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Original Articles.

THE OCULAR SYMPTOMS OF LESIONS OF THE OPTIC CHIASM,

WITH THE REPORT OF THREE CASES OF BITEMPORAL HEMIANOPSIA.*

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In order to study the ocular symptoms of lesions of the optic chiasm, the following classification, although somewhat artificial, naturally suggests itself:

1. The anatomic relations and structure of the optic chiasm.
2. Anomalies of the visual field.
3. Ophthalmoscopic changes.
4. Anomalies of the external ocular muscles.
5. Alterations in the pupil reflexes, with special reference to the hemiopic pupillary inaction.
6. The lesions which produce alteration in the structure and function of the optic chiasm and give rise to the ocular symptoms from which their position is inferred.
7. Diseases of the pituitary body, with special reference to the ocular symptoms of acromegaly.
8. Simulation of chiasm disease by other affections, for example, hysteria, locomotor ataxia, brain tumors.
9. The effect of certain toxic agents in causing lesions of the optic chiasm.

ANATOMIC RELATIONS.

Beneath the floor of the third ventricle the optic chiasm rests in the optic groove of the sphenoid bone. Its important anatomic relations are ventrally the sphenoid bone, dorsally the third ventricle of the brain and posteriorly the hypophysis with its prolongation, the infundibulum. The circular venous sinus and the internal carotid arteries, with their anterior cerebral branches, are in close surgical relation to the chiasm.

Microscopic Structures.—As is well known, there has been considerable difference of opinion in regard to the disposition of the fibers in the optic chiasm, whether on the one hand there is total crossing of the fibers, as Michel and von Kölliker believe, or whether, according to the majority of authors, there is, as a rule, a partial decussation. The literature of this subject, often involved and contradictory, has been best analyzed in comparatively recent times by Llewellys Barker,[1] and we can not do better than quote in a somewhat condensed manner from his admirable review as follows:

The long processes, or axones, of the ganglion cells pass into the nerve fiber layer of the retina, reaching the papilla or nervehead, and proceed to the optic nerve. Having reached the optic chiasm, a portion of the fibers of one optic nerve cross over and enter the optic tract of the opposite side, forming the crossed fasciculus, while a certain number of other fibers do not cross, but enter the optic tract of the same side, forming the noncrossed fasciculus. The noncrossed fasciculus arises chiefly from the temporal side of the retina, while the crossed fasciculus arises from the ganglion cells of the nasal side of the retina. The bundle of the macula lutea, or papillo-macular bundle, in general terms, is situated in the central part of the optic nerve and maintains its central position in the optic chiasm and in the optic tract, and is composed of crossing and direct fibers.

Now, although secondary degenerations observed in pathologic cases in higher animals and in human beings seem to prove a semi-decussation and not total crossing of the optic chiasm, and although von Gudden has shown that in the rabbit, where the decussation is almost total, there is a small non-crossed fasciculus and that total decussation is present only in such animals in which the visual fields of the two eyes are entirely separate, for example, in fish, amphibia and birds, von Michel asserts that even in man the decussation is complete or total. He bases his opinion on serial sections of the normal optic chiasm, on sections of the optic nerves, chiasm and tracts, in cases of degeneration in men and animals; and on certain physiologic considerations.

Apparently, however, his views are not tenable when taken into consideration with the great mass of evidence which has accumulated on the opposite side. Von Gudden, with careful consideration of the superior commissure of Meynert, the inferior commissure of Gudden, and the hemispheric bundle, has demonstrated by unobjectionable methods, that each of these, as well as the crossed fasciculus and the non-crossed fasciculus, can be individually isolated. He has shown that the well-known experiments of Nicati, by which the optic chiasm was cut in the middle through the mouths of cats, demonstrate that these cats could still see, which would be difficult or impossible to explain if the decussation was total, and in Siemerling's case of destruction of one optic tract with diminished sharpness of the opposite eye, the patient could still see with the temporal side of his retina, also an impossiblity if complete decussation had been present.

Finally, we come to the studies of Henschen, based on elaborately studied and collected clinical material. According to this observer, whose views are accepted by almost all modern writers on the subject, the following is the arrangement of the fibers in the chiasm: The macular fibers, both crossed and uncrossed, are axial in situation, the crossed bundles being central while the uncrossed bundles are found medial and lateral. The papillo-macular bundle, although mainly axial, almost reaches the periphery behind the center of the chiasm

* Read in the Section on Ophthalmology of the American Medical Association, at the Fifty-fifth Annual Session, June, 1904.

1. The Nervous System and Its Constituent Neuroses, 1899, p. 782.

where the crossing fibers are exposed to injury by a circumscribed lesion in the median line. The fasciculus cruciatus from each optic nerve is found on the dorsal and ventral aspects; while the *fasciculus non-cruciatus* is found medial and lateral.* In addition, the chiasm at its posterior angle contains two sets of commissural fibers not concerned in vision—the superior commissure of Meynert and the inferior commissure of von Gudden.

While it is undoubtedly true that this represents the usual anatomic arrangement in the chiasm, individual differences of great variety are possible, and indeed, have been found, varying from the entire absence of the chiasm (the right optic nerve going to the right tract and the left nerve to the left tract), to perhaps total decussation in the chiasm. (Fig. 1.)

ANOMALIES OF THE VISUAL FIELD IN CHIASM DISEASE.

The literature of this subject is extensive, and although we have examined it with some thoroughness and carefully analyzed between forty and fifty of the most important papers, it does not seem profitable in a communication of this character to do more than present a condensed statement of the possibilities in visual field changes without detailed reference to individual cases. Moreover, the entire subject has been dealt with in so masterly a manner by Wilbrand[2] that it would be impossible to avoid quoting him as freely as we have in the section which follows:[3]

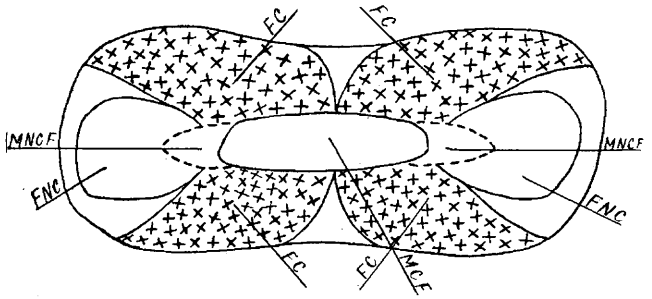

Fig. 1.—Henschen's arrangement of the fibers and chiasm according to Barker: f. c., crossed fasciculus; f. n. c., uncrossed fasciculus; m. n. c. f., macular non-crossing fibers; m. c. f., macular crossed fibers.

