The Reversed Fixation Test

A Diagnostic Test for Dissociated Horizontal Deviation

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Background: Dissociated horizontal deviation is one of several conditions that manifest unequal horizontal deviations depending on which of the 2 eyes is fixating.

Purpose: To describe the reversed fixation test as an essential tool to establish the diagnosis of dissociated horizontal deviation.

Methods: Analysis of 4 case scenarios depicting the utility of the reversed fixation test.

Results: The reversed fixation test distinguishes dissociated horizontal deviation from an unequal exodeviation of the 2 eyes resulting from postoperative slippage or weakness of a horizontal rectus muscle.

Conclusion: The reversed fixation test is necessary to establish the diagnosis of dissociated horizontal deviation.

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The adjective “dissociated” was first used to describe binocular eye movements by Bielschowsky; he applied the term “dissociated vertical divergence” to the alternating hyperdeviation that accompanies congenital strabismus. In 1976, Raab described the slow unilateral abduction of the deviating eye as a horizontal variant of dissociated vertical divergence. In 1990, Spielmann assigned the name “dissociated horizontal deviation” to patients with infantile strabismus with intermittent esodeviation of either eye. Spielmann noted that some esodeviations are smaller when the child is visually inattentive than when the child is fixating or during cover testing. This finding suggested that monocular fixation can increase esotonus in some patients with infantile strabismus.

Beginning also in 1990, several clinical reports applied the term “dissociated horizontal deviation” to intermittent exodeviations that were larger in 1 eye or confined to 1 eye on alternate cover testing, ie, dissociated. Affected patients manifested an exodeviation of variable amplitude. Associated findings such as dissociated vertical divergence, latent nystagmus, and sensorial suppression of 1 eye (even when the eyes were aligned) also distinguished this form of dissociated horizontal deviation from intermittent exotropia. The exodeviation was noted to be larger during periods of visual inattention. The authors of these reports advocated limiting surgery to a single lateral rectus muscle in the exodeviating eye (recession with or without a posterior fixation suture) for unilateral cases of dissociated horizontal deviation, while reserving bilateral lateral rectus muscle recession for cases of so-called bilateral dissociated horizontal deviation or unilateral dissociated horizontal deviation combined with exotropia.

Dissociated horizontal deviation has to be defined as the horizontal vergence that is brought about by a change in the balance of visual inputs derived from the right and left eyes. The etiology of dissociated horizontal deviation is open to conjecture. Zubcov et al proposed that greater degrees of convergence might be used to damp larger degrees of latent nystagmus that develop when the eye with poorer vision is fixating. However, it is equally possible that the latent nystagmus is not causal and that the change in vergence results from the fixation shift from one eye to the other, with the unequal damping of latent nystagmus occurring as a side effect. Depending on the baseline horizontal deviation of the eyes under binocular conditions, the same fixation-induced vergence mechanism could manifest as a dissociated esotropia or dissociated exotropia.
Many cases of asymmetrical esodeviation and exodeviation are attributable to conditions that simulate dissociated horizontal deviation. For example, many patients with asymmetrical exodeviations have a history of strabismus surgery for infantile esotropia. In such cases, a slipped, overrecessed, or weak medial rectus muscle or a tight lateral rectus muscle can produce an incomitance with an increase of the squint angle when the eye with impaired motility is forced to fixate. Dissociated horizontal deviation must also be considered in the postoperative patient with congenital strabismus who develops an intermittent exodeviation that spontaneously changes to esotropia. Before considering this diagnosis, the examiner must also exclude a convergence substitution movement in patients with impaired volitional gaze.

The examiner must also place the patient in the full cycloplegic refraction to exclude unequal accommodative convergence caused by uncorrected anisometropia. For example, a patient with anisohyperopia (plano OD; +5.00 OS) may show 15 prism diopters of exotropia when fixating with the right eye, and 10 prism diopters of esotropia when fixating with the left eye.

Thus, to confirm the diagnosis of dissociated horizontal deviation, the head posture, the direction of gaze, the fixation distance, and the degree of accommodation must remain unchanged as fixation switches from one eye to the other. The reversed fixation test, as described by Mattheus and Kommerell, was developed to measure dissociated deviations. This test makes it possible to rule out simulating conditions. The performance of this test with prisms and its outcomes in different situations of horizontal deviation are described below.

