A TUMOR OF THE CORPORA QUADRIGEMINA¹

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Tumors involving and practically limited to the region of the corpora quadrigemina are not frequent and I report this case because it may have some bearing upon the physiology and clinical importance of this part of the brain stem.

There is especially a dearth of literature of accurately observed cases, clinically and pathologically, on the relation between lesions of the corpora quadrigemina and the functions of hearing and sight; therefore this case deserves careful consideration and analysis.

CASE I.—Patient E. C. H., aged seventeen, school-girl; parents absolutely well. With the exception of the diseases of childhood, she had always been robust. About one year ago patient began having headaches. Two months later she began to have pain in the eye-balls, and about the same time she began to see double. The pain was chiefly located in the frontal region and on the right side. When walking she would often stagger to the right side. The right arm and leg, although not weak, did not seem right. In September she began to lose vision, and in December became totally blind. The patient often had hiccoughs, and vomited almost daily, especially when the headaches were violent. She at times had sudden attacks of rigidity of all her muscles, fell to the ground but did not lose consciousness.

REPORT OF DR. S. C. AYRES

June 17, 1908. For three or four months has had headaches every day, coming on in the morning and lasting until noon. Her general health has been good, she is abnormally fat but is as active as girls of her age.

Both optic discs are very much swollen, there is marked congestion and tortuosity of the veins. There is a small hemorrhage above the right disc. V.=1 in both eyes. Pupils moderately dilated and very slightly responsive to light.

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July 6. R. e. V.=1, L. e. V.=15/20, discs more swollen, diplopia, paresis of left ext. rectus.

July 15. L. e. V.=15/30; up to this time the vision of the right eye was normal.

July 30. R. e. V.=15/20, L. e. V.=15/30.

Aug. 10. R. e. V.=15/30, L. e. V.=15/40.

Sept. 17. Conditions much worse, V.=motions of hands only.

Dec. 10. V.=perception of light.

Feb. 1, 1909. Fell to the floor, but was not unconscious, two weeks later had a similar attack, her extremities were cold, had to keep her feet warm in cold weather by hot water bottles.

April 19, '09. Optic discs blanched, numbness of right side of body and pain in right side of head.

Examination by Dr. Hoppe.—April 19, 1909. Patient's mental condition was good. Pupils were dilated. There was no pupillary response to light; atrophy of both optic nerves, with choked discs; paralysis of both external recti. The external muscles of the left eye were all paralyzed except those which move the eyeball downward. She was unable to raise the right eye upward or turn it outward, but it could be turned inward and downward. There was slight ptosis of both eyelids; no anesthesia of either cornea. There was static ataxia, and when patient walked she showed a tendency to fall to either side, but mostly to the right. There was some weakness (?) of the left leg; patellar reflexes were normal. There was no defect of hearing. Tests being made with tuning fork, etc.

Diagnosis.—Subtentorial growth of uncertain location.

Course of Disease.—An operation was asked for by the father and daughter, but was deferred because of the hope of giving relief by the use of drugs. Relief was obtained by the use of acetylsalicylic acid (aspirin) and codein sulphate. The patient quickly lost her ability to walk at all, on account of extreme ataxia, showing a tendency to retropulsion and falling backward. Patient retained normal hearing to the very end. Somnolence increased. Incontinence of urine and feces set in. The headache and vomiting suddenly disappeared, and for two months before her death did not return. On August 12 patient died, a few hours after an attack of coma.

Autopsy.—Limited to the cranial cavity. There was very little cerebrospinal fluid. The cortex was anemic and the convolutions were flattened. Both lateral ventricles were dilated, and the right one was filled with a large blood-clot, which had caused the exitus. The floor of the right lateral ventricle over the basal ganglia was covered by a soft tumorous mass, very extensive, but not very thick, and hardly infiltrating the thalamus. The main mass occupied the region of the corpora quadrigemina, completely obliterating the canal of Sylvius, and extending backward into the

substance of the pons and laterally affecting the margin of the left lobe of the cerebellum. The rest of the cerebellum, both lateral and middle lobes, were uninvolved. The tumor was not more than an inch in diameter.

REPORT OF DR. LAMBERT

The brain stem and cerebellum posterior to cut *a-b*, Fig. 4, were received in formalin; several slices had been previously taken from different regions of the tumor and transverse-oblique cuts had been made through the brain stem and cerebellum, Figs.

