WHILE tumors of dural origin are rather common in the cerebral envelope, the reverse is said to be true of the posterior fossa. Cushing and Eisenhardt recorded 27 instances among 295 cases, an incidence of 13.4 per cent. Dandy in his large experience wrote that (in 1927) he had encountered but 5 such tumors. Horrax found but 4 among 60 cases.

Schreiber reported cases, de Martel and Guillaume, 1, Voss, 4, André-Thomas, 1 Michon and Rousseaux, Gardner and Turner, Cohen, Freiman and Ficarra and Ecker each. Globus et al. described 2 cases of multiple meningioma with clearly established malignant characteristics, in each of which there were one or more tumors in the posterior fossa. In a recent discussion of meningiomas arising from the tentorium and the transverse sinus, Arnvig reported 1 case in which the tumor was purely subtentorial and 2 cases in which it lay both above and below the tentorium. In his discussion he referred to 1 case reported by Tönnis and 4 by Lysholm, which reports were not available to us.

We have had the fortune, or in some instances the misfortune, to encounter 9 in a relatively small series of 25 cases of intracranial meningioma at the Albany Hospital. It is to record this experience and to point out certain diagnostic features apparently peculiar to these lesions, that this paper is written.

Clinical classification has been most conveniently made according to location within the posterior fossa. Exclusive of tumors that lay at or within the foramen magnum, our cases fell into two main groups: (1) those that arose from the under surface of the tentorium, the lateral recesses and the convexity; and (2) those that took origin above the clivus or in the cerebellopontine angles. In the first group, symptoms and signs were not unlike those of many neoplasms of cerebellar origin. Save for the rather long history in Case 2 and the tell-tale calcification in Case 3, there was no evidence upon which to predict the type of tumor. On the other hand, meningiomas of the clivus and cerebellopontine angle involved cranial nerves early, grew relatively slowly, eroded underlying bone deeply, involved brain stem structures much less quickly than gliomas that arose within it, and in short, produced a clinical picture which, while not diagnostic in every case, might at least make one strongly suspicious of the nature of the tumor before operation.

The first group included 3 tumors that arose from the under surface of the tentorium, 1 from the lateral recess, and 1 from the convexity. All oc-
curered in adults ranging in age from 24 to 67 years. While from their histological appearance it seemed likely that they were slow-growing tumors (with the exception of the malignant neoplasm in Case 5), a review of the histories revealed that the preoperative duration of symptoms was comparable with that of many cerebellar tumors, having been 2 years, "several" years, 2 months, 2 years and 1 year respectively.

A.B. (Case 2) is an interesting and perhaps important exception in that she had complained of diplopia for several years. In general neither the symptomatology nor (save for Case 4) the neurological picture was remarkable. Headache, vertigo, nausea and vomiting were experienced by those with increased intracranial pressure. Ataxia and visual disturbances were present in 4. One patient had experienced a single "seizure" in which she lost consciousness, became rigid and bit her lip. Another had a mandibular branch tic douloureux syndrome which was quite typical save for a single bout of pain in the mastoid region 2 years previously and the fact that a thorough injection of the mandibular nerve at the foramen ovale failed to stop the tic pain. Seventh and/or 8th nerve palsies appeared in the late stages in 3 cases.

Thus one is not able (save possibly by vertebral arteriography) to predict the type of neoplasm in these parts of the posterior fossa, nor indeed is such preoperative pathological diagnosis necessary; it will ordinarily suffice to localize and then expose the tumor by the suboccipital approach.

In one patient (Case 3), the tumor had bulged so far upward that it was thought to be supratentorial, and was removed from above. While a supratentorial attack on an infratentorial tumor has many advantages, it is very likely to entail injury or sacrifice of a portion of the adjacent occipital lobe. Both the bone and the soft tissues were quite vascular in all but two patients (Cases 4 and 5), as might be expected with this type of neoplasm.

Case 1 is illustrative of the group as a whole and the favorable outcome is in keeping with that which should be obtained in the majority.

Case 1. A.H. #85582. E.F., a 45-year-old white housewife, was admitted Aug. 10, 1941 because of headache and vomiting. She had been well until 2 years previously when she began to fatigue readily. During the last 6 months her vision had become blurred. She had had bitemporal and occipital headache for 2 years and projectile vomiting for 4 days.

Examination. She was a very drowsy but fairly well oriented woman in a good state of nutrition. Temperature, pulse, respirations and blood pressure were normal. There was moderate nuchal rigidity and photophobia. The pupils were dilated, fixed to light and on accommodation. There was horizontal nystagmus to the left on lateral gaze. Both fundi showed papilloedema, more marked on left. There was some weakness of left arm and leg. Biceps and ankle jerks were slightly hyperactive on the left; abdominal reflexes were absent bilaterally. There was past-pointing and adiakokinesia on the left. Romberg could not be tested because of patient's weakness. Neurological examination was otherwise negative. Laboratory studies showed no significant findings. Stereoscopic roentgenograms of the skull were normal. Clinical diagnosis: Cerebellar tumor, left.

Operation. On Aug. 14, 1941 ventriculography disclosed dilated ventricular system back to, though not including the aqueduct. She was operated upon the same day through a bilateral suboccipital approach under avertin-ether anesthesia (E. C.). Both scalp and bone were
POSTERIOR FOSSA MENINGIOMAS

extremely vascular. The dura was tense. As soon as the bone was removed a tumor was seen on the left side attached to the dura of the posterior wall (Fig. 1) in an area about 2 cm. in diameter. After opening the dura down through the foramen magnum, a collar of dura around the dural attachment was excised. The tumor, which was spheroidal in shape, well encapsulated and about 5 cm. in diameter, was slowly worked out of its bed, the few blood vessels which entered it being secured with clips. The wound was closed in layers with interrupted fine silk without drainage.

Pathological Examination (Dr. A. W. Wright). "Sections of this tumor show whorls and strands of fibrous tissue coursing irregularly throughout. The central part of the tumor, which shows uniformly fusiform cells, is partly necrotic and partly hyalinized as a result of the poor vascularization. A thick membrane, the dura mater, is seen on one side of the well encapsulated neoplasm. From the sections it becomes apparent that the tumor arose from the dura. Diagnosis: Meningioma. Cushing type III."

