VASCULAR TUMORS OF THE BRAIN AND SPINAL CORD AND THEIR TREATMENT

MASON TRU PP, M.D.,* AND ERNEST SACHS, M.D.

Washington University School of Medicine, St. Louis, Missouri

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Blood vessel tumors of the nervous system have given rise to considerable discussion for many years. Virchow was the first to point out that, as a rule, they are of congenital origin.

In 1915, one of us (E.S.) described a number of these lesions and, in order to make it clear that they are not true tumors, suggested the term intracranial telangiectasis. This term has not been generally accepted, though Cushing and Bailey, in a comprehensive monograph on these "tumors" in 1928, divided them into four groups and used this term to describe the first of their groups, which were as follows: (1) Telangiectases; (2) angioma venosum; (3) angioma arteriale; and (4) hemangioblastoma.

That the first three types are not true neoplasms is well recognized by pathologists, and in his recent Textbook of Pathology Robert Moore brings this point out clearly. In the opening sentence of the section on tumors of vessels, he says: "Benign tumors of vessels are of two types, hemangioma and lymphangioma. Most examples are not arteriovenous neoplasms but remnants of fetal tissue misplaced or disordered in development. . . ."

He further points out that, of the four types Cushing and Bailey describe, the only one that may be called a true neoplasm is the hemangioblastoma. This is the view that one of us (E.S.) has maintained and taught for many years. Cushing and Bailey make the statement: "From our personal experience, it is evident that surgery, at its present state of development, offers little as a means of controlling one of these lesions in the brain by direct intervention and any attempt at their operative removal is foolhardy."

In 1929 we attempted for the first time to treat one of these lesions by coagulation (Case 27). Because the treatment of these tumors constitutes a problem of its own, it has seemed to us of interest to collect and report our experiences. Before entering into a discussion of this problem, however, we are obliged to state that we have found Cushing and Bailey's classification unsatisfactory, since both clinically and pathologically it is not possible to differentiate the four types they describe. There are imperceptible gradations ranging from telangiectases to venous and arterial angiomata in which one or the other type of vessel predominates. The one type that is a distinct entity is the hemangioblastoma, which is a true tumor. In this paper, however, we are considering only those cases that fall into the first three groups.

Certain men's names are associated with descriptions of these tumors, notably von Hippel, Lindau and Dandy. These men have made notable

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* Fellow in Neurological Surgery, Washington University School of Medicine, 1945-1947. Now at 349 Plant Avenue, Tampa 6, Florida.
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contributions which have tended to clarify some phase of the subject. von Hippel in 1904 described an angiomatous condition in the retina; Lindau in 1927 pointed out that these lesions might be multiple and that when they occurred in the eye there were frequently lesions also in the brain. In 1930 one of us pointed out that, since in certain cases of polycythemia choked discs had occurred, the possibility that a tumor might be present should be considered in every instance. Carpenter, Schwartz and Walker\(^4\) in 1943 proved that this was true and demonstrated in two cases of so-called polycythemia vera that the underlying cause actually was an angioma of the cerebellum, and that, when this tumor was removed, the blood picture became normal. We had such a case in 1944 (Case 10). Whether eyeground changes that are indistinguishable from choked disc may occur in polycythemia and yet not be associated with tumor is as yet an unsettled question.

All the patients in this series have been operated upon by one of us (E.S.) or by Dr. Leonard T. Furlow. In this series there are 28 cases of angioma. Of these, 7 occurred in the spinal cord; the other 21 occurred in the cerebral or cerebellar cortex. All lesions, both cranial and spinal, fall into one of three categories: telangiectasis, angioma venosum, or angioma arteriale. At times it was impossible to determine to which group a case belonged. In the early cases, the symptoms are indistinguishable and in the well developed cases, it is often quite impossible to distinguish between an angioma venosum and an angioma arteriale. The classification made by Cushing and Bailey, therefore, is quite arbitrary, since not infrequently there is a mixture of the two latter types (Case 13). Hence, from a clinical point of view, whether of treatment or prognosis, it is entirely adequate to call these lesions either telangiectases or angiomata.

**DIAGNOSIS**

The diagnosis of these conditions prior to operation is very difficult to make; in fact, in most cases it may be little more than a suspicion. Although we have, on several occasions, suspected such a lesion, an absolutely positive preoperative diagnosis has rarely been possible. Occasionally the diagnosis may be made from the roentgenogram, as in Case 13 (Fig. 5). In this case, many of the larger vessels of the angioma were calcified but, at operation, the picture that presented was very different, for, in addition to the larger vessels seen in the x-ray, there was a mass of capillary vessels (Fig. 6). In the spinal cases, there is usually nothing distinctive. Of course, when a patient with a large skin telangiectasis, as in Case 12, suddenly develops a paraplegia with a level corresponding to the site of the skin lesion, the diagnosis is obvious, or, as in Case 21, a very unusual history may make such a diagnosis probable. In the cranial cases, the history of prolonged Jacksonian convulsions, without pressure symptoms and without the history of trauma, should make one suspect such a lesion. If, in addition, there are lesions in the skin, this becomes more likely. If there is a vascular abnormality of the retina, as in Case 19, an intracranial blood vessel lesion is probable.
The spinal cases, as will be seen from the abstracts which follow, presented the picture of a focal spinal lesion which might be produced by any tumor. The cranial cases, on the other hand, had local signs, but the one sign most striking was the absence of choked disc. Since we frequently see tumor cases that have no choked disc, this is of no value in differential diagnosis. It was Hughlings Jackson who made the statement: "The absence of a symptom has no diagnostic value."

In the entire series, only 3 patients had a bruit which could be readily heard (Cases 3, 7, 13).

