Tumours of the cerebellum / by John Wyllie.

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BY

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LONDON
H. K. LEWIS, 136, GOWER STREET
1908

TO THE MEMORY OF

ROBERT WYLLIE, L.R.C.P. Ed.

ONE OF WHOSE GREATEST DESIRES WAS THAT HIS SON
SHOULD OCCUPY AN HONOURABLE POSITION
IN THE PROFESSION HE HIMSELF LOVED SO WELL
THIS SMALL VOLUME
IS AFFECTIONATELY DEDICATED

PREFACE

THIS work is based on the careful analysis of a large number of recorded cases, all of which were proved to be cerebellar tumours, either by operation or post-mortem examination.

The anatomical notes are derived from the best English text-books, and those on physiology are the opinions of men distinguished in that science.

I have to acknowledge my indebtedness to the writings of, among others, Sir William Gowers, Drs. Ferrier and James Taylor.

If my little effort in the way of book-writing is found to be of any service to students about to face the ordeal of their final professional examination, I shall have had my reward.

JOHN WYLLIE, M.D.

262, BEVERLEY ROAD, HULL,
December, 1907.

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TUMOURS OF THE CEREBELLUM

PART I

BEFORE beginning the consideration of the various symptoms caused by tumours of the cerebellum, it will be in order first to give a short résumé of its structure and relationship to neighbouring organs, as well as of its functions.

CHAPTER I

THE STRUCTURE OF THE CEREBELLUM

THIS portion of the brain lies in the inferior occipital fossæ of the cranium, and has above it the occipital lobes of the cerebrum, and below it the pons Varolii and medulla oblongata, and the space between its under surface and the medulla forms the fourth ventricle.

It is covered by a fold of dura mater, known as the **tentorium cerebelli,** and a reflection of this tentorium forms the **falx cerebelli,** which separates the lateral lobes. The weight of the cerebellum compared to that of the cerebrum is as 1 : 8$\frac{4}{7}$.

The cerebellum consists of two lateral lobes, or

hemispheres, united by a central portion, called the **vermiform process, vermis**, or **worm,** and is united with the rest of the encephalon by means of three pairs of peduncles (foot-stalk of leaf); the superior pair uniting it with the cerebrum, the middle pair uniting it with the pons Varolii, and the inferior pair uniting it with the medulla oblongata.

The surfaces, both upper and lower, are distinguished by their laminated or foliated appearance, the fissures running transversely across the hemispheres, with a slight curve towards the free margins. They do not all run to the edge of the hemispheres, some of them running into others.

The Upper Surface.—The upper worm consists of five lobules, which are continuous with the hemispheres on each side. The lobules of the upper worm and corresponding parts of the hemispheres are, from before backwards, named as under:

Hemisphere.	Worm.	Hemisphere.
	Lingula	
Ala lobuli centralis	Central lobe	Ala lobuli centralis
Anterior crescentic lobe	Culmen monticuli	Anterior crescentic lobe
Posterior crescentic lobe	Clivus monticuli	Posterior crescentic lobe
Posterior superior lobe	Folium cacuminis	Posterior superior lobe

The great horizontal fissure divides the cerebellum into an upper and lower portion.

The **under surface** of the vermis is less clearly continued into the lobes forming the hemispheres. The

lobules of the lower worm and the corresponding parts of the hemispheres are, in Quain's 'Anatomy,' enumerated from before backwards, as under:

Hemisphere.	Worm.	Hemisphere.
Frænulum lingulæ	Lingula	Frænulum lingulæ
Ala lobuli centralis	Lobulis centralis	Ala lobuli centralis
Lobus lunatus anterior	Culmen monticuli	Lobus lunatus anterior
Lobus lunatus posterior	Clivus monticuli	Lobus lunatus posterior
Lobus posterior superior	Folium cacuminis	Lobus posterior superior
Lobus posterior inferior	Tuber valvulæ	Lobus posterior inferior
Lobus biventralis	Pyramis	Lobus biventralis
(Tonsils) Amygdala	Uvulæ	Amygdala
Flocculus	Nodulus	Flocculus

The nodule and tonsils project into the floor of the fourth ventricle.

The names of the constituent parts of the hemispheres are given to show the relationship of each with the different parts of the vermis.

Arbor Vitæ Cerebelli.—When the vermis or either hemisphere is cut across in the direction of the laminæ, the interior is seen to consist of a central stem of **white medullary** matter and a cortex of **grey** matter. The section represents a characteristic tree-like appearance—hence its name, arbor vitæ—its larger folia being formed of secondary, and these being again divided into tertiary folia.

Within the white matter or central stem there are four independent centres or nuclei of grey matter.

1. The **nucleus dentatus**, the largest, is a capsule of grey matter open at one end, and enclosing white

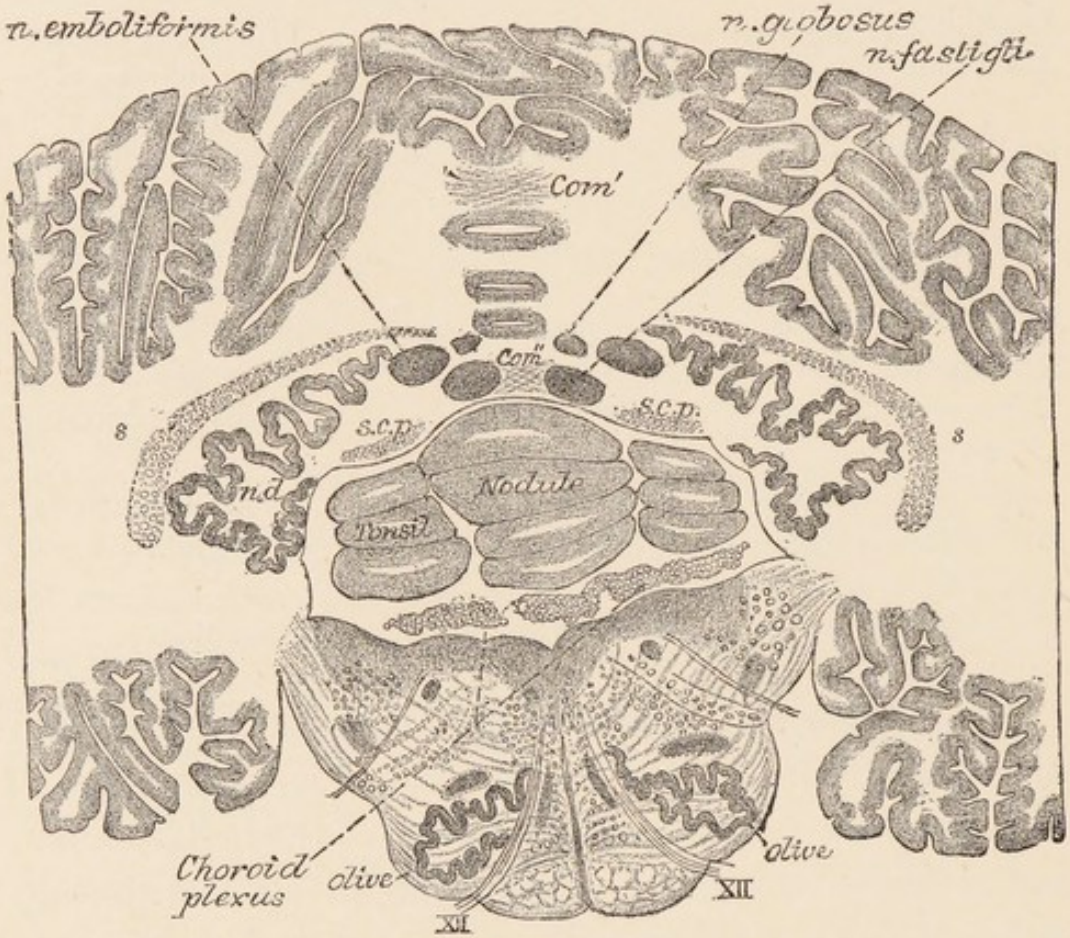

FIG. 1.—NUCLEI IN THE WHITE MATTER OF THE CEREBELLUM.

n.d., Nucleus dentatus cerebelli; *ss*, band of fibres derived from restiform body, partly covering dentate nucleus; *s.c.p.*, commencement of superior cerebellar peduncle; *com'*, *com''*, commissural fibres crossing in median white matter.

(Pen-and-ink sketch from Quain's 'Anatomy.')

matter in its interior. Stellate cells, $\frac{1}{1500}$ to $\frac{1}{2500}$ inch in diameter, lie in the grey matter, which is traversed by bundles of nerve fibres.

2. The **nucleus emboliformis**, partly covering the hilum of the previous centre.

3. The **nucleus globosus**, the smallest of the four.

4. The **nucleus fastigii**, or nucleus of the roof, only separated from the others by a streak of white matter. They are not quite isolated, being connected with each other—*i.e.*, the three last with each other, and all of them with the nucleus dentatus.

Besides these centres, commissural fibres of grey matter in the white matter, consisting of **decussating commissural**, or **crossing, fibres**, which connect one lamina with another (Quain).

The **superior** peduncles of the cerebellum connect this organ with the cerebrum. They arise from the nucleus, close to the boundary between the middle and lateral lobes, and run upwards and forwards to the corpora quadrigemina, underneath which they pass to the optic thalamus, and it is also said to the cerebral cortex.

Each peduncle forms the upper part of the lateral boundary of the fourth ventricle, and is connected with its fellow of the opposite side by the valve of Vieussens, a thin translucent fold of white matter which forms part of the roof of the fourth ventricle.

The **middle** peduncles are the largest of the three sets, and are distinguished by the small size of their fibres, which arise from the pons Varolii, and enter the white matter of the cerebellum in two main bundles, one of which radiates into the medullary centre of the hemisphere, while the other enters the vermis.

The **inferior** peduncles pass from the white matter

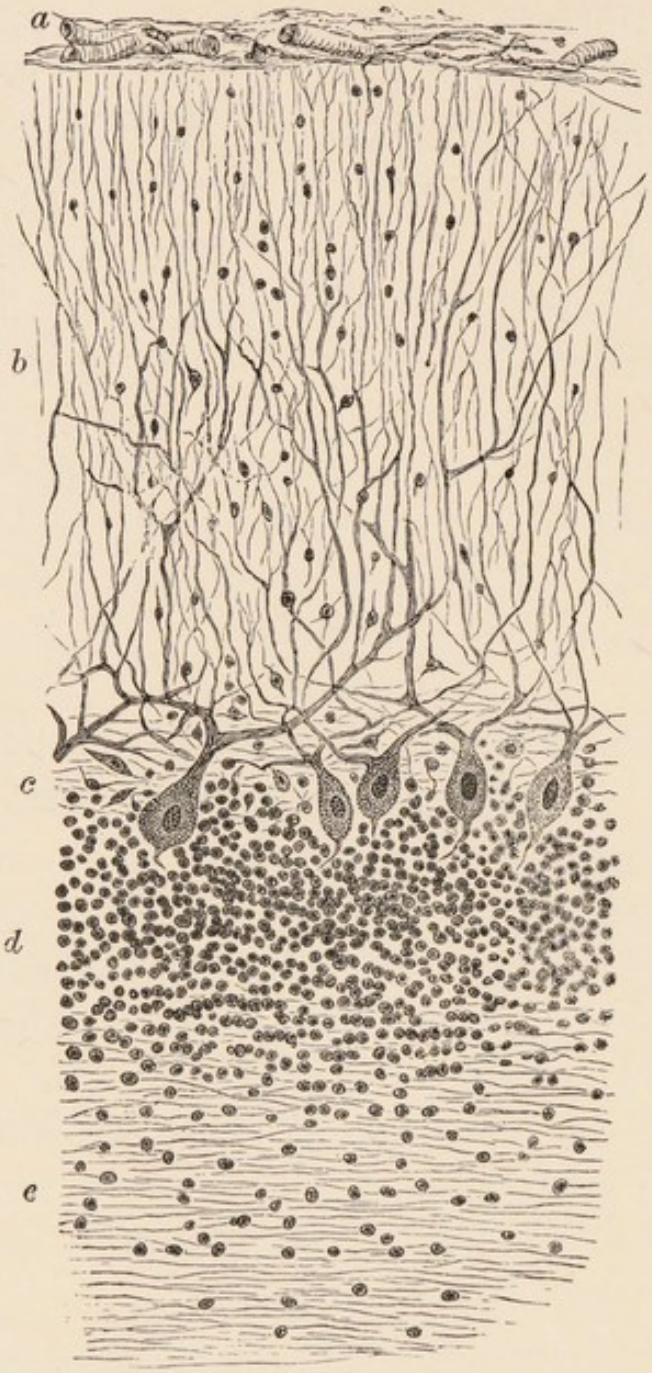

FIG. 2.

a, Pia mater; *b*, external layer; *c*, layer of corpuscles of Purkinje; *d*, inner or granule layer; *e*, medullary centre.

of the lateral hemispheres between the other two, to form the lateral wall of the fourth ventricle, and become the restiform bodies of the medulla oblongata.

The Cortex of the Cerebellum.—Each lamina of the cerebellum consists of a core of white matter, continued from the central stem, and a cortex of grey matter, consisting of an external and internal layer. The **external cellular** or **molecular** layer consists of nerve fibres, some of which run parallel and others (Bergmann's fibres) vertically to the surface and between these fibres and nerve cells, which are neither so numerous nor so small as those of the granular layer.

In the deepest part of the external layer are the characteristic cells of the cerebellum, the **corpuscles of Purkinje** (Fig. 1)—large flask-shaped cells, each of them having a number of branching processes (dendritic processes, or dendrites) directed towards the surface, and an axis cylinder directed to the granular layer.

The **internal granular** or **rust-coloured** layer contains numerous granules of a reddish colour, embedded in a gelatinous material, and are the more numerous the nearer they are to the cells of Purkinje, near which are also a number of large cells, usually considered glia cells, with dendritic processes pointing towards the surface, along with the processes from the cells of Purkinje.

CHAPTER II

THE FUNCTIONS OF THE CEREBELLUM

THE **direct cerebellar tract** lies between the lateral pyramidal tract and the surface of the spinal cord, and does not extend further forward than that tract.

It begins at the level of the root of the first lumbar nerve, ascends to form part of the restiform body of the medulla oblongata, contains ascending fibres, and increases in size as it ascends.

Gowers' tract, or the **antero-lateral ascending tract,*** is a band of fibres on the surface of the cord in front of the direct cerebellar tract. It contains ascending fibres, which enter the outer side of the tract of the fillet.

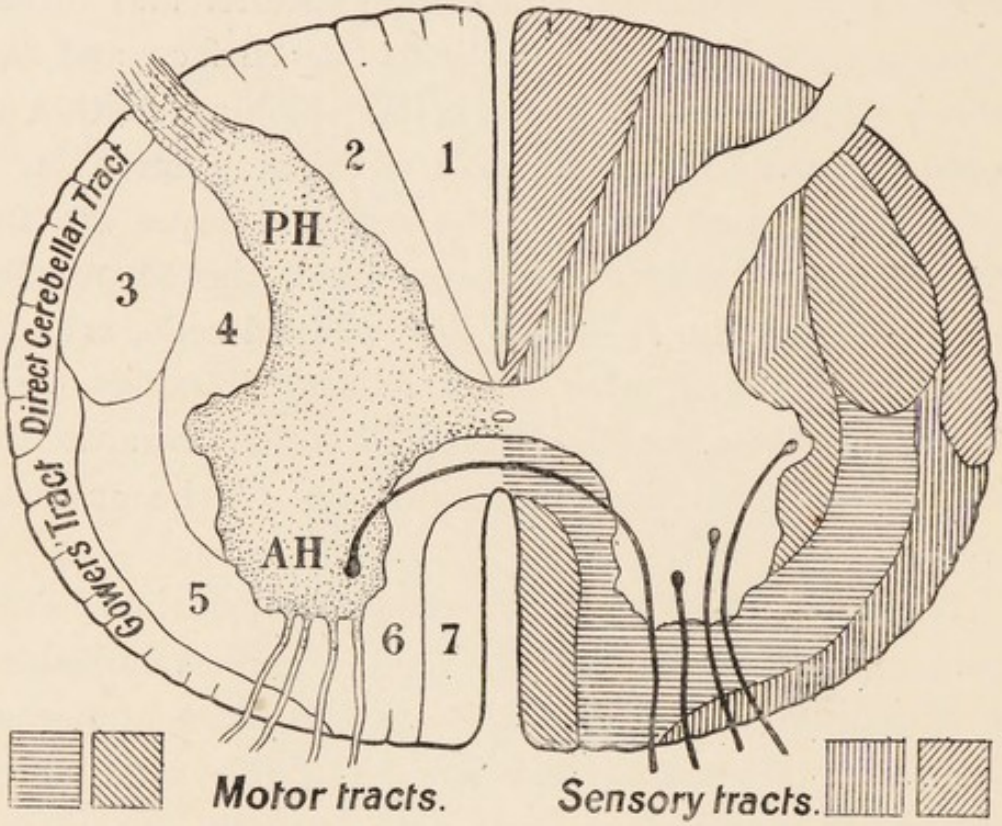

FIG. 3.—DIAGRAM SHOWING THE POSITION OF THE CEREBELLAR TRACTS: G.T. AND D.C.

1, Column of Goll; 2, column of Burdach; P.H., posterior horn; A.H., anterior horn; direct cerebellar tract; 3, crossed pyramidal tract; 4, lateral ground bundle; Gowers' tract; 5, mixed lateral zone; 6, anterior ground bundle; 7, direct pyramidal tract.

(After Deaver's 'Surgical Anatomy.')

* An ascending tract is one in which degeneration takes place above the site of the section or injury.

