

Post Suborbital Flight Orthostatic Intolerance: A possible health concern

J.M. Serrador¹

¹War Related Illness & Injury Study Center, VA NJ Health Care System, East Orange, NJ & Dept of Neurology, Harvard Medical School, Boston, MA

Introduction

Post spaceflight orthostatic intolerance, the inability to remain upright without becoming light headed or dizzy, is a common problem among returning astronauts even following short duration flights of 5 days. While the mechanism underlying this problem remains unclear we have recently shown that the vestibular system may be involved. Rapid vestibular adaptations to changing G states may affect the brain blood flow response and thus result in the development of orthostatic intolerance. The advent of suborbital flights represents a new paradigm that may also produce the conditions necessary to cause orthostatic intolerance since passengers will experience both hyper- and microgravity during flights. Our previous research suggests this is an area that needs further study.

Hypergravity Induced Changes in Brain Blood Flow Regulation

We have previously examined the role of 30 min of exposure to either +3 G_Z or G_X on the brain blood flow and blood pressure response to the upright position post centrifugation.(3) We found that centrifugation resulted in changes in brain blood flow regulation that were correlated with vestibular ocular reflexes during centrifugation. Thus, the vestibular activation associated with adaptation to hypergravity also produced changes in the brain blood flow response. These data highlight that exposure to hypergravity could result in changes in brain blood flow regulation that could precipitate intolerance to the upright posture. However, subjects in this study were exposed to fairly long hypergravity exposure and thus shorter exposures may not produce the same effects.

Post Parabolic Flight Orthostatic Intolerance

Parabolic flight provides the opportunity to expose individuals to both hyper- and hypogravity over very short (~25-45 sec) periods. To examine the effect of short exposures we flew 16 novice flyers and examined their response to an upright tilt test both pre and post parabolic flight(2). We found that while all 16 subjects were able to complete a 30 min tilt table test preflight, 8 of the subjects developed orthostatic intolerance post parabolic flight. Those that developed orthostatic intolerance also demonstrated greater drops in brain blood flow as well as brain blood flow regulation problems. These data highlight that even short duration exposure to hyper- and hypogravity can produce post flight orthostatic intolerance.

Role of Vestibular Loss in Brain Blood Flow Regulation

Based on our previous research that highlighted a possible role for the vestibular system in brain blood flow changes following altered gravity exposures, we began work examining the role of the vestibular system in brain blood flow regulation. We were able to demonstrate in healthy subjects that activation of the vestibular system resulted in changes in brain blood flow (1). We also found that if we screened subjects for vestibular function, that those with impaired vestibular function demonstrated greater drops in brain blood flow when upright. This work highlights that changes in vestibular function may underlie the development of post flight orthostatic intolerance.

Summary and Future Directions

Our work highlights that exposure to both hyper- and hypogravity can result in changes in brain blood flow that can produce orthostatic intolerance. Since the next generation of suborbital flights will expose passengers to both hyper- and hypogravity, the possibility that orthostatic intolerance may develop post flight should be considered. Future work is needed to determine if the gravity profiles experienced during these flights is sufficient to cause vestibular adaptations that may affect brain blood flow and cause orthostatic intolerance.

Acknowledgements

I would like to thank Drs. Wood, Schlegel, Bondar, Shoemaker and Black who all contributed extensively to this work. In addition I would like to thank Dr. Gopalakrishnan, Mr. Baker, Ms. Divine for their assistance in data collection. Supported by NASA and NIH.

References

- 1.Serrador J, Schlegel T, Black FO, and Wood S. Vestibular effects on cerebral blood flow. *BMC Neuroscience* 10: 119, 2009.
- 2.Serrador JM, Shoemaker JK, Brown TE, Kassam MS, Bondar RL, and Schlegel TT. Cerebral vasoconstriction precedes orthostatic intolerance after parabolic flight. *Brain Res Bull* 53: 113-120, 2000.
- 3.Serrador JM, Wood SJ, Picot PA, Stein F, Kassam MS, Bondar RL, Rupert AH, and Schlegel TT. Effect of acute exposure to hypergravity (GX vs. GZ) on dynamic cerebral autoregulation. *J Appl Physiol* 91: 1986-1994., 2001.