DEFINING THE RELATIONSHIP BETWEEN BIOMARKERS OF OXIDATIVE AND INFLAMMATORY STRESS AND THE RISK FOR ATHEROSCLEROSIS IN ASTRONAUTS DURING AND AFTER LONG-DURATION SPACEFLIGHT

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BACKGROUND

Future human space travel will consist primarily of long-duration missions onboard the International Space Station (ISS) or exploration-class missions to Mars, its moons, or nearby asteroids. These missions will expose astronauts to increased risk of oxidative and inflammatory damage from a variety of sources, including radiation, psychological stress, reduced physical activity, diminished nutritional status, and hyperoxic exposure during extravehicular activity. Evidence exists that increased oxidative damage and inflammation can accelerate the development of atherosclerosis.

PURPOSE

The purpose of this investigation is to determine whether biomarkers of oxidative and inflammatory stress are elevated during and after long-duration spaceflight and determine if a relation exists between levels of these biomarkers and structural and functional indices of atherosclerotic risk measured in the carotid and brachial arteries. This is the first study to propose assessing atherosclerotic risk using biochemical, structural, and functional measures before, during, and immediately after spaceflight, and structural and functional measures for up to 5 yr post-landing.

METHODS

A panel of biomarkers of oxidative and inflammatory stress are measured in venous blood samples and 24-h (in-flight) and 48-h (pre- and post-flight) urine pools twice before flight, early (flight days 15 and 60) and late (2 weeks before landing) during the mission, and early in the post-flight recovery phase (~3-5 days after landing). Arterial structure and function are measured at the same times and also at 1, 3, and 5 yr after landing (surveillance). Arterial structure is assessed from measures of carotid intima-media thickness, which has been shown to be a better indicator of atherosclerotic risk than the Framingham Risk Score. Arterial function is assessed using brachial flow-mediated dilation, a well-validated measure used to assess endothelium-dependent vasodilation and is a sensitive predictor of atherosclerotic risk. Arterial pulse pressure measured in the brachial artery and stroke volume measured from cardiac ultrasound will be used to assess hemodynamic status, cardiac function, and systemic vascular compliance.

We will study 12 astronauts before, during, and up to 5 years after long-duration ISS missions. Five astronauts have completed pre-, in-, and immediate post-flight data collection, and three have completed testing at R+1 yr. Four astronauts have participated in pre- and in-flight data collection, and three have begun pre-flight training and data collection. Analysis of arterial structure and function data are in progress and a subset of the in-flight blood and urine samples have been received from ISS.

EXPECTED RESULTS

We hypothesize that biomarkers of oxidative and inflammatory stress will increase with spaceflight and will be related to increased carotid intima-media thickness during and after flight and with decreased flow-mediated dilation after the mission. Furthermore, we hypothesize that measures of oxidative stress will return to baseline after flight, but biomarkers of inflammatory stress and vascular indices of atherosclerotic risk will remain elevated.