Monochromatic optical aberrations in Myopic and Astigmatic Anisometropia.

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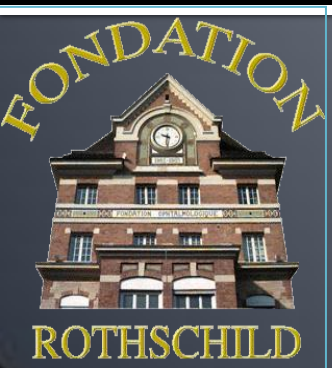
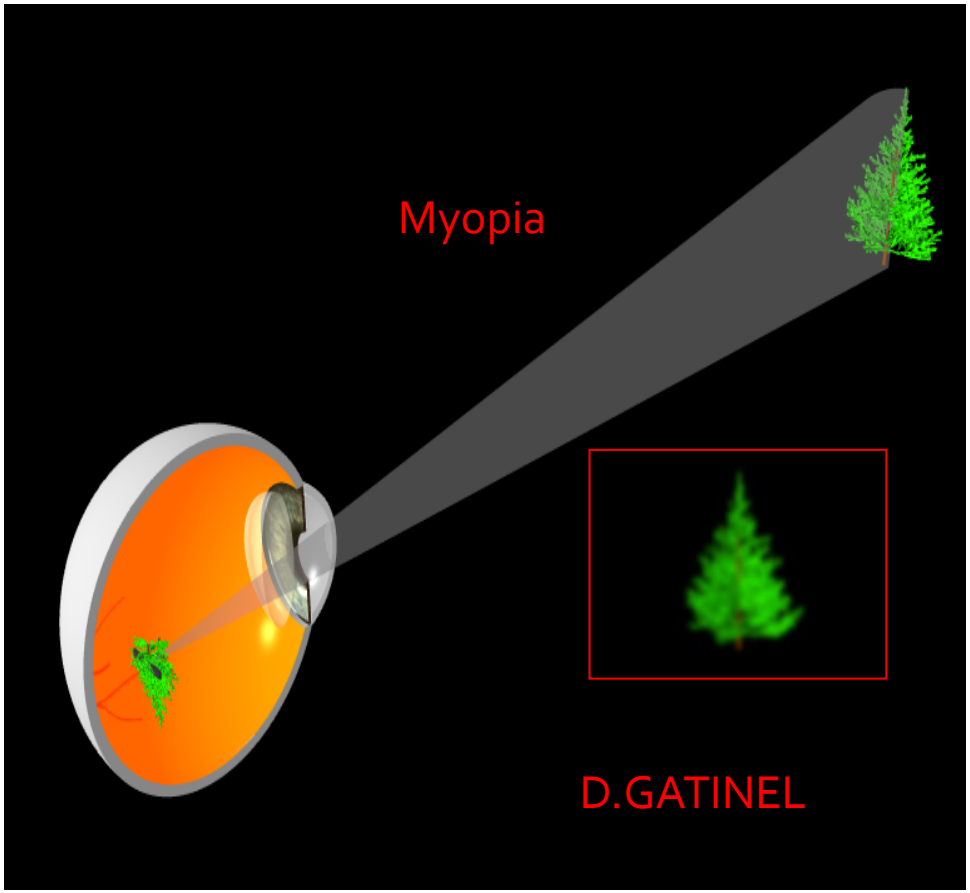


Introduction

- The development and progression of myopia are multifactorial.
- Myopia might develop as a result of a highly aberrated, blurred axial retinal image or as a result of relative peripheral hyperopia, ➔ ↑ Axial length➔myopia?
- Controversial relationship between myopia and optical aberrations.



Relationship between myopia and optical aberrations

No correlation between optical aberrations and refractive error.

Relationship between Refractive Error and Monochromatic Aberrations of the Eye

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Higher amounts of aberrations in myopes when compared to emmetropes .

