ENCEPHALOGRAPHY IN DIAGNOSIS OF POSTERIOR-FOSSA TUMOURS*

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n recent years encephalography has become accepted as the procedure of choice in the investigation of cerebral tumours. With the use of fractional techniques it has become a safer and more informative procedure than ventriculography and it allows us to distinguish between intracerebral and extracerebral tumours.

One of the main difficulties in the diagnosis of posterior-fossa tumours is the frequent failure to obtain ventricular filling. The subarachnoid cisterns therefore assume an almost greater importance than the ventricular system itself. The present study of 13 confirmed posterior-fossa tumours was undertaken to explore the diagnostic possibilities of the so-called "failed encephalogram." In these cases the diagnosis was indicated by one or more of the following features which will be discussed on an anatomical basis.

(1) Hydrocephalus
(2) Herniation of the cerebellar tonsils
(3) Flattening of the pontine cistern
(4) Displacement of the quadrigeminal plate

Additional findings may consist of:
(5) Outlining the tumour itself
(6) Displacement or dilatation of the vallecula

The technique of fractional encephalography has been described fully by Robertson and Lindgren and it is necessary to mention only one or two points. A successful examination, without risk to the patient, demands the closest co-operation between the surgeon and the radiologist. The procedure is therefore undertaken only as a prelude to possible craniotomy. Papilloedema is not considered a contraindication to encephalography and it was fully established in 4 of the cases whilst 1 patient showed early papilloedema. There were no complications attributable to the procedure but facilities for an emergency twist-drill burr hole should be available; others feel reassured if parietal burr holes are made prior to the examination.

In order to maintain the intracranial pressure no cerebrospinal fluid is removed until the end of the examination and then only a small amount for laboratory studies. We use only small amounts of air, 7 cc. at a time, and these are instilled extremely slowly (viz. at the rate of 1 cc. per min.) to a maximum of about 35 cc. Each step is followed with lateral and postero-anterior films taken in the sitting position until it is judged that sufficient air is present in the ventricles and the subarachnoid spaces.

In the event of failure to obtain ventricular filling and evidence of tonsillar herniation, we do not always abandon the procedure but sometimes persist in trying to obtain ventricular filling. Even if these attempts fail, air will pass into the subarachnoid cisterns which often contribute sufficient information for a positive diagnosis. At the end of the examination it is our practice to take the normal brow-up and brow-down films as the presence of a supratentorial lesion may be disclosed. This was possible in 1 case in which there were metastases in the right frontal region and the right cerebellar hemisphere. The diagnosis was made because the filling films showed the vallecula to be displaced to the left and the pontine cistern to be flat-
Dilatation of the pontine cistern, however, may be seen in cortical atrophy. It was noted in 13 out of 100 cases but failure to obtain ventricular filling in this condition is most unusual. Studies at autopsy show that, whilst there may be considerable cortical atrophy, dilatation of the pericallosal cistern is not a striking feature. The real value of the observation lies in raising our index of suspicion to the presence of a tumour and in not dismissing the appearances as being caused by cerebral atrophy.

The ambient cistern is a two-fold cistern:

Fig. 1. "Failed encephalogram" in case of posterior fossa meningioma. The inferior margin of the herniated cerebellar tonsils is indicated (arrow). The pontine cistern is flattened. The callosal sulcus is stretched indicating hydrocephalus; it is also dilated.

Fig. 2. Dilated pericallosal cistern in case of 4th ventricle tumour. Note also diastasis of suture.

Fig. 3. Stretched and dilated callosal sulcus indicating hydrocephalus.
the ambient cistern proper which extends in
a fan-wise manner around the brain stem
(Fig. 5) and the ambient wings which lie
depth to the fornix. The ambient wings enfold
the thalamus from the foramen of Monro in
front, cap the pulvinar and then extend
forwards medial to the temporal horn, finally
to end against the uncus. They are separated
from the choroid plexus of the temporal horn
only by a thin layer of pia and ependyma
(Fig. 6). Each wing communicates with its
fellow above the roof of the 3rd ventricle and
below the hippocampal commissure, this
component being known as the velum inter-
positum.

At encephalography the ambient wings
are seen as semilunar shadows which cross
the middle or just in front of the quadri-
geminal plates (Fig. 7). They are seldom seen
in the postero-anterior projection but when

Fig. 4. Dilated callosal sulcus outlining pericallosal
arteries. Air in Sylvian fissure, rounded laterally, also
indicates hydrocephalus.

Fig. 6. Coronal section of brain in region of trigone
shown from behind. On the right, the pulvinar and
quadrigeminal plates have been exposed, also the
cavity of the 3rd ventricle. The pineal gland is shown
on the left. The ambient wing extends from the fora-
men of Monro in front, backwards, outwards and down-
wards around the pulvinar of the thalamus. Its rela-
tionship to the temporal horn is shown.
so seen curve outwards and forwards around the thalamus (Fig. 8).

FIG. 7. Encephalogram, lateral view, shows a semi-lunar air shadow crossing just in front of quadrigeminal plates. These are the ambient wings outlining the pulvinar of the thalamus. Air also is present in the 4th ventricle, aqueduct, 3rd and lateral ventricles.

Developmentally the ambient-wing cistern is formed when the cerebral vesicles double back above the 3rd ventricle to enclose a double fold of primitive pia mater. This space is obliterated later by pressure of the fornix but remains distensible under certain conditions. Thus, in the same way as dilatation of the pericallosal cistern has been observed in cases of posterior-fossa tumour, so has dilatation of the ambient wings. It was noted in 6 of the 15 cases and in 4 of a further 6 (Fig. 9).