Diagrammatic sketch showing in Fig. 4, a sagittal section through the normal brain stem. *cc*, corpus callosum; *p*, pineal gland; *on*, optic nerve; *om* and *t*, the oculo motor and trochlear nerves; *a-b*, the line of original section; I, II, III, the slices removed for sectioning, the dotted area, the approximate extent of the tumor.

Section I, from the anterior slice (Fig. 4) shows the pons, *p*; the dotted area the extent of tumor involvement.

Section II from the middle slice (Fig. 4); *p*, pons; dotted area represents the tumor.

Section III from the middle slice (Fig. 4); *p*, pons; dotted area represents the tumor; *cq*, the site of the corpora quadrigemina; *x*, the tumor growth beyond the boundaries.

4, 1, 2, 3. From these levels large slices were taken for alcohol-paraffin imbedding. Sections from near the middle of each of these blocks are represented in sketches 1, 2 and 3.

In section i, which is incomplete, compare with level from which it was taken, Fig. 4, the pons portion containing the projection, pyramidal fibers, and the mesial fillet is intact except for compression. The tissue surrounding what seems to be the Sylvian aqueduct (?), no ependyma being demonstrable, is extremely cellular; this diffusely infiltrating growth is gliomatous and gradually fades into normal tissue as one passes away from the supposed aqueduct. The nuclei of the tumor cells are round and oval, often polymorphous, are rather scantily clothed with cytoplasm, and lie in a moderately rich fibrillar matrix which stains differentially by Mallory's neuroglia stain. Numerous gliomatous giant cells are also present, Photo B. The nuclei and roots of the fourth pair of nerves are involved; to what extent, if any, the third nuclei are invaded cannot be determined, the anterior portion of the tumor not being available.

In section ii, Fig. 4, the posterior (?) corpora quadrigemina are cut through; a gap in the stained section is the site from which a slice had been previously taken. The posterior corpora quadrigemina are completely involved in the gliomatous new growth. An occasional diffusely staining nerve cell is seen. The tumor has penetrated the pia and overgrown the corpora quadrigemina particularly on the left side, and has grown backward along the superior cerebellar artery, and has invaded the cerebellum as seen in section iii. A "pseudoglandular" pattern uniformly present in glioma where growth is unrestricted is well seen in that portion of the tumor immediately overlying the corpora quadrigemina, Photo A. In the walls of many of the smaller arteries and precapillaries in the tumor and the nervous tissue immediately bordering it are seen numerous colloid-calcareous granules, Photo C; calco-spherites are also not uncommon.

The mesial fillet and projection, pyramidal, fibers are unin-
vaded by the new growth at this level. The corpora quadrigemina are almost completely infiltrated with the glioma cells and only few nerve cells remain; the termination of the lateral fillet, the spinal-tectal and thalamic tract, the superior arms and posterior longitudinal fasciculus are also in a position to be considerably interfered with, if not destroyed, by the tumor growth at this level.

In section iii, the tumor has extended backward and upward into the left cerebellar hemisphere. Here the tumor is rather more vascular, the larger centrally located vessels belong, no doubt, to the superior cerebellar artery (compare with the vessels of the opposite side). The tumor is richly cellular, mitoses are not uncommon and atypical forms are occasionally seen, Photo D. Here fibril production is patchy, the tumor cells near the vessels have a palisade arrangement and here fibril production is richest; in the intermediate vascular zones fibril production is scanty.

Summary.—A richly cellular, infiltrating glioma, approximately 2 by 4 cm. in its diameters, relatively scant in fibril production and containing numerous giant cells, involves the corpora quadrigemina almost symmetrically and the floor of the Sylvian aqueduct. The extent of the tumor anterior to the level of the nuclei of the fourth pair of nerves is not known. Its posterior extent is most marked on the left side where it has grown backward into the left cerebellar hemisphere laterally along the superior cerebellar artery, and to a slight extent invaded the left pons-cerebellar arm. The anatomical structures in a position to be injured by the tumor growth would be: The nuclei and roots of the fourth pair of nerves (injury to third probable but not ascertainable), the posterior corpora quadrigemina (anterior probable) (owing to a previous pathological examination for the purpose of determining the nature of the growth, a section was removed which involved that portion of the growth which destroyed the posterior corpora quadrigemina) the termination of the lateral fillet, the superior cerebellar arm, and to a slight extent the left middle cerebellar arm, the spinal-tectal and thalamic tracts, and the posterior longitudinal fasciculus; the other structures, as the fillet and pyramidal fiber system, and especially the sixth pair of nerves, would be subject to indirect compression and injury.