Vision Res. 2002 Apr;42(8):1063-70.
Wavefront aberrations in eyes of emmetropic and moderately myopic school children and young adults.
He JC, Sun P, Held R, Thorn F, Sun X, Gwiazda JE.
High amounts of wavefront aberrations, which degrade the retinal image, may play a role in the development of myopia.

No significant difference between aberrations and refractive error.

Myopic versus hyperopic eyes: axial length, corneal shape and optical aberrations

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Myopes showing lower spherical aberrations

Clin Exp Optom 2009; 92: 3: 304–312

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Monochromatic aberrations of the human eye and myopia

Conclusions: Our study shows that spherical aberration is associated with refractive error. More myopic eyes tended to have smaller amounts of spherical aberration, however, the 'cause or effect' question remains. Longitudinal studies are needed to further investigate the relationship between monochromatic aberrations and refractive development.

Methods

- 66 eyes of 33 anisometropic patients.
- Mean age: 35.02 years.
- Spherical equivalent difference≥ 2D.
- Cylinder < 3D.
- SE between +3.25 and -21.75.
- Axial Length measured with IOL master.
- OPDscan:
  - High (up to 5 th order) and low order monochromatic aberrations were measured for 5mm pupils
  - Corneal Asphericity.

- Statistical Analysis: Non parametric paired Wilcoxon signed rank test.

Results 1: Axial Length, Spherical Equivalent and Corneal Shape.

- The **axial lengths** (AL) of the less myopic_(LM) eyes (24.32 ± 1.34 mm) were significantly lower (p<0.0001) than the axial lengths of the more myopic eyes(MM) (26.93 ±_2.24 mm).
- The **spherical equivalents** of the LM eyes (-2.33 ± 3.06) were significantly less negative (p < 0.0001) than those of the MM eyes (-9.33 ± 5.22).
- Mean **keratometric** measurements were not significantly different (p = 0.108) between the MM and LM eyes and neither was the **cylindrical difference** (p>0.005) and the **magnitude of corneal astigmatism** between these two groups.

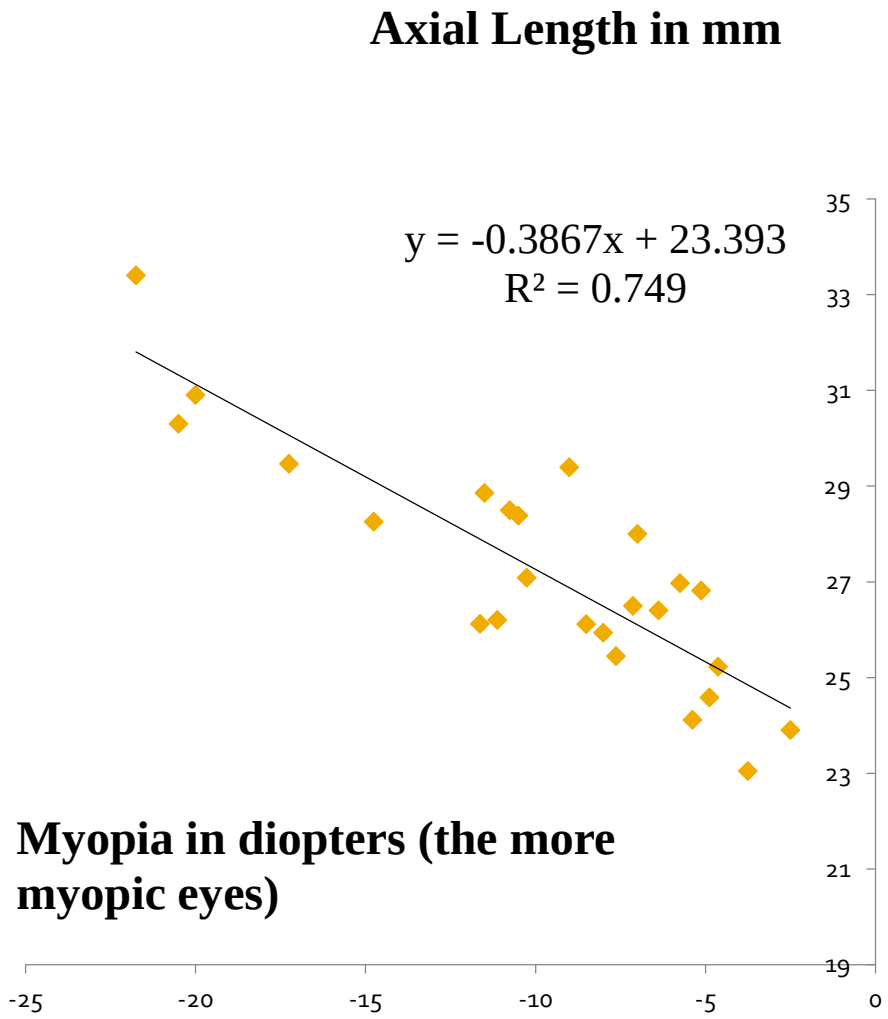
Axial Length, Spherical Equivalent and Corneal Shape

