Historical vignette

Battling blood loss in neurosurgery: Harvey Cushing’s embrace of electrosurgery

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For his pioneering spirit, definitive work, and unparalleled devotion to conquering neurosurgery’s toughest obstacles, Harvey Williams Cushing inarguably has earned the title, “The Father of Neurosurgery.” His revolutionary incorporation of electrosurgical techniques in neurosurgery was not exceptional, but part of a pattern of recognizing, embracing, and establishing the use of medical technologies with great potential. Until 1910, Cushing had systematically reduced neurosurgery’s primary complications—infec tion and the effects of intracranial pressure—to decrease mortality rates. Hemostasis had always been a concern of William Halsted’s surgical protégé, but only after 1910 could Cushing primarily focus on it. In fact, Cushing’s crucial collaboration with William T. Bovie and his electrosurgical apparatus conquered this major obstacle in 1926. The nature of their collaboration—two experts in their respective fields who were passionate about their work, working side by side in the operating room—resulted in progress that surpassed all predecessors in the field. Cushing never did learn the physics behind one of the most important advances of his career. Nonetheless, he did know that by greatly reducing blood loss, electrosurgery allowed him to operate in patients whose tumors had been previously deemed inoperable and on the entire spectrum of neurosurgical patients more safely.

KEY WORDS • Harvey Cushing • blood loss • neurosurgical history • electrosurgery • William T. Bovie

The mere description on paper of the elaborate ceremony incidental to the safe extirpation of a brain tumor under any circumstances falls far short of the actual performance; and when a description of the novel electrosurgical methods of dehydrating and coagulating the tissues of the central nervous system is called for in addition, one despairs of doing justice to the subject. The control of bleeding in operations for brain tumors was the title of Cushing’s 1911 publication, which had been sparked by the development of his first major weapon against blood loss from the brain, the silver clip. Because Cushing’s techniques enabled him to treat many tumors directly, the majority of his work now involved direct contact with delicate brain tissue. Accepted mechanisms for controlling bleeding in general surgery, such as suturing or clamping, were not suitable for the delicate brain tissue or were too awkward for the small operative field. In this way, procedures became longer and more tedious, and hemostasis more important. The duration of the surgical procedures—extended numerous times to deal with hemostasis—was itself a risk. The amount of blood lost at any point during an operation would be doubled by the time the wound was properly closed, because it took Cushing as long to get out of as it did to get into the brain. He believed that “a more general loss of blood with the consequent lowering of arterial tension is a cordial invitation to relative shock, favors the onset of respiratory paralysis in cases associated with medullary pressure and makes anesthesia more dangerous, and lowers resistance to infection through secondary anemia.” Furthermore, he described the complications caused by bleeding during an operation: “Neighboring oozing obscures the clear view essential to the safety of such delicate manipulations as are required for the removal of, let us say, a lateral recess tumor or the trigeminal ganglion.” Blood loss was a major obstacle to the refinement of his techniques and success in complicated procedures.

Battling blood loss offered a special challenge to Cushing, particularly before the introduction of electrosurgery. Although he used a variety of procedures to control bleeding, including the placement of muscle pledges, the need to stop at each step to control bleeding markedly extended the duration of any operation. Excessive bleeding forced him to end some operations prematurely. Furthermore, he did not dare to attempt removing some tumors early in his ca-
career because the risk of life-threatening hemorrhage was too great.

Although some physicians had made use of electrical currents in surgery, this concept was not widely known by general surgeons. The many different terms coined in relation to electrosurgery in the first quarter of the twentieth century caused confusion in many, especially those like Cushing who did not care to understand the physics behind the electrosurgical techniques. Cushing’s 1926 publication describing his accomplishments with Bovie’s electrosurgical unit revealed the significant advantages of electrosurgery to the surgical community, and “Bovie” became a common name in the operating room. To gain insight into the development and introduction of electrocautery in Cushing’s practice and the discipline of neurosurgery, we reviewed Cushing’s relevant correspondence housed at the Harvey Cushing Manuscripts and Archives Collection at the Yale University Sterling Library.

