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A TUMOR (NEUROGLIOMA) OF THE SUPERIOR WORM
OF THE CEREBELLUM ASSOCIATED WITH COR-
PORA QUADRIGEMINAL SYMPTOMS.*

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Tumors involving by direct pressure or actual ingrowth, or taking their origin in the corpora quadrigeminal bodies, are neither so rare as to be unique or so frequent as to make a report of a case lacking in interest. It is only by constant study and analysis of the results of such lesions that we are able in any degree to appreciate the functions and connections of these bodies, as well as the focal symptoms incident to their disease. The following case occurred in my service at the Samaritan Hospital:

Mr. B. W., by occupation a wagon-maker; age 21; a native of the United States; born and reared in our vicinity, presented himself at the hospital January 24, 1899, complaining of very severe headache, difficulty in walking and partial loss of vision. His family history was entirely negative. Patient had suffered from the usual diseases of infancy and childhood, since which time has been perfectly well and strong. Denied absolutely any venereal infection. He had been injured in

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the scrotum some years before, which injury resulted in a hydrocele. Was moderate in the use of alcohol and tobacco. Could elicit no history of head injury.

Present trouble began in April, 1898, with severe pains in the head, situated principally in the frontal region. This headache continued more or less constant, and two months later it was followed by a gradual failure of sight in both eyes, for which he consulted Dr. Smith, of Troy, who made an examination and discovered a beginning optic neuritis, involving about equally both eyes, vision being 20-30 in each eye. Pupils were mid-wide and reacted to light and accommodation. The visual fields were normal; there was no nystagmus or paralysis of the ocular muscles. From that time the headaches increased in severity and have at times been accompanied by projectile vomiting. Eyesight has been gradually failing, and his friends have noticed that in walking he swayed to and fro like a drunken man, and, unless supported, that he would almost invariably fall to the left side. Later on he developed dizzy attacks with a feeling of pressure in the head together with intense occipital headache. After entering the hospital he complained of headache on both sides, but principally on the right side. Has irregular choreiform twitchings or contractions of the muscles of both upper and lower extremities. No focal or general convulsions have ever occurred; has a staggering gait, the tendency always being to fall toward his left side. There is no difficulty in swallowing; has perfect control over bladder and rectum; for the past two weeks has suffered from great thirst and has voided large quantities of pale and almost colorless urine. Sexual power normal; bowels constipated; appetite poor; cerebration is decidedly slower than normal, and his memory is gradually failing both for past and recent events. There is no evidence of aphasia.

Status præsens. Patient well-built, five feet seven inches in height, weighs 180 pounds. Examination of lungs and heart disclosed nothing abnormal. Specific gravity of urine 1.010, otherwise normal; face symmetrical, equal palpebral fissures, angles of mouth normal; pupils dilated, left slightly more than right, both react sluggishly to accommodation and doubtfully to light; slight convergence of eyeballs. Slight lateral nystagmus; no hemianopsia; movements of eyeballs normal, save upward and downward, both of which motions were practically abolished; slight double ptosis, the lids falling to the level of the pupils on each side. Patient is able to distinguish and name objects accurately, recognizes colors,

but is unable to read moderately-coarse print; evidence of double optic neuritis, passing on to atrophy, exists. The movements of the facial muscles, as well as those of mastication, are normal. Tongue is protruded straight; all of its movements normal, and no tremor or wasting of that member exists. The uvula is in the median line and moves normally. Soft palate and pillars of fauces normal; no anesthesia of mucous surfaces; smell and taste normal. Heard ordinary conversation very distinctly, and watch 3 feet away from each ear; no dysphagia; no stiffness of muscles of neck. Percussion of scalp elicited no tenderness. All movements of arms and hands performed in a normal manner. Dynamometer "outer scale," right hand 200, left hand 225. No stiffness or wasting of muscles of upper extremities; hands very cyanotic; when patient attempts to contract muscles of forearms or hands, the last two phalanges become chalk-like in color; no incoördination or ataxia of upper limbs. Patient recognized immediately the various objects placed in his hands. On voluntary motion of both upper extremities there was created a coarse, jerky tremor, resembling quite closely that of multiple sclerosis. The patient's gait is of a cerebellar character. He walks with his feet wide apart, does not lift them high, and sways from side to side like a drunken man, and has a marked tendency to fall to the left. Rhomberg's symptom is present in a most characteristic manner. He cannot walk backward without falling. When recumbent it is impossible for him to place the left heel on right knee by movement in a straight line, but the leg sways this way and that, as if uncertain of the exact direction of the knee. Movements of the right leg showed no ataxia. Legs and feet like the arms and hands, very cyanotic.