Complete Bitemporal Hemianopsia.—The most characteristic alteration of the visual field which may be regarded as pathognomic of chiasmal lesion is bitemporal hemianopsia, which, with its various modifications, is called by Griffith "the localizing form of hemianopsia." In a typical example there is blindness of the temporal halves of the visual field, with preservation of the normal function of the nasal halves, the dividing line making a sharp, vertical separation between the two portions of the field of vision. (Fig. 2). Instead of loss of the temporal field exactly to the fixation point, a portion of the field may be retained beyond this position, i. e., the line of separation does not lie in the vertical meridian.

This "over-shot field of vision," as it has been called, suggests the supply of the macula with a double set of nerves, one from each hemisphere, and has been explained by Schmidt-Rimpler by assuming anastomoses of the fibers in the optic nerves and chiasms. An interesting fact is the occasional long unchanged duration of bitemporal hemianopsia, as in Förster's[4] case, where with complete loss of the temporal fields those on the nasal side remained unaltered for ten years. In these typical cases, not only does the nasal field for form remain unchanged, but the color-limits of the same sides are also preserved and coincide with the vertical separation. The temporal field defect is not necessarily complete *ab initio;* it may begin with loss for colors only, to be followed later by loss of form sense and light sense, or the form sense and color sense may be lost, and the light sense retained entirely or in part.

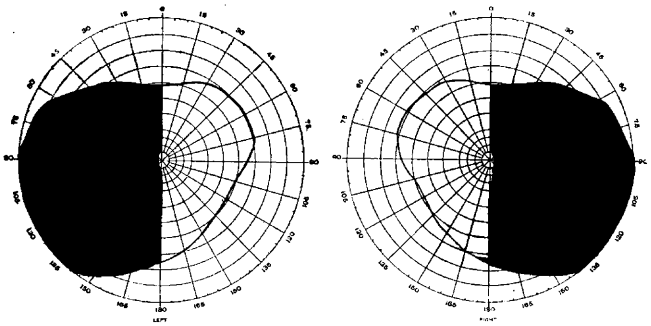

Fig. 2.—Typical bitemporal hemianopsia.

Again, the process may begin with paracentral or bitemporal hemianopic scotomas, which gradually broaden into bitemporal hemianopsia. Such cases, according to Wilbrand, have been reported by Beer, Förster, and Vossius.[5] In the last-named author's case, the condition began with bilateral temporal contraction of the visual fields and paracentral scotomas, and was followed by sharply limited bitemporal hemianopsia (Fig. 3).

Finally, the original condition of bitemporal hemianopsia may change and result in symmetrical paracentral hemianopic scotomas, as in Treitel's[6] case, which is quoted by Wilbrand. (Fig. 4).

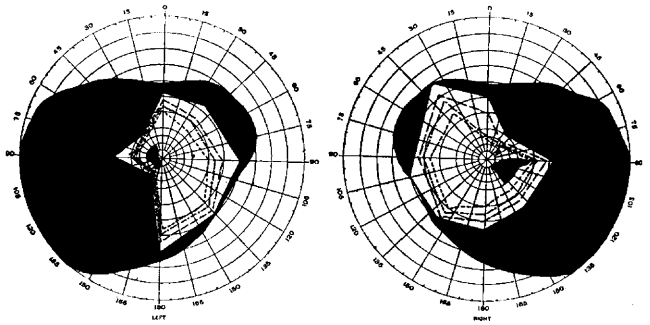

Fig. 3.—Bitemporal contraction of the visual fields and paracentral scotomas, followed later by bitemporal hemianopsia, after Vossius.

Significance: Typical bitemporal hemianopsia of permanent character is caused by a lesion which destroys the function, or, as it is called, the conductivity of both crossed fasciculi, leaving the non-crossed fasciculi unaffected. The best reported case of this character has been recorded by Weir Mitchell and Dercum,[7] in which

*A somewhat different arrangement of the chiasm fibers is given by Wilbrand and Saenger, Neurologie des Auges, vol. iii, p. 79.

2. Perimetry and Its Clinical Value: A System of Diseases of the Eye, edited by Norris and Oliver, vol. ii, 1897, pp. 262-278. See also by the same author, Die Hemianopischen Gesichtsfeld-Formen und das optische Wahrnehmungszentrum: Wiesbaden, 1890. Since writing this paper Die Neurologie des Auges., vol. iii, 1904, by Wilbrand and Saenger has appeared. It has not been possible to incorporate the superb studies of chiasm diseases contained in its pages.

3. See also Das Gesichtsfeld: Karl Baas, 1896, p. 216.

4. Graefe und Saemisch, Handbuch der gesammten Augenheilkunde, vol. vii, p. 116.

5. Graefe's Archiv f. Ophthalmologie, vol. xxx, 3, p. 172.

6. Centralbl. f. prakt. Augenheilk., 1881, p. 320.

7. Jour. Nervous and Mental Disease, vol. xiv, 1889, p. 44.

an aneurism destroyed the center of the chiasm and obliterated the function of the crossed fasciculi. Paracentral or hemianopic scotomas indicate that the lesion is confined to that point on the dorsal surface of the chiasm where the papillo-macular fibers of the crossed fasciculus are interwoven.

Bitemporal hemianopsia subject to fluctuations in the extent of the visual disturbances depends on the basal disease, especially syphilis, as has been pointed out by Oppenheim.[8] Improvements, even to complete recovery, may be followed by subsequent loss of vision. In such a case as Treitel's, previously quoted (See Fig. 4), Wilbrand suggests that a basilar gummatous meningitis may have injured the crossed fasciculus, while an interstitial neuritis may have caused atrophy at the intersection of the papillo-macular fibers.

In this connection we briefly refer to two cases of bitemporal hemianopsia with autopsy:

BASAL GUMMA AND BITEMPORAL HEMIANOPSIA.

CASE 1.—This case one of us (de Schweinitz[9]) has already reported briefly.

