Ocular optical quality dynamics during accommodation in subjects with accommodative dysfunctions

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Introduction

Image from http://biology-igcse.weebly.com/-accommodation.html
Introduction

• What are (the) accommodative dysfunctions?
  • Accommodative Insufficiency
  • Accommodative Excess
  • Accommodative Infacility
Introduction

• Prevalence of accommodative dysfunctions

Franco et al. 2018 unpublished data
Introduction

• How to diagnose?

- Case history
  - Special attention for the symptomatology

- Refractive exam
  - Static retinoscopy
  - Subjective exam

- Binocular Vision
  - Phoria and vergences for distance and near vision
  - NPC

- Accommodation
  - Amplitude of accommodation
  - NRA and PRA
  - MEM
  - Accommodative facility

- Ocular health
  - Ophthalmoscopy
  - Biomicroscopy
Introduction

• There are several different criteria to diagnose the accommodative dysfunctions.

• There are symptomatic subjects that “pass” all the criteria.
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Can we use the ocular optical quality data to study/diagnose accommodative dysfunctions?

Do people with these dysfunctions have a different behavior? If so, what is it like?
Introduction

• To evaluate ocular accommodation from ocular wavefront aberrations data continuously measured during the response to different accommodative demands.

• To compare the results of symptomatic and non-symptomatic subjects.
Methods

Ocular optical quality dynamics during accommodation in subjects with accommodative dysfunctions.
Method

- Hartmann-Shack aberrometer
  - resolution of $1280 \times 1024$, $39 \times 31$ lenslets, working with a frequency of 15 Hz
Methods
Methods

• The operator can see in real time the time-course of the aberrations.

• The data acquisition is synchronized with the lens system.
Methods
Methods

\[
M = \frac{-4\sqrt{3} \times Z(2,0)}{r^2}
\]

\[
J_{45} = \frac{-2\sqrt{6} \times Z(2,-2)}{r^2}
\]

\[
J_0 = \frac{-2\sqrt{6} \times Z(2,2)}{r^2}
\]
Methods
Methods

• In addition to the optical quality parameters, several accommodative parameters were computed from the collected data:
  • accommodative response,
  • lag of accommodation,
  • response time.

• These parameters were computed for all the accommodation stimulus.
## Methods

<table>
<thead>
<tr>
<th></th>
<th>Age (years)</th>
<th>Am (D)</th>
<th>M.E.M. retinoscopy (D)</th>
<th>AF (cpm)</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject A</td>
<td>22</td>
<td>9.00</td>
<td>+0.50</td>
<td>19</td>
<td>Far blurred vision after performing a near vision task</td>
</tr>
<tr>
<td>Subject B</td>
<td>28</td>
<td>8.50</td>
<td>+0.50</td>
<td>12</td>
<td>No symptoms</td>
</tr>
</tbody>
</table>
Results

Ocular optical quality dynamics during accommodation in subjects with accommodative dysfunctions
Results
Results

• RMS vs Accommodative stimulus
Results

\[ R^2 = 0.892 \]

\[ R^2 = 0.0236 \]

Subject A

Subject C
Results

• Accommodative response

Subject A

Subject B

Accommodative stimulus
Accommodative response
Accommodative response (average)
Results

Subject A

Subject B

Accommodative stimulus (D)

Accommodative response (D)

Accommodative lag (D)

R² = 0.9917

R² = 0.981

R² = 0.5045

R² = 0.9616
Results

\[ y = y_0 + a \left( 1 - e^{t/\tau} \right) \]

\( a \) represents the amplitude of the response, \( t \) represents time in seconds, and \( \tau \) represents the time constant.

Stimulus: 0.45 D
Subject A took 1.41 s to achieve a stable accommodation response of 0.66 D.

Subject B took 0.05 s to achieve a stable accommodation response of 0.19 D

\( a = 0.17; r = 0.4147; t = 0.009 \)
Conclusions

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Conclusions

• The patient with symptoms after a near vision task, presented several alterations in his accommodative performance that were not found in the optometric exam.

• This method shows the presence of anomalies even before they can be detectable in a optometric exam.

• The measurement of wavefront ocular aberrations can be a tool to diagnose accommodative disorders.

• It might also be useful to analyse the effects of visual therapy as a treatment option.
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