SHOULD EXTIRPATION BE ATTEMPTED IN CASES OF NEOPLASM IN OR NEAR THE THIRD VENTRICLE OF THE BRAIN?

EXPERIENCES WITH A PALLIATIVE METHOD

ARNE TORKILSEN, M.D.

Neurological and Neurosurgical University Clinic (Chief: Prof. G. H. Monrad-Krohn), Oslo, Norway

(Received for publication November 23, 1947)

Tumors in the pineal region as well as neoplasms in or near the 3rd ventricle are characterized by signs of intracranial hypertension at an early stage of the disease due to the obstruction of the circulation of the cerebrospinal fluid. Neurological signs due to the local pressure of the tumor in many cases occur late or not at all. Most of the symptoms are of hydrodynamic genesis.

Until recently our knowledge concerning tumors in the pineal region and neoplasms in or near the 3rd ventricle has been based predominantly on autopsy findings. The development of neurosurgery has to some extent widened our experiences, and at the present time a considerable number of publications have appeared dealing with successful removal of tumors from this central region of the brain. As a rule the reports concern isolated cases. Accounts of series of such operations are rare. A series of 21 cases of neoplasm in the 3rd ventricle, published by Dandy,\(^5\) attracts special interest, comprising 5 cases of colloid cyst and 16 cases of neoplastic lesions of other nature. His immediate operative mortality was 33.3 per cent. While patients surviving the extirpation of a colloid cyst usually are cured, this is frequently not true of patients surviving the extirpation of gliomas in the 3rd ventricle or its walls. It is not possible to judge concerning the late results in Dandy's series, as 6 of the 16 patients had lived 8 months or less when his work was published. It is to be feared that recurrence has taken place in a number of his cases and has changed the impression of the immediate result of his operations. Not all neurosurgeons have been so successful as Dandy. Babbini et al.\(^1\) in 1944 reported 6 cases of tumor in the 3rd ventricle operated upon with a mortality of 100 per cent.

In the publication mentioned above, Dandy did not include his cases of tumor in the pineal region. As far as the practical surgical results are concerned, tumors in this region constitute a depressing chapter. By 1932 Cushing had operated upon 14 patients, all of whom died. So far, reports on successful removal of tumors in the pineal region have been rare. In 1943 Russell and Sachs\(^5\) collected from the literature 58 cases, and in 55 of these death occurred; 32 of the 58 patients had been operated upon.

A recent report by Müller and Wohlfart\(^4\) indicates that the results may be improved, as Olivecrona has operated in 41 cases with a mortality of 50 per cent.
In view of the unsatisfactory results of the attempts at surgical removal of most of the neoplasms in or near the 3rd ventricle, other methods should be worked out. Pituitary adenomas, suprasellar meningiomas and cholesteatomas do not come into consideration here.

A new operative procedure has been devised by the writer. It consists in establishing an artificial communication between the lateral ventricle and cisterna magna. The operation aims exclusively at the relief of the hydrodynamic alterations caused by the obstruction of the flow of the cerebrospinal fluid. By means of a rubber tube running outside the cranium, with one end in the lateral ventricle and the other end fixed in the cisterna magna, the cerebrospinal fluid is short-circuited about the pathological region. In a previous paper I have described the technical details of the procedure.  

Patients who have been operated upon by this method continue to live with the neoplasm untouched. Their fate consequently depends on the expansive energy of the new growth. My experience has shown that the neoplasms in question are frequently extremely indolent. In some of my cases it has not been possible to demonstrate growth of the neoplasm by neurological or ventriculographic examination after intervals of 7 or 8 years.

Up to July 1945, 8 patients with neoplasm in the pineal region and 11 with tumor in the 3rd ventricle or its immediate vicinity have been treated by this method.* Only 1 of the patients with tumor in the pineal region and 2 patients with tumor compressing the 3rd ventricle have died in consequence of the operative procedure. The other patients have lived a sufficiently long time after the treatment to allow interesting observations concerning the effect of the operation on the intracranial hypertension and concerning the further growth of the neoplasms.

The clinical material and the results of the operations are briefly recorded below.

1. TUMORS IN THE PINEAL REGION

8 Cases

ANAMNESTIC DATA

The group comprises 8 patients, the ages varying from 11 to 54 years. There were 5 males and 3 females. In all cases, the first symptoms were of increased intracranial pressure without any local signs giving reason to

* Two additional cases have been omitted from this discussion. One was a neoplasm in the pineal region: an osteoplastic craniotomy with extirpation of an infiltrating astrocytoma was followed by ventriculocisternostomy on the same day. The patient died postoperatively. It is not possible to determine whether the 1st or the 2nd of these operations was of importance in the subsequent death.

The second case omitted was in the group of tumors in or near the 3rd ventricle. The patient presented neurological and radiological signs of intracranial hypertension due to a neoplasm in the 3rd ventricle. On the same day, subtotal extirpation of a glioma in the 3rd ventricle and ventriculocisternostomy were performed by 2 separate operations. The patient recovered well and has not developed new signs of intracranial hypertension after more than 2½ years. It is, however, not possible to tell whether the improvement was due to the 1st or the 2nd operation, and the case has therefore not been included in this discussion.
suspect a neoplasm in the pineal region. Bilateral headaches was the initial symptom in all 8 cases, vomiting occurred in 7, and there was loss of vision in 3 cases at an early stage of the disease, shortly after the onset of headaches and vomiting. Other symptoms later in the course of the disease were diplopia, apania and somnolence.

In only 1 case was a palsy of the oculomotor nerve seen at an early stage of the disease (Case 6). There was a ptosis on the left side and a lateral deviation of that eye. This was noted 3 months after the first symptom—headaches—was recorded. None of my patients showed signs of precocious sexual development.

In 1 case the earliest symptoms—headaches and vomiting—had lasted about 4 years off and on. In the others, no symptom had lasted more than 12 months.

In 2 (Cases 6 and 7) attacks of unconsciousness occurred.

RESULTS OF THE EXAMINATIONS

On the first admission of the patients to the ward, the following findings were present:

_Cranial Nerves._ All the patients had bilateral papilledema, with discs projecting from 3 to 7 diopters. In 3 cases this was the only abnormal ophthalmological finding.

Abnormal pupillary reactions were seen in 4 cases. In 2 of these (Cases 3 and 7) no reaction to light or accommodation was present and in 2 (Cases 6 and 8) it was found that the reaction to light was more sluggish than that to accommodation.

Nystagmus was noted in 1 only (Case 2), on looking to the right.

Paresis of the ocular movements on gazing upward was found in 3 (Cases 3, 6 and 7). In these 3 cases the pupillary reaction was also abnormal.

Anisocoria was present in 4 (Cases 2, 3, 4 and 7). In 2 of these cases there was at the same time abnormal pupillary reaction to light and ocular palsy on gazing upwards.

Ptosis was present in 2 (Cases 6 and 8), in both instances associated with abnormal pupillary reaction.

Paresis of the 6th nerve was seen in Case 2 (bilateral) and in Case 6 (left side).

The importance of the ophthalmological findings in the diagnosis of neoplasms in the pineal region has been well known, especially since Parinaud in 1879 pointed out that patients with neoplasms in or near the superior colliculi frequently were unable to move their eyes upward. This sign, which was present in 3 of my 8 cases, occurred in about 25 per cent of 46 patients examined by Olivecrona.

_Motor System._ One patient (Case 7) had considerable paresis and rigidity in all limbs, mostly on the left side. In Case 5 there was cerebellar dysfunction on the right side (autopsy revealed a tumor in the pineal region in the midline).
Endocrine Symptoms. Two patients were rather stout (Cases 4 and 5), but not definitely beyond normal limits.

Status Generalis. The 2 oldest patients (Cases 4 and 5), 54 and 43 years old, had a blood pressure of 175/110 and 160/110 respectively, but otherwise there was nothing unusual regarding the general physical state of the group.

Cases 3 and 6 had lost considerable weight due to frequent vomiting.

