Space Medicine Symposium

Space Medicine Symposium Physiological Sciences in Space Environment Application to Space Medicine

(March 28, 15 : 30–18 : 00, Room A)

2SS1A-1

The future research strategy for space medicine

Mukai, Chiaki; Takeoka, Hajime; Ohshima, Hiroshi; Yamamoto, Masafumi (*Japan Aerospace Exploration Agency(JAXA)*)

Since 1992 when the first JAXA astronaut flew in space, the JAXA medical team has successfully supported 8 short-term space flights. As we enter the era of full-scale utilization of space environment in the International Space Station (ISS), JAXA has strengthened its medical capacity to support human space flight by expanding its focus from clinical medicine to include basic research, which can elucidate the mechanisms of the problems engendered by space flight. By combining both clinical and basic scientific approaches, we can expect more comprehensive understanding of the problems. Therefore, the JAXA Space Biomedical Research Office (J-SBRO) was created in 2007 to promote JAXA's in-house research. There are 5 areas of concern for J-SBRO : Development of Physiological Countermeasures (currently focusing on bone and muscle), Psychological Support such as developing stress monitoring and management methods, On-orbit Medical Technology/Systems including telemedicine/telescience technology, Cosmic Radiation for evaluating the biological effects and designing the methods of protection, and a monitoring of the module Environment for both toxic gases and bacteria. With the expectation of increasing research in space, JAXA established a center for applied space medicine and human research (J-CASMHR), which will coordinate with such research organizations in Japan. The presentation will address the future research strategy for space medicine.

2SS1A-2

Space flight induced bone loss and countermeasure program

Ohshima, Hiroshi (*Space Biomedical Research Office, JAXA*)

Space flight induced bone loss and kidney stone are well known as essential problems for astronauts to overcome during extended stays in space. Crewmembers must engage in physical exercise for two and half hours a day, six times a week. However, the risks of these problems occurring cannot be completely eliminated by physical exercise alone. Bone plays important roles as a structure supporting the body and storing calcium. In a micro gravity environment, because of less loading stimuli, increased bone resorption and no change or possibly decreased bone formation lead to bone mass declines at a rate of about ten times that of osteoporosis. The proximal femoral bone loses 1.5 percent of its mass per month or roughly 10 percent over a six-month stay in space, the recovery of which after returning to earth takes at least three or four years. Bisphosphonate is one of therapeutic agents used for osteoporosis and it has been used for treating osteoporosis patients for more than a decade. Through 90-day bed rest research on Earth, we confirmed that this agent has a preventive effect in the loss of bone mass. Based on these results, JAXA and NASA decided to collaborate on a space biomedical experiment on preventive bone loss during space flight. Some JAXA and NASA crew members are participating this study by taking this agent once a week while in space. Our study is still ongoing, however, it dose appear that astronauts can reduce the risk of bone loss and renal stone risk by proper intake of appropriate nutrients, such as calcium and vitamin D, incorporating an effective exercise program, and taking minimum amounts of medication.

2SS1A-3

Cardiovascular autonomic function and circadian rhythm during long space flight

Otsuka, Kuniaki[1]; Yamamoto, Naomune[1]; Ohshima, Hiroshi[2]; Mukai, Chiaki[2] ([1]*Tokyo Women's Medical University, Medical Center East;* [2]*Japan Aerospace Exploration Agency(JAXA)*)

Alterations of autonomic activity, suppressed sleep quality, and circadian disruptions could have serious consequences on the health and safety of astronaut crews. Thus, it is urgent to clarify any dynamical alterations of circadian rhythm in space, in particular during long-term missions in the International Space Station. Aim is to clarify whether the circadian rhythm on RR intervals and heart rate variability (HRV) for 24 hours change during long space flight. HRV was monitored by 24-h ECG records from 7 healthy astronauts, averaged age of 48.5 years, before a mission (Pre FL), around days 24 (1^{st} DF), 73 (2^{nd} DF), and 159 (3^{rd} DF) of a 180-day mission, and after the mission (Post FL). Average periods of circadian rhythm of each record were kept almost within normal range ; 22.36±2.50, 25.46±4.37, 23.17±5.97, 22.46±1.75 and 26.16±7.18 hour, respectively. The circadian rhythm power was significantly stronger in the 3rd DF than that in the 1st and 2nd DF ($p<0.001$). High frequency domain (HF) of HRV showed significant decline in 1^{st} DF, and then improved as flight prolonged (Pre FL vs. 1^{st} DF vs. 2^{nd} DF vs. 3^{rd} DF vs. Post FL=3.68±3.70vs.2.38±3.28 vs. 5.47±1.75 vs. 6.04±3.51 vs. 4.66±3.37, ANOVA, $p<0.001$, Pre FL vs. 3^{rd} DF, 1^{st} DF vs. 3^{rd} DF, $^{*}p<0.05$). In conclusion, long space flight enhanced circadian rhythm on RR intervals for 24 hours. Because of the re-adaptation of parasympathetic nerve function might be related the circadian rhythm improvement.

2SS1A-4

Time- and gravity-difference and space medicine

Ishikawa, Yoshihiro (*Cardiovascular Research Institute Yokohama City University Graduate School of Medicine Yokohama, Japan*)

With the advance in technology, our life style has been dramatically changed in the past centuries. With the invention of electric light, our daily activity was expanded, and we sleep for fewer hours than ever before in the past 4 million years. With the invention of rail road, we started making longer distance trips than before, and thus can move to another time zone easily. With the invention of airplanes, such changes became even more drastic. People may travel from one place to another that belongs to the opposite time zone within several hours. Because human being has never been exposed to such time difference, at least, for the past 4 million years, we have faced a new era to adapt ourselves to such new environment, and need to study physiological mechanism to regulate our biological "clock". Accordingly, we have learned the mechanism of biological clock not only in the central nervous system, but in the peripheral organs. We can now control such clock pharmacologically. Similarly, with the initiation of space life, we are facing gravity-difference. Because human being has never exposed to such low gravity in our history, we need to adapt ourselves and examine the impact of gravity difference on our body. As we did overcome time difference in the past decade, we must overcome gravity difference in the next decade. With the advances in space medicine, understanding of physiological mechanism to regulating gravity-difference and also potential pharmacological treatment will be explored.