

A REVIEW OF A YEAR'S SERIES OF INTRACRANIAL TUMORS

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The object of this report is to give a survey of the 255 cases, with the presumptive diagnosis of "brain tumor," that passed through Dr. Cushing's service during my twelve months' period as his assistant. All patients referred to the hospital as possible tumor cases (suspects) have been included, even though further investigation has proved the condition to be other than tumor.

A year ago one of my predecessors, Dr. Percival Bailey, made a report¹ on the working classification of brain tumors then in use in the clinic. In grouping the present series, a few modifications will be made in the program which he employed. The cases will be presented under four main divisions:

1. *Verified Brain Tumors*.—In this group, the diagnosis, with the few exceptions to be noted, has been determined by the histologic examination of tissue secured at operation or necropsy.

2. *Unverified Brain Tumors*.—In these cases, though the diagnosis of brain tumor is almost certainly correct, the lesion has not as yet been disclosed and hence its histologic character remains undetermined.

3. *Brain Tumor Suspects*.—This group consists of borderline cases in which the diagnosis remains uncertain though the symptoms are strongly suggestive of tumor.

4. *Nontumor Group*.—This includes the cases referred to the hospital as tentative tumor cases, but in which, as the result of necropsy or of careful clinical study, the conditions were proved to be, or have come to be regarded as, other than tumor.

CLASSIFICATION OF CASES

The 255 cases of the year's series are numerically apportioned in these four groups under the subdivisions shown in Table 1.

This classification differs from the one presented by Dr. Bailey in the following ways: Under Group A of "verified tumors," a subdivision (1-b) of those "verified macroscopically" has been introduced.

1. Bailey, P.: Concerning the Clinical Classification of Intracranial Tumors, Arch. Neurol. & Psychiat. 5:418-438 (April) 1921.

This is to accommodate certain tumors exposed at operation but which proved so vascular as to prohibit removal of tissue for study. Three of these tumors were obviously angiomas.

A fourth group of nontumors has been introduced in order to cover two kinds of cases: (1) certain suspected cases of tumor which were finally proved by necropsy to be conditions other than tumor; (2) cases which were referred to the clinic as possible tumor but which on careful study proved to be so obviously something else that they should not properly be regarded even as tumor "suspects." For instance, a patient with progressive muscular atrophy with bulbar palsy, although sent in with a tentative diagnosis, by a local physician, of cerebellar tumor, was without hesitation placed in the nontumor group.

TABLE 1.—GENERAL CLASSIFICATION OF CASES

| | |
|---|-----|
| A. Brain Tumors Verified: | |
| 1. At operation (a) microscopically proved..... | 86 |
| (b) macroscopically proved..... | 6 |
| 2. At necropsy (unverified at operation)..... | 12 |
| 3. At necropsy (unoperated)..... | 3 |
| Total..... | 107 |
| B. Brain Tumors Unverified: | |
| 1. Evidence disclosed at operation (a) subtemporal decompression..... | 15 |
| (b) exploration..... | 31 |
| 2. Unoperated..... | 14* |
| Total..... | 60 |
| C. Brain Tumor Suspects: | |
| 1. Clinically doubtful (unoperated)..... | 49 |
| 2. Clinically operable (negative tumor findings)..... | 7 |
| Total..... | 56 |
| D. Nontumor Group: | |
| 1. Clinically tumor suspect (necropsy no tumor)..... | 6 |
| 2. Tentative tumor diagnosis not supported..... | 26 |
| Total..... | 32 |

* Several of these are in the wards awaiting operation.

The group contains, nevertheless, a number of patients sent in as acoustic tumor suspects in the stage before choked disk or cerebellar symptoms have set in, and though they have been discarded, some of them in time may actually prove to have tumors.

Because Dr. Bailey was chiefly concerned with discussing the group of tumor suspects, which are more interesting from the standpoint purely of neurologic diagnosis, he placed this group first in his classification. This has been reversed in favor of the verified tumors, which are, after all, the more important from a therapeutic point of view.

It is not infrequent that a single case while under study, whether the patient is temporarily discharged from the hospital or not, shifts its position in the classification from one group to another. These changes may be illustrated by a case which passed step by step from Group C to Group A.

CASE 1 (Surg. No. 13783).—*A case primarily a tumor suspect (Group C); questionable thrombosis syphilitica. Subtemporal decompression; tumor unverified (Group B). Two-stage exploration; neuroblastoma verified (Group A).*—*History.*—Jan. 4, 1921, A. S., a farmer, aged 49, married, was admitted, complaining of recent weakness of the right arm and leg. The father and mother had both died of cardiovascular disease. The wife had had no miscarriages. There had been one child, who was living and well. The past history was unimportant, except for frontal headaches attributed to eye strain during the last twenty years.

Present Illness.—Dec. 14, 1920, three weeks before entry, the patient awakened about daybreak with a severe left frontal headache. He slept again, but on arising in the morning felt tired and bewildered. He went to work but came home at noon with a sensation of numbness of the right arm and leg. The following day he noticed that his right leg dragged somewhat.

Frontal headaches continued and were severe, and the weakness of the right arm and leg became progressive. Ten days after onset, there was a second more severe "attack of numbness of the right arm and leg," and following this the leg became so weak that the patient was confined to bed. His speech also at this time became hesitant, with some misuse of words.

Physical Examination.—He was well developed and nourished, of slow mentality, bewildered and mildly euphoric. Speech was somewhat incoherent, words were confused and incorrectly pronounced, and there was some apraxia. There was a hemiparesis of the right lower side of the face, arm and leg, as well as a hypesthesia of the right arm, leg and trunk. Some spasticity and a Babinski reflex were present on the right side.

Eye: The fundus of the right eye was pale, showing secondary atrophy with an elevation of 2 diopters. The margins of the disk were hazy and the retina showed very extensive choroiditis with numerous large patches of pigmentation. The left eye showed no choroiditis and no atrophy. There were a few linear hemorrhages, and the disk also measured 2 diopters.

Urinalysis and blood Wassermann test were negative. The roentgen ray revealed suggestive evidence of increased intracranial pressure.

The loss of power, with numbness in the right arm, leg and face, with aphasia indicating an extensive lesion of the left hemisphere, might well have been produced by thrombosis of the middle cerebral artery. The choroiditis suggested syphilis. In the hope of gaining more evidence, a lumbar puncture was made and a few c.c. of fluid, not under excessive pressure, were slowly withdrawn. It contained four cells per c.c. and no increase in globulin. A + Wassermann reaction was reported in 1 c.c. dilution. Although a positive diagnosis was not made, the symptoms and signs were sufficiently suggestive of syphilitic thrombosis, so that the patient was kept under observation and operative procedure deferred. Had the patient been discharged or transferred at this time the classification would have been "Brain tumor suspect: syphilitic thrombosis? (Group C)." He was recommended for transfer to the medical service.

