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REPORT ON CASES OF CEREBELLAR DISEASE TREATED IN THE ROYAL INFIRMARY DURING THE LAST THREE YEARS.

By Professor Sir T. GRAINGER STEWART, M.D., LL.D., F.R.C.P.Ed.,

AND

G. A. GIBSON, M.D., D.Sc., F.R.C.P Ed.

Reprinted from Volume Fifth of the Edinburgh Hospital Reports.

Edinburgh and London, Young J. Pentland, 1898.

Report on Cases of Cerebellar Disease treated in the Royal Infirmary during the last Three Years, by Professor Sir T. Grainger Stewart, M.D., LL.D., F.R.C.P.Ed., and G. A. Gibson, M.D., D.Sc., F.R.C.P.Ed.

We think it well to put on record the facts regarding five cases of cerebellar disease, with the inferences which we have drawn from their study. They are the only cases in which a diagnosis of cerebellar affection was made in these wards during the period under review, and they have been observed with great care. The success which attended the operation in one of them has attracted much attention. It was described in the third volume of these Reports by Dr. J. Purves Stewart, then resident physician in the wards, who had made an important suggestion [1] as to one of the symptoms. The surgical treatment of the patients was kindly undertaken in some cases by Professor Annandale, in some by Professor Chiene, to both of whom our thanks are due.

Case 1.—*Cerebellar tumour; operated on by Prof. Annandale; recovery.*—I. K., a married woman, æt. 25, was sent by Dr. Laing of Dundee, on 8th April 1895, to the Royal Infirmary. She complained of headache, giddiness, and difficulty in walking. These symptoms had commenced ten months before admission, and had steadily grown worse in spite of treatment.

Her family history was satisfactory, there being no evidence either of tubercular or syphilitic disease. She had been married for three and a half years, and had borne one child, who had died from convulsions at the age of 8

[1] *Edin. Hosp. Rep.*, 1895, vol. iii. p. 447.

months, four weeks before patient's admission to Hospital. When 3 months old the child had on its face and body a rash, the exact nature of which the mother could not describe. The patient never had any miscarriages, neither was there any history of syphilis, primary or secondary. The state of health of her husband, who was a sailor, could not be ascertained.

The patient was examined on the day after admission, and the following conditions were found in the nervous system:—As regards the sensory functions, there were no subjective sensations of any sort, with the exception of a deep-seated headache, which patient described as feeling "like a sharp dagger," strictly localised to the frontal region, exactly over the left eye. This pain was not increased on firm pressure, or by tapping over the painful area. There was no cutaneous anæsthesia anywhere, and the muscular sense was normal. On examination of the eyes there was found constant marked nystagmus, both in the horizontal and in the vertical meridians. Both pupils reacted to light and accommodation, but the left was larger than the right. On ophthalmoscopic examination, distinct optic neuritis was found in both eyes. Although the external and middle ears were normal, yet the patient was completely deaf in the right ear, both to external sounds, such as the ticking of a watch, and to a tuning-fork placed on the vertex. Taste and smell were normal.

As regards the motor functions, there was no motor paralysis or paresis, with one exception, namely, that the movements and functions of the soft palate seemed to be slightly impaired, for regurgitation of fluids through the nose occasionally interfered with the act of swallowing. Her voice was somewhat "bleating" in character, and she herself noticed that it had altered from its normal state. The larynx was not examined. The organic reflexes were normal, with the exception of deglutition, which was occasionally a little difficult, especially when she attempted to drink large draughts of fluid. The skin reflexes were normal. Both knee-jerks were equally exaggerated, and ankle-clonus could occasionally be elicited on both sides. The patient's

gait was very pitching and staggering in character; she reeled along, walking on a broad base, planting her feet widely apart, but neither stamping with her heels, nor scraping her toes along the ground. She complained of distressing vertigo, but only when she moved in bed, or tried to sit up or walk. So long as she lay still there was no feeling of giddiness. Her gait was so unsteady that she inclined to fall unless supported, and there seemed to be a tendency to fall towards the right side. On making the patient stand with her eyes shut and feet together, the swaying was very marked, and here also she tended to fall to the right side.

There were no vasomotor or trophic changes. The patient's intelligence, attention, and memory were excellent. She slept badly, owing to the persistent headache, which was always worst at night. There was no abnormality to be discovered on examination of the cranium and spine. As regards the other systems, the alimentary system was normal, save for a slight tendency to constipation; the lungs and heart were quite sound. As to the integumentary system, there was a small patch of ichthyosis over each ligamentum patellæ. With respect to the reproductive system, the patient had amenorrhœa of four months' standing. The urine contained no abnormal constituents.

Prior to admission, the patient had not suffered from vomiting, but this symptom supervened a few days after she came into Hospital. The act recurred at intervals, at first of several days, but later more frequently, and it was quite unassociated with the ingestion of food.

Such being the clinical facts, the question of diagnosis next arose. The presence of headache, vomiting, and double optic neuritis indicated some intracranial lesion. The absence of distinct motor paralysis, either of limbs, trunk, or face, combined with the presence of a staggering gait and distressing vertigo, pointed clearly to the cerebellum as the seat of the lesion.

On attempting to attain to a more definite localisation, there were several points to guide us. The tendency to fall towards the right side is usually regarded as significant of

right-sided cerebellar lesions, and had some weight in determining the diagnosis. The right-sided labyrinthine deafness showed that there was some lesion of the auditory path on that side. According to some of the most influential authorities on the subject, after leaving the nucleus, the auditory tract passes through the cerebellum; and whether this be admitted or not, there can be no doubt that the right-sided deafness points to the probability of pressure upon some part of the auditory part or its nucleus. It seemed clear that the affection was right-sided, and on account of the trouble connected with deglutition, as well as with hearing, it seemed probable that it was situated at a low level.

But in addition to these facts there was another point which was of much interest. It is one which had not, so far as is known to us, been suggested as of diagnostic import, until this case was under observation; and although we cannot as yet assert that its diagnostic value is established, it appears to us probable that it may be entitled to take an important place. Dr. Purves Stewart, the resident physician, was struck by the persistency of headache in the left frontal region, and suggested that it might be produced by irritation of the fronto-cerebellar fibres crossing from the left frontal region to the superior cerebellar peduncle. Whether it may ultimately prove of as much use as we wish, cannot at present be predicted with confidence, but some corroborative facts have already been brought under our notice, and we cherish the hope that it may prove of real value in diagnosis.

From a consideration of these facts, the diagnosis was made that there was a tumour in the lower part of the right lateral lobe of the cerebellum. Whether the tumour was of the nature of a gumma, a tubercular mass, or a new formation, could not be determined. With the view of eliminating as far as possible the chance of the lesion being a syphilitic one, the patient was at once placed under treatment, by gradually increasing doses of iodide of potassium, until, on 20th April, she was taking 60 grs. three times a day. In addition to these massive doses of iodide, inunction with blue ointment was applied every day to two parts of the head,—

over the right half of the cerebellum, and over the seat of pain in the frontal region. This treatment was continued until 30th April. So far from improving, the patient grew worse; all her symptoms became more aggravated, and more especially the vomiting became more frequent. On 30th April, therefore, after consultation with Professor Annandale, she was transferred to his ward, with a view to surgical interference.