Postoperative course was uneventful. At time of discharge, 19 days after operation, her gait was still somewhat unsteady. There was slight flattening of the right nasolabial fold. Hearing was moderately diminished on the left. There was slight residual weakness of left leg and diminution of vibratory sensation in right ankle.

Seven months later she appeared to be fully recovered save for minimal weakness of convergence.

The next case was of particular interest for two reasons: first the long
history and second the fact that on the first admission, little or no demonstrable hydrocepalus had developed.

Case 2. A.H. #69051. A.B., a 42-year-old unmarried white woman, was admitted on July 12, 1940 complaining of headache and blurring of vision of 1 year's duration. Several years previously she began to have diplopia on lying down and noted difficulty in accommodating to darkness. For 1 year she had had headache over the vertex, sharp in intensity, lasting 1 to 3 minutes and at times associated with momentary unconsciousness. She became nervous and fatigued readily. Amblyopia was noted, together with visual hallucinations in the left field. There had been slight giddiness with her more severe headaches.

Examination. The patient was an obese white woman, whose temperature, pulse, respirations and blood pressure were normal. Flexion of neck accentuated the headache. There was bilateral papilloedema: 6 D., O.D.; 4 D., O.S. Visual acuity was 20/70 O.D., 20/40 O.S. Visual fields were normal, except for enlarged blind spots bilaterally. There was slight left facial weakness, and a fine nystagmus to the right. In the Romberg test she swayed backward and to the right, but did not fall. There were no other abnormal findings. Routine blood and urine studies were normal. Roentgenograms of skull showed only some atrophic changes in the posterior clinoids.

1st Operation. With a clinical diagnosis of unlocalized brain tumor, ventriculography was carried out. Although the fluid was under moderately increased pressure, the ventricular system appeared neither enlarged nor displaced. A right subtemporal decompression was therefore performed because of the papilloedema.

Postoperative course was uneventful and she was discharged 16 days after operation, by which time the papilloedema had greatly receded.

She was thereafter followed in the Out-Patient Department. Some papilloedema persisted and the decompression remained tense. By Oct. 7, 1940 headaches had increased and she had noted tingling of left arm and leg. A month later marked weakness of the left side of the body had developed with hyperactive reflexes on that side. She was readmitted Sept. 2,
1941 because of increasing headaches, made worse by bending over and accompanied by giddiness.

Examination on Readmission. The decompression was bulging. There was some nuchal rigidity. Optic discs were moderately choked. There was some horizontal nystagmus to the right. The corneal reflex and perception of pin-prick and light-touch were diminished on the left face. There was some left facial weakness. Hearing on the left was slightly diminished. There was some weakness of left arm and leg. On the left side the deep reflexes were hyperactive, abdominal reflexes were absent and Hoffmann's sign was positive. Vibration sense was absent in left foot. Finger-to-nose and heel-to-knee tests were somewhat ataxic on the left and there was some adiadochokinesis of left arm.

2nd Operation. When ventriculography was repeated the fluid was found to be under increased pressure and the ventricular system symmetrically dilated down to the mid-aqueduct. Under intratracheal ether anesthesia, a wide suboccipital exposure was carried out the same day. It was necessary to remove the arch of the atlas to relieve medullary compression. A hard circumscribed tumor lay in the left lateral recess. It was the size of a black walnut and was attached to the dura over the lateral sinus at the junction with the sigmoid. Figs. 2 and 3. The tentorium was incised and the lateral and sigmoid sinus resected between ligatures, thus permitting easy delivery of the tumor. A tongue of the latter extended into the sigmoid sinus. The wound was closed in layers with interrupted fine silk sutures without drainage.

Pathological Diagnosis (Dr. A. W. Wright). Meningioma, Cushing type III.

Postoperative course was uneventful and she was discharged Oct. 10, 1941. Her recovery has apparently been complete. Two years later she was doing her housework and considered herself perfectly well.

Posterior fossa tumors with calcification demonstrable by roentgenogram are, in our experience very rare. In the next case the lesion was located so high that it was thought to be supratentorial. The patient seemingly came through the operation nicely but died 3 months later of a frontal lobe abscess, the origin of which is not altogether clear.

Case 3. A.H. #A28289, E.J., a 50-year-old white housewife, was admitted to the hospital Sept. 14, 1944 because of headaches of 2 months' duration.

While accurate information could not be obtained from the patient, her daughter stated that she had had headaches all her life. However, 2 months before admission they changed in character, becoming much more severe and constant. They were both frontal and occipital in location. For 1 year she had been unsteady when standing and had staggered on walking. One month before admission she had had an attack in which she was unable to speak for a few minutes, after which she became unconscious and rigid and bit her lip. For about 2 weeks she had complained of double vision. Within that period she became irritable, undependable, frivolous, and had begun to have difficulty in finding the correct word, often substituting the word "riggin."
Examination. General physical examination revealed no significant abnormalities. Sensory aphasia was present to a moderate degree. Extraocular movements were carried through the full range without nystagmus, but the patient consistently complained of diplopia on looking to the right. Fundi showed bilateral papilloedema with numerous old and recent hemorrhages. There was slight right facial weakness. Hearing was unimpaired. Gait was characterized by slight staggering to the right. Otherwise neurological findings were normal as were routine blood and urine studies. Visual field studies were unsatisfactory due to poor comprehension.

Roentgenograms of skull (Fig. 4) disclosed an area containing calcium deposit in the right occipital region and extending to the midline. It measured $5 \times 4$ cm. in diameter and sug-

![Image](image_url)

Fig. 4. Case 3. Lateral roentgenogram of skull showing calcification in subtentorial tumor.

gested tumor. Marked atrophic changes were visible in the posterior clinoid process and there was thinning of the floor of the sella turcica. Preoperative diagnosis: Right occipital meningioma.

