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P-008 Microgravity exposure significantly decreases sperm motility and vitality. Can we consider human reproduction outside the Earth?

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Study question: Are fresh human sperm samples affected by different gravitational conditions than on Earth?

Summary answer: Motility and vitality of fresh human sperm samples are significantly decreased under microgravity conditions obtained by parabolic flight.

What is known already: Microgravity effects on the male reproductive system have mainly been studied in the animal model with diverse results and discouraging extrapolation in humans. While an increased motility was reported in bulls, mice models showed a decrease. Although preliminary data from the Micro-11 experiment presented by NASA reported human sperm alterations after microgravity exposure, our first study failed to show any significant effect of microgravity on “frozen” samples, suggesting that human sperm could be safely shipped outside the earth if important aspects related with cryopreservation were solved.

Study design, size, duration: Prospective study carried out in collaboration between the ART centre, a Technical University, and an Aviation Club specializing in parabolic flights. Two parabolic flights were conducted between 2020-2021, each consisting of 20 parabolic maneuvers, which means 160 seconds of microgravity exposure per sample. Fifteen sperm samples obtained from healthy men were included in the study in order to analyse the effects of microgravity and compare the results with those obtained in Earth gravity.

Participants/materials, setting, methods: Fresh sperm samples were checked pre-flight to evaluate vitality, concentration, motility and morphology. Samples were split into two to compare the effects of different gravity exposure: microgravity (flight) and Earth gravity (ground). After the flight, the same analysis were repeated, plus kinematics, DNA fragmentation by sperm chromatin dispersion, apoptosis by magnetic activated cell sorting, and oxidative stress by colorimetric test (Halosperm-Halotech). Computer Aided Semen Analysis (SCA-Scope) was used for cell counting.

Main results and the role of chance: On comparison of the mean values between fresh samples exposed to microgravity and those maintained on Earth gravity, statistical significant differences ($p < 0,05$) were found in the following parameters: vitality ($69,7 \pm 9,9$ vs $72,4 \pm 9,7$ %), motile sperm concentration ($23,7 \pm 15,3$ M/ml vs $31,5 \pm 25,1$ M/ml), grade “a” sperm concentration ($8,7 \pm 6,5$ vs $11,7 \pm 9,9$ M/ml), percentage of spermatozoa with progressive motility ($30 \pm 12,9$ vs $36 \pm 14,3$ %), curvilinear motility-VCL ($45,7 \pm 12,8$ vs $47,7 \pm 13,3$ $\mu\text{m/s}$). Under the study conditions, non-statistically significant differences were observed in the other kinematic parameters: Lineal Velocity (VSL), Average Path Velocity (VAP), Straightness (STR), Amplitude of Lateral Head displacement (ALH), Linearity (LIN),

Wobble (WOB), Beat-Cross Frequency (BCF), total sperm concentration ($81,7 \pm 112,1$ vs $79,7 \pm 89,8$ M/ml), morphology ($11,3 \pm 6,3$ vs $10,6 \pm 5,3$ %), DNA fragmentation ($14,6 \pm 9,6$ vs $15,7 \pm 9,4$), apoptosis ($2,8 \pm 2,8$ vs $3,8 \pm 4,4$) and oxidative stress, since all samples maintained the same stress level in both splits.

Limitations, reasons for caution: Parabolic flight is an accepted ground-based method for obtaining microgravity conditions, but provides a short period of elapsed exposure to microgravity. Therefore, the results obtained need to be confirmed by using other platforms that provide a much longer time of exposure. More cases must be analysed to confirm the results.

Wider implications of the findings: Short exposure to microgravity significantly decreases sperm motility and vitality. Such an effect is likely to be stronger with longer exposure. These findings should be taken into account since this may eventually affect sperm fertilizing capacity and therefore natural conception or ART with fresh/frozen sperm, outside of the Earth.

Trial registration number: NCT03760783