After her admission to the Surgical Wards the vomiting became even more frequent, and the patient was evidently going from bad to worse.

On 3rd May, Professor Annandale cut down over the right lobe of the cerebellum, trephined the skull, and discovered a firm mass about half an inch below the surface. The mass was about the size of a pigeon's egg, and lay low down in the lateral lobe, at a point rather closer to the foramen magnum than to the outer wall of the skull. On opening into it, about a drachm of clear serous fluid escaped, and was lost. Within the cyst was found a solid tumour, apparently encapsulated. This was completely removed piecemeal, and subsequent microscopic investigation showed it to be of the nature of a fibro-sarcoma.

The progress of the case after the operation was eminently satisfactory. When the patient recovered from the chloroform anæsthesia, the frontal headache had entirely disappeared, and it has never recurred since. The sickness had entirely ceased; the nystagmus became much slower and less marked. Instead of being constant, as it was before the operation, it occurred only when the patient fixed her eyes on some object not directly in front of her. When the globes of the eyes were in a position of rest—that is, looking straight forward—there was almost no nystagmus. The feeling of giddiness on changing her position also entirely disappeared. Her swallowing became quite perfect, even with fluids. Her gait improved distinctly. The optic neuritis almost disappeared.

Since leaving the Royal Infirmary the progress of the case has been most satisfactory.

On the 18th of November, Dr. Laing reported that three

weeks previously the patient had been delivered of a healthy girl, after a perfectly easy and normal labour. She had made an excellent recovery. But for this domestic incident, she would have been across to report herself. She was able to walk quite well, spoke as she used to do, and no longer complained of headache or giddiness. There was still a little nystagmus, and over the site of the operation one could detect a painless, fluctuating swelling.

The patient has been twice seen by us since the date of this communication—once in the beginning of 1896, and again in the month of May of the present year. There are now absolutely no symptoms of the disease, except the deafness, some degree of nystagmus, and slight exaggeration of the knee-jerks, without ankle-clonus. The right knee-jerk is somewhat more exaggerated than the left.

Case 2.—*Supposed cerebellar tumour; operation declined.*—W. B., æt. 33, labourer, married, was admitted to Ward 22 of the Royal Infirmary, 8th March 1897, complaining of giddiness, headache, staggering, and weakness in the lower limbs, of four weeks' duration. The patient's father had died of hæmorrhagic smallpox. His mother was alive and well. The only other member of the family, besides himself, was one brother, about whom nothing could be ascertained, as he had been lost sight of. The patient had always been a temperate man, and his surroundings had been satisfactory, although his occupation involved considerable labour.

With the exception of a severe attack of influenza, four years before admission, the patient had never suffered from any illness of consequence. There was, however, a history of attacks of indigestion, during which the vision was often so affected as to induce diplopia. Sometimes these attacks occurred independently of any apparent stomach disturbance, but the converse never occurred. These disorders had been intensified since the commencement of the illness for which he was admitted.

On 15th February 1897, the patient suddenly felt an extreme weakness in his legs while at work, and had to hobble home with a stick, taking eighty minutes to walk a

distance which he usually accomplished in a fourth of the time. He was extremely giddy, and reeled when he walked. Similar attacks recurred on several occasions during the succeeding four weeks, and the disturbance of vision, similar to that which has already been referred to, became so bad that he could not read except when he closed one eye. He latterly became so ill that he had to give up his work and seek admission to the Infirmary.

The patient was found on admission to be a tall, well-built man, 6 ft. 5½ in. in height, and 14 stone in weight. His face had every appearance of health, but his expression was stolid.

The appetite was poor. He had never vomited. There was constipation. The abdominal viscera and the glandular system presented no abnormality.

The walls of the radial artery were healthy; the pulse-rate was 65, and its rhythm perfectly regular, and the beat was fairly full; the tension was, however, low. There were no abnormal phenomena connected with the circulatory, respiratory, integumentary, or urinary systems.

The patient suffered severely, as above remarked, from headache, which was most severe in the occipital region. He said that the whole head felt as if squeezed in a vice, but there was no complaint of frontal headache. The sensation of giddiness, always present, became worse on standing up, and even more exaggerated on leaning forwards. There were some pains and sensations of cold in the lower extremities. Sensibility, tested in every way, was perfect. The muscular sense, ascertained by the use of weights and otherwise, appeared intact. The sight was good, except during the attacks already mentioned. The pupils were somewhat dilated. They reacted to light, both directly and indirectly, the right eye being somewhat sharper in its reaction to the direct effect of light, the left eye being quicker to light indirect. There was no optic neuritis, the fundus of the eye being absolutely healthy. There was well-marked nystagmus, more especially on turning the eyes to the right, less so on looking up and to the left, and least of all on looking downwards.

The organic reflexes were normal. The superficial

reflexes were slightly exaggerated, the knee-jerks were considerably exaggerated, especially on the left side. There was double ankle-clonus, best marked on the left side. Co-ordination was apparently unaffected, the patient being able to point to his toes in any position, and to move his extremities to any point mentioned while his eyes were shut. He walked slowly with his eyes fixed on the ground, and as long as he could do so he got on pretty well. If, however, he looked upwards or even straight forwards, he staggered to the right but did not fall. When he stood with his feet together and his eyes closed, he swayed to the right and tended to fall in that direction. The vasomotor and nutritive functions were apparently normal. The cerebral and mental functions were somewhat impaired. When asked any question, the patient appeared to take some seconds to apprehend its import, and then he responded slowly and deliberately. Sometimes the question had to be repeated. His memory was not very good, and he had considerable difficulty in making definite statements. His attention was obviously rather apt to wander. The cranium and spine showed no abnormality. The muscles of the lower extremities were flaccid but not atrophic.

From these symptoms we concluded that a cerebellar tumour existed on the right side; the only difficulty in the way of accepting such a diagnosis was the absence of optic neuritis. On the whole we thought it our duty to recommend operative interference, but the patient declined this, and left the Hospital in the condition we have described.

Case 3.—*Cerebellar cyst; operation prevented by sudden death of patient.*—J. M., æt. 29, married, and engaged in household duties; was admitted to Ward 25, 29th September 1897, complaining of weakness. There was no history of hereditary tendency to nervous disease, and her social conditions were in every way satisfactory. The patient's previous health also had been in all respects good.

The symptoms for which the patient sought admission began about three months before her entrance into the Hospital, at which time she had a child, and since when

she had complained of weakness. On admission she was pale, but not anæmic. Her expression was listless, and it was difficult to fix her attention on any subject. She was by no means emaciated, although of slender build. There were no special symptoms connected with any system other than the nervous.

Sensory functions.—The patient complained very much of constant occipital headache, and there was some tenderness on tapping that region. There was no complaint of frontal pain. She was also much afflicted by a subjective sensation of giddiness, and frequently vomited without any reason for it, so far as the digestive system was concerned. Ordinary sensibility was unimpaired. The special senses were in no respect interfered with; sight, hearing, taste, and smell being absolutely intact.

Examination of the fundus of the eye revealed a very slight degree of optic neuritis, and on testing the movements of the eye there was distinct lateral nystagmus, but no oscillation in the vertical direction. The pupil reflex was active.

Motor functions.—The organic reflexes concerned in deglutition, respiration, and circulation were unimpaired, but there was total loss of control over the bladder and rectum. The superficial reflexes were perfectly absent.

