Supplementary Material

Anterior chamber depth measurement error (OCT)

The Optical Coherence Tomography device measures optical path length \( (OPL) \) through the anterior chamber. The OPL is related to the physical anterior chamber depth \( (ACD) \) by the group refractive index of aqueous humor (1.342 at 830 nm):

\[
OPL = 1.342 \times ACD
\]

When the anterior chamber is refilled with an Ophthalmic Viscoelastic Device (OVD), the ACD remains the same, but the OPL is now related to the ACD by the group refractive index of the OVD used \( (n_v) \):

\[
OPL = n_{OVD} \times ACD
\]

However, the on-board biometry software still converts the OPL to ACD using the known group refractive index of aqueous humor, resulting in the measured ACD value, \( acd \), to be:

\[
acd = \frac{OPL}{1.342} = n_{OVD} \times \frac{ACD}{1.342}
\]

Therefore, we find that the error in measurement of the ACD, \( \Delta ACD \), caused by the change in group refractive index of the anterior chamber is:

\[
\Delta ACD = acd - ACD = \left( \frac{n_{OVD}}{1.342} - 1 \right) \times ACD
\]

For our calculations, we assumed an anterior chamber depth (ACD) of 3.1 mm according to the Gullstrand Model\(^{18} \). The error between real and reported anterior chamber depth is (in mm):

\[
\Delta ACD = \left( \frac{n_{OVD}}{1.342} - 1 \right) \times 3.1
\]
Femtosecond laser beam focus error

The focusing error of the FS-laser is determined by calculating the conjugate of the anterior capsule through the anterior chamber, cornea and external media. Then, the position of the image of this conjugate created by the cornea when the anterior chamber is filled with OVD is calculated. The error in beam focus position (ΔFS) is the difference between the anterior capsule position and the altered focus position.

First, we consider cornea as a thin lens in a focusing system (Figure A1), where the laser is being focused onto the anterior capsule, a distance FS away from the cornea in the image space. We find the position of the conjugate of the capsule, s, through the anterior chamber (filled with aqueous humor of group refractive index 1.336 at 1040 nm), cornea and external media by using the conjugation formula:

\[
\frac{1.336}{FS} = \frac{n}{s} + K
\]

Where \( K \) represents the power of the cornea and \( n \) represents the refractive index of the external media. We then determine where the image, \( f_s \), of this conjugate through the external media, cornea and anterior chamber is located when the anterior chamber is refilled with OVD (\( n_{OVD} \)). Again, we use the conjugation formula:

\[
\frac{n_{OVD}}{f_s} = k + \frac{n}{s}
\]

Where \( k \) represents the corneal power when the anterior chamber is refilled with OVD. Combining the two equations, we obtain:

\[
f_s = \frac{n_{OVD}}{k - K + \frac{1.336}{FS}}
\]
In the thin-lens paraxial approximation, corneal power is a function of anterior and posterior surface powers ($K_1$ and $K_2$, respectively)

$$K = K_1 + K_2$$

In the refilled case, the anterior corneal power does not change, but the posterior corneal power ($k_2$) changes due to the change in refractive index of the anterior chamber:

$$k = K_1 + k_2$$

Subtracting $k - K$, and using the above expression for $fs$, our error, $\Delta FS$, then becomes:

$$\Delta FS = fs - FS = \frac{n_{OVD}}{(k_2 - K_2) + \frac{1.336}{FS}} - FS$$

We express $K_2$ and $k_2$ in terms of the posterior radius of curvature (6.8 mm), set $FS$ equal to the anterior chamber depth (3.1 mm), the equation becomes:

$$\Delta FS = \frac{n_{OVD}}{1.336 - \frac{1.336}{FS} + \frac{3.1}{6.8}} - 3.1$$

**Lateral Magnification Error**

A change in refractive index of the anterior chamber also affects the diameter of the FS-laser cut. The change in the cut diameter can be estimated by calculating the change in magnification. Using the same assumptions and notation as for the calculation of the change in focus, the magnification, $M_{AQ}$, of the cornea with the anterior chamber filled with aqueous humor is:

$$M_{AQ} = \frac{n \cdot FS}{n_{AQ} \cdot s}$$
The magnification, $M_{OVD}$, of the cornea with the anterior chamber filled with OVD is:

$$M_{OVD} = \frac{n \cdot f_s}{n_{OVD} \cdot s}$$

The ratio of the two magnifications is also the ratio of the cut diameters with the anterior chamber refilled with aqueous, $D_{AQ}$ and with OVD, $D_{OVD}$. Combining both equations yields:

$$\frac{D_{OVD}}{D_{AQ}} = \frac{M_{OVD}}{M_{AQ}} = \frac{n_{AQ} \cdot f_s}{n_{OVD} \cdot F_s}$$

Combining with the equation for $\Delta F_s$ above, we find

$$\frac{D_{OVD}}{D_{AQ}} = \frac{1.336}{\frac{(n_{OVD} - 1.336) + 1.336}{6.8} + \frac{1.336}{3.1}}$$
Supplementary Figure S1. Diagram of the error in femtosecond laser beam focus position. Top shows the natural anterior chamber. Bottom shows the refilled anterior chamber.