Hemianopia

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Editor's Comment

The value of visual field defects in lesion localization is undisputed. Carefully plotted, they point unerringly to the site of the lesion. Nevertheless, most of us do not regularly extract the most information from our examination of visual field deficits, partly because of awkwardness, inefficiency, or inexpertness in the actual examination, and partly because our interpretation lacks the sureness required. This lesson describes the proper examination technique concisely and clearly. Although most practicing neurologists and neurosurgeons do not perform formal perimetry, careful confrontation testing should be sufficient in most instances to provide localization. Dr. Ellenberger's comments about the symptoms which occur in the hemianopias are interesting and clinically useful, as are the paragraphs describing the special diagnostic features of hemianopia. How many of us know, for example, that the border of a field defect provides a clue as to whether the lesion causing it is stable or progressing?

Peritz Scheinberg, MD

Hemianopia, literally "half vision," indicates a disturbance of conduction in the visual pathways somewhere between the optic chiasm through the optic tract and the lateral geniculate nucleus to the occipital cortex. Although many patients with hemianopia have not lost exactly half of their vision, we still apply the term hemianopia when we detect a sharp border anywhere along the vertical meridian between one abnormal half field and its normal opposite (Figure 1). The vertical border is the clue that the lesion affects the chiasmal or retrochiasmal visual pathways. Thus, hemianopia is a valuable neurologic sign, not only because it reliably indicates the presence and location of a lesion, but also because it is the only type of visual field disturbance that can be caused by such a lesion. We show below that careful measurements and delineation of hemianopia can provide valuable topographic and diagnostic information and that measuring the progression or regression of hemianopia may be the most accurate method of following the course of brain lesions, such as pituitary adenomas.

Symptoms of Hemianopia

Hemianopia is likely to be noticed if its onset is abrupt. Delayed diagnosis of chiasmal lesions results primarily from the fact that the slowly progressing bitemporal hemianopia does not come to the attention of its victims. Eventually, however, all patients with hemianopia become aware of a visual defect on one or both sides of their field of vision when they collide with unseen objects or motor vehicles approaching from the blind side. Patients with right homonymous hemianopia may describe difficulty in reading smoothly along a line of printed words. Those with left homonymous hemianopia may not be able to move their eyes unerringly from the end of one line of print to the beginning of the next line. Although the less perceptive patient with hemianopia may complain only of "blurred vision," hemianopia alone, even if it "splits" the point of visual fixation, does not reduce visual acuity. Even the patient with bilateral hemianopia and only a segment of visual field remaining can read the
bottom line of the eye chart if the apex of the remaining segment of vision includes the fixation point. Thus, preserved visual acuity does not necessarily indicate the presence of “macular sparing” (see below).

Another symptom of hemianopia that is more common than is usually realized is diplopia. Intact half fields, especially in bitemporal hemianopia, may have a tendency to slide apart—the “hemifield slide phenomenon.” Loss of bilaterally projecting retinal ganglion cells has been offered as an explanation. This tendency of the hemifields to dissociate, which is possibly stronger in those patients with an underlying exophoria, may be greater in patients with bitemporal hemianopic defects because of the presence of “postfixational” blindness. Simple geometric calculations can demonstrate that, if bitemporal hemianopia is complete, there will be a wedge-shaped area of blindness distant from the point of visual fixation, in the postfixational space (Figure 2). This blindness, as well as the loss of stereopsis, may cause difficulty in the performance of precision tasks that demand precise anterior-posterior orientation, such as cutting nails, threading needles, and other tasks that require stereoscopic vision. Patients with complete bitemporal hemianopia have binocular vision only in a diamond-shaped region between the point of fixation and the nose—the prefixational space.

Diagnosis of Hemianopia by Confrontation Testing

The basis for confrontation testing is a comparison between the half field thought to be impaired and the opposite half field (thought to be normal). The patient should be asked to compare the brightness, saturation, or hue of color of two identical objects placed on either side of the vertical meridian. The closer to the vertical meridian the objects are placed, the easier the comparison and the denser the defect. We use bright red or blue “swizzle sticks” from a restaurant or bar, but any two small, colored, identical objects, such as the tops of ophthalmic dropper bottles, red-tipped match sticks, or occasionally the palms of each hand, are useful stimuli. Half fields should be compared about 10 to 20° above and below the point of visual fixation.