The knee-jerks were absolutely abolished—there were, in fact, no myotatic contractions discoverable in any part of the body.

There was some weakness of all the muscles, and yet paralysis of none. The patient was able to move all her limbs quite freely, but on walking or standing there was a distinct tendency to fall towards the right side.

In this case it seemed clear that there was some abnormality of intracranial pressure, and the symptoms pointed in the direction of a cerebellar lesion. At the same time there were features not proper to that condition, and considerable difficulty attended the diagnosis. While we were hesitating as to the exact localisation of the affection, the patient suddenly fell into a condition of deep hebetude. On consultation with Professor Chiene, it was resolved to have recourse to surgical treatment, and the sanction of the rela-

tions having been obtained, the patient was transferred to his ward; she died, however, on the evening of the day on which she was removed, from a sudden respiratory failure. At the post-mortem examination a cyst about the size of a walnut was found in the posterior part of the right lobe of the cerebellum.

We have much regretted that in this case we did not take more immediate steps in the direction of surgical relief, but the difficulty of arriving at a decision was necessarily great, and obviously all the nervous symptoms could not be referred to the cerebellar lesion.

Case 4.—*Cerebellar cyst; operation; temporary improvement; death.*—J. E., æt. 41, surveyor, was sent to Ward 22 of the Royal Infirmary on 15th December 1896, by Professor Annandale. He complained of pain in the back of the head and nape of the neck, as well as over the forehead, where it was most severe over the site of a recent operation for the removal of a tumour over the right brow. He also complained of giddiness, which caused his gait to resemble that of a man in a state of intoxication, and of weakness in all his limbs, together with some alteration in speech. His mother and two paternal uncles died of phthisis. There were no other hereditary tendencies to disease. His social condition had always been satisfactory, and his habits had been unexceptionable. For sixteen years the patient had been in the Government Survey, until four years ago for the most part in the open air, but since then he was confined to office work.

He had never suffered from any illness excepting the ordinary ailments of childhood until September 1896, three months before his admission, when he had a small tumour removed from the scalp in the right frontal region. As to the nature of the tumour nothing can be definitely ascertained.

One month after the removal of the tumour, he complained to his fellow-workers of severe pain at back and front of head, and said he felt as if his head "were being blown up from behind." Slight alteration in speech

was noticed early in November. On 15th November he complained of great giddiness, and became for the first time very unsteady on his feet.

Four days later, while walking out with his wife, he was noticed to reel in a drunken manner, and on two occasions he staggered and all but fell. The falling was towards the right side. Next day (18th November) he was taken suddenly worse, was unable to go to his work, and vomited. Vomiting was repeated on the two following days, but there has been no recurrence since. The pain, which was paroxysmal, became agonising, and during attacks he lost his self-control, and on one occasion bit his wife's hand. His giddiness became more marked, insomuch that he was unable to stand, and had to be supported when out of bed. His wife thinks he always showed a greater tendency to fall to his right.

His intellect up to this time (18th November) was unimpaired. He never appeared to be in the least deaf. There were never any convulsive seizures. Sight was unaffected, and he took his food well.

Dr. Gilruth was called in on account of the pain, and prescribed—Tincture of hyoscyamus, 20 minims every two hours; 30 grains of bromide of potassium thrice daily, and a mixture containing opium.

After a day or two the hyoscyamus was ordered to be given in 10-minim doses, whenever the pain was severe. The pains recurred frequently, sometimes more than once in an hour. His wife thinks that the drugs were accountable for the fact that his intellect became much dulled. He also got very weak, apparently all four limbs were equally and simultaneously affected. Speech became thick and indistinct.

His bowels were constipated, moving only every two or three days, but he had complete control of the sphincter till admission to Ward 7. He had incontinence of urine a day or two previous to admission.

He was admitted to Ward 7 on 7th December, and remained there for a week. A consultation was held some little time afterwards, but in the absence of localising

symptoms it was decided not to operate. He was therefore transferred to Ward 22 for observation.

On admission to Ward 22 the patient was emaciated, with soft and flabby muscles. There was a scar on the right frontal region. The face was gaunt, the eyes had rather a wild look at times. The temperature was 97°·6.

The tongue was dry, fissured, and furred. Deglutition was normal. He generally took what food was given to him without any trouble. Sometimes, however, it was difficult to get him to open his mouth. There was incontinence of fæces. The abdomen was greatly retracted. The liver dulness reached about a finger's breadth below costal margin. The heart was normal in size, the sounds distinct, and there were no murmurs. The pulse was 30, and regular. The wall was healthy, the force good, and the tension fair. The breathing at the right apex was very harsh, without marked dulness. The skin was dry. There was marked general wasting. A scattered papular and pustular eruption covered the trunk. It was probably due to the use of bromides. He had no control over his bladder. The urine contained a small quantity of bile acids, but was otherwise normal. The nervous system presented marked symptoms.

Sensory functions.—The patient complained of pain in the sub-occipital region, increased on moving the head, and of pain on the right side of the forehead at the seat of the old operation. The pain was not increased on percussion, save slightly on the right side of forehead. Muscular sense apparently normal. On examination of the eyes, Dr. Sym found marked neuritis in the right eye, slightly in the left. The pupils were widely dilated and sluggish. There was paresis of the left external rectus. No nystagmus. Hearing normal.

Motor functions. — *Organic reflexes.* — There was incontinence of urine and fæces, with diarrhœa, the stools being offensive. There was apparently no difficulty in swallowing, but sometimes a decided objection to opening the mouth. The skin reflexes were abolished, except the plantar, which became very pronounced during the last few days he was in Ward 22. The knee-jerks were absent. The muscular

movements were very feeble, but the patient could move any one of his limbs when asked. All four limbs appeared equally affected. Co-ordination was interfered with in a peculiar way; the patient could not sign his name, and did not appear to know what to do with the pen. Even on being set to wash his hands he made purposeless movements, as if not knowing what he was expected to do.

Vasomotor and trophic functions.—There was general and rapid wasting, and the limbs were reduced to skin and bone. Bedsores threatened to form between his knees and on his heels, and a small one did form over his sacrum.

Cerebral and mental functions.—The patient was in an almost torpid condition, but he understood what was said to him, and answered the first few questions put to him, but soon became tired, and lapsed into nonsense or silence. The memory had become very defective. Speech was slow and thick.

The locomotory system showed nothing beyond the general wasting of muscles.

It was concluded from these facts that the patient was suffering from a lesion of the right lobe of the cerebellum, and possibly also some general toxæmic or inflammatory condition. He was therefore retransferred to Professor Annandale's Ward, in order to undergo operation.

1*st January* 1897.—Professor Annandale trephined over the right lobe of the cerebellum. At first he could find nothing save a decided bulging of the dura, and of the brain substance when the dura had been cut through. Nothing was to be felt with the finger to begin with, but, on a second examination, a cyst was opened into, and clear serous fluid escaped. In one diameter the cyst was 2 in. long; it projected across the middle line a short distance into the left lobe. A considerable amount of clear fluid having escaped, a gauze drain was inserted into the cavity.

On the afternoon of the operation the pulse was 128, very feeble. The patient was, however, so far improved as to be able, though after a little delay, to spell his name and tell where he was born. Temperature remained subnormal.

