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case report

Blink Vergence in an Antimetropic Patient

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ABSTRACT

A patient with uncorrected antimetropia was found to attain motor fusion through blinking. Although this patient was also able to attain motor fusion through saccadic vergence and slow fusional vergence, he usually relied on blink vergence. In this patient, blink vergence was an efficient alternative to slow fusional vergence.

Key Words: blink vergence, saccadic vergence, antimetropia, motor fusion, binocular vision

The vergence system may supplement its response to disparity with disjunctive eye movements other than fusional or accommodative vergence. Saccades mixed with fusional vergence eye movements can significantly accelerate the disjunctive response to a vergence demand.[1] Saccades with large dynamic overshoots may be even more efficient for vergence.[2] This case report illustrates another mechanism for the recruitment of a fast and large-amplitude disjunctive response to a vergence demand: vergence associated with blinking (blink vergence).

Blinking helps intermittent exotropes to regain fusion. Stella[3] found that the eyes of intermittent exotropes, like normals,[4,5] converge during reflex blinking. Most of the exotropic deviation in these patients disappeared during the short period of a single blink.

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Our patient used blink vergence frequently even though he did not have distance intermittent exotropia, and he could use fusional, saccadic, or blink vergence to surmount his large nearpoint exophoria.

CASE REPORT

History

The patient is a healthy 35-year-old male lawyer with no visual complaints. He has no history of treatment for squint or other oculomotor problems but occasionally manifests nearpoint exotropia. He does not experience diplopia under casual viewing conditions and wears no corrective lenses for antimetropia. He uses the right eye for distance vision and the left eye for nearpoint vision. The patient's father is highly myopic and had retinal detachments in both eyes.

Diagnostic Data

Uncorrected distance visual acuities were 6/4.5 (20/15) OD and 6/60 (20/200) OS. Subjective refractions were +2.75 −0.75 × 90, 6/4.5 (20/15) OD, and −1.50 −0.75 × 90, 6/4.5 (20/15) OS. The keratometry readings were 45.00 @ 180/44.50 @ 90 OD, and 44.50 @ 180/44.75 @ 90 OS. As expected, alternating cover test phoria varied as a function of the fixating eye when the antimetropia was uncorrected. Cover test at 40 cm with full correction in place initially revealed unequal phoria depending on the fixating eye. After several cover alternations the exo deviation was equalized and was measured as 14 Δ. The nearpoint of convergence was 5 cm from the spectacle plane. The Von Graefe phoria method showed 3 Δ base-in at 3 m, and 16 Δ base-in at 40 cm. Prism vergences induced suppression. There was no significant vertical deviation. The Lancaster test showed the deviation to be comitant with either eye fixating. A slight exofixation disparity was noted at distance, and no fixation disparity at 40 cm. No measurable stereopsis was noted at distance, with or without correction. Suppression by the left eye of letters smaller than 6/15 (20/50) was noted, with full correction, on the AO vectograph chart. Nearpoint stereoacuity was 200 sec arc on the Wirt circles of the Titmus fly test and 400 sec arc on the random dot stereogram. Stereopsis was not measurable without correction at 40 cm. Ophthalmoscopy revealed no retinal disease or significant abnormality.

Eye Movement Recording

We used an infrared limbal tracking technique to record the horizontal position of both eyes. Eye movements were recorded during a semiautomated cover test procedure conducted at 50 cm.[1] With and without optical correction, 20 unilateral cover test eye movement samples, 10 from each eye, and 10 alternating cover test movements were recorded. Only those results obtained without optical correction are shown, as this reflects the patient's habitual status.

The patient's 4.25 D of uncorrected antimetropia induced a difference of heterophoria related to the fixating eye (Fig. 1). The left half of each trace shows 2 s of eye movements recorded immediately after the shift of the occluder from left to right eye, whereas the right half shows the 2 s of eye movements immediately after reversal of the occlusion. The smaller exophoria seen at the beginning of the "OD covered" phase results from accommodation by the previously fixating hyperopic right eye. By midtrace, a 28 Δ exophoria appears as the myopic left eye takes over fixation and reduces the accommodative convergence. Reversal of the occluder (at midtrace) returns the phoria to the lower level characteristic of fixation by the hyperopic eye.

