Cephalad fluid shifting and cerebral venous congestion in microgravity may be key factors in causing VIIP. SPACECOT (NCT02493985) is a randomized, blinded crossover design study using combined -12° HDT and 0.5% CO₂ and with brief exposure to 3% CO₂. We report intracranial blood volume changes using a novel non invasive technology, VIPS.

**BACKGROUND**

- Up to 70% of US astronauts are reported to have variable ocular and cerebral VIIP manifestations.¹
- CO₂, a potent intracranial vasodilator is reported to average at levels of 0.45% in ISS atmosphere. ²
- Combined effects of HDT and 0.5 % CO₂ can be complementary in VIIP causality.
- Microgravity induced air pocketing can create microenvironments with enriched CO₂ and short duration exposures can enhance VIIP pathophysiology.

**VIPS**

- VIPS (Cerebrotech Medical Systems Inc, Pleasanton, CA) analyzes the phase-shifts in low energy radio waves transmitted through a medium.²-⁴(Fig 1.)
- Due to variable biotraceability, different fluid compartments in the skull (i.e. brain parenchyma, CSF and blood) induce specific signal changes.

**OBJECTIVES**

1. To assess intracranial blood volume changes induced by 12 degree HDT
2. To assess combined influence of HDT and 0.5% CO₂ exposure on intracranial blood volume.
3. To assess the effect of acute 3% CO₂ induced intracranial blood volume changes

**METHODS**

- The study was conducted at enviHah, DLR, Cologne, Germany, approved by Baylor College of Medicine IRB and the ethics board at DLR.
- 6 healthy volunteers underwent 21±2 hours of exposure to - 12° HDT with or without 0.5% CO₂ in two campaigns separated by a week of washout period.
- At the end of each campaign, the subjects underwent a short term 3% CO₂ exposure for 1 hour
- VIPS measurements were obtained at baseline, 2, 5, and 22±2 hours after initiation of HDT and at the end of an hour of 3% CO₂ exposure (Fig 2)
- Paired t-tests with multiple adjusted comparisons, and ANOVA tests were used to compare means of changes in the intracranial volumes in different atmospheres, time points and for order effects.

**RESULTS**

- Six healthy male volunteers completed the study protocol successfully.
- Fifty nine of the 60 data points were collected. One reading was lost due to machine error.
- There was no change in the intracranial blood volume with HDT in either atmospheres (p=0.659)
- 3% CO₂ induced a 5.7% increase in intracranial blood volume when compared to measurements taken 1 hour post HDT in subjects under different atmospheres (p=0.022: 95% CI: 5.7-7.0%)
- 3% CO₂ induced increase in the intracranial blood volume was blunted when subjects were exposed to 0.5% CO₂ apriori when using 1 hour post HDT as the baseline(4.9% when breathing ambient air apriori as compared to 3.1% with 0.5% CO₂: p=0.659)
- However when measured to supine baseline, the blunted increase in the intracranial blood volumes by 3% CO₂ did not reach statistical significance.

**CONCLUSION**

- HDT induces a reduction in the intracranial blood volume which may be likely related to cerebral autoregulation and diuresis due to body posture.
- Pre-exposure to 0.5% CO₂ demonstrated a blunted response to 3% CO₂ induced increased intracranial volume which could be related to a primed adaptive mechanism.
- Further analyses and studies are warranted to establish our findings.

**References**


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