During the week succeeding the operation, the symptoms

were distinctly relieved, but on the seventh day the patient sank into a state of torpor, and died suddenly of respiratory failure in the evening.

At the post-mortem examination it was found that the entire cerebellum had been transformed into a cyst, without any definite lining membrane, and that there was considerable distension of all the cerebral ventricles. The autopsy revealed no facts throwing light on the origin of the change.

In this case, as in the preceding, we were inclined to regret not having sooner recommended operative interference, but some cerebellar symptoms were wanting, and indications of more widespread disease deterred us at first from doing so. It is doubtful if any earlier operation could have given permanent relief.

It is of interest to note that in both these cases the patients died of respiratory failure, a mode of death in intracranial tumours and similar conditions which has long been recognised as one of the most frequent terminations.

Case 5.—*Cerebellar tumour; operation by Professor Chiene; recovery.*—G. K., æt. 46, groom, married; was admitted to Ward 22, 11th February 1897, complaining of headache and giddiness, with deafness and ringing in the ears, which had existed for eighteen months.

There were no well-marked hereditary tendencies to disease. Both his parents lived till above 70 years of age. They had only one other child, a son, whose health had always been excellent. The patient had been married for twenty years, and had six children, of whom four died in early life of children's diseases. His occupation, surroundings, and habits had been satisfactory. The only fact in regard to previous illness was that, when about 17 or 18 years of age, he had venereal disease. Some months afterwards he suffered from a bad sore throat, and several years later he had some sores upon the top of his head, which were connected with the bones of the cranium. The present illness began about eighteen months ago.

When going out one evening (after tea, as he assured us)

he suddenly became giddy and could not stand. For two or three days thereafter he suffered from giddiness, but continued his work in the stables, although he was afraid to ride. He then appeared to improve; but one day, about three weeks later, he suddenly fell backwards "as if he had been shot." He did not, however, lose consciousness.

A few weeks afterwards a second fall occurred. During the months which followed he appeared to be improving, although suffering at times from giddiness. After about twelve weeks he had another fall, and from that time he began to get nervous about himself. Ringing in the ears, especially the left, set in, and gradually his hearing became worse, so that he became completely deaf in the left ear. The ringing at the same time became more severe in the right ear. It was always present, although varying in severity. Latterly he occasionally became quite deaf in both ears, especially on stooping or after excitement. The giddiness also increased *pari passu*.

When walking, the patient felt as if the ground were rising up towards him. He also had the sensation of everything going round him from right to left, and when lying in bed he occasionally experienced a feeling as if the roof were coming down on the top of him.

When he became giddy while walking, he always tried to lay hold of something, and if he failed to do so he usually fell. But such falls were, he said, quite distinct from the sudden retro-precipitations already described. When the giddy fits came on he staggered like a drunken man, and had a sensation as if he were walking in the dark on the deck of a ship during a storm. For three months before admission he had tended to lurch to the left side.

By that time, however, the headache had become the prominent symptom. It affected the occipital region, and was relieved by leaning the back of his head on any fixed object. The pain shot forwards to the frontal region, giving sometimes a sensation of passing through the brain, sometimes of passing along the vault of the skull. Latterly it has been more pronounced on the vertex, and he had a feeling as if his head were going to burst. He further complained of a nervous

trembling of the lower lip and the body generally, also of coldness of the feet, and a shivering sensation. He stated that he had always been very nervous since the commencement of the illness, and that this had increased latterly, and been associated with much more irritability of temper than was natural to him.

On examination, the patient was found to be 5 ft. 3 in. in height, and 8 st. 9 lb. in weight. His development was good, and he was fairly muscular.

The most prominent appearances were: The lower lip on the left side was drawn down, and was distinctly tremulous, especially when the patient was answering questions or was otherwise excited. He presented a staring look, and had an anxious expression. His favourite attitude was on the back, with the hands clasped behind the head. The temperature was normal.

The appetite was poor, but there was no vomiting. There were no other digestive or abdominal symptoms. There was no enlargement of the glands or of the spleen. The radial artery was healthy, the vessel moderately full, and the tension moderate. The pulse-rate was 64, and its rhythm perfectly regular. The heart sounds were somewhat feeble, otherwise the circulatory system presented no abnormality. The respiratory system was perfectly normal. The patient perspired considerably, and especially about the head; but there were no other symptoms connected with the skin. The urinary system was normal.

The chief interest in the case centred in the nervous system.

Sensory functions.—The patient complained of a cold sensation in the feet. There was pain in the occipital region, passing to the vertex, as already described. Cutaneous sensibility and the muscular sense were normal. When standing with the eyes shut and the feet together, the patient always fell towards the left side, but with the feet apart this symptom scarcely showed itself.

Well-marked nystagmus, both lateral and vertical, was present. There was no optic neuritis. The vision was not impaired except during the giddy attacks. The pupils were

moderately dilated. The patient was absolutely deaf in the left ear, and the right was impaired. Dr. M'Bride reported that the left tympanic membrane was thickened and indrawn, and expressed the opinion that the impaired hearing was due to disease either within the cranium or labyrinth.

Motor functions.—The organic reflexes were unimpaired; the skin reflexes were but slightly marked, with the exception of the plantar; the knee-jerks were exaggerated on both sides, and there was some ankle-clonus on both sides. Voluntary movements were feeble, both as regards grasping with the hands and pushing with the feet. The co-ordination of muscular movement was somewhat impaired. When walking along a plank the patient always lurched to the left side. When standing with the feet together and the eyes shut he always fell to the left side, as already mentioned.

Vasomotor and trophic functions.—The vasomotor and nutritive functions were in no way impaired.

Cerebral and mental functions.—The intelligence was good, and the attention could be sustained well. The memory, however, was impaired. Speech was unaffected. There was much insomnia. There was no pain on percussion of the cranium.

Locomotory system.—The muscles of both thighs, as well as those around the left side of the mouth, exhibited fibrillary twitchings.

The symptoms in this case seemed to point to a lesion of the cerebellum, probably situated on the left side. Professor Chiene was therefore called in consultation, with a view to operation.

On the 15th March he operated by making a curved incision with its vertex backwards from behind the mastoid process, on the left side of the occipital protuberance. The flap was turned down; an opening was made in the skull, midway between the occipital protuberance and the tip of the mastoid process. The dura mater did not bulge to any considerable extent. The opening was enlarged to the size of a shilling-piece, and then the cerebellum bulged considerably, while a large quantity of serous fluid flowed out. By pressing on the cerebellum, Mr. Chiene sought to favour the escape of the

fluid. The tissue at this point felt so far normal. It was freely incised and explored, first by the director and afterwards by the finger. Nothing like a smooth-walled cyst or tumour was discovered, yet there seemed to be a cavity of some sort.

The skin incision was closed with horse-hair, and the wound was dressed. Before opening, the pulse was 88; but after the escape of the fluid it fell to 82, and became much stronger. After getting the patient back to bed his pulse was 48.

The patient made an uninterrupted recovery, and was allowed to go home on 3rd April 1897.

Clinical Comments.

In order to facilitate the study of the salient points of these five cases, we have thought it well to put in tabular form the facts regarding them. We have grouped the facts in the way that we are accustomed to do in the wards, under the categories of sensory, motor, vasomotor and trophic, cerebral and mental functions, and state of spine and cranium, but have placed some eye symptoms amongst the sensory groups although only doubtfully belonging to it.

