UNILATERAL HYDROCEPHALUS RESULTING FROM OCCLUSION OF FORAMEN OF MONRO

COMPLICATION OF RADICAL REMOVAL OF BRAIN ABSCESS

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The treatment of brain abscesses in all stages of encapsulation by radical removal of abscess and adjacent softened brain tissue has been reported by several authors. The reduction in over-all mortality using this method in conjunction with systemic and intraventricular penicillin is a consistent finding in all the reports in the literature. Chorobski and Kunicki6, in a recent publication reviewing all reported brain abscesses treated by radical removal, state that there were no cases in which meningitis was reactivated by the operation provided antibodies were used.

In view of the growing enthusiasm for this type of treatment of brain abscesses, 2 cases are presented with unilateral hydrocephalus secondary to obstruction of the foramen of Monro following removal of a brain abscess.

The causal relationship between obstruction in the cerebrospinal fluid circulation and the development of hydrocephalus has been suspected for over half a century and proved experimentally since 1913. The first experimental production of hydrocephalus in animals by occlusion of one foramen of Monro by Thomas20 was overshadowed by the publications of Dandy9 at about the same time. Both workers gave adequate experimental proof of the development of hydrocephalus in animals following occlusion of the cerebrospinal fluid pathways.

Severe reactions in the ependyma of the lateral ventricles, 3rd ventricle, or aqueduct of Sylvius producing subsequent gliosis and obstruction to the interventricular passages have been occasionally reported. The cause of the ependymitis in some cases has not been determined. In others the gliosis of the ependyma has been secondary to known or suspected meningitis. Burr and McCarthy4 as early as 1900 attempted to duplicate this picture by injecting irritating substances into the lateral ventricles of experimental animals. They successfully produced ependymitis but unfortunately did not allow their experimental subjects to survive long enough to develop dilatation of the ventricles.

The first clearly defined clinical case of unilateral hydrocephalus from obstruction to one foramen of Monro was described by Cushing. In this presentation Cushing considered the obstruction was secondary to ependymitis, the result of so-called “brain fever” some months previously. The

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number of cases reported in the literature is small and the surgical attempts
to alleviate this condition have been remarkably few. Dott19 in 1927 de-
scribed a patient 9 months of age with obstruction of one foramen of Monro
and severe unilateral hydrocephalus. The patient was apparently permanent-
ly relieved of symptoms of increased intracranial pressure by an opening,
made at operation, through the septum pellucidum.

More recently Cairns et al.3 have described 2 cases resulting from gun-
shot wounds of the head in which portions of the lateral ventricles had been
sealed off from the rest of the ventricular system by scar tissue. These
patients suffered from local dilatation of the lateral ventricle confined to
its occluded portion of sufficient severity to cause generalized increase in
intracranial pressure. In one patient communication between the occluded
inferior horn of the lateral ventricle and the body of the ventricle was estab-
lished and the choroid plexus within the cyst removed. In the other case the
choroid plexus was removed. In both patients the increased intracranial
pressure was relieved.

During the past 2 years one of us (E.H.B.) has treated 8 patients with
brain abscess by means of radical excision. There has been 1 death. In 2
instances in which the abscess was poorly encapsulated with but thin walls
and in close proximity to the lateral ventricle, the abscess was ruptured
during removal and the adjacent ventricle opened. In both patients penicil-
lin was used locally in the cerebral cavity and in one streptomycin was also
used. Intraventricular injections of these antibiotics were also made post-
operatively. The prompt recovery with complete bacteriological cure was
impressive. The subsequent insidious development of signs which were mis-
takenly interpreted as recurrence of an abscess and satisfactory surgical
cure of these patients when the true nature of the condition was found by
ventriculography are related below.

PRESENTATION OF CASES

Case 1. B98276. R. P., male, 19 years.

