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Salivary amylase and stress during stressful environment: Three Mars analog mission crews study

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ABSTRACT

After the establishment of the space age physicians, human factors engineers, neurologist and psychologists and their special attention to work on people's capability to meet up the physical, psychological, neuroscience and interpersonal strains of working in space, it has been regarded as an issue that seeks urgent consideration. Not study was conducted on effect of simulated Mars analog environment on stress and salivary amylase. So, this study aimed to confirm whether salivary amylase is act as stress biomarker in crew members who took part in Mars analog mission in an isolated and stressful environment. The 18 crew members were selected who took part in Mars Analog Research Station, Utah. Salivary amylase was measured using a biosensor of salivary amylase monitor and State-Trait Anxiety Inventory score at pre-extravehicular activity, post-extravehicular activity and on before mission. The state and trait anxiety scores at pre-extravehicular activity for each commander were elevated as compared to after extravehicular activity. There were significant differences in the state and trait anxiety scores between before extravehicular activity and after extravehicular activity of Commander and other members, also there were significant differences in values of before-extravehicular activity between commanders and other members. There were significant differences in values of salivary amylase at before extravehicular activity and after extravehicular activity between commander group and other members. There was significant correlation between salivary amylase and state and trait anxiety scores in all groups. Measuring salivary amylase level could be useful for stress assessment of crew members and population working in a stressful and isolated environment.

1. Introduction

As the duration of space flights increases and crews become more heterogeneous, psychosocial factors are likely to play an increasingly important task in influential mission success like mission to Mars [5]. Being restricted and isolated with the same individuals for such a long period of time millions of miles from Earth might create psychological and interpersonal stress for the crewmembers and affect their ability to carry out mission goals. The psychosocial and psychiatric issues affecting a crew such as Mars, it is important to begin by examining the on-orbit experience. A major challenge for long mission planning is to ensure the ability of the crew to function efficiently and safely under these conditions. Stress is probably the most prevalent psychosocial problem. Therefore, stress management among the most issues of health and safety to address [1,7]. Evaluation of the stress level of each crew members under stressful and extreme conditions is a vital part of stress management. The subjective and objective methods such as State-Trait Anxiety Inventory (STAI) [13], α-amylase and cortisol [6,13] are frequently used to assess stress. Salivary α-amylase activity is linked with the sympatho–adreno–medullary system [11,14] and is significantly correlated with noradrenaline levels in saliva [11]. It has been reported that salivary amylase levels rise in response to physiological and psychological stress [8,11]. Extreme environments allow us to examine various aspects of the hormone physiological relationship that is essential to fully understand the concept of adaptation of humans to the stresses of these environments [9]. The MDRS, Utah (USA) provides a unique opportunity to examine mental stress. The Mars Desert Research Station (MDRS) is an analog to a Mars surface habitat, constructed for mission simulations according to Mars Reference Mission guidelines [4], and located in a US southwest desert region relevant to Mars analog geology and biology research. MDRS includes an upper deck with six private staterooms having personal storage and desks, a galley

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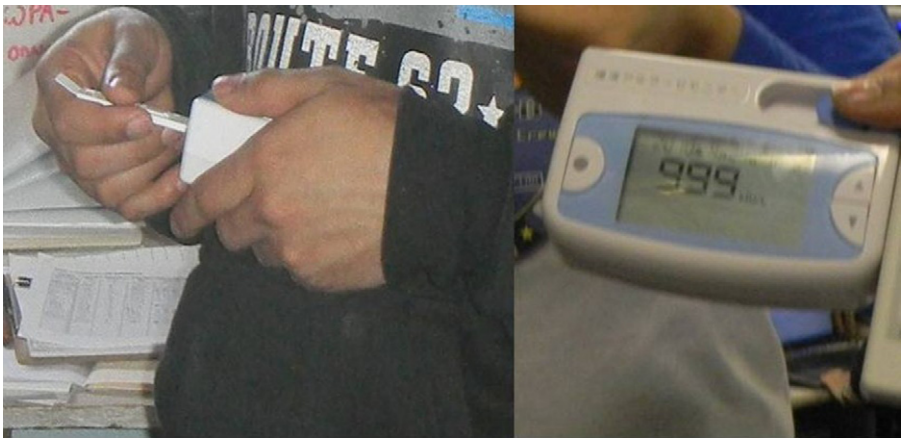

Fig. 1. Salivary amylase biosensor.

area, workstations, and meeting/eating area, plus a lower deck with a laboratory, toilet, shower, and extra-vehicular activity (EVA) preparation rooms. Thus, the measurement of salivary amylase may be utilized for evaluation of the stress level of each crew members caused by extreme and isolated environments, whereas, until now, no study has evaluated the stress of crew members during simulated Mars Mission using salivary amylase. This study aimed to confirm whether salivary amylase is useful as a biomarker for stress in crew members working in a stressful environment.

