TUMOUR OF THE CEREBELLUM IN A DOG, ASSOCIATED WITH FORCED MOVEMENTS.

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(1) INTRODUCTION.

It is well known from experimental investigation that injury to or removal of portions of the cerebellum in lower animals gives rise to a definite train of symptoms, of which possibly the attitude assumed, the rotation of the animal on its long axis and the circus movements are the most striking, although not the most characteristic and constant features, of such a lesion.

Apart from experimental lesions, some observations have been made in animals, in which the symptoms during life pointed to a cerebellar lesion, and on investigation, a cerebellar lesion was found; such are the cases reported by Herringham and Andrewes, Risien Russell, and Thomas Lewis. Rotation on the long axis was not present in any of these cases, and circus movements were present only in the case reported by Thomas Lewis.

In all these reports, atrophy of *both* lateral lobes of the cerebellum was present.

In the first place it will be well to describe the symptoms which the dog presented and the pathological appearances, and afterward to compare the symptoms with those which have been observed after experimental lesion.

(2) HISTORY OF THE CASE.

The following is the history of the dog, as obtained from Mr. Prime, the veterinary surgeon, under whose care the dog came. Mr. Prime recognised the unusual nature of the symptoms, and sent the dog to Mr. Hobday for a further opinion. The dog, a black mongrel terrier, aged 18 months to 2 years, was bought in London three weeks before for two shillings, and was being trained as a jumping dog—the trainer had not noticed the animal to have had any bad falls on the head. Five days before sending the dog to Mr. Hobday, Mr. Prime had noticed slight loss of control of the hind quarters, gradually increasing till three days after the first symptoms had appeared the dog could not stand. He carried his head to one side, and rolled over when excited.

The dog was seen with Mr. Hobday by Dr. Gordon Holmes and myself, and the following account of the symptoms is based on notes and drawings made by Dr. Holmes and myself at the time of, and immediately after, seeing the animal:—

In one or two points the accounts differ, more especially in regard to the attitude. It is of interest to note that although we are describing the same phenomenon, and we are in perfect agreement as to the direction of the rotation, Dr. Holmes says, "the animal at once rolled over to the left," whilst my description is "the dog at once rotates on its long axis from left to right;" both of us at once qualify the statement by a description of the movement, which leaves no doubt as to the agreement, but the fact demonstrates how misleading the terms "rotation to the right or left" may be, and that other nomenclature is needed to describe these movements. The dog was unable to stand. If held up by the scruff of the neck and by the skin over the rump, he squirmed about so that it was hardly possible to hold him.

If stood on his hind legs, with the fore limbs and head held between the knees, he could support his weight.

Attitude.—When left alone the dog lay on the ground on his right side, and with the right side of the face against the ground, the left side being turned up. The whole body was curved, the concavity being ventralwards, and on the left side of the body. (Plate I.)

The position of the head was very marked and constant. The head was flexed so that the right ear approximated to

PLATE I.

FIG. 1.

FIG. 2.

PLATE I.—FIGS. 1 AND 2.

These figures indicate the position assumed by the dog as seen from above, the animal lying on the floor on its right side.

Fig. 1 represents the position as reconstructed from a rough sketch of mine made at the time. (F.E.B.)

Fig. 2 represents the position as reconstructed from a sketch made by Dr. Holmes.

The letter *A* indicates the circumference of the circle, and the direction of the "circus movements" which the dog performed.

The letter *B* indicates the direction in which the dog rotated on its long axis along the stable floor.

For the reconstruction of the drawings from the rough sketches I am indebted to my brother (Mr. J. D. Batten).

the right shoulder. The head was rotated on its long axis so that the left side of the face was turned up. The head was kept in close approximation to the ground. There was no great rigidity of the neck muscles. (Plate I., figs. 1 and 2.)

