

# Gaze strategy and balance in patients with varying degrees of glaucomatous visual field damage

**Authors:** Aleksandra Mihailovic<sup>1</sup>, David S. Friedman<sup>1</sup>, Sheila K. West<sup>1</sup>, Pradeep Y. Ramulu<sup>1</sup>

<sup>1</sup>Glaucoma Center for Excellence, Johns Hopkins University/Wilmer Eye Institute, Baltimore, Maryland, United States;

**Purpose:** More severe visual field (VF) damage is associated with worse balance in glaucoma patients. Here we investigate how balance changes between different gaze strategies across the spectrum of VF damage.

**Methods:** The OPAL kinematic system (APDM, Inc., Portland, OR) was used to measure balance (root mean square (RMS) sway) while having participants stand on a foam pad. Visual targets were positioned 2 meters from the patient's eyes, either at eye-level or on the ground, and viewed under the following head-gaze conditions: head neutral-gaze forward (HNGF), head neutral-gaze down (HNGD), and head flexed-gaze down (HFGD). Balance was also tested with eyes closed (EC) under head neutral (HNEC) or head flexed (HFEC) conditions. Mean sensitivities of the total, inferior, and superior point-wise integrated visual fields (IVF) were used as measures of glaucoma damage. Regression models were constructed in which RMS sway for each head-gaze condition, or differences in RMS sway between head-gaze conditions, were considered as the dependent variables and IVF sensitivity of the entire field (total IVF), superior IVF, or inferior IVF were included as the primary independent variables. Models controlled for age, race, gender, comorbidities and polypharmacy when appropriate.

**Results:** Data from 195 participants were used in this analysis. Worse balance was noted during eyes closed conditions (HNEC and HFEC) as compared to the analogous eyes open conditions (HNGF and HFGD respectively,  $p < 0.001$  for both). Optimal balance was noted during gaze down conditions, with HFGD balance significantly better than HNGF balance ( $p = 0.006$ ). Neither regional nor overall VF sensitivity was associated with balance during eyes closed conditions. In separate models, worse overall, inferior, and superior VF sensitivities were associated with worse balance for all 3 eyes open conditions ( $p < 0.05$  for all). Superiority of HFGD balance as compared to HNGF balance was less pronounced in patients with greater superior damage ( $p = 0.04$ ), but not in patients with greater overall or inferior damage ( $p > 0.1$  for both).

**Conclusions:** Glaucoma patients demonstrate better balance during gaze down as opposed to gaze forward condition, though this advantage is diminished in persons with greater levels of superior VF damage. Determining if gaze modification could enhance safety and prevent falls in glaucoma patients is worthy of additional study.