Persistent Expression Changes of Fibrosis-Related Genes in the Lung Tissues of Rats Exposed to Lunar Dust Particles

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ABSTRACT

The Moon's surface is covered by a layer of fine, potential reactive dust. Lunar dust contain about 1-2% of very fine respirable dust (< 3 μm). The habitable area of any lunar landing vehicle and outpost would inevitably be contaminated with lunar dust that could pose a health risk. The purpose of the study is to evaluate the toxicity of Apollo moon dust in rodents to assess the health risk of dust exposures to humans. One of the particular interests in the study is to evaluate dust-induced changes of the expression of fibrosis-related genes, and to identify specific signaling pathways involved in lunar dust-induced toxicity.

F344 rats were exposed for 4 weeks (6h/d; 5d/wk) in nose-only inhalation chambers to concentrations of 0 (control air), 2.1, 6.8, 21, and 61 mg/m^3 of lunar dust. Five rats per group were euthanized at 1 day, 1 week, 1 month, and 3 months after the last inhalation exposure. The bronchoalveolar lavage fluid (BALF) was collected by lavaging with phosphate-buffered saline (PBS). A zymosan-induced luminol-based chemiluminescence assay was used to assess the activity of BAL cells. The lavaged lung tissue was snap frozen in LN2 and total RNA was isolated using the Qigen RNeasy kit. The expression of 84 fibrosis-related genes were analyzed using the RT^2 Profiler PCR Array technique. The expression of 18 genes of interest were further measured using real-time PCR technique in all the samples.

10 out of 18 genes of interest showed persistently significant expression changes in the local lung tissue exposed to lunar dust, indicating a prolonged proinflammatory response. The expressions of several of these genes were dose- and time-dependent and were significantly correlated with other pathological parameters. The potential signaling pathways and upstream regulators were further analyzed using IPA pathway analysis tool based on the gene expression data. The data presented in this study, for the first time, explore the molecular mechanisms of lunar dust induced toxicity, contributing not only the risk assessment for future space exploration, but also understandings of the dust-induced toxicity in humans on earth.