History.—The patient, a colored man, in the wards of Dr. H. C. Wood in the Philadelphia Hospital, was a syphilitic aged 55, who had epileptic attacks, Jacksonian in type, partial loss of hearing on one side, demonstrable loss of taste and smell, partial hemianesthesia and hemiplegia. Wernicke's pupil symptom could not be demonstrated. Both nerves were atrophic, and there was complete bilateral temporal hemianopsia,, with marked contraction of the preserved fields (Fig. 5).

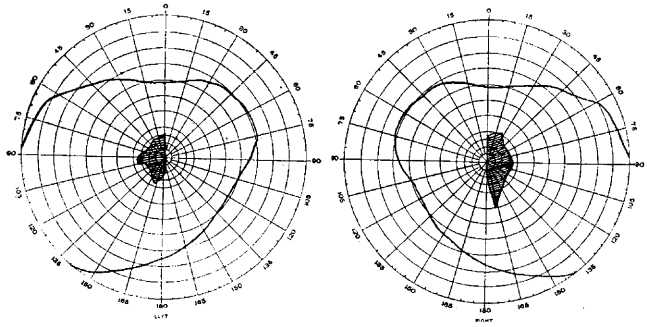

Fig. 4.—Symmetrical paracentral scotomas, after Treitel.

Autopsy.—At the postmortem examination a band-like gumma was found which stretched across the anterior end of the pons and reached to the cribriform space. One end of the tumor was thicker and heavier than the other. The corpora quadrigemina and optic tract and chiasm were involved. Microscopic examination was not made.

TUMOR OF CHIASM; METASTASIS FROM MAMMARY CARCINOMA; BITEMPORAL HEMIANOPSIA.

CASE 2.—This patient, a woman between 50 and 60 years of age, was examined by one of us (de Schweinitz) in consultation with Drs. Tyson and Mills, who will report the case in detail. It is now referred to as a typical example of temporal hemianopsia in which a growth secondary to a carcinoma of the breast was situated at the base of the brain and involved in the chiasm. The visual fields (Fig. 6) indicate that the crossed fasciculi were divided. Dr. Spiller's examination of the specimens is as follows:

Autopsy.—The findings in the chiasm of Mrs. G. are as follows: The sella turcica was much enlarged and was about one and one-half inches in width from side to side, and about one inch from before backward. A large tumor mass filled the sella turcica, and the tumor was larger on the left side than on the right. The tumor extended around the optic chiasm and grew from behind it, and extended backwards almost as far as the anterior part of the pons. The right optic nerve was not imbedded in the tumor, but the tumor grew into the left orbit and surrounded the left optic nerve.

Microscopic Examination.—This showed that the tumor was a carcinoma, and that the optic chiasm was much degenerated by the invasion of and pressure from the tumor.

Temporal Hemianopsia of One Eye and Partial or Complete Blindness of the Opposite Eye.—Partial or complete blindness of one eye, with loss of vision in the temporal field of the opposite eye, has been reported a number of times. Thus there may be temporal hemianopsia of one eye, with entire loss of vision in the opposite eye, except in its upper or lower nasal quadrant; or the loss of vision in the opposite eye may be complete for color or form, but partially retained for light in one nasal quadrant; or, finally, the loss of vision in the opposite eye may be absolute. Cases of this character have been reported by Hirschberg, Lang and Schoen.

Significance: Under these circumstances the clinical picture is significant of a spreading lesion gradually involving the entire chiasm. Thus, if the upper or lower quadrant of the nasal field of the opposite eye is lost, in addition to its temporal blindness, it means that the disease has spread to the areas of the chiasm represented by the loss of visual function.

In this connection we record the following case already briefly reported by one of us (de Schweinitz[10]).

CASE 3.—A man, aged 34, clerk, American by birth, presented himself on Nov. 3, 1903.

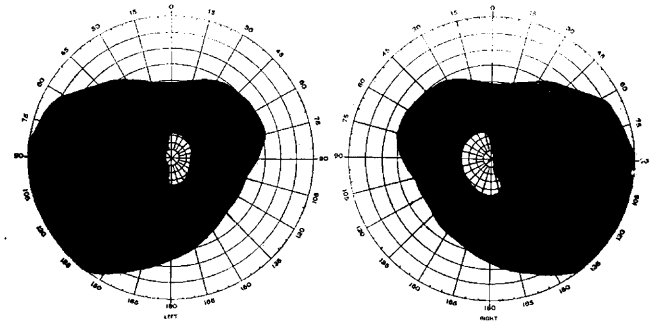

Fig. 5.—Bitemporal hemianopsia and contraction of preserved visual fields from a patient under care of H. C. Wood. The lesion was basal gumma.

History.—The patient's father and mother are living, as also are four brothers and one sister, all of whom are in good health and have no organic defects of vision. Since an attack of dysentery at the age of 2 he has enjoyed good health, history of severe illness being absent. In 1883 he fell from a horse and was injured on the forehead over the left eye, but the skull was not fractured, so far as is known. The patient has led a healthful life, has no drug habits and denies venereal taint of any kind. His eye sight gave him no concern until seven years ago, when it began to fail, first on the left and later on the right side, the defect in vision being manifest by loss of the visual field on the temporal sides. There was never at any time pain, headache or signs of ocular inflammation.

General Examination.—The patient was undersized, but well nourished and presents all of the physical signs of infantilism of the myxedematous variety. With this exception, examinations made by us, as well as by other physicians, failed to find signs of organic disease. The urine was normal.

Examination of Eyes.—The eyelids were slightly puffy, and there was a moderate conjunctivitis of the left eye. V. of R. E. with + 0.75 sph. 6/7.5; amplitude of accommodation, 6 D. The optic nerve was ophthalmoscopically a narrow, vertical oval and atrophic, being bounded on its outside by a widened

8. Mills, Univ. of Penn. Med. Bulletin, May, 1904, p. 110.

9. Jour. of Nervous and Mental Disease, vol. xlv, 1887; also Nervous Diseases and Their Diagnosis, by H. C. Wood, p. 271.