The involvement of the pons and cerebellum was so limited as we have seen by the very careful pathological examination that many, if not all the clinical manifestations in this case were caused by the destruction of the corpora quadrigemina and adjacent tissues. (See diagrammatic sketch.)

Let us summarize the chief symptoms and signs.

Double vision, staggering gait, falling to the right, gradual loss of vision, ending in three to four months in total blindness, sudden attack of rigidity in all muscles, falling to ground, without loss of consciousness, equal pupils, atrophy of optic nerves, no light response in pupils, all movement lost in left eye except downward movement, all movement lost in right eye, except inward and downward, slight ptosis of both lids, normal hearing, extreme static ataxia with retropulsion, so that patient was finally unable to walk at all, motion and sensation and reflexes not affected. There were at no time forced position or forced movements.

SUMMARY OF DR. LAMBERT'S REPORT

"The anatomical structures in a position to be injured by the tumor growth would be the nuclei and roots of the fourth pair of nerves (injury to the third probable but not ascertainable): the

Photograph A. Shows a low magnification of a portion of the tumor. Near Section II, the irregular columns of nuclei fringed with a fibrillar protoplasm produce a pseudo-glandular pattern. The bloodvessels are thin walled and much engorged.

posterior corpora quadrigemina (anterior probable): the termination of the lateral fillet, the superior cerebellar arms, and to a slight extent the left middle cerebellar arm, the spinal-tectal and

thalamic tracts and the posterior longitudinal fasciculus. The other structures as the fillet and pyramidal fiber system and especially the sixth pair of nerves, would be subject to indirect compression and injury."

We have therefore definite clinical signs and an accurate account of what anatomical structures were destroyed by the growth. Moreover the growth was practically limited to the region of the corpora quadrigemina and the structures immediately subjacent and therefore the case is valuable in throwing some light, not only from the standpoint of the physiology of these parts, but also from a point of localization. Owing to a mutilation of the specimen in its anterior region, the case does not offer any light upon the point of the localization of the nuclei of the various external eye muscles which are innervated by the third nerve and we can dismiss this point at once.

The only paralysis of external muscles of the eyes, not explainable by nuclear destruction, is the bilateral paralysis of the abducens. The loss of movement upward and inward can be explained by a destruction of the nuclei of the third and fourth nerves. The only explanation of the loss of function of the external recti lies in compression or destruction of the posterior longitudinal bundle, or it was caused by pressure of the nerve at the base, resulting from intra-cranial pressure.

Ransom (*Lancet*, May 4, 1895) reports a similar case with paralysis of the external recti, where the lesion was distal to the nuclei of the sixth. Cushing's explanation of constriction of the nerve trunks, caused by pressure of the artery, all due to increased intra-cranial pressure may offer an explanation.

As to the relation between the corpora quadrigemina and the function of sight, we cannot draw any positive conclusions either.

Ludwig Bach, who worked up the literature of 1890, concludes from a critical study of all cases, that isolated destruction of the corpora quadrigemina in man does not cause blindness. Whether or not any disturbance of vision occurs at all, he says, cannot be determined definitely, although the answer seems to be in the negative.

W. Nissen, analyzing eight cases of tubercles in this region, concludes that destruction of the corpora quadrigemina does not produce blindness, no gross disturbance of vision having been noted in any of these cases.

Photograph B. A higher magnification showing various types of nuclei and cells. The small round or oval type preponderates; numerous large multinuclear giant cells, some clothed with a moderate amount of cytoplasm are seen; the large dumb-bell shaped giant cell in the center is striking.