1. Among the *sensory symptoms* we have placed first headache. It was present in *all* the cases. We desire to direct attention to the character and the seat of the symptom.

The character of the headache was by no means uniform, varying from a dull, heavy feeling to a sharp, piercing sensation in different cases, and even in the same case at different times. We have already noted the seat of the headache as being in the frontal region in the first of our cases, and as varying between the occiput and the frontal region, with a considerable inclination towards localisation on the vertex, in Case 5. Dr. Purves Stewart informs us that the frontal position of the headache in cerebellar disease is by no means uncommon, according to his researches. The symptom has been observed by Murri, as he states in a recent contribution,[1] and was well marked in the early stages of a valuable

[1] *Lancet*, London, 1897, vol. i. p. 291.

case recorded by Hughlings Jackson and Risien Russell.[1] A side-light is perhaps thrown upon this subject by an interesting case of cerebral tumour recently under our care. The patient was a girl æt. 14, who was under treatment in Ward 25 for some months, on account of headache, giddiness, vomiting, and optic neuritis, without at first any localising symptoms. By degrees, however, fixation and prominence of one of the eyeballs were developed, and a bulging outwards of the frontal

TABLE SHOWING THE NERVOUS SYMPTOMS IN FIVE CASES OF CEREBELLAR DISEASE.

		I. K.	W. B.	J. M.	J. E.	G. K.
Sensory Functions.	Headache	+	+	+	+	+
	Giddiness	+	+	+	+	+
	Sensibility good	+	+	+	+	+
	Double vision	...	+	...	...	...
	Nystagmus	+	+	+	...	+
	Optic neuritis	+	...	+	+	...
	Deafness	+	...	...	...	+
	Integrity of muscular sense	+	+	+	+	+
Motor Functions.	Vomiting	...	...	+	+	...
	Impaired deglutition	+	...	...	...	...
	Incontinence of urine or fæces	...	...	+	+	...
	Superficial reflexes unaltered	+	+	+	+	+
	Knee-jerk exaggerated	+	+	...	...	+
	Knee-jerk lost	...	...	+	+	...
	Ankle-clonus	+	+	...	...	+
	Weakness of legs	+	+	+	+	+
	Weakness of face muscles	...	...	...	...	+
	Weakness of spinal muscles	...	+	+	+	...
	Staggering	+	+	+	+	+
	Romberg's symptom	+	+	+	+	+
	Impairment of co-ordination	+	+	+	+	+
Vasomotor and Trophic Functions.	Wasting	...	...	+	+	...
Cerebral and Mental Functions.	Alteration of speech	+	...	...	+	...
	Hebetude	+	+	+	+	+

region above the left eye took place. At the post-mortem examination a large sarcomatous tumour was found in the anterior and inferior portion of the left frontal lobe of the brain, which had become incorporated with the frontal bone. In this patient there never was pain over the frontal region, but from first to last there was an agonising headache situated over the right occipital region. The question

[1] *Brit. Med. Journ.*, London, 1894, vol. i. p. 393.

naturally arises, whether this headache may be produced by conditions the converse of those related in the first case.

2. The second symptom was *giddiness.*—It also was present in all the cases. We satisfied ourselves that it was not a mere secondary result of staggering, but that the staggering resulted from it. Moreover, it was only complained of when the patient stood or sat up; and it was relieved if the patient was allowed to lie, or to lean the back of the head against any solid object, or even if the hand or a finger was firmly pressed in the neighbourhood of the occipital protuberance.

3. *General cutaneous sensibility.*—We have thought it well to draw attention to the fact that in all the cases this was absolutely normal.

4. *Eye symptoms.*—(*a*) Nystagmus was distinctly present in four of the cases, but in one it only appeared when the patient looked to one side, and was not attended in any by the twittering movement of the upper lid which sometimes occurs in association with it.

(*b*) Double vision.—This occurred but in one case, and that only occasionally.

(*c*) Optic neuritis.—This symptom, although carefully looked for in every case, was present only in three. In one of those in which it was absent the disease was found on operation to be a cyst; in the other, no operation was performed, but there was no possibility of denying the existence of cerebellar disease, considering the other symptoms present.

5. *Deafness* occurred in two of the cases, in one of which it was exclusively, and in the other chiefly, unilateral. We believe it was due in each case to involvement of the auditory nerve, either by direct pressure of the tumour, or of attendant inflammatory effusion.

6. *Muscular sense.*—In all the cases this function was carefully tested in every way, and was found absolutely unimpaired.

7. Passing now to the motor functions, we take, in the first place, *the organic reflexes.*

(*a*) Impaired deglutition was unmistakably present in one

case, and appeared to us as probably due to pressure upon the glosso-pharyngeal nerve.

(*b*) Vomiting occurred in two cases. It exhibited the usual features of intracranial vomiting, in that it was unconnected with the ingestion of food. Its absence in the other cases appeared to us worthy of special remark, inasmuch as our impression is that in cases of cerebral tumour it is much more constant than when the cerebellum is affected.

(*c*) Incontinence of urine was observed in two of the cases.

8. The *skin reflexes* were normal in every case.

9. The *deep reflexes*.—(*a*) The knee-jerks were exaggerated in three cases and absent in two. We were not able to trace any relationship to the side of the cerebellum affected to the condition of the knee-jerks, except in the first, in which after recovery the knee-jerk on the side of the lesion was more pronounced than on the opposite side, and we could not discover that at that stage the condition was different from what it had been.

(*b*) Ankle-clonus was present in three cases, and these, as might naturally be expected, were those in which the knee-jerk was exaggerated. In all three it was nearly equal on both sides.

10. *Voluntary movement*.—(*a*) In all the five cases there was distinct weakness of the legs. This was manifested, not only in the patient's equilibration and gait, but also in the movements when lying in bed.

(*b*) Weakness of spinal muscles.—This was present in three of the cases: in one of them the effect of letting the patient use crutches was tried, and unmistakable relief followed; but in the other two we found no distinct evidence of such weakness.

The importance of this symptom was pointed out by Niemeyer,[1] who insists upon paresis of the muscles concerned in bending, erection, and lateral movement of the spinal cord, passing into an utter inability of the body to maintain itself.

Hughlings Jackson has long held that destructive lesions

[1] "A Text-Book of Practical Medicine," translated from the eighth German edition by G. H. Humphreys, M.D., and C. E. Hackley, M.D., 1876, vol. ii. p. 244.

of the cerebellum, or at least of its middle lobe, give rise to true motor paralysis or paresis, in which the trunk muscles are first and most affected, those of the inferior extremities next in order and severity, and those of the superior extremities last and least. The experimental investigations of Risien Russell, which will be discussed below, appear to support these views.

In the case already referred to, Hughlings Jackson and Risien Russell [1] observed that, while the muscles of the arm were unaffected, and those of the legs were slightly impaired, those of the trunk were so weakened as to give rise to lordosis.

