

Article • A Symptom of Diplopia Demands Accommodative and Convergence Assessment Despite Advancing Age or Ocular Pathology – A Case Series

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ABSTRACT

Background: Accommodation is stimulated by various factors, including probable size and distance of a stimulus, blur, spherical and chromatic aberrations, and continuous oscillations of the ciliary muscle tone. It is also influenced by spectacle or contact lenses wear. Two uncommon cases are reported with complaints of diplopia due to accommodative spasm as a result of uncorrected facultative hyperopia and convergence excess in a keratoconic patient due to contact lens wear.

Case Reports:

Case 1: A 58-year-old retired male presented with complaints of double vision both at distance and near. He was an extensive e-book reader. His best-corrected visual acuity improved to 6/6 and N6 in both eyes with spectacles, but the diplopia persisted. A homatropine refraction was performed, which revealed an uncorrected facultative hyperopic component leading to accommodative spasm. Upon full correction of the manifest hyperopia, the patient attained relief from accommodative spasm, and the diplopia resolved.

Case 2: A 27-year-old male keratoconic patient whose vision was blurred with spectacles presented for an examination. His vision improved to 6/6 and N6 with Rose K contact lenses, but he developed diplopia at near with the contact

lenses. Further examination revealed convergence excess. Consequently, he was prescribed +0.75 DS spectacles to be worn on top of his contact lenses for near and intermediate distance viewing, which relieved the diplopia.

Conclusion: Diplopia has many causative factors, as seen by the two case reports presented. A full binocular vision workup including cycloplegic or dynamic refraction is warranted to help determine causation .

Keywords: diplopia, keratoconus, accommodative spasm, facultative hyperopia, convergence excess

Introduction

Accommodation is the ability of the eye to alter the refractive status by modifying the lens structure to focus an object at various distances. This variation is brought about by contracting the ciliary muscle, which consequently relaxes the zonules of Zinn, thereby reducing the crystalline lens capsular tension. This further brings reduction in the lens diameter, increase in the lens thickness, forward protrusion of the lens center, and a relative flattening of the lens periphery. These conglomerate processes are mediated by the parasympathetic nervous system through the third nerve (oculomotor).¹

Accommodation is stimulated by various factors like probable size and distance of a stimulus, blur, spherical and chromatic aberrations, and continuous oscillations of the ciliary muscle tone.² Accommodation is also influenced in an ametropic eye when shifted between spectacles and contact lenses, the reasons being altered vergence demand due to the difference in vertex distance, induced prismatic effect with spectacles, and the constant movement of the contact lens on the cornea with blinking and eye movements.³ Therefore, a myope wearing contact lenses accommodates and converges more compared to when wearing spectacles; the reverse is true in a hyperope.⁴

In this case series, two infrequent happenings were encountered where accommodation and vergence received excess stimulation, leading to complaints of diplopia. In the first case, a 58-year-old patient went into accommodative spasm due to uncorrected facultative hyperopia. In the second case, a 27-year-old keratoconic patient developed convergence excess when fitted with Rose K contact lenses.

Case Series

Case 1

A 58-year-old retired male presented with complaints of double vision that occurred more at distance than at near. He was an extensive e-book reader. His vision with his existing spectacles was 6/9+ and N12 in both eyes, with doubling of the images binocularly. The existing spectacles had a prescription of +2.50-1.25x30 and +1.25 DS in the right and left eyes, respectively, with an add of +2.75 DS OU. The patient showed 3 prism diopters of esophoria with the previous prescription. His refraction revealed +2.50-1.25x30 and +1.50 DS in the right and left eyes, respectively, with vision of 6/6 for distance and N6 for near through a +2.75 DS add. This was similar to his previous spectacle prescription. No reduction in the diplopia was found for both distance and near.