Pneumography. In Case 1 a small encephalography was performed, but no air could be seen in the ventricular system. The spinal fluid contained approximately double the amount of albumin, but was normal otherwise. In the other 7 cases no spinal puncture was made because of the highly increased intracranial tension.

In all 8 cases, ventriculography was performed. The ventriculograms in each instance gave positive evidence of a tumor in the posterior portion of the 3rd ventricle. The ventricular fluid was not abnormal.

Operative Results and Postoperative Examinations

In Case 3 the operation was followed by fatality. In the other 7 cases the patient lived long enough to allow postoperative investigations concerning, first of all, the influence of the operation on the intracranial pressure, and second, the neurological symptoms associated with further growth of the tumor.

It has been found that the importance of the operation as a means of reducing increased intracranial pressure is beyond doubt. The alteration of the intracranial hypertension has been estimated primarily by the disappearance of the papilledema, but in some instances it has also been estimated by pressure readings after ventricular puncture.

In all 7 patients the swelling of the optic discs was seen to subside rapidly following the operation. In 2 with choked discs of 2 and 3 diopters respectively, all signs of stasis disappeared in the course of 5 or 6 weeks. In 2 with discs of 4 diopters, the swelling subsided to 1 diopter during the first 2 weeks and later disappeared completely. In 1 case the swelling decreased from 4 to 2 diopters in the course of the first 7 weeks and later subsided completely. Finally there was 1 patient with discs of 4 diopters, which 4 weeks later showed definite improvement, but the clinical record does not state exactly the number of diopters then found. The patient died later, making further investigation of this point impossible.

Simultaneously with the subsidence of the prominence of the optic discs, which took place in all cases, one could observe disappearance of the other alterations that ordinarily accompany choked discs. The edema disappeared, the hyperaemic eyeground assumed a normal picture and the hemorrhages of the retina were resorbed. In cases where there had been choked discs of long standing, secondary atrophy followed. In order to give a clear survey of the ophthalmologic changes, the findings have been summarized in Table 1.
Together with the ophthalmologic improvements, one could observe disappearance of the clinical expressions of abnormal intracranial tension. The headaches improved, vomiting became less disturbing, and stuporous patients gradually came out of their stupor and became less drowsy.

In cases where a malignant tumor was present it would continue its growth and the improvement obviously was of transitory nature. In such cases the condition of the patient sooner or later grew worse, depending upon the biological energy of the neoplasm. A tumor of high neoplastic activity growing in the central cerebral region would sooner or later destroy vital nervous tissue and due to this, even in cases where there was no obstruction of the flow of the cerebrospinal fluid, the life of the patient was limited.

Interesting postoperative phenomena were observed in Case 2, a female who developed very pronounced hirsutism and markedly virile facial charac-

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex</th>
<th>Age</th>
<th>Edematous Eye ground</th>
<th>Swelling of Optic Discs</th>
<th>Operation</th>
<th>Examine</th>
<th>Edematous Eyeground</th>
<th>Swelling of Optic Discs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>♂</td>
<td>23</td>
<td>Yes</td>
<td>R 4 D L 4 D</td>
<td>Sept. 6, 1938</td>
<td>Oct. 7, 1938</td>
<td>R 1 D</td>
<td>L 1 D</td>
</tr>
<tr>
<td>2</td>
<td>♀</td>
<td>29</td>
<td>Yes</td>
<td>7 7</td>
<td>Sept. 28, 1938</td>
<td>Oct. 30, 1938</td>
<td>Sharp edges Pales discs</td>
<td>0 0</td>
</tr>
<tr>
<td>3</td>
<td>♀</td>
<td>10</td>
<td>Yes</td>
<td>2 2</td>
<td>Oct. 17, 1940</td>
<td>Death Oct. 23, 1940</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>♀</td>
<td>54</td>
<td>Yes</td>
<td>3 3</td>
<td>Aug. 14, 1941</td>
<td>Aug. 29, 1941</td>
<td>Sharp edges Pales discs</td>
<td>1 2</td>
</tr>
<tr>
<td>5</td>
<td>♂</td>
<td>43</td>
<td>Yes</td>
<td>3 3</td>
<td>June 2, 1941</td>
<td>July 28, 1941</td>
<td>Sharp edges Pales discs</td>
<td>0 0</td>
</tr>
<tr>
<td>6</td>
<td>♂</td>
<td>15</td>
<td>Yes</td>
<td>4 4</td>
<td>Aug. 18, 1941</td>
<td>Sept. 17, 1941</td>
<td>Improved</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>♂</td>
<td>11</td>
<td>Yes</td>
<td>3 3</td>
<td>Mar. 6, 1944</td>
<td>Apr. 12, 1944</td>
<td>Pale discs</td>
<td>0 0</td>
</tr>
<tr>
<td>8</td>
<td>♂</td>
<td>19</td>
<td>Yes</td>
<td>4 4</td>
<td>Nov. 10, 1944</td>
<td>Jan. 6, 1945</td>
<td>Sharp edges Mar. 1947: Normal eye-ground</td>
<td>2 2</td>
</tr>
</tbody>
</table>
teristics. Her chin, lips, arms and legs became densely covered by coarse hairs, and her facial and bodily appearance finally bore little resemblance to the female traits of former days. Finally she became completely deaf.

The patient who died shortly after operation (Case 3) was a girl 10 years of age who had suffered from headaches and vomiting for 4 months, and who gradually became quite apathetic with bilateral rigidity.

The other 7 patients stood the operation well (Table 2). One of them (Case 6) died 2 months later from further growth of the pathological process.

### TABLE 2

*Tumors in the pineal region. Operative results*

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex</th>
<th>Age</th>
<th>Alive</th>
<th>Postoperative Death</th>
<th>Dead Later</th>
<th>Pathological Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>♂</td>
<td>23</td>
<td>9½ yrs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>♀</td>
<td>29</td>
<td></td>
<td></td>
<td>6½ mos.</td>
<td>Glioblastoma</td>
</tr>
<tr>
<td>3</td>
<td>♀</td>
<td>10</td>
<td></td>
<td>6 days</td>
<td></td>
<td>Medulloblastoma</td>
</tr>
<tr>
<td>4</td>
<td>♀</td>
<td>54</td>
<td>7 yrs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>♂</td>
<td>43</td>
<td></td>
<td>4 yrs.</td>
<td></td>
<td>Ependymoma</td>
</tr>
<tr>
<td>6</td>
<td>♂</td>
<td>15</td>
<td></td>
<td>2 mos.</td>
<td></td>
<td>Cyst</td>
</tr>
<tr>
<td>7</td>
<td>♂</td>
<td>11</td>
<td></td>
<td>2 mos.</td>
<td></td>
<td>No autopsy</td>
</tr>
<tr>
<td>8</td>
<td>♂</td>
<td>19</td>
<td>3 yrs.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Case 7 improved considerably after the operation, was discharged to his home, but died sometime later. Case 2 after marked improvement died more than 6 months later from continued growth of the tumor. Case 5 was re-admitted after an interval of more than 4 years. He was then stuporous and disoriented. He had been well and able to work since the previous operation.

Three of the patients are still alive after a postoperative period of 7½ years, 4½ years and 2 years. They are fully capable of attending the work they did previous to onset of the illness (Cases 1, 4 and 8). Case 1 since the operation has become a teacher. He performed his duties feeling absolutely fit and well more than 7 years after operation, leading a life of considerable physical and mental strain. Case 4 works as a housekeeper. She has no difficulties in doing her work apart from those due to a slight loss of vision which had taken place before the operation.

Case 8 is physically and mentally in a good condition and cannot notice any sign of illness apart from some loss of vision in one eye.
TREATMENT OF NEOPLASM IN OR NEAR THIRD VENTRICLE

PATHOLOGICAL ANATOMY

Case 2 suffered from a glioblastoma in the pineal region. The tumor was rich in cells of high histobiological activity.