Two Paths Intersect: Surgeon and Physicist Collaborate

By a twist of fate, Cushing and W. T. Bovie came together in a collaboration that made revolutionary progress in surgical technology. Bovie was an assistant professor of biophysics at Harvard who constructed an electrosurgical unit as part of his work as a research fellow for the Cancer Commission. The two men nearly missed each other, although they had both been at Harvard for more than 10 years. They spent only a few months together before Bovie left Boston. Although hemostasis had been Cushing’s greatest challenge since 1910, he did not realize until the fall of 1926, after seeing Bovie demonstrate his apparatus, that electrosurgery was the solution. Moreover, until Bovie’s technical advancements in instrumentation, electrosurgery did not have the potential to be effectively applied to neurosurgical procedures.

Cushing had little experience with electrosurgery prior to his interaction with Bovie. Many terms were used to refer to the procedure—“diathermy,” “fulguration,” “desiccation,” “endothomy”—and relatively few respectable doctors had adopted the technique. Electrosurgery was considered relatively confusing. In one of his letters Cushing credited Howard Kelly, formerly of the Johns Hopkins Hospital and founder of the Howard A. Kelly Hospital in Baltimore, as one of the first to consider electrosurgery. Cushing recalled in 1927, “My good friend Howard Kelly told me two or three years ago that I ought to get into this diatherme business in my special line of work and I am afraid I have been very slow about it.” In addition, Samuel Harvey, one of Cushing’s former residents, remembered an occasion at a medical convention in June 1925 when he and John Morton, also one of Cushing’s trainees, were watching a demonstration of a diathermy machine desiccating and cutting a large piece of beef. When Cushing approached them, one of the two residents jokingly told Cushing, “Here’s something you ought to use on the brain!” The joke was made to stir up Cushing; Harvey and Morton could not imagine such a “gross and disgusting procedure” having any application to the brain. Cushing’s response was surprising: he stood still, remaining thoughtful for some time. Although he did not then realize the potential of the electrosurgical methods, it is noteworthy that he entertained the idea. This event may have led him to try a similar machine given that in his 1928 paper he noted, “Three or four years ago with a form of apparatus then on the market, I essayed to make incisions in the brain with an electrified needle, but either for lack of experience or lack of imagination I did not see how for cutting or haemostasis the novelty could possibly supersede the more familiar methods in general use.” Cushing’s early experiences demonstrate that the limitations of the available electrosurgical instrument may have been the main reason he did not recognize the potential of electrosurgery in neurosurgery until Bovie’s developments.

Bovie’s electrical cutting loop and his technique of bloodlessly scooping out pieces of tumor tissue attracted Cushing’s attention. Cushing recognized elements in the technique that were similar to those in the internal debulking of tumors, which had become relatively standard for him. Recalling his first encounter with Bovie’s machine in the fall of 1926, Cushing stated, “When I first had the good fortune to see this loop being used bloodlessly to scoop out bits of tissue from a malignant tumor for the purpose of biopsy, I foresaw that a new tool had been put into our hands to facilitate the piecemeal removal of at least some of the heretofore inaccessible intracranial tumors.” After seeing the features of the loop and the similarity of its application to his enucleation procedure, Cushing realized that he had a new, relatively bloodless means of performing his already established procedure with less risk.

Trouble with hemostasis during a particular operation prompted Cushing’s first attempt at the electrosurgical techniques. On September 28, 1926, just a few days after he had seen the demonstration of Bovie’s loop, Cushing performed surgery in a 64-year-old man who had presented with a large, painless swelling on the right side of the head. X-ray films had shown that the bone beneath the tumor was highly vascularized and definitive. Cushing’s best guess at a diagnosis was a rapidly growing sarcoma. He attempted to remove the extracranial portion of the tumor, but the lesion’s high vascularity led to excessive bleeding. The bleeding was eventually controlled by the implantation of muscle and wet cotton pledgets. The loss of blood threatened the patient’s condition and forced Cushing to end the first surgery early even though the majority of the tumor was left intact. This unfortunate, but somewhat typical, complication together with the potential of Bovie’s loop fresh in his mind compelled Cushing to request the physicist’s help.