The cavity of the velum interpositum often is seen at autopsy and Robertson stated that it is found in all age groups. He ascribes no particular significance to the finding whilst we feel that when found distended in a "failed encephalogram" it should alert us to the possible presence of a tumour.

FIG. 8. Ventriculogram (left) and encephalogram (right) in case of 4th ventricle tumours. Note filling defect in the 4th ventricle. The ambient wing is dilated (arrow) and also the callosal sulcus (arrow).
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It is likely that in some cases dilatation may result from interference with the normal cerebrospinal fluid circulation whilst at other times it is the result of distortion or displacement.

The aqueduct of Sylvius is our most sensitive indicator of a posterior-fossa expanding lesion. In approximately one-third of cases it describes a gentle curve from the 3rd to the 4th ventricle but in fully two-thirds there is a kink between the superior and inferior colliculi.\(^7\) As a result of this intimate relationship when there is failure to demonstrate the aqueduct, we may orientate ourselves by means of the quadrigeminal plates and the quadrigeminal-plate cistern. On the other hand, if both the aqueduct and the quadrigeminal plates are demonstrated we are in a position to diagnose a quadrigeminal-plate tumour, for in this condition, the distance between the quadrigeminal plates and the aqueduct is increased (Fig. 10).

The displacement of the quadrigeminal plates varies according to the site of the
lesion. Mid-brain tumours will displace them backward, often eccentrically (Fig. 11). Tumours of the upper vermis exaggerate the normal kink (Fig. 12) whilst tumours of the tentorial edge, by angulating the aqueduct at its junction with the 3rd ventricle, displace both quadrigeminal plates forward. The 1 tentorial meningioma in the series behaved as a cerebellar tumour as it arose from the inferior and posterior aspect of the tentorium and had compressed the right cerebellar hemisphere. Tumours of the lower vermis and 4th ventricle may cause dilatation of the 4th ventricle and aqueduct, displacing the quadrigeminal plates upward; a dorsal outbulging of the anterior medullary velum may then be seen (Fig. 13).

Fig. 11. (A) "Failed encephalogram" in case of metastasis in right mid-brain. The quadrigeminal plates are displaced backward (arrow); the ambient wings crossing them are dilated. The pontine cistern is flattened, the cerebellar tonsils are herniated and the callosal sulcus is stretched. (B) Frontal projection shows eccentrically displaced quadrigeminal plate (arrow) and ambient cistern. Compare with Fig. 5.

Fig. 11C. Myodil ventriculogram confirming backward displacement of aqueduct. See Fig. 11, A and B.

Fig. 12. "Failed encephalogram." Pontine cistern is flattened. Inferior colliculus is displaced forward (arrow). Case of cerebellar tumour.
The pontine cistern communicates above with the crural cistern and laterally with the cerebellopontine-angle cisterns. It is limited in front by the clivus and behind by the convexity of the pons. Normally it measures about 0.5 mm. and "flattening" of this cistern will indicate the presence of a posterior fossa expanding lesion. Its size, however, should be assessed in the supine position for it becomes smaller in the erect particularly when the head is flexed. Flattening or obliteration of the pontine cistern was seen in all the cases except those of acoustic neuromas.

Pontine, pre-pontine and angle tumours may produce identical deformities in the ventricular system in that the aqueduct and 4th ventricle are displaced backward and the floor of the 3rd ventricle is elevated. Pontine and pre-pontine lesions are distinguished by the filling or lack of filling of the pontine cistern.

Tumours of the cerebellopontine angle may be bilateral, may cause no bony erosion and may exert no influence on the ventricular system. They may mimic a 4th ventricle tumour (Fig. 14), or they may rotate the 4th ventricle. They are diagnosed best by outlin-
ing them with air and in all 3 cases were so demonstrated (Fig. 15). In a 4th case (not included in the series) there was only minimal lateral displacement of the 4th ventricle but the acoustic neuroma was outlined clearly with air.

The vallecula is the gateway to the 4th ventricle; it extends upwards and forwards from the cisterna magna between the cerebellar tonsils to the foramen of Magendie. Prolapse of the cerebellar tonsils usually prevents filling of the 4th ventricle and in 6 of the 15 cases they were outlined in the upper cervical canal.

Displacement of the vallecula may occur with both cerebellar and cerebellopontine-angle tumours and the latter are distinguished by the finding of a normal pontine cistern. Displacement of the vallecula was seen in 2 of the 4 cases of cerebellar tumour and in 1 further case (not part of the series) thought to be of an angle tumour.

Fourth ventricle tumours are most resistant to diagnosis by encephalography but a dilated vallecula may make one suspect their presence. This was noted in 2 out of the 5—the tumour had grown back between the cerebellar tonsils and the inferior edge of it was outlined in the upper cervical canal. One case remained entirely unrecognised, being mistaken for hypoplasia at encephalography and for aqueduct stenosis at ventriculography.

CONCLUSION

In the investigation of tumour suspects we seldom can forecast with confidence which examination will provide us with all the information necessary. Often we need to employ all methods available to us and these should be regarded as complementary rather than competitive. The “failed encephalogram” is a valuable link in the chain of evidence, for in many instances the sub-arachnoid cisterns furnish sufficient information for an anatomical diagnosis.

SUMMARY

The encephalograms in 15 cases of confirmed posterior-fossa tumours have been reviewed. In these there had been a failure to obtain ventricular filling and the diagnosis rested on one or more of the following features which are discussed in turn: (1) Hydrocephalus; (2) herniation of the cerebellar tonsils; (3) flattening of the pontine cistern; (4) displacement of the quadrigeminal plate; (5) outlining the tumour itself; and (6) displacement or dilatation of the vallecula.

It is concluded that consideration of these points in a “failed encephalogram” will lead to a positive diagnosis in many of the cases.

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REFERENCES