It is true that our patient was blind, and that blindness set in unusually rapidly, but we know that papilledema of an unusual degree was present before the deterioration of vision, and that later on atrophy of the optic nerves was present. We can conclude therefore that blindness was caused by a degeneration of the optic nerves and this is probably true in many other cases, and not by a destruction of the corpora quadrigemina. Moreover it is my opinion that the tumor began in the corpora quadrigemina and must have destroyed at least to a great extent these structures before it attained a size large enough to produce such a degree of intra-cranial pressure as to cause a very violent papilledema and that therefore disturbance of vision, if caused by a destruction of the corpora quadrigemina, should have preceded the development of the papilledema, whereas we know from Dr. Ayres's examination that vision was normal when the papilledema was at its height. It is very logical, therefore, to assume in this case that a destruction of the corpora quadrigemina did not cause blindness, but that blindness was accidental, being caused by an atrophy of the optic nerve following papilledema. When the external geniculate bodies, however, are involved in the destructive process we may have either hemianopsia or total blindness.

The centers for the iris are supposed to lie in advance of the nucleus of the third nerve and therefore unless the tumor is in advance of the corpora quadrigemina the light reaction will not be affected (Spiller, Kolisch, Bristowe, Sachs).

In our case, Dr. Ayres found that the pupils responded to light, although when I examined them light reaction was lost, but this was undoubtedly caused by the atrophy of the optic nerves. Bach, however, concludes that bilateral destruction of the corpora quadrigemina causes bilateral loss of pupillary light reflex. Unilateral destruction causes loss of light reflex of the pupil of the same side.

We will next take up the subject of the relation between hearing and the posterior corpora quadrigemina. We have seen from the clinical examination of our case the hearing was unimpaired, even up to the very last. A careful examination, both for air and bone conduction was made, but no defect of hearing was found. The pathological report states that the posterior corpora quadrigemina were completely destroyed, and that the

Photograph C. Colloid calcareous material; calco-spherites.

termination of the lateral fillet was in position to be injured. Clinical and pathological reports on this point are contradictory.

The experiments of Kallisher on trained dogs would indicate not only that the dogs can hear, but that they can differentiate between tones, even though the posterior quadrigemina are destroyed. These experiments were repeated and the conclusions affirmed by Rothmann, viz., that the posterior corpora quadrigemina can be destroyed without causing central deafness. Rothmann, however, found that there is some relation between the

Photograph D. An atypical mitotic figure three equatorial plates, spindles and centrosomes.

posterior corpora quadrigemina and the sense of hearing, but that its importance is secondary to the internal geniculate body, and that when the posterior corpora quadrigemina are destroyed, its function is capable of compensation. Bach (*Zeitschrift für Augenheilkunde*, Vol. VIII, p. 213) states as a result of a clinical and pathological analysis, that central deafness seems to result from a destruction of the posterior corpora quadrigemina, and that the destruction of one is followed by deafness of the opposite side.

Weinland (I quote Allen Starr) made a collection of 27 cases of lesions of the posterior *corpora quadrigemina*. In 13 cases deafness was noted, but in all these cases the lateral lemniscus was

affected. In some cases there was bilateral deafness, in others the deafness was on the side opposite the lesion. Weinland, upon the evidence of his own case as well as that of Ruel and Ferrier, comes to the conclusions that unilateral destruction of one posterior corpora quadrigemina and the lateral lemniscus leads to deafness of the opposite ear. In the other 14 cases the lesion did not reach the lateral lemniscus or there was no mention made of disturbance of hearing.

Oppenheim quotes Seibman who holds that disturbances of hearing result from lesions either of the lateral lemniscus or the posterior corpora quadrigemina.

The accepted course of auditory impulses (Held, Thomas, Van Gehuchten) is to the acoustic centers in the pons, thence along the lateral fillet, posterior corpora quadrigemina to the internal geniculate body and thence to the cortex of the temporal lobe. In our case this tract was interrupted by a destructive lesion, destroying the corpora quadrigemina and the ending of the lateral fillet, and still hearing was intact. There are not many of cases of this kind on record. In none of W. Nissen's eight cases was hearing involved at all.

In commenting on these cases Nissen² expresses the view "that the corpora quadrigemina may be a reflex area in which the acoustic system is connected with the nuclei for ocular movements."

In Collins case hearing was normal. Similar cases have been put on record by Gordinier and Bielschowsky but in these cases, while the posterior corpora quadrigemina were destroyed the lateral fillet was not affected. Our case differs from these in so far as both posterior corpora quadrigemina were destroyed and the "lateral fillet in position to be injured."

