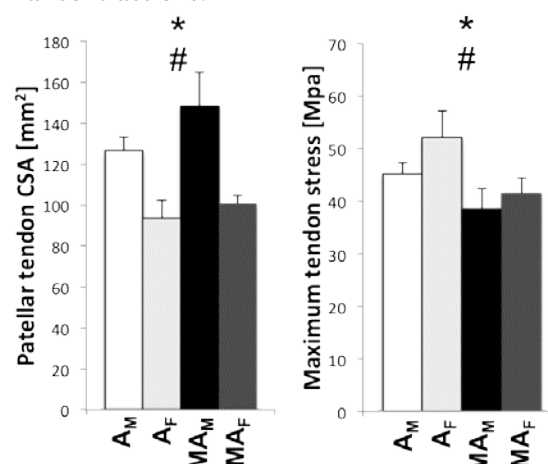


Figure 1: Mean values and standard error of mean (error bars) of the patellar tendon cross sectional area (left) and maximum tendon stress (right) female (F) and male (M) adolescent (A) and middle-aged (MA) athletes. # significant effect of sex ( $p < 0.05$ ), \* significant effect of age ( $p < 0.05$ )

## Discussion

We provide evidence of an imbalanced development of muscle strength and tendon mechanical and morphological properties in adolescent athletes. Whereas muscle strength is similar to middle-aged athletes, tendon hypertrophy has not yet been equally manifested, which results in greater tendon stress. This imbalance may be associated with the development of overuse injuries and the findings call for interventions facilitating tendon adaptation.

## References

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