Summary. Frontal osteomyelitis and left frontal lobe abscess. Radical removal
of abscess; ventricle opened; intraventricular penicillin. Temporary improvement
followed by gradual onset of signs of space-occupying lesion of left cerebral cortex.
Unilateral hydrocephalus; obstruction left foramen of Monro, relieved by opening
made through septum pellucidum.

Present Illness. This 19-year-old boy was in good health until Jan. 3, 1947, when
acute left frontal sinusitis developed. On Jan. 9, 1947, a swelling in the left frontal
region was drained and purulent material from this cultured Streptococcus haemolyti-
cus. On sulfonamide therapy he made a gradual recovery until about Feb. 15, 1947,
when he was admitted to the Neurosurgical Service of the Toronto General Hospital
in semi-coma.

Examination. Temperature 101° F., pulse 60, respirations 10. He was drowsy,
rather poorly nourished and responded, answering simple questions correctly.
Findings were: edema of the left forehead, moderate bilateral papilledema with
small retinal hemorrhages, and weakness of the right lateral rectus muscle. Power
in the extremities and superficial and deep reflexes were considered normal. There was no aphasia. The patient was right-handed.

**Laboratory Data.** Wbc. 9,200. Roentgenograms of the skull showed frontal sinusitis and osteomyelitis of the frontal bone (Fig. 1).

Shortly following admission the patient had a generalized seizure with respiratory arrest of alarming duration. Immediate operation was necessary.

**Operation,** Feb. 15, 1947. Using a left frontal scalp flap, the infected bone of the left frontal region was removed together with a safe margin of normal bone surrounding it. The left frontal sinus was obliterated. The dura was infected and there was a large abscess of the left frontal lobe. This was radically removed together with surrounding softened edematous brain and the anterior horn of the left lateral ventricle was opened. A burr hole was made in the right posterior parietal region and penicillin (5000 ox.

**Postoperative Course.** He was given systemic penicillin and sulfadiazine, as well as local instillation of penicillin, 10,000 units, into the operative site on 2 occasions and 10,000 units of penicillin by lumbar route on 4 successive days after operation. He left the hospital much improved.

For 1 month after leaving hospital he gradually became increasingly drowsy, at times irrational and confused, and spent most of the time in bed.

He was readmitted on May 13, 1947. The frontal decompression on the left side was full; there was a right lower facial weakness as well as a right homonymous hemianopsia. The right arm and leg were weak, with hyperactive reflexes of the right leg but no pathological reflexes.

Reexplanation of his left frontal region was carried out. There was no abscess and the left frontal horn of the ventricle was encountered only a short distance under the cortex. A ventriculogram was done 3 weeks later, June 4, 1947. This showed a greatly enlarged left lateral ventricle and a localized dilatation of the left frontal region, which it was felt might not have adequate communication with the rest of the ventricular system.

The patient showed improvement following this procedure and was able to be out of bed alone. By Nov. 3, 1947, he had gained some strength in his right side and was more active. Dysphasia was present at this time, which had not been noted previously. He was given intensive physiotherapy and occupational therapy, without improvement.

**Readmission,** Jan. 28, 1948. The patient had shown little change in his condition...
until about 1 week before admission. He then began to be drowsy and to complain of severe headache. There had been an increase in the weakness of his right side. The dysphasia was more severe than previously. The scalp over the left frontal bone defect was tense and bulging.

It was again considered that there was a recurrence of his left frontal lobe abscess. Tapping the left frontal region through the defect, however, did not reveal an abscess but rather the anterior horn of the left lateral ventricle, containing clear colorless fluid under pressure.

Ventriculography, Feb. 4, 1948 (Figs. 2 and 3). Air was first inserted in the right occipital horn. Air was seen in the right lateral ventricle, which was shifted slightly to the right. There was no air in the left side. The left frontal horn was tapped and air introduced into this ventricle. A large cystic cavity was seen.

