Localization of Intracranial Tumours

Nearly a century ago Sir William Macewen (1848–1924), the father of brain surgery, described the brain as “the dark continent.” By this he meant there were seldom unequivocal signs or symptoms pointing accurately to the position of an intracranial mass. The brain surgeon cannot delve with his hand deeply into the brain, as the abdominal surgeon may into the abdomen, so that the dark continent remained dark after Macewen’s time. But new methods of obtaining radiological contrast in the brain and of scanning it by means of radioactive isotopes have allowed much more precise information to be obtained. Nowadays it is usually possible to predict fairly accurately both the position of an intracranial mass and its pathological nature.

X rays were discovered in 1895, and as early as 1912 A. Schüller wrote a book on the radiology of the skull, showing how valuable information could be obtained by accurate interpretation. W. E. Dandy introduced ventriculography and air encephalography in 1917, E. Moniz introduced angiography in 1927, and G. E. Moore introduced encephalography in 1948. Meanwhile H. Berger had introduced the electroencephalograph, and L. Leksell applied ultrasonics to the brain in 1955. But it is only in the last few years that all these methods have been clearly correlated. The diagnostic use of air in the brain and cerebral arteriography both carry a slight morbidity and even mortality. The modern trend, therefore, is to try to obtain the maximum information by other and harmless procedures. This course also has an economic advantage in saving the occupation of hospital beds. Concurrently with the discovery of these new techniques over the years clinical neurologists, psychiatrists, clinical psychologists, neuro-ophthalmologists, and neuro-otologists have made advances which enable them to point more firmly towards the diagnosis before ancillary aids have to be called in.

When an intracranial mass is suspected the skull is x-rayed. Four radiographs in appropriate projections are usually a sufficient survey, but if a lesion in the region of the optic or acoustic nerves is suspected it is necessary to take special projections in addition. In adults the chest is x-rayed as a routine. This is essential if the patient is middle-aged or over, because bronchial carcinoma, a frequent source of metastases in the brain, is now such a common disease. An E.E.G. and ultrasound examination can readily be performed at the same time. Having obtained the results of these examinations, the neurologist can then review the situation and decide what further investigations, if any, are necessary.

Before considering the more elaborate methods of radiological investigation it is important to be clear about the types of intracranial mass which might be found and their incidence. Firstly, it is not always possible to differentiate clinically between neoplasms, vascular lesions, and inflammatory masses. About one-half of all intracranial tumours belong to the glioma family; these infiltrate the brain in a haphazard fashion and usually have no discrete edge. About four out of five of them are...
malignant. The majority of the remaining intracranial tumours are extracerebral—that is, with the important exception of metastases they press on rather than invade the brain. Meningiomas and pituitary tumours each account for about 15%, acoustic neuromas for about 8%. Intracerebral metastases were found to be relatively rare until recent times, accounting for rather less than 5% in most large series reported from neurosurgical clinics. However, nowadays the figure approaches 10% and may be more. Other types of tumour, though important, are relatively rare. Among the most likely non-neoplastic conditions are abscess, subdural haematoma, and intracerebral haematoma.

The pattern of investigation will vary much from patient to patient, depending partly on the provisional clinical diagnosis and partly on the patient's state of health. The latter can vary from almost normal health to intense coma associated with severe papilloedema. Before the invention of isotope scanning it was nearly always necessary to admit any case of suspected brain tumour to hospital for investigation. Nowadays this is not always essential, and the economic and social advantages of outpatient investigation are obvious. A good example is the case of a middle-aged or elderly person, usually male, who develops perhaps slight symptoms and signs of an intracerebral mass. Plain radiographs of the skull may be negative, and even if a mass is present in one hemisphere the pineal gland (if it is calcified) is not always deviated sufficiently to enable the radiologist to confirm it. However, the ultrasound examination will usually be positive in such cases and so may be the E.E.G. The chest will be x-rayed as a routine, for bronchial carcinoma is far and away the commonest primary site of a secondary in the brain. The next step is to scan the brain after injection of a radioactive isotope. This merely entails a small intravenous injection and is readily carried out on outpatients. If the chest x-ray is abnormal, and the scan shows more than one intracranial mass, the diagnosis is virtually certain. As many as six or seven metastases have been shown on brain scans, but the limiting factor is the size of the metastases, those less than 2 cm. in diameter not being demonstrable. Meningiomas nearly always give a positive scan, and a high percentage show characteristic changes on a plain radiograph. If these changes can be related to the size, shape, and position of the mass shown on the scan the diagnosis is sometimes sufficiently certain for a surgeon to explore. Scanning is usually positive with malignant gliomas and the larger acoustic tumours, and with subdural and intracerebral haematomas, but seldom with the pituitary group of tumours.