1st Operation. On Sept. 21, 1944, under avertin rectally, supplemented by intratracheal ether, a right occipital osteoplastic bone flap was reflected (R.D.W.). The scalp and bone were found to be excessively vascular; hence a transfusion of citrated blood was started. The dura was very tense but pulsed well after the left lateral ventricle was tapped through an occipital burr hole. After opening the dura the occipital lobe was seen to be flattened and whitened, and upon gently elevating it the tentorium was seen bulging upward over the tumor. After coagulating and dividing several vascular connections from the occipital lobe to the tentorium, the latter was opened in cruciate fashion and the capsule of the neoplasm at once
POSTERIOR FOSSA MENINGIOMAS

visualized. It was firm and flesh-colored. The capsule was incised and biopsy taken for frozen section was reported as “tumor of fibroblastic origin.” The tumor was partially removed with cautery loop and curettes, numerous spicules of bone being encountered. The growth was extremely vascular. After a portion about the size of a large plum had been enucleated, it was felt that it would be wise to interrupt the procedure and continue at another sitting, since in spite of 500 cc. of blood and 500 cc. of plasma, her blood pressure remained low. Because the occipital lobe had by now become extremely edematous, its tip was resected; the dura was arranged over the resected surface and the bone flap sacrificed. The wound was closed in layers in the usual fashion with interrupted fine silk without drainage. By this time blood pressure had risen to 110/80 and she was returned to bed in good condition.

Pathological Diagnosis (Dr. A. W. Wright). Meningioma, psammomatous. Cushing type III.

Postoperative course was prolonged but essentially uneventful, although numerous taps of the left ventricle and of the defect were required. No new abnormal neurological signs appeared save for left homonymous hemianopsia, and she became much more alert and responsive.

2nd Operation. On Nov. 28, 1944, under ether anesthesia, the old wound was reopened and immediately an arachnoid cyst was entered, into which the posterior horn of the right lateral ventricle opened. The remaining portion of the occipital lobe was gently freed from the tentorium and covered with moist cotton. The tumor was gradually shelled out until the main bulk of it was delivered through the tentorial opening. The principal blood supply of the neoplasm came from the posterior edge of the petrous bone near the tip, where there was a small fragment of residual tumor. This was thoroughly coagulated. At one point during the operation the patient's blood pressure had been unobtainable; after she had been given 1000 cc. of citrated blood and 1000 cc. of plasma, it had risen to the preoperative level. Additional bleeding points were secured and the huge defect filled with salt solution. The wound was closed in the usual fashion in layers with interrupted fine silk without drainage and the patient returned to bed in good condition. She was alert, conscious and oriented before 5 hours passed.

Course. She made an uneventful recovery and was discharged on Dec. 17, 1944, at which time there were no abnormal neurological signs save for the hemianopsia.

She was readmitted to the hospital on Feb. 21, 1945, 3 months after the 2nd operation. In the previous month she had become irritable and overactive, and for 1 week stuporous. Upon examination the flap was tense. The temporal half of the right disc was red and outline of the disc was blurred. There was right facial weakness. The right arm and leg were moved less than the left. Deep tendon reflexes were hyperactive. Babinski was positive on the right.

Laboratory data: R.b.c., 4,000,000; hgb., 15 gm.; w.b.c., 8900 with 58 per cent polymorphonuclear leucocytes. N.P.N. 44 mg. per cent.

The flap was tapped and xanthochromic fluid containing 158 mg. per cent of protein was removed. There was no appreciable improvement in her condition. A second tap yielded fluid from which Pneumococcus type 10A was isolated. Intensive sulfadiazine therapy was instituted, but the patient failed progressively and expired on Mar. 4, 1945.

Necropsy revealed 400 cc. of turbid fluid in the peritoneal cavity and 500 cc. of clear straw-colored fluid in each pleural cavity. There was extreme edema and congestion of all lobes of the lungs. The left frontal lobe was exceedingly necrotic and the right cerebellar lobe was replaced by a large purulent abscess. The right lateral sinus appeared obliterated. The right car did not appear to be involved in the inflammatory process.

After fixation there was slight prominence of the left frontal lobe, which was soft and cystic. On coronal sections a large purulent, thick-walled abscess was found in the left frontal lobe, extending from the anterior tip back almost to the basilar ganglion, and containing thick, creamy material. The basal ganglia appeared normal but the ependymal lining of the ventricles was thickened and the subependymal tissues were necrotic and had numerous tiny hemorrhages. The major portion of the right occipital lobe was necrotic and purulent. Beneath this area was a large defect in the right cerebellar lobe, which was covered with purulent exudate. The 4th ventricle was dilated and the left cerebellar lobe uninvolved.
Microscopic Examination. There was no evidence of any inflammatory reaction in the lungs. There was acute splenitis and diffuse fatty degeneration and central necrosis of the liver. Sections of the brain confirmed the gross impression of acute purulent meningitis and abscess formation. There was no evidence of any residual tumor. Pneumococcus type 10A was isolated from the basilar exudate.

Anatomical diagnoses: Meningitis, acute, due to Pneumococcus type 10A; abscesses, pyogenic, large, of left frontal lobe and right lobe of cerebellum.

This series contains but 1 example of tic douloureux syndrome. While the absence of neurological changes, and the type and location of the pain as well as its precipitation by washing or touching the face were quite typical, one should have been put on guard both by the failure to obtain relief when complete anesthesia was secured by alcohol injection and by the history of a few bouts of severe pain in the corresponding mastoid region 2 years previously. The additional mistake of not accurately identifying or removing the tumor was even more obvious.

Case 4. A.H. £A4312. M.B., a 67-year-old white married housewife, was first seen by one of us (R.D.W.) Oct. 21, 1942 because of pain in the left lower jaw of approximately 6 months' duration.

Two years previously she had first experienced episodes of sharp, throbbing pain behind the left ear. These had gradually increased in frequency and for 6 months had radiated along the left lower jaw, without spread to other parts of the face. Some attacks had been precipitated by washing the face or by eating. The pain was severe, sudden in onset and of short duration. Save for moderate exertional dyspnea her past history was unimportant.

Examination at that time disclosed generalized osteoarthritis, an enlarged heart with apical and basal murmurs and a totally irregular rhythm. Blood pressure was 200/104. There were no other abnormalities. Because of her poor general condition, alcohol injection was carried out. Satisfactory anesthesia of the 2nd and 3rd divisions and a portion of the 1st was secured by injection at the foramen ovale. No relief of pain followed. The injection was repeated, again without success. She was admitted to the hospital on Feb. 21, 1943.

Examination on Admission. The findings were similar to those present at the first consultation. There were still no abnormal neurological signs, except that the right pupil reacted sluggishly to light (due, it was thought, to a previous cataract removal). Hypertensive heart disease with auricular fibrillation was present; she appeared well compensated.

Blood counts and Wassermann reactions were negative.

Urinalysis showed albumin 1+, 6–8 w.b.c./h.p.f., and a few granular casts. An electrocardiogram revealed auricular fibrillation with fairly rapid ventricular rate and evidence of hypertensive heart disease.