Operation, Feb. 5, 1948. The left frontal region was reexplored. There was considerable scarring of the frontal lobe. Exploration of the left lateral ventricle showed extensive scarring about the site of the foramen of Monro and no opening could be made out. The remainder of the visible ependyma did not appear abnormal. An opening was made in the septum pellucidum establishing communication with the right lateral ventricle. Since air had been previously injected into the right lateral ventricle there was no free flow of CSF between the ventricles but it was felt that a definite communication had been established.

Postoperative Course. The patient was much brighter and showed an improve-
ment in the function of his right arm and leg. He was mentally much more alert and his dysphasia began to decrease. Although still severely disabled, the improvement was striking and he was discharged.

When carefully examined 6 months after operation he showed further improvement. He came 40 miles to the clinic, alone, by bus. He has had no convulsions or headaches. He walks with a hemiplegic gait but can hold objects in his right hand. The right facial weakness is barely perceptible. The dysphasia is evident only on careful testing and he can carry on an intelligent conversation without noticeable difficulty. The homonymous hemianopsia persists and is complete. Optic discs and visual acuity are normal.

Comment. The intermittent onset of symptoms in this patient with periods of apparent improvement led to a mistaken interpretation of the underlying cause of his signs and symptoms. Ventriculography done 9 months prior to final operation might have led to a correct diagnosis if air had been injected into one ventricle only. An intermittent incomplete block would have explained the patient's picture, and ventriculography performed by injecting air into one side only might not have given conclusive information at that time.

In spite of the fact that the second patient entered the hospital for his last admission only a few weeks after the dramatic improvement of Case 1 following operation, the true nature of the condition was not suspected until ventriculography was done. Once the condition was shown in its proper light, certain details learned from Case 1 were used to advantage.

Case 2. B25262. H. S., male, 30 years.

Summary. Right occipital abscess secondary to bronchiectasis. Radical removal of abscess; exudate in ventricle; intraventricular antibiotics. Temporary improvement followed by gradual onset of signs of space-occupying lesion in right cerebral hemisphere. Obstruction right foramen of Monro; unilateral hydrocephalus relieved by opening in septum pellucidum.

History. In 1934 this patient had bronchopneumonia; bilateral bronchiectasis followed this, proved by lipiodol bronchograms. The most severely involved portions, the left lower lobe and the lingual process of the left upper lobe, were removed by Dr. Robert Janes on Oct. 8, 1942. Sputum cultured *Streptococcus haemolyticus*. Marked improvement followed this operation. During the succeeding 4 years the patient raised only a small amount of sputum, and was able to work steadily in a cold climate without any recurrence of pulmonary infection.

Present Illness. On Sept. 1, 1947 there suddenly developed a severe right frontal headache which persisted almost without remission. He had shown no signs of recurrent pulmonary infection, and had continued to expectorate only small amounts of sputum. Examination by his family physician showed no cause for headaches but a spinal puncture revealed normal pressure, with increased globulin, 250 lymphocytes per mm.; and a first zone rise in the gold sol curve. He was admitted to Toronto General Hospital, Sept. 15, 1947.

Examination. He was found to have a left homonymous hemianopsia with macular sparing, no papilledema and no evident weakness of the left side.

Operation 1, Sept. 22, 1947. Ventriculography was done. This demonstrated a space-occupying lesion of the right occipital region which at subsequent operation
proved to be a very large abscess (Fig. 4). There was little or no capsule; the abscess, together with a large area of surrounding edema and encephalitis in the occipital and parietal lobes, was removed. In the process of removing the abscess it was ruptured. The tentorium was exposed and the ventricle opened; there was evidence at this time of exudate over the choroid plexus, and of cloudy ventricular fluid. The patient was given systemic penicillin and sulfadiazine; 25,000 units of penicillin (5000 u/cc.) were injected into the right lateral ventricle and cerebral defect. The wound was closed tightly and the bone flap sacrificed.