TREATMENT

There is no lesion one sees at the operating table that is more breathtaking than one of these large angiomatous lesions. Sometimes the vessels are huge. In Case 27 the main vessel was fully as large as a little finger and very thin-walled. Fig. 9 illustrates the great variation in the size of vessels. Often there are large vessels with a nest of small vessels so densely matted together than the underlying cortex cannot be seen. It is impossible to determine whether such a nest of vessels is arterial or venous or whether it is a dilated capillary bed, which it may well be. And it was to such a case that the term telangiectasis was applied. The vessels are so thin-walled that their ligation is very precarious. We have tried ligation and occasionally have succeeded, but much more frequently have abandoned the procedure because the sutures tore through. Silver clips, also, are useless because they are too small to encompass many of the larger vessels.

In 1929, while operating upon Case 27, we accidentally discovered a new method of applying electro-coagulation. By using a very low coagulating current and stroking along the vessel wall, it is possible gradually to shrink the very largest vessels and then, finally, to obliterate them. The procedure must be carried out slowly, a very low current must be used and the vessel must be stroked backward and then forward but never grasped. This latter precaution is essential, for if a vessel is grasped and coagulated the tissue will stick to the forceps and this, when removed, may tear the vessel.

Since our success with this method in 1929, we have used electro-coagulation on these tumors whenever possible. In the series that follows we employed this method 19 times. It proved efficacious in 15 cases: Cases 2, 6, 7, 10, 11, 12, 13, 14, 15, 17, 21, 22, 23, 26 and 28, though only partially in Case 27. In Cases 3, 8, 18, 19 and 21 the method either was not used or proved ineffective. In Case 21, every time a vessel was touched, even with the weakest current, it blew up. Silver clips and silk ties also were useless so we were obliged to abandon the procedure. Case 21 has been operated upon three times and each time we had to back out after transfusing the patient repeatedly. The lesion (see history) involved the spinal cord and subcutaneous tissues extensively.

In some cases we have followed the operation with deep roentgen therapy. This is routine procedure, of course, with the hemangioblastomas, but how
much effect x-ray has on the telangiectatic-like lesions or angiomas containing huge vessels, is not clear to us. In one case (24) we thought that an excessive amount of x-ray might have been a factor in the patient’s ultimate death, 11 years after she was first seen.

In the past year, Pilcher has described 3 cases in which he excised the entire lesion. This seems to us an extremely radical procedure and certainly would not have been applicable to most of the lesions recorded in this paper.

MORTALITY

Using electro-coagulation as here described is not a dangerous procedure. In our series of 28, there were 4 operative deaths (Cases 3, 15, 17, 24). The cause of death in Case 3 was a spreading cerebral thrombosis, and this is a complication one always fears, yet there is no reason why it should occur any more frequently after the vessels have been occluded by coagulation than by ligation. There have been several deaths which have occurred a long time after the operation and which cannot in any way be attributed to this procedure. Case 11 had an angioma coagulated and remained well for 4 months, after which she developed new symptoms; a former assistant re-operated upon her in my absence, and she died 2 days later. Just what the cause of death was, we never knew.

CONCLUSIONS

We have described a method for treating certain vascular lesions of the brain and spinal cord which, in our hands, has proved of great value. Only in rare instances has it been ineffective but in those cases in which the vessels were so very friable, no other form of surgical treatment would have been applicable.

CASE REPORTS

Case 1. R.D., boy, aged 10. Referred by Dr. Dawson of Cape Vincent, New York. Admitted July 1909 to Beth Israel Hospital, New York with complaint of convulsions in left face, arm and leg. Past history was negative except for injury 4 years prior to admission. One year later, he began to have convulsions, starting in left arm and leg. These occurred once a month.

Examination. There was a suggestion of ankle clonus on both sides; eyegrounds were normal; neurological findings otherwise were negative. Patient was sent home on anti-convulsants. No improvement occurred and he returned in November. Dr. Charles Dana saw him in consultation and recommended exploration.

Operation Nov. 19, 1909. On opening the dura, an extensive mass of vessels was exposed over the cortex (Fig. 1). These vessels were connected with pial veins. Nothing was done and there was the usual closure.

Course. The patient had an acute suppression of urine. Three weeks postoperative a cerebrospinal leak developed. The wound was reopened December 7. Some of the vessels were ligated. Patient was euphoric after operation but died 14 hours later with hyperthermia.

Diagnosis: Angioma.

Case 2. H.A., male, aged 22 (B.H. No. 74571). Referred by Dr. W. S. Barcus, Fort Worth, Texas. Admitted April 24, 1939. Patient had been perfectly well until 4 weeks before admission when he noted blurring and double vision. In the course of the next weeks, the right eyeball was drawn far to the right; no headache or vomiting.
Examination. Neurological findings, aside from 3rd and 4th nerve paralysis on right, were negative. Encephalogram and Wassermann negative. Preoperative diagnosis: Lesion in region of sphenoidal fissure. Type of lesion was not suspected.

Operation. A huge group of vessels was encountered in the sylvian fissure which ran down into the cavernous sinus. They were entirely independent of the normal cortical circulation. The vessels were coagulated without impairing cortical circulation.

Course. Recovery was uneventful. Patient was last heard from in October 1939; eye movements had recovered almost completely.

Diagnosis: Partial arterial and venous angioma.

Fig. 1. Case 1. This mass of vessels undoubtedly could have been coagulated if we had developed the technique at this time.

Case 3. J.H.B., male, aged 29 (B.H. No. 109572). Referred by Dr. N. S. White, Tulsa, Oklahoma. Admitted Nov. 22, 1943, with complaint of headaches for 3 years; and loss of vision, dizziness and ringing in ears for 2 years. Past history was negative. His illness began with increasing headache and loss of vision in left eye. Vision in right eye was also impaired and for past 8 months patient could not read. He had lost weight, from 300 pounds to 150.

Examination. There was exophthalmos on the left, with hyperemia and dilatation of vessels of left lid and conjunctiva. There was optic atrophy but no evidence of previous choked discs. X-ray showed large sella. Two convulsions occurred 2 days after admission. Exophthalmos was pulsating, and over the eyeball a loud bruit could be heard. Impression: "Left frontal lesion. Sudden increase of symptoms may be due to an aneurysm rapidly increasing in size but which has not ruptured, as there is no stiff neck. Inadvisable to do a lumbar puncture. To be explored under local anesthesia."