Limbs.—The right fore-limbs were abducted and placed on the ground, at an angle of about 45° to the long axis of the head. The left fore-limb was flexed, and the fore part lay parallel with the long axis of the dog. (See plate I., fig. 1.) Dr. Holmes and myself are not in absolute agreement on this point, and it may be well to give his description of the attitude in his own words: "The right fore-limb lay partly under, partly behind the body—the humerus seemed to separate the shoulders from the floor, while the arm and paw lay flat on the ground." (See plate I., fig. 2.) The hind legs were generally flexed, but at times became extended, the right being generally more extended than the left. The legs were not spastic, for they could be passively flexed with the greatest ease; on the other hand, when handled, they were generally found to be rigid, this rigidity seeming to be due to volitional effort in the attempt to avoid forced movement. Dr. Holmes considered the right hind-limb was distinctly stiffer than the left.

Movements.—(1) Forced movement of rotation on long axis.—If the dog was undisturbed he would lie still in the position above described for some time; but under emotional stimulus, or if the right fore-limb was brought in parallel to the long axis of the body, so that it no longer formed a support, the dog at once rotated on its long axis from left to right; *i.e.*, regarded as a corkscrew or common screw,¹ he rotated as an outcoming screw, or, in other words, the right shoulder moved forwards across the trunk until the same relative position was reached. At times the rotatory movement would occur two or three times, so that the dog rolled over and over along the stable floor on his long axis, and only came to rest when the right fore-limb was sufficiently far out to prevent further rotation. The rotation was so rapidly performed that it was impossible to describe any movement of the body during its execution.

¹ The head of the animal corresponded to the head of the screw or the handle of the corkscrew.

Dr. Holmes, in his description, says the animal at once rolled over to his left (*i.e.*, when lying on its right side the limbs arose and passed across the trunk and then the trunk over the limbs).

We are in perfect agreement as to which way the dog did roll, and the difference in description depends upon the fact that one is accustomed to regard an animal in the prone position, a man in the erect or dorsal position.

I, myself, am of opinion that the method of describing rotation in the terms "the right (or left, as the case may be) shoulder moves forward" is that which is least liable to error.

The ingoing and outcoming screw is also a perfectly clear method of describing rotation to all who are familiar with the use of an ordinary screw and do not wish to quibble as to a male or female, and a right- or left-handed screw, the head of the animal representing the head of the screw.

(3) CIRCUS MOVEMENTS.

Apart from the rotatory movement on its long axis, the dog tended to move round in a circle on the floor anti-clockwise, *i.e.*, if a watch were placed on the floor with the face upward, the movements would be in a direction opposite to that of the hands (plate I, figs. 1 and 2), the direction of the circus movement is indicated by the circumference of a circle with an arrow mark. During these movements the dog, lying on his right side, kept the head on the ground and "paddled himself round with short movements of the forelimbs in a circle, whose centre corresponded approximately to the hip joints and with a radius extending from here to the tip of the nose." To what extent the movement was volitional or to what extent it was a forced movement was impossible to tell.

The dog appeared in good health, had a good coat, and was friendly and responsive. There was no paralysis of the face, no nystagmus, no ocular paralysis. The knee-jerks were present and equal.

The dog was killed with hydrocyanic acid and a *post-mortem* immediately made.

(4) PATHOLOGICAL APPEARANCES.

On superficial examination the cerebral cortex, the surface of the cerebellum and spinal cord, appeared quite normal. On examination of the medulla and under surface of cerebellum, a tumour was seen to occupy the medulla on the right side and involved the region of the olive and inferior peduncles of the cerebellum on that side. The tumour had obliterated the external configuration of the structure in this neighbourhood, but did not affect the pyramid. On section, the tumour was seen to involve the central and peripheral portion of the right lateral lobe of the cerebellum together with the flocculus, restiform body, and the eighth nerve in its course and exit. The whole of the right side of the medulla was much larger than the left, and the tumour involved the region of the inferior cerebellar peduncles, the upper and outer portion of the olive, and the ascending root of the fifth. The total length of the tumour was 1.4 cm. On section, the tumour was firm and more vascular than the surrounding brain tissue.