Operation. On Feb. 27, 1943, under novocaine anesthesia, the sensory root of the left 5th nerve was exposed by the suboccipital approach (R.D.W.). The pons appeared to be distorted as if by a tumor within. The 8th, 9th and 10th cranial nerves were displaced backward and the 5th nerve forward so that it was exposed with difficulty. After cauterization and division of a petrosal vein, subtotal section of the 5th nerve was carried out. The wound was closed with silk without drainage and the patient returned to her room in good condition.

Course. Following operation she was free of pain and had diminution but not absence of sensation in the trigeminal area. Forty-eight hours after operation her temperature rose from 101° to 104° (R), she breathed heavily and the pulse became weak. She was stuporous and did not move the right side even upon painful stimulation. In the ensuing day she improved somewhat and began to move her right leg. There were bilateral Babinski reactions. Throughout, the flap remained clean, soft and pulsated normally.

Two days later there were definite signs of pneumonia at the left lung base. She expired on Mar. 14, 1943.
Autopsy (limited to the brain) revealed a firm, well circumscribed globular tumor, 3 cm. in diameter, which arose from the under surface of the tentorium. Its dural base extended from the left border of the incisura to the petrous apex. The pons was compressed to the right and posteriorly, while the 5th, 7th and 8th nerves were pushed downward. Arteries composing the circle of Willis were markedly atheromatous. There was no evidence of thrombosis.

Microscopic Examination. The tumor was composed of oval and fusiform cells, the scant cytoplasm of which was almost syncytial in character. These cells tended to arrange themselves into interlacing bundles and whorls which, in some instances, were separated by thin, eosinophilic, collagenous septa. Scattered throughout the sections and located for the most part in the center of the whorls were round, laminated calcified psammoma bodies (Fig. 5).

Diagnosis: Meningioma, Cushing type II.

The final case of this group is of considerable interest not only because the meningioma was malignant, but also because it has thus far (5 years) been held in partial abeyance by deep roentgenotherapy.

Case 5. A.H. #95140, M.F., a 42-year-old white married housewife, was admitted to the hospital for the first time on Sept. 4, 1942 complaining of vomiting and headache.

She had been in good health until 1 year before when she began to suffer from occasional headache; 1½ months later headaches began to occur daily and to last 2 hours. They were located in the right suboccipital region and radiated to the right frontal area. They gradually increased in intensity and duration and at time of admission were continuous. Vomiting was at first rare but later occurred several times daily. For the last 5 weeks she had been bedridden. Family history disclosed that an aunt had died from brain tumor, type unknown.
Examination. General physical and neurological findings were not remarkable. Fundi were negative. X-rays of skull and lungs and routine laboratory studies were negative. Lumbar puncture showed an initial pressure of 155 mm. of water; total protein was 31.8 mg. per cent. Other determinations, including cell count and Wassermann reactions, were also normal.

Course. She was allowed to go home at her own request but returned a month later since headaches and vomiting had persisted and she had become increasingly depressed. She had also begun to notice diplopia and unsteadiness of gait.

Examination then disclosed bilateral papilloedema with retinal hemorrhages, bilateral 6th nerve palsies, horizontal and rotatory nystagmus both on movement and on fixation, ataxia in the heel-to-knee tests, and hyperactivity of the right knee and ankle jerks. There was subtotal loss of hearing on the right with an inactive labyrinth on that side. Diagnosis: Posterior fossa tumor, probably in cerebellar vermis with extension to the right.

1st Operation. On Oct. 17, 1942 under local novocaine infiltration, operation was performed (R.D.W.). Because of the evidence of involvement of the right cerebello-pontine angle, exploration was limited to a right-sided flap. The bone was extremely thin and the dura very tense, but the latter pulsed normally after tapping the left lateral ventricle. As soon as the dura was opened a smooth, flesh-colored, encapsulated tumor came into view, lying in the recess between the tentorium and the right lateral wall. Its appearance suggested a meningioma. There were a few vascular connections with the tentorium; these were coagulated and divided. The tumor then came away easily from both the tentorium and the cerebellum and was apparently removed in toto. That portion of the tentorium from which the tumor appeared to have arisen was heavily coagulated with the electric cautery. The wound was closed in layers with interrupted fine silk sutures and the patient returned to her room in good condition.

Pathological Examination (Dr. A. W. Wright). "The specimen consists of a rather well circumscribed . . . tannish-white mass measuring 3.5 cm. in diameter. It is partially covered by a very thin, fibrous membrane. The cut surface is slightly translucent but homogeneous, and is reddish in color (Fig. 6)."

Diagnosis: Meningioma (911-854). "The tumor is fibroblastic in type and probably corresponds to Cushing's type III meningioma. However, the extreme cellularity of the neoplasm makes us believe that the new growth may be sarcomatous in character" (Figs. 7 and 8).

Postoperative course was uneventful. When she was discharged 2 weeks later there was moderate left lateral rectus weakness, and nystagmus in all directions; hearing had markedly improved. Both labyrinth were active. All deep reflexes were slightly hyperactive on the right. Finger-to-nose test was unsteady and there was some lagging of the right arm on rapid pronation and supination. Right heel-to-knee test was ataxic. Romberg was positive to the right and gait was unsteady, with a tendency to fall to the right.

She did well for 5 months when she returned complaining of diminished hearing in the right ear and increasing unsteadiness of gait. The findings were otherwise essentially the same as at time of discharge, save that the flap was tense and bulging. Forty cc. of xanthochromic fluid were aspirated with marked relief. Thereafter the symptoms and the bulging of the flap occurred at intervals and repeated aspirations were performed during the next
Fig. 7. Case 5. Low power microphotograph showing cellular nature of tumor. (Hematoxylin and eosin, X180)

Fig 8. Case 5. Higher power view of same field as in Fig. 7. (Hematoxylin and eosin, X625)
Fig. 9. Case 5. Low power microphotograph showing increased cellularity of tumor. (Hematoxylin and eosin, ×180)

Fig. 10. Case 5. Higher power view of tumor shown in Fig. 9. Several mitotic figures are visible. (Hematoxylin and eosin, ×625)
5 months. It was evident by Sept. 12, 1943 that a solid tumor mass underlay the flap and she was readmitted.

