Mars mission and Human Factor: Overviews

Rajnish K. Jain, Simmi Kharb, S C Anand

Abstract

Artificial gravity represents a different approach to the problem of microgravity effects on the human body, as it simply mimics our natural 1-g environment. Not just one physiological system at a time is challenged by artificial gravity, but all systems simultaneously: bone stress, anti-gravity muscles, vestibular organs, and cardiovascular apparatus. This Paper reviewed the important facts related to zero-gravity and human factors.

Key words

Zero Gravity , Human Factor, Aeronautic Dentistry.

Introduction

Flying in space has been a dream for human beings all over the world specially on mars . Presently, being in mars has become a routine type of task for a certain privileged group of the population called marsonauts .Although the fascination with being in space may fill the astronauts with a sense of fulfillment; many other physiological and psychological effects come into play. The physiological effects are quite varied in nature and include changes in energy requirements, body composition, fluid homeostasis, protein utilization, calcium/bone metabolism and hematopoiesis 1. Physiological adaptation to microgravity can result in loss of red blood cells, bone loss, and changes in gastrointestinal motility 2. Other aspects of the space environment can lead to alterations in the chemosensory perception of foods;these include diet, illness, and biochemical shifts. These adaptive changes to weight lessness present a formidable obstacle to the human exploration of space, particularly for missions requiring travel times of several months or more, such as on a trip to Mars. Hence, this paper was focused the effect of mars envirements on the marsonaunt , and how body can make a balance in this condition.

Mars environments

1. Low pressure. The atmospheric pressure on mostly due to Mars carbon dioxide ,varies from approximately 7.4 to 10 millibar (mbar) 3
2. Low temperature. The average diurnal temperature ranges from approximately 170 K to 268 K. At this temperatures would completely freeze any organism and depending on the freezing process would cause cellular damage through the formation of ice crystals. Low temperatures would raise the activation energy for enzyme catalyzed processes and thus inhibit biochemical/ metabolic reactions. Biochemical reactions occur in solution and the transport of metabolites would not occur efficiently in a ice crystals 4.
3. Water. Liquid water which is a prerequisite for life ,under the current Martian atmospheric pressure is unstable. Such extreme dry conditions would cause dehydration, for example damaging DNA and leading to mutation and cell/organism death.
4. Radiation. The main source of radiation at the Martian surface is ultraviolet (UV) radiation between the wavelengths of 190 and 300 nm. In the absence of an ozone layer, organisms can only escape the lethal affects of UV-radiation by living in protected habitats 5.
5. Oxidants. Due to UV-radiation the topmost layer of the regolith is thought to contain strong oxidants which are damaging for cellular components.
6. Oxygen and Carbon dioxide. Oxygen on Mars is 0.02%.The major atmospheric component is carbon dioxide .In organisms

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Reprint requests: Dr. Rajnish K. Jain
MDS (Endodontics)
Kalka Dental Collage, U. P.

the relatively high concentration of carbon dioxide would cause a low intracellular pH. This may lead to damaging for cellular proteins, cellular components and cellular metabolism. 6Also, free radical induced damage is likely to biomolecules and cellular components.

7. No organic material. Because of the continuous bombardment of UV-radiation and oxidizing conditions, no organic material will be present on the Martian surface.