Four other tracts pass up from the posterior division of the cord to the cortex of the middle lobe of the cerebellum; their functions are doubtful, and none of them pass directly to the lateral lobes.

If the inferior peduncles be divided or destroyed, there is rolling to the side of the section; something similar, but not to the same extent, occurs if the superior or middle peduncles be divided.

When one hemisphere is removed, extensive degeneration is seen in all three peduncles of the same side, and very little in those of the opposite side, a fact suggesting the idea that none of the peduncles have crossing fibres.

On removal of half the vermis the degeneration of the superior peduncle is slight; that of the middle peduncle is most marked in the upper one-third of the pons; that of the inferior peduncle is limited to the outer or lateral part of the restiform body (Quain).

On the removal of the whole of the cerebral cortex the inferior and middle cerebellar peduncles, with the hemispheres and other structures in the neighbourhood, undergo atrophy.

It is well known that the relationship between one side of the cerebellum and the opposite cerebral hemisphere is of a very intimate order, and is well exemplified in Dr. Ferrier's book on the 'Functions of the Brain,' in which the anterior half of the **left** cerebral hemisphere is wanting, and the **right** half of the cerebellum is atrophied.

Whether the cerebellum of an animal is removed

altogether or only in part, ordinary movement after a time is regained; what is lost is precision and completeness of movement.

Nor is the animal so decerebellated any the worse in its psychical power or intelligence, in its hearing or eyesight; and if a person who is suffering from a cerebellar tumour loses his eyesight, it is not because of the destruction of so much cerebellum, but on account of the pressure of the tumour on neighbouring structures.

If one half of the organ be removed, the animal stands or tries to walk on the other side, and leans on the injured side, and the eyes deviate to the uninjured side, and the attempt at correction causes repeated jerking movements (lateral nystagmus) back towards the uninjured side.

The physiologist Gall propounded a theory that the cerebellum, and in particular its middle lobe, was related to the sexual instinct. Later observers found that this instinct originated in the posterior surface of the medulla and pons, and that when it is noticed to be abnormal in cerebellar disease, it is due to irritation by that disease of the underlying structures.

Experiments on animals and clinical phenomena equally support the theory that the cerebellum is the chief organ of progression and equilibration; but that it is not the only organ of the kind is seen by the fact that an animal deprived of its cerebellum will in the course of a few months, after other parts of the central nervous system have developed compensatory functions, resume possession of the powers of standing, walking,

running, swimming, etc., which it had temporarily been deprived of, and eventually be no worse for the injury it had sustained, with the exception that there always persists a tremor of the whole muscular system when the animal is in voluntary motion. This condition of general tremor is noticed in cases of extreme atrophy of the cerebellum.

Equilibrium requires a central nervous organ and a **sensory** or **afferent** mechanism, by which the requirements of the body may be made known to it, and an **efferent** or **motor** mechanism, the motor nerves and voluntary muscles, by means of which muscular adjustments may be effected.

The afferent mechanism consists of three kinds of impressions :

1. **Kinæsthetic**—those which give a person a 'sense of movement'—are the impulses received from skin muscle, ligament, etc., and which are conducted thence to the cerebellum by way of the direct cerebellar and Gowers' tracts, and enter the cerebellum in the first case by its inferior peduncles, and in the second by the superior peduncles, while impressions from the muscles of the eyes enter also by the superior peduncles.*

2. **Visual.**—These arise in the eyes and enter the cerebellum by way of the superior peduncles through the optic thalamus.

3. Most important of all are the **aural** impressions

* Dr. Hughlings Jackson says that, since the cerebellum is the essential organ in progression and locomotion, there must be represented therein associated ocular movements.

from the semicircular canals of the labyrinth, and the utricle and saccule of the internal ear, which enter the cerebellum by its inferior and middle peduncles, through the agency of the auditory nerve (eighth).

'The cells of Purkinje then originate impulses, which are sent to the cerebral cortex chiefly of the opposite side, to the nuclei of the cranial nerves in the mid- and hind-brain, and some which pass down the cord. The cerebellum thus influences the discharge of new impulses from these structures, and . . . co-ordinates the movements of the muscles of the body' (article in the *Practitioner*).

'The cerebellum preponderately helps to secure co-ordinate innervation of the skeletal musculature, both for maintenance of attitude and for execution of movements. So far as the geotropism and stereotropism of the animal can be "centred" at any one limited field of the central nervous system, that field is cerebellar. It supports habitual posture, and is at least as importantly associated with the movements depending on the lower cerebral centres—*e.g.*, walking and running—as with those elaborated in connexion with the highest—*e.g.*, technical movements' (Michael Foster).

Agreeing with Hughlings Jackson, Clark and Horsley have found that 'the eye movements described by Ferrier as obtainable by excitation from the surface of the cerebellum owe their motor genesis, not to localized centres in the cortex cerebelli, but to foci in the intrinsic nuclei'; and Sir Victor Horsley further says 'that the cerebellar cortex is the first chief station of representa-

tion of the afferent basis of movements of all the skeletal muscles.'*

That the semicircular canals are concerned with equilibration was first demonstrated by Flourens, and others have since noticed the same facts. Dr. Ferrier says that, if the horizontal canal of a pigeon is divided on one side, the head 'oscillates in a horizontal plane round the vertical axis. These cease after a time, but on section of the corresponding canal on the other side, reappear with greater intensity, and the animal is unable to maintain its equilibrium, falling or turning in a vertical axis or circling round and round. These conditions pass away in eight or ten days. When the posterior vertical canals are divided, the disturbances of equilibrium are similar, but more violent; in this case the movements are in a vertical plane, round a horizontal axis, and, instead of spinning round a vertical axis, the animal tends to execute a somersault, head over heels. These disturbances may all subside in a fortnight, but the animal is totally unable to fly.'

* The functions of the cerebellum will be again noticed under 'Ataxia.'

PART II

THE consideration of the various symptoms caused by cerebellar tumours is a study both interesting and lengthy, and the difficulty in writing upon it is that, while endeavouring to express oneself briefly and to the purpose, briefness may be purchased at the expense of clearness; and, on the other hand, it may be possible to somewhat labour one's point by an undue desire to be clear and well understood.

The general symptoms, which in the vast majority of cases are the first to appear, will be dealt with first, and others will be taken in their supposed order of priority of development.

It may be here noted that, considering the relative bulks of the cerebellum and cerebrum, the former is much more liable to the formation of new growths than the latter.

CHAPTER III

HEADACHE AND VOMITING

WITH a few very rare exceptions in which tumours, chiefly of tubercular origin, seem to produce practically no symptoms whatever, the first indication of trouble, except in some cases of the extracerebellar

variety, is beyond all doubt headache. This by itself is not a basis upon which to found a diagnosis of any kind or sort in intracranial disease. It may create in one's mind a suspicion, possibly of the gravest character; but other forms of severe headache are so many and so diverse that any early suspicion there may be must not be recorded either in written or spoken language, and we await developments. If our surmise is correct, we may not have long to wait for the following on of the next symptom in the sequence of this tragedy of troubles, and it is very likely to be vomiting.

There are two important points in the headaches of cerebellar tumours which particularly call for discussion, and they are their **site** and **nature.** As to the first of these, it is not surprising that the pain should on most occasions be referred to the occiput, and, indeed, be still clearer localized to one or other side of the occiput. In a distinctly smaller number of cases it is at first frontal, remaining so throughout the illness; or as time goes on it may cease to be referred to the frontal region, and occipital pain only is complained of.

Frontal headache is usually on the side of the lesion, but this law is not universal, for in case No. 42 there was pain over the **right** eye, and the lesion was found in the **left** lobe of the cerebellum. In about one-fifth of the whole number of cases pain is occipito-frontal, and when that is the case it is for the most part unilateral, and remains thus to the end. Or the headache may be of a general character for a time, and become localized at the back of the head late in the

illness. Only in one of the eighty cases upon which these chapters are based was the pain at the vertex, and in that case it was referred to the occiput later on. It is thus seen that, whether headache is at first experienced at the back of the head or not, it becomes so localized as the disease advances; and frequently the area of the pain becomes enlarged by its radiating down the neck or causing stiffness of the cervical muscles, with some pain on turning the head. It may be here observed that drowsiness is a noticeable feature when the pain continues frontal long.

As to the **nature** of the pain, if there is one thing which more than another strikes the medical observer, it is its intensity and paroxysmal character, causing him perhaps to think that if ever headache by itself has caused a man to become mad, surely it must have been this particular form of it. Headache may be as intense in uræmia, lead-poisoning, or typhoid fever, but it cannot well be worse; and it may be of the same paroxysmal character in quickly growing cerebral cysts and gliomata, but the paroxysms can scarcely be more acute.

Assuming that a tumour is present in the cerebellum, the question arises as to the manner in which it causes pain. Is it by pressure on neighbouring nerves, by the œdema it may have produced in the surrounding brain substance, by the nature of its own structure, or by what other cause?

One may well imagine that all these causes play a part in the generation of headache: the cyst, gumma, and tubercle by their pressure upon, and consequent

œdema of, the neighbouring brain-matter, and the stretching of the tentorium, and the malignant growth by the nature of its formation in addition.

Intracranial pressure is a more probable factor than any or all of the preceding causes taken together, and it is proved by the fact that when this pressure is relieved, either by tapping the distended ventricles or by the removal of a disc of bone and the incision of the dura mater, headache almost disappears.

As the expression 'intracranial pressure' will be used frequently in the following pages, it may be well now to state that by it is meant that general and equal pressure upon the contents of the cranial cavity by fluid, in the subarachnoid space and in the ventricles, which has been exuded through general vascular congestion, and by the blood in the veins which drain the ventricles, the veins of the choroid plexus, being obstructed in its flow in the veins of Galen towards the straight sinus.

This condition is *de facto* a chronic hydrocephalus, and because of it a gradual enlargement of the head is a constantly associated symptom of cerebellar tumours in children; but the pressure in adults is not great enough to cause the bones to yield, but pressing on the yielding brain is sufficient to cause headache.

This hydrocephalic state may mask the symptoms of cerebellar lesions, or, on the other hand, produce false localizing signs.

The obtrusive character of the headache is not so marked in extracerebellar tumours, in which variety we also find that it is not by any means the earliest

symptom; indeed, it may only in such cases develop when other symptoms have made the nature of the disease obvious.

With headache may be bracketed **bulging of the cranium** and **tenderness on pressure**, which, however, are far more common in children than in adults, and in the extra- than in the intracerebellar type of tumour, and particularly that class which grows from bone or the meninges and occupies the posterior occipital fossa.

The idea that cysts do not cause so much headache as solid growths is not supported by the inquiries engaged in by the writer.

Headache is never so severe in children who suffer from any form of intracranial tumour as it is in grown-up people, and when the bones of the skull yield with the hydrocephalus, the intracranial pressure being relieved, the headache, as one would imagine, is even less complained of.

The presence of vomiting, erratic and uncertain in its coming and going, is considered by many practitioners a *sine qua non* in all cases of cerebellar tumours, and it certainly is present in most cases, but not invariably so; nor does there seem to be any relationship between its presence or absence and the site of the headache.

The vomiting belongs to the type known as cerebral, and consists of a single emesis on each occasion, the food being projected straight from the mouth. The stomach is not emptied, nor does the recent ingestion of food bring vomiting on, as a severe paroxysm of headache seems to do.

Vomiting and optic neuritis are often noticed to be

absent together. This absence does not suggest co-relationship, as optic neuritis may be present without vomiting; but vomiting is seldom, if ever, present without optic neuritis being also present.

In the majority of cases vomiting becomes a noticeable feature concomitantly with headache, and while it never precedes the latter, it very often appears for the first time when the patient has suffered in that way for some weeks, or even months. Its late or occasional appearance or absolute absence is more frequent in the extra- than in the intracerebellar variety.

The vomiting may be troublesome, but it has not the urgent character it may assume in other intracranial troubles—*e.g.*, abscess; nor is it, as a rule, associated with a foul tongue or great nausea.

The accident of sex has no bearing upon its occurrence, but that of age has to a small extent; for while very few people under twenty years of age who suffer from cerebellar tumours are without it, its absence when the patient is on the wrong side of forty becomes a fact that cannot be ignored.

When headache is paroxysmal we may see vomiting occur during the paroxysm, and, altogether independent of headache, it may be noticed to precede attacks of giddiness.

Vomiting is said to be present more frequently in tumours of the vermis and middle peduncles than in those of the lateral lobes; but, as a matter of fact, it is absent only in a few cases, and in those few the vermis, in the opinion of the writer, figures no oftener than the lateral lobes as the seat of the trouble.

It seems to be absent more frequently in the cases of those tumours which lie in the posterior occipital fossa than in any other kind; in seven such cases vomiting was absent in four.

The fact of headache being associated with this form of vomiting may easily lead to grave mistakes, a case in point having recently occurred in the writer's practice. A man had had such symptoms many weeks, with a peculiar walk, and a liability to fall to one side; but the disease was locomotor ataxia, the gait and other symptoms being characteristic.

CHAPTER IV

OPTIC NEURITIS

A VARYING degree of swelling and redness of the optic disc and retina, blurring of the margin of the disc—first of its upper and lower edges, then of its inner, and later of its outer margin—with the veins first turgid, then tortuous and swollen, and the arteries constricted, constitute the condition known as **optic neuritis**, which is present sooner or later in almost all cases of tumours of the cerebellum, either solid or cystic. To this condition there are soon added changes in the macula and retinal hæmorrhages, which at first are small and confined to the neighbourhood of the disc, but later are larger and more scattered; then, as the third and final stage, patches of white exudation, constituting postneuritic or secondary atrophy, appear on the disc and retina.

The usual amount of swelling of the disc in cases of cerebellar tumours is from 5 to 7 dioptres, but blindness may ensue when only 4 dioptres are registered; cerebral tumours average 2 dioptres less.

Speaking of tumours of the brain as a whole, Sir William Gowers gives the percentage of those suffering from optic neuritis as 4 to 5; of its occurrence in those suffering from cerebellar tumours the writer's examination into recorded cases places the percentage at 15 to 16.

Failure of sight on account of this important objective sign is never the first fact which indicates a departure from the healthy state; usually it appears from one to three months after the commencement of the illness, and occasionally after a very much longer lapse of time. Of course, failure of sight does not mean that the optic neuritis is just beginning; it rather suggests that the optic neuritis has been present some time, and has made great progress.

Whether headache or optic neuritis is the first to begin is a controversial point. My inquiries suggest the former as the first; some leading neurologists emphatically give the latter the precedence.

The optic neuritis of subtentorial tumours (those of the cerebellum, pons, and medulla) becomes intense sooner, with few exceptions, than those growing above the tentorium, and, as already stated, the intensity also, as a rule, runs higher, averaging from 5 to 7 dioptres in cerebellar and 3 to 5 dioptres in cerebral tumours.

This sign occurs late when the tumour grows from bone or the meninges and lies in the posterior occipital

fossa, and early when the tumour originates in the brain substance, and is therefore intracerebellar or extracerebellar of the pontocerebellar type.

Headache and vomiting may have been present many months, the peculiar gait, as of a drunken man, and possibly other symptoms, have long been obvious, yet the patient complains of no dimness of vision, and although the eyes may have been frequently examined, no optic neuritis is discoverable; and through its absence the diagnosis of a cerebellar tumour continues somewhat uncertain, one necessary link being wanted in an otherwise unbroken chain of symptoms.

It is not suggested that because optic neuritis occurs so very often in the case of cerebellar tumours it is peculiar to them, for there are few intracranial diseases in which it may not be present; yet, being known to occur in almost all cases of this kind, its presence is now looked upon as being little short of absolutely necessary; and its value, considered apart from other symptoms, is that its presence makes a diagnosis possible, and its continued absence makes a certain diagnosis *im*possible.

Of intracranial tumours Dr. James Taylor says: 'Optic neuritis is rarely absent throughout the whole course of the disease, except when a growth is situated in the medulla or dorsal part of the pons Varolii, and when a growth early destroys the oculo-motor nuclei. In the former case it may never be present; in the latter, if present, it subsides with the extinction of the oculo-motor nuclei. The absence of optic neuritis in adult cases of intracranial tumour, when the growth

is not situated in the pons, is generally in causal relation with advanced arterial degeneration, a condition which never exists in childhood.'

A great difficulty is to know what length of time is the outside limit for the appearance of optic neuritis. If you reason that headache and vomiting have been present a long time, and, as optic neuritis has not developed, there cannot be any form of cerebellar tumour present—for if there was, optic neuritis would have made its appearance within a given number of months—you will be told that the reasoning is inadmissible, as a patient has been known to develop this sign almost two years after other symptoms had commenced, and perhaps this length of time may have been exceeded.

The earliest appearance of optic neuritis is, for the most part, on the side in which the lesion is situated; but in a very short time, possibly in a few days, the other eye also becomes affected, and soon it may be difficult to say in which eye the trouble first originated.

In some cases the two eyes commence simultaneously, but one of them soon shows a greater degree of inflammation than the other, and that eye which exhibits this greater neural inflammation is also on the side of the lesion.

Some neurologists hold that the side opposite the lesion is first affected, but that the difference is so small that the side which is first noticed to be affected cannot be allowed to have any localizing value.

The progress of optic neuritis when once begun seems to depend on whether the tumour is of quick

or slow growth than of small or large size. It passes from simple congestion of the disc to congestion with œdema, and from that to the different degrees of papillitis, accordingly as the tumour enlarges quickly or slowly, and the neuritis depends to some extent on the degree of disturbance of the surrounding structures.

