EFFECT OF LOWER BODY NEGATIVE PRESSURE ON OCULAR PERFUSION PRESSURE

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INTRODUCTION: Lower body negative pressure (LBNP) has been proposed as a method to mitigate the cephalad fluid shifts during spaceflight associated with the development of Space Flight Associated Neuro-ocular Syndrome (SANS). This study aims to quantify the effect of LBNP on intraocular pressure (IOP), mean arterial pressure at eye level (MAP_{eye}), and ocular perfusion pressure (OPP).

METHODS: Twenty-four subjects (12M/12F) were subjected to graded LBNP in 0° supine and 15° head down tilt (HDT) postures from 0 mmHg to –50 mmHg, in 10 mmHg increments. IOP and MAP_{eye} were measured at each condition and OPP calculated as MAP_{eye} – IOP. Dose-response models quantifying the effects of pressure, sex, and posture were constructed over the range of LBNP considered using linear mixed models.

RESULTS: Between 0 and –50 mmHg of LBNP, OPP significantly increased in 15° HDT from 70.5 ± 3.1 mmHg to 75.5 ± 3.1 mmHg ($p = 0.010$) but showed no significant change in 0° supine ($p = 0.539$). MAP_{eye} significantly decreased from 89.1 ± 2.6 mmHg to 84.2 ± 2.7 mmHg in 0° supine ($p = 0.016$) but remained constant in 15° HDT.

IOP decreased significantly from 22.8 ± 0.9 mmHg to 17.5 ± 0.9 mmHg (i.e., 1.0 ± 0.095 mmHg per 10 mmHg LBNP) in 15° HDT ($p < 0.001$). IOP also decreased from 19.1 ± 0.75 mmHg to 15.4 ± 0.76 mmHg (i.e., 0.7 ± 0.09 mmHg per 10 mmHg LBNP) in 0° supine ($p < 0.001$).

Sex did not have a significant effect on OPP, IOP, or MAP_{eye}. Tilt angle was found to have a significant impact on OPP ($p < 0.001$), MAP_{eye} ($p < 0.001$), and IOP ($p < 0.001$).

DISCUSSION: The reduction in IOP during increasing LBNP led to the increase in OPP in 15° HDT. Six of the twelve females did not complete the protocol in either 0° supine or 15° HDT conditions past the –30 to –40 mmHg pressure level. Only one male subject was unable to complete the full protocol (at 0° supine). The etiology behind this sex disparity should be well understood prior to long duration space missions. Future work should also seek to understand the relationship between OPP and SANS, and the impact of LBNP on these ocular responses as part of countermeasure development.

LEARNING OBJECTIVES:

1. The audience will learn about the effect of lower body negative pressure on ocular perfusion pressure, mean arterial pressure at eye level, and intraocular pressure.
2. The audience will learn about sex differences observed in ocular perfusion pressure, mean arterial pressure at eye level, and intraocular pressure during lower body negative pressure

QUESTIONS

Question 1: In head down tilt (HDT) with LBNP increasing from 0 to -50 mmHg pressure, ocular perfusion pressure (OPP) decreases. True or False?

Answer: False, OPP was found to increase.

Question 2: The observed sex differences included which of the following?

A) Differences in OPP between males and females in 0°
B) Differences in MAP_{eye} between males and females in HDT
C) Differences in IOP between males and females in HDT
D) No significant differences

Answer: D, there were no significant differences between sexes found in any measure studied.

Question 3: LBNP was found to be effective at reducing intraocular pressure (IOP) in both HDT and 0° postures. True or False?

Answer: True, IOP decreased in both head down tilt and 0° supine postures with increasing levels of negative pressure.