MAPPING BY VESGEN OF BLOOD VESSELS IN THE HUMAN RETINA UNDERGOING BED REST FOR INCREASED UNDERSTANDING OF VIIP

P. A. Parsons-Wingerter[1], G. Vizzeri[2], G. Taibbi[2], S. B. Zanello[3], and R. Ploutz-Snyder[3]
[1]John Glenn Research Center, NASA, Cleveland OH, patricia.a.parsons-wingerter@nasa.gov, [2]Department of Ophthalmology and Visual Sciences, University of Texas Medical Branch, Galveston TX, and [3]Universities Space Research Association, NASA Johnson Space Center, Houston TX.

INTRODUCTION AND BACKGROUND

Research by NASA [1] has recently established that significant risks for visual impairment in association with increased intracranial pressure (VIIP) are incurred by microgravity spaceflight, especially by long-duration missions. Impairments include posterior globe flattening, choroidal folds, optic disc edema, cotton wool spots and decreased near visual acuity. 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 healthy human subjects undergoing the flight analog of head-down tilt during bed rest. We hypothesize that pathophysiological remodeling of retinal blood vessels occurs in coordination with microgravity-induced fluid shifts prior to development of visual impairments. We will first test our hypothesis using head-down tilt bed rest as a proof-of-concept study. 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 new 2013 NASA NRA award. The study will be conducted by a straightforward add-on protocol that will now include the Spectralis® autofluorescence (AF) and infrared (IR) imaging modalities in addition to ophthalmic clinical imaging by Spectralis® OCT as previously conducted for NASA bed rest studies. Retinal blood vessels from the AF and IR images will be mapped and quantified using VESGEN (patent pending), a mature, beta-level software developed at NASA as a translational and basic research discovery tool for biomedical vascular applications [3, 4], particularly for retinal vascular disease [2, 3].

CONCLUSION

Modified retinal vascular patterning may provide early warning 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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