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Microgravity-induced metabolic response in 2D and 3D TCam-2 cell cultures†

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The past few decades have seen an increasing number of both space travels and studies aimed at investigating the effects induced by the space flights and environment on humans. One of the main feature of these conditions, is the presence of an altered gravity mostly represented by microgravity experienced by astronauts. Microgravity is well known to induce deleterious effects at cellular, organ and systemic levels, including alterations in the male and female reproductive systems.

In the present study, we investigated the effect of simulated microgravity on the metabolic activity of male germ cells using TCam-2 line as cell model. These cells were cultured in the Random Positioning Machine that simulated microgravity conditions, and were grown as 2D monolayers or 3D spheroids to assay the effects on single cells or on organ-like structure. After a 24 hour-exposure to simulated microgravity, TCam-2 monolayers showed: 1) a decreased proliferation rate and a delay in cell cycle progression; 2) increased anaerobic metabolism; 3) increased levels of reactive oxygen species and superoxide anion; 4) modifications in mitochondrial morphology. After the same 24 hour-exposure, TCam-2 spheroids showed: 1) an increased anaerobic and aerobic activity in 40% and 26% of samples, respectively; 2) alterations in the redox balance with a decrease in catalase activity in about 65% of cell samples, therefore a deficit in the cellular antioxidant capacity; 3) increases in oxidative damage to proteins and lipids in more than 50% of cell samples.

In conclusion, these data demonstrated a clear inference of simulated microgravity on the metabolic activity of TCam-2 cells, which is expressed through the activation of an oxidative stress state, that, if not compensated for, could result deleterious over time.

Keywords
TCam-2 cells, cellular spheroids, simulated microgravity, ROS, oxidative stress, cellular metabolism