10. Ophth. Record., vol. xiii, 1904.

scleral ring; the veins were rather fuller than normal and were faintly streaked with white lines; the arteries were unchanged in size, both sets of vessels carrying normally tinted blood. Distinct evidences of neuritis were lacking and there were no gross changes in the retina or choroid. The visual field for form and colors exhibited the typical chart of temporal hemianopsia, the preserved form field (1 cm. square of white) being normal in extent, while the color fields (red and green) are markedly contracted, the dividing line exactly following the vertical meridian, the macular representation being in the preserved field (Fig. 7). The light field was preserved, except the upper and outer quadrant, which was entirely dark. The direct light reflex of the pupil was preserved, the consensual reflex absent, and the hemiopic pupil inaction (Wernicke's sign) could not be demonstrated, although the response was not so prompt when the light was directed on the blind side of the retina as when it fell on the opposite side.

V. of L. E. was *nil*, light perception being absolutely lacking. The optic disc ophthalmoscopically was small, round and entirely atrophic, but there was no marked decrease in size of the retinal vessels, and as on the other side, no distinct signs of a previous neuritis. The direct light reflex of the pupil was, of course, absent; the consensual reflex preserved;

Examination of Nose and Throat.—Examination of the rhino-pharynx and sinuses by Dr. Walter Freeman yielded negative results, who writes: "I find no evidences of sinus or nasal disease which could account for the eye trouble; I believe the sphenoids and ethmoids are normal."

Examination of the Head.—Examinations of the cranium by means of the *x*-rays were made by Dr. Henry Pancoast at the Hospital of the University of Pennsylvania, and the skiagraphs showed a shadow directly in the position which would be occupied by the chiasm, which shadow was not present in a skiagraph of the normal head, kindly loaned by Dr. Pancoast.

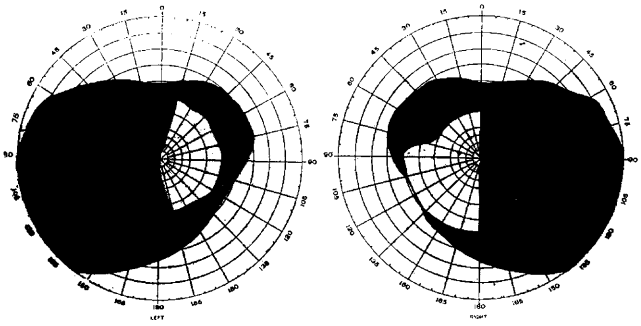

Fig. 6.—Bitemporal hemianopsia; tumor involved chiasm.

Remarks.—In the present instance we evidently had to deal with a case which was originally bitemporal hemianopsia, because the patient's statement accurately described the loss of the temporal side of each visual field as his first visual disabilities. Gradually the degeneration of the optic nerve continued, until on the left side the blindness became complete, and there is now temporal hemianopsia of the right eye for form and color and with a partial retention of the light sense, that is to say, it is preserved in the lower temporal quadrant and completely on the nasal side. In other words, we had here a very good example of a spreading lesion, so that only the nasal field of one eye remains perfect.

As to the probable lesion, three possibilities may be named, and in studying them we have had the advantage of Dr. William Spiller's examinations, who saw the case in consultation: 1, Myxedematous enlargement of the pituitary body; 2, as the patient once suffered from tapeworm, cysticercus of the chiasm; 3, aneurism or tumor at the chiasm.

What the exact lesion is is purely speculative, except there can be no doubt that the optic chiasm is involved. Sphenoid disease, which we first thought of, seems to be eliminated by Dr. Freeman's report. Dr. Pancoast's skiagram seems to show a shadow approximately in the region of the chiasm, a shadow, moreover, which is abnormal and which may indicate a growth, for example, an exostosis. Naturally, the injury which this patient received when he was thrown from a horse suggests the possibility that there may have been a fracture extending into the sphenoid bone. It is, however, difficult to accept this explanation in view of the fact that the injury occurred twenty years ago, while his visual defects were noticed only seven or eight years ago. Specific history is denied and there was no response to antisyphilitic treatment. He seems to have improved slightly in his general condition under the influence of thyroid extract. There has been no change, however, in the visual defects and also no progression.

Bitemporal Achromatopsia with Central Scotoma for Colors.—As already noted, the defect in the temporal fields may begin with loss for colors only, followed later by loss of form and light sense. In a case reported by Benson,[11] in addition to a bitemporal defect for colors, there was a scotoma for colors. The patient had acromegaly and was an excessive smoker. Sometimes, it would seem, there may be simply scotoma for color on one side, for example, in Doyne's case,[12] while on the other the scotoma is absolute.

Significance: In these hemiachromatoptic cases we may assume the interference in the conduction of the fibers involved has been sufficiently great only to lead to an inability to recognize colors, for example, red and green. Greater disturbance would lead to inability to recognize blue. As the power of conductivity grows less and less perfect, the patient gradually fails to distinguish black from white, and finally when it is lost the perception of light is lost.[13]

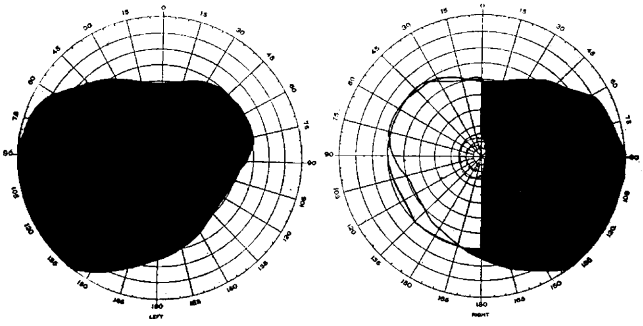

Fig. 7.—Temporal hemianopsia of right eye; complete blindness of left eye.

Chiasmal Central Amblyopia.—The development of bitemporal hemianopsia from symmetrical paracentral scotomas has been described. But it would seem that central scotomas, very difficult to distinguish from those seen in toxic amblyopia, are sometimes the initial signs of chiasm disease. According to Nettleship,[14] "the loss of the central field in the earlier stages is more abruptly defined than in tobacco amblyopia, and the symmetry is less precise, both in time and degree than in the latter disease." In one case in which a postmortem examination was obtained and the chiasm incorporated in a cyst, there was a central scotoma of oval shape, beginning just outside the fixation point, and extending twenty degress outward; the peripheral fields were intact.