Case 3 had a medulloblastoma in the pineal region. It was a very cellular tumor composed of rather uniform cells which at some places were arranged as typical pseudo-rosettes.

Case 5 had an ependymoma with well-developed typical rosettes.

Case 6 had disseminated cystic encephalomalacia of cryptogenetic origin. There was a fairly big cyst slightly to the left and in front of the pineal gland. On microscopical examination several cysts of varying age were evident.

Cases 1, 4, 7 and 8 are still alive. Biopsy has not been performed on any of them and the type of lesion has not been decided.

CASE REPORTS

Tumors in the Pineal Region

Case 1. 1505/38. R. D., 28-year-old man.
Admitted 4.1.46. Discharged 11.1.46.

Anamnesis. He had previously been in good health. For almost 1 year he had suffered from headaches, vomiting and loss of vision.

Examination. Bilateral papilledema, with choked discs of about 4 D.

Encephalography. Attempted twice, but no air visible in ventricular system.

Ventriculography. Tumor in pineal region (Figs. 1 and 2).

Figs. 1 and 2. Case 1. Ventriculograms Sept. 6, 1938, disclosing tumor in the pineal region.
Both lateral ventricles are considerably dilated. Lateral view clearly shows the neoplasm.

Ventriculocisternostomy 9.9.38 without complication. Postoperative course uneventful.

Control 1946. After the operation in 1938 all signs of intracranial hypertension disappeared rapidly. Since discharge he has felt perfectly well, and has been at work as a teacher all the
time. There are no abnormal neurological findings. Ventriculograms show the tumor in the pineal region (Figs. 3 and 4). It has not changed visibly in size since 1938.

**Case 2.** 2680/39. R.O., 29-year-old woman.
*Anamnesis.* She had suffered from headaches, dizziness and loss of vision for about 9 months.

*Examination.* Bilateral papilledema; discs about 7 D.

*Ventriculography.* Enlargement of both lateral ventricles and a tumor in pineal region.

*Ventriculocisternostomy* 28.9.39 without complications. Following operation the signs of intracranial hypertension disappeared. The patient developed hirsutism and deafness. New ventriculograms showed considerable growth of the tumor. Death occurred about 6 months postoperative, preceded by new signs of intracranial hypertension.

*Autopsy.* Huge glioblastoma in pineal region.

**Case 3.** 3200/40. S.O., 10-year-old girl.
*Anamnesis.* Increasing headaches, vomiting and apathy for 4 months.
*Examination.* Bilateral papilledema and paralysis of ocular movements on upward gaze.

*Ventriculography.* Tumor in pineal region.

*Ventriculocisternostomy* 17.10.40. The patient was in extremely poor condition. The operation resulted in death.

*Autopsy.* Medulloblastoma in pineal region.

**Case 4.** 873/41. A.G., 54-year-old woman.
Admitted 28.7.41. Discharged 21.10.41, improved.
Admitted 6.3.46. Discharged 18.3.46.
*Anamnesis.* Headaches, vomiting and tinnitus for 4 years. Gradually increasing loss of vision.

*Examination.* Almost blind in right eye; 5/10 vision on left. Bilateral papilledema; discs about 3 D.
Ventriculography. Symmetrical enlargement of both lateral ventricles and 3rd ventricle. Tumor seen in pineal region.

Ventriculocisternostomy 14.8.41 without complications. Uneventful postoperative course, during which the signs of intracranial hypertension disappeared.

Control March 1946. Apart from loss of vision there are no symptoms of the previous illness. She can manage her house. Examination: Atrophy of optic discs; no signs of papilledema. Ventriculograms show findings similar to those on previous admission.

Case 5. 10244/41. J. L., 45-year-old man.
Admitted 21.5.41. Discharged 23.7.41, improved.
Admitted 23.4.42. Discharged 23.6.42.
Admitted 24.8.42. Discharged 30.9.42.
Admitted 1.4.45. Discharged 8.4.45, dead.

Anamnesis. Increasing headaches and vomiting since June 1940.

Examination, February 1941. Papilledema.

Ventriculography 2.6.41. Tumor in pineal region.

Ventriculocisternostomy 2.6.41 without complications. The operation was followed by disappearance of the signs of intracranial hypertension.

Course. He was repeatedly admitted for control examination and x-ray treatment. No new signs of intracranial hypertension developed. On final admission he was disoriented and stuporous because of progression of the neoplasm. He died Apr. 4, 1945.

Autopsy. Ependymoma in the pineal region.

Admitted 8.8.41. Discharged 8.10.41, dead.

Anamnesis. Headaches for about 9 months.

Examination. Bilateral papilledema, oculomotor nerve palsy and loss of hearing.

Ventriculography. Tumor in pineal region.

Ventriculocisternostomy 17.8.41 was followed by subsidence of signs of intracranial hypertension. The patient died 2 months later; no new signs of increased intracranial tension had developed.


Case 7. 9160/44. I.J., 11-year-old boy.
Admitted 29.2.44. Discharged 20.4.44, improved.

Anamnesis. For 3 months headaches, vomiting and stupor.

Examination. Bilateral papilledema; optic discs 3 D. Bilateral oculomotor nerve palsy.

Ventriculography. Tumor in pineal region.

Ventriculocisternostomy Mar. 6, 1944 without complications, followed by disappearance of signs of intracranial hypertension. The patient was discharged to his home, where he died May 8, 1944 in a fit of convulsions.

Admitted 28.10.44. Discharged 17.2.45, improved.

Anamnesis. During the last year headaches and loss of vision.

Examination. Bilateral papilledema, and paresis of oculomotor nerves.

Ventriculography. Tumor in pineal region.

Ventriculocisternostomy Nov. 10, 1944 without complications, followed by disappearance of the signs of intracranial hypertension.

Control February 1947. Apart from loss of vision in left eye, he has no sign of the previous illness. No recurrence of symptoms of intracranial hypertension. Atrophy of left optic disc. He did not consent to control ventriculography.
2. TUMORS IN THE THIRD VENTRICLE OR ITS WALLS OUTSIDE
THE PINEAL REGION

11 Cases

ANAMNESTIC DATA

The group comprises 4 males and 7 females, the ages varying from 13 to 59 years. In 9 of the cases the first signs of illness were increased intracranial pressure, headaches and vomiting. In the 2 in which signs of intracranial hypertension were absent at onset, the first symptoms were amenorrheal in Case 16 (a woman of 35), and strabismus convergence and an abnormal feeling of hunger in Case 17.

In 9 cases the headaches were diffuse. In 2 the pain in the head was on the left side (Case 19, a colloid cyst in the 3rd ventricle, and Case 16, a tumor in the anterior wall of the 3rd ventricle to the left of the midline). Case 18 had olfactory hallucinations. Case 12 had "always been rather stout." Cases 10 and 16 had attacks of loss of consciousness with generalized convulsions.

Only Case 9 presented a symptom of localizing value, in the form of a hemihypesthesia. In no other instance could certain conclusions be made from the anamnese as to the affected side and region of the central nervous system.

The duration of the symptoms was about 3 years in 3 cases (Nos. 11, 12 and 15), in the form of headaches; in 2 (Nos. 10 and 19) the headaches had lasted about 2 years, and in the other cases the duration was 1 year or less.

In spite of the close relationship of the lesions to the autonomic centres of the diencephalon, signs of autonomic dysfunction were seen in only a few patients. Amenorrhea occurred in Case 16, dystrophia adipose genitalis in Case 17 and general nervousness in Case 18.

RESULTS OF THE EXAMINATIONS

On admission all patients had papilledema except 1 (Case 12), who had pale discs with blurred edges indicating the presence of choking at earlier stages of the illness. In these 10 the prominence of the discs varied between 1 and 5 diopters, being about equal on both sides.

Six patients (Cases 10, 11, 12, 14, 15 and 17) had paresis of the 3rd, 4th and 6th nerves. Three (Cases 9, 12 and 17) had a central facial palsy. Two (Cases 11 and 17) had paresis of the motor portion of the 5th nerve, and 2 (Cases 17 and 19) had paresis of the 9th and 10th nerves.

