Impact of illuminance on Distance Visual Acuity in Pseudophakic eyes with Monofocal versus EDOF IOLs

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Purpose - Methods

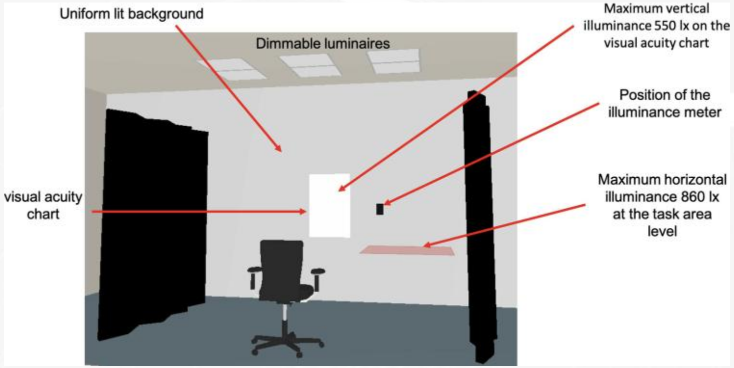
Purpose

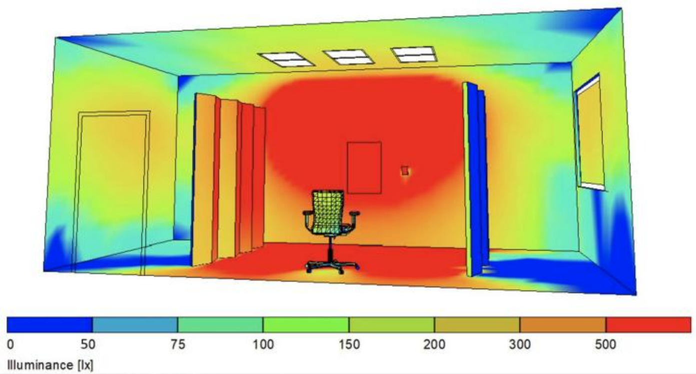
- To introduce a contemporary methodology for updating lighting standards addressing pseudophakic patients implanted with monofocal and extended depth-of-focus (EDOF) intraocular lenses (IOLs).

Methods

- An experimental facility at the University Hospital of Alexandroupolis was constructed for the sake of this study.
- In a hospital room with flat white surface walls, an advanced light diffusion system was installed, which secured maximal uniformity at different user-defined lighting settings. LED luminaires were mounted on the ceiling.
- The maximum light output of the luminaires on a visual acuity Landolt C chart was 550 ± 15 lx.

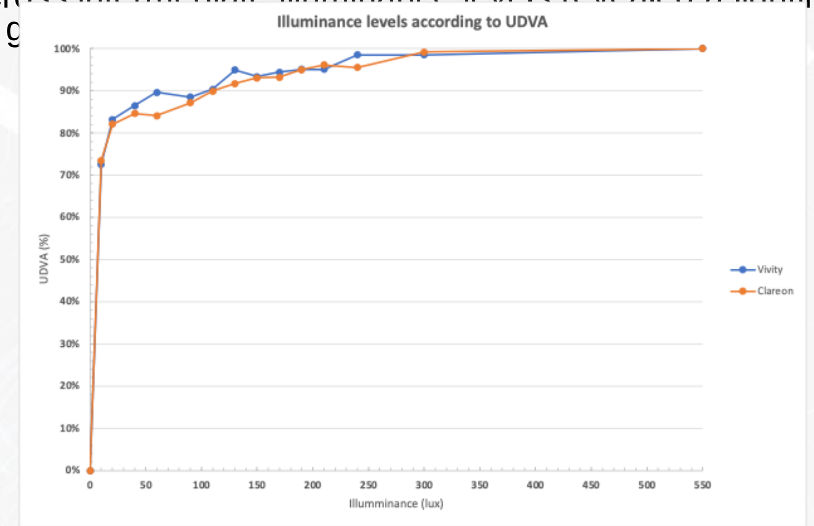
- In a study group of patients implanted with the **EDOF IOL Vivity (SG)** and in a control group of patients implanted with the **monofocal IOL Clareon (CG)** uncorrected distance visual acuity (UDVA) was measured at illuminance of 550 lx (**optimal UDVA**).
- Landolt ring charts at a 4-meter distance were used to estimate UDVA at different vertical illuminance levels in the following consistent way:
  - Following dark adaptation, the illuminance was randomly increased gradually from 10 lx to 550 lx or decreased gradually from 550 lx to 10 lx.
  - The illuminance steps were **10 lx, 20 lx, 40 lx, 60 lx, 90 lx, 110 lx, 130 lx, 150 lx, 170 lx, 190 lx, 210 lx, 240 lx, 300 lx, 550 lx**, without a resting period for the patient among them.
  - Different *Landolt ring charts* were used in order to avoid memory effect.





