CHRONIC LUNAR DUST EXPOSURE ON RAT CORNEA: EVALUATION BY GENE EXPRESSION PROFILING

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The surface of the moon is constantly bombarded by micrometeoroids, the solar winds, and galactic cosmic radiation. The result of this geological history is a surface that is blanketed with a layer of fine dust that is characterized by its ionized state, small particle size, and large reactive surface. Lunar dust is also electrically charged due to its iron content, specifically metallic iron in the 0 and +2 oxidation state. Lunar dust is capable of entering habitats and vehicle compartments by sticking to spacesuits or other objects that are transferred into the spacecraft from the lunar surface and has been reported to cause irritation upon exposure. During the Apollo missions, crewmembers reported irritation specifically to the skin and eyes after contamination of the lunar and service modules. It has since been hypothesized that ocular irritation and abrasion might occur as a result of such exposure, impairing crew vision. Recent work has shown that both ultrafine and unground lunar dust exhibited minimal irritancy of the ocular surface (i.e., cornea); however, the assessment of the severity of ocular damage resulting from contact of lunar dust particles to the cornea has focused only on macroscopic signs of mechanical irritancy and cytotoxicity. Given the chemical reactive properties of lunar dust, exposure of the cornea may contribute to detrimental effects at the molecular level including but not limited to oxidative damage. Additionally, low level chronic exposures may confound any results obtained in previous acute studies. We report here preliminary results from a tissue sharing effort using 10-week-old Fischer 344 male rats chronically exposed to filtered air or jet milled lunar dust collected during Apollo 14 using a Jaeger-NYU nose-only chamber for a total of 120 hours (6 hours daily, 5 days a week) over a 4-week period. RNA was isolated from corneas collected from rats at 1 day and 7 days after being exposed to concentrations of 0, 20, and 60 mg/m^3 of lunar dust. Microarray analysis was performed using the Affymetrix GeneChip Rat Genome 230 2.0 Array with Affymetrix Expression Console and Transcriptome Analysis Console used for normalization and secondary analysis. An Ingenuity iReport™ was then generated for canonical pathway identification. The number of differentially expressed genes identified increases with dose compared to controls suggesting a more severe response to the lunar dust insult at higher levels. Pathways of interests that have been identified in all exposed samples include oxidative stress response, mitochondrial dysfunction, fibrosis, epithelial healing, TGF-β signaling, and extracellular matrix remodeling. Several biological processes related to cell migration, cellular proliferation, and eye development were also identified to be altered by exposure to lunar dust. Our preliminary results suggest that even a chronic insult of lunar dust as low as 20 mg/m^3 elicits a molecular response in cornea tissue. Lunar dust on the surface of the moon would have the added properties of ionization and activation potentially leading to further damage to the cornea and greater sensitivity to any other environmental insult such as exposure to radiation. Additional studies are required to fully assess the risk of vision impairment and the mechanistic responses initiated in cornea exposed to lunar dust as well as the potential for long-term effects to astronaut health.