Our case is a clinical confirmation of the animal experiments of Kallischer and Rothmann, that destruction of the corpora quadrigemina does not lead to deafness. In just how far the lateral fillet was destroyed, the pathological report does not say. It merely says that the termination of the lateral fillets at the level of the section made through the region of the posterior corpora quadrigemina are in a position to be considerably interfered with, if not destroyed by the tumor growth in this level. They may

² I quote Spiller, whose articles in "The Eye and Nervous System" I have used freely in the preparation of this paper.

have not been totally destroyed, as the corpora quadrigemina were and this may be a reason for the retention of the faculty of hearing.

Less interesting but equally important from a diagnostic point in our case is the presence of intense ataxia and retropulsion. The development of the ataxia is interesting from a standpoint of differential diagnosis. The ataxia was practically the last of the symptoms to develop in a chronological order. While there was some uncertainty of gait and a tendency to stagger to the right side, this was slight, and hardly noticeable even after blindness had set in. Ataxia became marked toward the end, after the general signs of cerebral tumor, external eye-muscle palsies and blindness had been in existence for months or even a year. This would seem to indicate as we have argued before, that the growth began in the corpora quadrigemina and extended downward. It would also be a proof that destruction of the corpora quadrigemina as such has no effect on coördination of movements, but that only when the lesion had advanced and penetrated the deeper structures and destroyed the superior cerebellar arms and the red nucleus that we have marked symptoms of ataxia. In this way alone can we explain the ataxia in this case which was so marked as to render locomotion impossible. The degree of ataxia was probably due to the complete destruction of the superior cerebellar arms in our case and not to the very slight involvement of the left cerebellum. In other words, destruction of the corpora quadrigemina themselves does not cause ataxia, but the latter is due to the destruction of the superior cerebellar arms which decussate under them and form the red nucleus. Nothnagel believed that the corpora quadrigemina are concerned in coördination, whereas Nissen has put a case of tumor of the corpora quadrigemina on record in which the growth was strictly confined to these bodies and no ataxia at all was found.

The chronological order of development of the ataxia is very important, as we see from this case. The combination of ataxia and ophthalmoplegia is very often seen in subtentorial growths. We cannot hold with Nothnagel that this is pathognomonic of tumors of the corpora quadrigemina. But with Spiller and Bruns, this case teaches us that if the general signs and symptoms of brain tumor are followed by ophthalmoplegia and the latter by ataxia, the growth is liable to originate in the corpora quad-

rigemina, but that if the ataxia precedes the development of the ophthalmoplegia the tumor originates in the cerebellum.

Just how to account for the tendency to stagger backward or to fall backward on attempting to walk, is perplexing. This symptom, however, was noticed by Turner (*Brain*, Vol. 21, 1898) also in one of his cases.

We can conclude from the critical analysis of this case that neither blindness nor deafness nor ataxia are pathognomonic of a disturbed function of the corpora quadrigemina. Nissen (*Jahresbericht für Kinderheilkunde*, Vol. 54, p. 645) has voiced this opinion before, and Marburg (*Wien. Klin. Wchnschr.*, 1905) has said more recently that hardly any focal symptoms are due to a destruction of the corpora quadrigemina.

Now while this may be true in a physiological sense, it is not a good policy from a clinical, diagnostic standpoint to circumscribe the corpora quadrigemina so very closely. We must recognize from a practical standpoint that no tumor is going to be strictly localized to the corpora quadrigemina—that tumors, however, do originate here and eventually invade and compress the surrounding territory, and although external eye palsies, disturbances of vision and hearing and ataxia are neighborhood symptoms, that they form such a characteristic syndrome, as to enable us to make such an accurate localizing diagnosis, as to rule out tumors originating from other parts of the cerebellum. The practical importance of this conclusion is that we will, in case we can localize a neoplasm in the corpora quadrigemina, not subject our patients to futile and perhaps fatal exploratory operations. This does not, however, rule out decompression operations, which I believe should be subtemporal rather than suboccipital, because the increased intra-cranial pressure in these cases is due to the development of internal hydrocephalus caused by the compression or occlusion of the canal of Sylvius. If this had been done early in our case it is possible that blindness could have been prevented and the girl's sight have been retained during the last year of her life.

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