Cushing planned to perform another surgery in his patient, and fearing a similar unsuccessful attempt, paid Bovie a visit. The latter recalled that Cushing “popped his head into my laboratory at Harvard and asked me if I thought we could prevent some loss of blood in a brain operation. And I said I wasn’t sure but perhaps we could.” On October 1, three days after the patient’s first operation, Bovie and his machine joined Cushing in the operating room for a procedure that would change the course of neurosurgery. As Cushing stated, “On October 1, Dr. Bovie came to our rescue.” Bovie’s machine proved its tremendous worth on that first day; however, the operation was not without complication, as Cushing described in his postoperative note, This operation was a perfect circus—many ringed. The New England Surgical Association was here and almost every hand was occupied with them. I had persuaded Dr. Bovie to bring his electrosurgical unit over here to let me see what I could do with his cutting loop. This had necessitated reelectrifying the operating room. Dr. Greenough appeared with four or five coughing...
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Frenchmen with colds in their heads, the student who was acting as a possible donor fainted and fell off the seat. It was a little too much for Davidoff’s successor who has been here only 2 or 3 days so that I finally had to call in Horrax. The patient, what is more, began to show marked falling off in r.b.c. and hemoglobin which had progressively dropped after his primary operation to this morning when his blood [count] was only 2,800,000. In spite of all this, and more, things went surprisingly well . . . a considerable amount of bleeding was started up afresh. I then roughly outlined the remaining extracranial crescent of tumor in the lower part of the field and in order to do so had to go through temporal muscle to get down to the temporal bone. This was somewhat difficult . . . Then with Dr. Bovie’s help I proceeded to take off most satisfactorily the remaining portion of tumor with practically none of the bleeding which was occasioned in the preceding operation. The loop acted perfectly and blood stilling was almost complete but whether we would venture to use anything of this kind in the brain tissue itself I am at a loss to know for almost certainly it would cause convulsions.6

Despite all of these external distractions, Cushing and Bovie were able to coordinate and successfully use electrosurgical techniques in neurosurgery for the first time.

Cushing planned a third and final operation in this patient. He wrote to Bovie the day after the second operation to express his gratitude, update Bovie on the patient’s condition, and invite him to attend the third operative session. In a letter to Bovie in 1926, Cushing wrote,

I very insuffiently thanked you for all your trouble yesterday. In spite of the confusion of our many-ringed circus I was delighted to see how well that loop worked. If I could have had it at the first stage I would have gotten along as far as I have now gotten in this second stage. I am glad to say that the man is in fine fettle this morning and I shall let you know when we do the last session, as you might perhaps come over and look on.

In this note Cushing acknowledges the substantial improvement Bovie’s machine made on his abilities as a surgeon. Note, however, that he also indicates that he did not realize the scope of the tool’s potential; he did not insist that Bovie and his machine accompany him at every future session. Although willing to experiment with a new technology, Cushing possessed a healthy degree of caution. In addition, his lack of understanding of the possible complications related to electrosurgery most likely prevented him from prematurely concluding that this technology would revolutionize his entire approach to neurosurgery.

At the patient’s third and final operation, some of the initial anxieties that accompany the use of a new technology were quelled. Because avoiding infection was Cushing’s standard priority, he feared the new technique might enhance the risk of infection. During the patient’s final surgery on October 11, 1926, Cushing was glad to find the tissues had not been adversely affected, stating, “It was a matter of great satisfaction to find at the final session . . . that there had been no unusual reactions from the large area of superficially charred tissue that had been so long buried.”7 He also wrote a follow-up note to Bovie, “The first of the patients has done splendidly well and in spite of the charred tissue the wound has healed without reaction.” This success gave Cushing faith in the new machine and its applications.