During the unilateral cover test of the right eye, the patient is able to aid his disjunctive response by using saccadic vergence (Fig. 2A). The occluder is applied at the extreme left of the trace, and removed at midtrace. Additional seconds between the occlusion and nonocclusion phases (not shown in the samples) were often required to reveal the full nearpoint deviation before removal of the occluder. For this patient, the saccadic vergence rapidly assumes 32% of the disjunctive response, whereas smooth vergence provides the remainder of the disjunctive response. However, because smooth vergence was slow, saccadic vergence does not suffice to speed this patient's recovery time to normal levels.[2] Other cover test eye movement samples that included smooth and saccadic vergence produced similar results, demonstrating inefficiency in the smooth fusional vergence system.

The weakness and slow speed of this patient's fusional vergence system, when uncorrected, may perhaps explain why he relies mostly on blink vergence (Fig. 2B). A single blink is usually sufficient to neutralize postocclusion disparity completely. Removal of the occluder causes very little response until the onset of the blink. The blinking eyelids, not eye movements, account for the large amplitude trace oscillations. By the time the eyelids clear the photodetectors (the cessation of the trace oscillations indicated by the right-hand arrow), the eyes have virtually

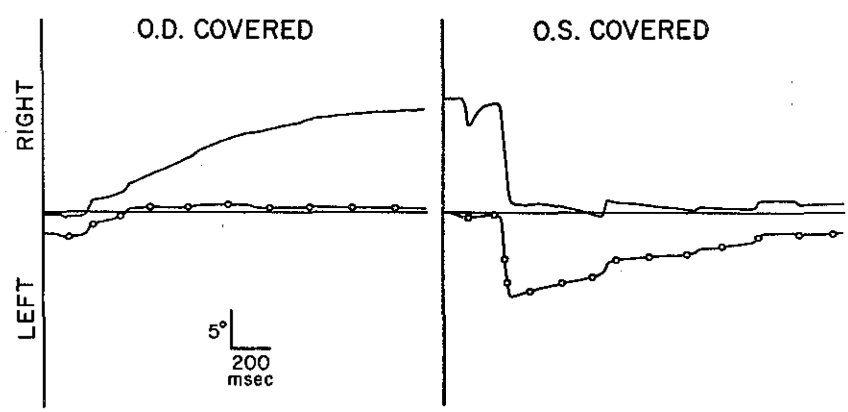

FIG. 1. An eye movement sample recorded during the alternating cover test. The patient's uncorrected antimetropia results in a larger phoria when the myopic left eye (dotted line) fixates (left half of trace) than when the right eye (solid line) fixates (right half of trace). Upward deflections indicate rightward eye movement; downward deflections, leftward movement. Fixation on the point of regard is indicated when a trace is superimposed on the horizontal baseline.