Examination on Readmission. There was no papilloedema but the right lateral rectus muscle was weak and coarse nystagmus appeared on looking to the right. The right corneal reflex was diminished. Air and bone conduction were absent on the right and the Weber was referred to the left. There was moderate weakness of right arm and leg with hyperactivity of deep reflexes and ataxia of these extremities together with adiadokokinesis of the right arm. Caloric test showed that the right labyrinth was not functioning.

2nd Operation. The wound was reexplored on Sept. 14, 1943 under local anesthesia. An enormous tumor was found filling the right side of the posterior fossa and attached to the entire inferior surface of the right tentorium and lateral wall. A little more than half the tumor was removed by morcellation; this was accompanied by considerable although not overwhelming bleeding. In view of the frozen section report of meningosarcoma and of the broad attachment and extent of the tumor, resection was abandoned as soon as normal pulsations of the brain appeared. The patient was transfused with 1000 cc. of citrated blood. The wound was closed in layers with interrupted silk without drainage and she was returned to her room in good condition.

Pathologic Diagnosis (Dr. A. W. Wright and Dr. Abner Wolf of N.Y.). Meningo-sarcoma (Figs. 9 and 10).

Course. She made an uneventful recovery and was discharged 15 days after operation. At that time the nystagmus, adiadokokinesis, and ataxia were unchanged. Prior to discharge a course of deep Roentgen-ray therapy was begun. In all she received 2000 r, in 10 divided doses.

She again improved rapidly, although the nystagmus and slight ataxia of right arm and leg persisted. Three subsequent courses of deep x-ray therapy were administered, in March 1944, February 1945, and March 1947, each of 2000 r. The second of these was given during the 4th month of pregnancy.

She was delivered by Caesarean section of a full term infant in August 1945. She has continued to be in good health since that time. When last examined, March 3, 1948, the abnormal findings were: slight tenderness over the flap, horizontal nystagmus both to right and left, slight ataxia of finger-to-nose tests bilaterally, and a somewhat ataxic gait. Detailed neurological examination was otherwise not remarkable.

Meningiomas of the cerebellopontine angle eventually result in a clinical picture similar to or at times identical with that of acoustic neuromas; when small, however, the presenting syndrome may be that of Ménière's disease or tic douloureux. The 1 patient (Case 6) in this classification had a large sessile neoplasm which filled the angle, eroded its way through the medial tip of the petrous bone and extended through the interpeduncular space to the dorsum sellae. It was thought before operation to have been an acoustic neuroma. A second tumor, not included in this group, also originated from the clivus, bulged part way into the angle, thus compressing the acoustic, facial and trigeminal nerves on that side, and likewise was thought preoperatively to have been an acoustic neuroma.

There were two features that in retrospect might have been useful in differentiating meningioma in the cerebellopontine angle from acoustic neuroma: first, the vestibular response to caloric test was not completely absent in either patient, being "hyperactive" in Case 6 and normal in Case 9; second, roentgenographic evidence of bone destruction in the petrous tip was present in both cases.
It is noteworthy that attacks of vertigo and tinnitus, together with gradual loss of hearing, were early symptoms in both patients. Partial paralysis of both facial and trigeminal nerves was eventually present in each.

In the single patient in this classification the tumor was so extensive, not only in the posterior fossa but within the petrous bone and upper clivus, that its complete removal appeared impossible at the time (1935). Perhaps with more skill, perseverance, the use of thrombin, and better access to the upper pole of the tumor by splitting the tentorium or by making a second approach through the middle fossa, it could have been done. How much she would have benefited by the subtotal removal is impossible to say, for postoperative meningitis ended the story.

Case 6. A.H. #12837. F.G., a 47-year-old white housewife, was admitted on Dec. 12, 1935 with the chief complaint of deafness and tinnitus in the right ear and of unsteadiness of gait for 2 years. At the onset she had experienced a sudden attack of vertigo accompanied by a hissing noise in the right ear; this lasted 3 days. Thereafter dizziness had been intermittent but tinnitus constant. Following the onset there had been rapidly increasing deafness of the right ear. Attacks of vertigo were precipitated by sudden movement of the eyes. Straining or laughing caused severe pain in the occiput and beneath the right mastoid. For 1 year she had had a constant feeling of pressure in the frontal region. For 6 months her gait had been unsteady and she tended to fall backward and to the left. Shortly prior to admission she had experienced difficulty in swallowing and in articulation. Memory for recent events had become defective. She was right-handed.

Examination. General physical examination was negative. There was early papilloedema on the right, none on the left. Perimetric tests disclosed general concentric constriction of the visual fields bilaterally. There was coarse nystagmus with the rapid component outward on lateral gaze to either side, especially to the right, and moderate rotatory nystagmus on upward gaze. The corneal reflex was absent on the right and diminished on the left. Hypesthesia was present over the right side of the face to cotton and to pin-prick. There was slight right facial weakness, involving mainly the lower facial muscles. Hearing was diminished on the right but bone conduction was greater than air conduction on this side. Gag reflex was slightly diminished. The left triceps, knee jerk and ankle jerk were hyperactive. Babinski was positive on the left. Finger-to-nose and heel-to-knee tests disclosed a coarse intention tremor on the right. Romberg was positive, backward and to the left. Gait was ataxic and she walked upon a wide base. Routine blood and urine studies were negative.

A hypoactive labyrinth was found on the right side, while the left was normal. Audiometry showed 34.6 per cent loss of hearing in the right ear and 20.3 per cent in the left. Clinical diagnosis: Slow-growing tumor in right cerebellopontine angle, probably an acoustic neuroma.

Operation. On Dec. 16, 1935 a bilateral suboccipital exposure was made under avertine-ether anesthesia (E.C.). The dura was moderately tense. The vermis and both cerebellar hemispheres appeared normal. The right cerebellopontine angle was then explored and a gray, granular-appearing tumor was seen filling and obliterating it. The 7th and 8th nerves were pushed backward but were apparently not surrounded by the neoplasm. A frozen section examination confirmed the diagnosis of meningioma. It was partially excised by means of a sharp curette. Bleeding was rather profuse but could be controlled with the cautery and with muscle stamps.

When an amount about the size of a black walnut had been removed, the incisura of the tentorium was reached. The 5th nerve was not visualized. The pulse and respiratory rates varied to such a degree that it was felt that no further manipulation should be made. But part of the tumor had been removed. The wound was closed in layers with interrupted silk without drainage. The patient left the table in good condition.
Pathological Diagnosis (Dr. A. W. Wright). Meningioma, Cushing type II.