Operation. A huge angiomatous lesion was found over the left cortex, partly arterial and partly venous. Coagulation was attempted but each time a vessel was touched with the
elektrode, it ruptured. No suture or clip would hold as the vessels were so delicate and friable. Finally, a large piece of muscle was removed from the thigh and plastered on the cortex. This stopped the bleeding.

**Course.** Patient left operating room in good condition, but never regained consciousness and died next day. Postmortem showed no secondary hemorrhage but a spreading thrombosis.

**Diagnosis:** Angioma of the cortex.

**Case 4.** W.T.B., male, aged 23 (B.H. No. 40937). Referred by Dr. Paul Weber, Olney, Illinois. Admitted Nov. 9, 1933, with paralysis of both legs. Past history was unimportant except that, 6 years before, he had had intermittent attacks of urinary incontinence. This cleared up until his present illness, when it recurred. Two and a half years before, patient was thrown from a road scraper. He continued work but had soreness of his back, and then girdle pains and increasing difficulty in walking developed. In October 1931 he fell down stairs and was unconscious for 80 minutes. On regaining consciousness he was completely paralyzed in both legs. The legs recovered enough to enable him to walk with canes and then crutches, but for the last several months, the disability had been increasing.

**Examination.** There was complete loss of sensation from D6 down and spastic paraplegia. Queckenstedt test: Complete block with total protein of 172 per cent. Kahn was negative.

**Operation,** by assistant of E. S., revealed a tumor lying to the left of the cord at D1 and 2 spines. This was removed. The cord was ribbon-like.

**Course.** There was no improvement after operation. Sections showed malignant lymphangioma. Patient returned 2 months later with evidence of spreading of the process. No further surgery was indicated.

**Diagnosis:** Lymphangioma of cord.

**Case 5.** L.F.R., female, aged 31 (B.H. No. S-16972). Referred from Washington University O.P.D. Admitted Jan. 17, 1924. Present illness began 10 years before, in 1914, with difficulty in walking which gradually increased, and the right leg became weaker. At the end of 4 months the patient had to use crutches. There were periods of remission. In 1917, 3 years after onset, she lost voluntary control of both lower extremities, and also bladder and rectal control.

**Examination.** Positive findings were: High degree of spasticity in both lower extremities; absent right abdominal reflexes; bilateral ankle clonus, Babinski and Oppenheim. No pain was present; all forms of sensation were diminished from umbilicus downward on both sides.

**Operation** Jan. 18, 1924. Under general anesthesia a laminectomy was carried out with removal of D7 to D10 spinous processes. When the dura was opened, a huge venous angioma compressing the spinal cord was exposed. In order to excise it completely, the 11th and 12th spinous processes also had to be removed. The large vein compressing the cord was doubly ligated both above and below (Fig. 2), and then excised. Usual closure by layer suture.

**Course.** Patient made an uneventful recovery but was very slow in regaining use of her legs. She was discharged May 15, 1924, still in a markedly spastic condition.

**Diagnosis:** Venous angioma.
Case 6. S.L.C., female, aged 21 (B.H. No. 91088). Referred from O.P.D., complaining of lump on head. Past history was irrelevant. Six or 7 years before, patient noticed a lump on her left forehead, which disappeared when she lay on her back but appeared when she leaned over. No symptoms were noted until 6 months before admission when mild pain occurred, and the mass became tender.

Examination. Neurological studies were entirely negative. The mass was to left of midline. No bruit, but occasional transmitted pulsation was noted. There was a small defect in the bone at the site of mass.

Operation (Dr. Furlow). Destruction of venous angioma with electro-coagulation. Lesion in the bone was plugged with wax.

Diagnosis: Angioma of frontal bone.


In 1928 the patient had a right-sided convulsion; 3 months later another convulsion occurred, starting in the right hand. In 1929 she had 7 focal convulsions in 1 week; in addition there were crying and screaming spells; also headache, double vision and occasional vomiting. Staggering gait was noted since September 1931. In the 2 weeks before admission, her husband observed right facial weakness.

Examination. She had uncontrolled outbursts of crying and laughing. There was slight paraphasia. Left pupil was larger than right, and bilateral choked discs with hemorrhages and exudate were noted. In addition, there were diplopia, right facial paresis, and weakness of the right upper and lower extremities. A bruit in left occipital region and mastoid was obliterated on jugular compression. Impression: An angiomatic lesion or very vascular tumor.

Operation revealed a large tumor mass with huge vessels. Some of them were coagulated and some clipped. Then we tried to cook the tumor by inserting an electric needle. This worked fairly well but there was some severe hemorrhage.

Course. The wound did not heal perfectly due to impaired circulation. Patient was discharged Jan. 21, 1932. She was readmitted May 4, 1932 because of continued convulsions. There was general improvement, and swelling of discs had subsided. She was treated with deep therapy. Death occurred a year later, cause unknown.

Diagnosis: Venous angioma.

Case 8. J.E., female, aged 44 (B.H. No. 134051). Referred by Dr. Gronoway of Macon Missouri. Admitted April 2, 1946, with complaint of weakness of right leg for the last 4 or 5 years. In October 1922 she had some trouble with her right leg and collapsed, but was not unconscious. In 1925, 3 days after delivery, she had two convulsions. She was put on pheno-barbital then, but from that time on she had occasional convulsions and began to limp about 8 years before admission. In 1945 she saw Dr. Maugs of St. Louis, who had roentgenograms taken which showed a calcified tumor in her left temporal region.

Examination. Eyegrounds were normal; abdominal reflexes were difficult to obtain; right lower extremity was weaker than left; right ankle jerk and knee jerk were more active than left. A positive Babinski and Chaddock and unsustained ankle clonus on the right were also noted. There were no sensory changes.