Three hours after operation the frontal horn of the right lateral ventricle was tapped and 100,000 units of penicillin and 1,000,000 units of streptomycin (1 gm.) were injected into the ventricle. The solutions containing these drugs were intended to be of substantially lower concentrations, but due to the error of an assistant in preparing them, the above were inadvertently used. The patient had a sharp rise in temperature to 104°F. the evening of the operation, but the following day he showed improvement and from that time until his discharge from the hospital his condition was satisfactory. Moderate concentrations (25,000 units) of penicillin and streptomycin were given intraventricularly through a right frontal burr hole for 3 days and continued for 4 days by the lumbar route. Systemic penicillin and streptomycin were continued for 6 days, sulfadiazine having been discontinued on the 2nd postoperative day because of hematuria. There was no infection of the wound and the patient left the hospital apparently free of headaches but with a persistent left homonymous hemianopsia; there was no hemiparesis. Culture of the pus from the abscess showed no organisms.

For 2 weeks following discharge, the patient was well; then he began to show personality changes. He talked irrationally, was dependent on his wife, and became incontinent of urine and feces. Left hemiplegia gradually developed, which was at some times more severe than others. There was no significant increase in pulmonary symptoms.

Readmission, Feb. 7, 1948. The patient was euphoric, disoriented, but cooperative. He showed evidence of dehydration. His attention could not be held in any
conversation. Neurological examination revealed fullness of the parieto-occipital bone defect, left homonymous hemianopsia, no papilledema, left lower facial weakness, weakness of both the left arm and left leg, incontinence of urine and feces. He was right-handed.

It was considered that he had a recurrence of his brain abscess or a second abscess located in the intracranial cavity. Sulfadiazine and penicillin were started systemically and intravenous fluids were given. He showed slight improvement but in general over the next month his condition remained much as on admission. He was listless, remained in bed, showed a persistent left hemiparesis, and was incontinent of urine and feces.

Operation 2, Mar. 8, 1948. Ventriculography. With the head turned on the right side, needles were inserted into both lateral ventricles through the posterior parietal burr holes. Clear colorless fluid dripped from both needles and the fluid was replaced with air in 10 cc. increments through the right needle only. A small amount of air was thought to have passed from the right to the left ventricle but only a small fraction of that injected. Air was injected into both ventricles before the patient was sent to the Roentgenology Department. The roentgenograms (Fig. 5) showed shift of the septum pellucidum to the left side with an enlargement of the right lateral ventricle. No air could be induced to enter the 3rd ventricle.

Under local anesthesia a right frontal bone flap was turned down. A burr hole was likewise made in the left frontal region and the tip of a ventricular needle passed into the anterior horn of the left ventricle. Through a cortical incision the right lateral ventricle was entered and thoroughly examined. The site of the foramen of Monro was easily made out but there was no visible opening. The ependyma did not appear grossly abnormal. The ventricular needle in the left anterior horn could be seen against the septum pellucidum and, using it as a guide, a large opening was made in the septum directly into the left ventricle. Isotonic saline was washed through the opening repeatedly using the needle in the left lateral ventricle, demonstrating the patency and size of the new ostium.

Postoperative Course. The patient showed immediate and dramatic improvement. His mental state cleared, he became continent of urine within 3 days and was out of bed of his own accord on the 5th postoperative day. The left hemiparesis cleared almost completely except for a slight lag in the left lower face on emotional expression. The right parieto-occipital bone defect was depressed and there was now no evidence of increased intracranial pressure. He continued to show daily improvement during the rest of his hospital stay and was discharged mentally clear and anxious to return to work. An X-ray of the chest shortly before discharge showed clearing as compared to previous films. There was still some clouding of the left base.
On April 1, 1949, the patient reported he was working full time as a clerk, taking a course in accounting, free of headaches and unaware of any weakness of the left arm or leg.

