Space radiation may cause prolonged cellular damage to astronauts

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With major implications for long-duration space travel, a study from the Lombardi Comprehensive Cancer Center at Georgetown University Medical Center demonstrates that the high-energy radiation found in space may lead to premature aging and prolonged oxidative stress in cells. The findings suggest that astronauts may be at increased risk of colon cancer due to exposure to the high linear energy transfer (LET) radiation found in space.

“Radiation exposure, either intentional or accidental, is inevitable during our lifetimes,” says Kamal Datta, M.D., assistant professor at Lombardi and the study’s lead author. “But with plans for a mission to Mars, we need to understand more about the nature of radiation in space. There is currently no conclusive information for estimating the risk that astronauts may experience.”

The kickoff of Project Constellation – the National Aeronautics and Space Administration (NASA) program to return humans to the moon and travel to Mars – has led to increased scrutiny of radiation exposures during space travel. A 2004 report from the National Academies suggested that cancer incidence may be higher in the astronaut population as compared to the general U.S. population, and the National Research Council published a report last month that recommended increased research into the radiation exposures experienced by astronauts during space travel, as well as development of new radiation shielding technologies.

Current risk estimates for radiation exposure rely exclusively on the cumulative dose a person receives in his or her lifetime. The Lombardi study suggests that a more accurate risk assessment should include not only dose, but also the quality of radiation.

To conduct the study, Datta and his team measured the level of free radicals present as well as the expression of stress response genes in the cells of mice exposed to high-LET radiation similar to that found in space. The researchers concluded that the cellular environment of the gastrointestinal tract was highly oxidative – or full of free radicals – for prolonged periods of time, a state which is conducive to cancer development.

The free radicals produced by the radiation causes damage to cells' DNA, and as this damage accumulates, it can lead to mutations -- and in some cases, malignant tumors. The prolonged exposure to free radicals creates ample opportunity for DNA damage to accumulate within individual cells. In fact, Datta and his team observed that the stress response continued for as long as two months after exposure to the high-LET radiation.

In addition the cellular damage from oxidative stress, the researchers also found that the mice exposed to the high-LET radiation aged prematurely. Datta says the mice's coats became prematurely grey, an observation the team plans to follow-up with MRI brain scans.

The Lombardi study, funded by NASA and presented at the 2008 American Association for Cancer Research annual meeting, compared these effects to those from low-LET radiation, such as gamma rays. Low-LET radiation is often used in medical imaging and radiotherapies for cancer, so humans are more often exposed to this class of radiation. The study showed that low-LET radiation did not create an oxidative environment in cells, though both types of radiation did induce a proinflammatory response.

High-LET radiation is found in solar flares and is made up of high-energy protons, charged iron particles, and some gamma radiation. The earth's atmosphere blocks the majority of this radiation, preventing exposure to these particles in normal life. High-LET radiation is known to cause a great deal of damage in a localized area, whereas the impact of low-LET tends to be more diffuse within a tissue.

Source: Georgetown University

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