Course.—During the next ten days his condition became progressively worse, with subnormal temperature, and pulse of about 60. Drowsiness became more marked. The degree of right hemiparesis and hemianesthesia increased. Aphasia became more pronounced, until his vocabulary was limited to “yes” and “no.” Headache was severe, and he vomited on two or three occasions. The disks now measured 3 diopters. The condition, whether due to tumor or edema, evidently demanded operative relief.

Operation.—January 17, a left subtemporal decompression was performed. This disclosed a tight brain with flattened convolutions and without surface fluid. The ventricular tap was dry.

At this point, owing to the conditions found at operation, the diagnosis shifted the case from the suspect group to that of a probable tumor, and had he been discharged without further intervention it would have been with the diagnosis “Brain tumor: unverified (Group B).”

Postoperative Course.—Following the decompression he improved markedly. There was some return of strength in the right arm and leg. His vocabulary increased so that he could, to a limited extent, respond to questions. Apraxia was still evident, and when given a candle and box of matches, he looked at them blankly and could not demonstrate their use. The decompression bulged markedly.

Because of this improvement, a left osteoplastic exploration was performed, and a well-circumscribed tumor of the postcentral gyrus was disclosed. Five days later, the flap was reelevated, and the tumor, which had the gross appearance of an endothelioma, was readily enucleated. The histologic report, however, was neurocytoma (glioma group).

He made a remarkably good operative recovery and was soon able to be out of bed. Strength was gradually regained in the leg so that he walked with a little assistance. The aphasia disappeared except for hesitation over an occasional word. The apraxia cleared, and the hemianesthesia was much less in degree. The choked disks subsided, leaving only a moderate formation of new tissue.

Because of the final verification of the nature of the tumor, the case came to be placed among the verified tumors (Group A) and among those histologically identified. Had he succumbed to the first stage of the exploration and necropsy been refused, the verification would have been only macroscopic, and under Dr. Bailey’s rulings would, therefore, have remained “Tumor unverified.”²

Not infrequently do cases shift in this way from one group to another in the records. Undoubtedly, a good many of the unoperated

2. It may be added that this is the chief reason for not classifying a tumor as “verified” without histologic examination, for it was my impression, owing to the circumscribed character of the tumor, its enucleability, and its attachment to the dura, that it was an endothelioma. H. C.

cases in the tumor suspect group may in time have symptoms sufficiently distinctive to justify exploration. But even an operation may sometimes fail to reveal the presence of a tumor, and tumors, indeed, may sometimes be overlooked at necropsy. The following is a striking example. The case, originally a "tumor suspect" (Group C), regarded at operation as "clinically nontumor" (Group D), proved at necropsy, made possible by a postoperative complication, to belong actually in Group A.

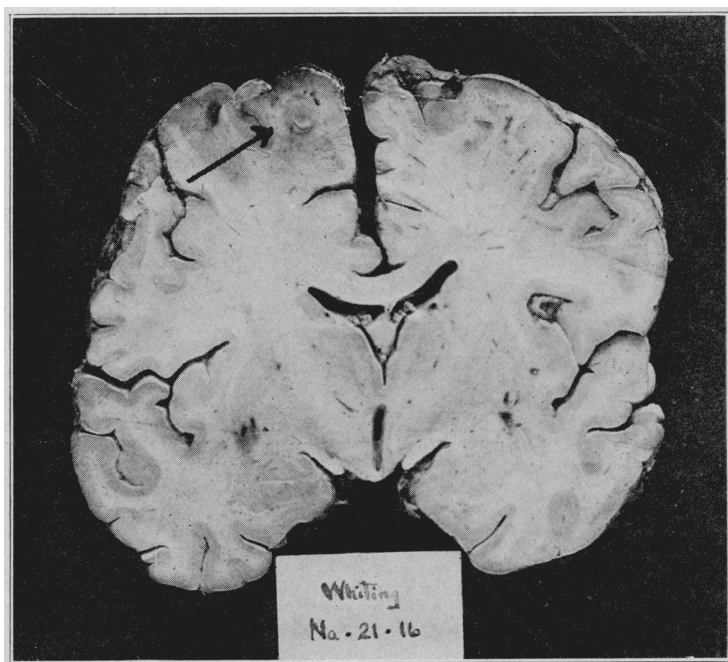


Fig. 1.—Coronal section photographed from in front. Arrow points to minute glioma in paracentral lobule.

CASE 2 (Surg. No. 14497).—*Brain tumor suspect* (Group C). *Exploration of hemisphere negative. Operative diagnosis cerebral arteriosclerosis* (Group D). *Fatality. Small glioma disclosed at necropsy* (Group A).—*History*.—Mr. C. W. W., aged 59, was admitted, May 9, 1921, with a history of recent paresthesia and progressive weakness of the left lower leg. There were no general pressure symptoms whatsoever.

Neurologic Examination.—This was negative except for slight loss of power associated with ankle clonus and some spasticity of the left lower leg. There were no sensory changes and no choked disks. The roentgenogram was negative. A diagnosis was made of presumptive tumor, possibly endothelioma involving the foot center.

Operation.—Right osteoplastic flap revealed a wet brain under no tension and some arteriovascular changes. Thorough exploration in all directions, even to the falx, showed no evidence whatsoever of tumor. The operative diagnosis was cerebral arteriosclerosis. Closure.

Postoperative Course.—Symptoms of the gradual formation of an extradural clot were overlooked. Consciousness was not regained. On the second day the flap was reflected and the clot was removed. The patient died eighteen hours later.

Necropsy.—The primary report on the brain was negative. Subsequent thin sections disclosed a small subcortical glioma, about 1.5 cm. in diameter, in the leg center of the right hemisphere (paracentral lobule).

TABLE 2.—VERIFIED TUMORS, GIVING LOCATION AND PATHOLOGIC TYPE

| Location | Glioma | Gliomatous Cyst | Pituitary Adenoma | Endothelioma | Pharyngeal Pouch | Neurofibroma | Carcinoma | Angioma | Tuberculoma | Cholesteatoma | Dermoid | Total |
|-------------------------|--------|-----------------|-------------------|--------------|------------------|--------------|-----------|---------|-------------|---------------|---------|-------|
| Frontal..... | 2 | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | 3 |
| Paracentral..... | 6 | 4 | .. | 5 | .. | .. | 2 | 2 | .. | .. | .. | 19 |
| Parietal..... | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Supramarginal..... | 3 | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | 4 |
| Temperosphenoidal.... | 5 | 2 | .. | 2 | .. | .. | .. | 1 | .. | .. | 1 | 11 |
| Occipital..... | 2 | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | 4 |
| Pituitary..... | .. | .. | 18 | .. | 2 | .. | .. | .. | .. | .. | .. | 20 |
| Suprasellar..... | .. | .. | 1 | .. | 5 | .. | .. | .. | .. | .. | .. | 6 |
| Cerebellar..... | 6 | 9 | .. | 2 | .. | .. | .. | .. | 2 | .. | .. | 19 |
| Extracerebellar..... | .. | .. | .. | .. | .. | 9 | 1 | .. | .. | .. | .. | 10 |
| Region fifth nerve..... | .. | .. | .. | 2 | .. | .. | 1 | .. | .. | .. | .. | 3 |
| Optic chiasm..... | 1 | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | 2 |
| Pons and basal nuclei. | 1 | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 2 |
| Lateral ventricle..... | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Parietal and temporal | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 1 |
| Total..... | 29 | 16 | 19 | 14 | 7 | 9 | 5 | 3 | 3 | 1 | 1 | 107 |

These two case reports serve to show how the diagnoses, as recorded in the hospital files, may shift on subsequent reentries from one group to another until in time they come to be verified in Group A as tumor, or in Group D as nontumor.