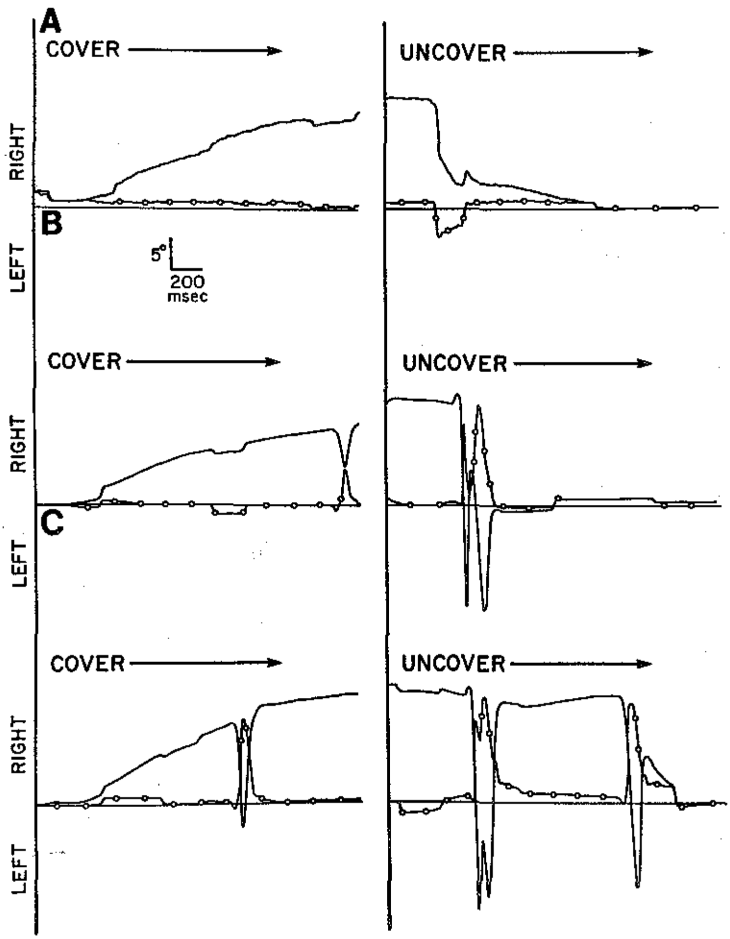

FIG. 2. Unilateral cover test eye movements demonstrate saccadic and blink vergence. Occlusion of the hyperopic right eye reveals a large exophoria and a saccadic vergence recovery when the occluder is removed (A). This response was uncommon in this patient under these circumstances. Blink vergence is the usual mechanism of fusional recovery after removal of the occluder from the right eye (B). Sometimes a second blink was required to initiate a blink vergence after removal of the occluder (C).

resumed bifixation on the point of regard. That is, the entire vergence response of 28 Δ occurred during the 200 ms duration of the blink. Occasionally, a second blink was required to trigger a vergence response (Fig. 2C). Blinks occurred frequently during the cover phase (e.g., left half of trace in Fig. 2C) but never triggered a blink vergence response in that circumstance.

When fully corrected again, the patient demonstrated a larger phoria when the left eye was covered than when the right eye was covered, probably due to unequal accommodation. In both cases he used blink vergence to attain fusion in the uncover phase. However, when requested, the patient could suppress the blink vergence response and use smooth vergence to attain fusion. The time required to complete the fusion response was more than 400 ms, about twice as long as the blink vergence response, even though the corrected phoria was half as large as the uncorrected phoria surmounted by the blink vergence. The fusion time completion of this patient, when corrected, was within normal limits.[2]

DISCUSSION

The absence of a complete blink vergence during occlusion suggests that this vergence is guided by physiological disparity. Reflex blinks in Stella's[3] records (his Fig. 6) were similar to our findings. Stella proposed that blink vergence is accomplished by a vergence innervation reset rather than by physiological disparity. A recent report[6] measuring eye movements during voluntary and reflex blinks found consistent inward deviation of about 2.5° in normals. These inward deviations without a sensory stimulus are an order of magnitude smaller than the blink vergence reported here and by Stella.[3] Stella did report one exotropic subject who converged his eyes, while one eye was covered, by using a long (≈1 s) purposeful blink, and claimed that the eyes were aligned accurately after the blink (his Fig. 4). Careful examination of the record shows an inward deviation of the fixating eye as well. This deviation, coupled with the length of the blink, suggests a not-so-accurate voluntary vergence basis for the convergence noted in this case.

Stella[3] speculated that blinking serves a sensory (suppression-like) role in blink vergence and compared it with the role of blinking in the initiation of conjugate saccades. Indeed, in several respects blink vergence movements more closely resemble saccades than vergence. The blink vergence movement is accomplished while the eyes are closed, indicating that once the disparity is processed, the movement is executed without continuous visual guidance. This behavior is characteristic of saccades, not smooth vergence.[7] The speed of blink vergence is also considerably greater than smooth vergence. Fig. 2B demonstrates that our patient's blink vergence neutralized a 16° disparity within the period of a blink lasting 200 ms. The velocity of this vergence response is at least 80°/s, within the range of saccadic eye movements.[8] Because our eye movement monitoring method could not monitor eye position when the eyes were closed, we have not demonstrated that blink vergence comprises the entire duration of eyelid closure. Thus, blink vergence may be faster than the above calculation suggests. Jampolsky,[9] on the other hand, felt that the role of blink was only as an important preprogramming step in the refusion mechanism. Thus, the blink serves a motor rather than a sensory role.

The mechanism for blink vergence behind the closed lids may be similar to saccadic vergence or saccades with large dynamic overshoots. Using techniques that enable recording of eye movements during blinking, Zee et al.[10] have demonstrated increased amplitude and velocity of saccades with simultaneous blinking in patients with cerebellar dysfunction. Saccade initiation was facilitated by blinking in one patient,[9] and large dynamic overshoots were noted in saccades associated with blinking in another patient.[11] Similar overshoots were recorded in normal observers performing saccades with their eyes closed.[12] These results suggest that blinking may be associated with dynamic overshoots. We have shown previously that overshoot saccades were effective in aiding fusion and may be trainable.[2]

Blink vergence is a rapid and efficient alternative to slow fusional vergence. If the blink vergence recorded in our patient is the same mechanism observed by clinicians during vergence training, this behavior should be encouraged. Whether it is trainable is yet to be determined.

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