Operation (Dr. Furlow). On turning a flap on the left side, and opening the dura, a large angioma was exposed. Some of the vessels were as large as a pencil; they covered the temporal lobe and extended up towards the longitudinal sinus. Some of the smaller vessels were coagulated, the large ones were not. On account of the size of the vessels, it was decided not to attempt to coagulate the larger ones and to give the patient deep x-ray therapy.

Course. She was discharged on April 29, 1946 and has been followed since. She has had only one convolution since operation and has definitely shown some improvement. In view of the fact that the patient has not improved as much as we should like, however, a second operation is being considered in order to try to remove the angioma.
Case 9. C.E., male, aged 10 (C.H. No. S-1873). Admitted Feb. 8, 1915. He had had 5 convulsions, 1 at age of 3 months, 1 at 5 years, and 3 between May and October of 1914. Attacks were all of the same character; they began with convulsive movement of left arm and hand. They were preceded by nausea, and the patient was able to run into house before the convulsive movements started.

Examination. There was an angioma on the face; otherwise physical examination was negative. "The fact that the patient has an angioma of face may mean that he has a similar process on the cortex."

Operation, Feb. 12, 1915. A mass of blood vessels was found on the dura; these connected with cortical vessels (Figs. 3 and 4). The middle meningeal artery was ligated and the vessels between dura and cortex were ligated.

Course. The patient had a few convulsions after operation. When last heard from, some years later, he was entirely free of convulsions.

Case 10. J.O.H., male, aged 20 (B.H. No. 114343). Referred by Neuro-medical Service and Dr. Harvey Howard. Admitted May 22, 1944, with complaint of blindness. Past history was negative. His illness began February 1928, with acute throat infection. Two months later dizzy spells and vomiting developed, which increased in severity. Five months after onset patient began to gain weight and to have blurred vision. At this time he was told he had polycythemia. In January 1929 the sight of his left eye had completely gone.

Examination. The patient was fat and pudgy in appearance. He was completely blind on the left; he had some light perception on the right. There were very moderate bilateral choked discs and suggestive pathological toe signs, but no cerebellar symptoms whatever. X-ray showed increased pressure and markedly enlarged sella turcica with destruction of dorsum sellae. Blood count: Rbc 6,230,000; wbc 9,450. Hb. 15.6 gm., 101 per cent.

Operation. Ventriculogram: Greatly dilated lateral and 3rd ventricles. Cerebellar craniotomy, with exposure of huge mass of vessels running up from the spinal canal. Attempts were made to coagulate the vessels, but they ruptured. To control the hemorrhage, it was necessary
to pack in a large amount of fibrin foam. This controlled all bleeding, and the wound was closed.

**Course.** The patient made a good recovery.

**Diagnosis:** Angioma of the vermis in a patient with polycythemia.

**Case 11.** L.J., female teacher, aged 22 (B.H. No. U-37703). Referred by Dr. L. E. Freimuth, St. Louis. Admitted Mar. 13, 1933, with complaint of visual disturbances for 6 weeks and staggering gait for 3 weeks. Past history was negative. Her illness began 8 months before. After diving many times, she noticed numbness of the face and then of the right leg. This lasted 2 months and disappeared. In the last 3½ months she had noticed visual disturbances, inability to focus, and that the right eye turned in. There was diminution of sensation over right arm and leg and recently there had been paramnesia. She would call pupils by their wrong names. She knew this but could not help it. Also, she had a sensation of unreality preceded by an aura of smell and taste. In the last few days there had been some speech defect. There were no motor convulsions but an unexplained biting of the left side of her tongue. The patient was right-handed.

**Examination.** Eyegrounds were normal (questionable). There were right 6th and 7th nerve weakness, present for many years; hypesthesia of right side of body, and partial motor involvement; Babinski on left; and no other reflex changes. Fields were done with difficulty because of patient’s dizziness but a partial, left homonymous hemianopsia seemed to be present. This patient had most elaborate visual hallucinations. On a number of occasions, while walking to school and in school, she had a sensation that she was a character in a history pageant. She knew she lived in the present yet was one of the characters of long ago. She felt as if the atmosphere were entirely changed. These attacks were unaccompanied by any visual or olfactory sensations, and were typical “dreamy states.”

**1st Operation.** A ventriculogram was attempted but the ventricle was so small that not enough air for a picture could be introduced. Therefore, we went ahead with a right-sided craniotomy to expose the temporal lobe. No tumor was found, but on incising the cortex there was some very troublesome bleeding from a large subcortical network of vessels. No coagulation was attempted. A decompression was done.

**Course.** X-ray therapy was given April, May and June 1933; following the last treatment, difficulty in walking developed. She was readmitted July 1933. Choked discs had developed, and the right facial weakness was more marked. There were right pyramidal tract signs.

**2nd Operation** (by former assistant as E.S. was out of town). Air injection was repeated and showed a right-sided lesion in spite of right-sided symptoms. The right side was re-explored. A nest of large vessels was encountered and removed by coagulation. The mass extended into the ventricle and was completely coagulated.

**Course.** Patient stood the operation well but, 2 days later, hyperthermia developed and she died.

**Diagnosis:** Angioma.

**Case 12.** M.J., female, aged 15 (B.H. No. 190809). Referred by Dr. L. V. Gates, Zeigler, Illinois, and Dr. A. B. Jones, St. Louis. Admitted Jan. 4, 1945, with paralysis of left leg of 2 days’ duration.

All her life the patient had had numerous naevi over the back. About 3 weeks before, while doing gymnastic work, tumbling and parallel bars, she suddenly felt an area of burning on her back. She thought she had injured some of the moles (patient’s name for them). This pain continued intermittently for 3 weeks. Two days before, while leaning over the table at breakfast, a sudden severe pain in the chest was felt, and several hours later at school, numbness of her right side developed. The pain was so intense that hypodermic treatment was given. When she woke up from this, both legs were numb. She was able to move the right leg but the left was paralyzed. She had to be catheterized, and her bowels would not move. There was tenderness over the spine of D5. Preoperative diagnosis: Hemangiomata of the cord, with subarachnoid bleeding. Lumbar puncture: protein 187 to 208 per cent; spinal fluid slightly greenish-yellow color; 630 crenated red cells; no block.
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Operation, Jan. 6, 1945. Pantopaque was injected, and blocked at D3. Laminectomy was done above the naevi. A number of large vessels were encountered which were coagulated. On opening the dura, a large angioma was found around the root of D5 on the right. The entire mass was coagulated, using very low heat. The mass shrievled up completely and was removed. Apparently the cord had not been injured by the coagulation. The dura was closed tightly, though I would have preferred to leave it open on account of the inevitable edema, but I feared the oozing.

