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Binasal Hemianopia: an Observational Teaching Case Report and Review of a Rare Visual Field Defect

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Abstract

Binasal hemianopia is a rare visual field defect with many causes. An under-reported cause is secondary to poor test instructions by the technician monitoring the test. This report highlights a case of false binasal hemianopia secondary to poor test instructions, which led to unnecessary neurological consultation and neuroimaging that was shown to be within normal limits. This case report provides an overview of binasal hemianopia, a suggested examination protocol for avoiding a false artifactual diagnosis, and a framework for identifying the underlying cause of true binasal hemianopia.

Key Words: *binasal hemianopia, fabricated visual field defect, false visual field defect, hemianopias, test instructions*

Introduction

True binasal hemianopia is a rare visual field defect.[1-14] The existence of true binasal hemianopic visual field defects has been met with doubt in the past.[5,15,16] Historically it has been suggested that many binasal hemianopic visual field defects appear hemianopic but are more likely intraocular nerve fiber bundle defects from bilateral optic nerve disease (e.g., glaucoma, optic disc drusen, papilledema).[6,11,16] However, extraocular binasal hemianopic visual field defects really can occur and have been reported with numerous causes, which include: intracranial vascular compression, optic chiasm disease and/or pituitary gland disorders, brain tumors and/or increased intracranial pressure, post-stroke, post-infection, post-surgery, sinus disease, bilateral lateral geniculate nuclei disease, bilateral optic nerve pathology, bilateral retinal disease, bilateral keratoconus, functional/nonorganic vision loss, idiopathic, and presumed congenital anomalies.[1-5,7-15,17-34] To expand on this list of known associations and causes, a report of an artifactual binasal hemianopia from improper visual field testing instructions by a technician follows.

Case Description

A 59-year-old African-American female presented for annual eye examination with no vision complaints. Her medical history included hypertension, diabetes mellitus, hypercholesterolemia, vitamin-D deficiency and asthma. Visual acuities were 20/20 right eye (OD) and 20/20 left eye (OS). Pupil testing was within normal limits, without afferent pupillary defect. Confrontation visual fields were also normal in both eyes (OU). Extraocular motilities showed full range of motion OU. Her exam was otherwise unremarkable until retinal examination. Bilateral optic nerve appearances were suspicious for glaucoma. Optical coherence tomography (OCT) imaging and automated visual field testing were ordered. Baseline visual field testing revealed binasal hemianopia OU that respected the vertical midline **(Figure 1)**. Repeat visual field

testing 1 week later showed identical binasal hemianopias. Given the visual field test repeatability, the severity of the defects that did not correlate with the glaucoma suspect status of the optic nerves, and the lack of retinal nerve fiber layer thinning on OCT **(Figure 2)**, an extraocular neurological cause of the visual field defects was suspected. The patient was referred urgently for neurological consultation. Neurological exam and magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) of her brain were entirely within normal limits. The patient was then lost to follow-up.

