BIOMECHANICAL ASPECTS OF ECCENTRIC MUSCLE DAMAGE AND RECOVERY

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INTRODUCTION

Previous investigators [1] have reported maximal power loss during multi-joint activities following damaging eccentric exercise. Biomechanical aspects of this power loss, however, have not been reported. The purposes of this investigation were to: 1) determine the extent to which ankle, knee, and hip joints absorbed power during eccentric cycling (Ecc_{cyc}) and 2) evaluate changes in power produced by those joints during maximal concentric cycling (Con_{cyc}). We hypothesized that the joint actions that absorbed the most power during Ecc_{cyc} would exhibit the greatest reductions in power produced during subsequent maximal Con_{cyc}.

METHODS

Nineteen trained cyclists participated in this study. Participants performed baseline 3-sec trials of maximal single-leg Con_{cyc} and subsequently performed acute single-leg Ecc_{cyc} (-70±4kJ). During Ecc_{cyc}, participants resisted the reverse moving pedal (60rpm) while targeting a power of 40% of their maximum single-leg Con_{cyc} power. 24hr following Ecc_{cyc}, participants again performed maximal Con_{cyc} trials. Limb kinematics were determined with an instrumented spatial linkage system [4] and pedal reaction forces were recorded with a force sensing pedal. Segmental masses, moments of inertia, and locations of centers of mass were estimated using regression equations [2]. Sagittal plane joint reaction forces and net joint moments were determined with inverse dynamic techniques. Joint powers, calculated as the product of net joint moment and joint angular velocity, were averaged over a full revolution and the extension (ext) and flexion (flex) phases of the pedal cycle. Dependent variables were assessed using repeated measures procedures.

RESULTS

The ankle, knee, and hip absorbed 6±1%, 56±3%, 33±3% of the total pedal power averaged over a complete revolution, respectively with 6±1% transferred across the hip to the pelvis. During the leg flexion phase of Ecc_{cyc} (eccentric extension) the knee absorbed more power than the hip (-185±12 vs. -92±14watts) while the hip absorbed more power than the knee during the leg extension phase (eccentric flexion; -28±3 vs. -6±4watts; $p<.05$; Table 1). At 24hr post Ecc_{cyc}, knee extension and hip flexion powers were reduced by 19±7% and 18±9%, respectively ($p<.01$; Figure 1).

DISCSSION AND CONCLUSION

These are the first data to document power absorbed during multi-joint eccentric actions and the resulting changes in joint specific power. As has been reported for Con_{cyc} [3], Ecc_{cyc} was performed with a combination of knee and hip actions including eccentric knee extension, eccentric hip extension, and eccentric hip flexion. During subsequent maximal Con_{cyc} knee extension and hip flexion powers were compromised whereas hip extension power was not. We interpret these data to suggest that knee extensor and hip flexor muscles are more readily damaged than hip extensor muscles. This is further supported by the fact that two individuals who absorbed power primarily with eccentric hip extension did not show reductions in hip extension powers produced during maximal Con_{cyc}. Thus, these data partially support our hypothesis in that those participants who absorbed power with knee extensor and hip flexor muscles demonstrated large reductions in knee extension and hip flexion powers. In contrast, none of the participants, even those who used an eccentric hip extension strategy to absorb power, demonstrated a decrease in hip extension power suggesting that hip extensor muscles are highly resistant to eccentric muscle damage. Our findings provide additional biomechanical insight into the resulting functional limitations associated with eccentric muscle damage.

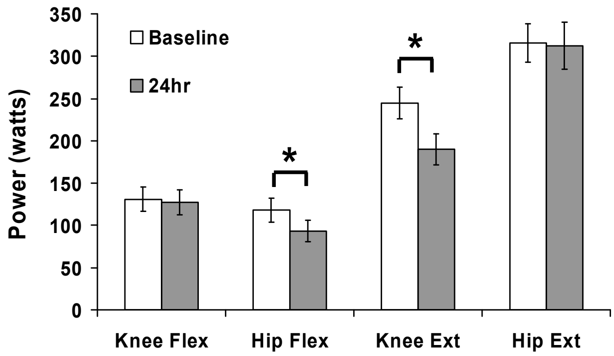

Figure 1: Power produced during maximal Con_{cyc} (mean±SEM). * different than baseline ($p<.01$).

ACKNOWLEDGEMENTS

ISB Dissertation Grant; Gatorade Sports Science Institute

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Table 1: Power absorbed during Ecc_{cyc} (mean±SEM watts). * different than hip ($p<.05$).

Joint	Full Revolution	Leg Flexion	Leg Extension
Knee	-99 ± 6*	-185 ± 12*	-28 ± 3*
Hip	-61 ± 8	-92 ± 14	-6 ± 4