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ANGIOMA ARTERIALE RACEMOSUM IN AN ACAL- LOSAL BRAIN: A CLINICAL AND PATHOLOGICAL REPORT.

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In a recently published monograph Cushing and Bailey¹ classify blood-vessel tumours of the brain into three main types—the teleangiectases, the angioma venosum, and the angioma arteriale; the last named having both arteries and veins entering into its composition might, they suggest, be more correctly termed angioma arteriale et venosum. Considering how infrequently such cases are encountered it is not surprising to find that pathological reports are few and far between and that the general histological description of arterial angioma is derived from the study of a few classical examples, to which Cushing and Bailey have been able to add only one.

The case of arterial angioma herein presented not only affords a striking example of this condition but has the additional interest in that it was associated with complete absence of the corpus callosum.

REPORT OF CASE.

A. S., a female, age 32, came under the care of one of us in 1924. Her mental state was one of dementia associated with epilepsy. No satisfactory history of her childhood could be obtained but she appears to have been thought normal by other members of the family and was able to assume the responsibilities of married life. She had one abortion preceding the birth of a boy, who was described as backward. From a brother it was ascertained that she commenced to have fits in her twenty-sixth year; at first of the nature of 'faints', they were more severe as time went on and ultimately became of the grand mal type. An important point elicited was the history of a severe blow on the head when the patient was nineteen; this was followed some time afterwards by the appearance of several dilated veins beneath the skin of the forehead. At the age of 21 the patient began to experience severe headaches and was stated to have had difficulty in walking. Three years later the right upper limb became paralysed and this marked the commencement of mental deterioration which was so rapid that when seen five years later the patient was in a state of profound dementia and completely bedridden.

The following notes were made on January 17, 1924.

Extending from the bridge of the nose upwards on to the forehead and scalp there is a subcutaneous varicose swelling which can be almost completely obliterated by firm pressure (fig.1). The strong pulsation in the vessels which compose it is synchronous with throbbing of the facial, temporal, occipital and carotid arteries. No bruit can be heard on auscultation of the cranium. A moderate degree of cardiac hypertrophy is present.

The patient's mental state is one of dementia; she is completely inaccessible, faulty in habits and her speech is limited to the words 'oh dear,' 'oh my God,' and 'wee wee.'

A certain amount of exophthalmos is present. The right pupil does not react to light; the left contracts sluggishly. Both pupils contract fairly well on convergence.

There is weakness of the lower half of the face and a complete and almost flaccid paralysis of the right upper limb. The right lower limb shows a lesser degree of paralysis with increase of muscle tone. The left limbs are normal.

FIG. 1.—Note varicose swelling on forehead; also slight degree of exophthalmos.

Reflexes.—Abdominals: not obtained; plantars: right extensor response, left normal; knee-jerks: exaggerated, especially the right.

On February 6, 1924, the patient developed fits, limited to the right face and right upper limb, with conjugate deviation of the head and eyes to the right. During the attacks, which varied in number from three to several hundred per day, consciousness was not lost. In April the fits ceased entirely and the patient seemed somewhat stronger but on May 11 severe generalised convulsions led to status epilepticus in which she died on May 15.

PATHOLOGICAL FINDINGS.

An autopsy was held 34 hours after death. The heart weighs 11 oz. and shows considerable hypertrophy; the aortic valve is incompetent. The internal carotid arteries appear larger than normal, especially in comparison with the external carotids. The liver weighs 38 oz. and is smaller than normal; spleen, 3 oz.; kidneys, right 4 oz.; left 4½ oz. Both show adherence of capsule, a granular surface and diminished cortex. A small lipoma is present on the left forearm.

The cirroid aneurysm in the forehead is found to consist of a number of thin-walled vessels which disappear into the interior of the skull through eleven foramina placed midway between the frontal eminences; for the most part these are small, but four larger holes admit the point of a surgical probe. The calvarium is thickened and its inner table channelled by deep grooves housing the meningeal arteries. The dura mater is adherent both to the skull-cap and surface of the brain; in the falx cerebri it shows gross thickening amounting to as much as 3 mm. in certain parts and numerous varicose blood-vessels traverse it in an anteroposterior direction. The superior cerebral veins which terminate in the sagittal sinus are all of large size and one of them, as large as the basilar artery, can be seen to enter the posterior ramus of the Sylvian fissure.

