THE VISCERAL BRAIN OF MAN*

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Gastro-intestinal, vasomotor, and other visceral disturbances secondary to focal brain lesions are phenomena of obvious importance not only to the neurosurgeon, neurologist and psychiatrist but also to the general surgeon, genito-urinary specialist, pediatrician and obstetrician.

Birth trauma, for example, may produce injuries of the hippocampal gyri leading subsequently to visceral disturbances associated with psychomotor attacks. Paroxysmal abdominal pain and intussusception may be manifestations of epilepsy in children and adults. Laparotomies have occasionally been done for gastro-intestinal symptoms, cystoscopic studies for difficulties in voiding, and electric shock treatments for viscero-emotional disturbances although the initial visceral symptoms in all these cases might have led to an earlier diagnosis of an organic cerebral lesion.

With regard to the frequent association of visceral and emotional disturbances, it is of interest to note that this important phenomenon has long been recognized, as indicated by the Lamentations of Jeremiah (Chapter I) in the old Testament: "... mine eye runneth down with water ... I am in distress: my bowels are troubled ... my sighs are many, and my heart is faint."

The viscera, strictly speaking, include only the soft hollow organs of the body such as the heart, blood vessels, gut, urinary bladder and lacrimal sac. For the purposes of this discussion, however, mention will also be made of respiratory phenomena. Both visceral and respiratory disturbances will therefore be considered with regard to their representation in the cerebral cortex as indicated by focal brain lesions or electrical stimulation. Visceral phenomena secondary to massive intracranial lesions or generalized increased intracranial pressure will not be considered, having no localizing value.

While it has long been known that visceral symptoms such as pallor, salivation and epigastric distress may herald or accompany an epileptic seizure, these symptoms cannot be regarded as having any localizing value unless a focal brain lesion is proved to be their cause. With increasing frequency in recent years, however, it has been shown that specific visceral phenomena of this and other kinds are often caused by focal lesions involving certain parts of the frontal or temporal cortex or the insula (island of Reil). Reasonably accurate localization of cerebral pathology in such cases has

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been made by pneumoencephalography or ventriculography, surface and depth electroencephalography, angiography and intracranial surgery for verification by inspection, electrical studies and biopsy.

In the last analysis, however, methods of localizing function in the human brain are relatively crude, for the precise extent and effects of a brain tumor, scar or cortical ablation upon adjacent brain tissue are difficult to define. Likewise the exact extent of spontaneous or artificially induced abnormalities in electrical activity may be equally difficult to determine. Nonetheless, when brain lesions or electrical excitation of specific parts of the brain result consistently in similar effects, there is ground for accepting a localization of function. This is particularly true of brain tumors that give rise to specific visceral symptomatology long before any other symptoms occur, especially when these visceral disturbances disappear following removal of the lesion.

Electrical stimulation of the brain is unquestionably a more nearly accurate means of localizing function in the sense that it is usually possible to elicit constant and consistent effects from relatively discrete points, whereas no effect or a different effect may be produced by stimulation only 2 mm. away. The fact that electrical stimulation may not yield an expected visceral response on excitation of a given cortical area may be caused by such influences as medication, anesthetic agents, metabolic or pathologic changes, existing background activity of the brain or viscera, or individual anatomical variations.

Despite these factors of inconstancy and uncertainty it is apparent that the effects of various lesions as well as electrical stimulation of the human brain indicate more or less discrete localization of visceral functions in the cerebral cortex.

Before assembling these data in diagrammatic form (Figs. 1–5) a few illustrative case summaries of brain lesions, including cortical ablations, will be presented with emphasis on visceral symptomatology. Observations on the effects of electrical stimulation and recording will then be described.

Additional data reported by others have been included in Figs. 1, 2, 3 and 5. Penfield, et al.,71,73,74 for example, have provided ample evidence that neoplastic or atrophic lesions of anteromedial temporal cortex and the insula may give rise to episodic vasomotor disturbances, such as pallor or tachycardia, and distressing epigastric sensations. Epigastric aura may also be secondary to “frontal intermediate” lesions.75 Others76,85 have confirmed the temporal and insular source of epigastric sensations.

Bucy,14 moreover, has described alteration of the peripheral circulation in the contralateral extremities following premotor cortical ablation, and also mentioned sudomotor changes secondary to lesions in this region. Scoville has reported transitory alterations in pulse rate on isolating the anterior cingulate gyri bilaterally,88,89 and vomiting in several cases after uncotomy.90