SOME OF HARVEY CUSHING'S CONTRIBUTIONS
TO NEUROLOGICAL SURGERY

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To the older group of neurological surgeons in this country and abroad and to many members of the Society which is sponsoring the Journal of Neurosurgery, the name of Harvey Cushing has stood for a large proportion of the advances which have been made in this specialty since the time, some fifty years ago, when Sir Victor Horsley may be said to have established it as a separate branch of surgery. Indeed, a large number of those practicing neurosurgery today had the privilege of seeing Dr. Cushing at work, of hearing many of his addresses to medical societies, or of benefitting immediately by the contributions which he was making continuously to his chosen field. To those who followed his career and to others who have been concerned with the advances in neurological surgery, a recital of his outstanding accomplishments would be as out of place as it would be unnecessary, since they are well known alike to his pupils and to his many admirers. However, during the last decade a large, younger generation of neurosurgeons has arisen, and it is perhaps particularly to them that this communication may be of interest.

It would be impossible in the space of a short review such as this to do more than touch upon what have seemed to be Dr. Cushing's major communications as they have influenced neurosurgery directly. Many of his brilliant experimental and laboratory studies have been omitted or merely mentioned since I have undertaken to confine myself for the most part to his purely technical contributions. At times, however, the laboratory and the clinic overlap so intimately that the story of one would be quite incomplete without the other.

In order to get a background for the life and work of Harvey Cushing, we must for a moment look at the status of this newly launched specialty up to the time when he appeared upon the scene. Not until the era of anesthesia and antisepsis, and particularly not until the beginnings of cerebral localization (circa 1870) had operations upon the brain and spinal cord advanced appreciably since medieval or ancient times. Soon after this, in the middle eighties of the nineteenth century, a very few, and very occasionally successful, operations upon brain tumors, brain abscesses and spinal cord tumors were performed. Finally, during the decade from 1890 to 1900, Victor Horsley by his vigorous pioneering and tireless physiological and pathological investigations, succeeded in getting before the medical profession the fact that much more could be accomplished surgically for certain lesions of the central nervous system than had previously been supposed. However, the technic of brain operations at this time was crude, and was influenced largely by
general surgical methods which we now know cannot be applied to such delicate performances. Even as late as 1906, Horsley\textsuperscript{32} himself made the following statement, "In fact, the advance in technique of the surgical treatment of diseases of the brain and the spinal cord has been relatively less than the improvement in our knowledge of the seat and nature of the diseases for which surgical intervention is useful and necessary." If this was true of Horsley's own work, it was even more so of the leading surgeons in Europe, notably Bergmann, Kocher, Krause, von Eiselsberg, Chipault, Broca and others, all of whom had made signal contributions and had written extensively on the subject of cranial and spinal operations even though their results were certainly not nearly so good as those of Horsley.

In other words, at the turn of the twentieth century it was evident that a large new field of surgery was opening, indeed had been opened, but that in this new field no one had as yet appeared who fully appreciated and was able to develop a surgical technic which was sufficiently delicate and meticulous to make operations, particularly on the brain, produce results at all comparable to the results of operations elsewhere in the body. It was at this juncture that Harvey Cushing in Baltimore began to devote himself almost entirely to the study and practice of neurological surgery at The Johns Hopkins Hospital and in the Hunterian Laboratory of the medical school.

The results of this study and practice began almost immediately to appear. In 1900, Cushing\textsuperscript{3} published the details of a method for the total extirpation of the gasserian ganglion. In essence, it was a refinement of the so-called Hartley-Krause procedure, but because of this refinement a complete removal of the ganglion could be accomplished for the first time with certainty, whereas by the older methods, removal almost always had been either incomplete or uncertain. The operation described in this article is, to all intents and purposes, the same subtemporal approach which is used today for division of the sensory root behind the ganglion. Cushing's illustrations show that not only the ganglion but also the sensory root of the trigeminal nerve was extirpated, but it was not realized until the work of Spiller and Frazier\textsuperscript{34} a year later that it was necessary only to divide the root, thus making removal of the ganglion superfluous.

During the next five years there were several notable contributions. In 1901, Cushing's\textsuperscript{3} announcement of a regulating mechanism in the vasomotor center for the control of blood pressure during cerebral compression was an epoch making event. This study was and is so important for the understanding of clinical states, operative complications, traumatic brain conditions and the like that it must be included here, although this review is primarily from the clinical standpoint. As Cushing himself stated,

The fact that cerebral compression occasions a rise in blood pressure is universally known, but it does not seem to have been recognized that the degree of this elevation occurs parti passu with the degree of compression (measured in millimetres of mercury) to which the medullary centres are subjected.

The article contains beautiful kymographic records showing synchronized