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case report

Functional Difficulties Resulting from Traumatic Anisocoria

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An abnormal mydriasis of the pupil may be present after blunt contusion of the eye. Prolonged mydriasis indicates partial or complete rupture of the iris sphincter and may be permanent.[1] Anisocoria resulting from unilateral mydriasis may be associated with visual difficulties. Difficulties may be expected at nearwork because of the reduced depth of focus of the dilated eye. Other difficulties may result from the different amount of light entering each eye. This difference can distort depth perception of moving objects in a manner similar to the distortion demonstrated by the "Pulfrich phenomenon."[2]

Increasing the pupil size beyond 2.5 mm increases optical aberrations, thereby decreasing the depth of focus of the eye. The depth of focus depends also on the distance of the target from the eye: the closer the target is to the eye the smaller is the tolerance of the eye to distance changes.[3] Thus, anisocoria that will cause little difficulty for distance vision may result in blurring of the image in the dilated eye at near, simulating unequal accommodation.

Different amounts of light entering each eye have an effect on depth perception known as the "Pulfrich phenomenon." If a pendulum bob oscillating in a frontal plane is viewed with a neutral density filter in front of one eye, the bob appears to move in an elliptical path. It seems to be nearer the observer when moving in one direction and further away when movement is in the opposite direction.[2] The illusion is caused by the increased latency of impulses from the eye covered with the dark filter. If the filter is in front of the right eye, the bob will appear to rotate counterclockwise; that is, on its swing from right to left it will appear further from the observer. Dilation of one pupil will cause that eye to receive more light and the effect will be similar to wearing a dark filter in front of the other eye, distorting depth perception of moving objects.

The case presented here demonstrates both unequal accommodation and a positive Pulfrich phenomenon as a result of traumatic anisocoria. These effects could explain the functional difficulties reported by the patient.

HISTORY

The patient, a 38-year-old white male, was seen in August 1983. At that time he complained of difficulties with nearwork and with driving. He attributed these difficulties to an eye injury sustained in an automobile accident 1 year previously. He reported that his right eye was injured and that he lost consciousness on impact. He suffered a blow-out fracture of the orbit, which was not treated surgically, a hyphema that resolved after 3 days, and multiple contusions around the orbit. He also noted diplopia on extreme upward gaze. General and ocular histories were otherwise unremarkable.

DIAGNOSTIC DATA

On examination, visual acuity with polymethyl methacrylate contact lenses was: OD $6/6^{-2}$ ($20/20^{-2}$), PH 6/6 (20/20); OS $6/6^{-1}$ ($20/20^{-1}$), PH 6/6 (20/20). Refraction: OD $-4.00\ 6/6^{-1}$ ($20/20^{-1}$), PH 6/6 (20/20); OS -4.50 6/6 (20/20). Visual fields were full by confrontation. Cover test revealed 2 Δ exophoria at distance, and 6 Δ exophoria at 16 in. A 2 Δ right hypotropia was measured in extreme upgaze. The red lens test showed fusion in the primary gaze position and downgaze and diplopia in the upgaze position. The diplopia in upgaze was maintained even without the red lens. Von Graefe's finding was

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2 Δ exophoria at distance and 8 Δ exophoria at near. Lids and conjunctiva were unremarkable. The cornea and anterior chambers were clear. Pupillary examination revealed anisocoria; the right pupil was 6.5 mm in diameter and the left was 3 mm. Both pupils reacted to light and accommodation. The right pupil was slightly irregular and responded sluggishly. The lens and vitreous were clear OU. The funduscopic examination was unremarkable. Cup to disc ratio was 0.3 OD, 0.2 OS. Gonioscopy revealed a wide angle at the superior nasal quadrant OD with suspected angle recession. Intraocular pressure was 10 mm Hg OU by applanation. Amplitude of accommodation was unequal; 3.50 D OD, 5.00 D OS measured with a minus lens. Range of push-up accommodation was 15 cm OD and 10 cm OS.

We tested the patient for the Pulfrich phenomenon without a filter in front of either eye. As expected, he reported that the pendulum appeared to rotate clockwise in an elliptical path. By placing an 0.4 log units neutral density filter over the right eye, we could balance the effect. When an 0.8 log unit neutral density filter was placed over the right eye, the direction of the rotation was reported to be counterclockwise.

TREATMENT

The patient was advised to report annually for an examination to rule out the development of glaucoma secondary to the angle recession. The relation of the anisocoria to the difficulties that he was reporting was explained to him. The recommended solution was to fit the patient with a tinted contact lens in the right eye to create a 3-mm artificial pupil. An alternative solution was an 0.4 log unit neutral density filter to be worn over the right eye while driving. The patient rejected both solutions for cosmetic reasons and decided to try to adapt to the changes and the difficulties over a longer period of time.

DISCUSSION

A patient with traumatic anisocoria should always be questioned about history of hyphema and examined gonioscopically for possible angle recession. At least 20% of patients with history of traumatic hyphema are found to have angle recession and should be followed for secondary glaucoma.[1] Even when angle recession is ruled out, the optometrist should look for possible functional difficulties caused by the anisocoria.

The effect of optical aberration resulting from increased pupil size is likely to manifest as unequal accommodation at nearwork when the depth of field becomes more critical.[4] Functional difficulties during fine work at near were reported recently in a patient with unequal accommodation after peripheral retinal cryosurgery.[5] Asthenopia was also reported in a case of subclinical maculopathy resulting in unilateral delay in vertical-cortical transmission.[6]

TABLE 1. Expected perceived direction of pendulum rotation for patients reporting positive Pulfrich phenomenon without use of filter.[a]

Condition	Involved Eye	
	OD	OS
Dilated eye (traumatic anisocoria)	Clockwise	Counterclockwise
Optic nerve disease	Counterclockwise	Clockwise

[a] The perceived direction can be inverted by inserting a neutral density filter in front of the dilated eye in the anisocoria case, or in front of the fellow eye in the optic nerve disease case.

Distortion of depth perception of moving objects can be found in other unilateral conditions, such as unilateral optic neuritis or unilateral demyelinating disease of the optic nerve[7]. Table 1 gives the expected response of patients with these conditions when tested for the Pulfrich phenomenon without a filter in front of the eyes. Positive response of a patient to the test can be verified by asking whether the elliptical path of the pendulum is turning clockwise or counterclockwise. The response can be further verified and quantified by applying a variable neutral density filter (Bernell, Inc.) to the dilated eye in anisocoria, or to the fellow eye in optic nerve disease. The value of the filter required for elimination of the distortion can be recorded (this value depends also on the speed of the pendulum motion). Testing for the Pulfrich phenomenon may be helpful in diagnosis of demyelinating optic nerve disease or optic neuritis. It should be noted, however, that many patients have difficulty perceiving the elliptical path illusion because of poor stereopsis or misunderstanding the test. Therefore, a negative response should not be used to rule out optic nerve involvement.

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