A cycloplegic refraction was performed using tropicamide.⁵ The wet refraction values were +2.75-1.50x30 and +2.00 DS in the right and left eyes, respectively, with an acuity of 6/6 in both eyes. With these findings, the diplopia became monocular in contrast to the earlier binocular diplopia. Since the diplopia was persistent in the right eye, a homatropine refraction was considered to rule out any latent hyperopia, which was done the following week.⁶⁻⁸ Though typically NRA and PRA are measured for near only, in this case, we measured them at distance as well, using the same methodology as for near in order to understand the amount of uncorrected residual hyperopia leading to a lead of accommodation.⁹ A 6/12 letter was given as the target. Binocularly, plus lenses were increased in 0.25D increments on top of the best-corrected subjective refraction value until the first sustained blur was reported for NRA. The same was repeated with minus lenses for PRA. This revealed an NRA of +1.00 DS and a PRA of -0.75 DS at distance. For near, the patient's NRA was +0.50 DS, and the PRA was -2.00 DS. A homatropine refraction was performed, and the post mydriatic test (PMT) revealed a refraction of +3.25-1.25x30 and +1.75

DS in the right and left eyes, respectively. With this new prescription in place, the diplopia was resolved; hence, the same was prescribed. Post mydriatic test refraction was performed after 4 days of cycloplegic instillation after the weaning of the cycloplegic effect. With the new Rx, he was found to have an NRA of +2.25 DS and a PRA of -0.75 DS for distance. For near, his NRA was +1.25 DS and his PRA was -2.25 DS.

His extraocular movements were full in all nine gazes, and he was orthophoric for both distance and near. The slit lamp evaluation and ophthalmoscopy evaluation were within normal limits.

A diagnosis of accommodative spasm due to uncorrected latent hyperopia was assigned. He was advised to wear spectacles for the full manifest hyperopic correction with the addition of +2.50 DS at near, which gave him a 6/6 and N6 vision along with a good range of working distance. The diplopia remained resolved. His 6-month follow-up revealed comfortable spectacle wear without any complaints.

Case 2

A 27-year-old male software engineer presented with complaints of blurred vision more at near than distance with two-year-old spectacles. The patient had visited two other hospitals with the same complaint and was diagnosed with keratoconus, for which collagen cross-linking was advised. Since the patient was not interested in an invasive procedure, he came for alternate advice.

The patient's previous spectacle prescription was plano-3.00x090 in the right eye and plano-3.50x090 in the left eye, with visual acuity of 6/9+3 and N6 associated with blurring/ghosting of the images in both eyes. Upon refraction, his best-corrected visual acuity improved to 6/6 and N6 (blurred/ghosting) with +0.25-3.00x090 and +1.00-3.50x90 in the right and left eyes, respectively. His topography revealed astigmatism of 2.60D @ 158 in the right eye and 4.10D @ 022 in the left eye.

His extraocular movements in all gazes were normal. The slit lamp biomicroscopy did not reveal any keratoconic changes, although his topography did. The ophthalmoscopy findings were within normal limits.

The patient was fit with Rose K lenses in both the eyes due to the corneal irregularity in the central 3 mm zone, as revealed by the topography. The parameters of the final lenses were 7.1/-4.75/11.4/std and 7.3/-4.25/11.40/std, with clear 6/6 vision in the right and left eyes, respectively, although the

near and intermediate vision with the contact lenses became double.

The patient's accommodative amplitude was 12.2 diopters binocularly using the RAF ruler, and the near point of convergence (NPC) was 6 cm with a penlight. As reported earlier, in a convergence excess patient, NPC is usually close to the face with an eso break.^{10,11} The phoria was assessed by a synoptophore, which revealed 2 prism diopters esophoria for distance. Additionally, -3.00D lenses were added to the synoptophore, which revealed an 8 prism diopter esophoria for near. His accommodative convergence to accommodation ratio (AC/A) was found to be 9.3/1 by the heterophoria method. He could only clear 8.5 cycles with +/-2.00 D accommodative flippers; the patient was found to be a little slow with minus. His vergence facility and NRA/PRA were not assessed. From the above tests, the patient was diagnosed to have convergence excess.