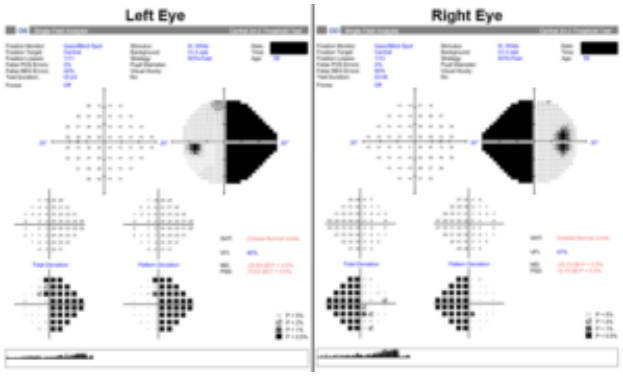

Figure 1. Baseline automated Humphrey visual field testing (24-2 protocol) showed binasal hemianopic visual field defects.
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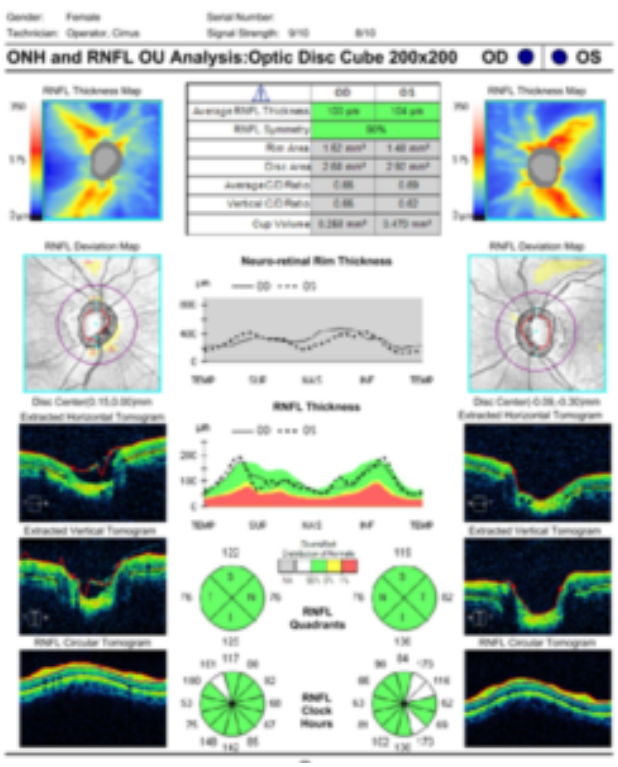

Figure 2. Baseline optical coherence tomography (Cirrus) scans showed normal, age-expected retinal nerve fiber layer thickness in both eyes.
Click to enlarge

Three years later the author assumed the patient's care as she was referred by her primary care physician for a dilated diabetic eye exam. The patient reported no changes to her vision or medical history since her visit 3 years prior. Visual acuities were stable at 20/20 OD and 20/20 OS. The remainder of her exam was stable from her visit 3 years prior. At this visit, the patient was asked what visual field test instructions she had been given at her initial appointment 3 years earlier. Interestingly, she vividly remembered being very confused by the directions at both the baseline and 1-week follow-up tests 3 years earlier. She reported that the technician phrased the visual field test directions in this manner:

"Mrs. XXX, we are going to perform a test to check your side vision. Please look straight ahead at the fixation target and click the button in your hand when a second light shows up in your side vision. Please cover your left eye with this eye patch as we are going to test your right side first."

The patient admitted she was confused as to why the technician said right side instead of right eye but was embarrassed to ask for clarification. Therefore, she performed the test as requested; she only clicked the button when the target light was in the temporal side of her vision (i.e., her right side). Because the patient completely ignored the nasal half of the visual field based on the instructions she was given, the result of her visual field test was a complete nasal hemianopia OD. The patient recalled that at the end of the right-eye visual field test, the technician continued in this manner:

"You have completed your side vision test for your first eye. Good job! Please cover your right eye with this eye patch as we are going to now check your left side."

The patient admitted she had been again too embarrassed to ask for clarification, and because the technician said "good job" she assumed she performed the test correctly with her right eye. Therefore, for the left eye test, she only clicked the button when she saw the target light on her left side. Thus, she produced false binasal hemianopic visual field defects. The patient said she was able to see the target in both nasal hemifields during testing but was doing her best to comply with the technician's directions. Astonishingly, she was able to completely re-create the entirely artifactual visual field defects at her follow-up test 1 week later, where, she reported, the technician gave her the same directions as the previous week (using the term "side" rather than "eye").

After this was made known by the patient, proper test instructions were reviewed with her before testing was repeated. The new tests showed normal visual fields OU **(Figure 3)**. Additionally, repeat OCT was stable OU compared to baseline testing 3 years earlier **(Figure 4)**.

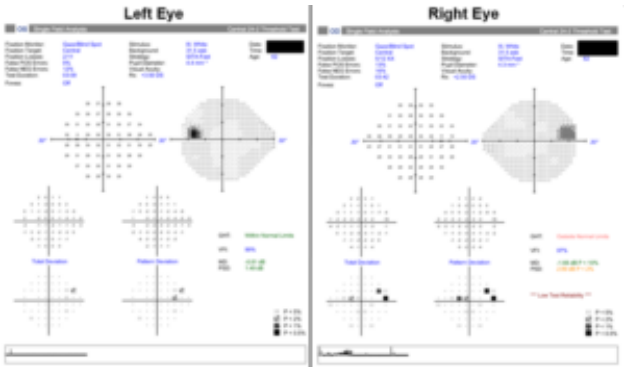

Figure 3. 3 years after baseline, and after correct test instructions were reviewed with the patient, the results of repeat automated Humphrey visual field testing were normal in both eyes. Click to enlarge