Reflexes: Patellar tendon reflexes were found absent after the most careful reinforcement. No triceps reflexes. Plantar reflexes possibly a little exaggerated; no Babinski phenomenon; gluteal, cremasteric, umbilical and epigastric reflexes normal. A very careful examination of the entire body failed to disclose the slightest sensory disturbance.

Here then we have a case which presented the following general and local symptoms: double optic neuritis passing on to atrophy, intense and continuous headache, vomiting, dizziness, slow cerebration and gradual loss of memory. The focal symptoms being an ophthalmoplegia interna, with a dou-

ble incomplete external ophthalmoplegia, a marked cerebellar gait, a coarse tremor of the hands and ataxia in the left leg. To these might well be added the choreiform movements, clearly the presence of intracranial pressure, the result doubtless of a growth the primary location of which was thought to be, from the few focal symptoms present, in the region of the corpora quadrigemina; these symptoms corresponding accurately to the requirements mentioned in the dictum of Nothnagel which appeared in the July number of *Brain*, 1889.¹ Nothnagel, after reviewing the literature and introducing a new case, formulated the following diagnostic indications, which may be relied upon in localizing tumors in the region of the corpora quadrigemina, (1) an uncertain, unsteady gait like that of a drunken man, especially if the gait is the first symptom; (2) in addition to the above, a double ophthalmoplegia, not being entirely symmetrical and not involving all the muscles to an equal degree, with an especial predilection for the superior and inferior recti muscles; (3) all other symptoms are subsidiary and of minor importance. In my case it was impossible to determine which of the two prominent symptoms appeared first, the incomplete ophthalmoplegia or the cerebellar gait, as both symptoms were present when the patient entered the hospital, and I could elicit nothing positive from him, his physician or friends in regard to it. But relying on the above dictum of Nothnagel, a diagnosis of a tumor in the region of the corpora quadrigemina was made. The absence of involvement of any of the cranial nerves, other than the optic and motor oculi, and the presence of the coarse intention tremor in the hands seemed to exclude the possibility of the growth being located primarily in the cerebellum and involving secondarily the region of the corpora quadrigemina.

It may not be amiss to state that in considering the question of diagnosis an aberrant form of multiple sclerosis was thought of. The only symptoms, however, indicative of such a condition, were nystagmus and the coarse intention tremor

¹Nothnagel. "On the Diagnosis of Diseases of the Corpora Quadrigemina." *Brain*, July 1889, p. 22.

in the hands. The presence of severe headache, the optic neuritis, the ophthalmoplegia and the cerebellar gait, together with the absence of scanning speech, epileptiform attacks, and evidence of motor tract involvement, seemed to negative such a diagnosis.

He remained in the hospital a week and then returned home, dying February 20, 1899.

