Microgravity-induced cephalic fluid shift and radiation exposure are some of the stressors seen in space exploration. Ocular changes leading to visual impairment in astronauts are of occupational health relevance. Therefore, we analyzed the effects of space flight in the eyes of mice. Six mice were assigned to Flight (FLT), Animal enclosure Module (AEM), or vivarium (VIV) group, respectively. Mice were sacrificed at 1, 5, or 7 days after landing from space. One eye was used for histological and immunohistochemistry analysis and the other eye for gene expression profiling. 8-OHdG and caspase-3 immunoactivity were increased in the retina in FLT samples at return (+7) compared to AEM/VIV groups, and decreased at day 7 (+7). β-amyloid was seen in the inner nuclear fibers at the posterior-laminar region of the optic nerve in the flight samples (+7). In addition, oxidative and cellular stress response genes were upregulated in the retina of FLT samples upon landing, and decreased by +7. According to the results, a reversible molecular damage may occur in the retina of mice exposed to spaceflight followed by protective cellular response.

MATERIALS & METHODS

Six female albino mice were assigned to a Flight (FLT) group flown on shuttle mission STS133, Animal Enclosure Module (AEM), and vivarium (VIV) ground controls. Both FLT and AEM ground control groups were kept at AEM/self-contained habitat that provides ventilation, waste management, food, water, and controlled lighting. Two mice of each group were sacrificed at 1, 5, and 7 days after the FLT group landed. One eye was fixed for histological sectioning and the contralateral eye was used for gene expression profiling by qPCR.

Histology and Immunohistochemistry:
Sections were analyzed by hematoxylin/eosin stain and processed for 8-hydroxy-2'-deoxyguanosine (8-OHdG), caspase-3, and double staining with β-amyloid fibril and glial fibrillary acidic protein (GFAP) and β-amyloid. Quantitative detection was done by grading immunostained slides from 0 to 3+. Quantitative detection of 8-OHdG and caspase 3 in the retina was done with NIH Image J software. Gene Expression Analysis: Mouse retina was microdissected and processed for a real-time qPCR analysis. Identified genes are in Table 1.

RESULTS

Histological Analysis. See Table 2 and Figure 1. Immunohistochemistry. See Figure 2.

Gene expression analysis. Gene expression of oxidative and cellular stress response genes was upregulated in the retina of FLT samples upon landing followed by lower levels by day 7 (Table 1).

Genes of interest evaluated for expression changes in the mouse retina. Grouping was done according to relevant cellular processes and complete gene name with gene symbol are provided, as well as references reporting possible relevant roles in retina physiology.

Histology. Data presented per group (+FLT, AEM, VIV) and day of sacrifice (1, 5, and 7). Two mice were studied at each time point. Retina and ON were morphologically normal in both groups.

REFERENCES


ACKNOWLEDGMENTS

This work was funded by the NASA Human Research Program.