Evaluation of the dysfunctional lens syndrome with Scheimpflug imaging and ray tracing wavefront analysis

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Dysfunctional Lens Syndrome (DLS)

- Concept "popularized" by George O. Waring IV in 2013
- Degenerative and progressive changes before ("true") cataract
    - Presbyopia
    - Internal High-order Aberrations
    - Lens opacities (++ nuclear)
    - +/- narrow angles
- Patient education
- Surgical planning

- Lens opacities
- Presbyopia
- Higher order aberrations
- Stage:
    - I - presbyopia, HOA
    - II - advancing presbyopia and HOA, early opacity
    - III - visually significant opacity affecting ADLs
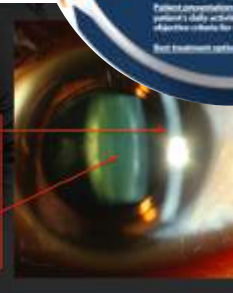
DLS – "Gather pieces together"

Presbyopia: The First Stage of Nuclear Cataract?

S.J. McGinty   R.J.W. Truscott

Ophthalmic Res 2006;38:137–148

Major protein oxidation and coloration are the hallmarks of Age-Related Nuclear (ARN) cataract. We postulate that the onset of the barrier, and the hardening of the nucleus, are intimately linked. Specifically, we propose that progressive age-dependent hardening of the lens nucleus may be responsible for both presbyopia and ARN cataract.

Crystalline Lens Optical Dysfunction through Aging

Jorge L. Alió, MD, PhD,[1,2] Patricia Schimchak, MD,[1] Herminio P. Negri, MD,[1] Robert Montés-Micó, OD, MPhil[1]

Ophthalmology 2005;112:2022–2029

Conclusion: There is a degradation of the optical quality of the crystalline lens with aging that is associated with morphological changes (thickness and density). These results are important for the consideration of lens replacement in the absence of evident cataract.

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ORIGINAL ARTICLE

Comparison of Dysfunctional Lens Index and Scheimpflug Lens Densitometry in the Evaluation of Age-Related Nuclear Cataracts

Fernando Faria-Correia, MD; Isaac Ramos, MD; Bernardo Lopes, MD; Tiago Monteiro, MD; Nuno Franqueira, MD; Renato Ambrósio, Jr., MD, PhD

[J Refract Surg. 2016;32(4):244-248.]

To describe the Dysfunctional Lens Index (DLI) from ray-tracing aberrometry and to test its relationship with corrected distance visual acuity (CDVA) and lens grading based on the LOCS III and the Scheimpflug-based lens density.
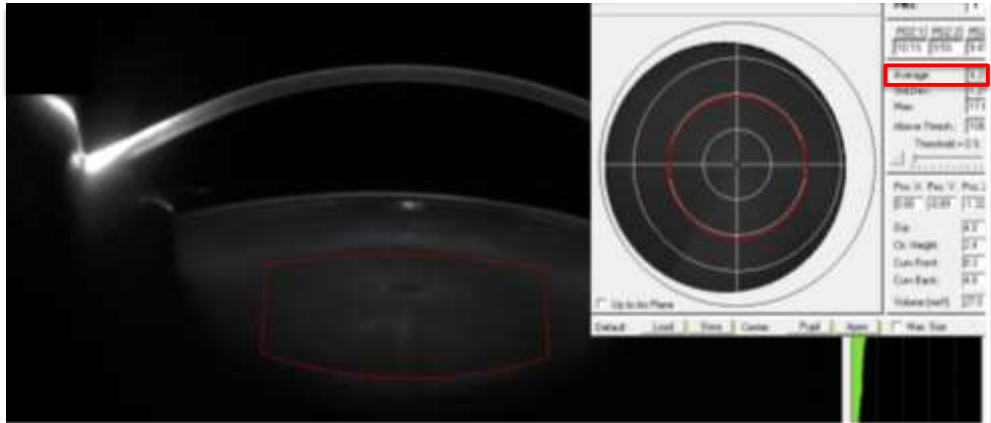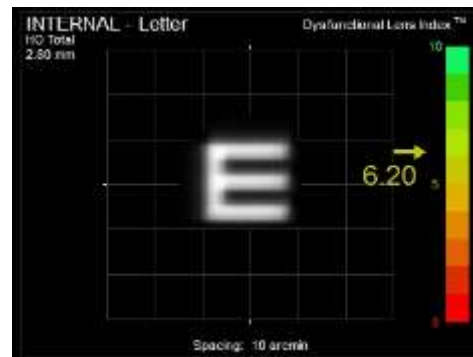
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2

Pentacam Nuclear Staging (PNS) software allows objective quantification of lens opacities inside of a **cylindrical** template:

- **average density** parameter (**continuous** scale from 0 to 100 %).