In Table 2 the cases have been arranged roughly in accordance with the primary location and histologic diagnosis. It can be seen that the pituitary cases predominate, the intracerebellar and the para-Rolandic tumors being a close second. It is probable that tumors in other parts of the cerebrum are often overlooked.

THE GLIOMAS

In this short series the true brain tumors constituting the glioma group represent 42.5 per cent. of all the lesions. Tooth³ in a series

3. Tooth, H.: Some Observations on the Growth and Survival Period of Intracranial Tumors, Brain **35**:61-108, 1912.

of 258 verified cases found 49.2 per cent. of gliomas. Heuer and Dandy⁴ in a series of forty-two cases found 50 per cent. Clarke,⁵ in ninety-nine cases, found 38.5 per cent. It is safe to say, therefore, that the gliomas represent between 40 and 50 per cent. of all intracranial tumors.

No attempt will be made to subdivide the gliomas and to distinguish neurocytomas, neuroblastomas, gliosarcomas, and so on, from the general group, for the surgical problem is the same for all and prognosis differs in no great respect. This is largely a matter for the neuropathologist, and this series is too small to draw any particular conclusions from these finer subdivisions.

From a surgical standpoint these tumors are by no means to be regarded as therapeutically hopeless, for certain of the gliomas are enucleable, and some of the gliomatous cysts when properly treated apparently are curable lesions. Dr. Cushing has pointed out⁶ that the first two successes in his tumor series, with apparent cures lasting over thirteen years, were: (1) a solid glioma, and (2) a large gliomatous cyst, both of the cerebellum. Even a large gliomatous tumor of the infiltrating type originating in the left hemisphere may offer a surgical problem not entirely hopeless. An illustration of this is the case of a physician's wife, who had been readmitted to the clinic on several previous occasions, though she first came under my observation in 1920. Though it is now twelve years since her first symptom of tumor, she still leads a comfortable existence and is able to look after her home duties.

CASE 3 (Surg. No. 14226).—*Glioma of left hemisphere with symptoms of twelve years' duration. First pressure symptoms five years ago. Repeated partial extirpations of tumor with marked relief of symptoms and signs.—History.*—Mrs. A., a physician's wife, in 1909, twelve years ago, began to have convulsions. These were usually of the petit mal type, but twice were generalized, without a focal element and with immediate loss of consciousness. It was not until seven years afterward (1916) that the patient developed pressure symptoms of headache and vomiting. At this time choked disks were found.

In September, 1916, she entered the Peter Bent Brigham Hospital, and a right subtemporal decompression was performed for an "unlocalized brain tumor."

During the next few months there were frequent attacks of numbness of the right arm, associated with weakness and awkwardness of that extremity. Reflexes were exaggerated, and there were some vasomotor disturbances in

4. Heuer, G., and Dandy, W.: A Report of Seventy Cases of Brain Tumor, *Bull. Johns Hopkins Hosp.* **27**:224-237 (Aug.) 1916.

5. Clarke, F.: A Study of the Anatomical Location and Histopathology of Ninety-Nine Brain Tumors, *Rev. neurol. & psychiat.* **14**:485-505, 1916.

6. Cushing, H.: The Special Field of Neurological Surgery: After Another Interval, *Arch. Neurol. & Psychiat.* **4**:603-637 (Dec.) 1920.

the right arm. Disks were elevated 2 diopters. An osteoplastic exploration in December, 1916, revealed a tumor about 6 cm. in diameter slightly adherent to the dura in the inferior postcentral region. The tumor, which was supposed to be an endothelioma, was removed apparently *in toto*. The histologic diagnosis, however, was glioma.

She made a perfect recovery and during the following two years she was quite normal, except for occasional attacks of numbness and jerking of the right arm, and two transient periods of aphasia lasting for less than five minutes. These symptoms, however, were comparatively slight and did not interfere at all with her social life, and she was considered entirely normal by her husband and friends. There were no more convulsions or headaches.

In 1918, the decompression area began to protrude, her right arm became weak, and there was some difficulty in writing. She was referred to Dr. W. E. Dandy in Dr. Cushing's absence abroad. He exposed the tumor again, drained

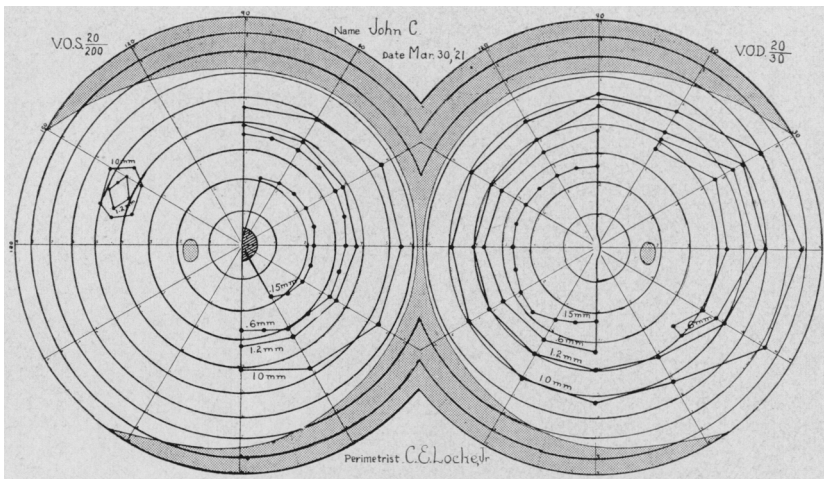


Fig. 2.—Fields of pituitary case, March 30, before operation, showing bitemporal hemianopsia in the left eye except for a small island, and in the right eye complete for smaller test objects.

a large degenerative cyst, and removed a small fragment of what appeared to be a widespread glioma, an impression confirmed by the histologic findings. She subsequently underwent a thorough course of treatment with radium. For the next two years her condition remained very good. Her right arm regained its normal strength, and she resumed her usual activities. During these two years there were very few periods of transient aphasia.

In October, 1920, she reentered the Peter Bent Brigham Hospital, owing to a recurrence of weakness of the right arm and some transient numbness both in the arm and right side of the face. There was increased intracranial pressure as evidenced by a bulging decompression and low grade of choked disk. The right arm showed weakness and slight anesthesia, some astereognosis and loss of muscle sense, as well as exaggerated deep reflexes.

