THE INTERACTION BETWEEN SURFACE GRADE AND EXERCISE DURATION FOR SERIAL SARCOMERE ADAPTATIONS FOLLOWING TREADMILL RUNNING IN RATS

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INTRODUCTION

It is well accepted that eccentric exercise results in muscle injury and adaptation. *In-vivo* studies, aimed at quantifying the magnitude of muscle injury, have shown that several extensor muscles of the hindlimb of the rat experience varying degrees of muscle injury following chronic downhill walking [1], illustrating that the damage to these muscles is not uniform. Subsequently, a significant increase in serial sarcomere number (SSN) has been reported in the same knee extensor muscles following long-term downhill walking [2], leading to the hypothesis that eccentric exercise-induced damage results in this cellular adaptation. However, recent studies have shown that one extensor muscle of the hindlimb of the rat undergoes active lengthening during uphill walking [3], which would be expected to result in injury and sarcomere number increase. However, this has not been reported [2]. Recently, we have shown that not only can sarcomere number adaptations differ within a muscle, but can also occur between synergistic muscles, indicating a differential adaptation that may not be damage dependent [4].

METHODS

Protocol I: 24 male Long-Evans rats (age = 150 days) were randomly assigned to one of three groups: uphill (U) group (n=8), downhill (D) group (n=8) and a control (C) group (n=8). All groups were trained in five minute sets, with 1.5 minutes rest between sets for 5 days at 16 meters/min.

Protocol II: 16 male Long-Evans rats (age = 150 days) were randomly assigned to one of two groups: uphill (U) group (n=8), and a downhill (D) group (n=8). All groups were trained in five minute sets, with 1.5 minutes rest between sets for 10 days at 16 meters/min. Total training durations for each group are given in table 1.

Tissue analysis: 72 hours following the last training bout, the rats were killed, and the hindlimbs removed and fixed with the knee maximally flexed. Fascicle and sarcomere lengths of the vastus intermedius were measured using computer software and laser diffraction respectively. A two-way ANOVA was used to assess the differences in SSN with respect to surface grade and time.

RESULTS AND DISCUSSION

There were no significant differences in serial sarcomere number after only five days of exercise in either group, when compared to the control group. However, there was a significant interaction between exercise duration and surface grade with respect to the serial sarcomere number in the vastus intermedius muscle ($p<.001$), illustrating that the adaptation in serial sarcomere number over time was significantly greater in the uphill group compared to the downhill group (Fig. 1).

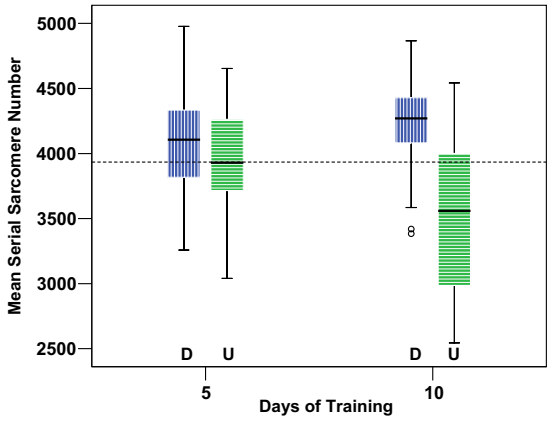

Figure 1. Interaction box plots for the uphill (U) and downhill (D) walking rats of 5 and 10 day duration, for the vastus intermedius muscle. Note the quantitative interaction of grade and duration on serial sarcomere number.

CONCLUSION

Serial sarcomere number changes in the vastus intermedius muscle can be predicted by surface grade only as a function of time. Although a previous study has shown that serial sarcomere numbers may vary depending on surface grade, the lack of a control group in that study does not allow the quantification of a gain or loss of sarcomeres compared to normal [2]. In addition, since knee extensor muscles have been shown to undergo lengthening contractions during uphill walking [3], the loss of sarcomeres in the uphill exercise group questions the role of muscle injury in the process of cellular adaptation.

REFERENCES

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Table 1. Training duration for each day of each protocol (minutes). 'H' indicates hindlimb tissue was harvested.

Protocol	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day10	Day11	Day12	Day 13
One	15	20	25	30	35			H					
Two	15	20	25	30	35	35	35	35	35	35			H