Motor System. The tumors in this central location of the brain near the midline affected the motor system to a slight extent only. This is not surprising as more alarming signals from this vital region usually come at an early stage. Only 2 patients showed signs of hemiparesis (Cases 9 and 11). One of these (Case 11) had a tumor in the 3rd ventricle. The other (Case 9) had a neoplasm in the thalamus, accounting for the hemiplegia. He also had a
hemihypoesthesia, as could be expected. Case 17 also had a thalamic tumor but no sensory disturbance was found.

*Examination of the Ventricular Fluid.* In all the cases ventriculography was performed. The cerebrospinal fluid showed alterations from normal values in only 1 (Case 13). This patient had a tumor of the basal ganglia affecting both lateral ventricles, and bringing the cerebrospinal fluid in direct contact with a large neoplastic surface. The fluid showed 4/3 cells, alb. 1/370 +1/400 −, glob. 1/7 +, 1/8 −.

*Ventriculographic Findings.* In 8 of the 11 cases the ventriculographic findings caused no difficulty in interpretation. There was bilateral dilatation of the lateral ventricles and of some part of the 3rd ventricle. In some cases there was a visible shadow of the neoplasm in the 3rd ventricle. In others the 3rd ventricle contained no air at all.

Three cases presented findings of special interest: In Case 9 the lateral ventricles were dilated without dislocation; the 3rd ventricle was also markedly dilated and this cavity was much displaced to the right. It had maintained its vertical position and did not slant in the usual way, the lower end being fixed above the sella. The first ventriculographic study of this case (Fig. 5) was done with a small amount of air, and did not clearly reveal the tumor in the left wall of the 3rd ventricle. This was first seen definitely in later ventriculograms taken for control (Figs. 6 and 7).

Another finding of interest was in Case 11, in which a great enlargement of both lateral ventricles had taken place. The pictures taken with the brow up showed no air in the 3rd ventricle. With the brow down a collection of air was seen in the usual location of the 3rd ventricle. In the lateral view this air shadow appeared posterior to the 3rd ventricle. The case thus appears to be an example of spontaneous ventricular rupture with the formation of a subtentorial cyst. This condition has been described only in a few publications by pathological anatomists, and a few reports from a radiological point of view. It now has aroused our attention, and I believe the finding will prove to be not so rare. I have seen it in 5 cases.

**Operative Results and Postoperative Examinations**

Of the 11 patients 1 died in immediate connection with the operation (Case 14). She was emaciated, apathetic and disoriented, with symptoms of highly increased intracranial pressure. She died 8 days after operation and proved to have multiple metastases from an adenosarcoma, the location of the original tumor being unknown.

Case 19 deserves special mention. Because of periodical attacks of headaches characteristic in cases of tumor in the 3rd ventricle, and especially since the ventriculograms supported that diagnosis, her 3rd ventricle was explored. A colloid cyst was removed. The operation was without immediate complications, but as signs of increased intracranial pressure continued ventriculocisternostomy was performed 4 weeks later, in order to ascertain
impaired outflow of fluid from the lateral ventricles. It was suspected that edema or a blood clot obstructed the 3rd ventricle or the aqueduct. The operation proved that diagnosis to be correct. On performing the ventriculocisternostomy the patient was in poor condition, and I am afraid I had hesitated too long in carrying out this procedure, which was followed by another complication in the form of obstruction of the communication between the two lateral ventricles. The patient died 16 days after ventriculocisternostomy. All the time signs of increased intracranial pressure were present. The result of the operation was not satisfactory.

Case 13 also took an unfavourable course. After ventriculocisternostomy signs of increased pressure remained, although less pronounced than before. One could see that the optic discs became pale and sharply outlined during the first 6 or 7 weeks after operation. Previously there had been papilledema, and retinal hyperaemia.

As the edema subsided, the patient noticed that her vision became clearer, and her behaviour became more natural. She had a tumor that completely filled the cavity of the 3rd ventricle, pressing itself up between the anterior horns of the lateral ventricles. In spite of definite general improvement some signs of increased pressure remained. Cerebrospinal fluid protruded under the scalp along the tube. Fearing that a partial obstruction might be present, I decided to inspect the intraventricular end of the tube. In retrospect I am afraid that I should have shown greater patience and awaited spontaneous regulation of the pressure. Since then, other cases have shown that considerable time may be required before the pressure finally reassumes normal level even where the conditions apparently are optimal. Case 15, for instance, had signs of increased pressure for several months, but finally showed a most gratifying result.

Any cerebral operation may be followed by increase of intracranial pressure. This was so in Case 13, as has been related above. After the craniotomy for inspection of the intraventricular portion of the tube (which was found in optimal position) further postoperative increase of intracranial pressure occurred. The patient died 3 months after the ventriculocisternostomy from hyperthermia.

In the 8 other cases a favourable postoperative course was run (Table 3). Two of the patients died later because of further expansion of the neoplasm. One of these (Case 10) lived for nearly 5 years and the other (Case 11) for 2 years. After the operation both of them lost any sign of increased intracranial pressure, death being due to neoplastic infiltration of vital cerebral structures. Case 10 earned her living as a stenographer most of the time after the operation. She got her training after discharge from the hospital. Case 11 worked on a farm until shortly before death.

Five of the patients are still alive, 1 after 8 years (Case 9), 2 after 5 years (Cases 12 and 13), 2 after 4 years (Cases 16 and 18), and 1 after 2 years (Case 17). In none of these cases are there signs of intracranial hypertension at the present time.
The patients who now are alive betray no clinical signs of progression of the neoplasm. Four of these feel nearly 100 per cent fit and well. Cases 12 and 16 work as housekeepers and manage the household for nine and twelve adults respectively. Case 15 goes to ordinary school, feeling physically and mentally in good health, and Case 9 has taken courses at evening schools and is now working in an office in a superior position. This patient was originally admitted to the ward with hemiplegia and hemihyposthesia. His gait was defective, the right leg dragging and the toes slapping the floor. Since operation all these signs have gradually disappeared in spite of his having a tumor that can be seen in the ventriculograms projecting into the 3rd ventricle from its left wall.

All 11 patients were admitted to the ward with clinical and ophthalmological signs (Table 4) that clearly indicated increased intracranial pressure (Case 12, however, had no protruding optic discs on admission). Of the 11 patients, 2 died at such an early stage after operation that there was no time for the development of postoperative ophthalmological changes. In the other 9 cases the subsidence of the papilledema and the retinal hyperaemia was undoubted. The patient who died 3 months after operation showed definite improvement but had at that time not yet regained a normal eyeground (Case 13). In the other 8 cases any trace of a stasis of the eyeground disappeared completely.