The relation of the optic neuritis to the progress of the causal disease may be gathered from the following extracts: In case No. 59 there was intense optic neuritis, passing into optic atrophy after seven months' illness; in No. 61, well-marked optic neuritis after five weeks' illness; in No. 62, intense optic neuritis after three weeks' illness; in No. 63, intense optic neuritis after four months' illness; in No. 64, intense optic neuritis after three and a half months' illness; in No. 65, intense optic neuritis after eighteen months' illness, patient not complaining of any loss of sight for the first ten months; in No. 67, severe optic neuritis after three weeks' illness. The above cases were all intracerebellar.

In No. 71 there was occipital headache for two years, but sight only began to fail when the patient had been ill one year nine months, but in three months more there was intense optic neuritis; in No. 72 patient was ill for twelve months, but there was no optic neuritis; No. 73 patient was ill for nine months, sight failed during the last three months, at the end of which time there was intense optic neuritis. In case No. 74 patient had suffered from headache and tinnitus for four years, and giddiness two years, but sight only began to fail during the last two months, at the end of which

time there was intense optic neuritis. The last four cases were extracerebellar.

While optic neuritis is peculiar to many diseases of the brain, its different phases are only its degrees of severity, which vary with the advance of the primary disease—*e.g.*, there is not one kind peculiar to cerebellar disease and another to basal meningitis or cerebral abscess; were it so, its value in diagnosis would be enormously increased.

This is the state of things at present, but it is almost incredible to conclude that it will always remain so. Some day a greatly improved ophthalmoscope, or an unusually observant ophthalmoscopist, may demonstrate to us the different appearances caused by tumour, abscess, or inflammation, or be able to say, This is the optic neuritis of the front-, this of the mid-, and that of the hind-brain and cerebellum.

If differentiation ever does take place, it may possibly be in this direction: that the optic neuritis as we now know it will be taken as a condition peculiar to all forms, and that the organs at the base of the brain—the meninges, the cortex, and the white matter—will each superadd phenomena peculiar to itself.

Sir William Gowers in 'Medical Ophthalmoscopy,' p. 47, says: 'Certain forms of neuritis may be distinguished according to the intensity of the changes, but our knowledge of the conditions on which they depend seems insufficient at present to distinguish them otherwise than as degrees of intensity, on whatever differences of mechanism they may ultimately be proved to depend.'

Patients occasionally, when suffering from cerebellar tumours, complain of failing sight before any appreciable change of the ocular fundus is revealed by the ophthalmoscope, or the degree of the neuritis may not be commensurate with the advancing blindness; but once optic neuritis having appeared, the vision fails as it advances, and transient fits of blindness may occur from time to time before it has reached an intense stage.

Temporary blindness of a few minutes' duration, associated with increased headache and giddiness, occurred in four cases—the real percentage may be greater—and it showed this peculiarity: that it only happened when the tumour occupied either the left posterior occipital fossa or the left lobe of the cerebellum.

It is supposed to be occasioned either by a temporary increase of the intracranial pressure on the optic nerves, or by temporary interference with the vascular supply of the occipital lobes. The former cause is the more likely, because if it were the latter we should have hemiopic or restricted vision, whereas the blindness is full and affects both eyes.

How long in this disease a person may be blind from intense optic neuritis and sight still be recoverable after successful operation or medicinal treatment, or, in other words, how long a neuritis may continue intense before it passes into optic atrophy, in which the inflammatory exudate deposited between the fibrillæ of the nerve shall have constricted, and for practical purposes destroyed these fibrillæ, is uncertain; but this

much we do know—that if there is little exudate about the disc, sight is yet possible if the cause be removed; but if the exudate is considerable, sight is irretrievably lost, and *any* exudate signifies that the vision is in the state of a forlorn hope.

Speaking of consecutive or postneuritic atrophy, Sir William Gowers says: 'The microscope shows the substance of the disc to be occupied by nucleated connective tissue, among which commonly few or no traces of nerve fibres are to be discerned. Often, however, the nuclei, by their grouping, indicate the position of the intervals between the fasciculi of former nerve fibres.'

A person may be quite blind when the optic neuritis has only been present two weeks, and, if the *fons et origo* of the disease were then removed sight would probably be restored; but the longest time the discs have been known to continue in a state of optic neuritis before they have passed into optic atrophy is not within the writer's knowledge.

A man who had been blind from intense optic neuritis for two months regained his sight in a fortnight after the successful removal of a cerebellar growth; but with the advent of optic atrophy over the whole of the disc such a desirable result would have become impossible, and consequently one of the chief incentives to operation would have passed away for ever. Fortunately, the atrophy may not affect the whole of the disc at one and the same time, and when this is the case the living portion of the nerve will still be in a condition to perform its proper function if the atrophizing process ceases.

Probably in some cases of cerebellar tumours which

are recorded as having had no optic neuritis this symptom would have developed later had not the patients been carried off prematurely by sudden stoppage of the respiration, a cause which unfortunately accounts for many deaths in this disease. In case No. 30 it is said that there was no optic neuritis, but the patient had only been ill ten weeks when she died from the above cause. In case No. 38 neither was there any optic neuritis, but it must be noted that the patient had only been ill four months when she died suddenly.

With many exceptions, optic neuritis begins early in this disease. In one of our cases we find the patient suffering from it in a severe form after only three weeks' illness, and while a person may become blind when the neuritis has only been present two weeks, we have it on good authority that the neuritic inflammation may continue quiescent or make very little progress during the space of two years.

The appearance of optic neuritis, as readers would observe from the few cases quoted some pages back, is late in some cases of extracerebellar growths. In thirteen it was late in all except one, which was a quickly growing glioma.

The *modus operandi* of the causation of optic neuritis is somewhat beyond the scope of this little work, but it may incidentally be remarked that in the case of a large growth of the cerebrum or cerebellum, or effusion of fluid in basal meningitis, we could not be far wrong in holding that the probable cause was intracranial pressure, or, as the Americans say, cerebral hypertension, especially as we know that when this intracranial

pressure is removed by operation the onward progress of the optic neuritis is checked, as headache is similarly relieved; but, as Sir William Gowers points out, intracranial pressure can scarcely be the cause when there is a small growth in the cerebral cortex or subcortex, and one may surmise that a small growth in one or other lobe of the cerebellum would be almost as unlikely.

CHAPTER V

THE REFLEXES

REFLEX action is the involuntary movement of muscles in obedience to irritation of sensory surfaces, and when this involuntary movement is in excess of or less than that which is present in health, or is altogether absent, the cause is diseased centres in the afferent tracts of the spinal cord.

Reflex action is recognized as **superficial** or **cutaneous**, and **tendon** or **deep**—'the one dependent on impressions conveyed by the ordinary afferent or sensory nerves, mainly those of the skin; the other dependent on any sudden impulse or blow applied directly to a muscle or to the tendons or fascia belonging to the muscle' (Bristowe).

The writer is not prepared to state in precise terms the time of appearance of the reflex phenomena which may be observed during the progress of a cerebellar tumour; that they occur frequently in such lesions is a fact perfectly well known to all members of the medical

profession, and it is equally well known that they are not the earliest symptoms. They are probably seldom noticed until some other symptoms suggest that the site of the ailment is in the central nervous system.

In this disease they are only found to be abnormal after headache and vomiting have persisted for weeks, or even months, and they probably proceed *pari passu* with the changing conditions of the optic discs. They are, as a rule, already abnormal when the ataxic gait becomes evident, and are sometimes earlier and sometimes later than the various paralyses which may develop.

As the deep occur the more frequently, they will be considered first.

It will be seen from the subjoined extracts that when the reflex, either deep or superficial, differs in the degree of variance from the normal on the two sides, the side that varies in the larger degree is not always the affected side, as is the rule in experimental ablation of cerebellar tissue. The cases not included are those which were normal in regard to the reflexes and those which were equal in their exaggeration, etc.

The Deep Reflexes.

Case.		
No. 29.	Left disappeared	Tumour in left lobe.
„ 49.	Right diminished	Tumour in left lobe.
„ 51.	Right absent, left diminished...	Tumour in right lobe.
„ 68.	All increased, right more than left	Tumour in vermis.
„ 76.	All brisk, right more than left...	Tumour in left posterior fossa.
„ 77.	All exaggerated on left ...	Tumour in right ponto-cerebellar region.

Case.		
No. 78.	All increased, right more than left	Tumour in left posterior fossa.
„ 58.	Variable, left brisker than right	Tumour in right lobe.
„ 73.	All brisker on right than left ...	Tumour in left posterior fossa.

The Superficial Reflexes.

No. 73.	Absent on right...	Tumour in left posterior fossa.
„ 61.	Abdominal diminished on right, brisk on left	Tumour in left lobe.
„ 65.	Present, more right than left ...	Tumour in vermis and left lobe.

Reflex Arc.—We are so accustomed to speak of the reflexes, that we may not always have in our minds the method of their production, which briefly is: The impulse from the irritated point, whether deep or superficial, is carried by the afferent sensory nerves to their roots in the spinal cord, then along nerve-cell processes in the grey matter of the cord to the roots of the motor efferent nerves, along which it is re-conducted to the point where the result is observed. The grey matter between the motor and sensory roots constitutes the 'reflex centre,' and this 'centre' with the roots is known as the 'reflex arc.'

The centre for the knee-jerk is at the level of the second and third lumbar nerves.

The centre for the ankle-clonus is at the level of the first to third sacral nerves.

The centre for the plantar reflex is at the level of the first to third sacral nerves.

The centre for the abdominal reflex is at the level of the eighth to twelfth dorsal nerves. (Bastian.)

Patellar Tendon.—In cerebellar tumours the abnormal reflex of most common occurrence is that of the patellar tendon, and the departure from its normal condition is noticed in rather more than half of the whole number of cases.

The fact that the knee-jerk is brisker than in the healthy subject is usually noticed first on the side opposite the lesion, the briskness increasing until it becomes gross exaggeration; but long before the latter condition has arrived the knee-jerk on the other side may have followed suit, and the two become equal in their exaggeration, and may remain so. A backward tendency may set in, and in a period relatively short—at any rate, much shorter than that of the advancement—the exaggerated knee-jerks become less and less brisk, until they are eventually found to be lost. It may be sometimes noticed that the state of the knee-jerks has a very decided relationship to that of the optic discs; an increased briskness of the former will be found to be coincident with slightly impaired eyesight, due to a red and swollen state of the disc on the side of the lesion. When gross exaggeration of the knee-jerks can be produced, there is also fully developed optic neuritis, with the margins of the discs gone, and the patient in consequence blind, or almost so; and when the knee-jerk can no longer be evoked, we find the optic neuritis very likely passing into secondary atrophy. This suggested relationship finds support in the fact that in the very few cases in which optic neuritis is not present, or is very late in its occurrence—in those very cases the knee-jerks are normal.

Ankle-Clonus.—Ankle-clonus consists in a succession of rhythmical convulsive movements affecting the ankle, which are induced, while the leg is extended, by suddenly pressing up the foot towards the leg. These movements can only be produced in disease, while the slight knee-jerk can be brought out in the healthy state. Ankle-clonus is not noticed nearly so often in cerebellar tumours as is the exaggerated knee-jerk, but when present it is of like significance. If it is obtainable only on one side, that is not the side of the lesion; and when it can be produced in both ankles, it is more evident on the unaffected side.

Ankle-Jerk.—This reflex consists in movements of the foot when the tendo Achillis is tapped while the patient kneels upon a chair. Its exaggeration or diminished briskness corresponds in significance with the knee-jerk, but, as the ankle-clonus cannot always be produced in health, its absence is of less importance in diagnosis.

The superficial reflexes frequently found abnormal are the abdominal and plantar.

Abdominal.—These reflexes are produced by stroking the skin below the edges of the lower ribs and above Poupart's ligament. They are occasionally absent in cerebellar tumours, and when this is the case, it is on the side opposite the lesion.

Babinski's Great-Toe Reflex.—When the side of the foot is irritated by stroke of pen or pencil, dorsal flexion of the great toe, and perhaps others, may follow. This reflex is pathological, and due to lesion of the pyramidal tract. Dr. Beevor, in his lectures before the London

Medical Society, February and March, 1907, says in cases of cerebellar tumours he has never known the plantar reflex to be extensor (dorsal flexion), except when the tumour is extracerebellar.

This opinion seems too rigid; it is very probable that the plantar reflex may be extensor in most cases of extracerebellar tumours, but, as will be seen from the following analysis, it is not always so.

Out of twenty cases in which the plantar reflex was examined—

The reflex was **flexor** in ten intracerebellar tumours.
" " **flexor** on left, **extensor** on right, in one extracerebellar tumour in left posterior fossa.
" " **flexor** on both sides in one extracerebellar tumour in right posterior fossa.
" " **flexor** in two extracerebellar tumours, pontocerebellar.
" " **flexor** on right in one extracerebellar tumour, left posterior fossa.
" " **flexor** in one extracerebellar tumour, under left lobe.
" " **extensor** in one extracerebellar tumour, left posterior fossa.
" " **extensor** in two extracerebellar tumours, under left lobe.
" " **extensor** in one extracerebellar tumour, between pons and right lobe.

It will be seen from the following extracts that when the reflexes, either deep or superficial, differ in their degree of variance from the normal on the two sides, the side that varies in the greater degree is the unaffected side. The cases not included are those which were normal in regard to the reflexes, and those which were equal in their exaggeration, etc.

The Deep Reflexes.

Case.		
No. 29.	Left disappeared	Tumour in left lobe.
„ 48.	Right diminished	Tumour in left lobe.
„ 51.	Right absent, left diminished...	Tumour in right lobe.
„ 68.	All increased, right more than left	Tumour in middle lobe.
„ 76.	All brisk, right more than left...	Tumour in left posterior occipital fossa.
„ 77.	All exaggerated on left ...	Tumour in right ponto-cerebellar region.

Babinski's Arm Sign.—This symptom may be noticed during the following little manœuvre: The patient places on a table both arms semiprone, and in turning them quickly round one may be found, in a person suffering from cerebellar disease, to perform the act more quickly than the other; when this is the case the inactive arm is on the side of the lesion. Babinski says this sign is always present; other observers aver that it is frequently absent when other symptoms are quite unequivocal.

Tumour of the cerebellum is only one of several diseases in which knee-jerk may be exaggerated, as tabes dorsalis is one of many in which it may be absent. Because the knee-jerk is exaggerated it would be absurd to diagnose cerebellar tumour; but should it and other reflexes be normal, there is placed upon the other symptoms a greater responsibility in the matter of diagnosis.

CHAPTER VI

ATAXIA

WHATEVER suspicions may arise in the course of an illness to suggest that such illness is due to a cerebellar growth, a definite indication is the peculiar staggering gait which is one of the most frequent and obvious symptoms of the disease; indeed, it is the most characteristic symptom of cerebellar disease in man, and it is due, as its name implies, to the loss of power to cause one set of muscular movements to be performed in agreement with others. This loss of agreement in muscular movements is known as **inco-ordination** of movement, and although motor, depends usually on disease of the afferent fibres.

And because ataxia is a definite and practically a constant symptom of cerebellar tumours, there falls to us the duty of considering the peculiar gait at length, to describe it, and contrast it with gaits of an analogous character; to suggest other diseases, if any, in which it may be observed; and to discuss the claims of one section of the cerebellum as against the remaining portion of the organ as being that which, when diseased or injured, can alone produce ataxia.

The appearance of a person who walks with a swaying motion, with his feet wide apart and his body forward, is so characteristic that it is described alike by the illiterate and the educated layman, by the general practitioner and the distinguished neurologist, as the walk of a half-drunken man, and it has been further

likened to the walk of a man on the deck of a ship when the sea is rough. The condition is somewhat loosely referred to as the 'cerebellar reel' or 'stagger,' but such expressions only convey a portion of the truth, for the person who walks as above described gives only one indication—albeit the most frequent and noticeable —of the ataxia or inco-ordinate condition, which may be observed in one leg only or in one or both arms.

Ataxia was observed to be thrice absent in the eighty cases, two being in tumours of the left lobe and one in the right. This proportion cannot be looked upon as authoritative, as several of the patients were unable to walk or stand when they first came under observation.

We at times notice a condition called **static ataxia** as present in this disease, but it is more frequently seen in tabes dorsalis and Friedreich's disease. It includes the lack of power to stand without falling, to hold the affected arm still when it is in a state of forced extension, and the power to properly appose the thumb and fingers.

As will be pointed out later, the peculiar method of walking is so often present that as soon as it is noticed the probability of cerebellar trouble is forced upon the observer's mind, and he must eliminate all other causes if he can.

The gait with the feet wide apart, etc., is the first stage in the trouble of walking, and soon further developments of the same trouble follow on; and it is observed that the patient not only walks in an odd and awkward manner, but he has become liable to stumble and stagger and just now actually to fall, and

progression becomes increasingly difficult for him and after a time quite impossible. And it is further noticed that, while he usually deviates and falls to the same side, it is not always so: he may deviate to one side and fall to the other. The side on which he falls is the one on which the lesion will invariably be found, and if he falls sometimes to the one and sometimes to the other side, it will eventually be found that the growth has invaded the vermis, and very likely injured, or at any rate be pressing upon, the opposite lobe. Not only may the patient fall to one or other side, but he may also be apt to fall forwards or backwards, indications that the vermis is affected, the anterior or posterior parts of which being indicated by the direction of the fall.

While the gait and the tendency to reel and stagger are the chief indications of inco-ordination so far as the lower extremities are concerned, the upper limbs sometimes exhibit a similar lack of co-ordinating power, as in their inability to pick up a pin, but at a later stage of the disease.

Cerebellar ataxia must be distinguished from the ataxia of tabes dorsalis in so far that in the latter the legs look as if they would run away with the body, while in the former the body looks as if it would run away with the legs.