Course. Spinal puncture after operation showed a complete block, but some cerebrospinal fluid was obtained. This continued for 3 days. Therefore, a 2nd laminectomy was done and the dura opened widely. The cord looked a little pale. Cerebrospinal fluid was obtained above the level of the lesion. Spinal puncture done at end of operation: no fluid was obtained; 3 days later puncture was followed by free flow of xanthochromic fluid. Reflexes were still absent 13 days after operation, but patient had slight sensation in left leg. She was discharged to her home physician Feb. 3, 1945. There was no voluntary movement of either leg. Slight reflexes were obtained; knee jerk and ankle jerk. Prognosis grave as to recovery of function.

Patient showed marked improvement, but when seen 3 months later had spastic paraplegia. April 13, 1946: She was walking with crutches, but still had no control over bladder. Last seen April 1947: Much better, has control of bladder, and walks with cane. Goes to school regularly. Given hydrotherapy and is exercising under water.

Diagnosis: Angioma of cord.

Case 13. M.J., male, aged 45 (B.H. No. U-86887). Referred by Dr. D. F. Stanley, Decatur, Illinois. Admitted Oct. 21, 1930, because of difficulty in vision and "epilepsy" for 3 years. He had been sent to large clinic in the north where he was told he had large blood vessels in his head and nothing could be done. Convulsions occurred once a month. He noticed a constant noise in his head. There had been difficulty in speech for 1 year.

Examination. The left fundus was normal; the right eye had a cataract and was slightly

Fig. 5. Case 13. Roentgenogram showing the greatly dilated calcified blood vessels.
prominent. Reflexes: Left greater than right; Babinski and Oppenheim on left but no clonus. An aneurysm in posterior occipital region was noted. There were right homonymous hemianopsia; nominal aphasia; and weakness of right side. X-ray showed huge, somewhat calcified blood vessels in left cerebrum (Fig. 5), in occipital and parietal regions, extending into frontal.

1st Operation, Oct. 25, 1930. Craniotomy. Bleeding from scalp was very severe. Patient had huge vessels which were coagulated, many coming through the bone. Blood spurted up a foot. Each opening was plugged with wax. Making the bone flap was a bloody procedure. When it was cracked back, there was profuse hemorrhage from numerous large dural vessels. This was controlled with coagulation, and a large piece of muscle. On opening the dura, a huge angioma of the occipital and temporal region was encountered (Fig. 6). By slowly stroking the vessels, they were coagulated and shriveled up. Not all the angioma was thus destroyed. We thought the rest might thrombose.

Course. He made an uneventful recovery, and was discharged Nov. 12, 1930. After operation, convulsions were very light. Patient was walking. He was readmitted Jan. 26, 1931 for further surgery because convulsions had continued though they were less severe.

2nd Operation. On reopening the flap, profuse bleeding was encountered. On the dura, where the large meningeal vessels had been, there were yellow strands, end result of coagulation. On opening the dura, we observed dense adhesions between the dura and the destroyed blood vessels. In trying to dissect the dura off, a huge extradural vessel ruptured; the bleeding finally was controlled by plugging it with muscle. Then the vessels in the temporal region were shriveled up with the coagulating current. The wound was closed in usual way.

3rd Operation, Mar. 4, 1931. Ligation of huge pulsating vessels over occipital region.


Case 14. M.K., male, aged 30 (B.H. No. 97002). Referred by Dr. Lawrence Goldman, St. Louis. Admitted April 20, 1942, with complaint of convulsions. In 1928 he had a severe head injury. Two years later the first of many convulsions occurred. They were nocturnal and about 6 months apart. Six or 7 years before admission, he had his first attack at day time. His left leg and arm drew up. There was definite aura of “uselessness of left arm,” often without an attack.

Examination. Eyegrounds were normal; eye fields not constricted. Left-sided reflexes were slightly increased; Babinski on left. Otherwise neurological findings were negative. Roentgenograms: Calcified shadow on right. Electroencephalogram: “Strong alpha rhythm from all areas with some frequency shift from the cortices. Only difference between hemispheres was the higher alpha from the right occipital. Within normal limits.” Preoperative diagnosis: Tumor, either meningioma or oligodendroglioma.

Operation. Right craniotomy under local anesthesia. On opening the dura, we ran into a
huge vessel, 5 to 7 mm. in diameter, running up from the temporal fossa. A number of vessels ran from the dura to this vessel. These were successively coagulated and cut, and then this large vessel lay in the field. It seemed to contain venous blood. The vessel was slowly and completely coagulated with the low current, then on stimulating the cortex we found the arm center just behind this vessel. The entire area of the arm center was coagulated but not excised. No convulsions. Usual closure with gutta-percha drain for 24 hours.

Course. For several days postoperative, patient had perfect arm movements. Then almost complete paralysis developed, which affected extension more than flexion but gradually cleared up. Presumably, as collateral circulation improved, all edema disappeared. As a prophylactic precaution, he was put on phenobarbital, 1 gr. twice a day. The question of deep x-ray was considered. Two months later, there was still slight weakness of left side at times; no convulsion. At end of 7 months, patient was seen again; still no convulsion. Therefore, no x-ray therapy given, but he was advised to continue phenobarbital for at least a year. He went back to his work in iron construction, and was cautioned not to climb high buildings.