**TABLE 3**

*Tumors in region of 3rd ventricle. Operative results*

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex</th>
<th>Age</th>
<th>Alive</th>
<th>Dead</th>
<th>Dead Later</th>
<th>Pathological Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>♂</td>
<td>16</td>
<td>9 yrs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>♂</td>
<td>21</td>
<td></td>
<td></td>
<td>4½ yrs.</td>
<td>Astroblastoma</td>
</tr>
<tr>
<td>11</td>
<td>♂</td>
<td>25</td>
<td></td>
<td></td>
<td>2 yrs.</td>
<td>No autopsy</td>
</tr>
<tr>
<td>12</td>
<td>♂</td>
<td>34</td>
<td>6 yrs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>♂</td>
<td>19</td>
<td></td>
<td></td>
<td>3 mos.</td>
<td>Astrocytoma magno-cellulare</td>
</tr>
<tr>
<td>14</td>
<td>♂</td>
<td>50</td>
<td></td>
<td></td>
<td>+</td>
<td>Adenosarcoma</td>
</tr>
<tr>
<td>15</td>
<td>♂</td>
<td>13</td>
<td>6 yrs.</td>
<td></td>
<td></td>
<td>Craniopharyngioma</td>
</tr>
<tr>
<td>16</td>
<td>♂</td>
<td>35</td>
<td>5 yrs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>♂</td>
<td>15</td>
<td></td>
<td></td>
<td>2 yrs.</td>
<td>Astrocytoma</td>
</tr>
<tr>
<td>18</td>
<td>♂</td>
<td>44</td>
<td></td>
<td></td>
<td>5 mos.</td>
<td>No autopsy</td>
</tr>
<tr>
<td>19</td>
<td>♂</td>
<td>34</td>
<td></td>
<td></td>
<td>+</td>
<td>Colloid cyst</td>
</tr>
</tbody>
</table>
### TABLE 4

*Tumors in region of 3rd ventricle. Ophthalmologic findings*

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex</th>
<th>Age</th>
<th>Pre-operative</th>
<th>Operation</th>
<th>Postoperative</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Edematous Eype-ground</td>
<td>Swelling of Optic Discs</td>
<td>Examined</td>
<td>Edematous Eype-ground</td>
</tr>
<tr>
<td>9</td>
<td>☥</td>
<td>16</td>
<td>Yes</td>
<td>R 4 D L 4 D</td>
<td>June 13, 1938</td>
<td>July 6, 1938</td>
</tr>
<tr>
<td>10</td>
<td>☥</td>
<td>21</td>
<td>Yes</td>
<td>2 2</td>
<td>May 31, 1939</td>
<td>June 19, 1939</td>
</tr>
<tr>
<td>11</td>
<td>☥</td>
<td>25</td>
<td>Yes</td>
<td>5 5</td>
<td>Apr. 19, 1939</td>
<td>June 2, 1939</td>
</tr>
<tr>
<td>12</td>
<td>☥</td>
<td>34</td>
<td>Yes</td>
<td>Blurred edges</td>
<td>Nov. 4, 1940</td>
<td>Nov. 26, 1940</td>
</tr>
<tr>
<td>13</td>
<td>☥</td>
<td>19</td>
<td>Yes</td>
<td>4 4</td>
<td>July 7, 1941</td>
<td>Aug. 29, 1941</td>
</tr>
<tr>
<td>14</td>
<td>☥</td>
<td>59</td>
<td>Yes</td>
<td>Considerable</td>
<td>Oct. 28, 1941</td>
<td>Death</td>
</tr>
<tr>
<td>15</td>
<td>☥</td>
<td>13</td>
<td>Yes</td>
<td>3 3</td>
<td>May 1, 1941</td>
<td>June 27, 1941</td>
</tr>
<tr>
<td>16</td>
<td>☥</td>
<td>35</td>
<td>Yes</td>
<td>1 1</td>
<td>Mar. 10, 1942</td>
<td>May 19, 1942</td>
</tr>
<tr>
<td>17</td>
<td>☥</td>
<td>15</td>
<td>Yes</td>
<td>2 2</td>
<td>Apr. 13, 1944</td>
<td>June 14, 1944</td>
</tr>
<tr>
<td>18</td>
<td>☥</td>
<td>44</td>
<td>Yes</td>
<td>4 4</td>
<td>July 25, 1944</td>
<td>Sept. 27, 1944</td>
</tr>
<tr>
<td>19</td>
<td>☥</td>
<td>34</td>
<td>Yes</td>
<td>4 4</td>
<td>Mar. 2, 1944</td>
<td>Death</td>
</tr>
</tbody>
</table>

**PATHOLOGICAL ANATOMY**

Case 10 had an astroblastoma in the left wall of the 3rd ventricle. Case 13 had a tumor of unusual histological type, the diagnosis of astrocytoma magno-cellulare being most likely.

Case 14 had cerebral metastases from an adenocarcinoma. It was not possible to find the primary tumor. Case 17 had an astrocytoma involving the left thalamus.

Case 19 had a colloid cyst. Cases 9, 11, 12, 15 and 16 are still alive. No
biopsies have been performed. There is good reason to consider that Case 15 has a craniopharyngioma.

CASE REPORTS

Tumors in or near the 3rd Ventricle, outside the Pineal Region

Admitted 9.10.38. Discharged 21.10.38
Admitted 22. 1.39. Discharged 4. 2.39
Admitted 8. 5.39. Discharged 17. 5.39
Admitted 17. 8.39. Discharged 25. 8.39
Admitted 23. 2.40. Discharged 18. 3.40
Admitted 4. 2.46. Discharged 30. 2.46

Fig. 5. Case 9. Ventriculogram June 13, 1938. The 3rd ventricle is dislocated to the right, and both lateral ventricles are widely dilated.

Anamnesis. Headaches, vomiting, diplopia and hemiparesis about 7 months previous to 1st admission.

Examination. Bilateral papilledema, hemiparesis and hemihypoesthesia on right side.

Ventriculography. Tumor to the left of 3rd ventricle. Considerable dislocation of the whole 3rd ventricle to the right (Fig. 5).
Ventriculocisternostomy 13.6.38. Rapid disappearance of symptoms of intracranial hypertension as well as of hemiparesis and hemihypoesthesia. Patient was seen at frequent intervals for control examination and x-ray treatment (Fig. 6). There was no recurrence of intracranial hypertension.

Control 1946. There is no subjective feeling of any illness. Neurological examination reveals a defect of the visual field, but otherwise there are no abnormal findings. Ventriculograms show that there has been no visible growth of the neoplasm during the 8 years (Fig. 7).

Figs. 6 and 7. Case 9. Ventriculograms taken for control. Left, Feb. 27, 1940, almost 2 years after ventriculocisternostomy. The 3rd ventricle is now seen in the midline. A tumor in left wall of 3rd ventricle is clearly visible. The lateral ventricles are definitely smaller than before operation. Right, Feb. 11, 1946, almost 8 years after operation. The contours of the neoplasm are about the same as on ventriculogram 6 years previously.

Admitted 1.10.42. Discharged 23.11.42

Anamnesis. For 2 years previous to 1st admission the patient had suffered from headaches, vomiting and amenorrhoea.

Examination. Bilateral papilledema.

Ventriculography. Tumor on the right side in posterior part of 3rd ventricle.

Ventriculocisternostomy 31.5.39. Rapid subsidence of signs of intracranial hypertension. She worked as a stenographer until October 1942, when a right hemiparesis developed. She was admitted for control examination and discharged in improved condition. She felt well until the summer of 1943, when signs of progression of the tumor gradually developed. She died in another hospital from pneumonia.

Autopsy. Astroblastoma infiltrating the posterior region of the 3rd ventricle including both thalami.

Admitted 3. 8.39. Discharged 17. 8.39
Admitted 16.10.39. Discharged 28.10.39
Admitted 30. 1.40. Discharged 13. 2.40
Admitted 14. 6.40. Discharged 27. 6.40
Admitted 6. 1.41. Discharged 6. 3.41
Anamnesis. For 3 years headaches, vomiting and loss of vision.
Examination. Bilateral papilledema, oculomotor nerve palsies, loss of vision, and cerebellar dysfunction on left side.

Ventriculography. Widely dilated lateral ventricles but no air in 3rd ventricle. There was an infratentorial cyst of the kind known in cases of spontaneous rupture of the ventricular system.

Ventriculocisternostomy 19.4.39. Rapid disappearance of signs of intracranial hypertension. The patient was seen a number of times in the ward for control examination and x-ray treatment. He lived at home until April 8, 1941, taking part in the work at his farm, and no new signs of intracranial hypertension developed. He entered a stuporous state, which lasted a couple of weeks, before he died. No autopsy.

Admitted 12.11.45. Discharged 19.11.45
Anamnesis. For several years increasing headaches, vomiting and loss of vision.
Examination. Atrophic optic discs with blurred edges.
Ventriculography. Symmetrical dilatation of both lateral ventricles and no air in 3rd ventricle.

Ventriculocisternostomy 4.11.40. Disappearance of the signs of increased intracranial pressure.