While the first patient was still recovering, a 12-year-old girl with a similar extracranial tumor was admitted to the hospital. Cushing once again solicited the help of Bovie and was pleased to find that “the extracranial lesion in spite of its vascularity was without difficulty cleanly removed in a single session, and what might otherwise have been a serious operation proved to be a simple matter.”8 The healing of this patient also proceeded without complication. With the completion of two successful operations involving the new electrosurgical apparatus, Cushing’s optimism grew. These two cases involved extracerebral tumors, however, and Cushing needed Bovie’s encouragement and knowledge to risk using this tool on tumors growing deeper in brain tissue.

Thus, these trials grew into a partnership between two devoted individuals. Cushing was anxious to develop such a potentially potent weapon to control bleeding, and Bovie was excited to have a respected and dedicated surgeon to explore the practical applications of his apparatus. The subsequent advancements were substantial because of the determined nature of their collaboration.

With a somewhat unspoken commitment, Cushing and Bovie continued to experiment with the electrosurgical apparatus in the operating room. An early demonstration of their dedication is captured in Bovie’s letter to Cushing on November 8, 1926: “Last Thursday it did not appear to me that the machine was giving the cutting current which it ought to. I could not be sure about it at the time because I did not know enough of the character of the tissue through which we were cutting.” As this note indicates, a knowledge gap existed—in Cushing on the physics side and in Bovie on the neurosurgery side—and both had to learn more about each other’s field to optimize the machine’s utility. Bovie especially played the role of the middle-man, having identified the lack of one as the limiting factor in the development of electrosurgery. Bovie followed up on some concerns that arose from the second patient’s operation and found that according to the ammeter at the medical school the apparatus had used only half as much current as it had during the first operation. He explained, “I do not know whether the difficulty was in the machine or the motor generator, but I hope to locate the source of the trouble and then have it corrected before the next operation.” Bovie’s presence in the operating room not only helped during surgery, but also made it easier for him to understand which adjustments the surgeon most needed and why.

Several technical problems with using Bovie’s apparatus in the operating room needed to be resolved. Bovie attempted to settle the problem regarding different types of available electrical currents. The Brigham Hospital supplied a direct current, whereas the electrosurgery machine required an alternating one. In mid-November, Bovie contacted the Liebel–Flarsheim Company in Cincinnati, Ohio, about supplying a rotary converter to access both types of current. Unfortunately, the company was having difficulty obtaining such a machine that worked well, “was not as big as a house,” and did not cost an extraordinary amount of money. Liebel–Flarsheim was adamant that it could provide the machine given more time. Bovie suggested that they bring in a 110-volt alternating current from the street, as that was how he had dealt with the same dilemma at the Huntington Hospital.

Cushing was grateful for Bovie’s efforts, stating, “If we can get this alternating current line in from the street, I shall hope to see you over here often and we may make a brain surgeon of you yet. I only wish you were here so that we
could tap your ventricles and get some of your ideas more often.” Cushing delegated the issue of obtaining alternating current for the operating room to the hospital superintendent Dr. Howard, and in early January 1927, Howard responded with general plans already underway for putting alternating current in several hospitals. Cushing informed Bovie and reiterated, “I shall hope when it is accomplished that I may feel justified in bothering you to come over from time to time to help with some of my cases.” The correspondence was still tentative, but little did Cushing know that he did not have to hesitate—Bovie was hooked.

The two found help from one of Cushing’s colleagues, Phillip Drinker of the Harvard Medical School, to supply the current needed for the machine. Bovie must have arranged the cooperation because Cushing’s secretary noted, “Dr. Bovie suggests that it might be a pleasant thing if you could telephone to Dr. Phillip Drinker and thank him for supplying the current for the machine on Saturday and ask if it would be all right to use it again tomorrow.” Cushing, in his usual fashion, wrote to Drinker, thanking him for, and explaining, his contribution: “Are you the fellow behind the scenes who has been supplying the current which has enabled Bovie and me to extinguite some deep-seated tumors of late? Certainly if there is any form of big-game hunting which calls on the entire faculty, it is the removal of a large cerebral meningioma.” With Bovie willing to attend operations, the Huntington Hospital willing to lend Bovie’s machine for Cushing’s use, and the electricity problem solved, during the next few months the two stood side by side in the operating room, advancing the limits of electrosurgery and neurosurgery (Appendix, a).