Postoperative Course. The immediate course was very satisfactory. She regained consciousness promptly. By the 3rd postoperative day the Babinski on the left had disappeared and she reported that the tinnitus in the right ear had become very faint. That day, however, the temperature arose to 103°F. Her condition gradually grew worse and by late evening of the 5th day she had become comatose. The right half of the wound was reopened and necrotic brain tissue removed. Some cloudy fluid was seen and cultured and found to contain Staphylococcus aureus. She expired on the 6th postoperative day.

Autopsy. There was a soft neoplasm in the right cerebellopontine angle, measuring 3 × 3 cm. It was attached to the right side of the incisura of the tentorium and invaded the petrous portion of the temporal bone in an excavation 1.5 × 1 × 1 cm. The brain was not invaded but the pons was compressed and pushed to the left. The tumor surrounded the 6th cranial nerve and extended as far forward as the infundibulum. Acute purulent meningitis was present.

Microscopic Study. The tumor was constituted of cells which occurred in sheets and in whorls. They were oval and sometimes spindle-shaped. The cytoplasm was generally clear and the nuclei somewhat vesicular. The tendency toward whorl formation was so marked that at first glance the tumor appeared to be composed of numerous structures resembling epithelial pearls. The neoplastic tissue immediately surrounding some of the smaller blood vessels appeared to be undergoing degeneration. No evidence of calcium deposit was found. The tumor was moderately cellular.

Some sections revealed that the tumor was extending out along the fibrous tissue surrounding some of the larger nerve trunks and nerve ganglia. One section showed the tumor extensively invading bone. Several of the marrow spaces were almost completely filled by tumor. Diagnosis: Meningioma, Cushing type II.

Basilar Group. Three of our 9 tumors arose from the clivus, and while their diagnostic localization was not difficult, their operative removal was extremely hazardous. Involvement of several adjacent cranial nerves and evidence of pontine and medullary compression were common in all. The fact that all these were highly vascular, that all lay immediately beneath the basilar artery system and brain stem, and that all had eroded bone deeply added greatly to the difficulties of operation.

That one may have to be content with incomplete removal in some cases and that, at times at least, even this may be worthwhile, is indicated by the following cases.

Case 7. A.H. #33645. E.F., a 34-year-old white housewife, was admitted to the hospital on May 10, 1937 complaining of progressive hoarseness and of difficulty in swallowing of 5 years' duration. Prior to onset of these disorders she had considered herself in good health. Dysphonia and dysphagia gradually grew worse and 2 years before admission increasing deafness was noted in the right ear. For 6 months there had been diplopia, progressive paralysis of the right side of the face and dizziness. Gait had been unsteady for 1 month.

Examination. Her general physical condition was not remarkable save for malnutrition. Fundi were normal. There was a right external rectus palsy and the corneal reflex on the right was diminished. There was marked weakness of the right face. Hearing was totally absent on the right. The uvula was deviated to the left and swallowing was difficult. The tongue deviated to the right and there was marked atrophy of the right sternocleidomastoid muscle (Fig. 11). Romberg and gait could not be tested because of the patient's extreme weakness. Routine blood and urine studies were negative.

X-rays of skull disclosed extensive destruction of the petrous portion of the right temporal bone and adjacent basi-occiput (Fig. 12).
The right labyrinth was inactive and an audiogram showed total loss of hearing in the right ear.

Operation was performed on May 13, 1937 under novocaine (E.C.). It proved long and tedious but was surprisingly well tolerated. A wide unilateral suboccipital exposure was made, extending above the lateral sinus and including the arch of the foramen magnum. Extrudal extension of the tumor was first encountered near the right mastoid. After the lateral ventricles had been tapped through occipital burr holes, the dura, which had been quite tense, pulsated normally and was opened. The right cerebellar hemisphere was gently elevated and a huge tumor filling the entire floor of the posterior fossa on the right was seen. It extended from the mastoid to the midline and upward as far as the tentorium, displacing the pons and medulla far to the left, and correspondingly flattening the right cerebellar hemisphere. The cap of the latter was then resected and the capsule of the tumor opened. Approximately \( \frac{2}{3} \) of the mass was gradually cored out. This was accompanied by profuse bleeding which protracted the operation greatly. The tumor was then rotated laterally and gradually separated from the adjacent brain. The main mass was eventually removed although a small portion remained just beneath the medulla. It was found that the tumor had extended intracranially up as far as the incisura and had also perforated the base of the occipital bone. The former extension was removed piecemeal with the cautery loop while the latter was shelled out with the finger. Its lower pole was surrounded by but not tightly adherent to muscle. A few bits of the extradural and extracranial portions remained but it was clear that the patient could stand no more at that time. She was given altogether 1000 cc. of citrated blood during the operative procedure. The wound was closed in layers with silk and the patient was returned to her room in good condition.

Pathological Diagnosis (Dr. A. W. Wright). Meningioma, Cushing type III.

Postoperative course was complicated by an ulceration of the right cornea, but was otherwise satisfactory. She was discharged 30 days after operation. She improved greatly and gained weight and strength. A year later the right leg was slightly spastic. Fundi were negative. There was nystagmus on right lateral gaze with rapid component outward. The right facial paralysis and deafness remained. Palate and tongue still deviated as before and there was slight ataxia on the right finger-to-nose and heel-to-knee tests. Right knee and ankle jeks were relatively hyperactive. She had resumed her household duties.

She was last seen 9 years later at which time she stated that she was free of headache but had occasional giddiness. There had been some loss of weight recently without adequate explanation. She continued to carry out her household duties. The right facial paralysis and deafness persisted, as did the atrophy of the right sternocleidomastoid. There was some ataxia of right arm and leg, and very slight unsteadiness in gait.

It is likely that few more vicious intracranial tumors occur than a large
angioblastic meningioma of the clivus. Perhaps the following case should have been considered “inoperable” from the beginning, but one can seldom be sure until one has tried, and besides, many lesions considered hopeless in the past are readily operable today. In view of the benefit obtained by the previous patient from subtotal removal of a somewhat similar tumor, it was hoped that at least that much could be accomplished, and hence the efforts which followed. Perhaps the murmur signified that the neoplasm was far too vascular; perhaps today with the newer hemostatic agents and a little more skill, one might have succeeded.

