CALCIUM KINETICS DURING LONG-DURATION SPACE FLIGHT

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INTRODUCTION

Bone loss represents one of the most significant effects of space flight on the human body. Understanding the mechanisms underlying this loss is critical for maintaining crew health and safety during and after flight. This investigation documents the changes in bone metabolism and calcium kinetics during and after space flight. We previously reported calcium studies on three subjects during and after a 115-d stay on the Russian space station Mir (*Am J Physiol*, 277:R1-R10, 1999). We report here data on an additional three subjects, whose stays on Mir were approximately 4 (n=1) and 6 (n=2) mos. Previously published data are included for comparison.

CURRENT STATUS OF RESEARCH

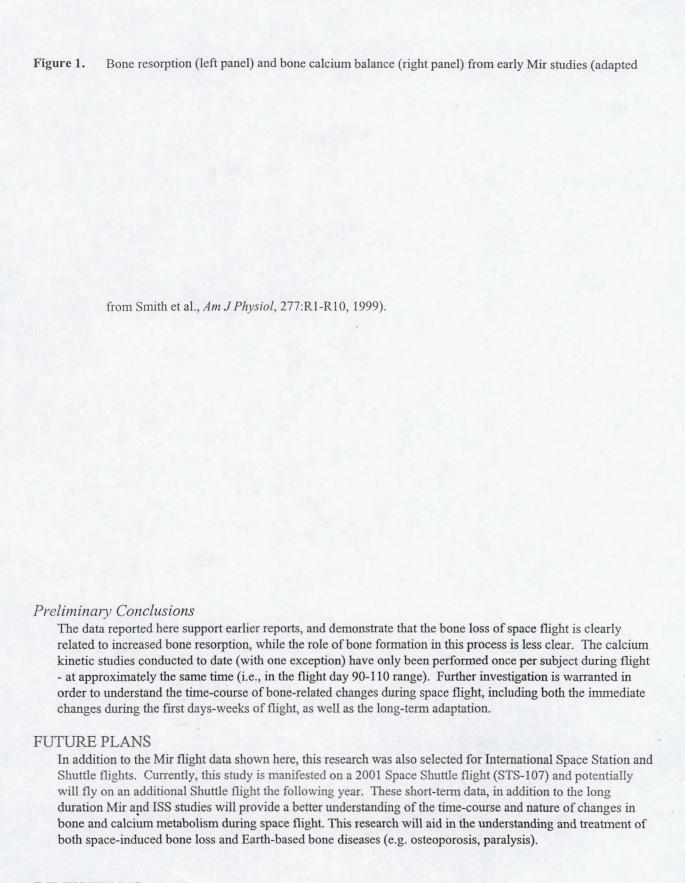
Methods

Subjects were three men, aged 44±3 years and weighing 82.7±5.4 kg. Calcium kinetic studies were performed before, during (at 2-3 months of flight), and after space flight. Stable isotope tracer kinetic studies were performed before, during, and after flight. Following administration of isotopes (⁴⁴Ca orally, ⁴²Ca intravenously), blood, urine, saliva, and fecal (pre- and post-flight only) samples were collected for 21 days. Isotope enrichments were determined using Thermal Ionization Mass Spectrometry, and the data analyzed using the SAAM (Simulation, Analysis and Modeling) software program and multi-compartmental mathematical modeling techniques. In addition to the kinetic studies, endocrine and biochemical markers of bone and calcium homeostasis were determined using standard analytical techniques.

Results

Biochemical and endocrine data are reported as percent differences from individual preflight data. Similar to previous reports, ionized calcium was unchanged (2.8±2.1%) during flight, calcium absorption was variable inflight, but was decreased after landing, and vitamin D stores were decreased inflight by 36±25%. By contrast, serum PTH was decreased more (59±9%) during flight than previously reported, while 1,25(OH)₂-vitamin D was decreased during flight in only 2 of the 3 subjects. Markers of bone resorption (e.g., collagen crosslinks) were increased in all subjects during flight. Bone-specific alkaline phosphatase, a bone formation marker, was decreased (n=1) or unchanged (n=2), while osteocalcin was decreased 34±23%.

Results from the recent Mir calcium kinetic studies confirm previous observations (Fig. 1) of increased bone resorption during space flight. These data demonstrate that the loss of bone during space flight is associated with increased resorption and either unchanged/decreased formation. Bone balance was negative during space flight (-232 \pm 150 mg/d) in the recent crewmembers studied, very similar to previously published results (Fig. 1).



INDEX TERMS

Bone, calcium, calcium kinetics, osteoporosis, bone loss, calcium metabolism