Plate II. shows the position of the tumour as seen from the base of the brain. Figs. Nos. 1—8 show the position of the tumour as seen on section by naked-eye examination.

(5) MICROSCOPICAL EXAMINATION.

The pons, cerebellum, and medulla were cut in series and stained by the Weigert-Pal, and van Geison method.

The extent and position of the growth.—A section of the cord at the level of the decussation of the pyramids showed no change.

In a section at the level of the posterior column nuclei, it was obvious that the right side of the cord was larger than the left, but on microscopical examination no obvious growth could be seen, nor was the cause of this enlargement of the cord on the right side apparent.

In a section at the lowest part of the fourth ventricle the growth appeared on the periphery of the cord growing into the substance of the cord from the vessels of the pia mater. In a section at the level of the inferior olive the growth involved a considerable portion of the right half of

PLATE II.

PLATE II.—FIGS. 1 TO 9.

Base of the brain of the dog. The shaded area indicates the position of the tumour, involving the medulla and under-surface of the cerebellum on the right side. The horizontal lines numbered 1—8 indicate the line of section, and the shaded areas in figures 1 to 8 show the position of the tumour as seen with the naked eye.

the medulla. It did not, at this level, invade the olive itself, but involved the region of the direct cerebellar tract and the substantia reticularis (plate III., fig. 6).

About this level the growth became much more extensive and involved the restiform body, the ascending root of the fifth and the outer part of the olive, but at no point was the pyramid involved (plate III., figs. 5 and 4). The eighth nerve on the right side was involved in the growth and the peripheral portion of the seventh nerve in its course through the medulla was also involved, the central portion remaining intact. The sixth nerve was not involved in the growth (plate III., fig. 3).

The region of Deiters' nucleus was not actually involved in the growth, but only a few multipolar cells of this nucleus could be seen, and these were more numerous on the right side than the left.

The growth extended up into the cerebellum, involving the cerebellar cortex in the region of the flocculus and the region of the dentate nucleus (figs. 2 and 1). The growth involved the fifth nerve on the right side, but did not destroy it, for it stains relatively well by the Weigert-Pal method.

In a similar manner the superior cerebellum peduncles were affected to a slight extent on the right side.

On the left side there was at this level a small mass of growth completely separated from the main growth. This growth involved the folia of the cerebellum, but did not extend into the middle of the cerebellum or involve the fifth nerve.

With regard to the cranial nuclei it is difficult to state that there was any definite change. The cells in the right hypoglossal nuclei were not so numerous as those in the left. The nuclei of the vagus were well stained. The sixth nucleus appeared normal, as did also many cells in the seventh, in spite of the fact that the intramedullary portion of the nerve passed through the growth.

Many fairly normal nerve cells could be seen lying within the growth.

Nature of the growth.—Sections were stained by van Gieson's method. Under the low power the growth is seen

PLATE III.

FIG. 1.

FIG. 4.

FIG. 2.

FIG. 5.

FIG. 3.

FIG. 6.

PLATE III.—FIGS. 1 TO 6.

FIG. 1.—Section through pons and cerebellum. The situation of the tumour is indicated in all the sections by the dotted areas.....

The tumour at this level occupies the central portion of the right lateral lobe of the cerebellum. The middle peduncle of the cerebellum, and the superior peduncle, to a limited extent, and ventrally involves the greater part of the fifth root, but does not completely destroy it.

FIG. 2.—Similar to the above, but below the fifth root.

FIG. 3.—Section through the medulla at its junction with the pons. The great mass of the growth is situated on the right side of the medulla and lower part of the cerebellum. It involves, at this region, the inferior peduncle of the cerebellum, the flocculus, the eighth nerve, and the seventh, in part of its course. The outer part of the right olive is also involved. A small mass of growth is also seen in the left lobe of the cerebellum, growing in from the pia mater, and involving the cortex of the cerebellum, but not extending into the middle of the lobe.