Ataxia is, so far as the writer is aware, a possible and even probable feature in all diseases of the cerebellum. In abscess, if such disease runs a subacute or chronic course—and the same may be said of apoplexy into or softening of the organ—in inflammation of its substance,

or encephalitis cerebelli, otherwise known as acute ataxia; and in inflammation of that portion of the meninges in relation with the cerebellum, posterior basic meningitis, ataxia of the upper and lower extremities is also noticed.

On the other hand, it must be stated that the peculiar gait is not absolutely restricted to cerebellar disease; it has been already spoken of as the kind of walk or half run of the half-drunken man. It is also said to be present in the early stage of myelitis, when that trouble is secondary to disease of the membranes, and the posterior columns of the cord are as yet only affected; in diphtheritic paralysis; in disseminated sclerosis, where it assumes a jerky character; and in Friedreich's disease, in which the lateral and posterior columns of the cord are diseased, and there is arrest of development in the cerebellum, with the cells of Purkinje often found in smaller numbers than usual.

There are other diseases in which this so-called ataxic gait may be noticed, and which are more likely to lead the diagnostician astray than those already mentioned —*i.e.*, diseases of the quadrate bodies and the frontal lobes; and as an extreme rarity it has been met with in disease of the cerebral cortex, in bulbar softening, and in disease of the crura cerebri.

Brunn records four cases of frontal lobe ataxia.

The following cases support the above statements: A man received a severe blow on the forehead, and fell to the ground unconscious; he remained in that state some days, and then recovered. In the course of four or five weeks he complained of severe headache and

vomiting, and walked with a gait that was characteristically cerebellar. Fortunately for him, a little later he developed a paresis of one hand and arm. Acting on this information, the surgeons in attendance trephined over the second frontal lobe and removed a clot of blood, and at one and the same time cured the paresis and the gait mistakenly considered cerebellar.

Leclercq, in a French journal, records a case of bulbar softening, in which certain symptoms usually attributed to cerebellar lesions were well marked. The patient was forty-eight years of age, with no history of syphilis or alcoholism. For a fortnight before his admission to hospital he had suffered from occipital headache and vomiting. Two days before admission he found he could not walk straight. When admitted he was affected with constant hiccough and could not swallow food or even saliva, and when he attempted to walk he staggered from side to side and finally fell, usually to the right side; there was also static ataxia. At the necropsy no lesion was found either in the right cerebral hemisphere or the cerebellum; the left half of the medulla oblongata was larger and redder than the right, and by means of stained sections the patch of softening was seen to extend from the olivary body to the nuclei in the floor of the fourth ventricle.

In the *Lancet* of July 11, 1885, the following case is reported: A patient complained of headache and vomiting, with progressive loss of sight, culminating in intense optic neuritis. She could not walk alone; the moment support was withdrawn, her legs gave way at the knees; there was, however, no paralysis.

At the necropsy the cerebrum and cerebellum were both found healthy, but on the under surface of the brain in the floor of the third ventricle, and situated between the crura cerebri, was a tubercular growth the size of a racquet-ball. These cases indicate that not only the cerebellum, but organs and areas near to and distant from it, are concerned in governing the co-ordinating power.

Nothnagel says that disturbances of co-ordination only occur when the lesion directly or indirectly involves the vermis, and that lesions actually limited to the hemispheres cannot be diagnosed, and that even lesions of the vermis do not always cause ataxic symptoms. Perhaps 'indirectly' means that if the disease does not extend into or infiltrate the vermis, symptoms peculiar to disease of that portion of the cerebellum may be produced by pressure upon it from disease in the lateral lobes. Without the qualifying word, 'indirectly' it would be difficult to accept the opinion of such an eminent authority as Nothnagel, because in the majority of cases of cerebellar disease, at any rate of new growths, we find that the lesion is in one or other lobe.

The highly developed cortex of the cerebellar hemispheres, with its large nerve cells of Purkinje, is, as we have shown, present for specific and important functions; but these functions, so far as the lateral lobes are concerned, seem neither to be vital nor of supreme value.

As disease or injury to the vermis is so productive of a swaying and staggering method of walking, it seems natural to assume that in the vermis is localized the

steering and guiding apparatus, and as disease of either lobe produces a great liability to fall, it also seems equally natural to assume that their function is to act as a keel to steady and give balance. Ferrier, Luciani, and Turner do not support the idea that the middle lobe alone exercises the functions of the cerebellum, but there is something to be said in favour of the theory.

In development of the human embryo it is the middle lobe that is first formed, and afterwards the lateral lobes arise from it. The lateral lobes have been removed without inducing any ataxia or peculiar gait, but generally the walk in such cases is for a time of a reeling character, the animal returning to the normal method in a few weeks. The remarkable thing in cerebellar ablations is how well the animal after a time can do without this organ, or any part of it.

In practice we may see the whole of one lobe destroyed by new growth or abscess, and no ataxia result. In studying the brains of the lower animals, we see that the lateral lobes quite disappear before any change occurs in the appearance or structure of the vermis.

In apes, the carnivora, hoofed animals, marsupials, and in the bird-mammal the ornithorhynchus, we see the lateral lobes lose, in the descent from a higher to a lower creature, first one and then another of their peculiarities, and no inco-ordination of muscular movement becomes apparent.

In birds the lateral lobes have become mere masses of unorganized white matter, and yet the pigeon in its rapid flight and the hawk in its swoop show no

symptoms of ataxia in their upper limbs; nor does the ostrich exhibit any want of co-ordination in its lower extremities, seeing that it can run in a straight line for miles as quickly as a pony can gallop.

In creatures next below birds, tortoises and turtles, there are absolutely no lateral appendages, but the vermis continues intact and retains its striation; and it is only when we arrive at a creature still lower in animal life—the crocodile—that we notice the vermis has lost its striation and become smooth.

While, then, ataxia is not the normal condition of the lower animals, which from above downwards present an increasing effacement of the lateral lobes, it does occur among them as a symptom of disease or mal-development.

Readers may remember the case of the litter of kittens reported some years ago at one of the London Medical Society's meetings. These kittens were observed to be affected by a peculiar form of paralysis when equilibrium was maintained; no movements of the limbs or of the head and neck were normal, and when attempts were made to walk or run the body swayed over, and the cat lost its balance and fell.

The diagnosis was failure of development of the cerebellum, and under the microscope it was found that the granular layer of the cerebellar cortex was almost absent, and the layer of cortical cells very poorly developed. Incidentally it may be mentioned that the above condition of the cerebellar cortex agrees with what has been said of Friedreich's disease.

Our studies in natural history cause us to incline to

the opinion that the vermis is the chief portion of the organ, but our clinical studies point to the fact that a destructive lesion of any portion of the cerebellum may cause ataxia; the two conclusions are not necessarily antagonistic.

After so much has been said and written upon this subject, it is somewhat surprising to know that a well-known physician has held the opinion that there is no inco-ordination of muscular movements in cerebellar ataxia. He says that it is quite certain that in many cases of cerebellar paralysis, whilst a patient has lost so much of his power over his limbs that he cannot stand up, yet with his limbs, singly or together, when he is laid upon his back he can perform the most complex movements. Dr. Herringham states that the patient's unsteadiness depends upon the erect position —that it is, indeed, only an inability to maintain his equilibrium.

The position we are in with regard to cerebellar ataxia is, that while it may be present in all forms of cerebellar disease in which the vermis is implicated or pressed upon, it is also a recognized symptom of disease of other parts of the nervous system, and an occasional symptom of still others.

It may be noted here that the writer does not rely upon excitement of the genital organs when there is hæmorrhage into the vermis, and absence of such excitement when there is hæmorrhage into the lateral lobes, to support his argument of the much greater functional importance of the vermis, as such excitement is due, as already stated in a previous part of this

work, to irritation of the pons and medulla by the closer approximation to them of the hæmorrhagic vermis than would be possible with hæmorrhage into the lateral lobes.

There is this difficulty in studying the functions of the cerebellum: whether the latter is healthy or diseased, the organ is not an entity by itself; it is a part of a system, the other parts being the cerebrum and spinal cord; and whatever functions are mainly located in the one, the others have correlating functions, and all may not be in sympathy, and while the student thinks of one part only with regard to a particular function, the whole system is at work in order that this function may come to fruition. Dr. Hughlings Jackson has put it on record that 'The cerebrum represents all parts of the body, and the cerebellum also represents all parts of the body . . .'; but he also says, 'The cerebellum is the centre for continuous movements, and the cerebrum for changing movements.'

CHAPTER VII

ATTITUDE, TREMOR, DEAFNESS AND TINNITUS, VERTIGO, NYSTAGMUS, CONVULSIONS, ETC.

Attitude.—The attitude is often as noticeable as the patient's mode of progression, and may be so striking that it has been called the 'cerebellar attitude.' We find in most cases a distinct **lordosis** when he is in the erect position, and also an extreme retraction of the

head, with rigidity of the cervical muscles. Associated with retraction of the head, and most obvious when the patient is lying down, is the flexion of the forearms and extension of the lower extremities, and pointing of the toes. Further, there may be a semirotation of the trunk, with the chin resting upon one shoulder and the occiput upon the other, and the shoulder upon which the occiput rests is, in all but a small fraction of cases, on the side of the lesion. If the patient is bedfast, he may show the same tendency to work to one side as he did when he stumbled to one side in his staggering walk, and he is apt to lie persistently on one side, which is for the most part the side of the lesion.

Another part of this distinctive attitude is that one shoulder is often held in front of and higher than the other.

In tumour of the vermis the patient is liable to suffer from occasional opisthotonos, called tetanus-like seizures by Dr. Hughlings Jackson, in which the head is bent backwards between the shoulder-blades, the body is pushed forwards, and the arms are in the position of a person running, one of them held horizontal and the other flexed, and the legs, feet, and toes are fully extended.

Pleurosthotonos has also been observed in tumours of the lateral lobes.

In diseases of the cerebellum other than tumour, as softening from thrombosis, the cerebellar attitude may be the one and only symptom present.

Not unconnected with the attitude is the condition of the muscular system. While the tone and strength

of muscles are for the most part unimpaired, we may find the muscles on one side—*i.e.*, on the side of the lesion—less firm than on the other, and the grasp of that arm weaker than the other. In the case of the lower extremities, we see that if the muscles are less firm on one side the patient cannot stand upon that leg as easily as he can upon the other—this condition is known as muscular asthenia.

The retractions of the head, etc., already referred to, are said not to be really of cerebellar origin, but to be due to growths in the cerebellum, which cause it to press upon the pons and medulla.

Forced movements, distortions of the normal axis of the trunk, are looked upon as the special diagnostic symptoms of the cerebellar peduncles.

The position in which the chin is directed to one shoulder and the occiput to another is an example of forced movement; so also is **rotation**, which, though very rare in man, is not altogether unknown, both the rotation and the distortion being directed to the side of the lesion.

Another variety of forced movement, and one more suggestive of disease of the superior and middle peduncles than of the organ itself, is that which compels a patient to lie on one or other side, from which if he is moved he returns.

Tremor is an occasional symptom, generally affecting the head and superior extremities, and usually seen on the side of the lesion, but it may be on the opposite side. It consists of consecutive movements

of very small amplitude, is spoken of as fine or coarse in character, and must not be associated with the 'fibrillary twitchings' seen in degenerative disease of the anterior cornual cells, and is often of the kind known as **intention** tremor—*i.e.*, it occurs when the patient performs some willed movement.

Tremor is seen in about one-half of all cases of cerebellar tumours, is independent of age and sex, and far more often when the lesion is on the left than on the right side. In ten cases which exhibited intention tremor the tumour was only once on the right side; it occurs equally in intra- and extracerebellar forms. It is best observed when the patient extends his arms and hands horizontally in front of him; when it occurs in both limbs it is more marked on the side of the lesion than on the opposite one.

Another disease in which this symptom is very prominent, and in which it occurs more frequently than in the one under our notice, is disseminated sclerosis, the two agreeing in showing tremor when there is, or has been, willed movement.

The diseases in which intention tremor is present more often than in any others are tumours of the quadrate bodies and the crura cerebri.

We also notice tremor in paralysis agitans, in which it is only absent when the patient is asleep, and not always then; in hysteria; after acute diseases, particularly typhoid fever; in exophthalmic goître; the toxic types, in which arsenic, mercury, and still more often lead, have acted upon the peripheral endings of nerves; and there are also the senile and hereditary kinds.

Deafness is frequently present in cases of cerebellar tumours, but not nearly so often as is ataxia, and with tinnitus it may be the very first symptom the patient complains of, particularly in extracerebellar disease; and while these two subjective symptoms often occur together, it is not always so: the same rule holds good here as obtains in disease of the ear itself. Deafness *may* be associated with tinnitus, but if the latter alone is present, it is almost certain that the former will soon follow; and when the time arrives for a diagnosis to be arrived at between the intra- and extra- types of a supposed cerebellar tumour, the fact that deafness and tinnitus were the earliest symptoms is a point in favour of the latter.

Deafness is always first experienced on the side of the lesion, and if both ears become affected the probability of the vermis being included in the disease is great; and when the deafness becomes absolute, it is so to both bony and aerial conduction.

The tinnitus may or may not be distressing, and is generally described as noise of a musical character, as singing, ringing of bells, or buzzing of bees, seldom of the loud, hissing, or steam-engine type.

Vertigo (*verto*, I turn).—Synonyms are giddiness, dizziness, swimming of the head. The chief cause of vertigo in cases of cerebellar tumours is interference with the intracranial vascular supply, and especially the vascular supply of the semicircular canals of the labyrinth; assistant causes, but still distinctly aural in character, are irritation of the nerve endings of the

semicircular canals and variations of pressure upon the tympanum.

The other troubles in which vertigo is seen are many, but it must be deemed sufficient here to say that arterial degeneration of the vessels of the encephalon, epilepsy and anæmia are of the number.

When to the deafness, tinnitus, and other symptoms already discussed, there is superadded the feeling of giddiness, which is independent of vomiting, or rather when the vertigo is not preceded by vomiting, but may give rise to it, matters are shaping towards a definite diagnosis.

Vertigo may be roughly estimated as occurring in about two-thirds of the cases of cerebellar tumours, and is often of decided character when hearing is normal.

During vertiginous attacks external objects may seem to move, or to be twisted from left to right or right to left, or go round sometimes in one, sometimes in the opposite direction; or the patient may feel himself, as well as the objects around him, moving from side to side. The floor may seem to rise up in front of him, or, as some patients have explained it, become corrugated, and such persons like to have a wall on one side of them to walk by. This feeling is far from peculiar to cerebellar disease, or even to distinctly aural troubles. The writer remembers having patients who complained in such manner who had not, either at the time or afterwards, any other symptom pointing to the cerebellum or ear.

Some sufferers do not complain of any movement, either of themselves or of the objects around them, or they experience it only when they move quickly.

The apparent movement of external objects may be in the direction opposite to that in which the head is moved, and as a rule such movements are from the side of the lesion.

Vertigo is more common in intra- than extracerebellar tumours, and while it is present the patient is incapable, but not unconscious.

If he rotates on his vertical axis, it is towards the side of the lesion, not away from it, as is the case with external objects, but the two feelings may occur in the same individual.

Nystagmus (from *νυστάζω*, I nod).—Nystagmus consists in consensual small oscillations of the eyeballs, which in slightly advanced cases may be apparent only at the moment when the patient endeavours to fix his glance upon some fresh object, or looks out of the corners of his eyes. They are generally constant, although *aggravated** by voluntary movements of the eyeballs. They cease when the patient is asleep, or when his eyes are shut in repose (Bristowe).

When an animal has been deprived of half its cerebellum abnormal action of the ocular muscles almost always results, and the eye looks or—to use a technical term—is deviated towards the uninjured side. We may then observe attempts at correction by way of jerking movements back towards the injured side. Such attempts at correction we call by the name of nystagmus, and its presence suggests either disablement of the cerebellum or some correlated nervous structure.

* The italics are the writer's.

Unfortunately, in the preparation of this little work the writer finds himself in opposition to some of the most distinguished of living neurologists—*e.g.*, in a well-known work it is stated that 'nystagmus is an occasional symptom of tumour in many parts, but is not frequent in tumours of the cerebellum'; and it is just at this point where difficulty enters, for unless reading has been done with very jaundiced eyes the very opposite would seem to be correct, and it must be recorded that nystagmus is a *very* frequent symptom of cerebellar tumours. It may not be with the frequency of headache, vomiting, optic neuritis or ataxia, but still it occurs very often.

It is seen in other diseases, both those having an encephalic origin, as basal meningitis and cerebral tumours, as well as those having no such origin, as disseminated sclerosis, and those having origin both in brain and cord, as chorea.

Its presence is irrespective of the nature of the growth, or the position of the latter in the lateral or middle lobes, or whether the site be intra- or extracerebellar. Of the general symptoms, vomiting is the one that is least seen in association with nystagmus; but ataxia is a constant, and vertigo, only a slightly less often correlated symptom, and paralyses of the cranial nerves occupy a similar position.

On lateral deviation of the eyes the jerks are slow and deliberate in the direction of the side of the lesion, but may be fine and rapid in the direction of the unaffected side.

Although nystagmus may appear in other diseases of

the nervous system, it has probably its origin always in diseased conditions of the cerebellum. 'In conditions in which the symptoms are chiefly spinal nystagmus may be present; but if the cerebellum be examined there is likely to be noticed a congestion of the vessels of the cerebellum, with small patches of cell infiltration, showing that the nystagmus may be of cerebellar origin, although the chief disease may have a different origin.'* A similar fact with regard to ataxia has already been exemplified as occurring in Friedreich's disease.

This is one of the symptoms which an operation otherwise successful may in no way relieve, the nystagmus months afterwards persisting in its former intensity, and this persistency does not seem to bear any relationship to the portion of the organ that has been affected.

In one case, a cyst of the left cerebellar lobe, it was observed that nystagmus absolutely disappeared after operation, and when improvement has been partial it is the fine and rapid movements which invariably are lost.