Comment. The apparent passage of a small amount of air from the right to the left lateral ventricle may have been due to the existence of a minute opening at the foramen of Monro not visible at operation. The great enlargement of the right lateral ventricle with the shift of the septum pellucidum to the opposite side would lead to the conclusion that there was a serious obstruction to the flow of cerebrospinal fluid through the right interventricular foramen. Since in this case, as in Case 1, the fluid in the enlarged ventricle was clear and colorless, it is probable that the occlusion of the foramen of Monro was not complete but of such importance as to cause increased intraventricular pressure.

The clinical improvement in this patient following the removal of the left lower lobe of his lung, in spite of the fact that other lobes were involved in the bronchiectatic process, is of passing interest. This improvement has now persisted for 6 years.

The fact that the first brain abscess was metastatic in origin led those who observed the patient during his last admission to feel that his symptoms were due to a second abscess of similar origin. In view of the well known tendency of metastatic brain abscess to be multiple, the solitary nature of the abscess in this patient is worthy of comment.

Although in cases with enlargement of both lateral ventricles and without scarring of the ventricular walls it is a simple matter to identify and open the septum pellucidum, it may be difficult to be certain of landmarks in cases such as those presented in this report. The procedure of placing a ventricular needle in the normal ventricle at the time of operation, as was done to advantage in Case 2, may be of assistance in the surgical treatment of similar cases in the future. The location, patency, and size of the artificial opening of the septum pellucidum can be readily demonstrated by this procedure.

DISCUSSION

The type of operation carried out in these cases was so direct and simple and the therapeutic results so satisfactory that it would seem advisable to avoid in future cases the long delay brought about by the mistaken impression that a second or recurrent abscess was the cause of the signs and symptoms.

There was, in each case, a dramatic recovery from the removal of the brain abscess, a period of improvement which lasted 1 to 3 months. Following this there was recurrence of headache, mental and physical lethargy, with subsequent development of contralateral hemiparesis. That hemiparesis can be caused by unilateral hydrocephalus has been previously recorded. In Case 1, in which the hydrocephalus occurred on the left side, the patient
also showed a partial aphasia. The course in each case was progressively downhill, though interrupted by periods of seeming improvement in Case 1, and before the final admission to the hospital each was bed-ridden, one of them incontinent of urine and feces.

The observation, at the time of removal of the brain abscess, of exudate over the choroid plexus and cloudy cerebrospinal fluid seems sufficient cause, in itself, for the later development of obliterative ependymitis and gliosis. Such late complications of bacterial infection of the central nervous system even after apparent bacteriological cure with antibiotics have been graphically illustrated by Bailey and by Alexander. Whether the intraventricular instillation of the antibiotic, penicillin, in one case with the addition of streptomycin in the other patient, both in relatively concentrated form, had any part in the ependymal reaction, it is difficult to say. Certainly, this might have been a factor in Case 2 in which inadvertently a greater concentration than was desired was put into the ventricle. Nevertheless in patients with direct invasion of the ventricles with organisms, the local use of antibiotics is justified, for without this form of therapy, infection may not be controlled. The frequent injection of solutions in low but effective concentrations would be advisable, avoiding concentrated solutions.

A carefully performed ventriculogram should be done at an early stage in any patient who has been operated upon for a brain abscess but subsequently shows a persistent interruption in the course of improvement. This would determine the location of any recurrent abscess. Such studies, done earlier in the course of illness of the patients presented herein, would have led to prompt diagnosis and appropriate treatment.

SUMMARY

1. Two cases of unilateral hydrocephalus from obstruction to the foramen of Monro have been presented.
2. Each patient had been successfully treated for a brain abscess by a radical removal of the abscess. In one patient the ventricle adjacent to the abscess was involved in the inflammatory process and in both patients the ventricle was opened at operation.
3. The relationship of the injection of concentrated solutions of antibiotics into the ventricles and the subsequent closure by scar tissue of the foramen of Monro has been discussed.
4. Attention is called to unilateral hydrocephalus as a cause of progressively deepening stupor with hemiparesis.
5. The relief of increased intracranial pressure by an artificial opening made surgically through the septum pellucidum was dramatic.

REFERENCES