The *fourth operation* conducted at this time consisted in removing a huge mass of tumor which had increased considerably in its area of distribution. It

was amazing that the procedure did not leave her completely aphasic and hemiplegic, but contrary to expectations no additional paralysis resulted and strength in the weak arm was soon partly regained. Periodic attacks in which there was slight aphasia subsequently occurred, but without loss of consciousness. She was remarkably well for another five months.

In April, 1921, because of increasing weakness of the right arm and a somewhat more pronounced aphasia, she presented herself again for study and possible operation, earnestly favored by her husband. At this time, therefore, a *fifth operation* was performed and another large mass of gliomatous tissue was scooped away. She did well, made a prompt recovery, and a recent letter tells of continued improvement since her discharge.

This illustrates, even with the least promising types of glioma, how a useful life may be prolonged for years by repeated comparatively simple operative procedures. The fact that the patient's husband is a physician and fully understands the ultimate outcome speaks well for the success of this unequal combat with a desperate disease by operative measures, several of which have been performed at his insistence under considerable protest.

GLIOMATOUS CYSTS

Though in the long run the infiltrating gliomas like the one mentioned above are the least amenable to surgical treatment of any of the brain tumors encountered, those gliomas which have undergone cystic degeneration are in many respects very favorable for operation and in their results often rival those following endothelioma extirpations. In this series, out of the forty-five gliomas, sixteen were classified as gliomatous cysts, as the cystic element predominated. It can be seen, furthermore, from the table, that the larger number of these were intracerebellar cysts, some of which are very favorable from a surgical standpoint.

According to this series these intracerebellar gliomas are particularly common in children. Indeed, it is interesting to note that out of the nineteen verified intracerebellar tumors fourteen, or 73 per cent., occurred in children. Also, ten of the nineteen verified tumors were cystic, and nine of these were found in children. This is in marked contrast to the series of forty-three cerebral tumors, of which only four occurred in children. Of the forty-three cerebral tumors, six were cysts, and only one occurred in a child. These figures illustrate not only the predominance of cystic gliomas in children but also their favorite anatomic location in the cerebellum.

The diagnosis of a straightforward cerebellar tumor is a comparatively simple matter when the cerebellar symptomatology is full blown. In the absence of the cardinal signs and symptoms, however, it may be most difficult to arrive at a decision. The following case may be cited in illustration.

CASE 4 (Surg. No. 14264).—*Cerebellar tumor suspect despite few cerebellar signs. Exploration; gliomatous cyst verified.*—*History.*—A school boy, aged 14, was admitted, March 20, 1921, complaining of nausea and vomiting, dizziness, and blurring of vision. In September, 1919, six months previous to entry, he began to complain of afternoon nausea. He was thought by his local physician to have chronic appendicitis. An appendectomy was performed and no pathologic condition demonstrated.

In November, 1920, he began having periodic headaches referred to the suboccipital region. During the next three months, the headache became more frequent, and there was some associated vertigo. No difficulty in gait was noted by the patient or his parents. Early in March, a few weeks previous to his admission, there was some blurring of vision with transient diplopia.

Neurologic Examination.—The only positive findings were: (1) slight suboccipital tenderness; (2) cracked-pot resonance of skull; (3) separation of cranial sutures and convolutional atrophy shown by the roentgen ray, and (4) choked disks of 4 diopters.

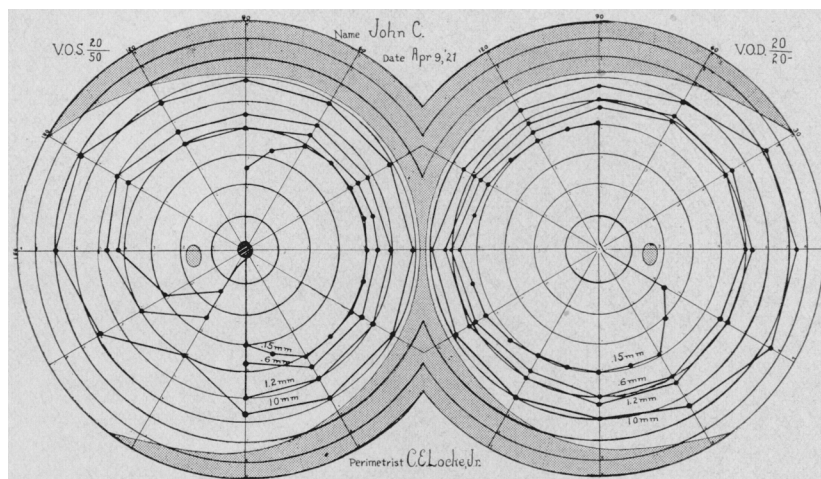


Fig. 3.—Fields on fifth day after transsphenoidal operation.

There was no nystagmus with the head in a vertical position, though when placed obliquely a few twitches occurred. Gait was very good, with no unsteadiness whatsoever. There was no definite hypermetria and no repulsion. There was a possible slight adiadokokinesia on the right, also slight hypotonia of lower extremities with diminished deep reflexes.

Although this case did not present at all a textbook picture of cerebellar tumor, it is quite representative of a fairly large group of cases. A presumptive diagnosis of cerebellar tumor (possible arachnoiditis) was made and a suboccipital exploration revealed a midline large gliomatous cyst. The points in the story that led to this diagnosis were chiefly the suboccipital headaches and tenderness and the diplopia, together with the evident internal hydrocephalus.

Comment may be made on the needless abdominal operation performed shortly before this patient's admission. It has always been the custom of the clinic to have a special paragraph in the histories of all tumor cases in which the previous diagnoses and operations are listed. It is a subject by itself and one which deserves a special report. Though abdominal operations, owing to nausea and vomiting, are not infrequent, those on the nose and throat are by far the more common, as Dr. Cushing has pointed out in some recent papers. This is possibly to be taken merely as indication of the difficulty of tumor diagnosis in the early stages of the process.