Comment. This case presents many interesting features: (1) Evidence suggested a tumor. (2)ENCEPHALOGRAM gave no localization. (3) Peculiar sequence postoperatively, paresis developing several days after operation and clearing up promptly. (4) Possibility of occluding very large vessels with electric coagulation.

Case 15. D.K., female, aged 18 (C.H. S-2502). Referred by Dr. R. J. Blattner, St. Louis. Admitted Sept. 22, 1942, with headache, vomiting and double vision. Past history was unimportant. Present illness began about 2 months before with headache, fatigue and staggering gait, more to right than left. She had lost 17 pounds in weight.

Examination. Right pupil was larger than left; right 6th weakness; double choked discs with hemorrhage. There was slight adiadochokinesis of right hand and tendency to fall to right, and marked MacEwen's sign. Diagnosis: Brain tumor, possibly 3rd ventricle tumor.

1st Operation. Ventriculography showed dilated lateral and 3rd ventricles; 45 cc. of fluid removed. Diagnosis: Posterior fossa lesion. Cerebellar craniotomy. Extreme vascularity of scalp and bone. Over vermis and along left medial edge of left lateral hemisphere, there was a huge vessel. On attempting to coagulate it with low heat, it burst. There were adhesions around the cisterna magna so that the atlas had to be removed to relieve constriction.

Postoperative course was characterized by back pain. There was repeated distention of cerebellar wound. Cerebrospinal fluid contained blood 1 week after operation. Deep x-ray therapy started 2 weeks after operation. She was readmitted Dec. 6, 1942, still with some choking and occasional vomiting. Cerebellar wound was soft. As she was not relieved, reexploration was made.

2nd Operation. Ventricles had increased enormously in size; 250 cc. of fluid removed. Cerebellar wound was reopened; no tumor found. Tentorium was then cut and upper surface of vermis explored; no tumor or angioima. The vermis was split and free communication with lateral ventricles made. Apparently there were adhesions due to 1st operation and subsequent x-ray therapy.

Postoperative course was stormy with bouts of hyperthermia. Lumbar puncture: Xanthochromic fluid; negative culture; only moderate number of cells. A cerebellar hernia developed due to rupture of muscular suture, and was repaired Feb. 17, 1943. Repeated lumbar punctures were done to keep pressure down; fluid usually xanthochromic. On Mar. 1, 1943, following lumbar puncture, patient had convulsion and went into status epilepticus, and died in 24 hours. There was no necropsy.

Diagnosis: Angioima of vermis.

Case 16. W.F. Mc., male, aged 27 (B.H. No. S-21090). Admitted June 22, 1925. Illness began about 4 months before with difficulty in walking, bladder involvement, and incontinence. Lumbar puncture was done 4 months before in another hospital. He also had pain in back lasting several months, and complained of weakness of left leg.

Examination. Cranial nerves and upper extremities were negative. Lower abdominal reflexes were absent. Knee jerks were present, but ankle jerks absent. There was bilateral Babinski. Sensation was diminished to pain, touch and temperature from L4 down on right, and from S1 on left; loss of joint sense in both feet. Queckenstedt: negative. Preoperative
note: "Typical conus lesion. Complete loss of control of bladder and rectal sphincter. Probably intramedullary tumor."

**Operation.** Laminectomy from D10 to L1. No tumor was found. There were numerous enlarged vessels over the conus (Fig. 7). Nothing was done; closure as usual. He made an uneventful recovery, without improvement.

**Diagnosis:** Telangiectasis of the cord.

**Case 17.** J.M., male, aged 27 (B.H. No. 57764). Referred by Dr. J. F. Reilly, Vincennes, Indiana. Admitted Oct. 23, 1936, complaining of progressive difficulty in vision during past 7 years. His eyesight formerly was excellent; he hunted much and was a good shot. Illness began 7 years before with difficulty in reading. This increased so that for the last 6 months he had refrained from all reading or attending movies. For the last 3 months he had headaches increasing in severity, and for 2 months he had noticed inability to see on the right.

**Examination.** Positive findings were: Percussion note higher on right than left side of head; diminution in olfactory sensation, more left than right; bilateral optic atrophy; right homonymous hemianopsia; right facial weakness; suggestive Babinski, right. Preoperative note—Dr. Sachs: "Venous angioma in the occipital lobe, or a slowly growing meningo, might produce this picture, but there might be something near the chiasm."

**Operation.** Left craniotomy to expose chiasmal region. On opening the dura, the cortex was covered by an angiomatous mass which extended down to the chiasm. Some of these vessels were coagulated but as it was impossible to distinguish normal from abnormal vessels, and I was afraid of producing an aphasia, I closed up and planned to give deep x-ray therapy.

**Course.** Patient had complete aphasia, and wound was reopened for possible clot on 3rd postoperative day. A small extradural clot was found and washed out. Two days later, he was talking very well. Recovery was uneventful. He was given deep x-ray therapy, and returned to work.

Two years later, in 1939, patient had a convulsion. Another course of deep therapy was given from Oct. 5 to 13. On Oct. 19, he had a convulsion, and his family was told to take him into hospital, but he died before he could be admitted. No autopsy was done.

**Diagnosis:** Angioma of cortex.

**Case 18.** C.F.O., male, aged 28 (B.H. No. S-5725). Referred from Base Hospital, Camp Dodge, Iowa. Admitted June 6, 1918, with complaint of Jacksonian convulsion. There was no history of injury. His first convulsion was at age of 21, Jacksonian, beginning in right leg. He was inducted into Army, though he had had attacks 3 times a month, but none for 5 months.

**Examination.** There were markedly exaggerated knee and ankle jerks on right; ankle and patellar clonus, and positive Babinski on right; and normal eyegrounds.

**Operation.** Extensive telangiectasis of left cortex exposed. Unsuitable case for cautery.
Leg center was located under mass of vessels by means of electrical stimulation. It was impossible to excise the center. Recovery was uneventful.

Case 19. J.P., Jr., male, aged 20 (B.H. No U–2809). Referred by Dr. S. I. Schwab, St. Louis. Admitted June 1929, with complaint of failing vision for 6 years. At the age of 14, patient began to have convulsive twitchings. About 1 year before admission, he began to have personality changes, auditory hallucinations and delusions of persecution.