Results

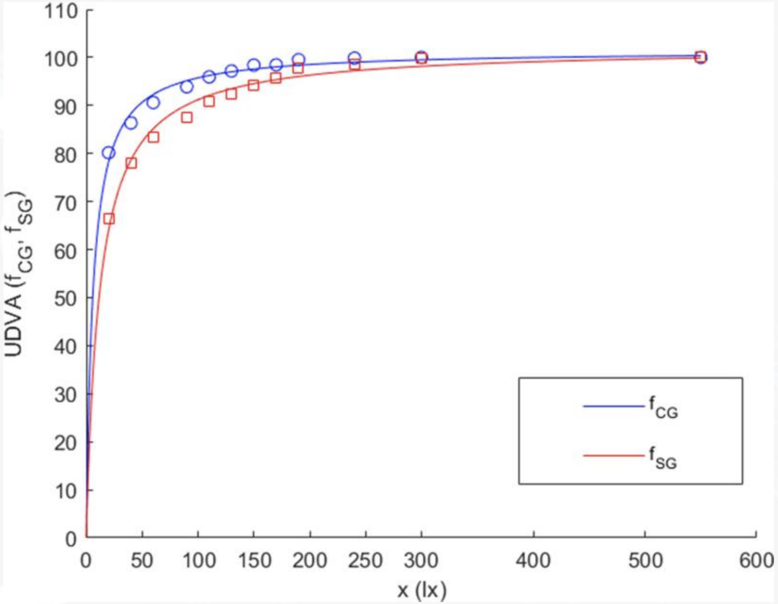
- A total of 20 eyes were included in the study (*preliminary results*)
  - 10 had undergone xEDOF IOL implantation, and (study group – SG)
  - 10 had undergone monofocal IOL implantation (control group – CG)
- In both groups, UDVA was significantly higher at an illuminance of 550 lx compared to 10 lx (CG: $p < 0.001$, SG: $p = 0.0018$). Specifically, in 10 lux, SG (Vivity IOL) reached 72.60 ± 8.93 % of their optimal UDVA (-20.6 letters), while SG (Clareon IOL) reached 73.52 ± 3.00 % of their optimal UDVA (-18.6 letters).
- No significant difference was observed between SG and CG groups for each illuminance level (10 to 550 lx) ($p > 0.05$). However, preliminary results revealed some superiority in UDVA in SG for 60, 130, and 240 lx in comparison to CG.
- Analysis of UDVA across intermediate illuminance levels revealed a lighting-dependent visual performance in both g



Discussion

- A former study (*Labiris et al. Clin Ophthalm. 2021*):
  - evaluated whether current lighting standards address the needs both of pseudophakic and normophakic patients by exploring **the impact of illuminance on visual acuity**
  - introduced a new lighting benefit metric, **the intraocular lens luminous efficiency function $V_{IOL}(\lambda)$**, which addresses lighting needs of both pseudophakic and normophakic patients
  - calculated the **$V_{Panoptix}(\lambda)$**, which addresses the specific *lighting needs* of patients who have been implanted with the prevalent *Panoptix IOL.*
  - suggested that *Panoptix eyes (SG) required* ***76.34% more light illuminance*** *for equal percentile UDVA with the normophakic eyes at the illuminance level of 20 lx*. The difference in lighting needs between pseudophakic and normophakic eyes was gradually reduced until the level of **190 lx**, when **Panoptix** eyes reached their **optimal UDVA**
- The present study revealed a lighting-dependent visual performance in both EDOF and monofocal IOL groups.
- Preliminary results revealed slightly superior UDVA in the SG compared with the CG at 60, 130, and 240 lx. This finding is expected to be confirmed upon completion of the study, if it persists in the final analysis.
- Furthermore, upon completion of the study, two specific mathematical formulas **$V_{Vivity}(\lambda)$** and **$V_{Clareon}(\lambda)$**, with the corresponding coefficients *k* and *λ* is expected to be derived for both the Vivity and Clareon IOLs.
- Finally, upon completion of the study, the **Minimum Required Illuminance Level (MRIL)** for each IOL is also expected to be determined, representing *the minimum illuminance level at which each group reaches its optimal UDVA.*

Labiris et al. Clin Ophthalm. 2021



CG: control group (with crystalline lens)
SG: study group (with Panoptix intraocular lens)

$$f_{CG} = \frac{a_{CG}x}{k_{CG}+x}\ ,\ f_{SG} = \frac{a_{SG}x}{k_{SG}+x}$$

where: $f_{CG} = \frac{UDVA_{CGactual}}{UDVA_{CGoptimal}}$, $f_{SG} = \frac{UDVA_{SGactual}}{UDVA_{SGoptimal}}$

$UDVA_{actual}$ = UDVA for each illuminance level,

$UDVA_{optimal}$ = UDVA at 550 lx,

x = illuminance (in lx),

a_{CG} = 1.0146, k_{CG} = 5.9612, and a_{SG} = 1.0205 k_{SG} = 11.9105.

Conclusions

- The present study revealed a lighting-dependent visual performance in both EDOF and monofocal IOL groups.

- The proposed methodology highlights the impact of IOL optical design on visual performance under varying lighting conditions, supporting the need to adapt lighting standards to IOL technology.