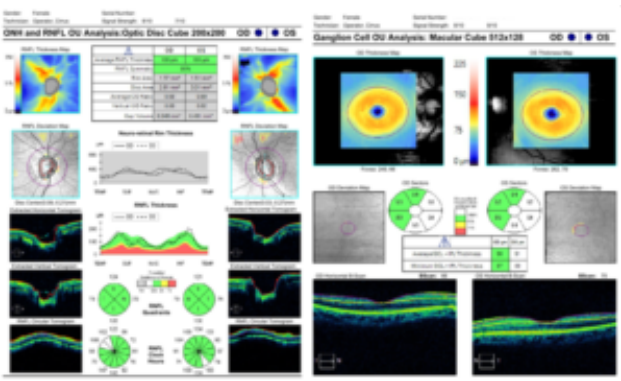

Figure 4. Left, repeat optical coherence tomography (OCT) scans (Cirrus) showed stable retinal nerve fiber layer thickness in both eyes 3 years after baseline. Right, OCT (Cirrus) ganglion cell analysis showed normal macula ganglion cell layer thickness in both eyes. Click to enlarge

Education Guidelines

Key concepts

1. The pathway of the visual fibers from the retina to the occipital lobe and corresponding visual field defects
2. Communicating with patients and the role of clear instructions
3. Patients' perception and understanding of tests and instructions

Learning objectives

1. Describe the classic presentation of binasal hemianopia with/without symptoms
2. Recognize the signs and symptoms of true vs. artifactual binasal hemianopia
3. Discuss differential diagnosis of binasal hemianopia
4. Identify causes of binasal hemianopia
5. Understand the visual pathway to predict lesion location based on visual field test findings
6. Identify additional testing to help diagnose true vs. artifactual binasal hemianopia
7. Develop a management plan for encountering possible binasal hemianopia

Discussion questions

1. Knowledge, understanding and facts about the clinical case and condition presentation

   a. what is the pathophysiology of true binasal hemianopia?
   b. describe the symptoms that would be expected in binasal hemianopia
   c. what case history questions/risk factors can be asked/identified to help identify true vs. artifactual binasal hemianopia?
   d. what is the most common cause of binasal visual field defects?

2. Differential diagnosis

   a. what conditions have been shown to cause true binasal hemianopia?
   b. how can certain etiologies be ruled out/in with a comprehensive eye exam?
   c. what additional diagnostic testing can be performed to aid proper diagnosis in patients suspected to have binasal hemianopia?
   d. what specific question(s) can be asked to help identify false binasal hemianopia?

3. Patient management and role of the optometrist

   a. when is neuroimaging (e.g., computed tomography [CT] or MRI) warranted in suspected cases of binasal hemianopia?
   b. how can you help prevent unnecessary neuroimaging in patients presenting with binasal hemianopia?
   c. when is neurological and/or neurosurgical consult warranted in suspected cases of binasal hemianopia?
   d. what patient education discussion points/tools can be used to explain findings to the patient efficiently and effectively?

Assessment of learning objectives
This case may be used in the clinical setting:

- the case can be presented and discussed in small groups
- visual field testing parameters and interpretation such as test selection, reliability indices, results and anatomical correlation to identified defects can be discussed (One activity could involve showing binasal hemianopic visual field defects and then predicting where the lesion(s) would need to be to cause such a defect)
- the neuroanatomy of the visual pathway (specifically the optic chiasm) can be reviewed to reinforce concepts learned in foundational optometric education classes

Discussion

Visual field defects

Visual field defects are numerous and may be unilateral or bilateral, complete or incomplete, central or peripheral, sectoral, arcuate, altitudinal, constricted, quadrantanopic, hemianopic or other patterns.[10] Visual field defects can be homonymous (corresponding left or right side of visual field missing bilaterally) or heteronymous (bitemporal or binasal).[2,3,6,9,10,12,15,16] Homonymous hemianopias are more common than heteronymous, and bitemporal heteronymous hemianopias are more common than binasal heteronymous hemianopias.[2,6,29,35]

General binasal visual field defects are most commonly caused by glaucoma.[1,2,11,14,20,36] Additionally, binasal visual field defects have been reported in 8 out of 100 (8%) visual field defects, with binasal

hemianopias accounting for only 2 of 8 of those cases (2%).[2] Binasal visual field defects have been reported to be intraocular in 75% cases and intracranial in 25% cases.[2] Neurologic binasal hemianopias are reported to be most commonly related to optic chiasm pathology (e.g., pituitary adenoma, ischemia, aneurysm).[3,4,9,13,15] As optic chiasms can be pre-fixed, centrally fixed or post-fixed over the pituitary gland, there appears to be considerable microvariability in the length, position, height, etc., of individuals' optic nerves, optic chiasm and optic tracts, which might result in varying patterns of visual field defects.[3,13,33,35,37]