Control November 1945. Since the operation she has been free from headaches and vomiting and has noticed no increase in loss of vision. There was no subjective feeling of being ill. Ventriculograms showed unchanged findings.

Admitted 7.7.41. Discharged 30.9.41, dead.
Anamnesis. Headaches, vomiting and loss of vision for some months previous to admission.
Examination. Bilateral papilledema. Reduced vision.
Ventriculography. Symmetrical enlargement of both lateral ventricles. A tumor was seen below the anterior horns.

Ventriculocisternostomy 7.7.41. The operation was followed by improvement but not by complete disappearance of the signs of intracranial hypertension. Osteoplastic craniotomy was carried out in order to control the intraventricular portion of the tube. It was found in optimal position. A specimen of the tumor was taken for diagnosis. This operation was followed by hyperthermia and death. The neoplasm proved to be an astrocytoma magno-cellsare.

Autopsy. Huge tumor in 3rd ventricle, pressing itself upward between the lateral ventricles.

Admitted 25.10.41. Discharged 5.11.41, dead.
Anamnesis. Headaches, vomiting and loss of vision for some months.
Examination. Bilateral papilledema and amaurosis.
Ventriculography. Tumors in 3rd ventricle and in posterior part of right lateral ventricle.

Ventriculocisternostomy 28.10.41 followed by hyperthermia and death.

Autopsy. Cerebral metastases from adenocarcinoma. The primary tumor was not found.

Admitted to private hospital 28.4.41. Discharged 27.6.41, improved.
Anamnesis. Headaches and vomiting for a couple of years.
Examination. Bilateral papilledema. Calcification above sella visible on x-ray pictures.
Ventriculography. Symmetrical enlargement of both lateral ventricles. No air visible in 3rd ventricle (Figs. 8 and 9).
Figs. 8 and 9. Case 15. Ventriculograms May 2, 1941. Craniopharyngioma showing characteristic calcification above the sella. Both lateral ventricles are widely dilated. No air is visible in the 3rd ventricle.

Fig. 10. Case 15. Ventriculogram Dec. 4, 1945. The findings are much the same as 4½ years previously. Since ventriculocisternostomy was carried out the patient has been relieved of all signs of intracranial hypertension.
TREATMENT OF NEOPLASM IN OR NEAR THIRD VENTRICLE

Ventriculocisternostomy 1.5.41. Disappearance of symptoms of intracranial hypertension. Puncture of a suprasellar cyst, with aspiration of 10 cc. of tar-coloured fluid, was made. Un-eventful postoperative course.

Control December 1945. She is in perfectly good health, not feeling ill in any way. Ventriculography showed no change since the previous air study (Fig. 10). Not any new signs of intracranial hypertension or any new abnormal neurological symptoms have developed.

Admitted 4.10.41. Discharged 13.11.41, improved.
Admitted 11. 2.42. Discharged 19. 5.42
Admitted 22.10.45. Discharged 27.10.45

Anamnesis. Headaches, vomiting and loss of vision for 1 year.
Examination. Papilledema and defect of the visual field.

Ventriculography. Considerable enlargement of both lateral ventricles, and anterior portion of 3rd ventricle compressed by a tumor.

Ventriculocisternostomy 10.3.44. Disappearance of signs of intracranial hypertension.

Control 1945. There had been no recurrence of the symptoms of intracranial hypertension. She feels perfectly well and works as a housekeeper. Ventriculography reveals no change since the previous pneumography.

Case 17. 9825/44. A. S., 15-year-old boy.
Admitted 3.2.44. Discharged 2.8.44, improved.
Admitted 1.7.46. Discharged 5.7.46, dead.

Anamnesis. Headaches and paresis of ocular movements for 1 year. Abnormal feeling of hunger. Low mental development.

Examination. Bilateral papilledema; lateral deviation of left eye. Mental retardation and dystrophia adiposo-genitalis.

Ventriculography. Tumor to the left of 3rd ventricle, involving left thalamus.

Ventriculocisternostomy 13.4.44. Subsidence of signs of increased intracranial pressure. Discharged to his home.

Control July 1946. Since discharge there had been no recurrence of the signs of intracranial hypertension. Ventriculographic control was carried out and was followed by sudden death 4 days later.

Autopsy. Astrocytoma involving the left thalamus and lateral geniculate body.

Admitted 17.7.44. Discharged 3.11.44, improved.

Anamnesis. Headaches, diplopia and vomiting for about 8 months.

Examination. Bilateral papilledema.

Ventriculography. Tumor in 3rd ventricle.

Ventriculocisternostomy 25.7.44. Disappearance of papilledema and other signs of intracranial hypertension.

He was discharged to his home, where he died during an attack of generalized convulsions. No autopsy.

Admitted 2.3.44. Discharged 18.3.44, dead.

Anamnesis. Headaches and vomiting for 2 years.

Examination. Bilateral papilledema.

Ventriculography. Considerable symmetrical enlargement of both lateral ventricles and no air in 3rd ventricle.

Craniotomy. A colloid cyst was removed from the 3rd ventricle, and a perforation of the septum pellucidum was performed. There was postoperative intraventricular hypertension. Ventriculocisternostomy on right side, 2.3.44. Ventriculography was repeated because of continued signs of intracranial hypertension. The investigations indicated defective communi-
cation between the lateral ventricles. New craniotomy on left side revealed blood clot in left lateral ventricle and closure of perforation made at previous operation. The septum pellucidum was resected. The operation led to death 1 week later.

*Autopsy.* Degenerative changes in region of 3rd ventricle from which the colloid cyst had been removed.

**DISCUSSION**

*Ventriculocisternostomy in Cases of Tumor in the Pineal Region.* Cases of stenosis of the rostral portion of the aqueduct due to tumor in the pineal region have been grouped together in this work.

Above I have stressed the point that attempts at removal of neoplasms in this region are associated with the greatest danger to life. It has, therefore, given me great satisfaction to see the good results that can be obtained by means of ventriculocisternostomy. Of my 8 patients treated by this operation only 1 died from the operation. This was a young girl (Case 3) who was in such a poor condition that it was unlikely that any operation could be carried through. Three patients (Cases 2, 6 and 7) died some months after the operation because of the progression of the tumor. One patient lived for 4½ years without developing new signs of intracranial hypertension before he died because of the growth of the neoplasm.

At present 3 patients are alive and free from symptoms. One of these (Case 8) has continued his life as a vagabond since the operation. He leads a life of great physical strain without noticing any of the previous symptoms, of which headaches and vomiting predominated. At the present time his only symptom is loss of vision in one eye. This has improved since the operation.

Case 4 has been working as a housekeeper since the operation, 4½ years ago, and enjoys good health. Case 1, whose ventriculocisternostomy was performed more than 7 years ago, has gone through the regular school and become a teacher since the operation. He is rather an intelligent man who states that he in no way has the feeling of being a patient. He leads a life of considerable physical and mental strain. He is very efficient and his work is of a very high grade.

*Ventriculocisternostomy in Cases of Tumor in the 3rd Ventricle.* Apart from the colloid cysts, the neoplasms in the 3rd ventricle as a rule are of gliomatous origin. Tumors of ependymal nature are comparatively frequent, and astrocytes and polar sponggioblasts are also common neoplastic cell types in this region of the brain.

Eleven patients with tumor in the 3rd ventricle or its walls outside the pineal region have been treated by ventriculocisternostomy. Of these 2 died from the operation, 2 died between 3 and 5 months later, while the remaining 7 lived 2 years or more. Two of my patients have died from the further growth of the neoplasm, 1 after 3 years and the other after almost 5 years. During the postoperative period of life, both of them had managed to support themselves, at times totally, at other times only partially. Five of my patients are still alive, 4 of them being entirely self-supporting, 4, 5, 5 and 8
years after the operation (Cases 9, 12, 15 and 16). They state that their working capacity is as good as before the onset of the illness. No new symptoms have appeared during the course of the observation.

