Three-Dimensional Magnetic Imaging of the Phakic Crystalline Lens During Accommodation

Using a two-dimensional (2-D) magnetic resonance imaging (MRI) paradigm, Sheppard et al.\(^1\) generated a complete three-dimensional (3-D) crystalline lens surface model from data obtained from 19 subjects. Twenty-four oblique axial slices of 0.8-mm thickness were used to image each whole human crystalline lens, at baseline and during 4 and 8 D of accommodative demand. Mean scan duration was 5 minutes 18 seconds. To generate a smooth 3-D representation of the lens, the authors used a smoothing process on the pooled data. (They do not provide the data from each of the subjects).

The authors concluded that the equatorial diameter and surface area of the lens decreased while the volume of the lens increased. To evaluate these conclusions, and based on the limited data provided, I tabulated the means and standard deviations of the surface area, volume, and equatorial diameter of the lenses at each of the two levels of accommodative demand (Table 1).

The standard deviations are 1.2 to 16 times larger than their associated means. With such large standard deviations in each of the accommodative demand groups, the statistical inferences are questionable. No change, an increase, or a decrease is just as likely in any of these parameters.

There are many possibilities that may explain the variability and/or poor precision of the authors’ measurements:

1. The changes in these parameters may be below the resolution of the authors’ MRI technique.
2. The authors’ editing of some regions of the lens surface to effect a complete characterization of the lens may have contributed.
3. The smoothing process used may have caused a change in lenticular shape not actually associated with accommodation.
4. Lack of masking of the data by the analysis team may have introduced the potential for bias.
5. The image distortion that occurs with 3-D MRI: The image distortion is readily seen in the authors’ computer-generated model of the lens (Fig. 1, a reproduction of the authors’ Fig. 2).

6. Fixed and unchanging positional references for alignment and registration were absent.

The authors failed to incorporate proper 2- and 3-D MRI image registration techniques,\(^9,10\) a basic requisite for measuring the small displacement dimensional changes that occur during accommodation.\(^7–11\) Since the movements of the eye during accommodation, cyclotorsion, and convergence are not random, statistical methods do not reduce the basic requirement for image registration.

Because of high variability, the validity of the authors’ observations is in doubt. Conclusions about the mechanism of accommodation are not possible from the results presented.

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References


Table 1. Mean Change in Selected Lens Parameters for Each of the Accommodative Demand Groups

<table>
<thead>
<tr>
<th>Parameter</th>
<th>0.17–4 D</th>
<th>4–8 D</th>
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<tbody>
<tr>
<td>Surface area, mm(^2)</td>
<td>-4.75 ± 13.3*</td>
<td>0.69 ± 3.27</td>
</tr>
<tr>
<td>Volume, mm(^3)</td>
<td>-4.75 ± 12.0†</td>
<td>9.44 ± 22.8†</td>
</tr>
<tr>
<td>Equatorial diameter, mm</td>
<td>-0.54 ± 0.65†</td>
<td>-0.040 ± 0.64†</td>
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Data represent the mean change in the parameter ± SD.

* Extrapolated from Figure 5 in Sheppard et al.\(^1\)
† Calculated from equations given in Sheppard et al.\(^1\) for the mean change in volume and equatorial diameter.


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