Examination. Optic discs were choked, with tortuous vessels extending over retina and in bunches. There were no other neurological signs. Air studies: Dilated ventricles and defect in left anterior horn.

Operation. Large left subtemporal decompression. On opening the dura, a typical angioma (venous type) of the cortex was found. It was impossible to do anything as process was very extensive. Deep x-ray therapy was given repeatedly. Eyegrounds cleared up; also mental symptoms.

Diagnosis: von Hippel’s disease.

Case 20. P.P., male, aged 23 (B.H. No. U–33236). Referred by Dr. G. B. Fletcher, Hot Springs, Arkansas. Admitted Feb. 15, 1932, with pain in sacral region, and weakness in both feet. Past history was negative. In 1929 patient had dull pain in his back which had recurred and had been constant since 1930. Numbness of feet appeared in 1931. In January 1932 there was difficulty in urination.

Examination. Positive findings were referable to legs: Bilateral foot-drop; knee jerks and left ankle jerk absent; right ankle jerk present. No pathological toe signs. Diminution of sensation for all forms from L1 down. Marked saddle anesthesia. There was a steppage gait. Vibratory sense in both legs gone. Lumbar puncture: Yellow fluid which coagulated (Froin’s syndrome). Complete block on Queckenstedt. “This is probably a conus tumor, might be a giant tumor of cauda.”

Operation. Laminectomy from D10 down. On opening the dura, the cord herniated enormously. A vascular tumor, 5 to 6 inches long, lay in front of the cord. Tumor was an angioma and contained numerous thrombi. It was not coagulated but removed by clipping vessels.

Diagnosis: Angioma of cord.

Case 21. G.R., female, aged 36 (B.H. No. 54497). Referred by Dr. S. I. Schwab, St. Louis. 1st admission, April 1920; 2nd, 1926; 3rd, 1947, complaining of disability of lower extremities and pain in right leg. At age of 14, patient suddenly had pain in her back. Within a few days she became completely paralyzed and had retention of urine, which lasted for several weeks. She was sent to a sanitarium in Odessa, Russia where she was treated with actual cautery for 3 months. She was then sent home and slowly improved, but was left with spastic paraplegia.

Examination. When admitted, she had spastic paraplegia, pathological reflexes, and bilateral ankle and patellar clonus. No record of lumbar puncture findings.

Operation, October 1920. Laminectomy. A huge group of tortuous vessels was found completely covering the cord (Fig. 8). Some of these vessels were ligated but it was impossible to remove them because of hemorrhage. Condition remained unchanged.

Course. In 1926, patient was readmitted and attempt was made again to remove lesion. This was impossible because of hemorrhage; every time a vessel was touched, it exploded. In 1947, at 3rd laminectomy, coagulation was attempted, but hemorrhage was impossible to control and wound was closed.

Diagnosis: Angioma of cord.

Case 22. J.R.R., male, aged 28 (B.H. No. U–24579). Referred by Dr. Jurgens, Quincy, Illinois. Admitted April 30, 1930, with numbness of right arm and hand. Past history was negative. About 1 year before admission, patient had a convulsion; 6 months later, he began to lose the grip of his right hand. This gradually improved but never became normal. For the
last 2 or 3 weeks he had numbness and tingling of right arm, which spread to the leg, but no convulsive movements or unconsciousness. Since then, gait has been hemiplegic.

Examination. Right wrist jerk, hyperactive; weakness of right hand; astereognosis of right hand; bilateral ankle clonus and Babinski on right; slight bilateral patellar clonus; no
choked disc but both eyegrounds show dark, tortuous veins. Preoperative diagnosis: Subcortical tumor in parietal region.

Operation. May 10, 1930. Under local anesthesia a large flap was turned down, and a huge vein was found running across the field. The vessel ruptured near the median line. It was finally controlled with clips, coagulation, and muscle transplant. The entire vessel was not coagulated as I feared function of the left cortex might be interfered with. Usual closure...

Course. After operation, patient had several convulsions and was partially aphasic. Three days later, wound was reopened and an extradural clot evacuated. Recovery was uneventful. He was discharged June 18, and given deep therapy.

Patient was readmitted 4 months later, Sept. 29, 1930. Recently complete 3rd nerve paralysis had developed. Other findings were: Weakness of left 6th and right 6th; lateral nystagmus; left 7th nerve weakness; loss of taste on left side of tongue; weakness of 9th nerve; bilateral ataxia of arms and legs; no choked discs.

Diagnosis: Posterior fossa lesion, possibly pontine. Angiomatous condition observed over cortex probably also existed in posterior fossa and patient may have had a hemorrhage. No surgery was undertaken, and he died Oct. 9, 1930. There was no autopsy.

Case 23. T.P.T., male, aged 10 (C.H. No. U—996). Referred by Dr. Blattner, St. Louis. Admitted June 17, 1945, with sudden complete paralysis. Past history was negative. One week before, following pain and numbness in legs, patient became totally paralyzed. There was retention of urine.

Examination. Knee jerks and ankle jerks were absent. Anesthesia extended up to umbilicus. Beevor's sign was positive. Lumbar puncture on admission: Bloody fluid with 40,000 rbc.; fluid xanthochromic; no block on Queckenstedt.

Operation, June 23, 1945. Laminectomy. Spines of D11–L2 and L1 removed; no extradural fat. On opening the dura, a bluish mass was exposed under the arachnoid. There was some subarachnoid blood which was evacuated, and then a huge vessel was exposed coming out of the cord in region of conus; at one point the vessel was 2 cm. in diameter. The mass pulsated; it was coagulated and completely shrivelled up.

Course. Two weeks after operation, patient had good extension but little flexion of legs. This improved, but his reflexes were still absent. He was discharged July 18, 1945.

