Department of Cell Physiology
Division of Aerospace Medicine

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General Summary

Our main research interests are gravitational physiology and aerospace medicine.

Research Activities

Gravitational physiology and aerospace medicine

1. Research on visual stimulus and posture control

Information for maintaining body direction and movement of the body center for maintaining posture are determined by visual input factors, equilibrium vestibular input factors, and somatosensory factors from the whole body (including muscles, tendons, joints, and skin). Visual information becomes the main factor in outer space because vestibular and somatosensory inputs are reduced owing to low or absent gravity. The objective of this research is to analyze changes in posture induced by visual stimuli.

2. The elucidation of the re-adaptation of attitude control after the return from long-term space flight

Astronauts returning from a long stay in space will be observed to learn more about the adaptive processes in the somatosensory system and the lower limb skeletal muscles and to acquire data that could contribute to astronaut rehabilitation after returning from space. To accomplish the above objective, astronauts who have stayed for a long time in space will be studied to measure the following items before and after their stay in orbit:

(1) Comparison of muscle activation patterns in lower limb antagonistic muscles
(2) Blood flow measurement in the lower limb skeletal muscles
(3) Body sway balance measurement

In the present experiment, no measurements were made in orbit; instead, measurements were made only before and after a stay in orbit. The aim is to use the resulting data as the basis for a better understanding of the physiological issues that occur in skeletal muscles and the somatosensory system because of a simulated space environment or long-term space flight and apply it to create a more effective training and rehabilitation course.

For astronauts who stay in space for a long time, the following are measured before and after their stay: (1) electromyography of the hind limb antagonistic muscles (the tibialis anterior and soleus, gastrocnemius, and plantaris muscles), (2) blood flow in the lower limb skeletal muscles by using a blood flow measuring device, and (3) the relationship between the nervous system and hind limb skeletal muscles in body-sway balance control by tilting their center of gravity on a force plate in a direction displayed by an image.

3. Biomedical analyses of human hair exposed to long-term space flight

The purpose of this research is to study the effects of long-term exposure in space flight on gene expression and mineral metabolism in human hair. In this experiment, we plan 2

analyses of human hair from International Space Station crews. These 2 analyses are (1) nucleic acids (RNA and mitochondrial DNA) and (2) minerals (Na, K, and Ca) and a trace element (Hg) in the hair shaft. The experiment requires in total 10 crew members of the International Space Station who will stay in orbit more than 90 days. During this experiment, hair samples will be collected a total of 6 times (2 times each in preflight, in flight, and in postflight periods) for each subject.

Hair matrix cells actively divide in a hair follicle and sensitively reflect physical conditions. The hair shaft has an advantage in that it records the metabolic conditions of the environment where the subject is. These samples give us useful physiological information to examine the effect of space flight. In space experiments, we believe that hair is one of the most suitable biological specimens because there are no special requirements for utilizing hardware and handling.

4. Outreach activities for aerospace medicine

Our outreach activities aim to promote public understanding of science and to provide information to the public by publishing books and holding public talks, lectures, and discussions.

Publications

Nagatomo F, Terada M, Ishioka N, Ishihara A. Effects of exposure to microgravity on neuromuscular systems: a review. *International Journal of Microgravity Science and Application*. 2014; **31:** 66–71.