Reflection of the dura mater exposes an extraordinary state of affairs beneath. Huge dilated vessels—many of them pursuing tortuous and abnormal

FIG. 2.—The left cerebral hemisphere showing the inextricable tangle of vessels entering into the formation of the angioma. Note the entire absence of the corpus callosum. A, indicates the position of the large saccular aneurysm. B, a huge vessel turning round the frontal pole and establishing relations with other vessels in the thickened falx cerebri.

courses—give to the brain a picture of excessive vascularity not easy to describe, and on separating the two cerebral hemispheres at their frontal poles a dense tangle of vessels is revealed (fig. 2). It is found impossible to trace all the connections of these and the following account deals only with the more salient points.

Vertebral Arteries.—Both vertebrals are tortuous and enlarged to about twice their normal size. The basilar artery shows several slight fusiform dilatations and presents a minute saccular aneurysm immediately cephalad to the point where the right anterior inferior cerebellar artery is given off.

Posterior Cerebral Arteries.—The left posterior cerebral artery appears as the main continuation of the parent trunk, while its fellow is much smaller and after giving off the posterior communicating artery divides into two

branches of equal size. The posterior communicating arteries are of unequal size and give off near their termination anterior choroidal arteries which are both much larger than normal. The two superior cerebellar arteries are of normal size.

Internal Carotid Arteries.—Both are much larger than normal and at the commencement of its intracranial course the right has on it a saccular aneurysm the size of a pea.

Anterior Cerebral Arteries.—The right anterior cerebral artery pursues a normal course. That on the left side is much larger and passing forward for a distance of about two centimetres terminates in a large saccular aneurysm the

FIG. 3.—Base of brain showing: A, aneurysm; A.C.A., anterior cerebral artery; M, mid-brain in which is embedded a large aberrant vessel. V, indicates the position of a large? venous sinus.

size of a pigeon's egg; this lies on the orbital margin of the inferior frontal convolution, completely covering the olfactory tract (fig. 3); the wall of this aneurysm is extraordinarily thin—so thin, indeed, as to be translucent: from its superior surface a large vessel proceeds outwards to be lost to view in a maze of smaller vessels on the medial aspect of the hemispheres. It is difficult to determine accurately the exact relations of the vessels in this tangle to the brain substance, but it is possible to trace a connection between them and a large aberrant vessel lying on the polar frontal region; this in its turn appears to be in direct communication with a rich plexus of vessels lying in the thickened falx cerebri.

A second abnormal vessel establishes relations with the crus cerebri and has the appearance of an enormous venous sinus closely applied to the crus. Having reached the midline it unites with the great cerebral vein and finally, much reduced in size, terminates by dividing into two branches. Of these, the larger and more conspicuous turns directly downwards in the substance of the tegmentum (fig. 3) to escape in the sulcus between the anterior portion of the quadrangular lobule and the midbrain.

The brain weighs 45 oz. Right cerebral hemisphere, $20\frac{1}{4}$ oz.; left, $18\frac{1}{2}$ oz.; cerebellum $6\frac{1}{4}$ oz.

The *left cerebral hemisphere* is smaller than the right and shows on its mesial aspect a maze of thin-walled blood-vessels which penetrate its substance near the frontal pole. In places the pia-arachnoid shows slight thickening.

Vertical coronal sections show that the angioma invades the lateral ventricle where it forms a tangled mass. The left internal capsule is narrowed considerably and the lenticular nucleus and optic thalamus are small.

FIG. 4.—Right cerebral hemisphere showing complete absence of corpus callosum.

Right cerebral hemisphere.—The right half of the brain is entirely free from angioma and has a fairly complex arrangement of its gyri. Complete absence of the corpus callosum makes the mesial aspect appear unduly narrow in its vertical depth (fig. 4). The gyri cinguli lie directly above the body of the fornix and the two lateral halves of the latter form conspicuous bundles; there do not appear to be any transverse commissural fibres uniting them, and the septum lucidum is also absent. The pillars of the fornix have their usual connections and the anterior commissure and corpora mammillaria can be identified.

The posterior horn of the lateral ventricle is dilated and its walls thinned. The gyrus cuneus is on the surface and the two main sulci of the parieto-occipital group are widely separated by a superficial gyrus. There is no evidence of the radial arrangement of gyri said to be characteristic of acallosal brains.

MICROSCOPIC APPEARANCES.

