Axial Length Probably Does Not Change with Shift in Gaze

Using a low coherence optical biometer, Ghosh A et al.[1] measured the axial length of the eye during gaze in each of the cardinal positions compared with the primary position. The authors find that the axial length increases approximately 10 microns in inferior, inferonasal, and superonasal and decreases approximately the same magnitude in superior and superotemporal gaze at the zero minute timepoint. For these measurements, the subjects maintain bilateral fusion of a Maltese cross while the axial length of the left eye was measured. The authors concluded the "axial length observed changes appear to be due to the influence of the extraocular muscles with change in gaze direction, since the effect was eliminated when head turn was used instead of eye turn, to shift the direction of gaze."

There is an alternate explanation for the authors' findings. The eye does not rotate around a central point. The eye translates during extraocular movements.[2,3] The magnitude of these translational eye movements is greater while gazing off the horizontal meridian.[2,3] These translational movements are not identical for both eyes. Since Panum's fusional area permits rapid fusion of objects that are disparate by 2° or more, it is highly unlikely that both eyes of the subject maintained the same alignment when gazing above and below the horizontal meridian.[4] This misalignment of the subjects' eyes can account for the authors' findings.

For example, a fusional disparity of 1.65° during inferior gaze would permit the subject to still fuse the Maltese cross. However, this magnitude of disparity can result in an off-axis measurement with an apparent increase in axial length of 10 microns.

$$\frac{24.457\ \text{mm}}{\cos(1.65^{\circ})} - 24.457\ \text{mm} = 10\ \text{microns}$$

In addition, considering the location of the insertions of the extraocular muscles, the directions of their force vectors, and the fact that the eye is surrounded by soft orbital fat, it is not clear from a mechanical point of view how the extraocular muscles can produce an increase in axial length in superonasal gaze and a decrease in superior and superotemporal gaze. The authors' findings are most consistent with a methodological error of off-axis measurement of axial length due to the subjects' fixation disparity between the eyes.

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