Irregular Losses in the Visual Field.—A number of case records have been published describing irregular losses of portions of the visual fields. To some of these reference has already been made. Wilbrand has arranged them as follows: Temporal hemianopsia of one

11. Brit. Med. Journ. October, 1895, p. 949.
12. Trans. Ophth. Soc. U.K., vol. xv, 1895, p. 134.
13. Consult Holden, Archives of Ophthalmology, vol. xxiv, 1895, p. 447.
14. Ophth. Rev., vol. xv, 1896, p. 309.

eye with loss of the upper outer quadrant of the visual field in the other (Schoen); temporal hemianopsia in one eye, in the other loss of the lower outer quadrant of the nasal visual field (Lang); loss only of the upper and outer quadrants of both fields; loss only of the lower and outer quadrants of both visual fields; loss of both visual fields, except their upper nasal quadrants which remained active; finally, loss of both visual fields, except their lower nasal quadrants which remained active is conceivable, although no such case has been reported. These irregular types of visual field defects are due to circumscribed lesions affecting small bundles of fibers in the chiasm. It is again to be noted that irregular losses of the visual fields with transient and varying types of bitemporal hemianopsia usually mean syphilitic meningitis, or gummatous involvement of the chiasm, in which recovery of vision often results from the administration of iodids or mercury.[15]

Binasal and Unilateral Nasal Hemianopsia.—Cases of binasal hemianopsia occur with comparative infrequency. The literature has been analyzed by Veasey,[16] who makes reference to nineteen cases, but who also includes in them cases of unilateral nasal hemianopsia of the bilateral form of the disease as it is seen in spinal cord disease. The subject has also been discussed by S. M. Burnett,[17] who reports a good example of this affection.

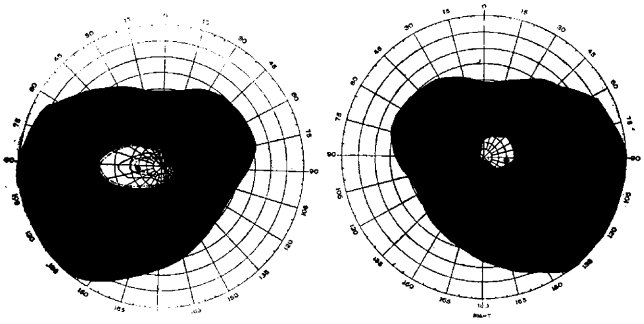

Fig. 8.—So-called binasal hemianopsia in hysteria, really simply an irregular contraction of the visual field. Patient under care of J. K. Mitchell and G. E. de Schweinitz.

Significance: The true chiasmal variety of the affection must be rare, if, indeed, it actually occurs. In Knapp's case it was ascribed to degeneration of the arteries of the corpus calosum, causing disease of the lateral angles of the chiasm. Burnett suggests as possible lesions in his case, in which the hemianopsia followed a fall on the forehead and remained unchanged for more than three years, a clot, or pathologic process set up by it, making pressure on the outer side of the right nerve trunk, and passing either above or below this trunk to the other side, without affecting intervening tissue, and there pressing on the temporal side of the left nerve. A double lesion affecting only the temporal supply-fibers in the tracts is also suggested as possible. Burnett himself recognizes, however, the difficulty surrounding the hypothesis he suggests. The irregularity of the remaining fields in most cases of binasal hemianopsia, as well as microscopic examinations which have been made, indicate that visual field phenomena are caused by optic nerve lesions. Thus, Gowers, commenting on Eales's case, suggests as an explanation bilateral inflammation of the trunks of the optic nerves in front of the chiasm, extending to this, and chiefly intense symmetrically at each side of the chiasm. Veasey accepts this explanation as most suited to his case.

A nasal hemianopsia on one side is produced by a lesion affecting the lateral portion of the chiasm involving the non-crossing fibers of one eye. Blindness of one eye and nasal hemianopsia of the other can not be explained by a single lesion. In Henschen's case the chiasm and optic tract were so involved that only the crossed fasciculus of one eye remained comparatively unaffected.

Bilateral Blindness of Chiasmal Origin.—Total loss of vision and of the pupillary reflexes in both eyes, followed in several weeks by bilateral optic nerve atrophy, is possible. Under such conditions we must assume that a lesion has divided the chiasm into an anterior and posterior portion and destroyed the conductivity of the lateral as well as the crossed fasciculi of both sides.

Superior and inferior hemianopsia have been described, and would indicate disease of the upper half of the chiasm, or, as in Uhthoff's case, symmetrical disease of the optic nerves.

OPHTHALMOSCOPIC CHANGES.

Following a destructive lesion affecting the optic chiasm, the ophthalmoscope usually reveals bilateral

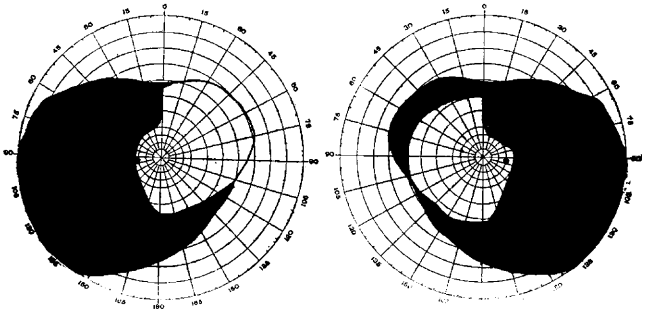

Fig. 9.—Bitemporal visual field defects in locomotor ataxia. Patient under care of G. E. de Schweinitz.

atrophy from descending degeneration. Partial atrophy of the optic disc results from circumscribed destruction of fasciculi of fibers on their passage through the chiasm. All grades of optic neuritis may be found with disease at the base of the brain involving the optic chiasm, varying from slight veiling of the edges to typical choked disc, but optic neuritis is not often found in chiasmal disease, even when produced by cerebral tumors. A reference to the report of the conditions of the eyegrounds in some fifty cases of disease of the chiasm show the following fundus changes, which can be conveniently grouped:

(*a*) Optic atrophy without preceding neuritis.

(*b*) Postneuritic atrophy.

(*c*) Atrophy of the temporal half of the nerve (partial atrophy).

(*d*) Slight optic neuritis as revealed by blurring of the disc edges.

(*e*) Well-marked optic neuritis and neuroretinitis with or without retinal hemorrhages.

(*f*) "Choked discs."

In one case mentioned by Hutchinson[18], the ophthalmoscope shows retinal arteries and veins diminished, retina white and hazy with many hemorrhages.