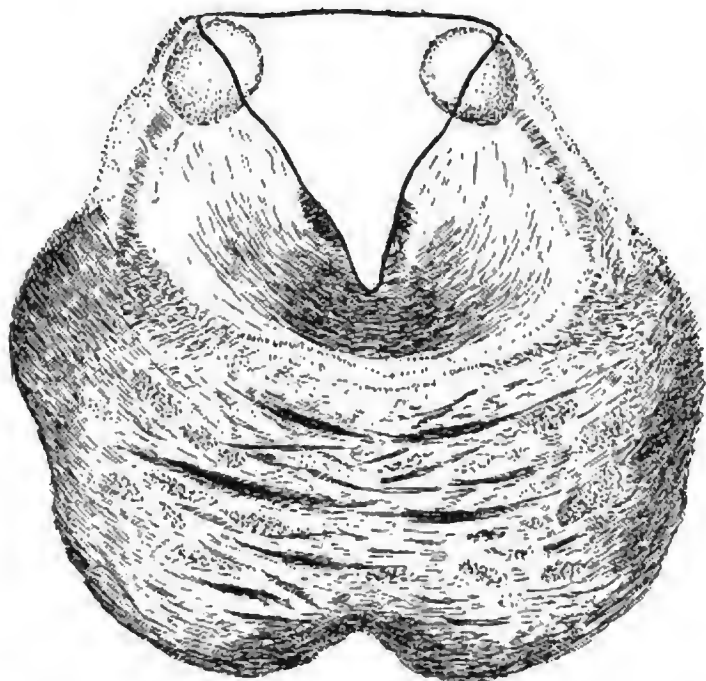


Fig. I. Section through posterior quadrigeminal bodies showing position of tumor, purely diagrammatic.

Autopsy 24 hours after death. Permission to examine only the brain was given. Skull-cap apparently not thickened and dura non-adherent to it. The superior longitudinal sinus contained a soft recent coagulum. The Pacchionian bodies were not specially prominent. Vessels of pia injected. Pia was non-adherent and easily removed, and not at all cloudy. The convolutions and fissures were well developed

and appeared normal. The cranial nerves were all free, not distorted or apparently atrophied. The blood vessels of base and convexity of brain normal. On removing the tentorium a growth was observed projecting from the superior worm of the cerebellum; it was irregularly quadrilateral in shape. The tumor evidently took its origin from the most ventral part of the monticulus, and in its growth forward had completely destroyed the culmen, central lobe and lingula of the superior worm, together with the superior vermiform process. The tumor measured $4 \times 3 \times 2$ 1-2 cm., and on section consisted of a soft homogeneous grayish mass resembling

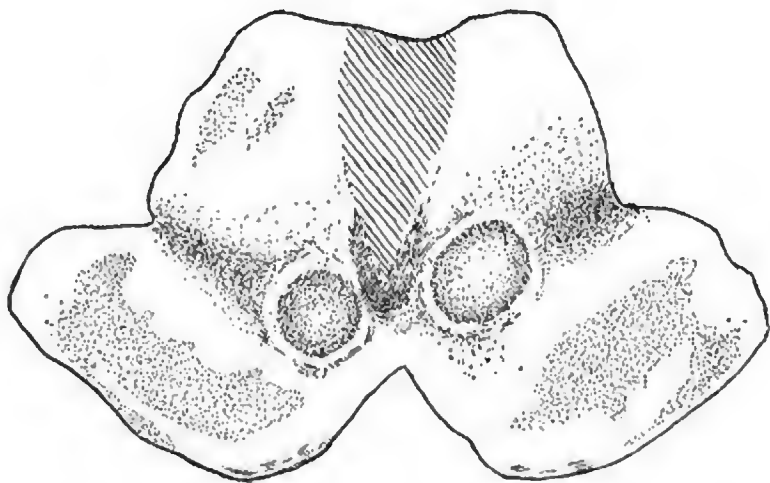


Fig. II. Section through midbrain showing position of tumor together with ventral displacement and atrophy of right red nucleus.

