Harvey Cushing's Early Treatment of Meningiomas: The Untold Story

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Key words
- Harvey Cushing
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BACKGROUND: **In his 1938 monograph, Cushing tabulated 313 meningioma cases treated throughout his career at the Johns Hopkins and the Peter Bent Brigham Hospitals. Of these, 18 patients were treated at the Johns Hopkins Hospital. Cushing provided basic demographic, perioperative, and outcomes data in his tables, but the operative details for many of his early meningioma cases have not been previously described.**

METHODS: **After institutional review board approval, and through the courtesy of the Alan Mason Chesney Archives, the surgical files for the Johns Hopkins Hospital from the period 1896 to 1912 were reviewed. Cases diagnosed as endothelioma or dural endothelioma were selected for further analysis.**

RESULTS: **Of the 14 patients with available records, 1 were male. The mean age was 34.4 years. Nine patients (64.3%) died during their inpatient stay. Cushing used staged resections in an attempt to minimize blood loss, morbidity, and mortality, albeit with limited success.**

CONCLUSIONS: **The operative details demonstrate Cushing's early attention to hemostasis, and use of staged resections in patients with large, highly vascular meningiomas. Cushing's first 18 cases of meningiomas, treated while a young attending physician at the Johns Hopkins Hospital, are not the most elegant operations in his lengthy series, but serve as an illustration of his ability to transform clinical challenges into opportunities for improvement.**

INTRODUCTION

During the 19h century, the nomenclature surrounding intracranial tumors, in particular meningiomas, was fraught with confusion; these tumors were referred to by a variety of terms, including tumeurs fongueuses, fungus durae matris, myeloid tumors, acervuloma, and tumeur fibroplastique (6). Virchow offered sarcoma and psammoma as alternate descriptions, whereas Golgi offered endothelioma as a compromise (6). However, the debate continued, with surgeons and pathologists from both sides of the Atlantic contributing potential terminology for these tumors, with the term meningioma being widely accepted, although it was already known that these tumors arose not from the meninges, but from "the cell clusters principally associated with the arachnoidal villi" (6).

Attempts were made to further subdivide these meningiomas, based largely on histopathologic appearance. Percival Bailey offered an elaborate subdivision: mesenchymatous, angioblastic, meningotheliomatous, psammomatous, osteoblatic, fibroblastic, melanoblastic, lipomatous, and generalized sarcomatosis of the meninges (2, 6). Harvey Cushing, in his 1938 monograph, offered a detailed description of meningiomas, dividing his case series into 29 distinct populations based on tumor location and behavior, with reference to histopathologic characteristics.

In this monograph, Cushing tabulated the 313 meningioma cases treated throughout his career at the Johns Hopkins

and the Peter Bent Brigham Hospitals. Of these, 18 patients were treated at the Johns Hopkins Hospital. Cushing provided basic demographic, perioperative, and outcomes data in his tables, and highlighted in detail mainly the meningiomas treated in the latter portion of his career at the Peter Bent Brigham Hospital. A handful of the Johns Hopkins cases were published in detail by Cushing, notably 2 suprasellar lesions, which were detailed in *The Pituitary Body and Its Disorders* (9). These early cases of meningiomas operated on by Cushing illustrate the challenges faced by neurosurgeons at the turn of the 20th century; in the absence of neuroimaging, electrocautery for intraoperative hemostasis, and antibiotics, entry into the intracranial space was fraught with peril. The 14 cases presented here document the intraoperative blood loss, transfusion requirements, and high mortality rates that were the bane of early neurosurgeons. The operative details and original illustrations for many of Cushing's early meningioma cases have not been previously described.

METHODS

After institutional review board approval, and through the courtesy of the Alan Mason Chesney Archives, the surgical files for the Johns Hopkins Hospital from the period 1896 to 1912 were reviewed. Cases diagnosed as endothelioma or dural endothelioma were selected for further analysis. To ensure completeness, patients included in Cushing's 1938 monograph were reviewed, and our database was searched by patient surgical record number. Of 18 patients tabulated in Cushing's publication, the surgical records of 14 were recovered from the archives. To allow easy reference to Cushing's published monograph, we have retained the original case numbers supplied by Cushing (6) in our case reports and tables.

RESULTS

Of the 14 patients with available records, 11 were male (78.6%). The mean age was 34.4 years (range 13 to 53). The mean length of stay was 28.6 days (range 3 to 148). Nine patients (64.3%) died during their inpatient stay; 4 (28.6%) were listed as well at the time of discharge, and 1 (7.1%) was listed as unimproved (Table 1). Two representative cases are described here.

