Historical Vignette

The radium bomb: Harvey Cushing and the interstitial irradiation of gliomas

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Upon his retirement from surgical practice in 1932, Harvey Cushing published a review of his pioneering experience in the surgery of more than 2000 cases of brain tumor; of these there were 832 with histologically verified gliomas. Many patients were afforded life-saving decompressive operations; however, these procedures were only palliative, as Cushing himself was well aware. The only treatment generally available after initial surgery was repeat decompression, which was helpful only up to a point, as Cushing emphasized earlier on. In some cases, external “teleradiotherapy” was also available.

Acting on the advice of a Swedish visitor, Professor Forsell, Cushing was led to try direct radium implantation after resection of glioma in a few patients. He described his technique as follows:

The type of “bomb” we have used is made up of a central core of radium needles enclosed in a rubber sponge and wrapped in thin rubber tissue, the size corresponding approximately to the size of the cavity left by a malignant tumor. The dosage we have customarily employed, viz. four needles each containing 12.5 mgm of radium screened with a one millimeter silver jacket and buried for four days represents approximately 5,000 mgm.hours.

We present here the available case histories of Harvey Cushing’s use of brachytherapy and a discussion of why he did not vigorously pursue a technique that remains the subject of ongoing investigation today.

Many of Cushing’s operative notes along with his sketches of the operative findings and other clinical documents are preserved in bound volumes of the Peter Bent Brigham Hospital Case Histories. All available volumes were reviewed; only three cases in which Cushing implanted radioactive radium needles were found.

Cushing described the radiation dose delivered in terms of “milligram hours” (mg-hrs), not the rad or Gray that is more familiar to neurosurgeons. This was standard terminology at the time and is still used by some radiation therapists in their planning for interstitial irradiation in areas other than the head, especially for gynecological tumors. Figuring the dose in centigray or rad from the prescription in milligram hours is not difficult. It can be done using published formulas if the radioactive sources are appropriately aligned and if the treatment volume is known. This latter information was not provided by Cushing, but a reasonable assumption is that the radium bombs were implanted in volumes of roughly 100 cm; this would imply a resection cavity between 5 and 6 cm in diameter. For a lesion of this size, the dose in mg-hrs × 1.28 = dose in cGy.
The radium bomb

Fig. 1. Case 2. Postoperative x-ray film showing the shape and location of radium bomb. Scattered surgical hemostatic clips are also seen.

Fig. 2. Cushing’s postoperative sketch showing the surgical resection cavity of the patient in Case 3.

Cushing’s Cases

Case 1

In January 1923 this 45-year-old woman presented in a “semicomatose” condition, having had a history of seizures and a progressive left hemiparesis over 7 years. Craniotomy with subtotal removal of a right postcentral gliomatous cyst was performed; at the same time, two radium tubes were inserted in the resection cavity and removed 28 hours later. No further details about the calculated total dose were available. Pathological examination showed a “glioma (unclassified).”

In July 1923 the patient underwent removal of a Staphylococcus abscess at the surgical site; this “cleanout” was repeated 1 month later. In August 1926, 40 cc of fluid was withdrawn from the craniotomy site after it had begun to bulge. In October 1926, the bulge worsened, as did her left hemiparesis; reexploration revealed multiple cysts containing approximately 300 cc of “muddy-colored fluid” along with tumor and necrosis. The patient improved immediately after this surgery but died in April 1928, 63 months following brachytherapy.

Case 2

This 40-year-old man underwent craniotomy for a right parietal oligodendroglioma in February 1930. Postoperative x-ray films showed persistent calcification; 2 weeks later a repeat operation was performed. More tumor was removed, and a “radium bag containing 50 mg of radium [was] placed in the center of the cavity” (Fig. 1). This was removed 4 days later after yielding a dose of 4600 mg-hours (50 mg × 92 hours = 5900 cGy).

In October 1930 the patient developed a recurrent left hemiparesis, and an x-ray film showed increased calcification. External radiotherapy was begun, but the patient died 10 months later. Survival time after brachytherapy was 18 months.

Case 3

This 61-year-old man was admitted in October 1930 with a 1-year history of progressive mental decline and headaches, culminating in several days of lethargy. On examination he had a right homonymous hemianopsia. At operation, a right temporal glioblastoma was “radically” removed (Fig. 2), after which, “Dr. Meagher provided a small radium bomb to implant . . . I folded a piece of cotton in to protect it . . . and laid this over the bomb so that it would nestle in the cavity.” These radium needles “had a 1 mm silver filter.”

On postoperative Day 3 the patient developed facial swelling and “some evidence of choking, so that I feared a possible pulmonary complication unless we could relieve tension.” This was accomplished by immediate removal of the radium implant after it yielded a dose of 3300 mg-hours (62 mg × 53 hours = 4200 cGy). The patient recovered reasonably well but remained confused. He was discharged to the referring hospital where he died 5 months later.

Unfortunately, autopsies could not be obtained on any of the above cases.

