Difficulties with Fusion

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Binocular vision

Low grade
Simultaneous perception
High grade
Sensory Fusion
Stereopsis

Images that are sufficiently similar
A well-trained sensorium that maintains the ability process these images
An intact efferent neuro-muscular system that can produce a response to do so (motor fusion)

Case 1
- 85yo F
- Constant diplopia since (minor) head injury two years ago
- 10Δ left esotropia, normal ductions, comitant, can intermittently fuse with prism, not consistent
- Bilateral cataract L > R moderate subcapsular component
- VAR = 6/9 c VAL = 6/12 c
- Planned cataract surgery
  - Warned of diplopia being clearer, need for further treatment etc
Case 1 - Management

- Postop 1st eye L 6/6 – still c/o diplopia
- Postop 2 R 6/7.5 – very occasional diplopia
- Fusing well with easily decompensated phoria
- Watching for now, doesn't want prism glasses as happy

Case 2

- 56yo F writer
- Previous R multiple retinal detachment surgery
  - One total RD, previous buckle
- Shuts right eye with reading
- R 6/180 pseudophakic with ERM / SiOil in situ
- L 6/5 pseudophakic
- Right hypertropia D 12pd, N 5pd
- Unable to fuse with prism
- Amsler grid distortion and aniseikonia ++

Case 2 - Management

- Occlusion of right eye
  - Did not tolerate occlusive CL
  - Does not want occlusive spectacles
Case 3

- 56yo M
  - Basal skull fracture 2000, motorsport accident
  - Persistent constant horizontal diplopia since that time, no treatment
- VAR=L=6/5 unaided, healthy eyes
- 30Δ L esotropia and 14Δ L hypertropia
- Unable to fuse with prisms, “would be quite happy” with prism glasses if they could work.

Case 3

- Marked fundus excyclotorsion L eye
- Double Maddox road = 30 degrees excyclotorsion
- Surgery stage 1: L inferior oblique recession and bilateral medial rectus recession
- Post-operative alignment
  - No vertical deviation in primary position
  - 10Δ residual esotropia, cannot fuse with prism
  - 25° excyclotorsion
- Planned for stage 2 surgery – bilateral harada-ito procedure and lateral rectus resections

Case 4

- RE -2.00 LE -8.00 for laser refractive surgery
- Good fusion with 60° stereo
- Post-op intractable diplopia from induced aniseikonia of 7%
- Be careful shifting anisometropic correction from spectacle to corneal plane
- Could have been predicted by
  - pre-op CL trial
  - the recognition in the history that previous problems with CLs might be for this reason
Images that are not similar

- Reduced image quality
  - Media opacity, poor afferent visual function
- Image size or orientation non-fusable
  - Aniseikonia (basic and refractive)
  - Torsion
- Distortion of image
  - Metamorphopsia

A well-trained sensorium that has the ability process these images

- Central loss of fusion
- Horror fusionis
- Hemifield slide
- Fixation switch diplopia

Central fusion disruption

- Acquired cause of persistent diplopia without suppression
- Images similar but cannot fuse with prism
- Common post closed-head trauma
- Vertical bobbing of non-dominant eye described
- Often permanent, sometimes improves
- Occlusive treatment often required
Case 5

- 70yo male
  - Bilateral cataracts
  - History of left amblyopia with 5Δ left esotropia, no diplopia
  - BSCVA R 6/18 L 6/60
  - Previous BSCVA 10 years ago R 6/6 L 6/9

Which eye to do first?

Fixation switch diplopia

- Occurs in adults who've had previous (micro) strabismus with suppression / and or amblyopia in their non-dominant eye
- A change in refraction (e.g. post-laser or cataract surgery) encourages fixation with their non-dominant eye
- Diplopia results

- Usually can be managed with optical correction to encourage fixation with the dominant eye

Hemifield slip / slide
An efferent neuro-muscular system that can produce a response to do so

- Horizontal and vertical deviations can be treated with prism or re-alignment surgery relatively easily
- Good fusional amplitudes facilitate single vision with optical or surgical treatments
- Torsion poses a more challenging situation as it cannot be corrected optically

Summary - Barriers to Fusion

- Images too dissimilar
  - Clarity
  - Size / Aniseikonia
  - Orientation / torsion
  - Distortion / metamorphopsia
- Central causes
  - Central loss of fusion
  - Loss of overlapping visual field
  - Horror fusionis
  - Abnormal visual development from childhood

Atropine for the Treatment of Myopia - Update

ATOM2 Study – Phase 1 washout

12 months results
ATOM 1 used 1% atropine and showed a slowed progression of myopia, but with unacceptable effects on accommodation, pupil dilation and ocular allergy.