PITUITARY ADENOMAS AND PHARYNGEAL POUCH TUMORS

If one is to consider these two types of tumor together in the pituitary group, as is usually done, they represent, next to the gliomas,

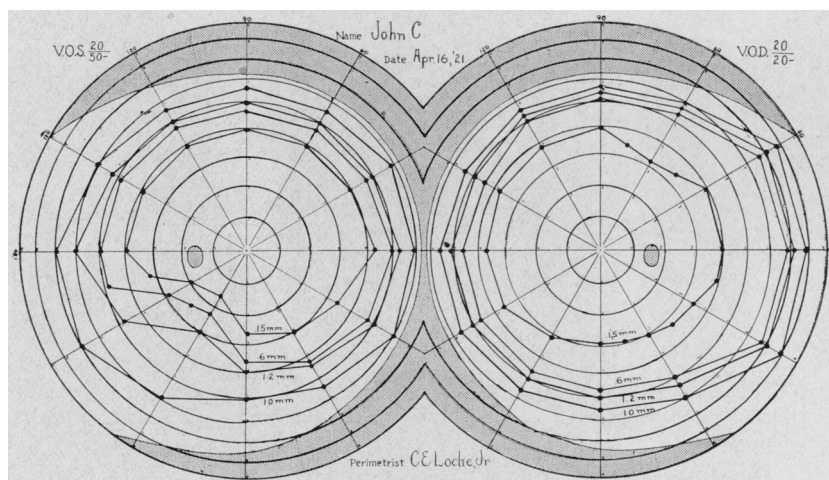


Fig. 4.—Fields on twelfth day after operation.

the largest group from the standpoint of tissue origin. In the year's series, there were twenty-six cases, nineteen of them primary adenomas of the gland and seven of them of pharyngeal pouch origin. By far the larger proportion of these lesions, therefore, were sellar rather than suprasellar, as shown in the table. There were two additional cases which gave typical pituitary signs, i. e., primary optic atrophy, bitemporal hemianopsia, low metabolism, headaches, etc., in which the lesion was also "suprasellar" but unrelated to the hypophysis. One was a glioma of the chiasm and the other a dural endothelioma of the base, both giving direct pressure on the pituitary. These I have placed in the table under optic chiasm.

The therapy of the pituitary disorders in its present stage is directed chiefly toward the preservation of vision. Indeed, loss of vision in my

brief experience is the complaint that brings most of these patients to seek surgical assistance. The usual patient with dyspituitarism disregards in large measure the general manifestations of his disorder—his neighborhood symptoms alone disturb him.

Few operations in surgery can be more gratifying to the patient or more interesting to the attendant, whose duty it is to observe the changes in the fields of vision, than one of these routine transsphenoidal procedures. That they are not unattended by some risk is shown by the results given in Table 3, two fatalities having occurred in the present series. In a few of the cases, moreover, the condition was so advanced that no great improvement in vision occurred after the operation. In the larger number of instances, however, the improvement has been rapid and sometimes astonishing. The following résumé of a case history is a good example.

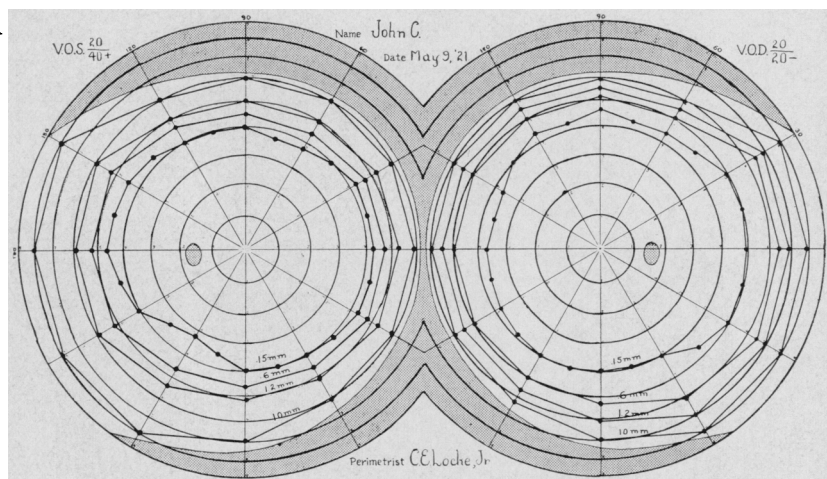


Fig. 5.—Fields one month after operation.

CASE 5 (Surg. No. 14267).—*Pituitary adenoma. Characteristic signs and symptoms. Operation. Relief.—History.*—Mr. C., a lawyer, aged 48, was admitted, March 29, 1921, complaining of loss of vision.

He had always been stout, as are several other members of his family. Between the ages of 25 and 30 he gained in weight from 150 to 190 pounds. About October, 1919, he commenced again to put on flesh, and in twelve months, his weight increased 23 pounds—from 208 to 231 pounds.

In March, 1920, about a year before his admission, he first noticed some blurring of vision, which glasses did not improve. There was gradual failure, particularly in the left eye. He had at times suffered from frontal headaches, though never severely.

Since January, 1921, five months ago, he had not been able to read even large type and he had experienced a loss of libido.

Physical Examination.—The patient was an obese middle-aged man, 5 feet, 6 inches in height, with normal features. The skin of the face was finely wrinkled, soft and of a sallow pallor. The comparative absence of body hirsuties was conspicuous. There was hypoplasia of the genitals. The basal metabolism was -10 . The temperature and pulse were slightly subnormal.

The roentgen ray showed a widely ballooned sella turcica with absorption of its walls. There was a bilateral primary optic atrophy, with marked pallor. The perimeter disclosed a bitemporal hemianopsia (Fig. 2), complete to a 10 mm. disk on the left and to a 0.6 mm. disk on the right, though in each case an island was preserved in the temporal field. Visual acuity on the left was 20/200; on the right 20/30.

Operation and Results.—April 4, a transsphenoidal operation was performed. The floor of the sella was found partially destroyed and the tumor had extended into the sphenoidal cells. The capsule of the gland was split and large masses of soft struma extruded and were removed with the pituitary spoon. He made a prompt recovery with immediate subjective improvement in vision. The extent of this was revealed by his first postoperative charts taken on the fifth day (Fig. 3). He was discharged on the thirteenth day, the fields being nearly normal (Fig. 4), has resumed his professional work, and is able to read small type with ease. The fields have been taken twice subsequently (Fig. 5). The acuity in the most affected eye improved from 20/200 to 20/40 in the course of a month.

In only one of the twenty transsphenoidal procedures was the operation done for another object than preservation of vision. The exception was in the case of an acromegalic with a large sella, who suffered intensely from so-called pituitary headaches. The usual transsphenoidal operation was carried out, with removal of possibly the lower half of the soft adenoma. There was no improvement whatsoever in her complaints. It would seem that acromegalic headaches, a most baffling symptom to relieve, may be due to some other cause than sellar distention. In my experience, the other type of patient, with enlarged sella and hypopituitarism, like the case cited above, has complete relief from headaches as a result of the sellar decompression with partial tumor removal.

It would seem that the chief difficulty confronting the neurosurgeon in these cases is to distinguish between those more suitable for a transfrontal than for a transsphenoidal operation. The fact that on the operative list (Table 3) there are more transsphenoidal and transfrontal operations than there are cases shown in Table 2 indicates that several of these patients had double operations. It is sometimes very difficult to tell in the individual case which is the route to be favored. Two cases, in particular, from this series have emphasized this to me. Both of them showed the rare combination of a bitemporal hemianopsia, a greatly enlarged sella and a choked disk. It was supposed in both cases that there was an intracranial extension of a pituitary adenoma blocking the foramina of Munro. In the first case, a transfrontal operation revealed, on puncture of the ventricle, an internal hydro-

cephalus, but the enlarged gland had not ruptured through its capsule, which was bulging between the legs of the chiasm. Consequently a transsphenoidal operation was subsequently performed but with no real improvement in vision. In the second case, that of a dentist with rapidly advancing blindness, a transsphenoidal operation was the primary one; but it exposed a flattened pituitary body instead of the soft adenoma or adenomatous cyst which was expected. Subsequently, a transfrontal operation was performed, which disclosed a large pharyngeal pouch cyst which was successfully peeled out despite its partly calcareous wall. Recovery was perfect, with rapid restoration of vision practically to the normal, so that he has been able to resume his professional work, which requires good eyesight.