Discussion

Harvey Cushing was not the first surgeon to treat a brain tumor with interstitial irradiation. In 1912 Hirsch placed a radium probe into the sella turcica of a patient with acromegaly via a transsphenoidal approach. Frazier was the first to report radium implantation into parenchymal tumors, but he gave few if any technical details. In 1920 he described three of the 24 cases so treated; two were in the posterior fossa (apparently extraaxial) and the other was a pituitary tumor. These patients all improved, which was not the case in any of the patients with gliomas. Brachytherapy was commonly used until the 1930s; the advent of improved devices and a greater concern for radiation safety led to a greater emphasis on external radiotherapy. Beginning in the 1960s, the development of safer radioactive sources, computerized tomography and magnetic resonance imaging, modern stereotactic neurosurgery, and three-dimensional treatment planning all led to a revival of interest in intracranial brachytherapy. Reviews of the evolution of neurosurgical brachytherapy can be found in articles by Bernstein and Gutin and Shrieve, et al.
Although Cushing was an advocate of teleradiotherapy for certain lesions, including arteriovenous malformations\(^6\) and medulloblastomas,\(^7\) it is clear that he was not impressed with the results of brachytherapy for brain tumors. Our review of all of his available patient histories and operative notes yielded only the three cases we have listed. It is possible that many of these records have been lost;\(^3\) however, the collection in the Cushing Library at the Brigham and Women’s Hospital is nearly complete beginning with 1922, which was the period during which Cushing was using radium implants, and thus it is quite unlikely that any significant number of cases was missed. Cushing himself was quite vague about this information in his writings, either omitting any mention of brachytherapy\(^1\) or stating that “we have occasionally buried a radium ‘bomb’ . . . after massive extirpations, particularly of glioblastomas.”

That he did not view this as a technique with exciting potential is also apparent from the fact that in the one and only case (Case 2) described in his book,\(^4\) he states that the “procedure was employed without appreciable benefit.” The reasons for this lack of enthusiasm can be inferred from other writings by Cushing.

Well into Cushing’s career as a neurosurgeon the only available treatment for unremovable or recurrent gliomas was decompression. He was able to improve dramatically the early postoperative outcome for patients with these lesions, but he remained only too aware of their ultimate poor prognosis and the futility of desperate treatments late in the course of the disease.\(^5\) The later advent of external irradiation did not serve to change this pessimistic viewpoint; the only mention of radiation techniques in Bailey and Cushing’s\(^1\) landmark work on gliomas is that “of late years many of the tumors have been subjected to therapeutic radiation which may or may not have lengthened their survival period.” In 1932 Cushing\(^6\) commented that “the consequent loss of hair and bedraggled appearance make this measure scarcely worth the inconvenience to the patient and time to the roentgenologist.” The unimpressive results in Cushing’s own experience with radium implants would hardly have encouraged him to pursue the matter with great zeal. In October 1930, a patient underwent urgent surgery for a left frontal glioblastoma: the operative note states that “this would have made a good case for the implantation of a ball of radium had we been sufficiently foresighted to have made preparation for it.” The patient remained lethargic after the surgery and died 6 days later, presumably from sepsis. Cases such as this might only have made the idea of radium implantation for gliomas seem that much more futile. Cushing was reluctant to consider the technique for deep midline lesions such as medulloblastomas or pituitary adenomas, as suggested by his concern for the patient in Case 3: “there will be very little lying between the bomb and the 3rd ventricle.”

Controversy regarding treatment of gliomas using radiation in general, and brachytherapy in particular, continued in the wake of Cushing’s experience. The clearest echo of the negative view can be found in Dandy’s\(^4\) statement that “no gliomata have been cured, or, in my experience, even helped by either radium or x-rays.” Loyal Davis,\(^5\) on the other hand, discussed the irradiation of brain tumors more hopefully and in some detail and concluded that “in the treatment of the more radiosensitive tumors . . . interstitial radiation becomes necessary in order to deliver an adequate dose to the tumor.” An intermediate approach was that of Sachs, et al.,\(^15\) who believed that interstitial radium was not helpful but advocated new techniques of external radiotherapy. Some years later Sachs\(^12\) argued for a controlled study of intracranial brachytherapy. As noted above, the technological advances of the last several decades led to a resurgence in the use of interstitial irradiation.\(^14\)

Cushing’s great achievement in the treatment of gliomas was to decrease operative mortality, establish clearcut clinicopathological correlation, and delineate the role of palliative surgery. It should not be surprising that he was not excited about the use of interstitial irradiation for these tumors, given his long experience with their relentless course, the relatively primitive techniques at his disposal, and the unfavorable outcome in the few patients he so treated. Neurosurgeons in the years since have continued to search for new methods to improve the survival and lives of their patients with gliomas, using various methods of irradiation, including brachytherapy, which has played a prominent role.\(^15\) However, they would do well to remember these words written by Cushing regarding desperate treatments for patients with brain tumors: “The mere prolongation of life, unless it be made better worth the living, does not justify such a measure.”

References


M. Schuler, et al.