BIOMECHANICAL CHARACTERISTICS OF THE ECCENTRIC ACHILLES TENDON EXERCISE

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INTRODUCTION

Eccentric exercise has been shown to provide good short-term clinical results in the treatment of painful mid-portion chronic Achilles tendinopathies [1]. However, the mechanisms behind the positive effects of eccentric rehabilitation regimes are not known, and research into the biomechanics of the exercise may improve our understanding. Differences in force fluctuations between eccentric and concentric exercises have been observed [2]. However, no details about the force fluctuation frequency were provided. The force fluctuation frequency is of interest since remodelling of other musculoskeletal tissues such as bone and muscle can be stimulated by high frequency loadings [3].

The purpose of this study was to test the hypothesis that the force fluctuation frequency during eccentric exercises differs significantly from that of concentric exercises.

METHODS

Sixteen healthy subjects performed one-legged full weight bearing ankle plantar and dorsiflexion exercises during which three-dimensional ground reaction forces (GRF) and ankle joint kinematics and kinetics were recorded using a force platform (AMTI) and a motion capture system (VICON). Surface electromyography (EMG) was recorded from gastrocnemius, soleus, the peronei and tibialis anterior. Sagittal plane ankle joint kinematics and resultant GRF frequency contents were calculated. From the ankle joint moment, Achilles tendon force was estimated and the Achilles tendon force impulses (ATFI) was calculated as the area under the time-force curve.

RESULTS

The mean peak plantar flexion angle was -23.7° (SE 0.6°), and the mean peak dorsiflexion angle was 30.4° (SE 0.6°). No differences in ATFI between concentric and eccentric phases were observed (P=0.66). The main part of the 1-Hz windowed frequency content was below 5 Hz with a peak around 2-3 Hz (figure). There was a significantly reduced eccentric phase frequency power in the 1-2 Hz frequency range (P = 0.0008), and significantly higher eccentric phase frequency power in the 8-12 frequency range (8-11 Hz: P<0.0001, 11-12 Hz: P=0.0316) compared to the concentric phase (figure).

The EMG was lower during eccentric movement phases compared to the concentric (P<0.0001).

DISCUSSION AND CONCLUSIONS

This descriptive study demonstrates differences in the movement biomechanics between the eccentric and concentric phases of one-legged full weight bearing ankle dorsal and plantar flexion exercises. In particular, the findings imply that although the tendon loads are similar, the tendon is vibrated at higher frequencies during the eccentric phase than during the concentric phases. Reduced eccentric EMG suggests incomplete and/or redistributed activation of the motor neuron pools, which in turn will change the load of the Achilles tendon. This study provides data that prompt future studies of the possible link between tendon healing and force fluctuations during eccentric exercises used in the treatment of Achilles tendinopathies.

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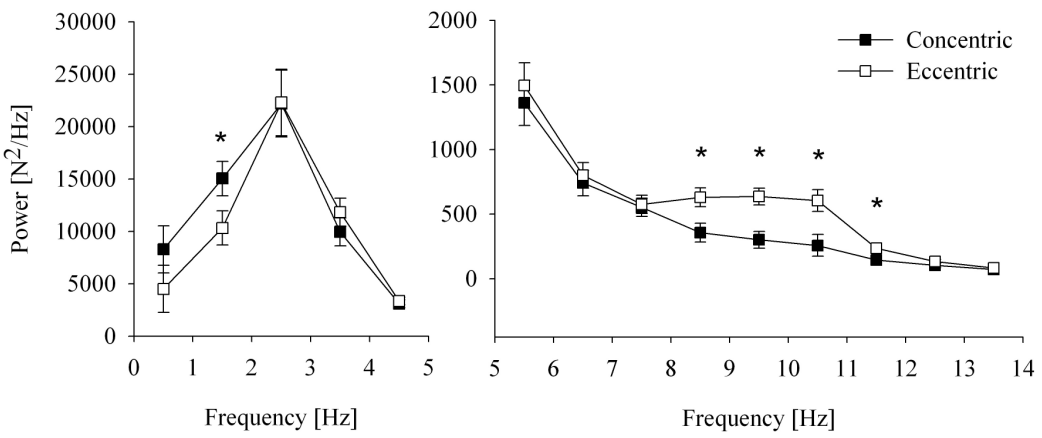

Figure: Group means (error bars: SE) for the power spectrum density of the resultant ground reaction force (GRFres) during the concentric (filled symbols) and eccentric (open symbols) movement phases. Note that the y-axis scales are different below (left) and above (right) 5 Hz for visual purpose.