brain tissue, apparently not very vascular. In its forward extension the tumor had involved by actual ingrowth the posterior corpus quadrigeminum of each side, the ingrowth being apparently symmetrical and destroying almost completely the interior of the right posterior corpus quadrigeminum, leaving but a superficial shell of cortex remaining, the left corpus being similarly although much less involved. The anterior corpora quadrigemina or optic thalami did not appear to be affected. The superior cerebellar peduncles could not have escaped involvement either by pressure, or actual destruction, owing to their proximity to the growth. The region of the aqueduct of Sylvius, together with adjoining teg-

mentum, was involved. The hemispheres of the cerebellum were not affected by ingrowth, although the right hemisphere may have been by actual pressure, as a part of the tumor rested on the right cerebellar hemisphere. Sections through the cerebral and cerebellar hemispheres and basal ganglia revealed nothing abnormal. The crura cerebri, together with the parts of the interpeduncular space, presented no macroscopic changes. The ventricles were slightly distended with fluid, and the aqueduct of Sylvius was distinctly narrowed or occluded. The choroid plexus and velum interpositum contained no cysts and were not specially adherent. Small cubes from various parts of the tumor were removed and hardened in alcohols of increasing strength. The cubes

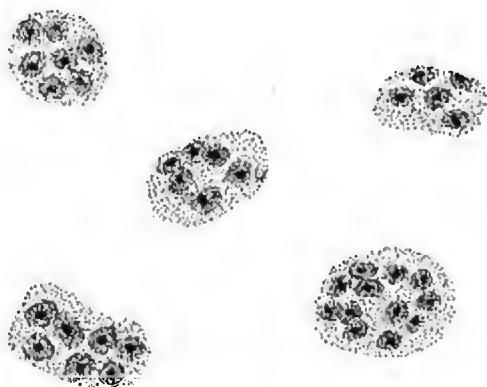


Fig. III. A group of multi-nucleated spheric-shaped cells.

were imbedded in celloidin and the sections stained in hematoxylin and eosin, Weigert's, carmine, nigrosin, Van Geison's stain, and Mallory's phosphotungstic acid hematoxylin.

The histological study of the growth shows it to belong to the type of the neuro-gliomata.² On section it consists of a homogenous dull grayish mass with but slight vascularity. With a low-power Zeiss ocular 2, objective 1-5, it consisted of a great variety of cells which were resolvable into four chief forms. First, large irregularly angular or spherical-shaped multi-nucleated cells variable as to size and containing from three to a dozen nuclei. The nuclear envelopes of the

²H. M. Thomas and Alice Hamilton. "A Case of Neuro-glioma of the Brain." *Journal of Experimental Medicine*, Vol. II, No. 6, 1897.

cells stain deeply, and most of the nuclei are filled with threads and granules of chromatin. The nuclei of many of these giant cells tend to an arrangement in a row along the periphery of the cell. These cells are devoid of processes, as the most careful search after selective staining failed to disclose their presence. The second variety of cells are polygonal or spindle in shape. They exist in large numbers and usually contain a single nucleus, although cells of this type containing two or three nuclei were not rare. With the ordinary nuclear stains, these cells appeared devoid of processes, but with selective neuroglia stains delicate processes could be seen extending from one or both ends of the cell body, which processes were one or more times in length the diameter of the

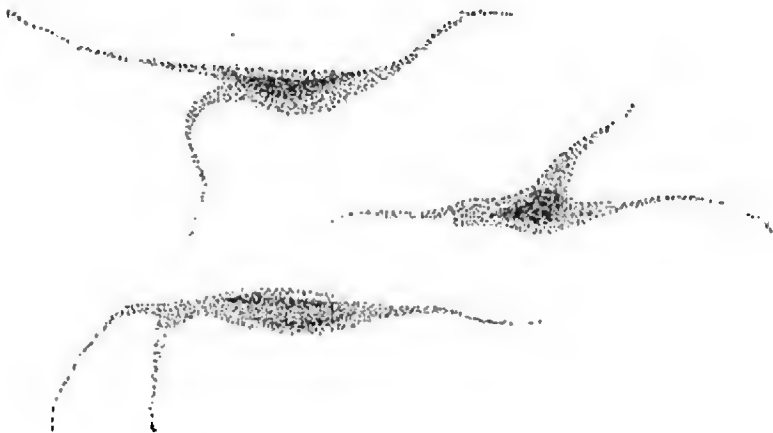


Fig. IV. Polygonal or spindle-shaped neuroglia cells.

