Comparison of normal rat leg bone with those under simulated microgravity and cosmic radiations conditions

Background/preliminary results

In space, microgravity conditions and cosmic radiation have detrimental effects on the skeletal system of humans such as weakened bones, lowered elastic moduli and abnormalized the concentrations of calcium and phosphorus, as compared to bones not subject to these conditions.[1] Biologically, bone has both organic and inorganic components that are interwoven to create a sturdy yet flexible skeletal structure. The organic components are mainly collagen and long chains of protein which intertwine in flexible fibers. The inorganic component is the hydroxyapatite ($Ca_5(PO_4)_3(OH)$), a calcium-rich mineral that strengthens the collagen.[2] Calcium and phosphorus are the two major elements of the bone. Approximately 20% of bone mineral is comprised of phosphorus, which combines with calcium to form hydroxyapatite. In the bone

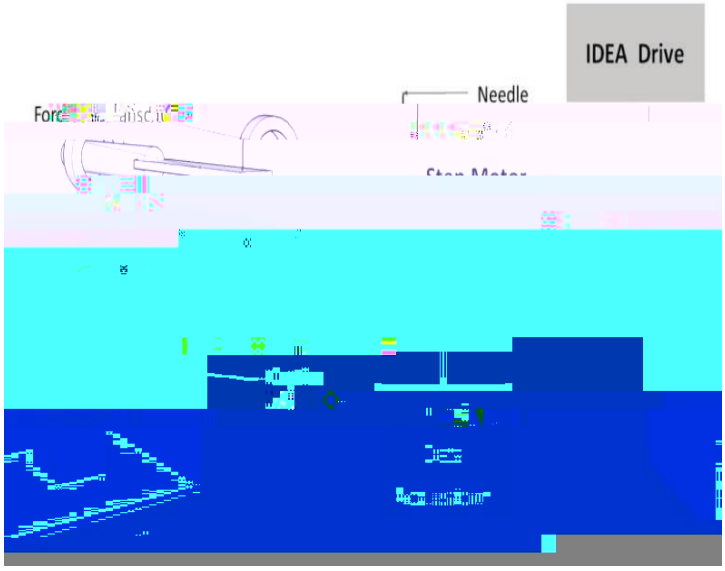

Figure2. (a) Sketch of the device showing the captive actuator, force transducer and the contact for bending. (b) A flow chart of the communication process to collecting and storing data.[9]

Question1: How are the elasticity different in the control, HLS and radiation groups?

Hypothesis: The HLS (Hind Limb suspension) group and radiation groups will have lower elasticity than the control group. The HLS groups will be the lowest among the groups.

Methods: The bones will be subjected to the three-point bending technique which is used to measure the biomechanical paramount such as stress, strain, and stiffness. The three-points bending method fixes the bones at both ends while a force transducer exerts a known force upwards at a known speed, acting perpendicular to the bone. Each leg bone (tibia and femur) were bent with force prod acting on: posterior, medial, lateral, anterior points of center of the bone. The WINDAQ software records and displays the force applied to the bone. Also, the lengths of bones and inner and outer radii of the bone will be measured. All those measurements will be used to calculate Young's Modulus of elasticity. The two-way ANOVA will be used for data analysis. Factor A will be control groups vs treatment groups. Factor B will be the bone orientation (posterior, medial, anterior and lateral).

Expected results: If our hypothesis is supported, I might observe that the HLS group and the radiation groups have the lower force to change than the control groups. And the HLS group has the lowest force change. This might be due to microgravity affecting bone, so osteoclast breaks the calcium down from their bone into their blood to achieve homeostasis and its elasticity decreases through this process. [10]

Question2: How are the elemental different in the control group, HLS (Hind Limb suspension) group and radiation groups?

Hypothesis: A trend of lowered calcium phosphate ratios will be in the HLS & irradiated bone cross-sections compared to the control group. The lowest ratio will be the radiation groups.

Methods: Bones will be cut in thin cross-section with a diamond tip saw. Then the bones are fixed to the slides, sputter-coated with gold for analysis using SEM (Scanning Electron

Microscope). In addition to imaging the bone, an energy disposed analysis (EDA) quantifies the relative percentages of carbon, oxygen, phosphorus, and calcium present. Data is summarized using graphs and the validity of data will be ascertained by using statistical analysis such as two-way ANOVA. Factor A will be control groups vs treatment groups. Factor B will be the bone orientation (posterior, medial, anterior and lateral).

Expected results: If our hypothesis is supported, the SEM data would indicate lowered calcium

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Appendix A. Gantt Chart of activities.