MAPPING BY VESGEN OF BLOOD VESSELS IN THE RETINAS OF ISS CREW MEMBERS AND BED REST SUBJECTS FOR INCREASED UNDERSTANDING OF VIIP

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INTRODUCTION AND BACKGROUND

Research by NASA [1] has established that significant risks for visual impairment in association with increased intracranial pressure (VIIP) are incurred by microgravity spaceflight, especially long-duration missions. Impairments include decreased near visual acuity, posterior globe flattening, choroidal folds, optic disc edema, and cotton wool spots. Much remains to be learned about the etiology of VIIP before effective countermeasures can be developed. Contributions of retinal vascular remodeling to the etiology of VIIP have not yet been investigated, primarily due to the current lack of ophthalmic tools for precisely measuring progressive pathophysiological remodeling of the retinal microvasculature. Although ophthalmic science and clinical practice are now highly sophisticated at detecting indirect, secondary signs of vascular remodeling such as cotton wool spots that arise during the progression of retinal vascular diseases, methods for quantifying direct, primary vascular changes are not yet established. To help develop insightful analysis of retinal vascular remodeling for aerospace medicine, we will map and quantify by our innovative VESsel GENeration Analysis (VESGEN) software [2,3] the remodeling status of retinal blood vessels in crew members before and after ISS missions, and in healthy human subjects before and after head-down tilt bed rest. For this proof-of-concept study, we hypothesize that pathophysiological remodeling of retinal blood vessels occurs in coordination with microgravity-induced fluid shifts prior to development of visual impairments. VESGEN analysis in previous research supported by the US National Institutes of Health identified surprising new opportunities to regenerate retinal vessels during early-stage progression of the visually impairing, potentially blinding disease, diabetic retinopathy [2].

METHODS

Our project is supported by a 2013 NASA NRA award. For our retrospective study of Spectralis® infrared (IR) images, retinal blood vessels will be mapped and quantified using VESGEN (patent pending), a mature, beta-level software developed as a translational and basic research discovery tool for biomedical vascular applications [3, 4], particularly for retinal vascular disease [2, 3]. The VESGEN results will subsequently be correlated with other ophthalmic imaging by Spectralis® OCT and medical findings. Study subjects include 1) ISS crew members monitored for routine occupational surveillance pre- and post-flight, and 2) healthy human subjects enrolled in NASA bed rest studies.

CONCLUSION

Modified retinal vascular patterning may offer early-stage predictions of future ophthalmological changes resulting in decreased visual acuity. Novel insights provided by VESGEN into progressively pathological and blinding vascular remodeling in the human retina currently help to guide other NIH- and NASA-supported therapeutic development for retinal disease and modeling of the VIIP risk.

REFERENCES

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