Fiscal Year:	FY 2006	**Task Last Updated:**	FY 05/09/2006
PI Name:	Rubin, Clinton Ph.D.		
Project Title:	Retention of skeletal, musculature, and postural status with a non-invasive, extremely low-level mechanical signal: a ground-based evaluation of efficacy		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Physiology		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **Bone Fracture**:Risk of Bone Fracture due to Spaceflight-induced Changes to Bone (2) **Osteo**:Risk Of Early Onset Osteoporosis Due To Spaceflight		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Stony Brook	**State:**	NY
Zip Code:	11794-2580	**Congressional District:**	1
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2003 Biomedical Research & Countermeasures 03-OBPR-04
Start Date:	07/01/2004	**End Date:**	06/30/2008
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	2	**No. of Master' Degrees:**	0
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Judex, Stefan (State University of New York at Stony Brook) Qin, Yi-Xian (State University of New York at Stony Brook)		
Grant/Contract No.:	NNJ04HA02G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The osteoporosis which develops in microgravity is one of the greatest hurdles to an extended human presence in space. Earth-based animal and human studies have demonstrated that extremely low magnitude mechanical stimuli (LMMS), if imposed at a high frequency, is strongly anabolic to the skeleton, and can serve to inhibit the bone loss, which typically parallels disuse. This experiment is designed to evaluate the efficacy of this unique biomechanical countermeasure to inhibit the disuse induced osteoporosis seen in long term bed-rest, the closest ground based equivalent of microgravity. To achieve this in a non-invasive, non-pharmacologic means would have tremendous impact not only in space, but would also address the bone loss which plagues over 20 million people world wide each year on earth. 1) Show that application of low magnitude (0.3g), high frequency (30Hz) mechanical stimulation, will reduce the loss of bone seen with long term disuse 2) Show that application of low magnitude, high frequency mechanical stimulation will improve the postural control of subjects undergoing long term bed-rest 3) Determine if long term bed-rest affects the sensitivity of the lower extremities. 3.b) Determine if the application of low magnitude, high frequency mechanical stimulation will inhibit the changes if they exist Non-pharmacologic countermeasure for the deterioration of the musculoskeletal system, and retention of postural stability.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	To achieve this in a non-invasive, non-pharmacologic means would have tremendous impact not only in space, but would also address the bone loss which plagues over 20 million people world wide each year on earth.
Task Progress:	Eight control subjects have been tested as of the date of this report. Four subjects (2 male, 2 female) underwent 90 days of bed-rest, with measurements taken at 0, 60, and 90 days. Four subjects (3 male, 1 female), underwent 45 days of bed-rest with measurements taken at day 0 and day 45. The second groups experiment was cut short when the hospital in Galveston, Texas was evacuated due to the approach of Hurricane Rita. Foot sensitivity Foot neurosensitivity tests found no change over the course of bed-rest in the sensitivity feet. Plantar nerve sensitivity tested by the use of monofilaments found no significant difference at each time point. Joint proprioception tests showed no effect of bed-rest results showed that subject had normal proprioception at all time points. The vibration identification test results found that the number of incorrect identifications doubled over baseline; however this change was not significant Bone Density Scans have been performed on the non-dominant ankle by quantitative ultrasound. Broadband Ultrasound Attenuation (BUA) and Ultrasound Velocity (UV) are calculated from the raw data. Both are indicators of the structure and composition of the bone). The more dense the bone is, the more signal will be attenuated and slower the velocity will be. Thinner, less structured bone will attenuate signal less, and have an overall greater velocity. Correct scans of the second subject group were not possible at day 45 due to the evacuation of Galveston. Computed Tomography scans of the hips have been analyzed. Significant decreases in bone mineral density (BMD) were found in several areas of the hip. The largest loss of bone was seen in the trabecular bone. Analysis of the spine BMD is underway. Analysis of the CT scans of the hips found a 1.6 +/- 1.25% loss in muscle cross sectional area per month in the leg during bed rest. Postural Control Postural control measurements are available only for the first group of four subjects. Results show that there was a significant increase in sway magnitude and velocity in both the anterior-posterior (AP) and medial-lateral (ML) directions. Maximum AP sway velocity increased significantly as well. Continued analysis of the postural control data are being performed, to identify the cause of the increase is sway. Increased sway is an indicator an increased risk of falling. Causes for an increased sway could be muscle loss, loss of sensation of the feet, and changes in the vestibular system. The neurosensitivity tests found no significant effect of bed-rest on the nerves of the feet. Present analysis is looking to identify if the changes are due solely to the muscle loss seen in the leg, or if there are changes in the vestibular system which could be affecting postural control. Application of LMMS Application of LMMS will be achieved through the use of a harness system. A vibrating platform, which provides a 0.3 g, 30 Hz signal is hung perpendicularly from a sled, which can be moved from bed to bed [Figure 11]. Subjects put on a vest, which is attached to the plate through the use of two springs. The treatment is given for 10 minutes a day, during which the subject is free to perform normal activities as they see fit. Our data so far shows baseline data for four healthy controls. Upon completion of the bed-rest study, we will be able to compare the bone mineral density of control subjects who under went 90 days of bed-rest simulating microgravity, and an experimental group who underwent the same bed-rest, but had daily treatments of 10 minutes of mechanical stimulation. If the data collected for bed-rest mirrors what we have seen in post-menopausal women as we hypothesize, there will be a significant drop in the loss of bone due to disuse. If this is the case, it may be possible to effectively reduce and/or stop the loss of bone seen in extended hypogravity. At present, exercise regimes in the ISS and shuttle have not been effective in decreasing the loss of bone in space. LMMS has been shown in multiple ground based models to reduce and/or prevent the loss of bone in at risk groups. Animal studies, as well as human studies of post-menopausal women and children with muscular dystrophy have shown significant improvement in bone density when compared to controls. By loading the experimental subjects with 60% of their body weight, we will be creating a short term load on their axial skeleton, which will be stimulated with the mechanical vibrations generated by the plate. Because the treatment only requires the astronaut to stand upright, they are free to perform other tasks which do not require extensive motion while they undergo treatment, such as reading, writing, or computer work. The plate itself isn't much larger than a bathroom scale. Considering the confined volume of the ISS and any space vehicle, and the high value of crew time, the treatment method is an improvement over time intensive exercise regimes requiring large equipment.
Bibliography Type:	Description: (Last Updated: 10/22/2009)
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Articles in Peer-reviewed Journals	Rubin C, Judex S, Qin Y-X. "Low-level mechanical signals and their potential as a non-pharmacologic intervention for osteoporosis. " Age and Ageing, in press 2006 , Jul-2006
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