It is interesting to notice what relief is afforded to this symptom by letting the patient walk with crutches, or by holding up the head, or by allowing it to rest on some fixed object. We have sometimes seen a patient who habitually staggered like a drunken man, walk steadily when supplied with crutches, and have greatly assisted others by putting the hands in the axillæ, or by holding the head firmly on each side. We do not feel certain that this is explained by the relief it affords to the weakened spinal muscles, for we have seen great comfort follow the mere pressure of a finger over the occipital protuberance, but the question merits further investigation.

(*c*) Weakness of the facial muscles was only seen in one case, that of G. K., and remained unchanged after the successful result of the operation.

11. *Co-ordination* was impaired in all the five cases, not only in the legs, but also in the arms. Romberg's symptom manifested itself in all. Perhaps it may be best at this point to draw attention to the fact that in each of the cases, in which by operation or post-mortem we were able to verify the position of the lesion, the patient fell towards the affected side.

12. The *electric relationship* was in every case in all respects normal.

13. *Vasomotor and trophic functions* showed no abnormality save in two cases, in both of which there was marked wasting, not only of the muscles, but of the other tissues.

[1] *Brit. Med. Journ.*, London, 1894, vol. i. p. 393.

14. The *cerebral and mental functions* exhibited profound changes in all the cases, generally by a degree of hebetude, in one instance by an extreme excitability culminating in an attack of temporary insanity, which entirely disappeared after the successful operation, and has not recurred. It appears probable that the secondary effects on the brain may account for this.

15. In one of the patients *the speech* was slow and stammering.

16. With regard to the *conditions of spine and cranium*, we did not discover any evidence of changes in the cranial or vertebral forces, or tenderness on percussion over the seat of tumour. With regard to the nature of the pathological changes, we have little to say.

Four of the five cases presented cysts. In three of them the cyst was simple, in one it was associated with a solid tumour. In the other case, we are unable to speak as to the pathological condition. One case of solid formation was a sarcomatous tumour. With regard to the cysts, we found that in no case was there a definite cyst wall—each appeared to be a somewhat indefinite collection of cerebro-spinal fluid.

Much interest attaches to the frequency of cysts in the cerebellum, and we regret that our cases have not allowed us to throw some light on their mode of origin. Apart from mere dilatation of ventricles, which sometimes results as a secondary mechanical result of cerebellar tumours, we recognise how often cysts in the substance of this portion of the encephalon occur. No doubt they are not infrequently (as in one of our own cases) associated with new formations, such as fibro-sarcoma or glioma, but they occur independently, and we have not been able to arrive at a conclusion as to their mode of origin. They are certainly quite different from the kind of cysts which sometimes follow on a hæmorrhage or other such lesion of the brain.

The pathological observations of Marchi, Ferrier and Turner, and Risien Russell, with regard to degenerations connected to lesions of the cerebellum, do not appear to bear directly upon our observations; to complete the subject, however, a short abstract of them may be given.

Experimental Research in relation to Secondary Degeneration.

Closely connected with the anatomical changes is the question of the secondary degenerations which have been found to result from artificial lesions of the cerebellum. The principal workers on this subject have been Marchi, Ferrier and Turner, and Risien Russell.

Marchi[1] found, after removal of half of the cerebellum, extensive degeneration in all the peduncles of the same side, and very little, if any, in the peduncles of the opposite side, the degenerated fibres in the superior peduncle to the tegmental nucleus of both sides, and some as far as the optic thalamus. There was complete degeneration of the middle peduncle up to the raphé. The degenerated fibres from this source passed among the pyramidal fibres of both sides, and among the fibres of the fillet and posterior longitudinal bundle, mostly on the side of the lesion. Degenerated fibres in the fillet and posterior longitudinal bundles passed up to the corpora quadrigemina, and down to a tract at the periphery of the antero-lateral region of the spinal cord. A bundle of degenerated fibres was traced to the pyramidal tract up to the corpora quadrigemina, and probably also to the corpus striatum, chiefly on the side of the lesion, and a few were traced into the spinal cord. There was atrophy and degeneration of the grey matter of the pons on the side of the lesion. The degeneration in the inferior peduncle involved mainly its outer and inner parts. A small bundle passed with the inner arched fibres across the raphé to the opposite inferior olive, which was atrophied. Other degenerated fibres passed from the restiform body to the fillet and posterior longitudinal bundle of the same side, whence they passed partly to the antero-lateral region of the cord, partly down the pyramidal tract. Degenerated fibres were also traced to the roots of the cranial nerves, the ascending root of the fifth, the striæ medullares, and the anterior roots of the spinal cord. The degeneration was most marked on the

[1] *Riv. sper. di freniat.*, Reggio-Emilia, 1886, An. 12, f. 1; and 1887, An. 13, f. 4.

side of the lesion, but also existed on the opposite side, the degenerated fibres to the cranial nerves reaching them by way of the posterior longitudinal bundles, and those to the spinal nerves by the descending antero-lateral tract of the spinal cord.

Removal of half of the middle lobe of the cerebellum produced only slight degeneration of the superior peduncle, all the degenerated fibres passing to the tegmental nucleus of the opposite side. The degeneration of the middle peduncle was most marked in the upper circle of the pons, that of the inferior peduncle occupied the outer and lateral part of the restiform body, a few fibres passing from this to the opposite side, others to the fillet and to the posterior longitudinal bundle, by which latter channel they reached the cranial nerve-roots. Other degenerated fibres were traced down the antero-lateral columns of the cord, but not down the pyramidal tract.

Ferrier and Turner[1] found that removal of one lateral lobe of the cerebellum, or section of the superior peduncle, demonstrated the existence of an efferent tract to the opposite red nucleus and to the optic thalamus; and an afferent tract, which they consider as the cerebellar termination of Gowers' antero-lateral ascending tract. Destruction of the lateral lobe or section of the middle peduncle produced diminution of the transverse fibres of the pons on the side of the lesion, and atrophy of the cells of the nucleus of the pons on the opposite side. Ablation of the lateral lobe or section of the inferior peduncle showed an afferent tract to the opposite inferior olive, and an afferent tract to the cortex, chiefly of the lateral lobe. They found no degeneration in the superior middle or inferior cerebellar peduncles after extirpation of the middle lobe, but there resulted degeneration and sclerosis of the tract passing from the vermiform process to Deiter's nucleus, *i.e.* the "direct sensory cerebellar tract" of Edinger.

Risien Russell,[2] as the result of his observations, found that on removal of one lateral lobe of the cerebellum there

[1] *Proc. Roy. Soc. London*, 1893, vol. liv. p. 476.
[2] *Phil. Trans.*, London, 1895, vol. clxxxvi. p. 633.

are degenerated fibres as follows:—Degenerated fibres pass along the superior peduncle of the side of the lesion to the opposite red nucleus and optic thalamus, a few going to the red nucleus on the side of the lesion. Some fibres pass along the superior peduncle of the opposite side, and become intermingled with the degenerated fibres and the other superior peduncle after the decussation. There can be no doubt that the fibres of the opposite superior peduncle which are degenerated are true commissural fibres. Degenerated fibres in the middle peduncle on the side of the lesion pass chiefly to the grey matter of the opposite half of the pons. There are no degenerated fibres leaving the cerebellum by the opposite middle peduncle. These degenerated fibres in the inferior peduncle on the side of the lesion pass down in the lateral medullary tract, and a few reach the cervical part of the cord, where they are scattered in the antero-lateral region. Most of the degenerated fibres, however, terminate in the grey matter of the medulla on the same side, while some pass to the opposite side. Some of these, however, pass to the inferior olive of the opposite side, and some to that of the same side. There are no degenerated fibres of the opposite inferior peduncle. There is no degeneration of the fillet, of the posterior longitudinal bundle, of the ascending root of the fifth, of the roots of the cranial or spinal nerves, and there is no degenerated tract in the periphery of the antero-lateral region of the spinal cord.

