Theme: Imaging Research in Basic and Clinical Science: Neuroscience, Cardiology and Oncology

Human retinal crosstalk: physiological evidence from vascular adaptation

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Abstract:
This work aims to find physiological evidence of retinal crosstalk in humans from retinal neurovascular coupling (NVC) responses induced by photic stimulation. Although animal studies have documented such interocular communication, physiological proof in humans is still lacking.
Fundus images (4x4 degrees) of the macular region (3 baseline acquisitions, 3 acquisitions following contralateral stimulation, 3 baseline, and 3 acquisitions following ipsilateral stimulation) of 32 healthy controls (age m(sd): 32.7(10.5) yrs.) and 20 type 1 diabetes mellitus (T1DM) patients (age m(sd): 35.0(12.3) yrs.) without diabetic retinopathy, gender and imaged eye balanced by group, were acquired using an adaptive optics fundus camera coupled with an external photic stimulator. Contralateral and ipsilateral retinal responses were recorded following a 15 Hz flicker for 20 seconds. Images were manually segmented by an experienced technician, and the NVC responses were determined using the average lumen diameter within a vessel segment. Overall, after using a set of selection criteria, 31.2% of the healthy controls showed a positive contralateral response, compared to only 15% of T1DM patients, while 6.2% of controls and 20% of T1DM patients exhibited a negative contralateral response. The contrasting response patterns between groups suggest that the crosstalk mechanism may be impaired by underlying metabolic conditions. Moreover, for the healthy control group, both ipsilateral and contralateral responses differed significantly from baseline measurements ($p=0.027$ and $p<0.001$, respectively), indicating robust responses.
Our findings provide the first evidence of an active neurovascular communication mechanism between human retinas. This retinal NVC reflex may ultimately serve as a novel biomarker for early diagnosis and disease progression monitoring of neurological disorders linked to vascular dysregulation, such as Alzheimer's disease and diabetes.

Keywords: Neurovascular coupling, retinal imaging, adaptive optics, retinal crosstalk, contralateral response