Dysfunctional Lens Index (DLI):

- **objective crystalline lens performance parameter**;
- calculated based on the internal HOAs, pupil size and contrast sensitivity data;
- ranks overall lens performance from **0 (very poor) to 10 (excellent) points**.

RESULTS:

- **Forty eyes** of 30 patients with mild to moderate age-related nuclear cataract were included retrospectively.
- Mean age was 67.53 ± 10.70 years (range: 46 to 90 years)
- Mean CDVA in logMAR units was 0.15 ± 0.13 (range: 0 to 0.4).

- LOCS III NO grade:
    - 4 eyes with grade 1
    - 5 eyes with grade 1.5
    - 15 eyes with grade 2
    - 10 eyes with grade 2.5
    - 6 eyes with grade 3

Table 1. Cataract evaluation by the different methods.

Parameter	Range	Mean ± SD
LOCS III NO score	1.0 – 3.0	2.13 ± 0.56
Average Density (based on Scheimpflug system)	7.1 – 11.0	8.21 ± 0.80
DLI (based on ray-tracing system)	2.01 – 10.0	7.54 ± 2.56

LOCS III NO = Lens Opacities Classification System III Nuclear Opalescence

DLI = Dysfunctional Lens Index

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RESULTS:

- **DLI** showed a high negative linear correlation with the LOCS III nuclear opalescence score (r = -0.616, P < .01).
- **Average nuclear density** was positively correlated with the LOCS III nuclear opalescence score (r = 0.697, P < .01).
- Scheimpflug-based average density parameter was negatively correlated with the DLI (r = -0.555; both P < .01).

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r = 0.610   r = 0.630   r = -0.702

- **CDVA** was correlated with the LOCS III nuclear opalescence score (*r* = 0.610; both *P* < .01) and with the average density values (*r* = 0.630; both *P* < .01).
- CDVA had a stronger relationship with the **DLI** parameter (r = -0.702, P < .01).
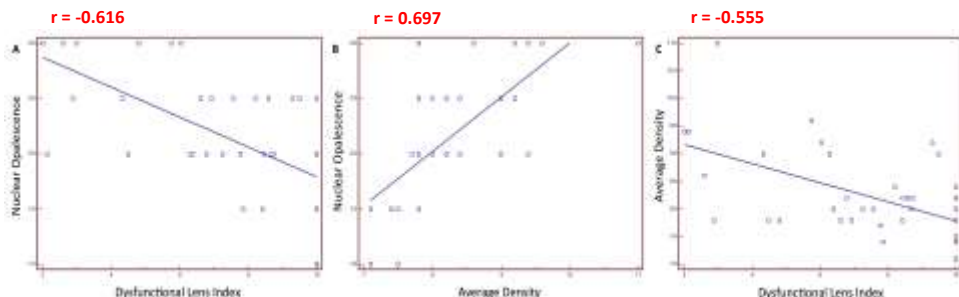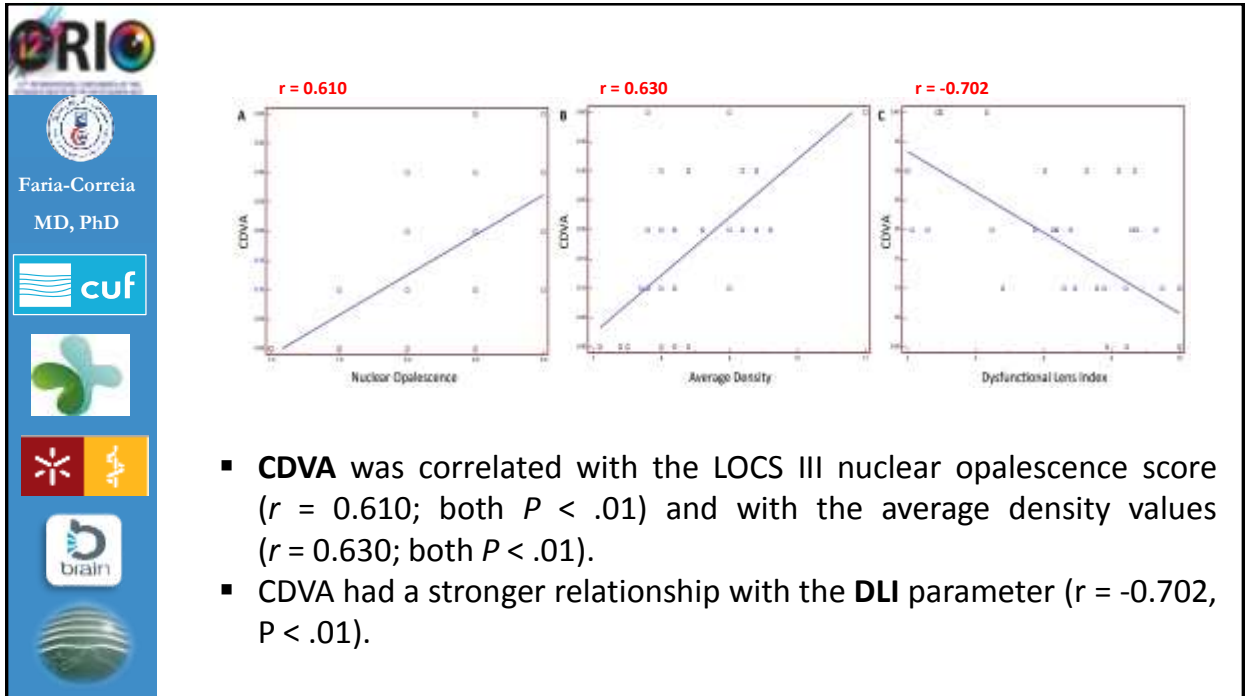
ORIGINAL ARTICLE