Removal of the middle lobe of the cerebellum gives degeneration of fibres in the superior peduncles, which decussate in the posterior quadrigeminal region, and pass to the red nucleus on the opposite side to the peduncle from which they arise. The degenerated fibres of the middle peduncle pass to the grey matter of the pons. The inferior peduncles contain degenerated fibres, which pass to the grey matter of the same side of the medulla, some to the opposite side, and a few to the upper part of the spinal cord. There is no degeneration of the fillet, of the posterior longitudinal bundle, of the cranial or spinal nerve-roots, or of a tract in the periphery of the antero-lateral region of the cord, the

few degenerated fibres in the upper part of the cord slightly representing these.

Experimental Research in relation to Clinical Features.

We desire now to inquire what amount of correspondence can be traced between the clinical facts observed in our five cases, and the results of the experimental investigations of Luciani and Risien Russell.

Luciani [1] succeeded in keeping mammals alive for some time after ablation of the cerebellum. They showed symptoms of irritation during the first few weeks, manifested by contractions and spasms, but these afterwards disappeared. Unsteadiness and titubation were permanent. Walking was impossible or imperfect, yet the animals could swim like healthy dogs. The intellectual and emotional functions were apparently intact.

Division of the cerebellum by mesial incision gave few irritative symptoms, but some failure of co-ordination. There was a want of energy and reduction of muscular tone. His conclusion was, that the cerebellum is physiologically one organ, whose functions are seriously impaired if it is divided into two halves.

When the middle lobe was destroyed, there was unsteadiness, squinting, spasm of cervical muscles, tonic extension of upper extremities in dogs, tonic flexion in monkeys. These lasted about a week. Asthenia, atonia, and astasia, especially of posterior extremities, lasted about a fortnight. Compensation resulted in all cases.

Extirpation of one lateral lobe gave curving of trunk towards side of lesion, tonic extension of anterior extremity on that side, rotation of the long axis towards the opposite side, and deviation of eyeballs towards opposite side. Asthenia, atonia, and astasia of muscles of side injured resulted. Compensation gradually occurred. Temporary glycosuria was frequent.

Ablation of half the cerebellum produced curving of the

[1] "Il Cervelleto," Firenze, 1891.

trunk towards the side of the lesion, rotation on long axis towards the opposite side, tonic extension of fore-limb of dog, and tonic flexion of fore-limb in monkey on side of lesion, occasionally affection of hind-limb, also squinting and nystagmus. Asthenia, atonia, and astasia of muscles on side of lesion occurred. Compensation was not perfect, some of the symptoms persisting, pointing to the fact that the other half of the cerebellum cannot perform all the functions of the half removed. Temporary polyuria and glycosuria sometimes occurred.

Destruction of one lateral lobe, after destruction of the middle lobe, produced symptoms similar to those just detailed.

Ablation of the entire cerebellum produced similar symptoms to those found in destruction of the middle lobe, but greater in degree, longer in duration, and wider in distribution.

Unilateral or bilateral destruction of the sigmoid gyrus, after removal of the cerebellum, caused the deficiency phenomena to be more pronounced and persistent, the animal being unable to walk without support nearly a year after the operation, whence Luciani concluded that compensation is produced by the sensory-motor region of the cerebrum after removal of the cerebellum. Luciani concluded that the cerebellum, though of bilateral function, has a direct, not a crossed action. Its influence is exerted on all voluntary muscles, not only on those connected with posture and locomotion, and is sthenic, tonic, and static. All parts have the same function. The middle lobe has no greater functional value than the lateral ones. Sensory disturbance consists specially of vertigo, motor of inco-ordination, while polyuria, glycosuria, and loss of weight are trophic symptoms.

Luciani thinks the cerebellum is a coadjutor and reinforcer of the cerebral spinal system, its action being *sui generis*. Deficiency produces asthenia, atonia, and astasia, just as motor and sensory paralysis attends deficiency of other parts. He holds that the cerebellum is relatively independent, that defects do not interfere with the passage of centripetal and centrifugal impulses passing between the cerebrum and the periphery, and that it does not dominate

over any territory reserved to itself. He insists upon the analogy between the cerebellum and the intervertebral ganglia, both the direct and indirect trophic actions being similar. The reinforcing action of the intervertebral ganglia on the anterior roots and the muscles they innervate closely resembles the sthenic, tonic, and static action of the cerebellum.

Risien Russell[1] found that median vertical section, separating the lateral halves from each other, produced no symptoms forty-eight hours after the operation, so that, although the connections between the two halves of the organ were severed, each half appeared to be able to perform its own functions without the co-operation of the other half, and no function seemed to be in abeyance in consequence of the separation of the two halves.

Removal of one lateral lobe, while the animal was still under the influence of the anæsthetic, produced ocular deviation, sometimes of both eyes, sometimes only of one. When both were affected, there was skew deviation, the eye on the side of the lesion being turned upwards and outwards, and the opposite one downwards and outwards. When only one eye deviated, it was that on the opposite side of the lesion, and it was always outwards and downwards. The knee-jerks were remarkably altered. The knee-jerk on the side of the lesion was greatly exaggerated, so as to give rise to clonus or even tonus, while on the opposite side there was diminution instead of exaggeration.

The effects seen after recovery from the anæsthetic varied greatly in severity and duration. The eyes entirely recovered after a time, the globe on the side of the lesion within a few hours, the opposite one after a few days. Nystagmus was present for a few days in a lateral direction, more marked in the opposite eye, with the jerks towards the affected side. Difficulty in standing was present for some days, due to weakness mainly of the limbs on the side of the lesion, so that the animal falls to that side. Circus movements, such as occur in labyrinthine lesions, were rare; when they occurred, the concavity of the circle was towards the affected

[1] *Phil. Trans.*, London, 1894, vol. clxxxv. p. 819.

side. Inco-ordination was shown by reeling, which has to be distinguished from falling, as has just been seen. Even before the animal was able to stand, it showed inco-ordination in the movements of the head and trunk. Any attempt at voluntary movement increased an unsteadiness always present. The reeling was always to the opposite side. It was difficult, of course, to ascertain the condition of sensibility; but one point was pretty clear, that the posterior extremity on the side of the lesion is interfered with. There was no affection of special sensibility, and no optic neuritis. The reflexes were exaggerated, more particularly on the side of the lesion. The knee-jerk was increased on that side, but diminished on opposite side. After the lapse of two or three months, very few symptoms were left, with the exception of an increase in the tendon reflexes on the side of the lesion.