Mars mission

Mars will be the first nearby world that humans will visit. Mars is the most Earth-like planet in our solar system. The greatest potential for human habitation lies on Mars. Although it has a very cold, dry climate, surface temperatures at the equator can reach 26°C during the summer 4-13. Scientists believe that conditions on Mars and Earth were similar billions of years ago. Data from past Mars missions suggest that the planet once had a warmer, wetter climate and abundant liquid water in the form of lakes, rivers, and even oceans during its early history 5-9. A detailed exploration of Mars could potentially provide insight into the past and future of our own planet. Finally, exploring the planet could create new commercial opportunities and sources of income. Robotic exploration missions have already provided detailed studies of the planet, located vital sources of water, analyzed soil samples, and identified the best landing sites. At the time this book is being written, the Mars Exploration Rovers Opportunity and Spirit are still exploring small patches of Mars on opposite sides of the planet. NASA and ESA are planning additional missions slated to land at various locations on Mars. These feature mobile or stationary landers equipped with robotic arms for exploration. The little Mars exploring robots are amazing pieces of engineering and have many discoveries left to make. However, they do have their limitations. It took Opportunity 56 days to explore a 20-meter crater. A year was required for Spirit to travel two kilometers, something an marsonaut or a more capable robot could perform in a couple of hours. Although robots will always be a required component of any exploration missions, humans are able to go a little further, wonder what's over the horizon, and explore areas that the rovers might not be able to reach.Marsonauts will drive for kilometers across the planet's diverse terrain in advanced roving vehicles equipped with specialized tools, drills, and analytical instruments. Much of their time will be spent searching for water and past and present evidence of Martian life forms, as well as conducting a wide range of scientific activities that cannot be accomplished by robotic exploration. The human explorers must also be shielded from harmful radiation while traveling in their spacecraft and when on the Red Planet's surface. And because the gravity on Mars is only 0.38 g, it is possible that this is not sufficient for counteracting the detrimental effects of microgravity on their body functions experienced during the journey to Mars. Their survival in such an inhospitable environment will be solely dependent on their combined expertise, specialized skills, available equipment, and countermeasures 8-20. When unexpected problems and challenges arise, as they undoubtedly will, the marsonauts will be required to solve them with little or no help from Earth. Radio communications with mission controllers will be difficult because of the transmission time delay between Mars and Earth. Depending on Mars's distance from Earth, which can range from 75 to 350 million km, radio signals from the planet can take anywhere from 5 to 20 minutes to reach Earth. No one knows how many billions of dollars a human mission to Mars will eventually cost, and the enormous financial burden must necessarily be shared by many nations. The urge to explore and natural curiosity are inherent human characteristics that will eventually inspire us to overcome the challenge of sending humans to Mars. Thanks to the vision of advocates for human Mars missions, realistic scenarios have been proposed. Since Wernher von Braun first sketched out his Mars Project in 1953, a succession of designs and human mission profiles have been seriously studied in the United States and the Soviet Union/Russia. The most recent studies of potential Mars mission scenarios include the Paine's Report on Pioneering the Space Frontier , Ride's Report of a Mars Exploration Plan ,NASA 90-Day Study

Mission, NASA Mars Evolution and Space Exploration Initiative studies, Robert Zubrin's Mars Direct approach, NASA's Design Reference Missions, and the latest NASA's Vision for Space Exploration and ESA's Aurora Programme 8-20. Historically, proposed scenarios for human missions to Mars have been divided into two categories: conjunction-class and opposition-class.Conjunction-class missions are characterized by low speed transits followed by a long, roughly 500-day, stay on Mars before returning to Earth. The long stay is required because by the time the ship has arrived at Mars, the Earth has traveled too far around the sun to be overtaken on a return trip .Opposition-class missions usually entail faster transits, higher delta-V braking requirements upon arrival, and far shorter stays of roughly 30 to 90 days on Mars. The typical total trip time for such a mission will be approximately 430 days. Often, an opposition-class mission will necessitate the transfer ship crossing inside the orbit of Venus upon return to catch up with the Earth 9-16.

Why artificial microgravity conditioned experiments importance in mars explore mission