THE ENDOTHELIOMAS

There have been fourteen of these in the series. They should properly be divided into two groups: (1) those arising from the meninges with a definite dural attachment, the more common type, of which there were twelve in the series, and (2) those of supposed pial origin. There were two of the latter, both exceedingly vascular tumors in the posterior fossa, disclosed by a suboccipital operation. Both of them, moreover, were in children, and though the tumors were exposed and have an unmistakable appearance, they were not histologically verified, and have therefore been placed in my Group A, 1-b.

The other and more common endotheliomas are in one sense the most favorable, from a therapeutic point of view, of all tumors, owing to their enucleability when accessible. When, however, they do not primarily involve an area of the cortex, irritation of which gives early evidence of their presence, they may be exceedingly difficult to diagnose and consequently may attain a large size which renders their removal extremely difficult and hazardous. Because of their comparatively slow rate of growth and the lack of reaction in the surrounding tissue, they often fail to produce either a choked disk or other evidences of increased intracranial pressure until late in their development, and the growth may reach almost the size of a baseball before symptoms come to light.

Their presence at times may be revealed by the roentgen ray, owing to the tendency of the overlying bone to become hypertrophied and thickened. This hyperostosis which is due to invasion of the bone by tumor may involve the inner surface of the adjacent cranium or may lead to a great thickening of the bone throughout. Under these circumstances, the diagnosis is readily made, but otherwise it may be difficult in the extreme. The tumors have definite seats of predilection which must be borne in mind when making a diagnosis. As shown by the table, five were paracentral, two were temporosphenoidal, arising from the

meninges of the middle fossa, two arose primarily from the gasserian meninges, if one may judge from the primary symptoms, another was frontal, still another a supramarginal case⁷ with global aphasia, and the last was an inoperable tumor overlying the pituitary fossa. These tumors provoke a characteristic reaction in the adjacent blood vessels, and although they themselves are not particularly vascular, the adjoining meningeal vessels and those of the diploe and scalp vessels become greatly enlarged. Indeed, mere palpation of the head sometimes reveals localized pulsation in the vessels of the scalp over the tumor. The meningeal vessels deeply groove the inner table, giving a characteristic appearance easily recognized by the roentgen ray. In consequence of this, operations on these tumors are attended by particular hazards not only from immediate loss of blood but from the likelihood of continued postoperative oozing from the denuded bone flap after its closure. One of these patients died, presumably from hemorrhage. The patient was a feeble young girl with marked pressure symptoms. The tumor was unexpectedly laid bare during an exploration for an "unlocalizable" growth. There was marked bleeding from the bone, and she did not survive for a second-stage procedure (Compare with Case 9 in the list of fatalities).

THE ACOUSTIC TUMORS

These tumors are in number next to the endotheliomas in the series, there having been nine under observation during the year. The particular description of this type of tumor has been covered in Dr. Cushing's monograph on the subject. In the stage in which they usually appear in the clinic, the diagnosis is possibly capable of greater exactitude than in any other form of tumor. Not only the precise location but the histologic character of the lesion can be foretold.

The chief difficulties lie in the attempt to make a diagnosis sufficiently early to permit of a total enucleation. For by the time general pressure symptoms are pronounced and the syndrome of the cerebello-pontile angle is full blown, the growth has so deformed the brain stem that attempts to remove it in its entirety have heretofore been disastrous. It has been the chief aim in this clinic to reduce the mortality of these procedures, which up to recent times have ranged from 60 per cent. upward. With this object, a less extensive procedure than an attempted total removal is carried out, namely, what is called an intracapsular enucleation.

7. Bremer, F.: Global Aphasia and Bilateral Apraxia Due to an Endothelioma Compressing the Gyrus Supramarginalis, *Arch. Neurol. & Psychiat.* **5**:663-669 (June) 1921.

There are certain cases in which this is not difficult, namely, those in which the tumor cells have undergone fatty degeneration, for under these circumstances the contents of the capsule may be scooped out, leaving little behind but the collapsed shell. When the tumor, however, is dense, fibrous and vascular, this procedure is impracticable, and little can be gained beyond the effect of the decompression.

It has been stated that several of the cases in the group of brain tumor suspects have been of patients sent in under the suspicion of having primary acoustic tumors, and though the auditory signs are sufficiently characteristic of possible primary involvement of the nerve from tumor, we are still somewhat hesitant in operating in such cases until the existence of a small tumor can be assured with more definiteness. It is to be hoped that the time will come when the distressing consequences of a fully developed acoustic tumor can be forestalled. Until then it would be foolhardy to take undue risks or to carry out an unnecessary exploration for a presumed growth which is giving no symptoms beyond partial deafness and may continue in this stage for many years.

Even in the advanced stage of the malady, in which at present the operations are usually conducted, Dr. Cushing confesses to giving way occasionally to the temptation of undertaking a more radical procedure than he has advocated in print. In one of the cases in my series (Case 8 in the series of fatalities), a very favorable one, after thorough enucleation of the tumor contents, the attempt to remove the largely detached capsule and thus complete the enucleation was irresistible. This caused some bleeding in the angle with resultant contusion of the brain stem while controlling it and an early fatality.

TUMORS OF VARIED HISTOLOGY

The remaining thirteen cases in this series represent far less common types of tumor, some of them so rare that they might not be represented in a group of tumor cases of a far greater number.

Carcinoma.—There were five cases so listed. Three of them were recognized as metastatic and the patients were not operated on, verification being possible at necropsy. In one, the lesion was located in the cerebellopontile angle with a symptomatology resembling that of an acoustic neuroma except for its very rapid course. Another was a rare example of adenocarcinoma of the pituitary invading the meninges of the middle fossa and giving trigeminal symptoms which led to a clinical diagnosis of endothelioma of the trigeminal sheath. Not until examination of the tissues removed at operation was the true nature of the lesion disclosed. This patient has made temporarily a good recovery.

Angioma.—There have been three of these rare lesions in the series, and there are not more than six in Dr. Cushing's entire list of nearly 700 verified tumors. In only one of the cases were there any pressure symptoms, that of a small child with a huge diffuse pulsating tangle of vessels of the temporal region. In the other two cases, the only symptoms were of focal epilepsy of recent origin. Both were young adults. In both of them an osteoplastic resection revealed a fairly circumscribed tangle of huge thin-walled vessels the size of a lead pencil, occupying an area about 5 cm. in diameter. In the first case, nothing was done except to ligate a single trunk and to leave subsequently an overlying cranial defect through which the area was radiated. In the second case, a more radical procedure was attempted which nearly led to a fatality from loss of blood. No tissue could be secured in either case, and I have therefore listed these lesions as verified only macroscopically in Group A.

