Effects of Head Down Tilt on Internal Jugular Vein Volume: Preliminary Results from the SPACE-COT Study.

Brian Stevens, BS[1], Chethan Venkatasubba Rao, MD[1], Jose I. Suarez, MD[1], Eusebia Calvillo, RN[1], Philippe Arbeille, MD, PhD[2], Haleh Sangi-Haghpeykar, PhD[1], and Eric M. Bershad, MD[1] on behalf of the SPACE-COT INVESTIGATORS

[1]Baylor College of Medicine, One Baylor Plaza, NB125, Houston, Texas, 77030, [2] University of Tours, Tours, France.

BACKGROUND

The VIIP Syndrome is thought to be related to cephalad fluid shifts and cerebral venous congestion due to the loss of the hydrostatic pressure gradient in in microgravity.

The internal jugular (IJ) veins are the main venous drainage pathway in the supine and head down tilt (HDT) positions, and are an important determinant of intracranial pressure (ICP).

Using ultrasonography, we evaluated the immediate and short-term effects of HDT on IJ volumes in healthy subjects.

The effects of 0.5% carbon dioxide exposure on IJ volumes at 12º HDT was also examined.

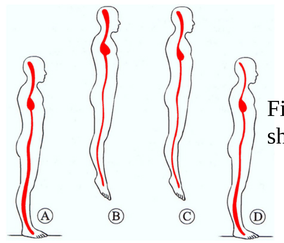


Fig.1. Cephalad fluid shifting in micro gravity

Ultrasonography

•Ultrasound imaging offers a fast, clinically safe method for collecting IJ vein images

•Using a technique developed by Professor Philippe Arbeille, France, to determine venous volume.

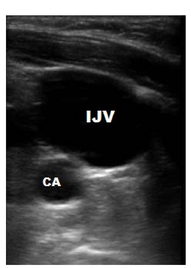


Fig.2. Sonosite M-Turbo

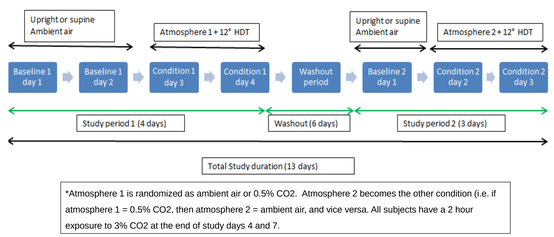
OBJECTIVES

1. Determine the immediate effects of various HDT angles on IJ volume in healthy subjects .
2. Determine the effects of prolonged 12º HDT and 0.5% CO_2 on IJ volumes.

METHODS

•The study was approved by Baylor College of Medicine IRB and the Ethics Committee of the Medical Council of North Rhine, Germany and conducted at the German Aerospace Center (DLR) in Cologne, Germany.

•Two campaigns were conducted for each subject. Each campaign consisted of a 24 hour baseline, ambient air period followed by 26 hours at 12º HDT +/- 0.5% CO_2 atmosphere.



•At baseline, Right IJ volume was measured 6 times, from supine to -30º HDT (in -6º increments) on an automated tilt table.

•The Right IJ volumes were also measured after 26 hours at 12º HDT.

•Right IJ was chosen, due to general dominance over the Left IJ (68% of population being dominant)[1], and time constraints of the study.

•IJ vein volume was calculated by measuring the cross sectional area (CSA) of the right IJ at 4 equal intervals from the supraclavicular to submandibular region of the right lateral neck.

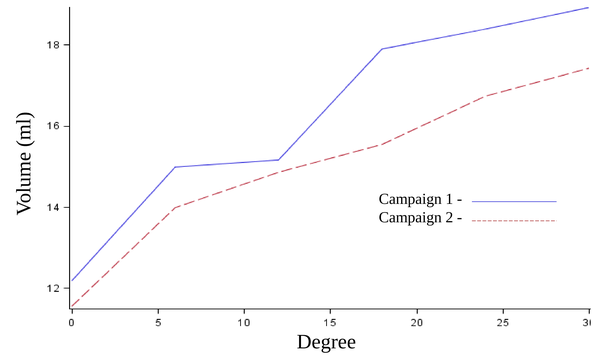


Fig 3. Change in IJ Volume with increasing HDT

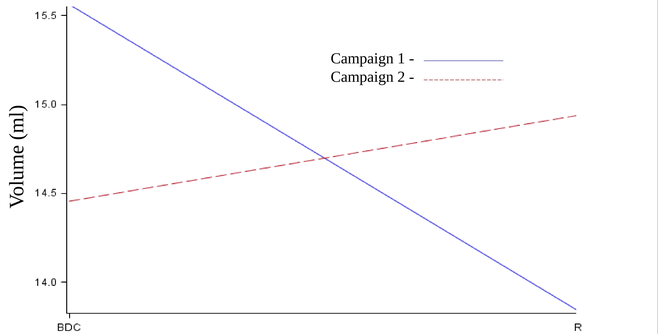


Fig 4. Change in IJ Volume in 12º HDT from Baseline to post bed rest by atmosphere

RESULTS

•Study included 6 healthy male, adult subjects (Median age 41 years)

•A total of 84 ultrasound sessions were performed with complete data and were analyzed.

•IJ volume increased with tilt angles, with significant increases from 0 HDT to 6º HDT (p = 0.006) (Fig 3).

•There is no significant difference between 26 hours 12º HDT in ambient or 0.5% CO_2 atmospheres (p = .11) (Fig 4).

•The four CSA intervals of the IJ vein increases with each tilt angle.

- CSA is highest at interval 1 (supraclavicular) and lowest at interval 4 (submandibular) across all angles (Fig 5).

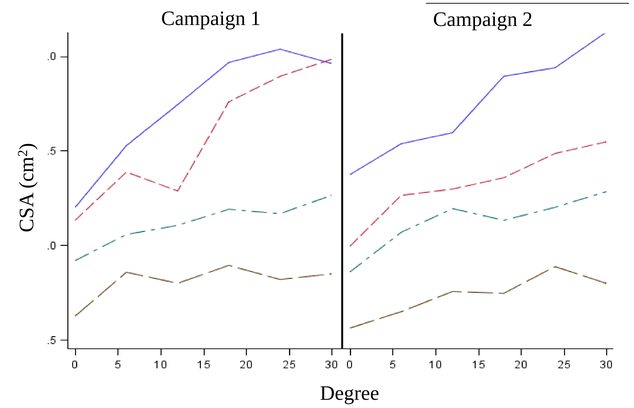


Fig 5. CSA and various IJ intervals with increasing HDT

CONCLUSION

•IJ vein volumes incrementally increased with steeper HDT angles (0 to -30º) during pre-bed rest tilt table testing.

•IJ volumes trended downward after 26 hours of 12º HDT in the presence of CO_2 (p = .09) compared to ambient air (p = .58).

- No significant difference between atmospheres on the change in IJ volume after 26 hours (p = .11)

•IJ interval 1 (supraclavicular) offers the biggest changes in IJ volume and is a stable, repeatable point for measurement between subjects

•Baseline IJ volumes were slightly higher during campaign 1 vs campaign 2 (p = 0.02).

- This is possibly related to bed rest induced plasma volume loss during campaign 1 that carried over to campaign 2.

•The relationship between these findings and ICP changes in -12º HDT needs further evaluation.

***Disclosure**: This study was funded by the National Space Biomedical Research Institute and the Baylor College of Medicine Center for Space Medicine*

References

1. Lichtenstein, D., et al. Intensive Care Med. 2001 Jan; 27(1): 301-5.