The results are thus considerably superior to those that have been obtained previously by other methods. The experience with my patients also shows the extremely slow growth ordinarily displayed by neoplasms in this region.

Such observations have previously not been possible because of partial or total extirpation of the tumor.

_Ventriculocisternostomy in Cases of Craniopharyngioma._ Neoplasms of this nature have been looked upon with great concern by most neurosurgeons because hardly any one has ever succeeded in his attempt at complete removal of the neoplasm, and the surgical attacks are combined with a high mortality. Transfrontal or transventricular partial removal, as a rule, is followed by signs of recurrence after a limited time. Subtemporal or suboccipital decompressions result in very limited relief only, and after a relatively short duration, the symptoms again disclose increased and steadily increasing intracranial pressure.

In 1941 I treated a patient with craniopharyngioma by ventriculocisternostomy. She was a girl 13 years of age. On admission, she had a high degree of papilledema and was troubled by loss of vision, vomiting and headaches. The control examination after an interval of 5 years shows that she has benefited from the operation in a most satisfactory way. The eyeground is now normal, there are no headaches, no vomiting and she has shown a normal intellectual development. The only sign of an abnormal condition consists of a somewhat retarded sexual development. This is not prominent, however, the growth of pubic hairs and the development of mammæ being almost normal, but as yet, she has not menstruated.

With this encouraging experience in mind there is reason to attempt the operation in more cases of this kind, especially since ventriculographic control after 5 years does not show any increase in size of the tumor (Figs. 8, 9 and 10).

_Ventriculostomy ad modum_ Dandy² or White⁷ demands as a condition for its performance that the 3rd ventricle is dilated and that an opening in its wall brings it in immediate connection with the adjacent cisternæ. In cases of craniopharyngioma, ventriculostomy thus cannot be carried out, as the neoplasm both obstructs the foramina of Monro and compresses the 3rd ventricle.

The results of ventriculocisternostomy in cases of tumor in or near the 3rd ventricle have been so encouraging that the operation should be carried out in an extensive series of cases which should include patients suffering from craniopharyngioma in order to increase our experience with this particular kind of lesion.

_Ventriculocisternostomy and Intracranial Hypertension._ All together I have treated 32 patients with intracranial hypertension by ventriculocis-
ternostomy. There were 8 cases of tumor in the pineal region, 11 cases of neoplasm in or near the 3rd ventricle outside the pineal region, and 13 cases of stenosis of the Sylvian aqueduct.

Of the 32 patients 7 died shortly after the operation, while 25 lived long enough to allow evaluation of the effect of the operative treatment on the intracranial hydrodynamic conditions. In the course of time some of the patients have died later due to further growth of the neoplasm, but the postoperative period of observation in those cases also has been long enough to offer opportunities for interesting observations.

<table>
<thead>
<tr>
<th>Period of Observation</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 2 to 3 months</td>
<td>4</td>
</tr>
<tr>
<td>From 4 to 5 months</td>
<td>1</td>
</tr>
<tr>
<td>From 1 to 2 years</td>
<td>3</td>
</tr>
<tr>
<td>From 2 to 3 years</td>
<td>4</td>
</tr>
<tr>
<td>More than 3 years</td>
<td>13</td>
</tr>
</tbody>
</table>

Total number of cases observed 25

Of these 25 patients 20 had papilledema previous to the operation. Four had atrophic optic discs without signs of edema or prominence, and in 1 patient only, 7 months old, it was not possible to study the eyegrounds because the child resisted the examination.

Of the 20 patients presenting papilledema and protruding optic discs, there was only 1 in whom there was not a definite subsidence of these pathological changes. This exceptional patient died 47 days after ventriculocisternostomy, the rubber tube being in a faulty position. In the other 19 cases a gradual and complete disappearance of the papilledema has taken place.

It should be stressed that the signs of intracranial hypertension disappeared after ventriculocisternostomy before any other kind of treatment had commenced. The patients who received deep x-ray treatment were treated by this therapeutic measure at a later stage and after the reduction of the intracranial hypertension was beyond doubt.

One of the patients at the time of discharge from the hospital, about 2 months after ventriculocisternostomy, had signs of papilledema and about 2 diopters prominence of the optic discs, showing no definite subsidence of the pre-operative changes. When he was seen 6 months later there were no signs of papilledema. Thus, it is not certain at what time the pathological ophthalmological findings disappeared. (He did not receive x-ray treatment.) In all the other cases it has been possible to decide approximately when the papilledema subsided. In 5 cases it took place within 4 weeks; in 5 cases between 4 and 8 weeks; in 5 cases between 8 and 12 weeks; in 2 cases between 12 and 16 weeks; and in 1 case the papilledema did not disappear before between 20 and 24 weeks after the operation. The following table illustrates these findings.
Disappearance of Papilledema

<table>
<thead>
<tr>
<th>Number of Cases</th>
<th>Number of Weeks before the Papilledema Subsided</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Within 4 weeks</td>
</tr>
<tr>
<td>5</td>
<td>Between 4 and 8 weeks</td>
</tr>
<tr>
<td>5</td>
<td>Between 8 and 12 weeks</td>
</tr>
<tr>
<td>2</td>
<td>Between 12 and 16 weeks</td>
</tr>
<tr>
<td>1</td>
<td>Between 20 and 24 weeks</td>
</tr>
<tr>
<td>1</td>
<td>Undecided</td>
</tr>
</tbody>
</table>

In cases of stenosis of the circulation of the cerebrospinal fluid, irrespective of the origin of the stenosis, headaches and vomiting usually are predominating symptoms due to intracranial hypertension. Below I shall account for these symptoms after ventriculocisternostomy.

Seven cases cannot be used for this study because the patients died soon after the operation. In another case headaches and vomiting continued until death occurred 47 days after the operation (the rubber tube had been placed in a faulty position).

In most of the remaining 24 cases a rapid subsidence of both headaches and vomiting was observed after the operation. In Case 2 (a rapidly growing tumor) the symptoms recurred at a later stage. At the time of the operation the optic discs protruded 7 diopters on either side. Within 4 weeks the swelling of the discs had completely disappeared and the patient became relieved of her headaches and vomiting. The rapid growth of her tumor could be seen by ventriculographic control. When the tumor some months later had attained a very large size she again became troubled by headaches and vomiting and again papilledema developed, although this time to a moderate degree.

The anamnnesis and the examination of the patients before and after ventriculocisternostomy indicate strongly that they were relieved of the intracranial hypertension within a comparatively short time. Of the surviving patients 12 have been controlled 2 years or longer after ventriculocisternostomy by ophthalmoscopy and by puncture of the lateral ventricles. None of them presented signs of papilledema and none of them showed increased intraventricular pressure. These findings leave no doubt that in my patients ventriculocisternostomy has resulted in normal intracranial pressure.

My experience has shown that even in cases where one would suppose that optimal conditions were present for the creation of the new circulatory system for the cerebrospinal fluid, considerable time may elapse before the intracranial pressure reassumes physiological values. The pressure can be judged in a reliable way by means of ventricular puncture and ophthalmological examination, as has been discussed above.

Reduction of intracranial hypertension is also expressed by the general clinical situation, especially in cases where the patient is stuporous. It has been noticeable how drowsiness and stupor (together with other subjective
feelings of not being well) have disappeared simultaneously with the registerable reduction of the raised intracranial pressure.

In some cases of intraventricular hypertension, the fluid has shown a tendency to collect along the rubber tube, forming some sort of subaponeurotical herniation, and occasionally the pressure has been great enough to cause a rupture of the wound with the formation of a fistula. In several instances in which such abnormal collections of fluid have resulted, I have examined the patency of the rubber tube and ascertained that both ends were in a satisfactory position. I have not been able to explain this complication in a relevant way.