Dura Mater.—Even to the naked eye it is obvious that the greatly thickened falx cerebri contains a large number of varicose vessels which give to it a noded appearance. In size these vary considerably, and it is by no means easy

FIG. 5.—Low power photomicrograph to show abnormal vessels in falx cerebri.

FIG. 6.—Transverse section of basilar artery showing great variation in thickness of the media.

to determine which are veins and which arteries, but the presence in many of a definite internal elastic membrane shows that arteries are certainly present.

With few exceptions the vessels have a mural structure totally unlike that of the normal artery or normal vein.

The intima of a vessel varies much in thickness ; at one side it may consist of a single row of flattened cells while at a neighbouring point there may be a localised area of proliferation, sufficiently marked to form an ingrowth encroaching on the lumen of the vessel. The cells lining the intima belong to the pavement type but in one vessel they have the typical appearance of cubical epithelium. In those situations where the intima forms nodules the elastica interna is usually split into several layers.

FIG 7.—Medium power photomicrograph of vessel in falx cerebri. Note great variation in the thickness of its walls. A leiomyomatous nodule can be seen at one end of the vessel.

The tunica media also shows marked variation in thickness (figs. 5 and 6) and in some situations is either entirely absent or to a large extent replaced by connective tissue. Thickenings in the shape of leiomyomatous nodules are not uncommon (fig. 7) and for the most part the muscle-fibres have a circular arrangement. Everywhere there is marked vascular engorgement.

Cerebrum.—Microscopic examination shows that the angiomatous tangle in the left cerebral hemisphere is far more extensive than naked eye examination would suggest, for abnormal vessels can be demonstrated in practically every area of the cortex except the occipital.

The ventricular walls are also implicated, but the basal ganglia escape. In contrast with the extensive implication of the left cerebral hemisphere, the

right shows microscopic evidence of angiomatous formation only on its mesial surface, there being no vessels with faulty structure in any of the cortical areas on the convex surface.

Coronal sections through the left cerebral hemisphere show that in the frontal region practically two-thirds of the tissue is composed of angioma. Low power examination shows an enormous number of dilated arterioles or veins all of which exhibit the abnormalities of structure detailed above. Between them there exists gliosed cerebral tissue in varying quantity, and a marked proliferation of the marginal glia is present in practically every region of the left cerebral hemisphere.

Degenerative changes both in the vessel walls and in the surrounding tissues are widely present. For the most part these are represented by deposits

FIG. 8.—Vessels of angioma showing calcification of their walls. Haematoxylin stain.

of salts of iron and calcium; in the vessels the calcium granules have in part coalesced to form solid rings in the adventitia (fig. 8). In the gliosed tissue surrounding them inorganic substance is present in the shape of granules of varying size and in some situations a large vessel may be found surrounded by a ring of calcified capillaries.

Outside the actual tumour area calcium and iron salts are found in the cortical grey matter so widely distributed that it is impossible to find a single cortical field in the left hemisphere which does not show some degree of deposit. Even in the area striata large deposits are present. One additional feature of interest must be referred to. In the centre of the angiomatous mass shown in fig. 2 a small plaque, staining deeply with fuchsin, was discovered. On examination under a higher power this was found to be composed of a substance identical

in appearance with hyaline cartilage (fig. 9). For the most part the cells are branched and their number and disposition suggests embryonic rather than adult cartilage.

The nerve-cells of the cerebral cortex exhibit chronic degenerative changes and a marked disturbance of their lamination in the neighbourhood of the angioma. Instead of the normal arrangement in which the apex is directed upwards and the base of the cell downwards many of the cells lie horizontally or obliquely much as in the brain of the general paralytic.

The Aneurysms.—The large saccular aneurysm on the anterior cerebral artery consists of two coats only, viz., intima and adventitia. No elastic lamina can be seen. Considerable variation in thickness of the wall is present and a deposit of calcium salts can be seen in various situations.

FIG. 9.—High power photomicrograph to show cartilage cells in substance of angioma.

The small aneurysm on the basilar artery was studied in serial sections. The parent vessel has a wall of varying thickness and its three coats are quite distinct. At the point where the aneurysm is given off the intima is thickened, the internal elastic lamina split and fragmented and the muscular layer poorly marked owing to replacement of muscle-fibres by connective-tissue cells (fig. 6). Sections of the dilated carotid arteries show no structural abnormalities.