	SD ± SD	AL± SD	K ± SD	Q ± SD
More myopic	-9.825±5.349	27.193±2.39	43.77±1.83	-0.206±0.196
Less myopic	-2.165±2.911	24.305±1.391	43.58±1.89	-0.274±0.311
Wilcoxon paired test	p<0.0001*	p<0.0001*	p= 0.108	p=0.541

SE:MEAN SPHERICAL EQUIVALENT; AL: MEAN AXIAL LENGTH; K: MEAN KERATOMETRY; SD: STANDARD DEVIATION.
Q:ASPHERICITY.
* SIGNIFICANT AT 0.05.

Axial Length and Spherical Equivalent

- **Linear Correlation between AL and SE** in the more myopic and less myopic eyes (*p*<0.001, r2= 0,749 and *p*<0.001, r2= 0.544. respectively).



Results 2: Monochromatic aberrations

- The more myopic eyes showed significantly higher root mean square (RMS) values of corneal spherical aberration ($p<0.0001$) than the less myopic eyes.
- **Corneal spherical aberrations** were significantly more positive (0.120 microns ± 0.051) in the MM eyes than in the LM eyes (0.105±0.045 microns) ($p=0.04$).
- **The RMS of high order aberrations**: total, internal and corneal (except for spherical aberrations) along with the **RMS of coma** didn't show any significant difference between the more myopic and less myopic eyes.

Results: Corneal monochromatic aberrations

	Corneal total high order aberrations	Corneal Third order aberrations	Corneal Fourth order aberrations	Corneal Spherical aberrations	Coma
More Myopic	0.266±03127	0.205±0.116	0.148±0.073	0.127±0.056	0.138±0.083
Less Myopic	0.242 ±0.073	0.189±0.082	0.119±0.012	0.103±0.041	0.152±0.110
P(Paired wilcoxon test)	1	0.69	<0.001	0.015	0.69

Discussion

- **Less negative asphericity in myopic eyes** → tendancy to a less rapid flattening in the periphery → More positive Spherical Aberrations (0.13microns) in the more myopic eyes compared to the less myopic eyes (0.103microns) (p=0.015).
- *Similar results to He et al., 2002 and Carkeet et al., 2002 but not to those of Collins et al. (1995).*

Discussion

- During ocular growth, instead of a rapid flattening of the cornea in myopic eyes as expected to maintain a smoother junction with the flatter sclera, the peripheral cornea remains unchanged or even steepens paradoxically to compensate for the increase in anterior chamber depth.
- More Myopic Eyes are less prolate→If requires LASIK→ choose specific aspheric profile of ablation to control for postoperative corneal asphericity.

Conclusion

We found a relationship between positive corneal spherical aberrations and myopia that could have been contributing to retinal image degradation in myopes but the cause and effect issue resides since those aberrations are well compensated by the negative internal aberrations making the eye a coordinated optical structure.