### REVERSED FIXATION TEST

Consider a patient who has had surgery for infantile esotropia and subsequently developed an intermittent exodeviation of the left eye. Alternate cover testing shows that only the left eye drifts out under the cover. The reversed fixation test is now necessary to confirm or rule out the presence of a dissociated deviation.

#### SCENARIO 1

Step 1: A base-in prism is placed before the left eye to neutralize the exodeviation. The left eye is covered for about 5 seconds. The cover is then switched briefly to the right eye and immediately back to the left eye to confirm that the exodeviation is neutralized. If not, the prism is changed and the procedure repeated until the exodeviation of the left eye is neutralized, eg, by 25 prism diopters. With the prism held before the left eye, the occluder is moved to cover the right eye. No movement of the left eye is seen (Figure 1, top).

Step 2 (Reversed fixation test): After about 5 seconds, the occluder again is briefly switched from the right eye to the left eye (with the prism still held in place in front of the left eye). No movement of the right eye is observed (Figure 1, bottom). This means that the 25 prism diopters are also corrective for left eye fixation.

Interpretation: The absence of right eye movement in the reversed fixation test demonstrates that the exotropia is not dissociated. Rather, this patient may have an adduction deficit of the right eye due to postoperative slippage of the right medial rectus muscle.

#### SCENARIO 2

Step 1: A 25 prism diopter base-in prism placed before the left eye is found to neutralize the exodeviation. With the 25 prism diopter base-in prism still in front of the left eye, the right eye is covered for several seconds (Figure 2, top). No movement of the left eye is seen.

Step 2 (Reversed fixation test): With the prism still in front of the left eye, after several seconds the occluder is switched from the right eye to the left eye. An abduction saccade of the right eye is observed, corresponding to an adducted position of the right eye under the cover (Figure 2, bottom). This adducted position can be measured by having a second observer (or the patient) place a base-out prism in front of the right eye while keeping the right eye occluded. Then the cover is for a short moment switched to the left eye and immediately back to the right eye to observe whether the adducted position of the right eye is neutralized. If not, the prism is changed and the procedure repeated until the adducted position is neutralized, eg, by a 25 prism diopter base-out prism.
Interpretation: In this situation, there is less esotropia when the right eye is fixating than when the left eye is fixating. Thus, when the left eye is made to fixate in its unchanged, abducted position (through the prism), the right eye assumes an adducted position of the same size behind the cover, ie, there is no squint angle. This patient has a dissociated component of 25 prism diopters which equals the entire exodeviation of the left eye (provided that unequal accommodative convergence is excluded by dynamic retinoscopy or by maximum visual acuity at distance with the patient in his or her corrected cycloplegic refraction). If there is no horizontal incomitance, the patient will also be orthotropic in straight gaze as long as the left eye is fixating.

**SCENARIO 3**

Step 1: A 25 prism diopter base-in prism is placed before the left eye to neutralize the exodeviation. With the prism held before the left eye, the occluder is moved to cover the right eye. No movement of the left eye is seen (Figure 3, top).

Step 2 (Reversed fixation test): With the prism still in front of the left eye, the occluder is briefly switched from the right eye to the left eye, then immediately back to the right eye. An abduction saccade of the right eye is observed, corresponding to an adducted position of the right eye under the cover (Figure 3, bottom). When measured with a second observer (or the patient) placing a base-out prism in front of the right eye, the size of the abduction saccade is 10 prism diopters.

Interpretation: Assuming that unequal accommodative convergence has been ruled out, this patient has 10 prism diopters of dissociated horizontal component superimposed on 25 prism diopters of underlying exotropia. The patient who spontaneously alternates fixation, will alternately manifest an exodeviation of 15 prism diopters in the right eye and an exodeviation of 25 prism diopters in the left eye.

**SCENARIO 4**

Consider the patient with the same history who manifests a large exodeviation during periods of visual inattention. Alternate cover testing shows a large exodeviation of the left eye and a small esodeviation of the right eye.