The spinal cord was not removed and the structure of its vessels could not therefore be followed. Abnormal vessels were, however, found in the pia-arachnoid covering the medulla oblongata. One of these situated in the roof of the fourth ventricle showed a curious fenestration of its wall which was not seen in any other situation.

Deposits of Iron and Calcium.—The presence of a gritty deposit both in

the substance of the angioma and in numerous cortical areas of the left cerebral hemisphere could be demonstrated by feeling the tissue and in some situations by inspection alone. This material made section-cutting difficult, as the knife edge soon became blunted and the sections torn. In unstained frozen sections yellowish masses of irregular shape can be seen in the deeper layers of the grey matter, either in discrete particles or aggregated into clusters surrounding the blood-vessels. With hæmatoxylin staining the sections have an intense bluish black colour.

Many of the larger vessels show a deposit of calcium in the thickened media and this is sometimes so marked that the vessel wall appears as a solid ring of calcium.

The small capillaries both in the angioma and in the grey matter of the cortex are brought into sharp relief by the presence of minute dark-staining granules immediately outside their walls ; in some situations they are converted into solid calcified tubes.

Chemical Analysis.—It has been shown by Eaves² that the hæmatoxylin reaction usually considered specific for calcium may also be given by deposits of salts of other metals, notably iron and magnesium. It was therefore considered advisable to check the histological results by chemical analysis. For this purpose pieces of cortex with white matter from the edge of the angioma and from the opposite cerebral hemisphere were excised. The samples were ashed and the ash dissolved in acetic acid. From this the calcium was precipitated as oxalate, and the oxalate was titrated in sulphuric acid with potassium permanganate. The acetic-insoluble residue was dissolved in hydrochloric acid and the iron estimated by comparing with standard solutions of iron and using the Prussian blue reaction.

Case of Cerebral Angioma.						Calcium mgm. per 100 grm.
Right cerebral hemisphere	...	...	...	...	...	31
Left cerebral hemisphere	...	...	...	...	...	158
Normal according to						
Geoghegan	...	...	...	...	...	1.6
Cameron	...	...	...	...	...	10
Hoppe Seyler	...	...	...	...	...	10
Own analysis	...	...	...	...	...	13

The calcium estimate above is almost certainly too low, since the brain had been four years in formalin, which is always acid and would therefore tend to dissolve out some of the calcium salts. The fact that the calcium is still far above normal is therefore conclusive in showing that the calcium was much increased, and makes it practically certain that the deposits seen were deposits of calcium salts.

An analysis of the iron present was not made since an estimate of the iron would have little meaning when such large blood-filled veins were present in the sample.

DISCUSSION.

In their survey of the aneurysmal angiomas Cushing and Bailey refer to the widely accepted view that there is a congenital malformation of the blood-vessels which at a later period of life takes on an increased activity in response to some form of stimulus, and especially trauma. In one of their nine cases a history of a blow on the head was forthcoming; a similar accident appears to have befallen our patient, and if the appearance of dilated veins on the forehead marked the commencement of the angioma, then the latter must have been in existence for 34 years.

Of the *clinical symptoms* perhaps the two most important are increased extracranial vascularity and an audible intracranial bruit. It is hardly possible to miss the former, but, as Cushing and Bailey point out, auscultation of the skull seems to be the one thing likely to be neglected in a routine neurological examination. In their series of nine cases a bruit was present in all but one; it varied however from case to case, in the time of relation to other symptoms, in its intensity and in its persistence. In our case the throbbing mass of vessels on the forehead suggested the presence of a bruit, yet oddly enough none was detected, possibly because the stethoscope was employed on only two occasions. The diagnostic importance of increased extracranial vascularity is almost equal to that of an extracranial murmur, but secondary phenomena of this sort are by no means constant; in Cushing and Bailey's series they were conspicuous in only two cases. This increased vascularity commonly affects the vessels of the scalp and the large arteries of the neck; with it there is usually some degree of cardiac hypertrophy. In the case reported above extracranial vascularity may be said to have dominated the clinical picture, visible pulsation being present in the snarl of vessels on the forehead, in the carotids and in the facial and temporal arteries. After death all these vessels were found to be much enlarged and the heart hypertrophied. As Holman³ has demonstrated, the explanation of these hypertrophies probably lies in the increase of blood volume which never fails to follow the establishment of an arteriovenous fistula. A third sign on which stress may be laid is the presence of exophthalmos, especially when unilateral. It was found in three of the nine cases observed by Cushing and Bailey and was so much more marked on the site of the lesion as to be essentially unilateral. In our patient the exophthalmos was of equal degree on both sides, possibly because the angioma occupied a position between the two hemispheres, although it must not be forgotten that a mild degree of exophthalmos is a not uncommon feature of increased intracranial tension from whatever source.