Correlations of Objective Metrics for Quantifying Dysfunctional Lens Syndrome With Visual Acuity and Phacodynamics

Fernando Faria-Correia, MD; Isaac Ramos, MD; Bernardo Lopes, MD; Tiago Monteiro, MD; Nuno Franqueira, MD; Renato Ambrósio, Jr., MD, PhD

[J Refract Surg. 2017;33(2):79-83.]

To analyze the relationship between objective metrics for quantifying crystalline lens dysfunction with visual impairment and phacodynamics parameters in patients with age-related nuclear cataract.

RESULTS:

- **Fifty-one eyes** of 34 patients (20 women and 14 men) with with age-related nuclear cataract were submitted to phacoemulsification were included retrospectively.
- Mean age: 70.77±9.19 years (52 – 90)
- Mean BCVA: 0.24±0.16 LogMAR (0 – 0.7)

- LOCS III NO grade:
  - 6 eyes with grade 1
  - 7 eyes with grade 2
  - 6 eyes with grade 3
  - 5 eyes with grade 4
  - 3 eyes with grade 5
  - 7 eyes with grade 1.5
  - 6 eyes with grade 2.5
  - 8 eyes with grade 3.5
  - 3 eyes with grade 4.5

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Pentacam Nuclear Staging (PNS) software allows objective quantification of lens opacities inside of a **cylindrical** template:
- **average density** parameter (**continuous** scale from 0 to 100 %).
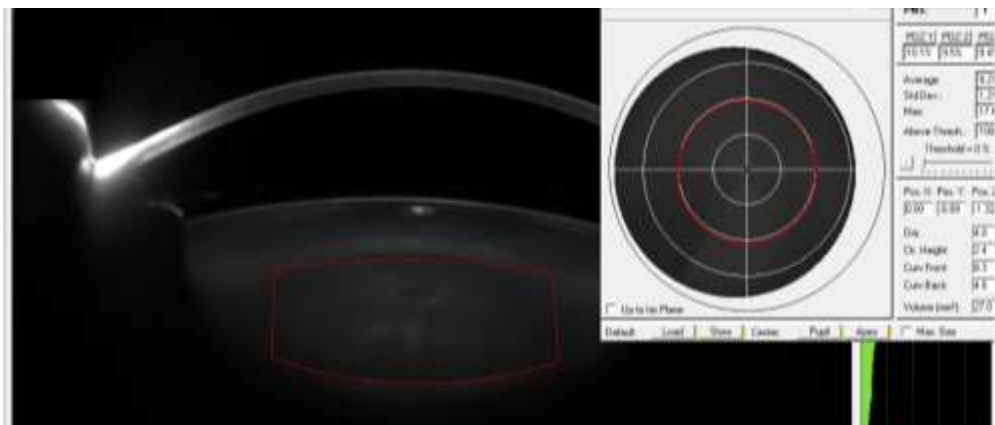
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- Dysfunctional Lens Index (DLI) ranks overall lens performance from **0 (very poor) to 10 (excellent) points**.