Case 11

On August 22, 1911, a 29-year-old clerk presented with complaints of headache, unilateral loss of vision in the left eye, nausea, vomiting, and 3 "convulsive seizures." His past medical history was unremarkable, except for a note written in the file margins by Cushing: "Two years ago came home with head badly cut up. A small amount of alcohol has a bad effect on him." His symptoms began 8 months before admission, with a headache, especially in the morning, and occasional attacks of nausea. His wife reported that the patient drank large quantities of water and was "apparently always thirsty." The patient's wife described him as having difficulty concentrating, but Dr. Sharpe noted on admission that PL "wife has not seen or been with husband for the past 3 months." The reasons for this were not explained; however, a note regarding frontal symptoms describes "Pt has been getting drunk more frequently during the past three months — about once every 2-3 weeks — at times once a week." Further, the patient had "no definite disorientation, except when intoxicated. Some loss of intellectual activity — always wanting to joke and jest."

Cushing brought him to the operating room on August 29, 1911, for "Extirpation of large inoperable tumor of right frontal lobe." His operative note and accompanying illustration (Figure 1) document the procedure:

> Under tourniquet a large bone flap was turned down, according to diagram [Figure 1], the basal end of the flap being rather narrow. All bleeding from bone seems along edges of dura. It was necessary to wax the surface of the bone and to hold cotton against it during the incision for particularly over the frontal prominence it oozed excessively.
>
> A primary trephine opening showed very much thinned bone and a very tense dura. The opening with the burr made in the anterior lower legs of the incision was cut as usual with monteno vesi [sic] forceps. Trephine opening and perforation were connected with the Gigli saw. Bone flap reflected. Dura exceedingly tense. Meningeal torn. Some bleeding. The greatly thinned bone was rongeured away preparatory to a decompression.
>
> After some hesitation it seemed best to expose the cortex and beginning from below so that a subtemporal decompression by which method the dura was gradually opened. Fortunately some surface fluid was present and the protrusion although extreme was not to a dangerous degree. As the anterior angles of the bony opening were approached a vascular tumor was disclosed. It had a fairly sharp outline with cortical demarcation. It was exceedingly vascular. An area of bone was then rongeured away toward the median line. This bone was thick and exceedingly vascular. The dura was incised into this opening and enucleation of the tumor begun. It was quite clearly outlined. A few clips were placed on the surface vessels. As the enucleation progressed it was quite evident that bleeding was getting to be too severe to justify a slow removal, consequently the operator by digital manipulation enucleated [the tumor].

Notes from the immediate postoperative period read: "6 PM. Pt lost a large amount of blood during operation. At 5 PM endeavor made by Dr. [illegible] to transfuse pt from father, but unsuccessful — patient dying." The patient died almost immediately after the note in the chart. Although an autopsy was performed, no postmortem examination of the brain was recorded.

Case 12

On November 2, 1911, a 13-year-old boy arrived from California for treatment of "convulsions, always beginning in right leg." His past history was remarkable for common childhood illnesses and frequent sick headaches; he had a remote history of cranial trauma from the use of forceps during delivery, but no other history of trauma. The first seizure occurred 5 years before admission. This episode began in his right foot, and spread to include his right leg and arm over approximately 5 minutes. These episodes were treated with a course of

Table 1. Demographics, Operative Details, and Postoperative Outcomes for Patients Operated on by Dr. Harvey Cushing for Intracranial Meningiomas at the Johns Hopkins Hospital, 1896–1912