cell. Sometimes, though rarely, these processes branched. A few terminated in brushes of fine fibrils, most of the processes, however, terminated in a single free extremity. Many of the nuclei of these cells stained deeply. Some contained vacuoles and stained very poorly. The third variety of cells were more or less spherical, contained a single nucleus and were devoid of processes. They were about the size of polynuclear leucocytes and resembled adult neuroglia cells without processes; they were abundantly distributed throughout, and often found in large numbers about the blood vessels; they may have been differentiated neuroglia cells. The fourth form of cells were normal neuroglia cells of the em-

bryonic type with a single long, undifferentiated process springing from each pole and terminating free or in a brush of fibers. Cells of the type of Deiters with processes radiating from all parts of the cell body were not found. All the above-mentioned forms of cells were separated by a very delicate reticulum of fine fibers, which fibers were not nearly as abundant as in most gliomata. Both the cells and fibers were best studied toward the periphery of the growth where the cells were not crowded so closely together. In a few situations the fibers were crowded into dense reticulum having in their meshes numerous small spherical cells. These fibers were only well seen after sections were stained with special neuroglia stains. The blood vessels were not very abundant



Fig. V. Neuroglia cells of embryonic type.

and, apart from a few of them presenting slight thickening of their walls, the result of proliferation of their spindle cells, were normal.

Although no typical nerve cells could be discovered, there existed a few large oval or flask-shaped cells resembling rather closely those of Purkinje. These cells contained single large centrally-placed nuclei, and distinct nucleoli, and possessed an apical process of some length, which did not appear to fork. No axones were found springing from these cells. With the Nissl or thionin stain, no characteristic arrangement of the chromophilic particles was observed. With Weigert's myeline stain, a few medullated nerve fibers were found

in sections of the growth connected with the cerebellar cortex, but in sections more remote none were seen.

The crura cerebri were severed close to their connection with the cerebral hemispheres, and they together with the pons and medulla were hardened in Orth's fluid, imbedded in celloidin, and the sections stained after the method of Weigert and Pal's modification of the same and with nigrosin. Sections through the mid-brain at the level of the anterior quadrigeminal bodies showed the Sylvian aqueduct to be occluded and the central gray matter to be spread out. Both red nuclei appeared smaller in comparison with those seen in normal sections, and

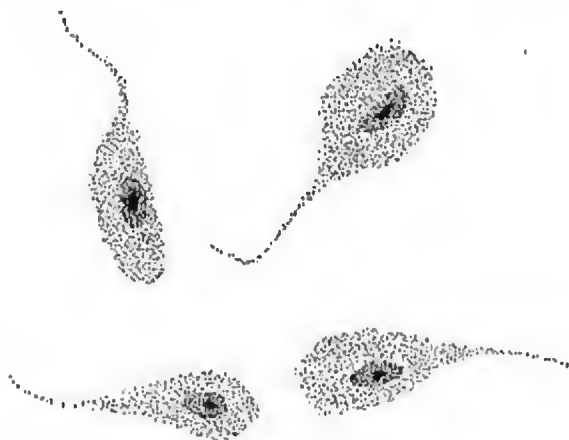


Fig. VI. Transitional cells of type of Purkinje.

the right was distinctly smaller than its fellow, and displaced considerably forward. The anterior quadrigeminal bodies were not involved. Owing to the spreading out of the central gray matter, the third nerve nuclei were distorted, and it was impossible to localize the various cell groups into which these nuclei have been divided. The left nucleus contained a less number of nerve cells than its fellow of the opposite side. The nucleus of each side contained numerous atrophic cells devoid of processes and without nuclei; other cells had lost their processes, their chromophylic particles were degenerated and their nuclei were often eccentrically placed, and the cells were deeply pigmented. This cell degeneration of the oculomotor nuclei was most marked in sections more dorsally placed, and seemed to involve, as well as one could

judge from the peculiar distortion of the parts, the most dorsal or spinal division of each oculomotor nucleus, as well as the small cells between the fibers of the dorsal longitudinal bundles.

