The short and the long eye issues. IPC course

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This talk

- The accuracy of conventional formulas breaks down in the short and the long eyes
- Why?
- How to improve the accuracy

Financial disclosure

Thomas Olsen MD

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  (www.PhacoOptics.com)
- Consultant to Haag-Streit AG

The short eye

- All dimensions small, every measurement error counts more!
- A small error in the ELP has a larger impact on the refraction!
The laser can measured the axial length with surprising accuracy.

Biometry is no longer a significant source of error!

Axial length by Ultrasound: $\pm 0.20$ mm
Laser interferometry: $\pm 0.02$ mm

The effect of axial length error

<table>
<thead>
<tr>
<th>Axial length (mm)</th>
<th>Rx error / mm axial length error</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>5.0</td>
</tr>
<tr>
<td>21</td>
<td>4.0</td>
</tr>
<tr>
<td>23</td>
<td>3.5</td>
</tr>
<tr>
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<td>27</td>
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<tr>
<td>29</td>
<td>2.0</td>
</tr>
<tr>
<td>31</td>
<td>1.5</td>
</tr>
</tbody>
</table>


The effect of ELP error

Sources of error in IOL power calculation (ideal)

- ELP
- Axial length
- K-reading
- Other
**Title**: C constant: New concept for ray tracing-assisted intraocular lens power calculation

**Authors**: Thomas Olsen, MD, PhD, Peter Hoffmann, MD

**Journal**: JCRS 2014; 40: 764-773

**Abstract**

**PURPOSE**: To evaluate the accuracy of the C constant for ray tracing-assisted intraocular lens (IOL) power calculation.

**DESIGN**: Case series.

**SETTING**: Public university hospital and private clinic.

**METHODS**: Thirty-three eyes were studied. The study compared the Haag-Streit® Lenstar laser biometry to other biometry formulas, including the Holladay 2, HOLO, and SRK/T formulas. Outcome measures were the absolute error, the average absolute error, and the absolute error between the measured refraction and the predicted refraction.

**RESULTS**: The C constant was significantly higher than the other biometry formulas. All biometry formulas showed a significant bias in terms of the anterior chamber depth (ACD) measurement and anterior segment length (ASL).

**CONCLUSION**: The C constant is a promising concept for ray tracing-assisted IOL power calculation.

**Images**

- **IOL position in the bag**: Chart showing IOL position with data points for various depths and axial lengths.
- **Haag-Streit® Lenstar laser biometry**: Image showing the laser biometry tool and its use in determining IOL position.
C-constant prediction of IOL position

Right / left symmetry

Right / left symmetry
The **C-constant** defines the position of the IOL as a fraction of capsular bag thickness!

\[
\text{IOL}_{K\text{-reading}} = \text{ACD} + \text{C}_{\text{IOL}} \times \text{LT}
\]

- The **C-constant** defines the IOL position in terms of the crystalline lens anatomy.
- Not dependent on the K-reading nor the axial length.

**Results – Olsen formula**

*Routine cases*

- The mean absolute error (MAE) was reduced by 14% as compared to optimum performance of the SRK/T formula.
- The number of errors > ± 1 D was reduced up to 85% as compared to the SRK/T.

**Formula comparison**

- Olsen & Hoffmann, JCRS 2014; 40: 764-773
**C-constant vs axial length**

![C-constant vs IOL type graph](image1)

**C-constant K-reading**

![C-constant and IOL type graph](image2)

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**Short eye study < 22 mm**

**German series, n = 100**

**Optimized dataset - comparing**

- Holladay II
- Hoffer Q
- Okulix (Preussner)
- PhacoOptics (Olsen)

* Source: Dr. med. Peter Hoffmann, Castrop-Rauxel, Germany
Short eye study < 22 mm
German series, n = 100

Long eye study
100 eyes > 26 mm *

Holladay I + II
Hoffer Q
Haigis
Barret Universal
Okulix (Preussner)
PhacoOptics (Olsen)

*) Source: Dr. med. Peter Hoffmann, Castrop-Rauxel, Germany

The corneal power!

- In a long eye, the effect of the IOL power is minimal. Hence you cannot optimize the IOL power calculation by adjusting the ELP.
- In an eye with zero IOL power, any error in the corneal power will translate into a constant prediction error.
Let's take a fresh look on corneal power.

Corneal power – what kind of melon is it?

\[
K = \frac{n - 1}{r}
\]

- \( n = 1.3375 \) (wrong!)
- \( n = 1.3315 \) (better!)

\[
D_{12} = D_1 + D_2 - d \cdot D_1 \cdot D_2
\]

Pentacam© mapped elevation data

Zemax© *) import of Pentacam data for exact ray tracing of the cornea

*Zemax LLC, Redmond, WA, USA
Zemax© exact ray tracing analysis of the cornea

- Effective corneal focal length - effect of pupil size

Corneal power by ray tracing - Customized setup
The ‘K-reading’ based on the assumed index of 1.3375 (most keratometers) is 1 D higher than the true power of the cornea!

All formulas based on the ‘K-reading’ will have a hyperopic error in eyes with a low IOL power (i.e. long eyes)