Tuberculoma.—Of the three cases in the series, the lesion in two was in the cerebellum. Both patients survive, but the experience of the clinic gives a very bad prognosis after removal even of an unruptured tubercle. Six months, I believe, has been the longest survival period, though cases have been reported from other clinics of longer survival and perhaps even of cure. In the single postoperative fatality (Case 19), a tuberculoma of the brain stem was disclosed at necropsy. The diagnosis otherwise would not have been verified, for the presence of a supposed right astereognosis led to an exploration of the left hemisphere.

Cholesteatoma.—This was possibly the most remarkable case in the series. It will be reported elsewhere. The tumor, which had produced no symptoms except thinning of the skull, was a huge growth almost displacing the entire hemisphere. It was removed intact by an osteoplastic cranial resection. It had no connection with the ear.

Dermoid.—Still more rare, though a tumor in the same category as the above, was a dermoid tumor the size of a golf ball removed from the tip of the temporal lobe. The patient, a young army officer, had had tuberculous glands of the neck and naturally was under the suspicion of having an intracranial tubercle. Both of these patients made perfect recoveries.

THE OPERATIVE PROCEDURES

In Table 3 I have attempted, in as simple terms as possible, to indicate the number of operative procedures and to couple them with the fatalities, early and late. It is a difficult matter to present, and I am not entirely satisfied with the table, which does not correspond with my general impression of the results. Of the ninety-five operations which resulted in tumor exposure, with partial or total enucleation, there were only eight fatalities, whereas there were twelve fatalities

resulting from the eighty-five operations in which the tumor was not exposed. My impression had been, until these figures were assembled, that the risks were greatly increased by the attempt at enucleation.

The fifty-four lateral osteoplastic flap operations of varying types represent the larger number. Sometimes these operations are conducted with an immediate subtemporal decompression when tension is marked, and even though no tumor is disclosed the flap is replaced. If the operator, however, has been led to open the dura widely, and no tumor, or a tumor obviously not enucleable, has been exposed, it may be necessary, owing to the protrusion, to peel off the reflected bone and close the scalp alone. Though every effort is made, particularly in cases which have a favorable ultimate prognosis, to preserve an intact cranium, it was necessary for the reasons given to sacrifice the bone in eight of the fifty-four operations. These, however, have usually been unfavorable cases.

TABLE 3.—BRAIN TUMOR OPERATIONS AND FATALITIES

| Operation | Complete or Partial Tumor Extirpation | | | Exploration or Decompression Alone | | | Total Operations | Total Fatalities |
|------------------------------------|---------------------------------------|----------------|---------------------|------------------------------------|----------------|---------------------|------------------|------------------|
| | Number | Early Fatality | Subsequent Fatality | Number | Early Fatality | Subsequent Fatality | | |
| Lateral osteoplastic exposure.... | 32 | 0 | 1 | 22 | 2 | 3 | 54 | 6 |
| Suboccipital exposure..... | 20 | 0 | 1 | 28 | 3 | 0 | 48 | 4 |
| Transsphenoidal pituitary..... | 23 | 0 | 2 | 0 | 0 | 0 | 23 | 2 |
| Osteoplastic frontal pituitary.... | 8 | 0 | 2 | 2 | 0 | 0 | 10 | 2 |
| Local craniectomy..... | 12 | 2 | 0 | 1 | 0 | 0 | 13 | 2 |
| Subtemporal decompression..... | 0 | 0 | 0 | 32 | 2 | 2 | 32 | 4 |
| Total..... | 95 | 2 | 6 | 85 | 7 | 5 | 180 | 20 |

The ten transfrontal explorations for suprasellar lesions, though also osteoplastic, have been separately listed, as they represent a special type of procedure.

Of the forty-eight cerebellar operations, seven were performed for cerebellopontile angle tumors, and forty-one for tumors of the cerebellum. In twenty-three of these operations tumors were exposed, in ten a chronic arachnoiditis was disclosed as the possible source of the supposed tumor symptoms, and in fifteen no lesion but great tension was found. Of the twenty-three cerebellar tumors brought into view, nine were gliomatous cysts. This, as I have stated, is considered a very favorable sort of lesion for surgical treatment and has an excellent prognosis.

Comment has already been made on the transsphenoidal operations and the basis on which they are conducted. The first twenty-one cases in the series were carried out without accident. The last two led to fatality. In one of them (Case 24 of the following list) the operation

was misjudged. The case was suited for a transfrontal operation, it being a pharyngeal pouch tumor which lay in a distended sella and thereby led to a presumptive diagnosis of pituitary adenoma. In the other case (Case 18 of the fatalities), though one favorable for a transsphenoidal procedure, the patient succumbed from meningitis on the sixteenth day. This gives an operative mortality for the twenty-three transsphenoidal procedures of 8.7 per cent. Of the transfrontal operations there were two fatalities in the ten operations, or 20 per cent. mortality; but as those procedures are carried out for totally different lesions, this comparison of mortality figures means nothing favorable or unfavorable to the route in question, even were the series larger.

The subtemporal decompression of course is employed usually as a temporizing measure in cases with pressure signs either to gain time or when the lesion is not susceptible of localization. In this way, vision may be preserved while the surgeon is awaiting localizing signs. In two of the thirty-two decompressions performed for this purpose, the tumor was unexpectedly exposed in the temporal lobe. There were four fatalities, three of the operations having been permitted by Dr. Cushing in practically moribund patients. I had performed a decompression in one case of like nature which seemed hopeless, yet the patient survived and subsequently had a successful tumor removal.

There were thirteen operations which have been grouped under craniectomy. These consisted of exploration through an opening similar to an enlarged ganglion exposure or through a defect made in an old osteoplastic flap.

There follows a list of the fatal cases.

NOTES ON FATAL CASES

CASE 6 (Surg. No. 15429).—A man, aged 24, presented symptoms of a posterior lesion. A ventricle tap was performed which yielded bloody fluid. Cerebellar exploration was negative. The patient died four hours after operation. Necropsy revealed a glioma filling the lateral ventricles.

CASE 7 (Surg. No. 13613).—A man, aged 27, presented symptoms of a posterior lesion and complete blindness. There was accidental trauma of the brain during perforation of the skull (paper thin). Cerebellar exploration was negative. The patient died ten hours after operation. Necropsy revealed an enormous subcortical glioma occupying about two thirds of the cerebral hemisphere.

CASE 8 (Surg. No. 14229).—A man, aged 49, had typical symptoms and signs of acoustic tumor. Cerebellar exploration and thorough enucleation of a large right acoustic tumor were performed. This resulted in shock and death nine hours after operation. Necropsy revealed a blood clot at the cerebellopontile angle.

