American Association of Certified Orthoptists
AAPOS Workshop 2013:

DVD - A Conceptual, Clinical and Surgical Overview

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Boston, Massachusetts
Moderators:
Edward L Raab, MD, JD
Alex Christoff CO, COT

Program

Welcome / Introductions
Alex Christoff / Edward Raab (Co-Moderators)

Concepts
David Guyton, MD
Michael Brodsky, MD

Clinical Considerations
Claire Hennesey, CO – Case Presentation
Kimberly Merrill, CO – Measurement Technique
Kathy Fray, CO – Measurement Technique

Surgical Treatment
David Morrison, MD
Eric Bothun, MD

Audience Q&A
Dissociated Vertical Deviation:

Mechanism and Purpose -

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The mechanism and purpose of dissociated vertical deviation (DVD) had been debated for over a century. In the late 1990s, we obtained and closely analyzed a series of scleral search coil recordings of young adults with DVD and were able to identify the various cyclovertical muscles primarily involved in the components of the DVD response, were able to show that each of the component movements obeys Hering’s law after all, and arrived at the conclusion that DVD is an acquired (learned), often anticipatory, response to taking up fixation with one eye, either when the fellow eye is covered, or spontaneously.1-4

Taking up fixation with one eye in these patients stimulates latent nystagmus, to a greater or lesser extent, both horizontal and cyclovertical. The patient may learn to use a head turn to fix with the adducting eye, which can help damp the horizontal nystagmus (Alexander’s law), but more commonly uses convergence to damp the horizontal nystagmus to improve vision. When strong dominance or amblyopia is present, the latent nystagmus is typically greater when the non-dominant eye fixes, and more convergence is used in an effort to improve vision. This leads to a larger esodeviation (or smaller exodeviation) when the non-dominant eye fixes, the hallmark of so-called “dissociated horizontal deviation.”5

The cyclovertical component of the latent nystagmus is quite conjugate, a vestibular type of nystagmus, characterized in 80% of our patients by the fixing eye’s drifting inward, downward, and intorting during the slow phases, with the non-fixing eye drifting outward, downward, and extorting. Thus the superior oblique muscle of the fixing eye and the inferior rectus muscle of the non-fixing eye are the primary movers of the eyes during the typical slow phases of the cyclovertical latent nystagmus.

The cyclovertical nystagmus interferes with vision, so the patient learns to damp the nystagmus, if possible, to improve vision. Sometimes the otolithic response from a particular head tilt will interfere with this vestibular-driven latent nystagmus, and the patient adopts that head tilt to see better.4 Some of our patients compulsively used this head tilt even though visual acuity improved by only a few letters. Typically the head tilt would persist when the non-fixing eye was covered, but would change or disappear when the fixing eye was covered.
The other mechanism that damps nystagmus is vergence. In the case of cyclovertical latent nystagmus, a vertical vergence is needed to damp the vertical component, because that is the component that interferes with vision. There is already an inborn vertical vergence that is used for small vertical corrections when the eyes become momentarily misaligned vertically from the vertical component of the normal vestibulo-ocular reflex.1,2 This vertical vergence involves primarily the oblique muscles, with the superior oblique muscle driving the higher eye downward and the inferior oblique muscle driving the lower eye upward. It appears that the patient with DVD adopts this vertical vergence and magnifies it greatly to help damp the vertical component of the cyclovertical latent nystagmus - thus creating this clinical phenomenon that we call DVD. The superior oblique muscle tries to drive the fixing eye downward, but this is balanced by a simultaneous upward version to keep the fixing eye fixing, such that the fixing eye simply intorts, easily seen on recordings and often clinically visible as well. The non-fixing eye, however, is driven upward by its contracting inferior oblique muscle and also by the simultaneous upward version which is driven primarily by both superior rectus muscles. The end result is the non-fixing eye’s being driven upward, extorting, and either abducting or adducting depending upon how much convergence is being used to damp the horizontal component of the latent nystagmus.

Additional observations support our conclusion that DVD and DHD are used to damp latent or manifest latent nystagmus to improve vision.1,2 Several patients with DVD could read down the eye chart with eyes essentially straight and peripherally fusing until they reached the 20/60 or 20/40 line of letters. At that point they broke fusion, fixated with one eye, and read farther down the chart. One patient with weak fusion commented that she liked to fuse most of the time, but when she had to see something most clearly in the distance, she broke fusion, looked with one eye, and let the other eye turn up.4 We measured her visual acuity under both conditions, and it was consistently three letters better when the DVD was present.

In the scleral search coil recordings, the latent nystagmus typically appeared, or the manifest latent nystagmus worsened, when either eye was covered, and always became damped as the DVD developed, as indicated by decreasing velocity of the slow phases.1,2 Occasionally, however, patients with DVD showed no clinically apparent latent nystagmus upon covering either eye. We believe this was because in these patients the DVD was so efficient that it anticipatorily occurred and blocked the latent nystagmus from developing in the first place. We know that patients do not have to experience visual disruption from the latent nystagmus to initiate the DVD process, because some patients with DVD could voluntarily fix with one eye or the other, and even could “imagine” doing so in total darkness. When these patients imagined taking up “fixation” with one eye in total darkness, typical DVD still occurred, recorded with the scleral search coils.4 These recordings were consistent with DVD’s being a learned, anticipatory, reflexive eye movement that occurs upon taking up fixation with one eye. This type of learned, anticipatory eye movement is somewhat analogous to the “bounce” or “rebound” phenomenon often seen during simultaneous prism and cover testing of strabismic patients.

Many strabismologists believe that there is no cause and effect relationship between latent nystagmus and DVD – that these are separate phenomena even though they often coexist. From our eye movement recordings, however, we are firmly convinced otherwise. We find strong evidence that DVD improves visual acuity in the fixing eye by helping damp latent or manifest latent nystagmus, thus
functioning as a nystagmus-blockage mechanism. This insight should prove useful to us in developing techniques, surgical or otherwise, to treat this vexing form of misalignment.

REFERENCES


What is DVD?

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Dorsal Light Reflex

Human Dorsal Light Reflex
Similarities to Dorsal Light Reflex

- Atavistic (expressed only when higher cortical functions are disabled)
- Modulated by luminance (Bielschowsky phenomenon)
- No diplopia (cortical suppression necessary to evoke)
- Other primitive visual reflexes expressed (MNTA---LN)
- Head tilt toward side of fixing eye

Test of Hypothesis

- True divergence movement
- Nonfixating eye always rotates dorsally
- Compensates for a perceived visual tilt under monocular conditions
- During ACT, the uncovered eye descends past fixation point
- Subclinical DVD present in normal binocular humans

Conclusions

1. DVD is a human dorsal light reflex
2. DVD is a visuo-vestibular eye movement
3. DVD occurs when our two eyes function as balance organs
4. Predicts that the covered or suppressed eye will only rotate dorsally
On behalf of the American Association of Certified Orthoptists, the workshop presenters, and my co-moderator Ed Raab, I thank you for attending this workshop.

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