Another useful confrontation test is the “finger counting” test. Most patients with normal vision can correctly count up to four or five fingers displayed simultaneously by the examiner on each hand on both sides of the point of visual fixation—which, conveniently is the examiner’s nose. Although binocular testing usually suffices to detect a right or left hemianopia, each eye should be tested individually to avoid missing a bitemporal defect. Repeated trials usually clarify uncertain results. The examiner should ask, “What is the total number of fingers?” Patients with complete hemianopia may not see the fingers in one field; patients with partial hemianopia may not be able to count them correctly every time. Other patients with lesions of the parietal lobe which do not directly interrupt conduction of visual pathways may “extinguish”
or "neglect" one of the examiner's hands when two are presented simultaneously on either side of the vertical meridian. These two methods are more consistently sensitive than the more commonly employed wiggling finger technique, probably because the latter test stimuli are large and moving and therefore too far above the threshold to detect less than complete defects.

Other variations of confrontation perimetry should be devised at the bedside or in the office to adapt the technique to each patient. Adaptations are especially useful when examining children or older patients with altered consciousness. Eye movements toward a stimulus that is "flashed" for a fraction of a second in various parts of the visual fields indicate at least some vision in those parts of the fields of infants and children. A stuffed animal entering the far temporal field from the rear of a child is a particularly good stimulus for infants and toddlers. Nonverbal infants, children, or adults may be capable of indicating intact vision by mimicking with their own hands the same number of fingers displayed by the examiner in different quadrants of the visual field.

Formal Perimetry

Our techniques of formal perimetry with a projection perimeter have been described recently. We employ this method because the illuminated bowl of the Goldmann or Tübinger perimeter light-adapts the visual system. Examining under light-adapted conditions is appropriate because a majority of the fibers in the visual pathways project from the fovea and macula, which are most sensitive in lighted conditions. A principle that we capitalize on is the fact that the weaker (smaller and dimmer) the perimetric stimulus, the larger the defect detected in vision. Thus, hemianopia may not be detected by a large, bright test spot, whereas it may be complete with a tiny, dim light or colored spot (Figure 1).

An early hemianopic defect is first seen adjacent to the vertical meridian, either above or below the point of fixation; it does not "close in" from the far temporal or nasal periphery of the visual field. Therefore, we move our small test spot from the peripheral visual field toward the fixation point carefully, both nasal to and temporal to the vertical meridian. The resultant "step" may be the earliest indication of a hemianopic defect. The mapping of several "isopters" obtained by the use of several different stimuli of varying strengths allows the most complete characterization of a hemianopic defect. Special advantages of colored stimuli, aside from the fact that they are weaker (less bright) than identical-sized white stimuli, have never been proved.

Special Diagnostic Features of Hemianopia

Isolated homonymous hemianopia tends to appear suddenly because it usually results from ischemic vascular disease in the territory of one posterior cerebral artery. In the majority of cases, the absence of associated motor and sensory signs and symptoms localizes the lesion to the occipital lobe. These patients may have macular or foveal sparing, and occasionally the hemianopia is bilateral (see below).

Congruity or congruence refers to the similarity of defects between the fields of both eyes, and the terms are usually applied to the description of homonymous rather than bitemporal hemianopia. Although congruence of defects is generally typical of lesions close to or in the striate cortex, congruence alone (or lack of it) is not usually sufficient for localization of any single lesion. Congruence is difficult to quantitate and depends on the care and skill of the perimetrist. Criteria for its presence or absence vary among examiners. For example, Van Buren and Baldwin considered the field defects of 23 of 33 patients after temporal lobectomy to be incongruous because they differed by as little as 5°. Most perimetrists would consider those criteria to be too strict. In contrast, Falconer and Wilson found congruous defects in the visual fields of all 50 of their patients after temporal lobectomy, but they used a less stringent definition of congruence.

"Gross incongruity" is unmistakable and generally indicates an optic tract lesion (Figure 3). The gross incongruity results from two factors. First, lesions that selectively involve the optic tract, partly because most of them are compressive in nature, do indeed tend to cause incongruous defects in the visual fields. Second, if such lesions expand anteriorly, they may eventually compress the ipsilateral optic nerve, thus adding an ipsilateral (monocular) central visual field defect to the contralateral homonymous hemianopia. Visual field measurement is critical in the diagnosis of the optic tract syndrome. Some evidence suggests that pathogenesis is as important as location of the lesion in the determination of congruity: Frisen described patients with vascular lesions of the lateral geniculate nuclei.