Aug. 28, 1945: All movements of legs returned but patient was weak. Knee jerks returned at end of 3 months. Mar. 22, 1946: Patient walked without support; was regaining bladder control. When seen in 1947 he walked perfectly well.

Diagnosis: Angioma, arterio-venous, of conus.

Case 24. J.K.V., female aged 17 (B.H. No. U—30905). Referred by Dr. Meyer Wiener, St. Louis. Admitted April 1933, complaining of blindness, left eye, and failing vision, right eye. Past history was negative. In March 1931 the patient consulted an oculist because of blurring vision. In May, she was blind in left eye. At that time the retina showed the typical picture of von Hippel's disease, she had lateral and vertical nystagmus, and some pressure markings were noted in x-ray of skull. Rbc 5,050,000, hb 85, wbc 10,000.

Examination. There was vertical and lateral nystagmus, and an angiomatous condition of retinae. Because patient was blind in left eye, and with the idea of saving vision in right eye, it was felt that she should have a subtemporal decompression.

Operation, April 15, 1932. Pressure was revealed, but no angiomatous condition of the cortex.

Course. X-ray therapy was begun, and deep therapy given every 6 to 8 weeks from 1932 to 1938. Vision became worse and she was sent to school for blind. In November 1942, 10 years later, patient died. The skull showed marked necrosis. Dr. Sherwood Moore raised the question that this might have been the late result of prolonged x-ray therapy.

Comment. This patient did not have polycythemia, but the nystagmus may have meant that she had a cerebellar lesion.

Case 25. H.B.V., male druggist, aged 49 (B.H. No. 17952). Referred by Dr. C. W. Tooker, St. Louis. Admitted November 1928, because of loss of memory, forgetfulness, and blurring
of vision. Past history was negative. Illness started rather suddenly 6 weeks before when patient was unable to fill a prescription. From this time on, he had difficulty in seeing. Two weeks later, attack of unconsciousness occurred; no convulsive movements. In last 4 months, he had difficulty in remembering people’s manes.

Examination. His memory was poor for recent events and persons. There was right partial homonymous hemianopsia. Vessels of both discs were tortuous and full, but no swelling.

Operation, Nov. 26, 1928. Craniotomy under local anesthesia. Over left temporal lobe large vessels were found running into the sylvian fissure. Nothing was done, as it was felt that occluding vessels might impair cerebral function.

Course. There was temporary aphasia after operation. Deep x-ray therapy was given before patient was discharged.

Diagnosis: Venous angioma.

Fig. 9. Case 27. This patient illustrates the huge size that these vessels may attain and that it is possible nevertheless to coagulate them. This is the first case in which we made use of coagulation.

Case 26. E.W., male, aged 35 (B.H. No. U-21752). Referred by Dr. H. Alexander, St. Louis. Admitted Nov. 8, 1930, with complaint of difficulty in walking. Past history was negative. About 5 years before, patient noticed clumsiness of left leg and sensory disturbance. Left foot began to drag. This was slowly progressive and after some months right leg also became involved. There was difficulty in urination and some rectal loss of function also. Two years before admission, urinary incontinence became so marked that the patient wore a urethral clamp. The last 1½ years he had been in a wheel chair.

Examination. Abnormality was all confined to lower extremities: Paralysis of both legs with diminished sensation from D10 dermatome down, most marked in left sacral region. No Beevor's sign. Abdominal reflexes all present. Knee jerks and left ankle jerk present. Right ankle jerk absent. No clonus. Positive Babinski and Oppenheim.

Operation, November 1930. Removal of D7 to D10 spines. The cord was covered by large tortuous vessels. When the veins were coagulated, the cord underneath looked abnormal and degenerated.
Course. December 1931: Patient had regained some function of both legs. Muscles in calves had filled out and were then powerful. Massage and exercises to be continued. Patient lost sight of.

Diagnosis: Angioma of cord.

Case 27. G.H.W., male, aged 24 (B.H. No. 18743). Referred by Dr. Tithen, Wichita, Kansas. Admitted January 1929, with complaint of convulsions. Past history was negative. One and a half years before, the patient had a focal convolution, beginning in his right arm, and then became unconscious. One month later he had another attack. Attacks became more frequent; recently he had had 3 in one night. They always began in the right arm, which lately had felt peculiar all the time and weak. There were some very mild seizures.

Examination. There was slight edema of the disc; veins full but not tortuous. Right hand was weaker than left. Reflexes in arms and legs were normal except for questionable Babinski, right. Roentgenogram: Increased vascularity of bone about over arm center. Preoperative note: "Jacksonian epilepsy, possibly angiomatous lesion."

Operation. Craniotomy under local anesthesia. When the dura was opened, we observed a huge angioma covering the frontoparietal region (Fig. 9). One vessel was as large as a little finger, others smaller. The mass of vessels was coagulated slowly. Then in trying to coagulate the large one, it ruptured. A terrific hemorrhage followed which was finally controlled by a large piece of muscle excised from thigh of patient.

Course. For 48 hours after operation there was impairment of speech, but it then cleared up rapidly. Deep x-ray therapy was given several times. The patient was seen 5 years later, in 1935, because of a Jacksonian convolution, and was given a course of deep therapy. In 1940, again he had a convolution, and was again given a course of deep therapy. In 1944, patient reported that he had only an occasional mild attack, about 6 a year. He was taking phenobarbital regularly, and recently it had been increased.

Case 28. C.W., male, aged 42 (B.H. No. U-34948). Referred by Dr. Clithero, St. Louis. Admitted July 1932, complaining of numbness and feeling of pins and needles in right arm and leg for 8 months. Past history was negative. He had had no convulsions. Ventriculogram: Filling defect in posterior part of left lateral ventricle.

Operation. Jan. 19, 1932. Craniotomy. Incision into cortex exposed a large vascular tumor, an angioma. A large part was excised and coagulated.

Course. Patient made an uneventful recovery, but had a partial aphasia. Wound healed. Six days after operation, edema of the lungs suddenly developed, and patient died. There was no autopsy.

Diagnosis: Angioma, intraventricular.

REFERENCES