CASE 9 (Surg. No. 14387).—A girl, aged 12, presented symptoms and signs of a subcortical tumor of the right hemisphere. Osteoplastic flap exploration revealed apparently endothelioma, with overlying bony changes. The procedure was associated with considerable hemorrhage. Enucleation was not attempted. Shock resulted and transfusion was performed. Death ensued one hour after operation. Necropsy revealed a very large endothelioma of the right hemisphere.

CASE 10 (Surg. No. 13028).—A man, aged 38, entered the ward in a moribund condition. There were few localizing signs, and a questionable left-sided hypesthesia. A right subtemporal decompression was performed. Reaction was poor. Bronchopneumonia developed and the patient died thirty hours after operation. Necropsy revealed a right temporal lobe glioma.

CASE 11 (Surg. No. 13340).—A boy, aged 14, presented neighborhood and glandular pituitary symptoms and very little change in sella. A transfrontal operation disclosed tumor of the chiasm. Postoperative hyperthermia developed and the patient died thirty-six hours later. Necropsy revealed glioma of the optic chiasm.

CASE 12 (Surg. No. 12540).—A woman, aged 60, had a lesion localized in the region of the left fifth nerve. Exploration revealed a widespreading tumor about the gasserian ganglion. Partial extirpation was performed; an attempt at more complete enucleation resulted in a tear of the cavernous sinus. Transfusion was performed. Death ensued four hours after operation. Necropsy revealed widespreading dural endothelioma of basal meninges from chiasm to medulla.

CASE 13 (Surg. No. 14222).—A boy, aged 14, presented a typical picture of intracerebellar tumor. Exploration (Horrax) disclosed a cystic glioma of the right hemisphere. Drainage of the cyst and removal of a fragment of wall were performed. Twenty-one days later the patient died. Necropsy revealed a very extensive glioma of the right and left hemispheres and vermis, partially cystic.

CASE 14 (Surg. No. 12610).—A woman, aged 52, for nineteen years had had jacksonian attacks of the right leg and a clear-cut clinical picture of a parasagittal endothelioma. Osteoplastic flap exploration disclosed a large parasagittal endothelioma. The bulk of the tumor was removed. Consciousness was not regained, and the patient died seven days after operation.

CASE 15 (Surg. No. 13886).—A man, aged 54, had suffered gradual mental impairment, associated with headaches, loss of vision, incontinence, drowsiness and untidiness. Examination revealed choked disks. A right osteoplastic frontal exploration, two stages, disclosed no tumor. Bronchopneumonia developed. The patient died twenty-nine days after operation. Necropsy revealed a huge endothelioma arising from the ethmoid region and separating the frontal lobes.

CASE 16 (Surg. No. 12581).—A woman, aged 31, presented a hypopituitary symptomatology—an extreme degree of exophthalmos, bilateral primary optic atrophy, and a history indicating increased intracranial pressure. A subtemporal decompression was performed; a very tight brain was encountered but no lesion, and the wound was closed. She rapidly went down hill. Bronchopneumonia developed and she died nineteen days after the operation. Necropsy was not performed.

CASE 17 (Surg. No. 14327).—A woman, aged 45, gave a long history of pituitary disorder—primary atrophy, destroyed sella, bitemporal hemianopsia, mental impairment and untidiness. A transfrontal osteoplastic flap operation

disclosed a large suprasellar cyst. There was drainage of chocolate colored contents. The cyst was largely excised and the wound closed. Postoperative hyperthermia and drowsiness developed and the patient died nine days later during a wave of hyperthermia, with a temperature of 107 F. Necropsy revealed remnants of a very large suprasellar tumor.

CASE 18 (Surg. No. 14323).—A man, aged 40, gave a typical pituitary history, with gain of weight, loss of vision and impotence. Examination revealed temporal hemianopsia, right eye; blindness, left eye; bilateral primary optic atrophy, etc. A transsphenoidal operation was performed. There was marked visual improvement, the blind eye returning to 20/50 acuity. The twelfth day after operation he had a chill, headache and rigidity of the neck. He died sixteen days after operation. Necropsy revealed basilar purulent meningitis; remnants of intrasellar tumor.

CASE 19 (Surg. No. 13426).—A boy, aged 8, presented a Weber's syndrome, pressure signs and questionable asteriognosis. Osteoplastic flap exploration was negative. A large internal hydrocephalus was found. Decompression was performed and the wound closed. The patient died twenty-two hours after operation. Necropsy revealed tuberculoma of the thalamus and pons, left.

CASE 20 (Surg. No. 13389).—A man, aged 54, entered the ward in comatose condition. There was a history of left hemiplegia and choked disks. A right subtemporal decompression was performed, resulting in an unexpected disclosure of a deep gliomatous cyst. The wound was closed. Postoperative hyperthermia developed. There was no return of consciousness. Bronchopneumonia developed, and the patient died three days after operation. No necropsy was performed.

CASE 21 (Surg. No. 14311).—A woman, aged 54, entered the ward in a comatose condition. There was a history of loss of orientation and hallucinations and choked disks. Subtemporal decompression, without anesthesia, showed a tense brain. The wound was closed and the patient died twelve hours later. Necropsy revealed a large right subcortical frontal glioma.

CASE 22 (Surg. No. 14497).—This case of small glioma is reported as Case 2 in the body of the article.

CASE 23 (Surg. No. 14037).—A woman, aged 50, gave a history of numbness of the right arm, headache, vomiting and amnesia. A right subtemporal decompression was performed. Eleven days after operation, marked stupor developed and soon Cheyne-Stokes' respirations. The patient died fourteen days after operation. Necropsy revealed ependymal glioma, metastatic, of the left superior parietal region and marked edema of the brain about it.

CASE 24 (Surg. No. 14011).—A boy, aged 11, presented the usual symptoms and signs of pituitary tumor. Transsphenoidal exploration disclosed a cyst which was drained. Following the operation there was a persistent leak of cerebrospinal fluid. The fourth day after operation he developed headache, high temperature and rigidity of the neck. He died the eighth day following operation. Necropsy revealed purulent basilar meningitis and a pharyngeal pouch tumor.

CASE 25 (Surg. No. 13951).—A boy, aged 17, had right hemiplegia and right homonymous hemianopsia and choked disks. A preliminary decompression was performed. An osteoplastic flap revealed negative findings. There was rapid loss of strength. He died fourteen days after operation, bronchopneumonia having developed. Necropsy revealed a large subcortical left temporoparietal glioma.

CONCLUSION

In closing this report I am aware that a year's experience with such a complicated subject as the surgery of brain tumors represents but a beginning. Moreover, the end-results of this series of operations are more important than the immediate results seen only during the course of twelve months. I wish to express my great obligation to Dr. Cushing for allowing me to present this brief review of the cases, in his service, which have come under my care.