![Figure 3. Grossly incongruous right homonymous hemianopic defect caused by a carotid aneurysm compressing the left optic tract. Note that central vision of the left eye is reduced (the fixation point is not included within the perimeter of either isopter) because the aneurysm also compressed the left optic nerve.](image-url)
patients with partial bilateral homonymous hemianopia caused by missile wounds in World War I. All of these patients lost the inferior quadrants of both homonymous half fields. These patients were overly represented in Holmes’ series because the victims of gunshot wounds that caused superior visual field defects did not survive because of associated damage to the cerebral dural venous system and probably also to the brain stem. In contrast, vascular ischemic disease can selectively involve either superior or inferior quadrants; the sharp horizontal border of a homonymous hemianopic defect can localize the lesion to either the gyrus superior to or inferior to the calcarine fissure. A variety of visual perceptive disorders, such as prosopagnosia and cerebral color blindness, accompany bilateral homonymous hemianopia.9

The junctional field defect was described by Traquair as an indication of a lesion at the junction of the optic nerve and chiasm. The term junctional, as commonly used, describes a temporal hemianopic defect contralateral to an optic nerve defect on the side of the lesion. Presumably, the lesion causing ipsilateral optic nerve compression expands to involve the fibers crossing in the chiasm from the opposite eye. Traquair, however, actually described a purely monocular visual field defect; his patients had a true unilateral temporal hemianopic scotoma, since the visual field of the opposite eye remained completely normal (Figure 6).10 This monocular junctional defect also indicated a lesion compressing one optic nerve and, selectively, ipsilateral crossing or uncrossing fibers.

Hemianopic scotomas. Some observers believe that bitemporal hemianopic scotomas have special diagnostic significance. Hoyt wrote, for example, that they result when the optic chiasm is tilted upward and flattened by an unusually large extrinsic (to the chiasm) mass projecting superiorly and posteriorly into the base of the brain. Intrinsic masses (arising within the third ventricle) causing bitemporal hemianopic scotomas may be large and cystic (e.g., craniopharyngioma) or small and invasive.11 Nevertheless, the variable incidence (3 to 50%) of bitemporal hemianopic scotomas among published series of patients with chiasmal lesions suggests that certain examining techniques may be more likely than others to disclose them. We have not found that hemianopic scotomas, bitemporal or homonymous, have any special diagnostic significance.

Binasal hemianopia is rare, since the uncrossed retinal projections are not segregated and paired together as the crossed projections are in the optic chiasm. Thus, most patients reported to have “binasal hemianopia” actually have bilateral defects in the nasal fields (often bilateral arcuate defects) that do not border on the vertical meridian. They result from a variety of bilateral retinal and optic nerve lesions. The optic atrophy that follows chronic papilledema may cause more constriction of the nasal halves of the visual fields and, thus, binasal field loss. The incidence of “true” binasal hemianopia is rare enough for a critical observer to suspect that, even in the best documented examples, the respect of the vertical meridian by the border of the defect might be coincidental. Cox et al reported on one patient with true unilateral nasal hemianopia that respected the vertical meridian, caused by a supraclinoid carotid aneurysm.12 After careful review of the medical literature, they came up with four previous examples of true nasal hemianopic defects.
REFERENCES


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who had very congruous hemianopic defects. Compressive lesions of the geniculate, like those of the optic tract, have been thought to cause incongruous defects. 4

Macular sparing is another potential localizing feature of homonymous hemianopia. Many patients with hemianopia retain an island of vision (1 to 10° in radius) around the point of fixation on the hemianopic side. In the past, some authors have attributed macular sparing to inadequate technique, suspecting that it relates to unstable visual fixation. This possibility can be avoided by special efforts to detect macular sparing: move a vertical bar, supporting three test objects in direct vertical alignment, horizontally from the hemianopic field into the seeing field using a tangent screen as the background. Patients with macular sparing should see the middle object, entering along the horizontal meridian, first.

Many examples of macular sparing are attributable to occipital lesions, but this pattern has been described with lesions in all parts of the retrochiasmal visual pathways. Intact collateral blood supply to the occipital pole via branches of the middle cerebral artery or posterior cerebral artery may indeed explain some cases of macular sparing, especially those with bilateral homonymous hemianopia and an intact island of central vision. Therefore, true macular sparing (5 to 10° in radius) suggests an occipital lesion, especially when sudden onset suggests brain infarction.

Recent anatomical and physiological studies in animals have shown convincingly that ganglion cell axons from a vertical band extending 2 to 3° to either side of the vertical meridian, and in greater concentration around the fovea, may project to either occipital lobe. These studies have restored the concept of bilateral occipital representation of the fovea. Bilateral representation seems to be a more appropriate explanation for those examples of macular sparing after occipital lobectomy. Sparing in these cases would be predictably less than 2 to 3° in diameter when measured carefully in a cooperative patient. After a re-study of patients in their series of cases with traumatic geniculostriate lesions, Koerner and Teuber found sparing of foveal vision (averaging 1.5°) in 9 of 10 cases and "splitting" of foveal vision in only one. They consider sparing to be the rule and attribute it to bilateral cerebral representation of the foveal region of the visual fields.