15. Just as this section was completed the third volume of Wilbrand and Saenger's "Die Neurologie des Auges." has come to hand, in which there is a most complete discussion of the visual field phenomena which would follow variously placed chiasm lesions.

16. Ophth. Rec. February, 1897.

17. Arch. of Ophth., vol. xxix, 1900, p. 1.

18. Ophth. Review, 1889.

It is important to remember that although central vision in most cases of bitemporal hemianopsia is lowered (rarely normal acuity of sight has been preserved), and that the final stage of chiasmal disease is apt to be total blindness with atrophic discs, occasionally, even after blindness has appeared, as Wilbrand remarks, nearly normal power may return.

ANOMALIES OF THE EXTERNAL OCULAR MUSCLES.

Chiasmal diseases may be accompanied by paralysis of nearly all the motor and sensory nerves of both eyes. The progress of the lesion can at times be closely followed by the successive involvement of the cranial nerves running to the orbit. Anosmia indicates the extension of the lesion forward; bilateral hemianopsia followed by unilateral blindness and paralysis of the cranial nerves entering the orbit of that side shows the extension of the disease toward the right or left side of the chiasm. The third nerve is most frequently affected.

ALTERATIONS IN THE PUPIL REFLEXES WITH SPECIAL REFERENCE TO THE HEMIANOPIC PUPILLARY INACTION.

The production of complete blindness by chiasmal disease gives the usual loss of direct pupil reaction. Most reporters have failed to note the presence of the hemianopic inaction.

In some forty cases referred to by the authors, whose reports we have examined, this inaction was noted in but four cases. The usual note was "pupil dilated and sluggish," or "unresponsive to light, react to convergence."

The hemianopic pupillary inaction has been unquestionably present in some cases and no doubt would have been found if more carefully looked for in many more cases of disease of the optic chiasm. It is a symptom difficult to elicit and its existence has been denied by some authors. Even Bach, with his large experience and skill, has not observed it, although he does not deny that it may occur.

LESIONS WHICH MAY PRODUCE ALTERATIONS IN THE STRUCTURE AND FUNCTION OF THE OPTIC CHIASM.

From a consideration of the anatomic relations of the chiasm, we may divide these lesions as follows:

1. Those which affect the chiasm from below. These include trauma, for example, fractures of the sphenoid bone, exostoses, basilar, gummatous and tubercular meningitis, periostitis, arterial disease, aneurism, syphilitic arteritis and hemorrhage, and tumors of the sphenoid bone.

2. Lesions which encroach on the chiasm from above. These include tumors of the third ventricle and distention of the floor of the third ventricle in internal hydrocephalus.

3. Lesions which affect the posterior angle of the chiasm. These include tumors and hypertrophy of the pituitary body—notably in acromegaly. To this frequent cause of chiasmal disease a more extended reference is made in a succeeding paragraph.

4. The lesions of multiple sclerosis. Cases of this character have been reported by Snell, Taylor, Uhthoff, Spiller and other authors.

5. The lesions of tabes dorsalis. Cases of this character have been reported by Gowers, Uhthoff, Popow, Moxter and Benedict.

The chiasmal symptoms in these cases may be due to syphilitic basilar lesion, and not to interstitial inflammation of the chiasm, as Gowers states. This author also includes as a possible cause of chiasmal disease interstitial inflammation from inherited gout. Interstitial hemorrhage has been reported. Swanzy states that tumors of the cerebellum, by closure of the aqueduct of Sylvius, may produce internal hydrocephalus and cause pressure upon the chiasm.

The above summary comprises the results of careful study of the literature for reports of postmortem findings in somewhat more than one hundred published papers.

ACROMEGALY.

As is well known, acromegaly is a frequent cause of bitemporal hemianopsia, and this visual field defect, to use the language of Swanzy, is one of the commonest and earliest symptoms of this affection. It does not seem necessary to do more than make the briefest reference to the facts in the case. According to Hinsdale, the bitemporal hemianopsia in acromegaly is caused by an overgrowth or neoplasm of the hypophysis pressing on the chiasm, and by bony changes consequent on the abnormal growth of the lesser wing of the sphenoid bone. It may occur as a bilateral defect, as an unilateral defect, either right or left sided, and in two instances, at least, has appeared in the form of a nasal hemianopsia.

While it is true that the bitemporal variety of the visual field defect is the one most commonly observed, homonymous hemianopsia has also been noted by several observers. One of them (de Schweinitz) has examined a case of this character for Dr. Dulles of Philadelphia, and he has also seen and examined two other cases with typical bitemporal hemianopsia, one in the service of Dr. H. C. Wood at the University Hospital and the other in his own practice.

SIMULATION OF CHIASM DISEASE BY OTHER AFFECTIONS.

Hysterical Hemianopsia.—There is much difference of opinion whether hemianopsia ever occurs as an ocular stigma of hysteria. Parinaud maintains that there is one variety of visual insensibility which hysteria appears to be incapable of producing, and that is hemianopsia in the sense in which this term is used in organic cerebral lesions, and this opinion apparently is shared by Charcot, Gilles de la Tourette, Gowers, Freund, Binswanger and others. On the other hand, Rosenthal[19] states that in all cases of hysterical amblyopia which he has investigated temporal hemianopsia was present[20]. Lateral non-crossed hemianopsia in hysteria has been recorded by a number of observers, for example, Bonnefoy, Westphal, Galezowski, M. W. Zimmerman and Henry Lloyd.

So far as we are able to judge from a critical examination of the literature, hemianopsia as an enduring ocular symptom of hysteria does not exist. On the other hand, as a temporary phenomenon it has been observed a good many times by those who are competent to judge, and has appeared, as already noted, as a bitemporal defect, a homonymous lateral defect, and even, it would seem, as a binasal obscuration. It is possible, according to Pierre Janet[21], that there may always be a period of hemianopsia when the ordinary hysterical amaurosis is recovering.

A similar observation was made by Galezowski and Daguenet prior to his publication, who have also noted

19. Wiener Med. Presse, Nr. 23, 1879, p. 736.

20. In Gilles de la Tourette's book Rosenthal is quoted as having written a letter to Charcot in which he retracts this statement, saying that hysterics exhibit only amblyopia and concentric contraction of the visual field.