Choked disc is another feature which tends to go hand in hand with exophthalmos and is probably determined by a similar process; it was present to a moderate degree in the case now reported.

Epileptiform seizures are a very common manifestation of cerebral angioma and are not infrequently the cause of death. They were present in over 50 per cent. of the angiomata described by Cushing and Bailey, who suggest that the explanation of their frequency is to be sought in the fact that the middle cerebral artery being the most widely distributed of the intracranial vessels is more likely than others to be involved and that in consequence the paracentral convolutions are likely to be implicated. Our patient had suffered from major epileptic attacks for more than 25 years and it was only at the end of her illness that local fits became a feature of the case. Although the middle cerebral artery did not entirely escape, it was in the distribution of the anterior cerebral artery that the greater portion of the tumour was located and there was no very definite evidence of involvement of the motor gyri.

Pathological Features.—Clinically, the patient exhibited so many of the essential manifestations of intracranial angioma that a diagnosis during life could be made with absolute certainty. The presence, too, of pulsating vessels on the forehead naturally suggested a blood-vessel tumour situated in the fore part of the brain, but its extraordinary size and ramifications were not suspected while the patient was alive. In this respect the case must be regarded as one of a most exceptional character, for in nearly all previously reported cases aneurysmal angiomata are confined to the domain of one cerebral artery, and though they penetrate deeply into the brain they have a limited wedge-shaped configuration with the apex of the wedge projecting inwards towards the ventricles. As will be seen from the illustrations the inextricable coil of vessels in our case lay on the whole of the mesial surface of the frontal convolutions and was connected with large sinus-like vessels in the neighbourhood of the crus cerebri, so that the angioma may be said to have covered nearly two-thirds of the mesial surface of the left cerebral hemisphere.

Another unusual feature in this case was the involvement of the falx cerebri, which in places was almost half a centimetre in thickness. This must be looked upon as altogether exceptional, as the majority of arterial angiomata are said to originate in the vessels of the pia mater, and the veins of exit, when present, enter the sinuses without disturbance of the structure of the dura. In one of Sachs's⁴ cases, however, the angiomatous process was found to be in the dura, although numerous pial connections were also present.

A third peculiarity of this case was the presence of aneurysmal dilatations both in close proximity to the angioma and at some distance from it. Lesions of this type have been reported by Falk⁵ and Leiser⁶, and in both rupture of the aneurysm was responsible for the patient's death. This, indeed, is the usual history in any case of intracranial aneurysm, provided it is of considerable size. In Fearnside's⁷ series signs attributable to cerebral hæmorrhage occurred in 80.7 per cent. of the cases, and it is not easy to understand how in this case an aneurysm so thin as to be translucent could yet maintain the continuity of its walls.

It has been shown that in the formation of these aneurysms a congenital weakness of wall at the junctional points plays an important part, and this could be demonstrated in serial sections of the small aneurysm on the basilar artery.

So far as we are aware in no previously reported case has absence of the corpus callosum been found; and while the association of these two rare congenital abnormalities must probably be looked upon as purely accidental it is impossible to dismiss entirely the possibility of the absent corpus callosum being brought about by the constricting influence of the enlarged falx cerebri on the anterior cerebral vesicle. This, however, is extremely unlikely, for constriction of the cerebral vesicle by the primitive falx occurs at a very early period of development—about the eighteenth day—and there is no evidence that an angioma can exist at so early a stage; indeed all the evidence goes to show that blood-vessel tumours of this character never occur in infancy or childhood.

According to Bruce⁸ irregular distribution of the anterior cerebral arteries has been admitted to be a possible cause of agenesis of the corpus callosum; certainly in our case one of these vessels was grossly abnormal, but at what stage of development the abnormality occurred it is impossible to say.

Space does not permit of our referring in detail to the anatomical peculiarities consequent on absence of the corpus callosum, but among the points of special interest we may note that its absence was complete, that it was not associated with a radial fissuration on the mesial aspect of the hemisphere, but was accompanied by a pronounced dilatation of the posterior horn of the lateral ventricle.