Case Number	Age	Sex	Operation Date	Operative Description	Outcome at Discharge	Length of Stay	Cause of Death
2	42	M	6/9/1908	Combined exploration and decompression for tumor in left temporal lobe.			
			6/15/1908	Second-stage operation for tumor of left temporal lobe. Partial enucleation of large growth.	Deceased	12	Significant intraoperative blood loss; postoperative respiratory depression
4	49	M	2/5/1909	First-stage operation for exposure of presumed recurrent tumor of right precentral region.			
			2/9/1909	Second-stage operation.	Well	29	Unknown; death immediately following resection of recurrence by Cushing, August 1927
5	27	M	6/11/1910	First-stage operation for removal of bony tumor of skull.			
			6/15/1910	Second-stage operation for frontal osteoma.	Well	16	
			11/8/1910	Removal of large island of bone, etc.	Well	16	"Heart failure" 11 years postoperatively
6	23	F	6/25/1910	First-stage operation for outline of proposed flap.			
			6/30/1910	Second-stage performance. Desperate measures carried too far owing to hemorrhage.	Deceased	10	Intraoperative hemorrhage
7	27	M	10/24/1910	[No description]	Well	16	Living and well as of April 23, 1937
8	33	M	3/28/1911	Attempted bone flap. Abandoned owing to hemorrhage from scalp.			
			4/5/1911	Second-stage operation.			
			4/14/1911	Third-stage operation.			
			4/20/1911	Fourth-stage operation for removal of right cerebral tumor.	Deceased	35	Intraoperative blood loss; postoperative respiratory depression
10	41	M	8/16/1911	Exploratory craniotomy with decompression.	Deceased	13	Unknown
11	29	M	8/29/1911	Extirpation of large inoperable tumor of right [illegible].	Deceased	7	Intraoperative blood loss; no response to transfusion from father
12	13	M	11/8/1911	Attempted enucleation of large endothelioma with fatal results.	Deceased	6	Intraoperative "primary cardiac failure"; no response to transfusion from father
13	41	F	12/17/1911	First-stage for removal of right cerebral tumor. Craniotomy.	Deceased	3	Intraoperative blood loss
14	29	M	1/17/1912	Right subtemporal decompression.			
			2/15/1912	Left exploration for tumor. Removal of bone flap.			
			2/28/1912	Second-stage dural exposure of endothelioma.			
			4/6/1912	Enucleation of large endothelioma from left cerebral cortex (weighing 170 g).	Well	148	Living and well as of April 2, 1937
15	53	F	2/28/1912	Sellar decompression. Opening of cerebrospinal space.	Deceased	20	Postoperative meningitis
16	27	M	3/27/1912	Exploratory craniotomy, right, for focal epilepsy.	Unimproved	21	Living and well as of December 31, 1937
18	47	M	8/9/1912	Decompression, right, for unlocalizable tumor.			
			8/10/1912	Partial extirpation of tumor and death.	Deceased	11	Coma following first-stage operation; "almost total exsanguinations" during second-stage operation

For consistency, and ease of reference, the case numbers used here are those assigned by Cushing in his 1938 monograph.
F, female; M, male.

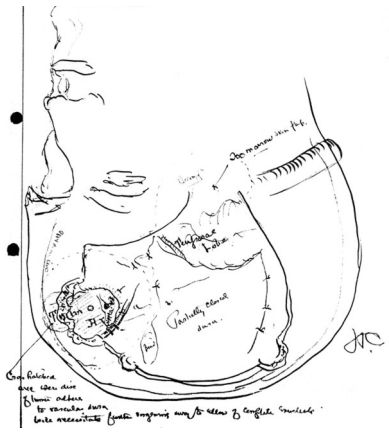

Figure 1. Cushing's original illustration documenting the operative approach for resection of a meningioma in a 29-year-old man, case 11. The labels read (top to bottom, left to right): too narrow skin flap, temporal lobe, tumor, brain, partially closed dura. The lower left label reads: cross-hatched area where disc of tumor adhere to vascular dura which necessitate further rongeuring away to allow of complete enucleat[ion].

potassium iodide, and "the attacks stopped after 1st dose for 2½ years." The seizures resumed 14 months before admission. A neurological examination demonstrated possible slight weakness in right leg, although Cushing noted "pt is left handed!" No other focal signs were documented.

Cushing brought the child to the operating room on November 8, 1911, for an "attempted exploration/enucleation of large endothelioma with fatal results."

> Under tourniquet a bone flap was turned down over the left hemisphere. The bone was somewhat thick in places but showed a single area of thinning particularly in the median line. It was reflected without difficulty and without special bleeding. The dura was tense. It was opened at its posterior margin and a tense brain protruded. With the suspicion that there might be an internal hydrocephalus the needle was introduced toward the neighborhood of the ventricle. No fluid was encountered. The dura was reflected and an incision was made through the pre [as written] postcentral gyrus near its upper end. This disclosed a yellowish cortex which for the moment was thought to be tumor and a fragment of it was removed. However, on removing this fragment the upper end of a nodular, enucleable reddish growth was disclosed. Its surface was covered with a multitude of tortuous blood vessels. The cortex was then further incised and most of the upper surface of the tumor was disclosed by slow dissection, the brain being pushed away from the tumor by pledgets of cotton. A growth, about the size of a tennis ball, was then brought into view and the fingers were introduced around it in the wound, and it was picked out. Profuse hemorrhage followed for the moment. This was controlled by packing, with cotton. The boy's condition was not such as to justify further procedure. For a few moments, however, the bleeding apparently entirely ceased. The wound was left awhile, the head was lowered and some stimulants and infusions were given. It seemed for about a half an hour that he was going to revive and at this juncture a transfusion from his father was given. During the transfusion the boy died, apparently with a primary cardiac failure.

The brain was fixed and sectioned postmortem (**Figure 2**), although a full autopsy was not conducted.