Sections through the posterior quadrigeminal bodies showed that the tumor, which on section was irregularly wedge-shaped, had destroyed a part of the interior of each of these bodies, the right being most involved. The aqueduct of Sylvius was obliterated, and the central gray matter almost entirely replaced by the growth. It displaced laterally the dorsal longitudinal bundles and destroyed the most ventral part of each posterior division of the oculomotor nucleus and the nuclei of the fourth nerves, as there remained only a few scattered atrophic nerve cells to indicate their position. Extending ventrally, the tumor grew into the tegmental region and occupied a position dorsal to the red nuclei, thus destroying the fibers of the superior cerebellar peduncles at their point of decussation. It is interesting to note that in examining a large number of transverse sections of the pons and medulla nothing abnormal was found, save a few degenerated fibers scattered irregularly through each superior cerebellar peduncle. The lateral and mesial fillet of each side were perfectly normal and contained no degenerated fibers. The cells of the ventral auditory nuclei appeared normal, as did these of the superior olivary bodies. The facial and abducens nuclei contained no degenerated nerve cells. The descending trigeminal root fibers of each side were intact. The fibers of the motor tracts were not degenerated.

To summarize the post-mortem findings: We have in this case a tumor, neuroglioma, taking its origin in the ventral part of the superior worm, which in its growth forward into the mid-brain region destroys the superior medullary velum, the interior of the posterior quadrigeminal bodies, more especially the right, the central gray matter surrounding the aqueduct of Sylvius, the dorsal part of each oculomotor nucleus as well as the nuclei for the trochlear nerves, the tegmentum in the region of the red nuclei, and the superior cerebellar peduncles at their point of decussation; involving most, the fibers of the peduncles coming from the left side.

In the light of these findings the salient symptoms of this case may be explained as follows: First, the cerebellar gait which was so prominent a symptom may be explained by de-

struction either of the superior worm of the cerebellum or the superior cerebellar peduncles; probably both causes were in operation in this case. The tendency to fall to the left was possibly due to the involvement of the fibers of the left superior cerebellar peduncle after their decussation, in the right tegmental region. As Curshman³ found after section of either peduncle, the animal would invariably fall toward the side of the lesion.

The ocular symptoms consisting of paralysis of accommodation and of light reflex, with inability to move the eye-balls upward and downward and double ptosis may be explained by the position of the lesion. Although much disagreement of opinion exists among anatomists and clinicians in regard to the exact location of the various centers of movement for the internal and external ocular muscles, it is the accepted opinion of most observers that the centers for the sphincter pupilli and accommodation are well forward, while those for the external ocular muscles are more dorsally placed. Koelliker⁴ does not believe that separate centers exist in the human oculomotor nuclei for the individual external ocular muscles, and his view is supported by the recent exhaustive experiments of Bach.⁵ Professor Starr,⁶ however, proves, by a review of the clinical cases, that the centers for the superior and inferior recti muscles, as well as for the inferior oblique, are grouped closely together, while the centers for the internal recti and levator muscles are more forward, the latter being placed by him first.

The paralysis of the internal ocular muscles in this case was probably a pressure symptom, as the growth did not extend forward enough to actually destroy these centers.

The paralysis of the upward and downward movement of the eyes, due to inaction of the superior and inferior recti muscles together with the superior and inferior oblique, was

³Curshman. Arch. für klin. Med. Bd. X, p. 250.

⁴Koelliker Gewebelehre. 6, Auflage, p. 294.

⁵A. Bach. Archiv. für Ophthalmolog. Band XLV, Abt. 2, p. 339.

⁶Starr, M. A. "Ophthalmoplegia externa partialis." JOURNAL OF NERVOUS AND MENTAL DISEASE, 1888, p. 301.

due to the involvement of the cells of the posterior portion of the oculomotor nuclei and of the fourth nerve nuclei.