The large majority of patients suspected of having an intracranial tumour require admission to hospital. They are ill, and, besides needing expert nursing attention, many have to be examined by cerebral angiograms and air studies entailing the injection of air (pneumography) at lumbar puncture (lumbar encephalography) or by ventriculography. One or more of these investigations is frequently necessary even if the scan examination is positive, for the scan seldom provides all the necessary information on the site and nature of the tumour.

In the last few years most European and American neurosurgeons have tended to recommend carotid arteriography before pneumography. Arteriography has the advantage of not upsetting the intracranial hydrodynamics, which is inevitable when air is introduced by whatever route. Thus the patient is generally less upset after an angiogram. On the other hand, an angiogram is more limited in the information it gives. Thus one internal or common carotid arteriogram may give useful information about one cerebral hemisphere but usually little or nothing about the opposite hemisphere or the mid-brain or posterior fossa structures. Pneumography, on the other hand, outlines the whole ventricular system, and if the air is introduced by lumbar puncture the cisterns and sulci of the brain are also outlined. If there is a strong suspicion on clinical examination, ultrasonic testing, the E.E.G., plain radiography, and scanning that a lesion is restricted to one hemisphere then carotid angiography on that side is indicated as the first contrast investigation. This may show the position of the lesion by the deformity produced on the arteries and veins, and sometimes, in addition, characteristic pathological blood vessels may be outlined, rather for example, in meningioma and malignant glioma. Sometimes, however, arteriography does not give all the information required. Pneumography is then needed to provide further information. If the patient shows signs and symptoms of grossly raised intracranial pressure it is usually considered safer to undertake a ventriculogram, but if these signs are absent more information can be obtained by undertaking a lumbar encephalogram. The position of the tumour can be analysed by noting the deformity of the ventricular system or the subarachnoid pathways.

Sometimes it is impossible to determine clinically or by the preliminary radiological and other investigations whether the suspected mass is supratentorial or infratentorial, and so there is no pointer to which arterial tree should be outlined. In these cases an encephalogram should be undertaken before an arteriogram. Then again, if the lesion is thought to be lying in the mid-brain or posterior fossa, experience shows that pneumography is more reliable in delineating the lesion than either carotid or vertebral arteriography.

There is yet another useful radiological investigation which has a small place in the diagnosis of tumours, and that is positive contrast ventriculography. It is valuable in outlining masses in the mid-brain or posterior fossa. Patients with such lesions usually suffer from moderate or considerable hydrocephalus, and an air ventriculogram can severely upset the intracranial hydrodynamics. With positive contrast ventriculography only 2–3 ml. of contrast substance needs to be used; it is then manipulated into the appropriate part of the ventricular system under television control. By this means there is no serious upset of intracranial hydrodynamics. In addition, a positive contrast substance has the advantage in sometimes delineating the lesion far more sharply than a small air shadow might.

Since such remarkably refined methods of radiological investigation are now available, it might be thought that no tumour or mass will remain undetected. Unfortunately this is not the case. Very small tumours, such as meningiomas pressing on the optic nerve, can evoke serious signs and symptoms, yet by virtue of their small size may not be detectable by any radiological method. Again, large infiltrating gliomas may fail (sometimes for years) to distort the ventricular or arterial anatomy and may also fail to take up an isotope. Thus in the last resort the astute neurologist or neurosurgeon must make the final decision, sometimes defying the results of all the negative investigations.