**ATOM 2**
- Double masked, single centre trial
- 6-12 yo patients with
  - Myopia >2.0D, <1.5D cyl
  - Progression >0.5D in 12/12
- Randomised 2:2:1 to Atropine noite 0.5% vs. 0.1% vs. 0.01%
  - n= 161 155 84

- Phase 1 - 2 year treatment, washout 1 year
- Phase 2 - those with further progression will be retreated

**Outcome measures**
- Myopic progression at two years
  - Mild <0.5D
  - Moderate 0.50-0.99D
  - Severe >1.00

- Secondary endpoints
  - Progression at one year
  - Axial length change at 1 and 2 years
  - Side effect parameters (accom / near VA / pupil size / allergy / glare etc)
Results

- 2 year data for 89%
- 0.01% no hyperopia shift (0.3-0.4D other groups)

Final myopia progression at 2 years

- 1.0% -0.28 ± 0.92 D ATOM 1
- 0.5% -0.30 ± 0.63 D
- 0.1% -0.38 ± 0.60 D
- 0.01% -0.49 ± 0.60 D

(Placebo -1.20 ± 0.69 D ATOM 1)

Change in Refraction

Figure 2. Mean change in spherical equivalent for groups from baseline, 1 week, and 4 to 24 months with atropine 0.01%, 0.1%, and 0.3% from the ATOM 1 study, and placebo and atropine 1.0% from the ATOM 1 study. A = atropine; ATOM = Atropine for the Treatment of Myopia; D = dioptr; m = months; w = week.

Progression of myopia according to severity

Figure 3. Progression of myopia according to severity (adapted from with atropine 0.1%, 0.3%, and 0.5% from the ATOM 1 study, and placebo and atropine 1% from the ATOM 1 study, at 1 and 2 years. Myopia progression from baseline 2.2 +/- D (mean), 1.5-0.9D (median), and 1.2 D (r) A = atropine; ATOM = Atropine for the Treatment of Myopia; D = dioptr.
Figure 4. Mean change in axial lengths for groups from baseline, 2 weeks, and 4 to 24 months. A = atropine; ATOM = Atropine for the Treatment of Myopia; m = month; w = week.

Atropine for the Treatment of Childhood Myopia: Changes after Stopping Atropine 0.01%, 0.1% and 0.5%

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Table 1. Demographic and Biometric Parameters of Spherical Equivalent and Axial Length Over Time in the Atropine 0.01%, 0.1% and 0.5% groups.

<table>
<thead>
<tr>
<th>Age at 24 months, mean (SD)</th>
<th>0.01%</th>
<th>0.1%</th>
<th>0.5%</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 months</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Change of BC (mm)</td>
<td>0.06</td>
<td>0.08</td>
<td>0.14</td>
<td>0.002</td>
</tr>
<tr>
<td>Baseline to 2 months</td>
<td>0.05</td>
<td>0.05</td>
<td>0.06</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Note: Baseline measurements taken 2 weeks after start of atropine.
*P value is based on the Fisher exact test.
Summary

• Myopic rebound greater in eyes treated with higher doses of atropine
  – Associated with rapid increase in AL in 0.1% and 0.5% groups (and 1%), but a more steady change in AL in 0.01% group
  – Dose related rebound effect
• Paradoxically at 36 months, the myopia progression was larger in 1% group from ATOM1 compared with weaker concentrations in ATOM2
• During washout phase, the SEQ change / AL change ratio was different between different arms

Summary

• During washout phase, the SEQ change / AL change ratio was different between different arms
  – 0.5% 3.5D / mm
  – 0.1% 2.1D / mm
  – 0.01% 1.5D / mm

  – i.e. not AL alone?corneal curvature?lens thickness?ratio of AC depth to PC depth
  – Aetiology of differences unknown?muscarinic receptor types / distribution within the eye

Conclusion

• Atropine 0.01% seems to have less myopic rebound than higher concentrations, which led to a more sustained effect on myopia retardation, and an overall reduction in myopia with
  – No systemic side effects/allergy
  – The least impact on pupil size/near VA
  – Fastest recovery of pupil size/near VA

• Is this the optimal dose