FIGS. 4, 5, and 6.—Sections through the medulla indicating the extent of the growth at various levels. The growth involves the direct cerebellar tract and restiform body, the ascending root of the fifth nerve, and the outer part of the olive, but does not involve the pyramidal fibres.

to be composed of small round cells, darkly stained, and larger oval cells lightly stained with a nucleus; these cells are fairly uniform in size.

The cells are massed for the most part round vessels, and hence the vessels are clearly picked out in their course through the growth. In portions of growth in which the vessels were cut in transverse section a vessel could be seen in the centre surrounded with layers of cells. No giant cells could be seen.

Towards the periphery of the growth, the extension was along the walls of the blood vessels.

The growth appeared to have started on the outer surface of the cord probably in the walls of the vessels of the pia mater and gradually to have invaded the medulla along the course of the blood vessels. The growth would probably be classified as a sarcoma growing from the outer sheaths of the blood vessels.

As another observer to whom I have submitted the specimen is not in agreement with the above statement, it may be well to state his views:—

Dr. Lazarus Barlow has kindly furnished the following report: "From the peculiar distribution around the blood vessels, from the character of the cells and particularly from the fact that I find a fair number of polymorphonuclear leucocytes intermixed with the chiefly lymphocytic elements forming the masses, I have come to the conclusion that the condition is inflammatory and not neoplastic. From the neoplastic point of view, the mass could only be angiosarcomatous, and I am convinced that it is not of that nature."

(6) SYMPTOMS OBSERVED IN THIS DOG COMPARED WITH THOSE SEEN AFTER EXPERIMENTAL LESIONS.

In order to compare the symptoms seen in this dog with those observed after experimental ablation, the following table had been arranged in terms of ablation of the right lateral lobe of the cerebellum.

From a comparison of the above results it will be seen that the direction of rotation in this dog corresponded to the experimental results of Luciani, Ferrier and Turner,

TABLE I.

Ablation of the Right Lateral Lobe of the Cerebellum.

	Luciani.	Ferrier and Turner.	Russell.	Thomas.	Dog Tumour of Right Side.
Rotation	To right. Right shoulder moves forward. Outcoming corkscrew	To right. Right shoulder moves forward. Outcoming corkscrew	To left. Ingoing corkscrew	To right, i.e., right shoulder moves forward. Outcoming corkscrew.	To right, i.e., right shoulder moves forward. Outcoming corkscrew.
Reeling.	To right		To left		Circus movements to left, i.e., anti-clockwise.
Attitude		Head inclined to right side and rotated to the left	Right side of face turned up. Right ear approximate to right shoulder	Head to right side shoulder. Left side of face turned up	Right ear approximated to right shoulder. Left side of face turned up.
Concavity of Spine	To left	None	To right	To the right, lies on right side	To the right, lies on right side.
Ataxia	On right side	General.. ..	Right side	Right side	General.
Weakness	On right side	None	Right side and posterior limb of opposite side	Right side	No true weakness, inability to stand due to forced movements.
Tone	Loss of tone on right side	No loss	Rigidity of right side ..	General rigidity, over action of right side	General slight rigidity.
Anæsthesia ..	None	None	Same as motor paresis		
Ocular paralysis ..	Skew deviation: Right, in and downwards. Left, up and out	Skew deviation: Right, in and down. Left, up and out	Left eyeball downwards and outwards	Deviation to the left	None.
Nystagmus ..			To the right		None.

and Thomas, but were in the opposite direction to those described by Russell.

With regard to the attitude assumed the position in the dog corresponded to the experimental results of the same observers and differed from Russell in the rotation of the neck.

The direction of the concavity of the spine corresponded to that observed by Russell and Thomas, and was the reverse to that seen by Luciani.

The other symptoms—the ataxia, weakness, rigidity of muscles—were general in the dog and not localised as in most of the experimental results.

No ocular paralysis or nystagmus was observed in this dog.

Seeing, however, that the tumour involved the eighth nerve on the right side in the dog, it is interesting to compare the result with those obtained by Russell on section of the nerve on the right side.

