RELATIONSHIP BETWEEN ANKLE JOINT ROTATIONAL IMPEDANCE AND TIBIALIS ANTERIOR FATIGUE ON TIBIAL RESPONSE DURING IMPACT

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INTRODUCTION

Local muscle fatigue (LMF) of the tibialis anterior (TA) has been shown to attenuate impact shock through the leg, even at the same ankle joint angle as during non-fatigued states [1]. This finding suggests that there could be a change in the rotational impedance of the ankle joint when TA fatigues.

The purpose of this study was to determine the individual muscle contributions (MJRI) to ankle joint rotational impedance (AJR) and to investigate the relationship between AJR and localized muscle fatigue on tibial response parameters (TRPs): peak acceleration (PA), time to peak acceleration (TPA), and acceleration slope (AS).

METHODS

The right leg of 15 male and 11 female runners was impacted into an EVA foam-covered force platform using a pendulum apparatus [2] in both non-fatigue (NF) and LMF conditions across a range of ankle angles (0%, 20%, 40%, and 60% maximum dorsiflexion angle). Impacts were delivered between 1.00-1.15 ms⁻¹ to achieve peak forces between 1.8-2.8 times body weight [2].

Surface EMG data for TA, fibularis longus (FL), lateral and medial gastrocnemius (LG, MG), and soleus (SOL), and ankle electrogoniometer and shank acceleration data were acquired at 4096 Hz and processed using custom LabVIEW® software. Data were obtained from impacts occurring in NF and LMF conditions. Fatigue was induced by dorsiflexion against resistance at 50% maximum voluntary exertion.

EMG-driven model moment curves were compared to joint reaction moment curves determined from subject anthropometry and kinematic data. This enabled an assessment of the internal and external joint moments and resulting MJRI and AJRI values in the sagittal plane [3] (Figure 1).

RESULTS

No differences in TRPs were found between non-fatigue and fatigue conditions, or between sexes. After the LMF, the mean MJRI of the TA significantly decreased by 9.4%, while the MJRI of the LG increased by 6.0%. AJRI increased by 20.8% on average from baseline (BL) to pre-impact (PRE). AJRI also decreased by 7.5% on average after the fatigue protocol. Overall, a positive relationship was found between AJRI and PA, as well as AJRI and AS, while a negative relationship existed between AJRI and TPA.

Figure 1: Changes in muscle joint rotational impedance (MJRI) and ankle joint rotational impedance (AJRI) with time. Baseline (BL), pre-impact (PRE) and post-impact (POST) time periods are labeled.

DISCUSSION AND CONCLUSIONS

Given the apparent tradeoff between the contributions of TA and LG to AJRI, it may be that the two muscles were working together to balance each other’s contributions, in order to maintain a consistent level of AJRI when TA was fatigued. The MG, SOL and FL remained consistent in their contributions to AJRI with LMF, supporting the notion that there may be an optimal amount of AJRI that must be maintained as an injury prevention strategy during impact activities with LMF onset.

It is also proposed that AJRI plays a significant role in how shock propagates through the leg. The idea of maintaining AJRI with fatigue is thought to balance the impedance requirements for preventing injury and running performance.

REFERENCES


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