21. La Presse Medicale, 1899, p. 243.

a transitory scotoma. Hirsh[22] describes hysterical blindness in a boy of thirteen. After return of sight, there was high grade contraction of the visual field, which gradually widened and showed a temporary bitemporal hemianopic character. Unilateral temporal hemianopsia has been described in hysteria by Landesberg[23] Wilfred Harris in his Cambridge Thesis[24] refers to two cases of hysterical binasal hemianopsia, one of temporary character reported by D. B. Lees, the other published by J. K. Mitchell and de Schweinitz. It is true they somewhat incautiously made use of the expression that the visual fields had the character of binasal hemianopsia, but they are quite sure they should be regarded simply as an unusual form of bilateral contraction. (Fig. 8.)

Bilateral Temporal Field Defects in Locomotor Ataxia.—As Gowers has pointed out, symptoms of a local lesion in the chiasm may occur in rare instances of tabetic atrophy. In one case which he has recorded the characteristic visual defect appeared suddenly. Popow[25] has examined in cases of ataxia the chiasm and found foci of degeneration. But the visual field changes in tabes dorsalis may simulate chiasm disease, when, in all probability, the chiasm itself is unaffected. It is probable that tabetic atrophy of the optic nerve may depend in part on disease and disappearance of the retinal ganglion cells. Should such disappearance occur on suitably situated symmetrical areas, symmetrical temporal field defects might follow. (Fig. 9.) It will be observed in a case which one of us (de Schweinitz) has observed, that although there is a form of bitemporal hemianopsia, the dividing line is irregularly placed and this in all probability would be a notably distinguishing, although not pathognomonic difference between ataxic and the chiasm-disease visual field.

Bilateral Temporal Field Defects in Brain Tumors Unconnected with the Chiasm.—As well recognized causes of bitemporal hemianopsia are basal tumors, and especially tumors of the pituitary body. But it should be remembered that a growth at a distance from the chiasm may occasion similar signs. As Swanzy, Gowers and others point out, a tumor of the cerebellum by closure of the aqueduct of Sylvius may produce internal hydrocephalus and thus exert pressure on the chiasm. So far as we are aware, bitemporal hemianopsia has never been observed as has cortical hemianopsia as a distant symptom. It is possible, however, that destruction of areas of retinal ganglion cells in cases of the choked discs of non-basilar cerebral tumor might give rise to bitemporal binasal visual field defects, but in such a case there would of necessity be marked irregularity in the line dividing the visual fields.

A brief reference to the lesions of the chiasm in multiple sclerosis has been made.

SYMPTOMS OF CHIASM DISEASE CAUSED BY CERTAIN TOXIC AGENTS.

We have already referred to central amblyopia and central scotoma as a sign of chiasm disease, and how such a scotoma may be difficult to distinguish from that produced by toxic amblyopia. One of us (de Schweinitz[26]) has published the results of microscopic examination of the optic nerves, chiasm and tracts from a typical case of so-called tobacco amblyopia with characteristic and intact visual fields. Degenerated patches are evident, occupying symmetrical positions in about the situation of the non-crossing macular fibers and leaving the remainder of the chiasmal structure intact.

Necessarily, they give no evidence of their existence except in the central scotomas. According to Westphal and Elschnig, optic neuritis with bitemporal hemianopsia has been observed as an ocular symptom of lead poisoning.

Homonymous lateral hemianopsia has been occasioned by illuminating gas toxemia, as reported by Purtscher and H. Friedenwald, but not the bitemporal variety of this form of the affection. Raffegean observed in a case of carbonic acid poisoning inferior hemianopsia dependent on a certain degree of interstitial neuritis of the optic nerves.

CONCLUDING REMARKS.

In the presence of typical bilateral hemianopsia, which, as we have before remarked, quoting the words of Griffith, may be regarded as the localizing form of hemianopsia, it is practically impossible to make a mistake, and the lesion must necessarily be, as already stated, one which destroys the conductivity of the crossed fasciculi, leaving the non-crossed fasciculi intact. When one comes to consider, however, the numerous irregularities in the visual field which may be present in chiasm disease, its existence can not always with safety be inferred from them without elaborately repeated examinations.

As Wilbrand has remarked, the chiasm with both tracts and the other intracranial portions of both optic nerves may be surrounded by diseased processes, particularly of a gummatous nature, and irregular defects of the field of vision result, from which a correct diagnosis would be difficult. Much depends on the method of examination and the degree of the destruction of the light sense. A careless examination might fail to develop a temporal field defect which a more careful one, conducted under diminished illumination, or using gray squares placed on white cardboard, would develop. On the other hand, an examination with a very bright light, for example, such as one uses in an electric perimeter, might reveal an intact visual field on the temporal side, good light sense being preserved, while it would be absent for form or colors.

Finally, the fact that a scotoma may be the beginning of a visual-field defect which will eventuate in a bitemporal hemianopsia and be significant of chiasm disease, should not be forgotten, and, moreover, a scotoma which to careless examination would seem to indicate simply papillo-macular bundle involvement and not involvement of the intermingling of the papillo-macular fibers in the chiasm.

The evident conclusion of the whole matter is that, in a large number of cases of optic nerve atrophy, the most elaborate examinations should be made by all known tests, under all degrees of illumination, and with all types of saturated colored squares, in order to eliminate or prove the presence of chiasm disease. We strongly suspect that there are a fair number of optic nerve atrophies on record, and, naturally, a much larger number in examination, which, if these precautions had been observed, would have yielded a larger percentage of chiasm disease than now seems indicated by the reports.

DISCUSSION.

DR. CASEY A. WOOD, Chicago, stated that for a number of years he has suspected that those curious cases of aversion to

22. Munch. med. Wochenschr., Nr. 13, 1903, p. 58.
23. Jour. of Nervous and Mental Disease, vol. xiii, 1886, p. 85.
24. Brain, 1897, p. 308.
25. Jahresbericht f. Ophth., vol. xxiv, 1893, p. 512.
26. Trans. of the am. Ophth. Soc., vol viii.

binocular single vision are due to certain congenital defects of development; in other words, to lack of proper crossing of the optic fibers as they run forward from the visual centers. So far as he knows no proof of such an anatomic anomaly has been advanced to explain this failure to obtain binocular single vision. The fact that in certain cases of squint (usually alternating) two eyes with equally good vision, though straightened and treated by every known means, should still object to a completion of the act of binocular single sight is remarkable. It is exasperating that after early operation and training under apparently the most favorable conditions binocular single vision is unobtainable. Dr. Wood has not been able to accept the theory of lack of development of the fusion centers; he believes that we shall find the explanation in lack of proper crossing of the fibers at the chiasm.