- **Cumulative dissipated energy (CDE)** was recorded after uneventful cataract surgery (stop-chop technique).

RESULTS:

Table 1. Cataract evaluation by the different methods.

Parameter	Range	Mean ± SD
LOCS III NO score	1.0 – 5.0	2.75 ± 1.19
Average Density (based on Scheimpflug system)	6.3 – 11.0	8.22 ± 1.16
DLI (based on ray-tracing system)	1.20 – 10.0	5.93 ± 2.49

LOCS III NO = Lens Opacities Classification System III Nuclear Opalescence

DLI = Dysfunctional Lens Index

- **DLI** showed a high negative linear correlation with the LOCS III nuclear opalescence score (r = -0.728, P < .01).
- **Average nuclear density** was positively correlated with the LOCS III nuclear opalescence score (r = 0.680, P < .01).
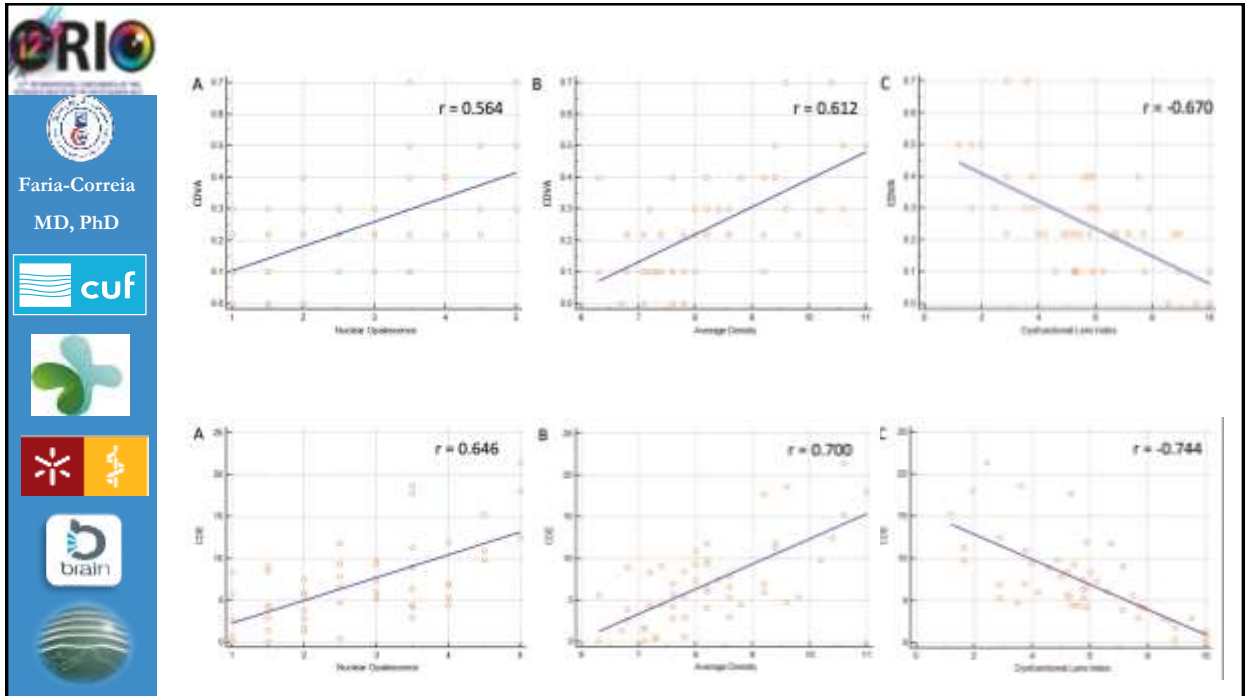
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- There is a correlation between the DLI and the Scheimpflug densitometry

- The Scheimpflug densitometry and the DLI were correlated with objective clinical data.

Scheimpflug imaging can be used as an objective tool to assess nuclear cataracts, as well as for deducing the functional state of the crystalline lens.

- Both objective metrics were useful to predict phacodynamics in eyes with age-related nuclear cataracts.

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Thank you for your attention!

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