Neurologic binasal hemianopic visual field defects are rare.[1-14] An early study of 300 cases of intracranial tumors found 5-6% cases had unilateral or bilateral nasal hemianopia.[2,38] Another study of intracranial tumors reported three incidents of binasal hemianopia in 3,033 cases (0.1% of cases), also underscoring the rarity of binasal hemianopic visual field defects.[14,39] In three other studies of patients with pituitary tumors, binasal hemianopia was reported in 1 of 21 patients (4.8%), < 1% patients, and 0% of patients, respectively.[13,33,35] In an additional study of 479 post-stroke patients with visual field loss, binasal hemianopia was reported in 1 patient (0.2%).[29]

Binasal hemianopia appears to occur equally in men and woman at an average age of approximately 44 years.[2] However, the patient age range seems to vary widely from 10-83 years.[1,2,4,7,9,11,15,17,21,25-27,34] This large age range likely reflects the many potential underlying causes and overall rare occurrence of binasal hemianopia in general.

Visual acuity, pupil response and color vision in binasal hemianopia may be normal or reduced depending on the underlying pathology.[1,2,9,11,15,17,21,26,27] Pre-fixation blindness can occur with binasal hemianopia in a similar fashion as post-fixation blindness occurs in bitemporal hemianopia.[40] If present, pre-fixation blindness suggests that the binasal hemianopic visual defect is likely real.

Possible causes of binasal hemianopia

Ocular cases of binasal hemianopia described in the literature include glaucoma, ischemic optic neuropathy, optic disc drusen, chronic papilledema, keratoconus, optic nerve pits, retinitis pigmentosa and other bilateral retinal diseases (e.g., toxicity, occlusive disease).[9,11,18,19] It is recommended that these ocular causes be ruled out first, especially glaucoma as it is the most common cause of binasal visual field defect, before neuroimaging and/or lab tests are ordered.[1,9,11,20,36] Fortunately, these ocular causes can be relatively easy to rule out with an astute comprehensive dilated eye examination.

Additionally, complete and incomplete binasal hemianopia has been reported in association with neurological visual pathway vascular compression (e.g., internal carotid artery aneurysm or atherosclerosis, internal carotid artery or anterior cerebral artery dolichoectasia and/or fusiform enlargement), increased intracranial pressure (e.g., hydrocephalus, distended third ventricle), sphenoid sinus disease, empty sella syndrome, post-infectious arachnoiditis, post-resection of pineocytoma, lateral geniculate nuclei myelinolysis, epilepsy, brain tumors (e.g., pituitary adenoma/apoplexy, cerebellar, intraventricular, meningioma), post-stroke, bilateral retinal disease (e.g., retinitis pigmentosa sine pigmento, retinal ischemia/occlusive disease), bilateral retinal toxicity (e.g., vigabatrin), bilateral temporally located keratoconus, neurosyphilis, functional/nonorganic vision loss and idiopathic and presumed congenital anomalies.[1-5,7-15,17-34]

Unilateral nasal hemianopia has been reported in the literature as being caused by aneurysm compressing the lateral uncrossed temporal retinal ganglion fibers of the optic chiasm.[12,28] In cases of aneurysmal compression of the lateral optic chiasm, 35-60% cases result in ipsilateral nasal visual field defects.[28]

It is also possible to have binasal quadrantanopsia (secondary to pituitary adenomas, optic disc drusen, optic disc pits).[2,30,31] Binasal quadrantanopsia was reported recently in one case of bilateral posterior

cerebral artery occlusion causing ischemic stroke.[41] Because glaucoma is the most common cause of binasal visual field defects, it is prudent to keep in mind the possibility of a binasal quadrantanopia mimicking a glaucomatous visual field defect in some clinical situations.[1,2,11,14,20,36]

