# Fact Sheet

## Vibrational Inhibition of Bone Erosion - A Low-Intensity Mechanical Countermeasure to Prohibit Osteoporosis in Astronauts During Long-Term Spaceflight (VIBE)

06.27.08

Experiment/Payload Overview

Brief Summary

Vibrational Inhibition of Bone Erosion - A Low-Intensity Mechanical Countermeasure to Prohibit Osteoporosis in Astronauts During Long-Term Spaceflight (VIBE) will examine bone loss during space flight using a non-invasive, non-drug dependent approach that, if successful, could become an effective countermeasure against bone loss caused by long-duration space flight.

Principal Investigator

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Payload Developer

Johnson Space Center, Human Research Program, Houston, TX

Sponsoring Agency

National Aeronautics and Space Administration (NASA)

Expeditions Assigned

No Information Available

Previous ISS Missions

VIBE is a unique payload that has not been performed in microgravity.

Experiment/Payload Description

Research Summary

- Bone loss as a result of long-term exposure to microgravity is a serious problem for astronauts. VIBE is designed to evaluate the efficacy of a unique biomechanical countermeasure to inhibit microgravity-induced osteoporosis.
- Achieving this by non-invasive, non-drug related means would have tremendous impact, not only in space, but also on Earth where bone loss plagues over 20 million people world-wide each year.

Description

The osteoporosis (bone loss) which develops in microgravity is one of the greatest hurdles to an extended human presence in space. A recently published study of International Space Station crewmembers found that, on average, they lost bone density in the hip at the rate of 1.6 to 2.7 percent per month, a serious and unacceptable consequence for a crew during transit to Mars. Earth-based human and animal studies have demonstrated that extremely low magnitude mechanical loading, if imposed at a high frequency, can inhibit bone loss in the load-bearing skeleton. If this biomechanical countermeasure is successful during spaceflight, low magnitude mechanical stimulation (LMMS) could reduce crew time and equipment constraints for exercise, and avoid any negative side effects associated with the use of pharmacological (drug-related) interventions.

This investigation will determine the efficacy of a non-invasive, biomechanical countermeasure against microgravity-induced bone loss in otherwise healthy astronauts. The primary objectives of the experiment are:

- to establish the efficacy of a 10-minute daily in-flight dose of high frequency (30Hz), low magnitude (0.3g, or $3m*s^{-2}$) mechanical acceleration to inhibit the loss of bone density in the lower appendicular skeleton (hips, spine)
- to establish the efficacy of this same stimulus to inhibit the loss of muscle strength and postural stability.

The experiment will be evaluated using pre- and post-flight measurements of bone mineral content, density, quality, and physical properties using a variety of x-ray, tomography dimension modeling, and ultrasound techniques. Several indices of muscle strength and power, and postural stability will also be used. Differences from the pre-flight baseline will be examined in terms of the ability of extremely low-level mechanical stimulation to inhibit the loss of bone quality and quantity. The principal areas of interest will be bilateral femurs, tibias, calcanei (foot bones), the spine, and non-dominant radius. Assays will evaluate bone density, cortical thickness, apparent bone quality, and bone mineral density. If there is an increased preservation of muscle strength and postural stability due to in-flight exposure to these mechanical signals, this will provide important insight into the regulatory stimulus in the maintenance of the musculoskeletal system. Efficacy will be determined on the ability of the signal to inhibit bone loss, and prevent loss of muscle power and postural stability.

Applications

Space Applications

This study, if successful, can provide a non-invasive, safe countermeasure for microgravity-induced bone loss during flight that offers secondary countermeasures against microgravity-induced muscle degradation, postflight terrestrial postural instability, and changes in bone quality cross-cutting benefits for muscle and sensory-motor capability. Use of the VIBE apparatus could reduce or replace the use of drug-related therapies.

Earth Applications

The effectiveness of the VIBE apparatus for arresting bone loss is expected to be the same on Earth as in space, therefore, it could offer an important new therapy for current sufferers of osteoporosis.

Operations

Operational Requirements

Four astronauts will participate in the experiment as controls. The control subjects will not receive in-flight treatments from the VIBE Plate, but pre- and post-flight measurements will be taken.

On later increments, twelve experimental ISS crewmember subjects will use the VIBE Plate system on board the ISS for ten minutes each day during their flight. These subjects will complete the same pre and post-flight tests as the control subjects.

Operational Protocols

ISS crewmembers will use the VIBE system on a daily basis for ten minutes to subject their lower appendicular skeleton, spine and associated muscles to minor amounts of gravitational acceleration. The preflight bone measurements, recorded for both control and inflight test crewmembers, will be compared to post-flight measurements to confirm that bone loss has not occurred in those subjects receiving the inflight treatment.

Related Publications


- Eisman JA. Good, good, good...good cibrations: the best option for better bones? Lancet. ;358. 2001
- Rubin C, Turner AS, Bain S, Mallinckrodt, McLeod. Low mechanical signals strengthen long bones. Nature. ;412:603-604. 2001
- Gandhi U. Scientist get vibes to build bones. The Globe and Mail. Tuesday, June 13, . 2006
- Fritton J, Rubin C, Qin Y-X, McLeod K. Vibration in the skeleton. Part I: Development of a resonance-based whole body vibration device. Journal of Biomedical Engineering. ;25:831-839. 1997
- Hannan M, Cheng D, Green E, Swift C, Rubin C, Kiel D. Establishing the compliance in elderly women for use of a low level mechanical stress device in a clinical osteoporosis study. Osteoporosis International. ;15:918-926. 2004
- Ward K, Alsop C, Brown S, Caulton J, Rubin C, Adams J, Mughal M. Low Magnitude Mechanical Loading Is Osteogenic in Children With Disabling Conditions. Journal of Bone and Mineral Research. ;19:360-369. 2004
- Rubin CT, Recker R, Raab D, Ryaby J, McCabe J, McLeod KJ. Prevention of post-menopausal bone loss by a low magnitude, high frequency mechanical stimuli; A clinical trial assessing compliance, efficacy and safety. Journal of Bone and Mineral Research. ;19:343-351. 2004
- Rubin C, Pope M, Fritton C, Magnusson M, Hansson T, McLeod K. Transmissibility of 15-35 Hz vibrations to the human hip and lumbar spine: Determining the physiologic feasibility of delivering low-level, anabolic mechanical stimuli to skeletal regions at greatest risk of fracture due to osteoporosis. Spine. ;28:2621-2627. 2003


Information Provided and Updated by the ISS Program Scientist's Office