CAN RESISTANCE EXERCISE DURING RECOVERY BETWEEN PERIODS OF DISUSE MINIMIZE DELETERIOUS CHANGES IN BONE METABOLISM MARKERS?

Corinne E. Metzger¹, Yasaman Shirazi-Fard², Anita V. Mantri¹, Susan A. Bloomfield¹, Harry A. Hogan²³

Departments of ¹Health and Kinesiology, ²Biomedical Engineering, ³Mechanical Engineering, ⁴Texas A&M University Health Science Center College of Medicine, Texas A&M University, College Station, TX

INTRODUCTION
Disuse-induced bone loss can contribute to increased fracture risk in astronauts and bedridden clinical populations. Multiple exposures to microgravity or bed rest may compound this threat to skeletal integrity. With the increased likelihood of repeat spaceflight crew members, the need to determine the effects of multiple cycles of microgravity on bone is critical. Our previous data showed that a second period of unloading following weight bearing recovery did not result in a cumulative negative effect on the proximal tibia metaphysis (PTM) as measured by in vivo longitudinal peripheral quantitative computed tomography (pQCT) [1].

PURPOSE
Using the traditional hindlimb unloading (HU) rat model, we sought to determine if resistance exercise (EX) during recovery from an initial unloading period would minimize the negative effects of a second bout of disuse. Our previous data demonstrated that EX enhanced recovery of bone density at the proximal tibia metaphysis (PTM), as measured by in vivo pQCT, but did not alter the losses due to the 2nd HU compared to the non-EX group [2]. In this study, we aimed to further explore the effects of EX during recovery on tissue-level changes in bone formation and serum markers of bone metabolism. We hypothesized that exercise during recovery would preserve bone formation and mitigate increases in bone resorption after a second period of disuse.

METHODS
Six-mo.-old male Sprague Dawley rats were randomly assigned to age-matched controls (AC; n=8) and two HU groups. 1HU+R-EX rats (n=8) were exposed to HU (4 wk) followed by weight bearing recovery including progressive resistance exercise (8 wk). 2HU rats (n=8) had the same treatments as 1HU+R-EX and then were exposed to a 2nd HU (4 wk). Double fluorochrome labels were given in the final week before termination to assess bone formation rate (BFR) at the midshaft tibia (cortical bone) and in PTM cancellous bone. Serum measures of bone resorption (CTX-1), bone formation (P1NP), and sclerostin, an inhibitor of Wnt signaling and osteoblast activity, were assessed with enzyme-linked immunoassays.

RESULTS
Following recovery from the 1st HU, cortical BFR was significantly higher than AC (p<0.0005) and CTX-1 was lower (p<0.05). After a 2nd bout of HU, cortical BFR was maintained at AC levels; however, cancellous BFR of 2HU trended lower than in 1HU+R-EX (p=0.08) and was significantly lower than AC values (p<0.05). Serum P1NP was significantly lower after the 2nd HU compared to AC and to 1HU+R-EX (p<0.001). Serum sclerostin remained lower compared to AC after exercise recovery and following the 2nd HU (p<0.05).

CONCLUSION
Resistance exercise potently increased cortical bone formation and favorably altered serum markers of bone metabolism following a first period of disuse. Exercise during recovery was able to preserve BFR at the cortical bone of the midshaft tibia during a second bout of disuse, but was unable to maintain cancellous BFR. The anabolic impact of exercise may appear to be somewhat prolonged, given that serum sclerostin remained suppressed even after a second period of disuse.

ACKNOWLEDGEMENTS
This study was supported by NASA grant NNX08AQ35G.

REFERENCES