

Quantitative Measurement of Retinal Structures Relative to the Geometric Axis of the Eye

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Purpose: While the concept of the Geometric Axis of the eye is well known, the precise relationship of retinal structures to it is loosely defined because it does not have anatomical significance. We have developed a method for quantifying the position of the axis' retinal intersection (the Geometric Pole) when the eye is orientated in a specific alignment condition. The goal of this study was to collect normative anatomic data pertaining to the relationship between the optic disc, the Geometric Pole of the eye, and the fovea. This enables targeting the spatial location of the fovea using only imaging of anterior eye features.

Methods: Evaluation of the retina was performed using a customized Canon CR-45 UAF non-mydratic fundus camera with a low-power laser beacon and anterior imaging system added collinear with the fundus imaging axis. Optical coherence tomography (Cirrus HD-OCT) was used to obtain a fundus image for registration and analysis of retinal features. When a subject's eye is oriented such that the reflection of the laser beacon and the center of the limbus boundary both occur at the system axis as seen in the anterior eye view, the laser beacon position in the fundus image defines the Geometric Axis intersection at the retina pole. Video data of the anterior and posterior eye was simultaneously recorded and then selected frames were extracted for offline processing.

Results: A total of 48 eyes were measured from both healthy and low vision subjects. Analysis of the limbus centers relative to the system center from anterior eye images confirmed the alignment condition for the corresponding frames selected for retinal processing. Analysis of these Canon fundus images registered to the Cirrus SLO images shows that the average distance of optic disc-to-fovea is 4.31 mm (SD 0.31 mm), distance from Pole-to-fovea is 1.29 mm (SD 0.23mm), and distance from Pole-to-optic disc is 3.19 mm (SD 0.36). Relative to the Geometric Pole, the average fovea is offset temporally by 1.15 mm and inferiorly by 0.56 mm.

Conclusions: The Geometric Axis, as defined by a customized device and unique eye alignment method, was used as a reference from which specific retinal structures can be located. Using only anterior imaging of the eye, the fovea and optic disc can be targeted in space within a certain positional tolerance by using the normative data from this study and the axial length of the eye, a standard ophthalmic measurement.