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WOUND HEALING RESPONSE TO LUNAR DUST EXPOSURE IN THE RAT CORNEA

Abstract

During the Apollo missions, astronauts reported nasal and eye irritation due to lunar dust exposure upon return from lunar extra-vehicular activities. Lunar dust include pneumatic size particles (¡ 20 m), minerals like iron and silica, and adhesive/abrasive properties due to electrostatic states. Studies have proved lunar dust toxicity on pulmonary tissue. However, a recent study on rabbit eyes showed minimal irritancy of the ocular surface from respirable and coarser unground lunar dust particles. Yet, it is plausible that signaling pathways within the ocular tissue are activated in response to lunar dust exposure, while still being subclinical, evading conventional tests aimed to diagnose change in ocular integrity. To date, no studies have been conducted to assess the effects of lunar dust toxicity at the molecular level. In a tissue sharing effort derived from a parent lunar dust nose-only inhalation study in which rats were exposed to 0, 20, and 60 mg/m3 of lunar dust for 4 weeks (6 h/d; 5 d/wk), we assessed gene profiles in cornea RNA collected from rats 1 and 7 days after the exposure. 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 iReportTM was then generated for canonical pathway identification.

Exposed corneas were collected, and the gene expression profiles were compared, at day 1 at high dose and day 7 at low dose, to that in unexposed corneas. The observed molecular responses in the high dose group suggest a rapid initiation of wound healing/repair process within the cornea. This may be the result of micro-abrasion or epithelial debridement from lunar dust particle contact. The actin cytoskeleton signaling response in conjunction with induction of filopodia and membrane ruffles suggest cytoskeleton remodeling to form projection and filopodia that could be used towards phagocytosis and transport of dust particles. The observed response at day 7 focuses more on repopulation of the tissue, differentiation and development, and remodeling of the stromal extracellular matrix. We also see processes suggesting mobilization of neutrophils, apoptosis of stromal cells, change in corneal morphology, and epithelial to mesenchymal transitions. Finally, there is a limited response to oxidative damage within keratocytes. Additional studies are required to fully assess the risk of vision decrements and the responses initiated in the cornea exposed to lunar dust as well as the potential for long-term effects to astronaut health.