2. Materials and methods

The study was conducted according to the Human subject research guidelines in the Helsinki Declaration and informed and writing consents were taken. The details of the study protocol were explained to all crew members from three crews. The subjects were 18 crew members (mean age = 23.2, SD = 2.1) who took part in Mars Analog Research Station, Utah, USA. There were three commanders (Principal responsible person) and 15 other members (three health and safety officer, three geologists, three biologists and three chief scientists). The 95 extravehicular activities were done. All crew members were healthy, non-smokers and non-alcoholic, no systemic diseases, non medicated and non pregnant. The body mass index (BMI) of all crew members was within normal limits (17.9–24.5 kg/m^2). The average energy and calcium intake by the volunteers during the microgravity simulation was 2567 kcal/day (range 2090–3178 kcal/day) and 1200 mg/day (900–1780), respectively. Dietary sodium and potassium intake were held constant at 90 and 80 mmol/day, respectively. Water intake was *ad libitum* 1378 mL/day (1000–2310). The baseline data, the anxiety of all subjects was assessed using the state and trait anxiety scores (STAI-S and STAI-T, respectively) of the STAI. Also, the salivary amylase of members was measured between 8:30 am and 9:00 am on before mission. Following the baseline measurements, the STAI-S was administered and salivary amylase was measured between 7:30 am and 8:30 am at 5 min before-EVA (extra-vehicular activity) and between 13:10 pm and 14:25 pm at 10 min after-EVA. Salivary amylase was measured using a portable salivary amylase analyzer (NIPRO, Osaka, JAPAN) (Fig. 1). The data of the STAI-S, STAI-T and salivary amylase on before mission day of the commander group were compared with a control group comprising 10 members (mean age = 23.4, SD = 4.1) engaged in remote support scientists team in India during the same period. The data of the control group were obtained between 8:00 am and 9:00 am. Differences in the means of the STAI-S and salivary amylase between the before- and after-EVA for each commander were analyzed using paired *t*-tests. Further, the mean of the STAI-S and salivary amylase for pre-mission, pre-EVA and post-EVA in the pilot group compared to the control group were analyzed using a one-way analysis of variance (ANOVA). Pearson correlation analysis was used to evaluate the correlation between the STAI-S and salivary amylase taken from the commander and control groups. Statistical analyses were performed using SPSS version 11.0 (USA).

3. Results

At baseline pre-mission, the means of the STAI-S and STAI-T in the commander group were 38.9 (SD 4.7) and 37.5 (3.4), respectively, and salivary amylase was 30.2 (12.4) kU/mL while in the control group (32.1 (SD 4.4), 33.6 (SD 8.4), and 30.2 (14.7) kU/mL, respectively. The STAI-S at before (pre)-EVA for each commander tended to be elevated compared to that at pre-mission. The STAI-S at pre-EVA for each commander was elevated as compared to after-EVA, which lowered to be almost equal to the level at base line (Fig. 2). Furthermore, there were significant differences in the mean of the STAI-S between before-EVA and after-EVA of Commander and other members (paired *t*-test; $P < 0.01$ and $P < 0.05$, respectively), also there were significant differences in values of before-EVA between commanders and other members. There were significant differences in values of salivary amylase at before-EVA and after-EVA between commander group and other members (Fig. 2). The means of the STAI-S at baseline (before start of mission), Before-EVA and after-EVA in the commander group, and at baseline in the control group were 38.9 (SD 4.7), 80.3 (4.5), 29.3 (7.8) and 36.7 (7.8), respectively. The mean of the STAI-S at before-EVA in the commander group was significantly higher compared to that for the before-EVA, after-EVA and control group ($P < 0.01$). The mean levels of salivary amylase at baseline-, before- and after-EVA in the commander group, and at baseline in the control

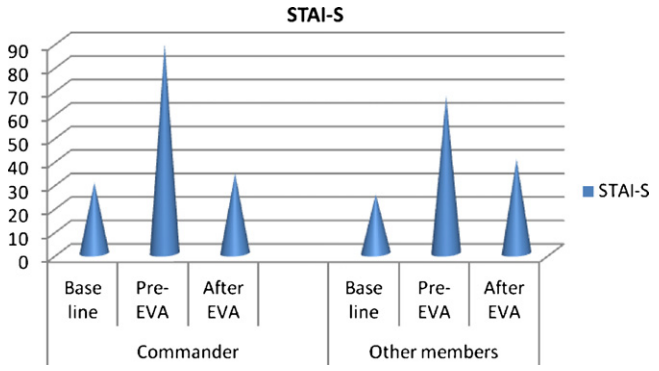

Fig. 2. STAI-S scores in commander and other members before- and after-EVA.