According to Wernicke, a separate center exists in the posterior corpora quadrigemina for the upward and downward movements of the eyes, similar in character although not in action to the abducens centers in the pons for the associated lateral movements of the eyes. That such a center exists seems doubtful and is not supported by clinical facts.

Although there is still some doubt as to the exact position of the center of movement for the levator muscles of the eyes, one author, Knies, placing it between the center of the sphincter pupilli and that for accommodation, while another, Siemerling,⁷ locates it in a small group of cells between the lower end of the third nerve nucleus and the fourth or trochlear. These cells being destroyed in a case examined by him of congenital ptosis. The weight of evidence, however, places this center with those of the other external muscles, save the superior oblique in the mid-region of the chief nucleus, which in my case was involved.

The slight convergence observed was probably due to spasm of the internal recti muscles, the result of irritation of their cell groups, or their root fibers, in the tegmentum; although it may have been the result of paresis of the external recti muscles from indirect pressure on the abducens nerves. These, however, showed no macroscopic changes and their nuclei were normal. The impaired vision I believe can be ascribed to the intense optic neuritis and not to impairment of function of the anterior corpora quadrigeminal bodies, as these latter bodies were normal, and Nothnagel, Henschen and others have proven are not directly concerned with the function of vision.

The general choreiform-like movements and the intention tremor of the hands observed in my case were probably due to implication of the superior cerebellar peduncles. In proof of this causation of the tremor and choreiform movements may be cited the well-known experiments of Ferrier and Turner, who have described similar tremors resulting from sec-

⁷Allbutt's System of Medicine, Vol VI, p. 767.

tion of the superior cerebellar peduncles in monkeys. They found that if a peduncle was divided between the cerebellum and its decussation in the tegmentum, the tremor was confined to the side of the lesion, and suggest that in clinical cases, one might explain the crossed tremor in unilateral lesions, by affection of the cerebellar peduncle above its decussation. In this connection will be briefly mentioned the very interesting cases of Bonhoffer and Sander.⁸ A merchant, aet. 55, had vertigo, headache and pain in arms, shoulders and legs, with marked choreiform movements in right arm and involuntary movements in the legs, especially the right. Movements of the same character were observed in the face and tongue. Ataxia existed in both legs, most marked in the right, also in right arm. Slight lateral nystagmus was present. Autopsy showed a carcinoma of the distal end of the posterior quadrigeminal bodies, involving the decussation of the superior cerebellar peduncles. The fillet, and oculomotor nucleus of each side were normal. Sander⁹ describes the following case: Postal clerk, aet. 72, had for four years after an apoplectiform attack, left side hemiparesis with disturbances of speech. Lively choreiform movements of the arms and legs of the right side existed. Right patellar reflex absent. Right-sided abducens paralysis. Double optic neuritis was present. Autopsy showed a gliosarcoma, rather larger than a walnut, which completely destroyed the right corpus dentatum. In the adjacent white matter external to this tumor existed another small growth.

In five of the eleven cases in literature, namely, those of Bruns, Weinland,¹⁰ Eisenlohr,¹¹ Ilberg¹² and Bonhoffer, in

⁸Bonhoffer. "Ein Beitrag zur Lokalisation der choreatischen Bewegungen." *Monatsschr. für Psychiatrie u. Neurologie*, B. I, p. 6.

⁹Sander. "Ein pathologischer Beitrag zur Function des Kleinhirns." *D. Zeitschr. f. Nervenheilk.*, B. X. 366.

¹⁰Weinland. "Ueber einem tumor der Vierhügelgegend und über die Beziehungen der hinteren Vierhügel zu Gehörsstörungen." *Archiv für Psychiatrie und Nervenkrankheiten*, C. XXVI, p. 363.

¹¹Eisenlohr. "Zur Diagnose der Vierhügel-Erkrankung." *Neurologisches Centralblatt*, B. IX, p. 1,747.