DR. JOHN T. CARPENTER, Philadelphia, said that perhaps Dr. Wood's suggestion could best be carried out in a general hospital, where such cases might be followed and autopsies properly made. He thought that the rarity of these cases is shown by the fact that in fourteen years he has not had a case of chiasm disease in his private practice.

DR. CLARENCE A. VEASEY, Philadelphia, exhibited a skiagraph of a recent case of chiasm disease. The patient is a robust man, perfectly healthy all his life, except for this ocular disease. He has been able most of the time to follow his vocation, that of a traveling salesman. Two years ago this chiasm disease showed itself, beginning in the temporal field of each eye as a slight fogginess. Later the form field was lost, the light sense being retained. The dividing line has varied from time to time. At one time it would pass directly through the fixation point; at another examination it would pass from 2½ to 15 degrees to the right or left of the fixation point; then again through the fixation point. There were no intraocular changes. This variability of the field can only be explained by a lesion, probably vascular, which produces change in the pressure between the examinations.

DR. J. L. BORSCH, Philadelphia, said that it is advisable, even when there is atrophy of the nerve, when destruction of nerve fiber has taken place and the chiasm is separated into an anterior and posterior portion, so to speak, to give a guarded prognosis, for a patient may present an atrophy of the optic nerve and one may be led to believe that permanent blindness has resulted, and still such a patient may recover his vision. Seven years ago Dr. Borsch saw a patient in the de Wecker clinic who had been brought in by a friend, which friend had wrested a revolver from him as he was about to take his life, as several oculists had told him that he was incurably blind; one of these gave him a certificate to that effect in order that he might enter the blind asylum. On examination it was found that he had complete atrophy of both nerves, with slight light perception on left side of field; on close questioning the fact was elicited that during the Franco-Prussian war he acquired lues, which had not been treated; he had had the ordinary diseases of childhood, but otherwise had never been ill, and in other respects was healthy. The man was placed on energetic specific treatment, and at the end of four months he had 1/6 vision, and in six months 2/3 vision. Dr. Borsch saw the patient last year while in Paris; he had normal vision in right eye and 2/3 in left.

DR. G. A. ASCHMAN, Wheeling, W. Va., mentioned a case seen six years ago of angiolithic sarcoma of the optic chiasm. The patient had a central scotoma which grew from week to week, but before that occurred it was thought to be a case of tobacco amblyopia, as he had been a heavy smoker. The interesting point was that this patient did not have any fundus changes for a long time. There were no signs of pressure; no choked disc. It was thought for a time that it might be a syphilitic trouble, but he did not improve at all on antisyphilitic treatment. It illustrates what has been said about confounding these cases with tobacco amblyopia.

DR. FLAVEL B. TIFFANY, Kansas City, Mo., said that he had a case a year ago of bitemporal hemianopsia in a man of 50 years of age, who came to him complaining of blindness on the temporal side of each eye. There was no history of syphilis, no trauma. Vision was 20/70 of the right eye and 20/200 of the left. The color sense was also impaired, especially for red. The treatment was pilocarpin ¼ grain twice a day, also vibratory massage once a day. The patient improved on this, his vision coming up to 20/40 and 20/70, respectively, in the two eyes. The etiology was very obscure. The trouble was probably due to a toxemia from grippe, which he had had two months before the onset of the hemianopsia. The lesion was evidently located in the chiasm involving the crossed fibers or those from the nasal side of each retinæ.

DR. C. R. HOLMES, Cincinnati, referred to a case in which the postmortem showed the exact condition afterward. A newspaper reporter came on account of inability to use his eyes. Careful examination revealed the fact that his glasses were correct, and with the ophthalmoscope no lesion was visible. He was ordered on a vacation, but returned worse than before. The condition was rather obscure. He, however, had a good deal of swelling in the nose and complained of inability to breathe. Dr. Holmes operated on one side, removing the hypertrophied tissue, and he was to come the following week for another operation. The day before the second operation was to have been performed Dr. Holmes was notified that he was not well enough to come, and the next day he learned that the patient was dead. He at once sent an assistant to try to secure a postmortem, which he succeeded in getting. It was found that there had been inflammation with necrosis of the sphenoid cavity, which had not been apparent at the examinations through the nose. When the brain was removed there was found a clot in the region of the sella turcica and extending over the chiasm. The bony roof had been entirely eroded, and a finger could be put into the sphenoid cavity.

DR. JOHN E. WEEKS, New York City, asked why we do not more frequently find choked disc in these cases. A compilation has recently been made by one of the physicians associated with the New York Eye and Ear Infirmary of 102 cases,[1] and in only one or two of these cases was choked disc observed. The theory advanced by one writer is that the disease of the chiasm closes the subarachnoid space where the optic nerves leave the chiasm, and that the entrance of the subarachnoid fluid into the subvaginal space of the optic nerve is thus prevented.

DR. G. E. DE SCHWEINITZ particularly called attention to the series of cases described in which there is simulation of chiasm disease by other affections, and particularly to the explanation which they have endeavored to give of so-called bitemporal hemianopsia of hysterical origin, which is never in their experience a permanent stigma of this condition, but which simply represents a form of the well-known amblyopia of hysteria.

THE MATHEMATICAL POINT OF REVERSAL IN SKIASCOPY.*

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Of all the objective methods for determining the refractive state of the eye, the shadow test is not only the most reliable, but, up to a certain point, the easiest to apply practically. In view of these facts it seems unaccountable that concerning the laws underlying the method, there should be such a lack of clear and positive proof offered, even by those who are supposed to deal with the subject in an authoritatively scientific manner. The ordinary text-books for students and general practitioners, without exception, I believe, pass over the theoretical part very superficially, giving attention wholly to the signification of shadow movements "with" and "against," mentioning the "point of reversal" only

1. N. Y. Eye and Ear Infirmary Reports, 1904.

* Read in the Section on Diseases of Children of the American Medical Association, at the Fifty-fifth Annual Session, June, 1904.