Pathophysiology of binasal hemianopia

The temporal retinal fibers of each eye serve the nasal visual fields, and each eye's temporal retinal fibers pass closest to one another at the optic chiasm.[13,42] The ratio of nasal to temporal fibers in the optic chiasm is believed to be 53:47, with the nasal fibers crossing in the chiasm, while the temporal fibers remain lateral and uncrossed as they travel via the ipsilateral optic tracts to the ipsilateral lateral geniculate nuclei.[3,13,37,42-44] Because the temporal retinal fibers serve the nasal visual fields, it has been suggested that bilateral and symmetrical optic nerve lesions were necessary to cause a binasal hemianopia.[3,4,11] However, lesions involving the optic chiasm might also impinge upon the temporal retinal fibers bilaterally as these fibers course temporally through the optic chiasm on their way to synapse at the lateral geniculate nuclei. Therefore, optic chiasm lesions also could result in binasal hemianopias.[3,4,11] Single lesions (e.g., tumors) near the optic chiasm have also been shown to cause binasal hemianopia.[4,13,30,31,33] This is similar to bitemporal hemianopia, which is most commonly caused by single lesions, such as pituitary adenomas, that cause compression of the nasal crossing fibers of the optic chiasm.[3,35]

Many theories about the pathophysiology of extraocular nasal or binasal visual field defects have emerged.[13,14,17,33,42] One theory is mechanical compression of the optic nerve in the optic canal where the superior and inferior temporal fibers pass.[33] Another theory holds that lateral optic chiasm compression could cause binasal hemianopia by compressing the temporal retinal ganglion cell axons as they pass through the lateral aspect of the optic chiasm.[13,14] A third theory put forth suggests that in some cases binasal hemianopia might be a congenital anomaly on the order of a "congenital temporal retinal axon missorting syndrome," similar to some cases of albinism in which there is abnormal decussation of the temporal retinal ganglion axons outside the normal 53:47 crossed-to-uncrossed ratio.[17,42] A fourth theory is that some of the idiopathic cases of binasal hemianopia described in the literature might be due to poor visual field test performance by patients or poor test instructions, as in our patient's case.

Kinetic vs. automated visual field testing in neurologic binasal visual field defects

To the author's knowledge, no studies have specifically compared kinetic (i.e., Goldmann perimetry) vs. automated (i.e., Humphrey Visual Field Analyzer 30-2/24-2 protocols) visual field testing in neurologic binasal hemianopic visual field defects. However, several studies have found very good correlation in general between kinetic and/or automated visual field testing in neurological visual field defects.[45,46] This suggests both modes of visual field testing are also acceptable in binasal hemianopia.

Fabricated and/or artifactual visual field defects

Is it possible for patients to willingly fabricate visual field defects? Fabricated and/or unreliable visual field defects are well-documented in a variety of disorders with either organic or nonorganic causes, and they can occur under the watchful guidance of experienced clinicians.[27,34,47-52] Several studies have indicated how easily neurological visual field defects can be fabricated by normal individuals.[47-49] In one study, a binasal hemianopia was completely fabricated by a normal individual.[47] The ability to fabricate visual field tests is reported to be similar between kinetic and automated perimetry.[49] The clinician must remain diligent in interpreting visual field test results and repeating suspect tests with correct instructions (as in this case), as well as correlating results to clinical findings as it is possible to easily fabricate a range of false neurological visual field defects.[47-49] When encountering a questionable heteronymous visual field defect such as binasal hemianopia on perimetry, the clinician should confirm it with monocular and/or binocular confrontation visual field testing.[47,51,52] If the defects are present on automated perimetry but

absent from confrontation visual field testing, the defects are likely fake. An additional clue could be the presence or absence of post-fixation blindness in bitemporal hemianopia, or pre-fixation blindness in binasal hemianopia.[40,50]

Suggested workup in binasal hemianopic cases

When encountering binasal hemianopic visual field defects in a clinical setting, clinicians should perform an astute dilated comprehensive exam to rule out ocular causes (approximately 75% cases).[2] Confirmation of the persistence of the binasal visual field defects with confrontation visual field testing and documenting the presence or absence of pre-fixation blindness is recommended. Previously suggested workup for binasal hemianopia from the late 1970s includes comprehensive eye examination including applanation tonometry, dilated optic nerve and retinal examination, electroretinogram, syphilis serology/tests, neurologic examination, erythrocyte sedimentation rate test and neuroimaging.[2] It now seems reasonable to add fundus photography, OCT, keratometry and/or corneal topography and electrophysiology to this diagnostic approach when clinically appropriate.[1,7,27,34,42]