Case 8. A.H. #89990. S.H., a white housewife, was admitted to the hospital Dec. 21, 1941 with chief complaints of headache, vomiting, deafness in the left ear and left facial paralysis, together with difficulty in walking. She had been in good health until 7 years before when she had a severe headache for a few days and was totally deaf for 2 weeks; there was no accompanying fever nor discharge from the ears. Thereafter her hearing recovered in part

Fig. 12. Case 7. Towne position X-ray showing extensive erosion of right petrous bone and basi-occiput.
but she had felt weak ever since. One year later paralysis of the left half of the face began, rapidly became complete and had persisted. Four years before admission pain occurred in the right ear with discharge; mastoidectomy was performed in another hospital. Six months previously a change in the patient's voice had been noted. For 3 months she had complained of liquids escaping from the left side of her mouth; for 1 month severe headaches, vomiting and unsteadiness of legs had been present. Swallowing became difficult and her memory began to fail. More recently diplopia and amblyopia had been noted.

Examination. The patient appeared ill, poorly nourished, and in considerable distress. General physical findings were not remarkable, except for a bruit over the left suboccipital region; this could be stopped by compression of the left carotid artery. There was bilateral papilloedema with both recent and old hemorrhages. The left pupil was 2 mm. larger than the right. The left lateral rectus muscle was paralyzed. There were anesthesias in the 1st and 2nd branches of the left 5th nerve and complete left facial paralysis. Hearing was absent on the left, with the Weber referred to the right. The uvula deviated to the right, speech was slurred, the left sternocleidomastoid muscle was weak and the tongue was atrophied on the left, with deviation to that side. There was generalized muscle weakness with relative hyperactivity of deep tendon reflexes on the right. Ataxia, past-pointing and adiadochokinesia were present bilaterally; Romberg was positive to the left. No sensory changes were observed.

Laboratory data: R.b.c., 3,810,000, hgb., 10 gm. (70 per cent), w.b.c., 9300. Urine and blood Wassermann were negative. Repeated studies of visual fields showed a normal field for the right eye and an inferior temporal quadrant defect for the left.

Roentgenograms of skull showed extensive destruction in the left base, extending from the sella and involving the anterior clinoid on the left, back to and including part of the foramen magnum. The left petrous pyramid was about two-thirds destroyed. In and about the region of destruction, there were several fine, mottled areas of increased density (Fig. 13).

An otolaryngological consultant found reddening and fullness of the left ear drum with tenderness over the left mastoid emissary vein; weakness of movement of the left vocal cord; complete deafness of left ear with the Weber referred to the right.

1st Operation. On Dec. 27, 1941, after repeated manual compression, the left carotid artery was completely ligated and the left internal carotid artery partially ligated. This resulted in cessation of the bruit. No change in the condition of the patient was noted save that she no longer complained of headache.

2nd Operation. On Jan. 3, 1942, under avertin supplemented by ether anesthesia, the tumor was exposed through a left suboccipital approach (E.C.). It was necessary to resect the lateral third of the left cerebellar hemisphere. Tremendous bleeding was encountered which required completion of the ligation of the left internal carotid artery, ligation of the right external carotid artery and ligation of the left lateral sinus for its partial control. It was then possible rapidly to enucleate the bulk of the neoplasm. It extended deeply into the muscles of the neck and obviously involved the carotid canal and jugular foramen. The bleeding was then controlled by packing with cotton; sulfathiazole was dusted in the wound and the latter closed in layers with interrupted silk. During the operative procedure the patient was given 2000 cc. of citrated blood.

Pathological Diagnosis (Dr. A. W. Wright). Meningioma, Cushing type IV.

Postoperative Course. The immediate course was uneventful. She was able to move the left arm and leg well and the right leg poorly. R.b.c. 2 days postoperatively was 2,250,000 with 50 per cent hgb.

On Jan. 5, 1942, the wound was reopened for removal of the pack. Bleeding was again violent but finally was apparently brought under control. However, the patient became comatose thereafter and expired the following day.

Necropsy revealed a recent subdural blood clot extending from the left middle fossa to the foramen magnum. It apparently arose from a laceration of the internal carotid artery where the latter traversed the tumor, covering the pons and upper part of the medulla. A firm, hemorrhagic, circumscribed tumor occupied the anterior portion of the left posterior fossa. The mass had no connection with the brain tissue and seemed to lie largely outside the
dura, being intimately connected with the latter. The growth extended into the foramen magnum and into the sella turcica, which was enormously widened. The ridge of the left petrous bone was totally destroyed by the neoplasm, to which it was densely adherent. There was no sinus thrombosis.

*Microscopic Examination.* The tumor was highly vascular with numerous hemorrhages. In places it was completely necrotic, while in other fields the cellular pattern could be visualized. The neoplastic cells were usually round or fusiform, with rather small, compact nuclei and often grew in heavy cords. Numerous thin-walled blood vessels were seen. Complete, although atypical bone spicules were dispersed irregularly throughout the entire neoplasm. Some small tumor cells were accompanied by strands of connective tissue and the impression was gained that this was laid down by neoplastic cells. In other areas the connective tissue became hyaline and denser and actual caseous metaplasia could be observed in several places. Mitotic figures were absent (Fig. 14). *Diagnosis:* The tumor was believed to be a meningioma with tendency to blood-vessel formation and fell well into the group described by Cushing and Eisenhardt as angioblastic meningioma, namely Type IV. No evidence of tumor invasion of the brain was seen.

*Fig. 13, Case 8. Towne position X-ray showing extensive destruction of left petrous apex and clivus, and calcification in the tumor.*
In the final case a probable diagnosis of a posterior fossa tumor was made on the basis of the history and physical findings but operation was postponed on the erroneous evidence of a seemingly normal ventriculogram. Fortunately the neoplasm was very slow-growing and was subsequently removed with success.

Case 9. A.H. #82980, C.H., a 30-year-old single, white truck-driver, was admitted on May 29, 1941, because of pain in the left suboccipital region of at least 3 years' duration. This occurred chiefly in the morning and was not aggravated by straining. There had been no nausea nor vomiting until shortly before admission. He had had tinnitus in the left ear for 3 years. The patient was not aware of deafness, but his mother noticed impairment of hearing and some recent tendency to stagger. She had also observed some personality change and difficulty in reading. He had noticed intermittent numbness and stiffness of the left arm and leg for about a year, blurring of vision and some urgency of urination. Past history indicated long-standing mental retardation.