Mars missions (duration mission) will have durations measured in years; so , the Mars exploration crews will be at risk of bad consequences should the systems that provide adequate air, water, food, and thermal control fail.The crews will be exposed to radiation throught out journey as well as on extraterrestrial surfaces that may result in serious health or safety risks.Behavioral issues associated with the prolonged isolation and confinement, and severe physiological deconditioning due to weightlessness and other hazards with which the explorers will face.Mitigating the harmful effects of prolonged exposure to space radiation and weightlessness is one the most significant challenges that must be addressed to realize the long-duration exploration missions. Given the fact that the marsonauts explorers who will undertake these missions will be exposed to these deleterious effects for up to several years while they travel to and from Mars, it is of extreme importance that effective countermeasures are identified, developed, tested, and proven prior to undertaking such challenging missions. It has been reported that the dose of radiation received during a 30-month journey to Mars will amount to about 1,000 times that of the annual dose on Earth, resulting in a high risk of developing chromosomal aberrations in blood lymphocytes and cancer later in the marsonauts' lives.Protective shielding and protective drugs may lower this risks to an acceptable level 21. The immediate physical effects are those induced by prolonged exposure to weightlessness. These include the loss of bone density, muscle mass, and red blood cells; cardiovascular, circulatory, and sensory-motor deconditioning; and changes in the immune system . Artificial gravity represents an alternative approach to addressing the problems of microgravity-induced effects on the human body. Artificial gravity stimulates all of the physiological systems simultaneously by reproducing the normal Earth gravitational environment. All physical and physiological systems are challenged. Bones are stressed, antigravity muscles are called into action, the otoliths of the vestibular system are stimulated in a manner similar to that on Earth, and the cardiovascular system is similarly stressed. Obviously, artificial gravity cannot address all of the problems associated with long duration spaceflight, in particular that of radiation exposure, altered day/night cycles,and the attendant psychological issues that will no doubt arise from extended confinement and isolation. It does, however, offer a countermeasure with the possibility to address the debilitating and potentially fatal problems of bone loss; cardiovascular deconditioning, muscle weakening; sensory-motor and neurovestibular disturbances, and regulatory disorders.

Effects of Long Duration Spaceflight on Crew Performance & Functioning 22

1. Exhaustion & Asthenia
    - Fatigue, feeling of tiredness
    - Emotional instability
    - Sleeplessness
    - Sharpening of Personality
    - Incapacity for work
    - Disruption in psychophysiological reaction
    - Psychosomatic Dysfunction
2. Euphoria

3. Depression

4. Neurosis

5. Accentuation of negative personality traits

6. Cognitive effects:

Psychomotor performance

Dual-task performance

Tracking performance

Fine manual control

Sleep-decrement induced cognitive factors:

Alertness

Vigilance

Response Time

Ability to Focus

Exposure to microgravity and the space environment during short- and long-duration space missions has following medical and dental conseques occurs-

1.Nerovastibular problem such as

Space motion sickness and disorientation during the flight 22,23 impaired balance and neuromuscular coordination after landing 24,25

2.cardiovascular and fluid-related problems

orthostatic hypotension immediately following spaceflight 26,27; Altered cardiac susceptibility to ventricular arrhythmias 28 reduced cardiac muscle mass and diminished cardiac function 29

3.muscle-related problems

atrophy involving loss of muscle mass, strength and endurance 30,31

4.Bone related problem

decrease in the bone mineral density 32,33

5.Circadian rhythm-related problems

sleep and performance 34

6.immune-related problems

infections and immunodeficiency 35

7.Problem related to oral cavity 37-40

Periodontitis

Salivary stone

Xerostomia

Oral infection

Change in taste

Edema of face

Teeth pain

Caries

Conclusions

Artificial gravity represents a different approach to the problem of microgravity effects on the human body, as it simply mimics our natural 1-g environment. Not just one physiological system at a time is challenged by artificial gravity, but all systems simultaneously: bone stress, anti-gravity muscles, vestibular organs, and cardiovascular apparatus . It is very likely that humans do not need gravity, or a fraction of it, 24-hours a day to remain healthy. If intermittent gravity is sufficient, a permanently rotating spacecraft would not be needed to produce a constant gravity force . Instead an onboard human short-arm centrifuge presents a realistic near-term opportunity for providing artificial gravity. Long duration spaceflight has revealed a multitude of psychological, physiological, psychosocial and environmental-interface challenges to crews operating within them. Further study is required to make ideal condition like mars environment than explore the human factors.

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