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PARABOLIC MANEUVERS OF THE SWISS AIR FORCE FIGHTER JET NORTHROP F5-E AS A
NEW PLATFORM TO IDENTIFY RAPID GRAVI-RESPONSIVE MECHANISMS IN CULTURED
MAMMALIAN CELLS

Abstract

Long-term sensitivity of human cells to reduced gravity has been supposed since the first Apollo missions and was demonstrated during several space missions in the past. However, primary and rapid gravi-responsive elements in mammalian cells are unknown. In search of rapid-responsive molecular alterations in mammalian cells, short term microgravity provided by parabolic flight maneuvers is an ideal instrument to elucidate such initial and primary effects. Modern biomedical research at the cellular and molecular level requires frequent repeats of experiments, which are performed usually in sequences of experiments and analyses. Therefore, a research platform on Earth, which provides frequent, easy and repeated access to real microgravity for cell culture experiments is strongly desired, but is lacking so far. For this reason, we developed a research platform on board of the military fighter jet aircraft Northrop F-5E "Tiger" in collaboration with the Swiss Air Force, which consists of a programmable and automatically operated system of six separate experiment modules, which were placed in the front compartment and work completely independent from the aircraft systems. Signal transduction in cultured human cells can be activated by addition of an activator solution at the onset of microgravity and terminated after

termination of microgravity by addition of a fixative. Before the beginning of a regular military training flight, a parabolic maneuver will be executed. After a 1g control phase, the parabolic maneuver starts from 13000ft and Mach 0.99 airspeed, following a free-fall ballistic Keplerian trajectory lasting 45 seconds with an apogee of 27000ft and Mach 0.4 airspeed. Temperature, pressure and acceleration were monitored constantly during the entire flight. Cells and activator solutions are kept at 37C during the entire experiment, until the fixative has been added. The parabolic flight profile provides 45s of microgravity at a quality of $<0.05g$ in x- and y-axis and $<0.1g$ in z-axis. Access time is 30min before take-off, retrieval time is 10min after landing. Fixed cells arrive in the fully equipped laboratories at University of Zurich within 45min. Therefore we conclude that microgravity provided by parabolic maneuvers using military fighter jets are a suitable research platform for frequent and repeated cell culture experiments, which fulfil the requirements of state-of-the art biomedical research. Remark: The Swiss Air Force authorized to execute a single parabolic flight maneuver at the beginning of a maximum of 60 normal fighter training missions, on the condition that there is no restriction on the following mission.