Removal of one entire half of the cerebellum produced effects almost identical with those resulting from removal of one lateral lobe; but all the symptoms were intensified and more permanent. The symptoms are therefore—(1) Rotation on the long axis towards the opposite side; (2) reeling towards the opposite side; (3) rotation of the cervical spine, so that the face on the side of the lesion is turned upwards, along with arching of the spine with its concavity to the side of the lesion; (4) inco-ordination chiefly in the limbs of the same side; (5) rigidity, mostly on the same side, and chiefly in the anterior extremity; (6) increase of the tendon reflexes, mostly on the same side; (7) motor weakness affecting both extremities on the side of the lesion, and the posterior extremity of the opposite side; (8) anæsthesia and analgesia, with same distribution as motor weakness; (9) deviation of opposite eyeball downwards and outwards, while that on the same side is only slightly affected; (10) lateral nystagmus, the jerks being from the opposite side towards the side of the lesion.

Removal of both lateral lobes produced downward and outward deviation of both eyeballs for a few days. Nystagmus was upward, with a tendency to rotation outwards at first. It was transitory. Motor paresis was present in all extremities, but more particularly the posterior. Inco-

ordination showed itself by general unsteadiness without rotation movements. Anæsthesia and analgesia were present in all extremities. All the tendon reflexes were increased. There was also rigidity, more marked, however, in the anterior extremities.

Removal of the posterior part of the middle lobe produced proptosis of both eyes, with downward and outward rotation. Sometimes nystagmus was present. There was paresis of the posterior extremities, with little affection of the anterior extremities. Inco-ordination showed itself by unsteadiness, especially on attempts at voluntary movements.

There was no lateral reeling, but on attempts to walk each succeeding step taken with the fore-limbs resulted in their being raised higher and higher from the ground; and one step followed another before the limb had reached the ground, the animal, as it were, attempting to find solidity in mid-air at an increasingly elevated level, until the fore-part of the body was raised so high that the dog fell backward. Sensory phenomena were shown by blunting of sensibility of all the extremities at first, the anterior recovering before the posterior. There was slight rigidity and slight increase of the tendon reflexes. All these effects passed off in a short time, with the exception of a slight defect in the movements of the posterior extremities.

Extirpation of the greater part of the middle lobe of the cerebellum, including the whole of the posterior half and some of the anterior, gave much less tendency to fall backwards. Inco-ordination was present, chiefly in the posterior extremities. Rigidity was present in all extremities, but mostly in anterior.

All the tendon reflexes were exaggerated. Motor paresis affected the anterior extremities only slightly, the posterior much more markedly. Anæsthesia and analgesia followed the same distribution. There was downward and outward movement of both eyeballs. Nystagmus was vertical or irregular, and rotatory in character.

Removal of half of the posterior part of the middle lobe gave rotation downwards and outwards of the eyeball on the side of the lesion, without deviation of the opposite eyeball.

Nystagmus of both globes to the opposite side and slightly upwards was also present. There was slight paresis of both posterior extremities, and of the anterior extremities on the side of the lesion. Inco-ordination could scarcely be detected. There was slight increase of the tendon reflexes on the side of the lesion. All these symptoms passed away in a few days, leaving no trace behind.

Removal of the whole cerebellum produced downward rotation of both eyeballs, with nystagmus only on voluntary movement of the globes. This was in the direction in which the eyes were turned. There was paresis of all extremities, chiefly, however, of the posterior. Great inco-ordination was present, with falling indiscriminately to one or the other side. There was anæsthesia and analgesia of all the extremities, passing off gradually from before backwards. There was rigidity of all the extremities, but chiefly of the anterior. All the tendon reflexes were increased.

Control experiments on the labyrinth and the eighth nerve were instituted by way of comparison, and the symptoms which resulted from lesions of the labyrinth and the eighth nerve were attended by almost identical results. Vertigo, evidenced by reeling, was constant, but most marked at first, and less distinct afterwards.

Rotation movements were uncommon, and took place on the long axis, towards the side of the lesion, not towards the opposite side, as in unilateral ablation of the cerebellum. Reeling always produced a tendency to fall towards the side of the lesion. Circus movements were constant around a central axis on the side of the lesion. Ocular deviation was also present, consisting in a rotation of the globe on the side of the lesion downwards, sometimes in addition inwards, sometimes outwards. Nystagmus was always distinct. The variety of nystagmus varied somewhat, but soon after the operation there was usually upward nystagmus of the globe on the side of the lesion, with some inward movement; while the other eye showed lateral nystagmus, the jerks being outward. Two or three hours after the operation there was rotatory nystagmus.

It was worthy of note that at first there was wasting in

the animals operated upon, but that after a few days they gained flesh as rapidly as they had lost it, and eventually became better nourished than before the operation. The wasting is believed by Risien Russell to be due to the fact that the animals would not attempt to take food at first.

In order to facilitate comparison of these experimental results with the facts of clinical experience, we have put in tabular form the points elicited by Luciani and Risien Russell:—

TABLE SHOWING THE SYMPTOMS PRODUCED BY EXPERIMENT.

	Mesial Section.		Posterior Middle Lobe.		Whole Middle Lobe.		One Lateral Lobe.		Both Lateral Lobes.		Half Cerebellum.		Whole Cerebellum.	
	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.
Anæsthesia . .	...	...	...	+	...	+	...	+	...	+	...	+	...	+
Nystagmus . .	...	...	...	+	...	+	+	+	...	+	+	+	...	+
Reflexes all increased	...	...	...	...	...	+	...	...	...	+	...	...	...	+
,, increased on side of lesion	...	...	...	+	...	...	...	+	...	...	...	+	...	...
,, diminished on opposite side	...	...	...	...	...	...	...	+	...	...	...	...	...	...
Paresis . . .	...	...	...	+	...	+	...	+	...	+	...	+	...	+
Asthenia . . .	+	...	...	...	+	...	+	...	...	...	+	...	+	...
Atonia . . .	+	...	...	...	+	...	+	...	...	...	+	...	+	...
Astasia . . .	+	...	...	+	+	+	+	+	...	...	+	+	+	+
Rigidity . . .	+	...	...	...	+	+	+	...	...	+	+	+	+	+
Circus movements .	...	...	...	...	...	...	...	+	...	...	...	...	...	...
Body curved towards lesion	...	...	...	...	...	...	+	...	...	...	+	...	...	...
Body rotated from lesion	...	...	...	...	...	...	+	...	...	...	+	+	...	...
Proptosis . . .	...	...	...	+	...	...	...	...	...	...	...	...	...	...
Ocular deviation .	+	...	...	+	...	+	...	+	...	+	...	+	...	+
Squint . . .	...	...	...	...	+	...	...	...	...	...	+	...	+	...

In this table the titles L. and R. stand respectively for Luciani and Risien Russell.

Therapeutic Indications.

The final question to which we wish to refer is with regard to the treatment of such cases. We are inclined to deduce the following rules:—(1) The only real hope, when syphilis and tubercle can be excluded, lies in surgical interference. (2) Operation should not be delayed, but should be recommended at once, when symptoms warranting a positive diagnosis of a cerebellar tumour or cyst are definitely recognised. (3) These symptoms are—(*a*) *General.*—Headache (the position of which may be of diagnostic importance), giddiness, optic neuritis, and, less frequently, vomiting. (*b*) *Focal.*—Nystagmus, staggering, ataxia, impairment of co-ordination, and more especially a tendency to fall in some definite direction. Unilateral deafness is also of value in this connection. The condition of the knee-jerk, and the presence or absence of ankle-clonus, are subject to such a degree of variation as to render them of little value in localisation.