Step 1: A 25 prism diopter base-in prism is placed before the left eye to neutralize the exodeviation. With the prism held before the left eye, the occluder is moved to cover the right eye. No movement of the left eye is seen (Figure 4, top).

Step 2 (Reversed fixation test): With the prism still in front of the left eye, the occluder is switched from the right eye to the left eye. An abduction saccade of the right eye is observed, demonstrating the dissociated nature of the exodeviation.

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_Figure 2._ Dissociated horizontal deviation. Top, Following neutralization with a 25 prism diopter base-in prism, the esotropus increases when the occluder is shifted to the right eye. Bottom, Reversed fixation test. When the occluder is again shifted to the left eye, a 25 prism diopter abduction saccade of the right eye is seen, demonstrating the dissociated nature of the exodeviation.

_Figure 3._ Dissociated horizontal deviation. Top, Following neutralization with a 25 prism diopter base-in prism, the esotropus increases when the occluder is shifted to the right eye. Bottom, Reversed fixation test. When the occluder is again shifted to the left eye, a 10 prism diopter abduction saccade of the right eye is seen, demonstrating the partially dissociated nature of the exodeviation.
The dissociated component of congenital strabismus may be inapparent on initial examination and variable under binocular conditions. The reversed fixation test was devised by Mattheus and Kommerell\textsuperscript{15,17} as a technique to visualize the dissociated component in patients with dissociated vertical divergence. The reversed fixation test is particularly useful for distinguishing dissociated vertical divergence from the nondissociated vertical divergence caused, for example, by primary oblique muscle overaction.\textsuperscript{17}

In the horizontal plane, a major advantage of the reversed fixation test is that an incomitant horizontal deviation will not be misdiagnosed as “dissociated.” This test allows the examiner to measure a dissociated component as the difference between the squint angle when the right eye is fixating and the angle when the left eye is fixating, without any change of the horizontal gaze direction. If the reversed fixation test shows that the angle is the same on right and left eye fixation, a dissociated component of the deviation has been ruled out. Since fixation per se (with either eye) can evoke differing degrees of esotony, the degree of exodeviation that is apparent with visual inattention (eg, when the patient is asked to remember an event 24 hours ago or to solve a mathematical task) can be larger than that measured when either eye is used to fixate.\textsuperscript{11,14}

The reversed fixation test shows that dissociated horizontal deviation exists in a minority of patients with unilateral exodeviation.\textsuperscript{13,14} While this disorder is referred to as dissociated horizontal deviation in the left or the right eye, it is well to remember that the dissociated component results from a change in vergence tonus on a supranuclear level when the fixating eye is switched, and that it actually involves both eyes.

In conclusion, dissociated horizontal deviation is a unique clinical disorder that can be diagnosed only after a variety of other simulating conditions have been excluded. The reversed fixation test is a decisive test for the diagnosis of dissociated horizontal deviation. With the reversed fixation test, keeping the neutralizing prism in its position in front of the same eye, a change in the fixation from one eye to the other normally does not alter the strabismus angle. With corrected cycloplegic refraction, when prism alternate cover testing discloses a movement of the eye not viewing through the prism, a dissociated component of the strabismus is established.

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REFERENCES

Correction

Error in Figure. In the Clinical Sciences article by Dawson et al titled “Histologic, Ultrastructural, and Immunofluorescent Evaluation of Human Laser-Assisted In Situ Keratomileusis Corneal Wounds,” published in the June issue of the ARCHIVES (2005;123:741-756), an incorrect figure appeared as Figure 11 on page 751. The corrected Figure 11 is reprinted here. The ARCHIVES regrets the error.

Figure 11. Immunofluorescence of a 5-year-old laser-assisted in situ keratomileusis (LASIK) corneal wound (arrows) showing type 1 collagen throughout the entire interface scar (A) and increased type 3 collagen at the wound margin only (B). Using the primary antibody for α smooth muscle actin, myofibroblasts were found in a 75-µm zone in the wound margin scar in a 4-month-old LASIK wound (C) and in first cell layer below the epithelial surface in a 3-year-old LASIK wound (D) (original magnification ×100).