Examination. General physical examination was negative. The pupils were large; the left was slightly greater than the right. Conjugate movements of the eyes were defective. Fundi were negative. Both corneal reflexes were slightly diminished. There was definite weakness of the left lower face with absence of taste on the anterior two-thirds of the tongue. Hearing was markedly impaired on the left. The tongue deviated slightly to the left.

There was weakness and hypotonia of left arm and leg. On the left deep reflexes were hy-
peractive, with sustained ankle clonus and positive Babinski. All modalities of sensation were diminished on the left, particularly caudally. The left finger-to-nose and heel-to-knee tests were ataxic. Romberg was negative. Gait was ataxic with tilting of the head to the left and relative immobility of the left arm.

Visual acuity was 20/30 O.U. Both visual fields were markedly constricted concentrically without localized defects. Audiograms showed 20 decibels loss on the right and 63 on the left. Both labyrinths functioned normally on the caloric test.

Routine blood and urine studies were negative. Lumbar puncture revealed cerebrospinal fluid pressure of 140 mm. of water; r.h.c. 60 per c.mm., total protein 118 mg. per cent, and negative Wassermann and colloidal gold curve. Immediately after the procedure pulse rate dropped to 38 with long periods of apnoea, with recovery within several minutes. Roentgenograms of skull disclosed atrophic changes in posterior clinoid processes.

Ventriculography was performed on June 3, 1941. The ventricular system appeared essentially normal. In view of the inconclusive findings and the absence of papilloedema, operation was deferred.

Readmission. He was readmitted to the hospital 10 months later. General physical examination was negative. The patient's responses were slow and his speech was thick. There was weakness of conjugate movements of both eyes. Fundi remained negative. Both corneal reflexes were diminished and there was diminution of perception of cotton-wool in the 2nd division of the left 5th nerve. Air conduction was absent on the left and the Weber was referred to the right. There was ataxia of both upper extremities, more marked on the left, with adiadokokinesis of left arm. Romberg was negative. Deep tendon reflexes were slightly hyperactive on the left.

Roentgen re-examination of skull disclosed extensive destruction of the left petrous pyramid, centering about the internal auditory meatus, involving approximately the medial two-thirds of the ridge, extending deeply into the bone and eroding about one-half of the dorsum sellae and posterior clinoids. Upon reviewing the previous films, similar though less extensive erosion was then noted (Fig. 15).

On lumbar puncture the spinal fluid pressure was found to be 145 mm. of water, protein 91 mg. per cent, cell count normal, Wassermann negative and colloidal gold curve 012442\(\times\)100.

There was total loss of hearing in the left ear (by audiogram) and a hypoactive labyrinth on that side. Motion of the left vocal cords was weak.

Operation. On April 28, 1942, under averitin and ether (E.C.), a suboccipital exposure was made. A rounded, reddish-gray tumor was found in the left cerebellopontine angle, with the 5th, 7th and 8th nerves tautly stretched over it. Sacrifice of these nerves was necessary in order to remove the well-encapsulated tumor piecemeal. It extended upward intracranially as far as the trochlear nerve, which fortunately could be spared, and medially as far as the basilar artery, from which it was dissected by moist cotton pledges. The tumor had burrowed into but not invaded the bone. When it had been shelled out, a smooth cavity remained, about 4\(\times\)5 cm. in size, which extended into the tip of the petrous pyramid, the clivus and the base of the posterior clinoid. There was very little bleeding. The wound was closed in layers with interrupted silk without drainage and the patient returned to the ward in good condition.

Pathologic Diagnosis (Dr. A. W. Wright). Meningioma, Cushing type III.

Postoperative course was complicated by rhinorrhea which, however, ceased spontaneously within 24 hours. Ulceration of the left cornea appeared at this time and was treated by external tarsorrhaphy.

On May 28, 1942, 1 month after operation, left spino-facial anastomosis was carried out and the patient was discharged 10 days later. At this time there was 6th nerve weakness, complete anesthesia of the left side of the face and complete left facial weakness. Air conduction was absent on the left and the Weber was lateralized to that side. The uvula drew slightly to the right and there was weakness of the left 11th nerve. There was adiadokokinesis on the left and slight ataxia of the left heel-to-knee test. The left ankle jerk was slightly hyperactive.

He was last seen on Mar. 8, 1948. He stated that he felt pretty well and was able to do
some work on his farm. The headaches were completely relieved. Examination disclosed slight unsteadiness of gait. The left trigeminal, abducens and acoustic nerves remained paralyzed, while the facial had partially recovered. The left sternomastoid and trapezius muscles were weak and there was very slight ataxia of the left heel-to-knee test. No other abnormalities were found.

Fig. 15. Case 9. Towne position X-ray showing erosion of left petrous apex, clivus and left half of dorsum sellae.

SUMMARY AND CONCLUSIONS

Nine cases of meningioma of the posterior fossa are reported. (Tumors within the foramen magnum were not included.) These fell into three main groups according to their origin: those of the tentorium, posterior wall and lateral recesses (5 cases); those of cerebellopontine angle (1 case); and those of the clivus (3 cases). The clinical manifestations of these groups are presented. Five patients are living and 4 dead.

The 5 tumors that arose from the under surface of the tentorium, the lateral recess and the convexity produced symptoms and signs much like tumors of
cerebellar origin. Neither upon clinical nor ventriculographic evidence would it have been possible to differentiate them (with two possible exceptions, Cases 2 and 3).

The meningioma of the cerebellopontine angle, like acoustic neuromas, grew slowly and eventually involved the acoustic, facial and trigeminal nerves; on the contrary, however, vestibular function of the involved 8th nerve was lost late, and bone erosion was demonstrable in the petrous tip and/or the adjacent clivus.

The 3 meningiomas of the clivus involved adjacent nerves early. Compression of the supratentorial pons and medulla was evident, although it was remarkable how large 2 of these tumors had grown without producing greater embarrassment. All eroded bone deeply. One tumor was removed completely and a second subtotally; both patients are living and able to work 9 and 4 years later. The third patient had a huge angioblastic meningioma which extended forward to encompass the left internal carotid artery; she succumbed 2 days after operation.

Since completion of this study we have seen 1 additional case of a meningioma in the right lateral recess penetrating the tentorium and eroding the mastoid.

REFERENCES