ENCEPHALOGRAPHY IN SURGICAL LESIONS OF THE BRAIN: REPORT OF FIFTY CONSECUTIVE CASES

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A carefully elicited history and a painstaking clinical examination of the patient will ever remain the most important means of diagnosing a surgical brain lesion. However, when these methods of study have yielded all the information possible, there still remains a considerable number of cases in which a cerebral pneumogram is necessary as an aid in the localization or identification of the lesion. Whether the spinal or the ventricular pneumogram is to be preferred is largely a matter of individual opinion. On the neurosurgical service of the Cleveland Clinic Hospital our confidence in the spinal method has been mounting steadily, so that the ventricular route is now only occasionally resorted to.

When encephalography began to come into more general use in America, many neurological surgeons felt that its field of applicability would be limited largely to non-surgical lesions. The reason for this feeling was the belief that a spinal air insufflation is a dangerous procedure in the presence of the high intracranial pressure which characterizes most surgical brain lesions. This feeling is still rather prevalent, but our experience in the 50 cases herein described would seem to indicate that such an opinion is not justified.

Of these 50 cases, choking of the optic discs was present in 33, and in several cases the intracranial pressure was extremely high. The only untoward result from the spinal air insufflation in this series was a respiratory embarrassment in one case of obstructive hydrocephalus, which was promptly relieved by introducing a cannula into the lateral ventricle.

At the outset, a word of warning is necessary as to the management of cases with increased intracranial pressure in which an encephalogram is contemplated. Most authorities on ventriculography agree that a craniotomy should follow this procedure as soon as the films are available. This same rule holds true for encephalography. If there is choking of the optic discs, encephalography should not be performed until all preparations have been made for an immediate craniotomy. There is no doubt that

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in cases of brain tumor the patient’s chances are distinctly lessened if operation is delayed for a longer period than is necessary to read the wet films. The reason for this is that after the cerebrospinal fluid has once been removed, it reaccumulates more rapidly. Therefore, if the fluid pressure was high before the procedure, it may reach a dangerous level a few hours later unless the lesion is removed or a decompression is provided.

In the rapidly accumulating literature on the subject one may find many variations in the technic of spinal air insufflation. In our experience the most satisfactory films in cases of surgical brain lesions have been obtained by the following method.

After the administration of a hypodermic injection of codeine and scopolamine, the patient is given 100 mg. of avertin per kilo of body weight, by rectum. Fifteen minutes later he is placed in the encephalogram chair, which is mounted on wheels. A lumbar puncture needle is introduced, to which are connected two two-way stopcocks and a 10 c.c. syringe placed end to end. To the side arm of one stopcock is attached a spinal manometer; the side arm of the other stopcock is used for the ejection of fluid and the aspiration of air. A preliminary spinal pressure reading is taken, after which 10 c.c. of air is introduced into the spinal canal before any fluid is withdrawn. The fluid is then removed in 5 c.c. amounts and air substituted in similar amounts until no more fluid can be obtained. A careful check on the spinal pressure is maintained during the procedure, and it is never allowed to fall below the preliminary reading with the patient in the horizontal position. The patient is then taken in the chair to the x-ray department, where films are made with an upright Bucky diaphragm, the tube at 40 inches. If it seems indicated, additional lateral films are also made with the patient in the horizontal position, in order to demonstrate the descending horns of the lateral ventricles. When the patient is in the upright position, the descending horns are dependent and therefore contain fluid. The films are developed and read at once. If choking of the optic discs is present, a craniotomy is performed with the patient under the same anesthetic.

In this series of 50 cases of surgical brain lesions, 14 cerebral hemispheric tumors and 5 cerebellar tumors were verified by histologic examination. In 5 additional cases of cerebral hemispheric tumor, the diagnosis was not verified histologically. In these cases the postoperative diagnosis was subcortical glioma in four instances and gumma in the fifth. In all remaining cases the diagnoses were verified and were as follows: 6 brain abscesses, 4 suprasellar tumors, 4 cases of active external hydrocephalus, 3 of subdural hematoma, 2 subdural effusions, and one case each of pituitary adenoma, stricture of the aqueduct of Sylvius, extradural
hemorrhage, subcortical hemorrhagic cyst, cerebellar arachnitis, diffuse subarachnoid nevus, and aneurysm of the basilar artery.

Of the 14 cases of cerebral hemispheric tumors in which the preoperative diagnosis was verified, a ventricular filling defect indicated the exact location of the tumor in 5 instances. In 6 additional cases the films were of lateralizing value, in that there was a definite displacement of the midline of the brain away from the tumor side, but the exact location of the lesion was not indicated. In 2 cases the ventricular system was normal in size, shape, and position, but the tumor side was indicated by a unilateral absence of subarachnoid cortical air. In one case no air passed beyond the level of the fourth ventricle and the films therefore were considered to be of no diagnostic value.

Of the 5 cerebral hemispheric tumors in which the diagnosis was not verified histologically, the encephalogram films indicated unquestionably a frontal lobe expanding lesion in 3 instances, while in 2 cases the films were of no diagnostic value.

Among 5 cases of cerebellar tumor the ventricles failed to fill in 3 instances, the films showing a herniation of the cerebellum through the foramen magnum, which obliterated the cisterna magna. Subsequent ventriculograms in these 3 cases demonstrated an obstructive hydrocephalus. In one case of cerebello-pontine angle tumor, the lateral and third ventricles were shown to be dilated and the fourth compressed. In another case of a very small acoustic nerve tumor the encephalogram films were entirely negative.