¹²Ilberg. "Ein Gumma der Vierhügelgegend." *Archiv. für Psychiatrie und Nervenkrankheiten*. B. XXVI, p. 325.

which lesions of the corpora quadrigeminal region were accompanied by tremor or choreiform movements, the superior cerebellar peduncles were involved. Both Bruns and Weinland believe that the tremor is due to irritation of the motor fibers of the pyramidal tracts, although in the cases they report the autopsies showed the motor tracts to be normal, while the superior cerebellar peduncles were diseased.

Owing to the connection of the inferior quadrigeminal bodies with the central auditory tracts, it is interesting that in the case herein reported hearing was normal; the patient hearing ordinary conversation very distinctly and the watch three feet away from each ear. This is entirely explicable by the absence of implication of the lateral fillet of either side, or of the nuclei about which their fibers terminate.

Weinland found loss of hearing in nine out of nineteen cases of tumor of these bodies, collected from literature. In five of this number, the loss was bilateral, while in four cases it was unilateral in character, involving the ear of the side opposite to the lesion.

In conclusion, it may be stated that the case here reported presented the typical symptom-complex outlined by Nothnagel as being diagnostic of tumors having their primary seat in the corpora quadrigeminal region. The autopsy showed, however, the growth to be located primarily in the cerebellum and to have involved secondarily these bodies together with the adjoining tegmental region.

In a somewhat similar case reported by Thomas, the diagnosis of tumor of the corpora quadrigemina was based upon the combination of double nerve deafness, cerebellar ataxia and weakness of the eye muscles. At the autopsy, however, the tumor was found to have its primary seat in the median side of the left cerebellar hemisphere and to have affected by pressure only, the corpora quadrigemina, particularly of the left side. The seventh and eighth nerves of the same side were flattened, while the same-named nerves of the opposite side were small and atrophied.

To these cases may be added the well-known case of Bruns, which presented in a most characteristic manner the

Nothnagel symptom-complex, but in which Bruns made a diagnosis of a primary cerebellar tumor with secondary involvement of the corpora quadrigemina. He based his diagnosis on the early appearance of cerebellar ataxia with slight paresis of the left abducens and the right facial nerves, and the late appearance of asymmetrical external ophthalmoplegia.

I have collected five cases, Ransom,¹³ Sachs,¹⁴ Bruns,¹⁵ Henoch,¹⁶ and Steffen,¹⁷ from literature in all of which ophthalmoplegia appeared first, the cerebellar gait appearing later. In each case the autopsy showed the primary location of the lesion to be in the region of the quadrigeminal bodies.

With the above-mentioned facts in mind, I believe the dictum of Nothnagel needs revision, as his statements are altogether too dogmatic. Bruns¹⁸ is nearer the truth when he states that a distinction between corpora quadrigeminal and cerebellar tumors is at times absolutely impossible. In favor of the tumor being primarily located in the corpora quadrigeminal bodies, is the appearance of an external bilateral asymmetrical ophthalmoplegia, often combined with internal ophthalmoplegia, as the first symptom, the cerebellar ataxia occurring later. Favoring the same situation is the absence of cranial nerve involvement other than the oculomotor or patheticus, and the presence of unilateral or bilateral deafness. In favor of the lesion being primarily situated in the cerebellum and involving secondarily the corpora quadrigemina, is the early appearance of a typical cerebellar gait, especially if combined with paralysis of the abducens or facial nerves of one or both sides, and followed by ophthalmoplegia of the above-described type.

¹³Ransom. *Lancet*, 1895, V. I, p. 1,115.

¹⁴B. Sachs. "Disease of the Mid-brain Region." *American Journal of the Medical Sciences*, March, 1891.

¹⁵Bruns. "Zur differentiellen Diagnose zwischen den Tumoren der Vierhügel und der Kleinhirnes." *Archiv. für Psychiatrie und Nervenkrankheiten*. B. XXVI, p. 300.

¹⁶Henoch. *Berliner klinische Wochenschrift*, 1864, No. 13.

¹⁷Steffen. *Berliner klinische Wochenschrift*. 1864, No. 20.

¹⁸Bruns. "Die Geschwülste des Nervensystems." p. 145.