Proposed VESGEN Read-Out of Retinal Vascular Alterations Associated with Increased Intracranial Pressure following Microgravity Space Flight

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ABSTRACT

Recently, adverse retinal changes have been discovered as a probable consequence of microgravity space flight, and human bed rest studies have been generally suspended. Although ophthalmic science and practice is now highly sophisticated at the diagnosis of indirect, secondary vascular changes manifested during the progress of retinal vascular disease, direct, primary vascular changes have not been analyzed, understood or properly diagnosed. To develop useful, insightful analysis of retinal vascular remodeling for astronaut applications, we first mapped and quantified progression of diabetic retinopathy (DR), a major blinding retinal vascular disease, using our innovative VESsel GENeration (VESGEN) Analysis software. Thirty vascular maps of branching arterial and venous trees were extracted from 15 eyes visualized by ophthalmic patient clinical photographs, for automatic mapping and quantification by VESGEN. Surprisingly, the fractal-based density of smaller retinal vessels oscillated up to 2.6x during four successive disease stages (\textit{IOVS} 51(1):498, 2010). VESGEN results contradict the current scientific and medical paradigm that DR progresses as a two-step process, in which the initial ischemia-driven, nonproliferative vascular dropout is followed by late-stage, potentially blinding proliferative angiogenesis (i.e., neovascularization; angiogenesis is defined as the growth of new blood vessels). Oscillation between angiogenesis and vascular dropout offers a new scientific and medical treatment paradigm with significantly greater potential for early-stage, regenerative treatment of astronauts, DR and other microvascular disorders. Following our first successful clinical investigation, retinal vascular alternations in response to microgravity and human bed rest studies should now be analyzed by the innovative VESGEN protocol as soon as possible, to evaluate for signs of vascular change, ischemia, and retinal damage. This new knowledge will provide a basis for developing successful bioastronautic countermeasures.

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