It seems rather peculiar that the pressure of the cerebrospinal fluid has remained at such a high level even after the establishment of uninhibited outflow for the intraventricular fluid. It may be because the production of the cerebrospinal fluid, previous to the ventriculocisternostomy, has taken place under increased resistance (the choroid plexus has been surrounded by fluid under abnormally high tension), and it is possible that the formation of cerebrospinal fluid for that reason has intensified. In any case, one has the impression that the choroid plexus for some time produces the cerebrospinal fluid with such intensity that the resorbing organs are unable to effect its removal with sufficient rapidity. It apparently takes some time to reach a balance between the production and the resorption.

The Indications for Ventriculocisternostomy. This operation should be carried out in all cases of tumor in the pineal region, and tumor in or near the 3rd ventricle (pituitary tumors, suprasellar meningiomas and cholesteatomas are not considered here).

Pathological processes that prevent the passage of the cerebrospinal fluid along the outside of the brain stem (such as inflammatory alterations causing adhesions in the neighbourhood of the incisura tentorii and infratentorial neoplasms) of course cannot be beneficially influenced by this operation.

As far as my experience goes, it is usually sufficient to lead the ventricular fluid from one lateral ventricle to the cisterna magna. When both foramina of Monro are obstructed, bilateral ventriculocisternostomy comes into consideration, and in some cases of tumor of the 3rd ventricle such a possibility should be kept in mind. As a rule there is sufficient communication between the two lateral ventricles, either by way of the foramina of Monro or by spontaneous rupture of the septum pellucidum. Bilateral ventricular puncture or ventriculography will give the required information concerning this point. If necessary, resection of a window in the septum pellucidum or bilateral ventriculocisternostomy could be performed. As yet, I have never practised the latter operation, which, of the two, is probably more preferable.

The Durability of the Rubber Tube. Foreign Body Reaction. When I first carried out ventriculocisternostomy I was anxious to learn if rubber was a suitable substance for the tube, and feared that in the course of time a favourable result of this operation might be disturbed by deterioration of the rubber or by foreign body reaction.
Experience has shown that once the rubber tube has been put in the right position and this new pathway of circulation has been adopted by the system, the cerebrospinal fluid continues to run through this new channel without interruption. In not less than 13 cases I have had occasion to observe this over a period of 3 years or more.

There has been no kind of complication due to deterioration of the rubber tube, and no sign of obstruction. In Case 5, in which fatality occurred about 4 years after ventriculocisternostomy, autopsy disclosed a sterile pus coating at the base of the brain, and a large number of cells were present in the cerebrospinal fluid a short time before death. These inflammatory alterations, however, were confined exclusively to the base of the brain, none being observed in the lateral ventricle, at the convexity of the brain near the rubber tube, nor in the region of the cisterna magna, where such changes supposedly should be especially pronounced if they were due to the tube. The rubber tube itself was in excellent condition.

In Case 10, at reoperation 3½ years after ventriculocisternostomy, the rubber substance was found to have undergone no changes, and the tube was patent and functioning satisfactorily. The patient died on Jan. 3, 1944, 4½ years after ventriculocisternostomy, and at autopsy the rubber substance was found to be in an excellent condition, showing no visible or palpable changes.

In Case 9 I had made the rubber tube too long, so that its intraventricular end touched the tip of the right temporal horn. At a control operation, about 7 years later, the ventriculograms showed that the ventricular system had decreased considerably in size. I regarded this as an indication for shortening the tube in order to prevent its end from being occluded by the ventricular wall. The tube consequently was pulled out from the lateral ventricle, shortened, and again put in place. Dense connective-tissue adhesions had formed along the tube extracranially and a canal with solid walls surrounded the tube in the hemisphere. The rubber substance was elastic and strong. It took as much force to tear the extirpated part of the tube to pieces as it takes for tearing a fresh tube. Thus, the warm moisture surrounding the tube apparently does not affect the rubber in a harmful way. Probably the absence of daylight is of importance for its conservation.

When 7 years can pass without the tube being noticeably affected, I believe it just to consider the rubber tube as satisfactory for any reasonable demand in connection with ventriculocisternostomy.

The Growth of the Neoplasm after Ventriculocisternostomy. Ventriculocisternostomy has opened new avenues for the study of the growth of neoplasms in the region of the 3rd ventricle and the brain stem. Previously, partial or total removal of such tumors precluded the possibility of studying the undisturbed biological activity of the tumors. However, in cases treated by ventriculocisternostomy, the tumor may continue its growth without interruption for a considerable time without causing the death of the patient.

The first surprising observation I made concerns the growth of tumors in
the pineal region. It has been shown that they may be almost stationary for a period of more than 7 years, as in Case 1. Ventriculograms taken in September 1938 and January 1946 show that the tumor has not grown visibly during this long interval. This gives reason to believe that the expansion of the tumor takes place so slowly that the patient most likely will not experience any neoplastic symptoms as long as there is an undisturbed function of the rubber tube. Consequently in such cases there is indication for ventriculocisternostomy before any attempt at the removal of the neoplasm. If radical extirpation should be tried later, the artificial aqueduct with which the patient is equipped will be of advantage, since this is likely to prevent obstruction of the flow of the cerebrospinal fluid due to blood clots or edema.

In cases of malignant neoplasm (as in Case 2), the operation may to some extent prolong the life and lessen the sufferings of the patient. In such cases no attempt at radical extirpation can possibly save the patient.

Interesting observations were also made concerning neoplasms in the region of the 3rd ventricle, showing that the patients may live for long periods of years after ventriculocisternostomy. In some of these cases the ventriculograms show that no visible increase in the size of the tumor has taken place over periods of 4 years (Case 12) and 5 years (Case 13). It should be stressed that from the clinical standpoint also, the tumors caused no new symptoms during this time. In other instances a very slow expansion of infiltrating neoplasms in this region (Cases 5 and 10) was observed.

The study of Case 9 has shown that a neoplasm arising from the wall of the 3rd ventricle may be of such indolence as to undergo no increase in size over a period of 7 or 8 years. I have also seen some of the grave symptoms that accompany tumors in this region subside and even disappear after ventriculocisternostomy. On admission, Case 9 had cerebellar dysfunction, hemiparesis and pronounced papilledema. Some time after ventriculocisternostomy these symptoms disappeared with surprising rapidity. A considerable dislocation of the 3rd ventricle seen on ventriculograms previous to ventriculocisternostomy could not be found in the pneumograms some time after the new outlet for the intraventricular fluid had been taken into use. This improvement was observed before commencement of radiation therapy.

It was found also that a craniopharyngioma may undergo no increase in size over a period of many years after ventriculocisternostomy, even in children with most alarming symptoms before the operation (Case 15). This new surgical treatment should therefore be tried before any attempt at extirpation is made.

SUMMARY AND CONCLUSIONS

Attempts at the removal of neoplasms in regions of the pineal gland and the 3rd ventricle of the brain are associated with such a grave mortality rate that, if possible, such operations should be avoided.
It is possible to treat patients with such lesions by ventriculocisternostomy, with satisfactory results. I have performed the operation in 8 cases of tumor in the pineal region, with 1 postoperative death, and in 11 cases of tumor in or near the 3rd ventricle outside the pineal region, with 2 fatalities. The above results show that the mortality rate by this operation is far below that following attempts at surgical extirpation of the tumors.

The fate of the patients depends primarily on the malignancy of the neoplasm. Tumors of high expanding energy infiltrating this region of the brain will in any case cause the death of the patient within limited time. In such cases no other operation can possibly save the life of the patient.

Most of the tumors, however, are of very slow growth, and the patients may live comfortably with the neoplasm if the symptoms due to the obstruction of the flow of the cerebrospinal fluid can be relieved. In my series there are several cases in which no visible growth of the neoplasm has taken place after intervals of 7 or 8 years.

In any case of tumor in the pineal region, neoplasm in or near the 3rd ventricle, craniopharyngioma, and stenosis of the Sylvian aqueduct whether due to neoplasm or not, ventriculocisternostomy should be carried out before any other surgical procedures are undertaken.

REFERENCES