Microscopic Appearances.—In this case the histological appearances are on the whole typical and do not differ in any important detail from those previously described. One may note the unequal development of the vascular walls, the faulty formation of the media, the presence of leiomyomatous nodules and intimal overgrowth; the splitting, faulty development and occasional absence of the elastic membrane and the aneurysmal swellings of microscopic size.

In the neighbourhood of the angioma the cerebral tissue showed sclerosis and irregular arrangement of nerve-cells. Peculiar to this case were the presence of cartilage-cells among the tangle of angiomatous vessels, and several vessels with an endothelial lining of cubical cells.

The widespread distribution of the above changes was perhaps the most important feature in the case, it being possible to find abnormal pial vessels as far apart as the occipital and temporal poles of the left cerebral hemisphere. In addition to this, abnormal vessels were found in the substance of the mid-brain and beneath the tentorium cerebelli.

In the aneurysms the changes encountered were very similar to those described by Cushing and Bailey, Green⁹ and others. The large saccular aneurysm consisted of two coats only, viz. adventitia and a markedly thickened

intima, while in the smaller aneurysms a deficiency in the elastic and muscular elements of the vessel wall was the principal abnormality. Although the carotid arteries showed a calibre much greater than the normal, little or no abnormality could be discovered on microscopic examination.

Calcium and Iron deposits.—Calcification in brains which are the seat of angiomas is a common feature and may often be demonstrated in X-ray photographs of the skull. Its mode of formation is not fully understood. Mallory¹⁰ has shown that colloid droplets are first deposited in the vessels and these at a later date become calcified. In the larger vessels this takes place in the media. Other writers, particularly Eaves, have suggested that the process of calcification may occur when the nervous tissue in the region of the angioma undergoes degeneration, the phosphoric acid set free tending to fix calcium, but this explanation seems almost too simple and it appears likely that some other factor must be added; otherwise, calcification would be a much more common finding.

Another explanation which has been suggested is related to the increased intracranial vascularity. In many of the cases reported reference is made to the presence of cardiac hypertrophy and if the blood pressure is raised, as it usually is, it is possible that the congenitally defective vessels of the angioma may be the site of calcium deposits, just as in atresia of the aorta calcification of the vessels may occur.

It is noteworthy that except in the neighbourhood of the angioma the deposits of calcium and iron were confined to the deeper layers of grey matter. It is in this situation that the short arterial twigs passing in from the pia mater terminate or become their smallest, and it has been suggested that the pathological process underlying calcification is a slowly progressive obliteration of the end-arteries, with a consequent production of areas of focal sclerosis. This in its turn is followed by a deposit of calcium in the walls of the obliterated vessels and in the surrounding nerve tissue. Possibly some other at present undetermined physicochemical factor is concerned in the process, for it may be recalled that the third and fourth cortical layers have a peculiar vulnerability which is shown in other diseases such as lead poisoning, intoxication by carbon monoxide, and pseudosclerosis.

SUMMARY.

1. In her nineteenth year the patient received a blow on the head; some little time afterwards a bunch of enlarged veins appeared on the forehead; this was followed by the development of severe headaches, defective gait and paralysis of the right upper limb.

2. Epileptic fits commenced when the patient was 26. At first slight, the fits ultimately became of the grand mal type and were associated with a marked degree of dementia. The patient died convulsed in her fifty-third year.

3. Post-mortem examination revealed the presence of a large angioma occupying the mesial surface of the frontal convolutions of the left cerebral

hemisphere and lying principally in the territory of the anterior cerebral artery.

4. The vessels entering into the formation of the angioma had the structure of veins and arteries, some being of tremendous size.

5. Saccular aneurysms were also present on the basilar and left anterior cerebral arteries; the former was minute, the latter the size of a pigeon's egg.

6. Microscopically, the angiomatous vessels showed proliferation of the intima, absence or splitting of the internal elastic membrane, imperfect development of the tunica media and thickening of the adventitia.

7. Deposits of calcium and iron were found in the vascular tumour and in numerous cortical areas.

8. The left cerebral hemisphere contained 158 mgm. of calcium per 100 grm. brain. The right cerebral hemisphere contained 31 mgm. of calcium per 100 grm. brain.

9. Abnormal and aberrant vessels were found in the substance of the midbrain.

10. The falx cerebri was markedly thickened and contained angiomatous vessels.

11. The corpus callosum was entirely absent.

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