The border of a visual field defect gives a clue to the temporal characteristics of the causative lesion (Figure 4). Sharp borders (excluding anatomic borders that fall on the vertical meridian) are indicated when all isopters fall close together or are superimposed on one another. These borders are characteristic of stable brain lesions. In contrast, sloping borders (indicating an area of reduced but not absent sensitivity—a "relative field defect") suggest that the causative lesion is progressing. Relative field loss (loss only to weaker stimuli) is likely to improve if the lesion is successfully reduced with corticosteroids or eradicated without further injury to the optic radiation. As mentioned previously, the weaker (i.e., smaller, dimmer) stimuli usually display the fullest extent of defects caused by progressive lesions; often an apparent quadrantanopia is a complete hemianopia when central isopters are mapped with a weak stimulus. This greater sensitivity of weak stimuli is a strong advantage of the projection perimeters on which contrast between the test spot and the background can be infinitely reduced.

The "temporal crescent" of the visual field is that part of the far temporal field, between about 60 and 90° from the point of fixation, that is visible only to the ipsilateral eye. Fibers from the far nasal periphery of the retina that carry images from this monocular portion of the visual field remain segregated within the visual pathways. But compacted within fiber tracts, these monocular fibers are unlikely to be selectively interrupted by brain lesions. Furthermore, selective partial or even total loss of the monocular temporal crescent may be difficult to detect at the perimeter. Sparing of the temporal crescent is easier to detect and, indeed, more likely to occur. At their termination in striate cortex, the optic radiations expand to occupy the entire length of the calcarine fissure. At the level of the striate cortex, therefore, monocular terminations may be spared by destructive lesions. Sparing of a temporal crescent (Figure 5) thus suggests that the lesion causing hemianopia is occipital.

Riddoch described a phenomenon that has come to carry his name. Several of his patients with traumatic occipital lobe lesions could see moving but not stationary stimuli in their affected visual fields. Unfortunately, Riddoch did not confirm his hypothesis—that such a finding is pathognomonic of occipital lobe disease—by adequately testing a sufficient number of patients with lesions elsewhere in the visual pathways. Later observers have demonstrated the "Riddoch effect" in patients with lesions in other locations along the visual pathways.

Bilateral homonymous hemianopia, when complete, may be called "cerebral" or "cortical" blindness. It occurs fairly often because both occipital lobes receive a common arterial supply. Holmes described several
POST-STUDY QUESTIONS

1. Macular (or foveal) sparing:
   A. May occur after occipital lobectomy
   B. Never occurs
   C. May occur after occlusion of a posterior cerebral artery
   D. Is an artifact related to unstable visual fixation
   E. A and C

2. Early hemianopic defects:
   A. Are best detected at the far temporal or nasal periphery of the field
   B. Are most prominent when detected by weak stimuli
   C. Are not usually detected by confrontation techniques
   D. Respect the vertical meridian
   E. B and D

3. Which of the following statements is not true about patients with bitemporal hemianopia? They:
   A. May have decreased libido
   B. May complain of “double” or “split” vision
   C. Usually detect it immediately
   D. Have abnormal stereoscopic vision
   E. A, B, and C

4. Visual fields:
   A. Cannot be tested in infants
   B. Should be done in light-adapted conditions
   C. Are most sensitively measured by the tangent screen method
   D. Should be measured with multiple test stimuli
   E. B and D

5. Which of the following statements about binasal field defects is not true?
   A. Binasal field defects indicate two lesions
   B. They indicate a chiasmal lesion
   C. They may indicate bilateral retinoschisis
   D. They are not true hemianopic defects

6. The optic chiasm:
   A. Inclines 45° from the horizontal plane
   B. Is in contact with cerebrospinal fluid
   C. Was discovered by Isaac Newton
   D. Is necessary for stereopsis
   E. All of the above

7. A spared temporal crescent:
   A. Suggests an occipital lesion
   B. Is usually bilateral
   C. Indicates chiasmal disease
   D. Is a form of quadrantanopia
   E. None of the above

8. Progressive neural lesions:
   A. Cause congruous field defects
   B. Cannot be distinguished from acute lesions by perimetry
   C. Cause incongruous field defects
   D. Are best detected by testing with multiple stimuli
   E. C and D

9. Congruity of hemianopic field defects:
   A. Depends on the location of the lesion
   B. Has no diagnostic value
   C. Depends on pathogenesis of the field defect
   D. Is greatest with optic tract lesions
   E. A and C

10. The “hemifield slide” phenomenon:
    A. Refers to the tendency of the eyes of a hemianopic patient to slide to the right
    B. Causes diplopia
    C. Suggests an occipital lobe lesion
    D. Denotes variability of hemianopia
    E. None of the above