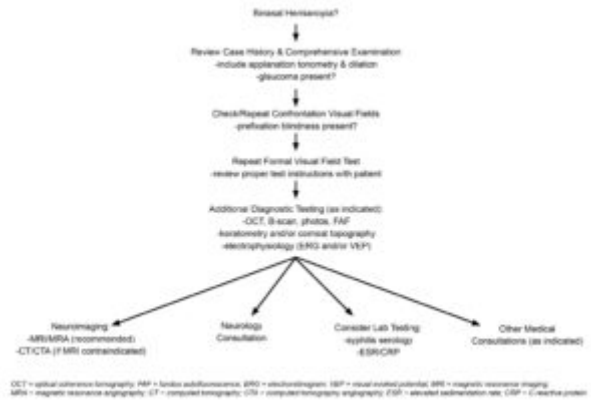

Figure 5. Overview of suggested protocol when encountering binasal hemianopia in a clinical setting.
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Common intraocular causes of nasal visual field defects (e.g., glaucoma, ischemic optic neuropathy, optic nerve drusen, retinal disease) should be ruled out before considering an intracranial lesion. This especially applies to glaucoma because it is the most common cause of binasal visual field defects.[1,11,20,28] In the absence of the common causes of nasal visual field defects, aneurysms and other intracranial lesions should be ruled out by MRI, MRA, CT or computed tomography angiography.[7,20,28] Prior to moving forward with neuroimaging, a good clinical rule of thumb may be to add the additional step of reviewing what visual field test instructions were provided to the patient by the technician. This would help ensure that miscommunication of the instructions is not responsible for the appearance of a binasal visual field defect, as in this case. **Figure 5** provides an updated suggested protocol for evaluating potential binasal hemianopia.

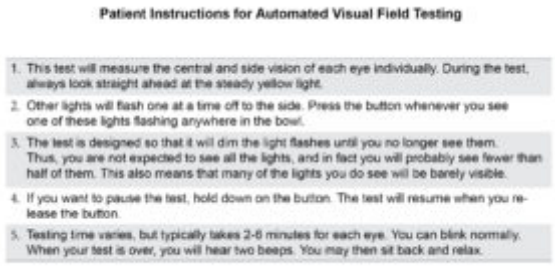
Treatment and prognosis

Eyecare providers should appropriately identify, treat and refer for further consultation cases of binasal hemianopia. Treatment should be directed at the underlying cause. Therefore, appropriate referrals might include ophthalmology subspecialists (glaucoma or neuro-ophthalmology), neurologists, neurosurgeons, primary care physicians or other medical specialists. Vision should be maximized with appropriate refractive error correction, and low vision rehabilitation should be strongly considered when quality of life and/or activities of daily living are impaired by decreased vision.

Prognosis is guarded and is likely variable based on time to diagnosis, extent of visual field damage,

involvement of central vision, response to treatment (if available), degree of visual pathway atrophy or appropriate referral. One paper has shown that some cases of binasal hemianopia may be reversible if treated appropriately and before permanent visual pathway damage occurs.[25]

Conclusion


Patient Instructions for Automated Visual Field Testing

1. This test will measure the central and side vision of each eye individually. During the test, always look straight ahead at the steady yellow light.
2. Other lights will flash one at a time off to the side. Press the button whenever you see one of these lights flashing anywhere in the bowl.
3. The test is designed so that it will dim the light flashes until you no longer see them. Thus, you are not expected to see all the lights, and in fact you will probably see fewer than half of them. This also means that many of the lights you do see will be barely visible.
4. If you want to pause the test, hold down on the button. The test will resume when you release the button.
5. Testing time varies, but typically takes 2-6 minutes for each eye. You can blink normally. When your test is over, you will hear two beeps. You may then sit back and relax.

Figure 6. Correct patient test instructions for automated visual field testing with the Humphrey Visual Analyzer (Carl Zeiss Meditec, Dublin, CA).[53,54]
Click to enlarge

True binasal hemianopia is rarely encountered clinically but can present a diagnostic challenge.[1-14] Eyecare providers should perform astute clinical examinations with appropriate technology to rule out ocular causes of binasal hemianopia before proceeding to considering intracranial causes.[2] Improper or unclear test instructions may lead to erroneous diagnosis of visual field defects, as in this case. Proper automated visual field test instructions should be explained to patients based on the manufacturer's recommendations **(Figure 6)**.[53,54] It is reasonable to verify the visual field test instructions given to patients with binasal hemianopia and repeat the test before proceeding to more expensive and time-consuming tests such as neuroimaging. This case report helps to expand the list of known causes of binasal hemianopic visual field defects to include improper visual field test instructions given by technicians supervising the test.

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