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THE COENZYME Q10 (COQ10) AS COUNTERMEASURE FOR RETINAL DAMAGE ONBOARD THE INTERNATIONAL SPACE STATION: THE CORM PROJECT

Abstract

Purpose. Cells, tissues and organs of astronauts aboard the International Space Station (ISS) are exposed to the damaging effects of microgravity and cosmic radiation. Space Agencies are forced to find effective therapeutic countermeasures to safeguard astronauts' health. Eye, and especially the retina, is one of the most critical and sensitive districts of astronaut organism. Since effective prevention strategies have been scarcely investigated so far, we aimed to find pharmacological countermeasures within a project

named CORM (CoQ10, Radiation, Microgravity), exploiting onboard the ISS the antiapoptotic activity of the Coenzyme Q10 (CoQ10) that we formerly established on ground in corneal and retinal cells both in vitro and in vivo.

Methodology. The CORM project involved two experimental phases. The first was the demonstration of CoQ10 ability to counteract radiation- and simulated microgravity-induced alterations of the human retinal pigment epithelial ARPE-19 and ganglion RGC-5 cells. The second was the execution onboard the ISS of an experiment in the frame of VITA (Vitality, Innovation, Technology, Ability) mission. The experiment has been primed at the Kennedy Space Center (FL, USA) inside a specific hardware developed by Kayser Italia, launched to the ISS within the SpaceX-12 vehicle, integrated in the Kubik incubator of ESA and returned to the Earth with the same vehicle. ARPE-19 cells treated and not treated with CoQ10 have been exposed to the ISS environment for 72h.

Results. Experiments on ground revealed that CoQ10 prevents simulated microgravity-induced cytoskeleton's alterations and apoptosis in both RGC-5 and ARPE-19 cells, and reduces X-radiation-induced DNA damage as well as promotion of senescence in ARPE-19 cells. Experiment onboard the ISS revealed that while ISS environment does not cause evident apoptosis of ARPE-19 cells, it determines severe alterations of cytoskeleton and transcriptomic profile, highlighting its impact on cellular and molecular behavior. Moreover, CoQ10 treatment markedly reduced cytoskeletal alterations and induced a transcriptomic change, whose typology suggested a protective response.

Conclusions. Overall, the CORM project revealed that human retinal cells are damaged by radiation and microgravity in both simulated experimental conditions on ground and onboard the ISS, and qualified CoQ10 as effective countermeasure. The protective effect of CoQ10 may have a major impact also on the Earth to treat different human retinopathies characterized by deaths of apoptotic cells, ranging from glaucoma to age-related macular degeneration.

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