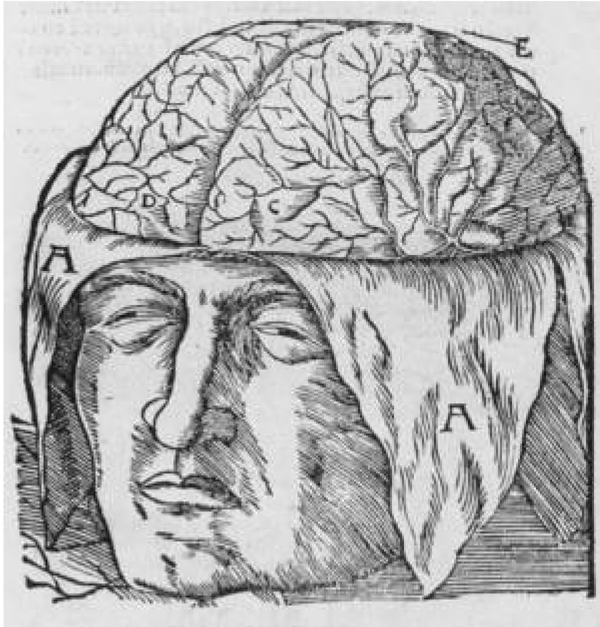
Localization



History

In the early days of neurosurgery the neurosurgeon was purely an operator acting under the guidance of the neurologist, who took the responsibility for the localization of the lesion and for the extent of the operative procedure.

The neurologist was at first almost entirely dependent on the history and the clinical findings in making his diagnosis and localization.

Valuable help came from the roentgen ray, and stereoscopic films of the skull X-rays.

Calcification in tumors was demonstrated quite frequently, and it was no longer difficult to determine whether the sella turcica shows pathological changes; the proliferation of the skull over a dural tumor may he an ingrowth of new bone, impossible to detect except with the roentgen ray; and localized erosions of the skull are frequently significant.

The most important advance came with the introduction of ventriculography or pneumoencephalography, by Walter Edward Dandy of Baltimore in 1918.

All tumors of the brain which give symptoms of pressure produce distortion or change in the size, shape or position of the ventricles. Dandy says that ten years ago less than 50 per cent of tumors of the brain could be exposed at operation; that now exposure is possible in 65 per cent because of better roentgen rays, better surgery and increased experience; and that all the remaining 35 per cent can be localized by the cerebral pneumogram. Have others been able to confirm this statement ? Grant [1)] has collected 392 cases from the records of several neurosurgeons. The method was of value in 311 cases, but in 218 it confirmed a neurological diagnosis, or was unverified, or ruled out a suspected tumor. Ninety three tumors were localized and exposed at operation solely through the aid of the pneumogram. There were errors of technique in 10 per cent of the cases, and the mortality was 8 per cent. But the mortality of unlocalized tumors is 100 per cent, and of the ninety three tumors which could not have been localized otherwise, forty four were removed at operation. Grant's figures substantiate Dandy's claims, if we allow for inexperience with a new method. It is fair to conclude that, in the hands of those competent to do a cerebral pneumogram and to interpret the findings, it will reduce almost to the vanishing point the number of tumors of the brain which cannot be localized and exposed at operation [2].

Subsequent advances in preoperative radiological localization included computed tomography (CT; 1971) and MRI (1977). Since then, other imaging modalities have been developed for clinical application although none as pivotal as CT and MRI. Intraoperative technological advances include the microscope, which has allowed precise surgery under magnification and improved lighting, and the endoscope, which has improved the treatment of hydrocephalus and allowed biopsy and complete resection of intraventricular, pituitary and pineal region tumors through a minimally invasive approach. Neuronavigation, intraoperative MRI, CT and ultrasound have increased the ability of the neurosurgeon to perform safe and maximal tumor resection. This may be facilitated by the use of fluorescing agents, which help define the tumor margin, and intraoperative neurophysiological monitoring, which helps identify and protect eloquent brain [3].

Modern neurosurgery

The basic principle of modern neurosurgery is precise lesion localization that results in a minimally invasive approach [4] [5] [6] [7].

To achieve this goal, various methods have been developed to define the correct position of the craniotomy and are considered standard in today's neurosurgical armamentarium [8] [9] [10] [11] [12] [13].

In this sense, the use of surgical navigation systems is becoming an increasingly important part of planning and performing intracranial surgery [14] [15] [16].

The aim of a study of Dho et al. from the Seoul National University Hospital, was to analyze the positional effect of MRI on the accuracy of neuronavigational localization for posterior fossa lesions when the operation is performed with the patient in the prone position.

Ten patients with posterior fossa tumors requiring surgery in the prone position were prospectively enrolled in the study. All patients underwent preoperative navigational MRI in both the supine and prone positions in a single session. Using simultaneous intraoperative registration of the supine and prone navigational MR images, the authors investigated the images' accuracy, spatial deformity, and source of errors for PF lesions. Accuracy was determined in terms of differences in the ability of the supine and prone MR images to localize 64 test points in the PF by using a neuronavigation system. Spatial deformities were analyzed and visualized by in-house-developed software with a 3D reconstruction function and spatial calculation of the MRI data. To identify the source of differences, the authors investigated the accuracy of fiducial point localization in the supine and prone MR images after taking the surface anatomy and age factors into consideration.

Neuronavigational localization performed using prone MRI was more accurate for PF lesions than routine supine MRI prior to prone position surgery. Prone MRI more accurately localized 93.8% of the tested PF areas than supine MRI. The spatial deformities in the neuronavigation system calculated using the supine MRI tended to move in the posterior-superior direction from the actual anatomical landmarks. The average distance of the spatial differences between the prone and supine MR images was 6.3 mm. The spatial difference had a tendency to increase close to the midline. An older age (> 60 years) and fiducial markers adjacent to the cervical muscles were considered to contribute significantly to the source of differences in the positional effect of neuronavigation ($p < 0.001$ and $p = 0.01$, respectively).

This study demonstrated the superior accuracy of neuronavigational localization with prone-position MRI during prone-position surgery for PF lesions. The authors recommended that the scan position of the neuronavigational MRI be matched with the surgical position for more precise localization [17].

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