Convulsions.—In the matter of convulsions, tumours of the cerebellum stand out in marked contrast to those of the cerebrum, or of the important structures at its base. In the latter cases persons may, and usually do, suffer from convulsions at an early stage of their trouble, and continue to so suffer during the whole course of their illness, sometimes many occurring in a day, and when the patient is seen by a competent observer, they throw great light upon the site of the disease. In the former, on the other hand, convulsions are rarely seen,

* Dr. Miller, in *Brain*, part cxviii.

and when they do occur, it is as a rule very late, and they are often the immediate forerunners of a fatal issue.

Convulsions only occurred three times in the eighty cases, in one of which, a sarcoma of the left lobe, there was marked opisthotonos at the time of the fit. They are not peculiar to tumour in any particular part of the cerebellum, and as a rule are general. In one of the three cases, a cyst in the fourth ventricle, they occurred early, and were at first unilateral, but became general afterwards.

If convulsions are seldom seen, the conditions of drowsiness and somnolence are the rule rather than the exception, and the drowsy patient is often noticed to be irritable and depressed, and easily moved to anger, and his facial expression is the opposite of bright and cheerful; indeed, his countenance seems wanting in meaning and intelligence.

Albuminuria is very constant in all the varieties. The pupils are said to be contracted until late in the disease. This rule cannot be laid down as absolute. In many of our cases the pupils became dilated as blindness was established, and they remained dilated, for the most part equally, and also for the most part retaining their power of contraction under the influence of light, until death.

The temperature is normal, or slightly subnormal, and any increase without other probable cause may mean that the tumour is breaking down into abscess.

The pulse is, as a rule, weak and slow until late in the disease, only being increased during the paroxysms of headache. In one case, a glioma of the right lobe,

in which convulsions occurred, it is recorded as having been 90 and strong.

Respiration is somewhat slow, and should it become of a sighing or sobbing character, sudden stoppage may not be far distant.

The catamenia in women is suspended.

CHAPTER VIII

PARALYSIS OF THE CRANIAL NERVES

In headache, vomiting, and optic neuritis, we saw symptoms referable to the brain as a whole; in ataxia and other phenomena we had evidence that the trouble was probably in the cerebellum, and in the falling to one or other side, the attitude and the nystagmus, we could suggest, often correctly, the particular portion of the organ which would be the seat of the disease. In paralysis of the cranial nerves we may be able to substantiate the previous information, and add immensely to it by being able to show that the tumour is upon or under the cerebellum, if not within it, and to say if the neighbouring structures are affected, and to what extent.

Thus, in the study of cranial nerve paralysis we have a key to the localization of cerebellar disease, which only occasionally fails us.

This form of paralysis bears to the cerebellum the same relationship as paralysis of spinal nerves does to the motor area of the cerebral cortex, and almost speaks as truly.

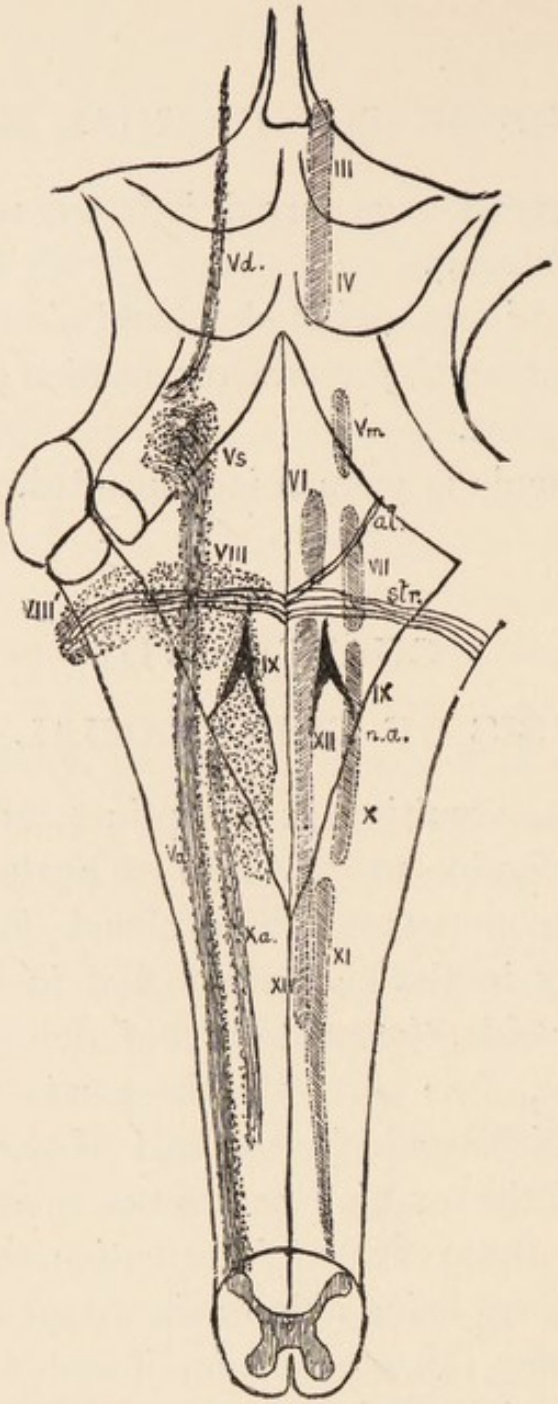

FIG. 4.—DIAGRAM SHOWING THE SITUATION OF THE CHIEF NERVE NUCLEI IN THE MEDULLA OBLONGATA AND PONS NEAR THE FLOOR OF THE FOURTH VENTRICLE. FROM BEHIND. (TWICE THE NATURAL SIZE.)

The efferent or motor nuclei are shaded with oblique lines, and on the right side only; the afferent or sensory with dots, and on the left. III, IV, ocu'o-motor and trochlear nuclei; Vd., descending root of fifth nerve; Vs., so-called sensory root of fifth; Va., ascending root of fifth; Vm., motor root of fifth; VI, nucleus of abductus; VII, nucleus of facial; nVII, root of facial curving round abductus nucleus; VIII, inner or dorsal root of auditory; VIII′, outer or ventral root of auditory; IX, X, vago-glosso-pharyngeal nucleus; n.a., nucleus ambiguus, accessory or efferent vago-glosso-pharyngeal nucleus; XI, nucleus of spinal accessory; XII, nucleus of hypoglossal; XII′, issuing root of hypoglossal.

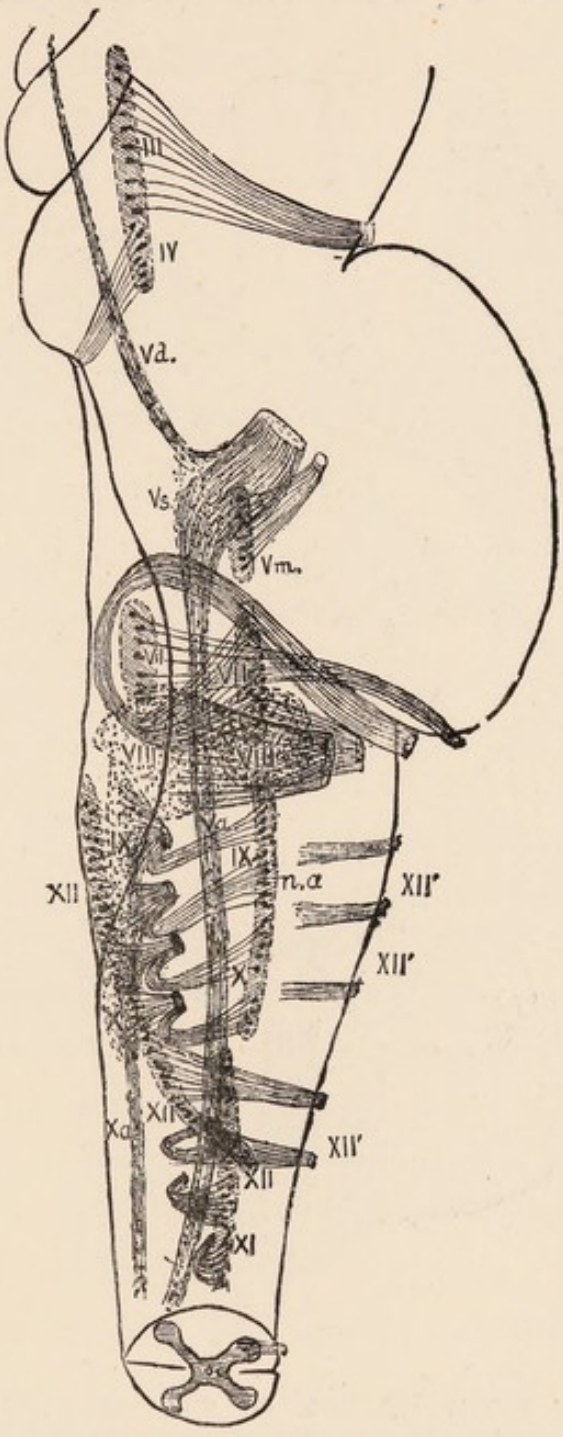

FIG. 5.—DIAGRAM SHOWING THE SITUATION OF THE CHIEF NERVE NUCLEI IN THE MEDULLA OBLONGATA AND PONS NEAR THE FLOOR OF THE FOURTH VENTRICLE. PROFILE VIEW OF RIGHT HALF, THE MEDULLA AND PONS BEING SUPPOSED TO BE TRANSPARENT. (TWICE THE NATURAL SIZE.)

For explanation of letters and numbers see Fig. 4.

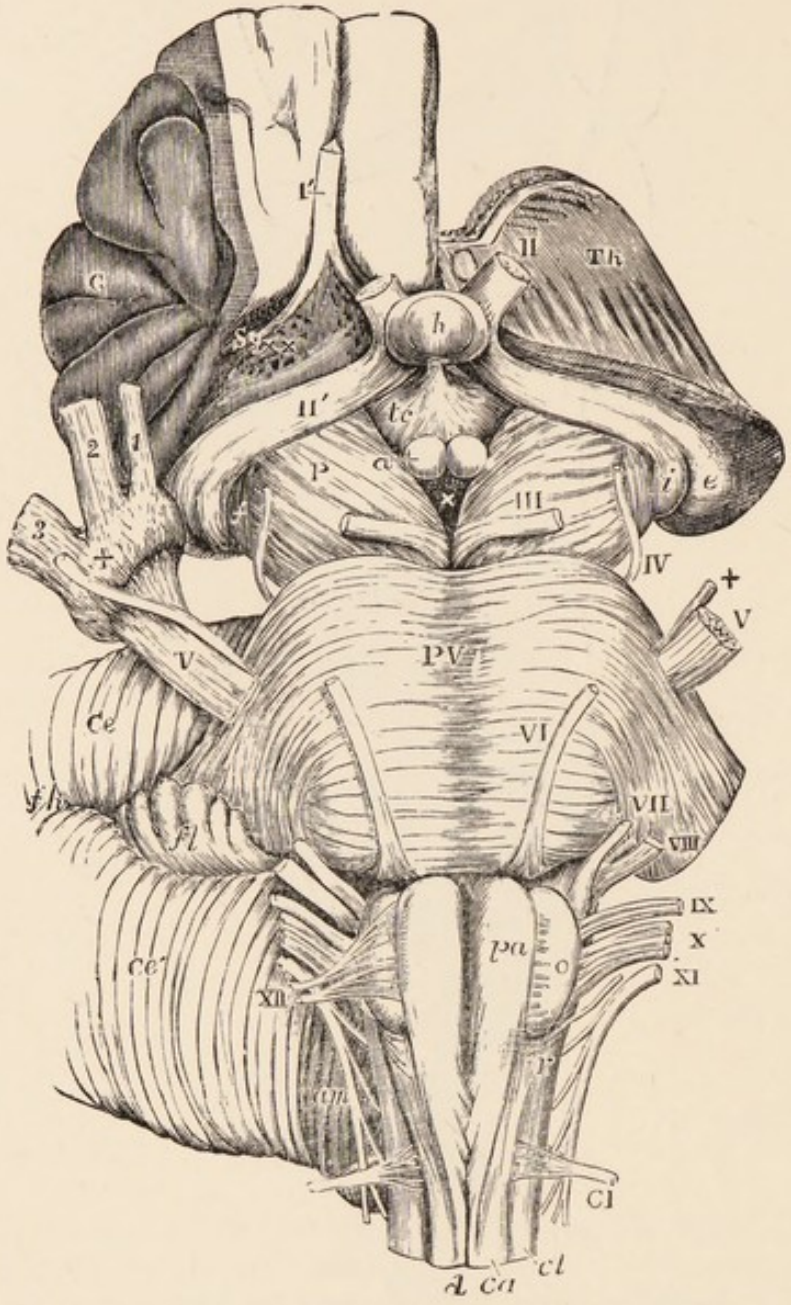

FIG. 6.—VIEW FROM BEFORE OF THE MEDULLA OBLONGATA, PONS VAROLII, CRURA CEREBELLI, AND OTHER CENTRAL PORTIONS OF THE ENCEPHALON (ALLEN THOMPSON).

I', The olfactory nerve cut short; II, the left optic nerve in front of the commissure; III, close to left oculo-motor nerve; P.V., pons Varolii; IV, fourth nerve; V, greater root of fifth nerve; +, lesser or motor root; VI, sixth nerve; VII, the facial; VIII, the auditory nerve; IX, glosso-pharyngeal; X, the pneumogastric; XI, the spinal accessory; XII, the hypoglossal nerve.

Disease of the first cranial nerve, the olfactory, enters very little into the question of cerebellar tumours. If the sense of smell is in fault, it is a rare exception, and occurs on the side of the lesion.

The second, the optic nerve, has already received attention under the heading of 'Optic Neuritis.'

As touching the consideration of the third, fourth, and sixth nerves, which next call for attention, it may be noted that there is said to be a distinct connexion between them through the fibres of the middle cerebellar peduncle.

When paralysis of identical muscles is present in both eyes, it suggests great extension of the disease, except in the case of the fourth nerve, when double paralysis may be due to the fact that there is decussation of the fibres before the nerves appear at the base.

Third Nerve: Oculo-motor.—The group of cells forming the nucleus of the third nerve extends upwards underneath the corpora quadrigemina, and the nerve emerges at the surface of the crus cerebri, just in front of the pons Varolii; it supplies the internal, superior and inferior recti, inferior oblique, and levator palpebræ muscles, and, through its connexion with the sympathetic, the ciliary muscle, and the sphincter of the iris. In case of its paralysis the upper eyelid droops and cannot be raised, and can only be moved inwards, and the pupils are slightly dilated and immovable; the paralysis, however, may only be partial, and only some of these conditions be present.

Third nerve paralysis, in full or in part, is of frequent

occurrence in cerebellar tumours, being perhaps next in frequency to that of the sixth nerve. Squint due to this cause is best seen when the face looks towards the shoulder of the same side.

Fourth Nerve: Trochlear or Pathetic. — The nucleus from which the fourth nerve originates lies just below and to the side of that from which the third nerve starts, at the level of the upper part of the inferior corpora quadrigemina, and it emerges on the outer side of the crus cerebri, immediately in front of the pons Varolii. This nerve supplies the superior oblique muscle, paralysis of which does not occur in the disease under notice quite so often as that of the muscles supplied by the third and sixth nerve. Squint caused by paralysis of this nerve is best seen when the face is turned downwards and towards the shoulder of the paralysed side, and it is a frequent factor in the production of double vision.

Diplopia.—Double vision is complained of in about one-half of the cases of cerebellar tumours, but not nearly so often as the various forms of squint by which it is caused. It is a symptom equally of the intra- and extracerebellar types, and of the middle as well as of the lateral lobes. Diplopia is often an occasional rather than a permanent trouble, and may be due to paralysis of the third, sixth, and eighth nerves, as well as of the fourth. It is experienced accordingly as there is a lateral, upward, or downward movement of the eye.

Sixth Nerve: Abducent.—The nucleus of the sixth nerve consists of large multipolar cells, lying on either

side of the median sulcus, just above the medullary striæ, in the floor of the fourth ventricle. The nerve emerges from the groove between the pons and medulla, and it supplies the external rectus of the eyeball.

Of all the cranial nerves, this one is the most frequently paralysed by tumours of the cerebellum; there are few, indeed, of such cases in which a convergent squint is not either perfectly obvious, or on close examination a weakness of the external rectus found.

If both external recti are paralysed, we find that one has become so at an earlier date than the other; and it is an almost invariable fact that the tumour is found on the side of the squint, and if the latter is double, we may find later that the tumour has spread from one side to the other through the vermis, or that, being originally in the vermis, the lateral lobes have become affected from it, either by pressure or invasion.

As long as the paralysis is confined to those muscles which are supplied by the third, fourth, and sixth nerves, and maybe the fifth and seventh, the possibility is hopeful that the disease is confined to the cerebellum; but if there is evidence that the eighth, ninth, tenth, eleventh, and twelfth are paralysed, the chances are vastly increased that the tumour may be inoperable, on account of the large portion of the organ that is implicated, or because other structures have become affected with the disease.

If paralyses of the third, fourth, and sixth nerves, either alone or together, are seen early in the case, and those of the eighth, ninth, tenth, eleventh, and twelfth,

alone or together, come on later, we may assume that the tumour originated in the cerebellum, and injured the pons later; but if the reverse was the order of procedure, it will be reasonable to assume that the trouble was originally pontine, and invaded the cerebellum secondarily.

The remark on inoperability does not include tumours lying in the occipital fossæ, and either growing from the bone or the meninges there.