Along with the Rose K lenses, the patient was prescribed a pair of +0.75 DS spectacles for intermediate and near work, with which his diplopia was relieved. Measurement of the phoria showed 2 prism diopters esophoria for near. The addition was prescribed based on the plus build-up method; i.e., the minimum plus required to reduce his esophoria and to eliminate the diplopia. Optometric vision therapy was not recommended since he lived 400 km from our hospital, and he could visit only once every 6 months for follow-up. He was reviewed after 6 months and 1 year, and he was comfortably wearing Rose K lenses coupled with spectacles without any complaints.

Discussion

Earlier literature revealed a general trend of a hyperopic shift from emmetropia and hyperopia with increased age, specifically after 45 years of age.¹² This tendency to shift towards hyperopia is attributed to the loss of the gradient index of the crystalline lens.¹³ Accommodation is not completely relaxed when an object is viewed at 6 meters, which is amply proved by fogging with plus lenses. The residual myopic shift exhibited by fogging is the physiological pseudomyopia. This physiological pseudomyopia is nullified by the cycloplegic effect by totally paralyzing the accommodation, which in turn leads to a hyperopic shift.¹⁴ It is a known fact that accommodative amplitude reduces with increased age, approximately 0.3 D/year from 5 to 52 years. The residual 1.00 D is contributed by the depth of focus.¹²

Since the patient in the first case was 58 years old, and his expected amplitude of accommodation is zero, the presence of increased amplitude was not anticipated. Hence, a tropicamide refraction was performed initially. As the patient was continuing to have double vision, a homatropine refraction was performed, which revealed an undetected facultative hyperopia leading to accommodative spasm due to extended near reading. This latent hyperopia was corrected with spectacles. Additionally, the patient was asked to reduce his reading hours and to take frequent breaks in between. Initially, when the patient presented with diplopia, his subjective distance doubling was greater than it was at near. Later, after the tropicamide refraction, when the diplopia became monocular in nature, the subjective doubling was same at distance and near, although the amount of diplopia for distance and near were not measured separately.

Convergence is a major factor in maintaining single binocular vision. A direct relationship between convergence and accommodation is represented by accommodative convergence. The association between the two is depicted by the AC/A ratio, the equation for which is the amount of accommodative convergence in prism diopters that occurs per diopter of accommodation. The AC/A is said to be high when the esodeviation for near is greater than for distance, leading to convergence excess.¹⁵ An earlier study compared the relationship between corneal topography and accommodation in both normal and thin keratoconic eyes¹⁶ and concluded that although a significant central corneal shape change was not present with accommodation, a small ocular excyclotorsion occurs and may have influence on the optical characteristics in near viewing conditions. In the second case, it was found that the patient exhibited convergence excess, which became exacerbated with contact lens correction due to increased accommodation and convergence demand, noted since his occupation involved excessive near and intermediate viewing. A plus lens on top with spectacle correction relieved the increased accommodative demand, and the base-out effect of the plus lens decreased the positive fusional vergence demand, thereby relieving the patient's diplopia and providing comfortable clear vision for prolonged near work. The added plus lenses were prescribed to reduce his accommodative demand primarily, whereas the prismatic effect created by the plus lenses was a secondary outcome. A previous

study stated that a gross reduction in stereopsis was found in keratoconic subjects.¹⁷ Hence, it becomes important to assess both the sensory and motor binocular vision status, especially after fitting with contact lenses for functional improvement in patients with corneal ectasias like keratoconus, pellucid marginal degeneration, post-LASIK ectasia, Terrien's marginal degeneration, etc.

Conclusion

Diplopia has many causative factors, as seen by the two case reports presented. A full binocular vision workup, including cycloplegic or dynamic refraction, is warranted to help determine causation.

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