Of 5 cases of cerebral abscess the lesion was localized in 3. In the fourth case the ventricles failed to empty, but the displacement of midline subarachnoid air indicated the presence and the side of the lesion. In the fifth case no air passed above the fourth ventricle, so that the films were of no diagnostic value. In one case of cerebellar abscess no air entered the ventricular system.

In 4 cases of suprasellar tumor the encephalogram findings were as follows. The cisterna chiasmatis was obliterated in each instance. In one case of craniopharyngeoma with choking of the optic discs the fourth ventricle was normal and the aqueduct of Sylvius was displaced backward and upward. The third ventricle was obliterated and only a small amount of air was present in each lateral ventricle, both of which were obviously dilated. No subarachnoid air was present. In a second case of craniopharyngeoma, without choking of the optic discs, subarachnoid air was present over both cerebral hemispheres and the ventricular system was well visualized. The lateral ventricles were dilated without displacement, and there was a very large filling defect in the lower portion of the third ventricle. In the case of suprasellar
arachnoid cyst with choking of the optic discs, the films showed no air over the cerebral hemispheres. There was a small amount of air in each lateral ventricle, both of which were dilated. The anterior half of the third ventricle was obliterated. In the case of suprasellar endothelioma without choking of the optic discs, subarachnoid air was present over both cerebral hemispheres. The ventricular system was normal except for a slight filling defect in the inferior portion of each anterior horn.

**Figs. 1 and 2. Preoperative Films in a Case of Large Left-Sided Subdural Hematoma, Showing the Characteristic Dislocation of the Ventrices**

**Figs. 3 and 4. Postoperative Films of the Case Shown in Figs. 1 and 2, Showing the Restoration of the Ventricles to Their Normal Position and the Subsequent Development of a Communicating Hydrocephalus Due to Pia-Arachnoid Adhesions**
In 4 cases diagnosed as active external hydrocephalus, the ventricular system was normal in each instance, but there was a tremendous dilatation of the subarachnoid spaces over the cerebral hemispheres. The activity of the process in these cases was manifested by a pronounced choking of the optic discs, and the diagnosis of external hydrocephalus was made on the basis of the encephalogram findings. The total volume of cerebrospinal fluid recovered in each instance was greatly increased.

Fig. 5. Encephalogram in a Case of Cerebral Abscess in Which the Ventricles Failed to Empty

This film, however, demonstrates the presence of an expanding lesion in the left hemisphere, as shown by the obliteration of the sulci on the left side, with a dislocation of the supracallosal air to the right.

In 3 cases of subdural hematoma the lesion was correctly localized in each instance by the characteristic compression and dislocation of the lateral ventriciles.

In 2 cases of subdural effusion with advanced choking of the optic discs, the films excluded the possibility of a localized space-filling lesion. The diagnosis in these cases was made at operation by the recovery of a large amount of yellow fluid from the subdural space, whereas the fluid recovered from the spinal canal was colorless.

In the remaining isolated cases of pituitary adenoma, stricture of the aqueduct of Sylvius, extradural hemorrhage, subcortical hemorrhagic cyst, cerebellar arachnitis, and diffuse subarachnoid

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nevus, the films were of localizing value in each instance. In the case of an aneurysm of the basilar artery the encephalogram findings were negative.

The proper interpretation of encephalogram films is beset with difficulties. In many instances the films themselves give little information until the findings are correlated with the history and physical examination of the patient. For this reason the encephalogram diagnosis should be arrived at by a consultation between the roentgenologist and the neurological surgeon, each acting as a check on the other. Even though the ventricles are not visualized, the films may be of diagnostic value. In three cases of cerebral tumor and in one case of cerebral abscess in which the ventricles failed to empty, a space-filling lesion was demonstrated by a lateral displacement of the midline air above the corpus callosum. In three cases of cerebellar tumor in which no air entered the cranial cavity, the location of the lesion was indicated by a foraminal hernia which obliterated the shadow of the cisterna magna.

In conclusion, let it be remembered that in surgery of the brain, laboratory studies must always be merely aids in diagnosis. Too great emphasis upon their value is apt to result in neglect of the clinical study of the patient. When indicated, however, such studies should be used without stint. Encephalography, by its ease of applicability, has saved many a patient an unnecessary cranial operation. By the same token it has led to more than one brilliant surgical result in cases in which, on the basis of clinical findings alone, surgery would have been contraindicated.

DISCUSSION

DR. A. W. ADSON (Rochester, Minn.): Dr. Gardner has been rather bold in advocating encephalography for patients with increased intracranial pressure, but he has also been cautious about being prepared for a craniotomy when he is employing encephalography in these cases. Generally, it is considered wise to carry out encephalography only when there is no evidence of intracranial pressure, performing ventriculography in the presence of increased pressure.

Ventricular estimation has proved to be a useful procedure when there is doubt as to the localization of the tumor. A preoperative ventricular estimation will often give the data desired without the radiographic films and permit one to proceed with the craniotomy. For instance, if there is doubt as to whether one is dealing with a frontal lobe or cerebellar tumor, a bilateral ventricular aspiration will tell whether one is dealing with a communicating hydrocephalus. If so, a frontal lobe tumor is eliminated from the diagnosis.

Lipiodol studies are valuable in localizing a small tumor which may be responsible for root pain but which is too small to produce signs of compression on the cord. It has also offered assistance in diagnosing intramedullary tumors and chronic meningitis.

We employ the heavy radiopaque oil by lumbar introduction, rather than the lighter oils, since the latter may enter the ventricles and give rise to an ependymitis.