The words 'pontine' and 'ponto-cerebellar' are frequently used, but with a certain degree of literary licence; what is meant for the most part is that the tumour is in near relationship with the pons, growing from the meninges at its side, and entering the cerebellum by way of its middle peduncle. One side of the pons is, on rare occasions, infiltrated by a tumour starting in the cerebellum, or growing from the meninges. A tumour may infiltrate the side of the pons as it does the cerebellum; but it must be remembered that the pons and medulla contain the centres necessary for life, and gross lesions like tumours would be incompatible with life.

Fifth Nerve.—The trifacial or trigeminus arises by two roots. The deep origin of the **larger** or **sensory** is chiefly from a long tract in the medulla, the so-called ascending root. The deep origin of the **smaller** or **motor** root is derived partly from a nucleus embedded in the grey matter of the floor of the fourth ventricle, and partly from a collection of nerve cells situated at the side of the aqueduct of Sylvius. The nerve

emerges at the side of the pons Varolii, nearer the upper than the lower border. The **sensory** portion is distributed to the face and that part of the scalp behind a perpendicular line drawn through the external meatus, the motor portion being distributed to the muscles of mastication.

Implication of the trigeminus is relatively frequent in tumour of the cerebellum—*i.e.*, it is observed in slightly less than half the cases, which are often of the extra-cerebellar type. Paralysis of the fifth nerve is mostly on the side of the lesion, and is seldom seen unless the seventh also is affected; but the reverse does not hold good, as we frequently see the seventh paralysed and the fifth normal.

When there is anæsthesia of the face, with weakness of the masseter, the suggestion is towards a ponto-cerebellar site; while if the trigeminal distribution is increased in intensity—*i.e.*, if there is a condition of hypoalgesia—we may expect to find the growth in the posterior occipital fossa of that side. Anæsthesia of the cornea was not noticed in any of the cases, but it is occasionally present, with resulting neuro-paralytic ophthalmia.

No case was recorded in which the fifth nerve *only* was paralysed, and the writer understands that no such case has been known to occur.

Seventh Nerve.— The facial nerve arises from a nucleus in the lower part of the pons, and becomes superficial from the lateral tract of the medulla in the groove between the olivary and restiform bodies.

It is the **motor** nerve of all the muscles of expression of the face, of the platysma and buccinator, and the muscles of the external ear, the posterior belly of the digastric and stylo-hyoid. By its chorda tympani it supplies the lingualis, and by its tympanic branch the stapedius.

Paralysis of this nerve, the **portio dura**, is of very frequent occurrence—indeed, almost as much so as that of the sixth nerve, with which in many cases it is in lonely association ; and while the two together, or even the seventh by itself, may only indicate intracerebellar disease, and that always on the side of the lesion, its presence suggests the possibility of the trouble being extracerebellar, which is exerting pressure upon, but rarely actually invading, the pons.

Again and again when these nerves, and perhaps the fifth with them, exhibit evidences of paralysis, it is found on operation or post-mortem examination that the pons has been more or less indented by a growth arising from the middle cerebellar peduncle.

By paralysing the stapedius, the seventh nerve may cause loss of hearing, without there being any paralysis of the eighth nerve.

Eighth Nerve. — The auditory nerve has its deep origin by two roots, which embrace the restiform body, and it emerges from the groove between the olivary and restiform bodies at the lower border of the pons. Deafness due to paralysis of this nerve is very common in the disease we are considering, and as a rule it is an early symptom, the patient first being deaf to aerial,

and afterwards very probably absolutely deaf to bone-conduction.

It is sometimes seen in cases of the intracerebellar type, but in extracerebellar cases deafness due to its paralysis would almost seem to be a *sine qua non*, whether the tumour lies in the occipital fossa, exists as a cyst or growth in the fourth ventricle, or implicates both cerebellum and pons.

However successful an operation may be in relieving other symptoms, deafness is not benefited thereby, except possibly in the case of a cyst, destruction of the nerve substance being too great for repair, or a section of the nerve being altogether destroyed. Auditory nerve paralysis never occurs without other cranial nerve paralysis.

The student must see in any suspected case that the deafness is not due to middle-ear disease by an examination of the tympanum and application of the tuning-fork.

Ninth Nerve.—The glosso-pharyngeal has a three-fold deep origin :

1. A nucleus of grey matter at the lower part of the fourth ventricle.

2. Fibres in the lower part of the medulla, just at the decussation of the pyramids.

3. From a collection of cells, the nucleus ambiguus, continuous with the nucleus vagus.

The nerve has its superficial origin in the groove between the olivary and restiform bodies.

The glosso-pharyngeal is the special nerve of taste to

the posterior third of the tongue and soft palate, and is the motor nerve for the stylo-pharyngeus, middle constrictor of the pharynx, the levator palati, and azygos uvulæ muscles; consequently, the chief symptom of its paralysis is loss of taste to the back of the tongue and diminished movement of the soft palate, and, to some extent, in the difficult pronunciation of words.

The nerve is only occasionally in fault in cerebellar tumours, and while its paralysis may mean in rare cases that the lobe of that side is the site of a growth, it is much more probable that the initial trouble was in or about the pons, and that the lateral lobe on the side of the paralysed ninth nerve has been affected secondarily.

Tenth Nerve.—The vagus nerve is composed both of motor and sensory fibres, and supplies the organs of voice and respiration with motor and sensory fibres, and pharynx, œsophagus, stomach, and heart with motor fibres. It arises from the **nucleus vagus** at the lower part of the floor of the fourth ventricle, passes through the fasciculi of the medulla, and emerges from the groove between the olivary and restiform bodies below the glosso-pharyngeal.

Paralysis of the vagus nerve is associated, as far as cerebellar growth is concerned, with indistinct speech, difficult deglutition, and, in conjunction with the accessory portion of the eleventh nerve, regurgitation of fluids through the nose. Any or all of these symptoms may be exhibited in intracerebellar growth, be the growth in either of the lateral lobes or in the vermis;

but they are then noticed in conjunction with paralysis of some one or more of the third, fifth, sixth, and seventh nerves. In the extracerebellar tumour they are almost the invariable rule, and the rule is wellnigh as invariable that in such cases there is also paralysis of other nerves of 'bulbar origin.'

Articulation is said to be impaired in 15 per cent. of the cases: it is difficult, hesitating, indistinct, slow, and of a slurring or scanning character. This imperfect speech and its frequent associate, difficult deglutition, are here considered as due to pressure on the bulb in the neighbourhood of the superficial origin of the vagus nerve; but it may be that, like ataxia, they are of truly cerebellar origin.

The occurrence of vagus paralysis is a matter of the greatest possible importance, as it is to the implication of this nerve, through its cardiac and pulmonary branches, that we explain the sudden deaths, by syncope or sudden stoppage of the respiration while the heart is still beating, which we see occasionally in persons who suffer from this disease. Although vagus paralysis may not be noticed to be present, we have the fact that, whether the growths be cystic or solid, in the vermis or lateral lobes, we see persons who so suffer die suddenly by either of the above methods. We may, therefore, justifiably conclude that, when a person is found to be suffering from a cerebellar tumour, sudden death is at any moment possible; aud when symptoms are exhibited of vagus paralysis, as is the case in almost all cases of extracerebellar tumours, the probability of such an ending becomes greatly increased.

Eleventh Nerve.—The spinal accessory nerve consists of two portions—the accessory, or that portion that is additional to the vagus, and the spinal.

The **accessory** or **bulbar** part has its deep origin from a nucleus of grey matter at the back of the medulla oblongata, and its superficial origin from the side of the medulla below the roots of the vagus. The **spinal** portion has its deep origin in the intermedio-lateral tract of the grey matter of the cord. Its superficial origin is by several filaments from the lateral tracts of the cord, as low down as the sixth cervical nerve.

Paralysis of the spinal accessory seems altogether confined to the extracerebellar type of tumour, in which it occurs in about one-half of the cases.

The symptoms produced are according as the accessory or spinal portion, or both, are affected. If only the former, there is loss of movement of the vocal cords, and consequently more or less loss of the power of phonation; but as aphonia is also a consequence of vagus paralysis, with which in this disease the eleventh is commonly associated, it is difficult or impossible to assign to each its proper part in the production. There is also paralysis of the palate, observed in slow movement in the attempt at phonation. Paralysis of the spinal portion is shown by loss of power in the trapezius and sterno-mastoid, which muscles are recognized to be paralysed by the patient's inability to turn his head to the opposite side when it is behind the vertical position.

Paralysis of the eleventh nerve, as already stated, is always associated in cerebellar tumours with that of

other cranial nerves, and is, on account of its origin, said to be bulbar.

As the seventh, ninth, and eleventh nerves* are frequently found paralysed together in cases of extracerebellar tumours, the student may very properly ask why, on these occasions, we do not see the classical symptoms of bulbar paralysis, or, as it is equally well known, glosso-labio-pharyngeal paralysis; and the reason is, that whenever disease begins in the cerebellum and affects the pons secondarily, or begins about the pons and afterwards invades the cerebellum, only the superficial roots of the seventh, ninth, and eleventh nerves are implicated—*i.e.*, the disease occupies a site superficial to the decussation of nerve fibres of opposite sides. In bulbar paralysis, properly so called, the above nerves have been affected by the degeneration of the nerve centres at their *deep* roots, and before decussation has taken place.

Twelfth Nerve.—The hypoglossal nerve is the motor nerve of the tongue. Its deep origin can be traced to a nucleus of grey matter in the floor of the fourth ventricle, on either side of the median line extending from the level of the auditory striæ to the lowest point of the ventricle of Arantius.

The hypoglossal, like the preceding nerves, may be paralysed in extracerebellar tumours, but not so often as the others. The paralysis is shown by the deviation of the tongue to the opposite side.

Paralysis of the extremities, or paresis in regions in

* The nerves chiefly producing bulbar paralysis.

them, is sometimes noticed, and was seen in some form or other twelve times in the eighty cases. This condition is also known under the names of **muscular asthenia** and **cerebellar weakness.**

It may be that one hand only is affected, or the upper and lower limbs of the same side, or both hands or both legs, or even both arms and legs; or the paralysis may be of the spastic type, and the arms and legs may be rigid. Destructive lesions of the cerebellum cause motor paralysis of the trunk and extremities in this order: muscles of the trunk most, legs next, arms the least. This is the reverse order of what obtains in cerebral paralysis, for in hemiplegia the usual order is: arms most, legs next, and trunk the least.

The presence of paralysed extremities, or weakness of groups of muscles, does not assist us in locating a cerebellar growth beyond the fact that the paralysis, when hemiplegic in form, is *exceedingly* likely to be on the side of the lesion; it may also be said that if both hands are affected, and one is worse than the other, the worse of the two is on the side of the lesion. The only case in which both lower limbs were paralysed, the arms retaining their normal power, was one in which a small cyst projected from the under surface of the middle lobe.

It is also observed that when there is any paralysis of the extremities present, other symptoms, whether general or special, are few—*e.g.*, vomiting may be absent, and with or without vomiting there may be little headache.

These are also the cases in which ataxia and nystag-

mus may be absent, and the cranial nerves are not implicated in the wholesale manner which so often holds good when paralysis of the extremities is absent.

Difficult speech is the most frequently associated symptom. When motor paralysis is on the side opposite the lesion, it is said to be due to pressure on the pyramidal tract above the decussation of the pyramids.

Anæsthesia of the skin of the extremities was not observed in any of our cases. When present it is usually seen on the homo-lateral side, but it may occur on the contra-lateral side. It is most frequently seen in the upper limb, and chiefly in the hands.

PART III

CHAPTER IX

ON THE STRUCTURE, FREQUENCY, CAUSES, AND SITE OF CEREBELLAR TUMOURS

Structure.—It will be seen from the subjoined list that the structure of cerebellar tumours is of a very varied character.

	Cases.	
Gliomata	14	
Sarcomata	10	
Glio-sarcomata	2	
Fibro-sarcoma	1	
Cystic glioma	1	
Psammoma	1	
Carcinoma	1	
Endothelioma	1	
Fibro-endothelioma	1	
Malignant	1	
	—	33
Fibromata	4	
Enchondroma	1	
	—	5
Tubercle	13	
Gumma	1	
	—	14
Tumours	10	
	—	10
Cysts	16	
Cystic growth	1	
Distension of fourth ventricle	1	
	—	18
Total		80

Since tabulating the above, two additional cases have come under notice—one an osteoma, the other an osteo-enchondroma. The latter produced no symptoms during life, and was described as benign.

Those neoplasms which belong to the class that are peculiar to the nervous system—the glioma, glio-sarcoma, cystic glioma, and psammoma—are not encapsuled; while the sarcoma and carcinoma, agreeing with them in being malignant, but differing from them in not being peculiar to the nervous system, may be, but seldom are, encapsuled, and the fibroma and enchondroma, which are neither malignant nor peculiar to the nervous system, are encapsuled.

The cysts were in several cases without a containing membrane.

The so-called tuberculous tumours of the cerebellum would be better described as well-defined masses of tubercle, rarely having an enclosing membrane, and, while capable of undergoing considerable shrinkage or atrophy, rarely become calcified.

Glioma of the cerebellum is very vascular, and has a fluctuating feel to the finger. It is usually single, and of rapid growth, and occurs as a soft ill-defined swelling, which infiltrates the surrounding structures. It may have the density of such a semigelatinous fluid as the vitreous humour, or be as firm as the tissue of the pons Varolii, which it may affect primarily, and spread to the cerebellum through the latter's peduncles; or, beginning similarly, it may spread to the cerebrum through the cerebral peduncles and the corpora quadrigemina.

The glio-sarcoma is more sarcomatous than glio-

matous, and the results of the removal of either glioma or glio-sarcoma are the least favourable of any of the neoplasms growing in connexion with the cerebellum.

The contents of cysts vary from a thin liquid of the density of blood-serum to that of a viscid fluid. There is in the majority of cases no containing membrane or capsule, but when one exists, it is usually formed of condensed nerve tissue; at other times it consists of an infinitely small malignant structure, which suggests by its presence that the tumour has been in its early history more solid than cystic, and that the cystic contents have increased at the expense of the solid, and in time all but annihilated the parent structure. The cysts found in solid tumours may be acting in a similar manner.

The walls of those cysts which have resulted from hæmorrhage, however produced, contain granules of hæmatoidin and minute hæmosiderin crystals; and those cysts which result from thrombosis or embolism contain softened brain tissue, the more solid portions of the same having been absorbed.

Frequency.—It may be here stated that more than one writer has upheld the opinion that cerebellar cysts are relatively frequent in idiots, because they have been found in a very few of these unfortunate people; but this theory, on examination, cannot be maintained. When they do so occur, they are probably due to defective development, as in the kindred case of cerebral cysts occurring in idiots.

Malignant tumours as a whole are, by the light of

this collection, seen to be far in excess of any other kind of tumour, and to be actually greater than all other forms of solid tumours taken together.

The gliomata—so called on account of their fancied resemblance to the neuroglia of the brain, but which are, in fact, round-celled sarcomata—are the most frequent, and the softer or mucoid greatly exceed in number the firmer or fibroid sort. Close upon the gliomata as regards numbers follow the spindle-celled sarcomata, while a carcinoma, psammoma, or endothelioma is a *rara avis*.

Tuberculous tumours are said to be relatively more common in the cerebellum than in the cerebrum. In the above list they were on several occasions multiple.

Cysts with or without a containing wall, and not including those malignant tumours which may have become cystic, occur oftener than any other special form.

Organized tumours are to the unorganized as 2·7 : 1, and of the latter the tuberculous are very common and the gummatous rare.

It must be noted here that 1 in 80 may not represent the proper ratio of syphilitic tumours in the cerebellum; perhaps the unclassified ten would have included one or more of them. Unfortunately, one growth has been recorded only as malignant, ten as tumours, and one as a cystic growth, the list being to this extent deprived of its importance.

The fibromata, which have a place between malignant and benign, are only represented by one, as are also the

purely benign enchondromata, while the lipomata are not represented at all.

Readers will be sure to notice the absence of hydatid cysts, and the writer of this booklet had almost concluded that the cerebellum had something in it which offered an insuperable opposition to the deposition and maturation of the echinococcus, as not one case of hydatid disease occurs, although one often sees cases of hydatid tumours of the cerebrum reported in the medical journals by Indian, South African, and Australian doctors, and we occasionally hear of such cases treated in the metropolitan and provincial hospitals of this country. To have stated that cerebellar hydatid disease never occurred would have been wrong, but it certainly is very rare.

Dr. Graham, in his work on 'Hydatid Disease,' in speaking of hydatid of the brain, says: 'This disease is relatively less frequent in the cerebellum, even when the normal proportions of these two parts are taken into consideration.'

The gliomata occurred for the most part in males, the ratio being as 9 : 4, the youngest patient being a girl five and a half years and the eldest a man forty-six years of age.

The sarcomata, oddly enough, differed from the foregoing in that they occurred mostly in females, the youngest patient being two and a half years and the eldest forty years old.

Dr. J. Taylor says: 'The frequency with which neoplasms affect the different parts of the brain is widely different, for while subtentorial are much less

common in the adult than supratentorial, supratentorial are very rare indeed before the age of sixteen years, and still more rare before the age of eight years.'

In 155 cases he quotes from another author there were:

Adults.	*Children under* 16 *Years.*
Supratentorial, 112.	Supratentorial, 5.
Infratentorial, 13.	Infratentorial, 25.

The patient with the carcinoma was a man of forty years, and the one with the endothelioma a youth of nineteen years. Of the fibromata, three were in males, the youngest being sixteen years, and the fourth occurred in a woman who was fifty-six years old.

The only really benign tumour was in a boy of eleven years.

The Causes.—The causes of these tumours are various, and probably are much the same as the causes of those in other regions.