In this animal after section of the eighth nerve, the dog rotated to the right (outcoming corkscrew), the reverse direction to that obtained by Russell on ablation of the right lobe. The dog fell to the right side, had concavity of the spine to the right, and performed circus movements to the right. There was no definite ataxia, weakness, loss of tone, or anæsthesia, nor was any definite position of the head assumed.

Section and irritation of the nerve gave the same result.

Dr. L. J. Muskens gives a good account of circus movements and rotation as seen both in the lower and higher vertebrates and his observations correspond with the movements observed in this dog. The ocular phenomena to which he pays special attention were not present in this dog.

(7) THE DESCRIPTION OF POSITION AS APPLICABLE TO MAN AND ANIMALS.

I have already made some allusion to this subject and the difficulty which arises in describing rotation movement to right or left.

Rotation in the long axis should be described in terms of the right or left shoulder moving forward, or in terms of an ingoing or outcoming screw.

Circus movements should be described in terms of the hands of a watch placed on the floor so that the observer can see the hands, clockwise or anti-clockwise.

(8) OBSERVATION ON ANIMALS PRESENTING CEREBELLAR SYMPTOMS.

A few observations on pathological lesion of the cerebellum have been made in animals. The family of half-breed Persian cats with cerebellar symptoms investigated by Dr. Herringham and Dr. Andrewes are of great interest. These animals showed atrophy of the whole of the cerebellum.

Another interesting observation is that of Dr. Risien Russell on a puppy, one of a litter, all of whom were similarly affected. In this case the cerebellum was reduced to almost three-fourths its normal size.

A third observation is that of Dr. Thomas Lewis in a dog who had exhibited "circus movements" for at least four years, and in which there was a general diminution in the size of the cerebellum with shrinking of the dorsal surface of the lateral lobes.

One other case is of interest in the connection. A black pug, 1 year old, had never been very strong and had had distemper three months previously. Discharge from the left ear had subsequently been noticed; one month previously the pug had become unsteady on its legs and had been much worse for the last week—it had vomited and seems to have lost his vision.

When placed on the floor the dog started off to walk and walked round and round in a circle to the right (clockwise). The dog on this occasion could not be got to go in the opposite direction. The dog would wander round and round the room, always to the right, and was only stopped by coming in contact with an object which prevented his turning to the right. He would then stand in a dazed

condition, and as soon as the obstruction was removed on he would go on his walk. Both hind legs were very weak, and it needed but a touch to upset his balance.

A few days later he walked round in a circle to the left (anti-clockwise). This movement was not so marked as had been the circus movement to the right. The dog was killed, and on macroscopic examination of the brain and spinal cord nothing abnormal was seen. On microscopical examination changes were present in the cerebrum, the cerebellum and spinal cord, similar to those found in diphtheritic paralysis, *i.e.*, degeneration of the myelin sheath, and some alteration in the nerve cells when stained by the Marchi and Nissl methods.

(9) CONCLUSION.

Forced movements of the character seen in this dog and after experimental lesion are but rarely seen in man.

The symptoms presented by this dog were such as to lead one to believe that the lesion was situated on the right lateral lobe of the cerebellum and in this situation and in the medulla the larger lesion was found; a small tumour was, however, present in the left lateral lobe.

My best thanks are due to my friend, Dr. Gordon Holmes, not only for superintending the preparation of the section, but also for his help both in the clinical and pathological investigation of this case.

REFERENCES.

- [1] FERRIER & TURNER. *Phil. Trans. Royal Soc.*, 1894, vol. clxxxv.
- [2] HERRINGHAM & ANDREWES. *St. Bart.'s Hosp. Reports*, 1888, vol. xxiv., p. 241.
- [3] THOMAS LEWIS. *Brain*, 1904, p. 84.
- [4] LUCIANI. *Il Cervelletto*, 1892.
- [5] MUSKENS. *Journal of Physiology*, 1904, vol. xxxi., p. 204.
- [6] RUSSELL. *Phil. Trans. Royal Soc.*, 1894, vol. clxxxv.
- [7] RUSSELL. *Brain*, 1895, vol. xviii., p. 528.