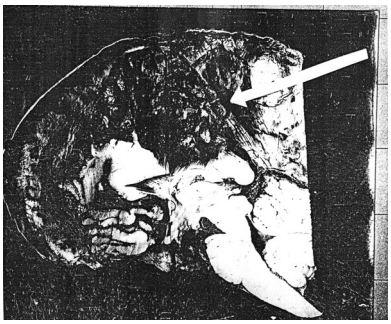

Figure 2. Photograph of brain as seen on autopsy, after attempted resection of a meningioma involving the falx in a 13-year-old boy, case 12. The arrow was included by Cushing, and indicates the location of the tumor.

CONCLUSIONS

It has been said that Cushing's monograph, *Meningiomas, Their Classification, Regional Behaviour, Life History, and Surgical End Results*, is not only a classic neurosurgical text but also a history of Cushing's development as a neurosurgeon (11). The text, begun in 1914 and completed in 1937, after Cushing's retirement from surgical practice, is a true retrospective view of his career. The monograph was the culmination of nearly 3 decades of operative experience, and was preceded by a number of smaller publications detailing specific case series or individual case reports. Indeed, Cushing published extensively on his series of meningioma cases before his monograph (6, 7), including some of the cases performed at the Johns Hopkins Hospital (5, 9), yet the operative details for most of the 18 patients treated during the early stages of his career have remained largely unknown.

It is interesting to note that Cushing's early series of meningiomas was largely male patients, when current literature describes a strong female predominance of these tumors. This discrepancy may be a result of rudimentary histopathology, and the convoluted nomenclature system in use at the time.

These cases illustrate Cushing's attention to hemostasis, using traditional methods of bone wax and cotton pledgets, along with silver clips of his own design (8). In patients with large tumors, or tumors with significant hyperostosis of the overlying bone, Cushing used staged resections in an attempt to minimize blood loss, morbidity, and mortality, albeit with limited success. For these multistage operations, Cushing credited Halsted with the suggestion of a protective dressing made from gutta-percha, a species of tropical tree, to protect the cortex, and allow for re-elevation of the bone flap after a brief interval (9). Cushing recognized that these early techniques for hemostasis were rudimentary at best. During his time in Boston, Cushing collaborated with William Bovie, introducing electrocautery to the operating room, to affect improved hemostasis during neurosurgical procedures (3). Cushing clearly believed the introduction of the electrocautery made a significant contribution to his operative results: in his monograph, Cushing divides his case series into discrete

groups, separated by notable events including his move to Boston in 1912, his service during World War I from 1917 to 1919, and the "introduction of electrosurgery" in mid-January 1927 (6). By Cushing's own accounting, he had 40 postoperative deaths in the 182 patients treated before the electrocautery (22%), and 16 postoperative deaths in the 131 patients treated after its advent (12%). Although increased operative experience and refinement of technique may also have contributed to this reduction in postoperative mortality, the dramatic improvements in intraoperative hemostasis provided by Bovie's electrocautery played a significant role.

Although Cushing's early cases are marred by an exceedingly high mortality rate, those patients who survived their operations, and were successfully discharged from the hospital, demonstrated long-term survival. Three of these cases were reoperated upon, by Cushing, at the Peter Bent Brigham Hospital. Of these, case 4 survived 17 years after his initial operation, dying after resection of a recurrence; case 5 survived 11 years after his initial operation; case 7 was alive and well as of April 23, 1937; and case 16 was alive and well as of December 31, 1937. In addition, Cushing maintained written correspondence with his patients, and his monograph documents that case 14 remained recurrence-free until his last communication in April 2, 1937. Considered independently of the intraoperative mortalities, these cases are in line with contemporary series of meningiomas (4, 10), which generally describe meningiomas as benign tumors with excellent prognosis for long-term survival. Although malignant progression of meningiomas has been demonstrated (1), this does not seem to be the case in Cushing's early patients; the cause of death in these patients was overwhelmingly due to operative complications, rather than from meningioma progression or malignant transformation.

In the latter half of his career, Cushing undoubtedly had refined his operative approaches to meningiomas, gained a more thorough understanding of this tumor, and greatly improved his patients' postoperative outcomes. Cushing himself commented that:

> The first case in the series happened to be a spinal cord tumor, and nearly five years elapsed before an intracranial meningioma was encountered and attacked with fatal issue. It was not an auspicious beginning, yet what was learned during the next four years from this and all the succeeding Johns Hopkins cases was out of all proportion to the fewness of their number" (6).

Cushing's first 18 cases of meningiomas, treated while a young attending physician at the Johns Hopkins Hospital, are not the most elegant operations in his lengthy series, but serve as an illustration of his ability to transform clinical challenges into opportunities for improvement.

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