The causes of cerebellar cysts are said to be defective development, hæmorrhage (due to any cause), softening, and dilatation of the perivascular lymph spaces, believed to be the cause of the **disseminated cysts**, which are found in large numbers, varying from the size of a millet-seed to a pea. This variety only occurred once in our collection of sixteen cases of cysts.

On this important question of the causation of cysts a controversy has raged as to whether violence is more likely to be followed by a cyst or a malignant growth, and in this connexion it must be pointed out that out

of our sixteen cases eight persons had been the subjects of violence, such as kicks, blows, or falls, or at least belonged, like policemen, to occupations in which direct violence might easily be surmised.

That violence is often the cause of cysts is supported by the fact that in many of them hæmatoidin crystals or granules were found, and the blood necessary for these crystals or granules was just as likely to have been due to violence as to the rupture of a small aneurism.

In very rare cases they may be due to a possible ventricular cavity in the vermis. We know that there is such a ventricle present in some birds—so writers upon this subject say—but the author is not in a position to say in which family of birds it occurs.

On the other hand, of the whole of the cases of malignant tumours, in only two was there a history of violence. The above suggestion as to violence being frequently the cause of cysts is contrary to the recognized teaching, which holds that violence is more likely to cause a malignant than a cystic tumour.

It cannot be too strongly emphasized that of solid tumours of the cerebellum, the cancerous are more likely to occur than the non-cancerous; and as to cancer, there is a far greater probability that it will be of the greatest than of the least malignancy—*i.e.*, that the mucoid or gelatinous element will predominate over the stroma.

If a person be known to have suffered from a fibroma elsewhere, it would not be unreasonable to assume the cerebellar growth to be a fibroma; and if he had

enchondromata on his hands or feet, one would naturally conclude that the cerebellar trouble would be in the same category. But it is possible that in each of these cases our assumptions might be wrong.

If a person belongs to a family which has yielded several victims to cancer, there may be good reason to fear that the growth is malignant. Similarly, if the patient be known to suffer from consumption, or there is consumption in his family, tubercle may be suspected; and if from syphilis, then a gumma or syphiloma.

Such deductions are not always correct, but they are more likely to be correct in the case of cancer than with tubercle or syphilis, because, as we have seen, malignancy in some form or other is much more frequent than both the others combined; but with tubercle and gummata mistakes are by no means uncommon.

Over and over again, because a person has been known to suffer from tuberculous lesions in other organs, or to be related to people who are suffering or have died from consumption, a tuberculous tumour has been diagnosed as present in his cerebellum, on symptoms pointing to that organ having appeared; but on operation or at the post-mortem examination a malignant tumour has been found, and exactly the same mistake has many times occurred in the case of a syphilitic person.

So far as these inquiries have proceeded, no person the victim of congenital syphilis has been known to have suffered from a gummatous deposit in his or her cerebellum.

The Site (in sixty-two cases).—In thirty cases the tumour was upon, or chiefly upon, the **left** side; in twenty-three cases the tumour was upon, or chiefly upon, the **right** side; in nine cases the tumour was in, or chiefly in, the **vermis.**

From this it would appear that the lateral lobes are six times more prone to tumours than the vermis, and the left lobe more prone than the right in ratio of 3 : 2·3.

CHAPTER X

DIAGNOSIS AND PROGNOSIS

Diagnosis.

In the very short time in which a student is called upon to make up his mind in the diagnosis of a case brought before him, he must not place too much emphasis on any one group of symptoms, however pertinent to the case they may appear to be, or he may find, after the examination is over, that he has been grievously at fault; and such an undesirable position is possible in the differentiation between a cerebellar tumour and disease of the upper cervical vertebræ, particularly of the axis and atlas, or of the occiput and these vertebræ.

The late Mr. Hilton, in his book on 'Rest and Pain,' mentions the case of a child who suffered from headache and pain radiating down the neck, and pain on pressure about the occiput, rigidity of the muscles of the neck, pain in the limbs, and stiffness in walking. She had

also some difficulty in deglutition, and her voice had changed lately in character and become feeble, but her trouble was in the articulation between the axis and occipital bone. The same writer mentions a second case due to disease between the axis and atlas, in which headache and pain in the neck were present, with difficulty in respiration, increasing enfeeblement of the voice, difficulty in deglutition, and inability to protrude the tongue, with consequent imperfect articulation and paralysis of the upper and lower limbs. In the above groups of symptoms we see elements for a wrong diagnosis if the student or practitioner should first consider the condition of the cranial nerves, and *then* attempt to make the headache, stiffness of the neck, pain on pressure, and abnormal walk fit in for a diagnosis of cerebellar disease. In Mr. Hilton's cases we have paralysis of the glosso-pharyngeal, vagus, perhaps of the spinal accessory, and certainly of the hypoglossal nerves, due to pressure on the medulla, the pressure arising in no wise from the central nervous system, but from a totally extraneous cause—that is, from the odontoid process of the atlas, freed by disease from the structure which should naturally control or contain it. The possibility of such a mistake is by no means visionary, and maybe has been made.

The moral is that the paralyses of the cranial nerves should be the *last* rather than the *first* part of the diagnostic structure; they constitute the most valuable of signposts, guiding us not so much to the town or village we seek as the street, or even the very house we wish to enter.

Lesions in the cerebral areas may be the cause of much uncertainty.

In the præfrontal lobe the general symptoms may be the same as in cerebellar tumours, and the gait may be that known as cerebellar, or if not distinctly so, it may sufficiently differ from natural walking as to be mistaken for it; but the possibility of a mistake will be minimized if it is remembered that in cases of cerebellar tumours, besides the ataxic gait, there is vertigo, nystagmus, and evidence of several cranial nerves implicated, and that in tumours of the frontal lobes all these symptoms are unusual, and instead there is the dull, apathetic state, sometimes tending to complete stupor, at other times to acute mania, and along with such a mental condition there is very likely incontinence of urine, and possibly weakness of the anal sphincter also.*

Tumours of the cerebellum in which there is weakness or paralysis of one arm or leg, or of both, may be simulated by tumours in the Rolandic area or near neighbourhood, as in the posterior parts of the frontal lobe, which by transmitted pressure on the Rolandic area cause paresis or paralysis of the extremities. In these cases true cerebellar symptoms are poorly expressed, although there may be a tendency to fall to one side or backwards, and vertigo; but it may be well to remember that there would also be the apathetic state, often abnormal taste and smell, and incontinence of urine.

A very possible and at the same time more excusable

* Sphincter troubles were only present once in our eighty cases.

mistake than any of the preceding ones would be a tumour in or between the crura cerebri, or in the optic thalami, causing cerebellar symptoms by transmitted pressure; but the same class of pressure would doubtless cause a fixed condition of the eyeball (ophthalmoplegia),* besides which the visual centre, deadened by pressure on the optic radiations, would yield hemianopia, and perhaps also colour-blindness.

With regard to diseases, other than those already considered, which exhibit some symptoms usually considered cerebellar, it will be well to remember the following facts:

In **tumours of the cervical portion of the spinal cord** there are often optic neuritis and vomiting.

In **disseminated sclerosis** there are a jerky walk, intentional tremors, nystagmus, vertigo, and exaggerated knee-jerk.

In **tabes dorsalis** there is an ataxic walk, but of a different character, often diplopia, and occasionally **headache and vomiting.**

In **posterior basic meningitis** retraction of the head, often developing into extreme opisthotonos, is a common occurrence; nystagmus is a marked feature of the same ailment, but optic neuritis is seldom noticed.

In **Friedreich's ataxy** there is no optic neuritis, and while the gait and nystagmus suggest cerebellar disease, the remaining symptomatology, excepting the plantar extensor response, differs widely.

* In one of our cases ophthalmoplegia was present, but the tumour was confined to the left cerebellum.

The symptoms ataxia, intention tremor, and nystagmus, will be found mentioned as occurring in various other diseases in the chapters devoted to their consideration.

If a patient has as yet only exhibited the general symptoms of headache, vomiting, and optic neuritis, and while these symptoms are still young he should have a convulsion, that fact in itself would be sufficient to suggest that the disease was not cerebellar in origin.

If the student or practitioner were to find in any case of illness that chanced to come under his notice all, or even most, of the symptoms which have been discussed in some detail in the preceding chapters, he might, by using due care, arrive at a correct diagnosis of cerebellar tumour—that is, if he had succeeded in possessing himself of a working knowledge of his profession.

When an adult under middle age, adolescent, or child is brought before us with a family history of cancer or tubercle, or a personal history of syphilis, who complains of headache, often of a paroxysmal character, and we are able to eliminate such causes of severe headache as renal disease, typhoid fever, lead-poisoning, toxæmia, disease of the various sinuses, etc., and there is vomiting which we cannot assign to any derangement of the digestive system or other usual cause, to which troubles the patient may say there has lately been added dimness of vision, gradually but surely becoming more intense, which on ophthalmoscopic examination has been found to be due to inflammation of one or both optic discs, one's mind

must inevitably centre on the brain as the organ that is probably diseased.

If, in addition to such general troubles, we notice in a short time a peculiar straddling walk, in which the patient's legs are kept wide apart and his body bent forward, his head drawn back, and perhaps resting upon one or other shoulder, and he is noticed to fall backwards or forwards, or to one or other side, and he complains that he is subject to fits of dizziness, and we find on examination that his reflexes are abnormal, the knee-jerk being diminished or exaggerated, with ankle-clonus present, and the plantar reflex extensor, with several of the cranial nerves, exhibiting symptoms of paralysis, and almost always including external squint, and that the convulsive movements of the eyeball known as nystagmus are also in evidence, we may suggest the cerebellum as the portion of the brain which is most probably diseased, and perhaps we may be able to advance a little further, and specify the side the disease is upon and its nature.

The picture produced by a cerebellar tumour is not always either painted in vivid colours or presented as a finished work at all. Some symptoms are expressed poorly; others, including those probably on which we chiefly rely, may be altogether wanting, or some other nervous disease may possibly also be present.

The headache may be slight or general, the vomiting may be absent, or the optic neuritis be long in making its appearance, and in very rare cases the ataxia and nystagmus may be absent. There may be no vertigo, and as for the paralyses of the cranial nerves, there

may be only a drooping upper eyelid and an external squint to represent them, and they, indeed, may be caused by many other intracranial diseases.

However easy it may be to give a name to the aggregation of symptoms forming the finished picture hung in full light, when we have to deal with a picture that seems only partly finished, and even then hung in the shade, it may require the careful and highly skilled master mind to bring to bear upon it all the special knowledge and acumen at his command before the intention embodied in the picture can be properly revealed.

When the cerebellum has been fixed upon as the site of a tumour, and the nature of the tumour suggested, the diagnosis cannot be considered complete unless we can suggest the right, left, or middle lobe of the organ as the part that is diseased, and the relation of the tumour to surrounding structures be explained.

If the patient falls forwards or backwards, the tumour may well be thought to be in the anterior or posterior part of the vermis, and as the writing of the foregoing pages proceeded it was the aim of the writer to suggest to which side the various symptoms pointed.

If the tumour is of slow growth, as measured by the non-severity of headache and slowly progressive optic neuritis, it is most probably tuberculous. Next in order of slowness are the benign tumours, then the sarcomata and psammomata, and the most quickly growing are the ultramalignant, the gliomata, and cysts.

Probably the most important question of all, after the great point of the cerebellar site has been settled, is to

arrive at an opinion as to whether a growth is contained wholly within the cerebellum, or is only partly within it and partly without, or whether the growth was originally pontine—*i.e.*, grew from the meninges at the side of the pons and medulla, and invaded the cerebellum by its middle peduncle secondarily. The elucidation of the latter part of this weighty problem depends upon the study of the cranial nerves in their various forms of paralysis.

If we find that these nerves, from the sixth to the twelfth, are all or several of them affected, there is ample reason to conclude that the growth is extracerebellar; and if these nerves exhibited signs of implication before the oncoming of such symptoms as ataxia, vertigo, retraction of the head, or nystagmus, we may decide that the trouble was very likely originally pontine, and became cerebellar afterwards.

How to differentiate between an extracerebellar tumour lying in the occipital fossa from one which is ponto-cerebellar is a question requiring further study, but this much is apparent to us: that bulging and tenderness of the occiput, or either of them, is frequent in the former variety, and less often so in the latter. It is also to be remembered that vomiting is absent more frequently in the former than in the latter.

Growths not in or about the cerebellum may press this organ into the foramen magnum, and so produce misleading cerebellar symptoms.

The pressure of the cerebellum, pons and medulla into the foramen magnum occurred in two of our cases, but the trouble was really cerebellar.

It may be well to note that all the symptoms of a cerebellar tumour may be present and yet speak falsely, and the tumour on operation or post-mortem examination may be found in a distant part of the brain. A case is on record in which a boy five and a half years old had the typical cerebellar gait—ataxia, intention tremor of the upper extremities, left-sided facial palsy, headache, and increasing drowsiness for three years, and then rapidly recovered.

Dr. Collier points out that this falsity is likely to occur when local signs appear late in the course of intracranial tumours, when general signs have alone pre-existed; that the absence of local signs during the early days of an illness in intracranial tumours is in itself a most important localizing sign, confining the disease to the supratentorial region; that true localizing signs at one time present may later be concealed, or be undemonstrable, owing to the development of other signs; and that in cases which come under observation for the first time late in the disease, diagnosis may be difficult, erroneous, or impossible.

The corollary to this statement will be that if symptoms usually thought cerebellar are not for certain reasons to be so considered, then of the supratentorial regions the frontal lobe is the most likely part to prove to be the site of the tumour.

It must be again stated that the cranial nerve paralyses, the abnormal knee-jerk, and the distinctive attitude, may be all on the side *opposite* to the lesion, though in the vast majority of cases they are found on the homo-lateral side.

Cerebellar symptoms, like those of the cerebrum, are occasionally observed to be present and then to disappear. This is explained by the theory of **compensation** —*e.g.*, when a small part of the cortex has been injured or destroyed, the cells of the neighbouring cortex or of the opposite hemisphere take up the functions of the destroyed parts; and when more of the cortex has been destroyed, the symptoms reappear, only to again disappear as the tumour increases in size. This method of compensation does not take place if the sensori-motor cortex of the opposite Rolandic area is also destroyed.

Atrophy of the whole or a portion of the organ is, as already stated, seen, but it is not common, and is said to be due to defective development and to occur either in imbeciles or persons of weak intellect. Ferrier says that the impaired intelligence or imbecility is only a symptom of a cerebral defect coincident with that which has led to the cerebellar atrophy. He quotes two cases occurring in girls. In the first the cerebellum was entirely atrophied, and its place was taken by a cyst filled with serum. She was insecure on her legs, and often fell; her intelligence was defective and articulation indistinct, but all her sensory faculties were normal. The second case also occurred in a girl of weak intellect. Her articulation was defective, but this might have been due to a narrow palate; there was no deficiency in her sensory faculties. She suffered from great muscular weakness and tremor of the hands when using them; she could walk well and steadily, but was never known to run. On post-mortem examina-

tion the left and middle lobes were found to be almost non-existent, and the right lobe was very diminutive.

Hypertrophy is also noticed, but it is even less common than atrophy, and also occurs chiefly in imbeciles.

One of the most important points, perhaps *the* most important, that can arise in the diagnosis of cerebellar tumours, is to say whether they are operable or otherwise. Unfortunately, the inoperable far exceed the operable. If a tumour is tuberculous or gummatous, it is more likely to be operable than if it is malignant; but large size, or the fact of the tumour being multiple, may negative operation, and these possibilities may be feared if the headache is general, and the reflexes are abnormal on the two sides of the body. A tumour will be inoperable if the bone is obviously partaking of the disease.

The more nerves which have a medullary origin affected, the greater is the fear that the disease may have begun to infiltrate the brain-stem, and made surgical interference impossible.

The symptoms, already discussed with some detail, are those of the **destructive** lesions (tumour and abscess) of the cerebellum, which, like the cerebrum, but to a less extent, is liable to vascular lesions which produce phenomena of an **irritative** character, and such lesions occur in the following order of frequency: thrombosis, hæmorrhage, embolism.

Irritative lesions would produce symptoms earlier than the destructive, and in case of apoplexy death may be immediate, or occur in a few days. Distortion of

the head and trunk, and other symptoms which are homo-lateral in destructive lesions, are contra-lateral in the irritative, and the hemiplegia tends to be of the rigid type. Theoretically the symptoms of the two varieties of lesions should differ, but practically there is no sharp dividing line. Softening, from either thrombosis or embolism, is rare, and is noticed in the area supplied by the posterior cerebellar artery. It produces hyperæmia of the cortical grey matter, and the immediately subjacent structures, and as a natural consequence irritability is evoked, which may be shown by unilateral convulsions or muscular spasms of small extent.

Cerebellar apoplexy is rare. When it does take place it is due, as a rule, to rupture of a branch of the superior cerebellar artery. The hæmorrhage, ploughing up a lateral lobe and part of the middle lobe, may make its way into the pons or burst into the fourth ventricle.

The following cases, which the recorders will perhaps permit me to introduce and give *in extenso*, well exemplify the course which cerebellar apoplexy usually runs, when not rapidly fatal ('Year-Book of Medicine and Surgery,' 1902, p. 441).

A man, aged twenty-nine years, was suddenly seized with dizziness, headache, nausea, and vomiting, the last being intensified when the patient raised his head. He was cold and clammy, but with a full, throbbing pulse of 70 beats per minute. There were no remissions of symptoms for two weeks, during which time there was no disturbance of mind or speech. On taking the patient out of bed at the end of this time, he could just

walk with legs well apart, and the effort was attended with great discomfort. Later on the symptoms became greatly intensified, and finally he suddenly expired. The post-mortem examination showed the right cerebellar lobe to be more prominent than the left, and from a rent in it the blood had found its way into the fourth ventricle, where a fresh coagulum indicated the cause of death.

Dr. W. Flynn reports a case of cerebellar apoplexy which presented retraction of the head and Kernig's sign. The patient was twenty years old, with an epileptic history. After eating several hearty meals, he was seized with vomiting during the night. Six hours later his head was retracted, and he had severe frontal headache. There was no loss of consciousness, ocular deviation, motor palsy, convulsions, twitchings, or modifications of the superficial reflexes, but the tendon reflexes were increased. Two weeks later he lost power in both legs, the right being first affected, and he died next day. On post-mortem examination coagulated blood was found extending from the right occipital lobe down to the cerebellum. The fourth ventricle was inundated, and contained a clot. There was no hæmorrhage at the base or meningitis, the probable order of events being hæmorrhage of the left lateral lobe of cerebellum, forcing its way into the fourth ventricle.

Prognosis.

The natural course of cerebellar tumours of every sort and every situation is towards a fatal issue. Treatment in the case of tuberculous and syphilitic deposits may

assist in bringing about a favourable result, especially in the former, in which there may be in some cases a natural tendency to recovery. There may be periods of improvement alternating with periods of exacerbation — times when the accompanying intracranial pressure is high and times when it is low. Unfortunately, this double process of improvement by natural and medicinal agencies may come too late, so far as the sight is concerned. On the whole, the outlook is bad if the tumour has been deemed inoperable. Certainly gummata may resolve under treatment, but they cannot be depended upon doing so, and, in any case, the capsule, if there is one, will remain and cause some symptoms. Neither will treatment remove the œdema which is an almost constant accompaniment of tumours, and in case of syphilis, arterial degeneration of the surrounding vessels will also remain, and be productive of symptoms, and also of death after the tumour itself may have become practically obsolescent.

The duration of illness is very variable: the shortest time recorded was three months and the longest seven years; the average is said to be two years. Tubercle appears to kill quicker than cancer, and the possessors of cysts seem to be the longest lived.

It has already been pointed out that cerebellar symptoms which occur years after an injury to the head are more likely to be due to traumatic cysts than malignant tumours, and with cysts may be coupled adhesions; but the greater the headache, the greater the probability of a cyst. Recovery from operation depends

much upon the time which has elapsed between the injury and the beginning of symptoms: the shorter the time, the more likely is recovery to take place.

CHAPTER XI

TREATMENT

THE end and aim of all diagnosis must be to indicate that form of treatment which leads the most quickly to recovery, or, if that is impossible, to soothe in as perfect a way as possible the patient's sufferings, and in such cases as we have been studying to determine, if medicinal treatment has proved futile, whether any surgical procedure is suitable or available; and the more refined the diagnosis has been, the more likely is the latter question to receive an answer.

Medicinal treatment falls to be considered under the heads of palliative and curative. Palliative treatment is necessary for all forms of tumours; curative is only possible in the case of tubercle and syphilis.

In the treatment of the paroxysms of headache we have in our hands beneficent remedies unknown to our predecessors. The coal-tar products include remedies which have an undoubted power of bringing ease to the sufferer, and in the writer's experience none of them possesses this power in a greater degree than antipyrin, in 10 or 15 grain doses; and, when guarded by as many drops of sal volatile, it may be given without fear of dangerous results in the shape of syncope or collapse, and may be repeated at intervals of one, two,

or three hours, according to necessity. Other agents of the same class, but slightly less efficacious, are phenacetin and ammonol, whilst antifebrin and its compound antikamnia are dangerous and therefore least desirable. Caffein added to the antipyrin and phenacetin seems to increase their efficiency.

Frequently repeated pills of butyl-chloral of 2½ or 3 grains often give relief when other treatment fails. Associated with these medicines, a blister applied to the shaved vertex is of some use in lessening the intracranial pressure, on which the paroxysm probably depends. Alcoholic stimulants, with or without anal gesics, are contra-indicated as being likely to increase the intracranial pressure. Large hypodermic injections of morphia are also advised, but in the writer's opinion are fraught with danger in the treatment of tumours of the brain. Small hypodermic injections are of some use in controlling the vomiting, while care must always be taken that only food of an unirritating kind is taken by patients who suffer in this way.

Medicines which are curative in certain cases are palliatives also, in so far that they go to the relief of headache.

If a medical man has, or even **thinks** he has, to deal with a case of cerebellar tumour, or there are present symptoms suggestive of such a lesion, but localizing signs are not sufficiently strong to admit of a precise diagnosis as to its site, it may become the doctor's duty, if medicinal treatment has had a fair trial and failed to afford relief, to urge upon the patient or his friends the great necessity of a partial operation, by

which the intracranial pressure may be relieved, and thus in great measure remove the liability to the fierce paroxysmal headaches, and perhaps stay the further progress of the optic neuritis.

The removal of a disc of bone from the occiput and an incision into the dura mater, if the bulging of the latter should suggest tension, which it almost invariably does, would not prejudice the successful removal of a growth, if at a later stage localizing signs were exhibited.

The author writes with some feeling upon this question, as he has certain misgivings about a patient who was occasionally under his notice, on whom a preliminary operation was not performed or even suggested. All symptoms are now quiescent except a coarse lateral nystagmus, but the patient is blind. My only excuse is that it occurred some years ago, when medical opinion on the question of a partial or preliminary operation was not so clearly expressed as it is to-day.

As regards intracranial tumours generally, the medical profession might be not a little astonished if it were possible for it to ascertain how many people there were in the United Kingdom, in and out of blind asylums, who are now needlessly blind because their medical advisers allowed the optic neuritis their patients were suffering from to pass into optic atrophy, without affording them the chances of retaining their sight which a partial operation holds out, in the vain hope that in time localizing signs might be exhibited.

I see occasionally an elderly lady (I am thankful to say that she was not a patient of mine) who thirty years

ago suffered severely from what appears to have been the general symptoms of intracranial tumour without localizing symptoms. During the greater part of the child-bearing period she has been, and now, in the autumn of life, continues to be, blind. She at present pins her hope for the restoration of her sight to that misrepresentation of science and Christianity called 'Christian Science,' which cannot well do less for her sight than did scientific medicine of three decades back.

Probably in each of the above cases the tumour was tuberculous, which, through the double action of appropriate medicines and that great power the *vis medicatrix naturæ*, has atrophied and shrunk until an eschar probably only remains where the disease originally was. Now, could the intensity of the headaches and neural inflammation have been held in check while this double force had had time to act, how different would life have been for these two people, the latter of whom has never seen the children she bore, saving the one who was born before the onset of her mother's great trouble.

To open the skull and remove a growth may require surgical skill of a high order, but to open the skull and simply incise the dura is surely within the power of anyone accustomed to perform operations. But because the partial operation is comparatively easy of performance, it is on that account not to be lightly undertaken; for we know from actual happenings in similar cases that if the intracranial pressure is removed too quickly in chronic cases, a fatal issue, on account of

the cerebellum, pons, and medulla being forced into the foramen magnum, or the cerebellum forced into the trephine opening, is a possible consequence. The former of these possibilities will be minimized and the latter altogether removed if the trephine opening be made above the tentorium, in which case the intraventricular tension will be more certainly relieved, and perhaps some intracranial pressure still remain.

We have, then, to consider what is the length of time which constitutes a case chronic, and for that there can be no strict law laid down ; each case must be considered by its own light. The author would consider intracranial pressure of six months' standing within the limits of safety to be dealt with by a partial operation.

The advisability or otherwise of taking this step is a question for the patient and his friends to decide. They may be told that in a very limited period he must lose his sight if an operation be not performed; that the operation will not rid him of his disease, but will very likely free him from headache, and may restore his sight ; or, if it fails in the latter, it will keep him in possession of any little sight that may be still left to him. Also they must be informed that cases are on record in which even this comparatively small operation has been followed by sudden death. Which will he have—loss of sight for the remainder of his life, or accept the chances of a possible but improbable fatal issue ?

The curative treatment is also both medicinal and

surgical, the former always being given a trial before the latter is resorted to.

For tuberculous tumours cod-liver oil and iron, especially the syrup of the iodide, are the remedies most frequently used, to which must now be added the tuberculin treatment, guarded by the variations of the opsonic index; but in intracranial tumours of tubercular origin the latter treatment has not up to the present time yielded satisfactory results.

The antisyphilitic medicines — mercury and iodide of potassium—are always in order and advisable. If the tumour is due to specific disease, which is only very rarely the case, they may bring about resolution, or they may not. Some authorities hold that they have no power to do so, but will prevent further deposition; others—and they are the majority—aver that antisyphilitics possess a very real power to cause the disappearance of a syphiloma. Be that as it may, it is always correct to give these remedies, even when it is thought that the tumour is tuberculous, or even malignant, as their power to control vascular tension and its product, intracranial pressure, is undoubted; and this power will be increased by the addition of such salines as nitrate or bicarbonate of potash.

Mercury is perhaps best administered by inunction or intramuscular injection when the patient is known to have suffered from syphilis, and in such cases the iodide of potassium must be given in not less than 20 or 30 grain doses. If it is thought that these remedies bring on or increase the vomiting, the mercury *must*

be used as an inunction, and the dose of the iodide should be materially lessened.

That tubercle does contract or atrophy and the accompanying symptoms disappear, leaving only an eschar to mark its place, is true enough. Unfortunately, it is equally true that this much-desired result very often does not occur until optic neuritis has passed into optic atrophy, and the patient has been doomed to lifelong darkness.

The so-called cures of both forms of unorganized tumours are doubtless at times cases of mistaken diagnosis. All the untoward cerebellar symptoms may have been due to distension of the fourth ventricle, from constriction of the orifice of the spinal canal, which condition the specific treatment would be very likely to remove, and so bring about recovery.

If medicine, after a reasonable trial, fails to bring about improvement, and the tumour can be localized and is considered to be operable, the question of the major operation for the removal of the growth must arise for serious consideration, and it is the patient's only chance, as the disease will otherwise eventually destroy life.

The aim of the writer throughout this work has been to endeavour to make plain what are the symptoms of tumour of the cerebellum, to make suggestions as to its exact localization, nature, and operability; but the description of the technique of operations must be left to the pens of others.

The great improvement in present-day surgery has wrought a real change in the treatment of cerebellar

tumours. Twenty-five years ago they were *all* thought to be beyond the surgeon's art, but during the interval between then and now *some* have been proved to be well within it, and many lives have thereby been saved and much suffering prevented. The only regret is that the *some* is only a small proportion of the whole—*i.e.*, about 10 per cent.

The results will be still better if the day should ever arrive when the physician is able to promulgate definite laws, which will differentiate the multiple from the solitary tubercle, and the encapsuled from the infiltrating growth.

With regard to the major operation, that in forming the large bony flap, it is advised 'to **apply the saw obliquely** in such a way that the flap of bone to be lifted up shall be **bevelled at the expense of its under surface.**' (Cotterill, in the 'Encyclopædia Medica,' vol. ii.) The advantages of such a plan are obvious; and its originator, whether Mr. Cotterill or whoever else it may have been, deserves well of his fellows for the suggestion.

Probably the surgeon will consider himself most fortunate when, having pierced the occiput, he finds the growth occupying the posterior occipital fossa; and his next keenest desire may be to find a cyst in one or other lobe or in the fourth ventricle, and after these, an encapsuled intracerebellar growth; and, most unfortunate of all, to find that the tumour, while chiefly cerebellar, has infiltrated a side of the pons. The last condition he may only become acquainted with on the post-mortem table.

CHAPTER XII

OPERATIONS AND THEIR RESULTS

If it is not within the compass of this work to dilate upon the actual *modus operandi* of the removal of cerebellar tumours, it is within our duty to speak of the dangers which may attend such operations, and to indicate the symptoms which are the soonest and most likely to be relieved by a successful operation.

The dangers may be immediate or secondary, both varieties including those which are incidental to all operations, and which are peculiar to operations on the cerebellum, hæmorrhage and shock belonging to the former category and sudden stoppage of the respiration to the latter.

Hæmorrhage during cerebellar operations is often very free—indeed, it is often spoken of as fierce and sometimes as terrific; yet it seems to be within the surgeon's power to deal with it, even if he may find it necessary to pack the cavity he has made and leave the completion of his work to a future date. Out of fifty-five deaths occurring after operations, we notice that only two were due to hæmorrhage, one being at the time of operation, the other occurring some time afterwards.

As to **shock**, it is quite conceivable that surgical interference in a neighbourhood where vital functions have their origin should be equivalent to a severe and stunning blow.

At the same time, there is in this method of ex-

pression a strange combination of the intangible and that which is not easily expressed, and our meaning in such cases should admit of greater materialization, and in the writer's opinion it would be preferable to use such a phrase as 'œdema of the brain,' for in many cases it means that and nothing more.

We do not hear of shock to such an extent after operations for cerebellar abscess: it may be that the semicomatose condition so often present in that disease hides the symptoms of shock. It is mostly in connexion with operative interference with tumours that shock occurs, and particularly with their sudden removal, and most of all in the drainage of cysts. The abrupt cessation of a long-continued pressure and the reopening of a long-disused circulation prove too much of a strain for the individual; or it may be that the removal only of a portion of a growth excites in the remaining part an unusual state of activity, attracting more blood into the surrounding tissues. When at an autopsy it is found that the tumour has not been removed in its entirety, it is often remembered that the patient exhibited positive evidence of suffering from shock. Incidentally, it may be remarked that this condition is noticed oftener in the cases of cerebellar than in those of cerebral tumours, for the reason previously stated.

Closely allied to shock, and perhaps due to the same causes, are those cases which seem to go on well for a few days and then die suddenly.

Septic infection, producing a purulent meningitis, is also a frequent cause of death after operations.

Hernia of the cerebellum—the passage of brain substance through an acquired opening, in which the replaced bone has not united—is the indirect cause of some deaths by the double action of shock and septic infection during the process of sloughing. Of course, such a cause is much less frequent after tumour than abscess, where the bone cannot be replaced on account of the necessary drainage.

We hear occasionally of the development of **pneumonia** after cerebellar operations. More than likely it is of the septic type, but that fact has never been mentioned. No acute inflammation of any other organ, apart from the brain itself, is recorded as a post-operative trouble.

The emptying of a cyst too rapidly has already been referred to as causative of shock, but the opposite condition may also occasion death, through the cystic contents being so coagulable that it clots in its passage through tube or cannula.

That death after cerebellar operations is frequent, because the operation has been too long delayed, every medical man will allow; and although this delay becomes most apparent to us in cases of abscess, it holds good in a less degree concerning tumours. The vital powers, reduced to their last extremity, prove themselves to have no recuperating force after the cause has been removed.

Sudden **stoppage of the respiration**, while the pulse remains good, has been already referred to as a by no

means improbable occurrence during the progress of a case of cerebellar tumour, and such an accident may happen during an operation for the removal of the tumour, or a few hours or even days afterwards; in the latter event there is a strong suggestion that the tumour has not been entirely removed. We notice such an ending to our case when the pressure on the respiratory centre has developed rapidly, as in abscess, rather than when it has been formed slowly, as in tumours.

The liability shown by patients to die within a few hours of the completion of the operation, or in the interval between the opening of the skull and the removal of the tumour a few days afterwards, has already been discussed.

Improvement of symptoms after an operation is in a great degree dependent upon the kind of tumour and its site, and both these matters have received some attention.

For the most part, if a cerebellar tumour has been successfully removed or cyst drained, the headache and vomiting are at once relieved; but one case at least is on record in which the vomiting continued for some weeks afterwards.

An operation in which a cerebellar tumour has been entirely removed, without much destruction of the organ itself, is very hopeful for the regaining of sight. It is very little short of certain that vision will be restored if optic atrophy has not at the time of operation become ascertainable by the ophthalmoscope. As a rule, optic neuritis begins to subside at once, and

good, often normal, vision, may be expected in the course of two months. In rare cases this much-hoped-for result may not take place, and the optic neuritis may proceed to optic atrophy, however successful the operation may otherwise have been. If the optic neuritis disappears after an operation for a cerebellar tumour, in the course of a few months no trace of neural inflammation may remain; but, as a rule, an unusual paleness of the disc and retina remains as a reminder of the storm through which they have passed.

Frequently after an operation all the old symptoms will at once become intensified, and will remain so for some days—*e.g.*, the conjugate deviation of the eyes to the side of the lesion becomes worse than before; improvement will then set in, and continue slowly, often to complete recovery. In the matter of the reflexes, the superficial ones become quickly normal, while the deep are for some days, or even weeks, worse than formerly; and skew deviation of the eyes—a condition in which one eye may be directed downwards and inwards, while the other is directed upwards and outwards—which may not have been observed before the operation, is very likely to set in at once, only to again slowly disappear.

The trigeminus is one of the first of the cranial nerves to reassert itself, and we see the masseter muscle regain its power, and the side of the face its normal feeling.

If deafness has only been partial, the hearing will return—at any rate, on that side where bone conduction of sound is still present; but if deafness has been

absolute on one or both sides, so it will continue, however fortunate the operation may have been in all other respects.

Nystagmus in many cases remains; such improvement as may occur is in the fine and rapid movements; the slow and coarse almost invariably remain. There is also, in addition, deliberate nystagmus on attempted movement of the eyes to the side of the lesion, but that also disappears shortly.

Flaccidity of the limbs, ataxia, and vertigo disappear. Even in the most favourable cases there may be very little improvement in two months in regard to them, but six months generally see them gone, and the same holds good with regard to the liability to stumble and fall to one side.

The lordosis is a condition that usually remains as it was before the operation; only in rare cases does it disappear entirely.

If in the course of a week or two after an operation the patient becomes dull and irritable, we must see in such a symptom indications of approaching death; fortunately, sometimes the patient throws off the dullness and irritability, and convalescence proceeds.

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