During the ensuing months, Cushing made several alterations to the neurosurgical techniques he had developed. As always, the major concern was the risk of infection. Initially, there were several patients who suffered from wound infections. Cushing was worried that the current might compromise the tissue. Eventually, he determined that faulty technique was the problem: “These few infections were due, as we have since learned, to faulty technique rather than to any lowering of resistance of the tissues to which we were first inclined to ascribe them.”

The method and delivery of anesthesia were areas that needed to be altered for use with Bovie’s tool. Cushing generally used local anesthesia for most intracranial operations, although inhalation anesthesia was on hand if needed. He discovered that a patient’s body could become so charged due, as we have since learned, to faulty technique rather than to any lowering of resistance of the tissues to which we were first inclined to ascribe them.”

Seizures were another rare complication of electrosurgery. They occurred on several occasions in which the tool was being used on the dura mater to check bleeding. Although the high frequency should not have caused convulsions, there was a possibility that the current could become so diffused that its so-called overtones were capable of causing a physiological response. Bovie indeed encountered this problem from the apparatus side.

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There was also an issue of the current being grounded through the metal instruments used at the operating table. Cushing described one particular instance, “Once the operator received a shock which passed through a metal retractor to his arm and out by the wire from his headlight, which was unpleasant to say the least.” Cushing determined that the complications due to such accidental grounding of the current were often a result of inexperience, although at times they were a feature of the apparatus itself. He experimented temporarily with a wooden table, wooden spatulas, and other tools to alleviate these problems. Over the course of time, however, the apparatus was altered to fit the needs of the surgeon with all of his preferred tools. Cushing’s objective in adjusting the tool to fit the established practices of the surgeon was predicated on the knowledge that the tool would be most successfully implemented if the surgeon did not have to deviate much from standard practices. His goal was to encourage the adoption of electrosurgery. He stated that “those who come to use the apparatus will be spared of the apparatus was altered to fit the needs of the surgeon with all of his preferred tools. Cushing’s objective in adjusting the tool to fit the established practices of the surgeon was predicated on the knowledge that the tool would be most successfully implemented if the surgeon did not have to deviate much from standard practices. His goal was to encourage the adoption of electrosurgery. He stated that “those who come to use the apparatus will be spared of the apparatus was altered to fit the needs of the surgeon with all of his preferred tools. Cushing’s objective in adjusting the tool to fit the established practices of the surgeon was predicated on the knowledge that the tool would be most successfully implemented if the surgeon did not have to deviate much from standard practices. His goal was to encourage the adoption of electrosurgery. He stated that “those who come to use the apparatus will be spared of the apparatus was altered to fit the needs of the surgeon with all of his preferred tools. Cushing’s objective in adjusting the tool to fit the established practices of the surgeon was predicated on the knowledge that the tool would be most successfully implemented if the surgeon did not have to deviate much from standard practices. His goal was to encourage the adoption of electrosurgery. He stated that “those who come to use the apparatus will be spared from much that we have gone through and will find it possible without risk to utilize their ordinary operating table equipment and customary methods of procedure.”

**A Reflection of Progress**

After focusing his efforts for several months on developing electrosurgical techniques in the operating room, the spring of 1927 allowed Cushing some time for reflection. He and Bovie had made great progress. Cushing began to invite back patients in whom he had previously refused to perform surgery. Despite extensive use of the electrosurgical techniques for several months, Cushing had remained relatively ignorant of the principles behind the technology or the history of its development. In this way, he was also somewhat unaware of the significance of his work. Cushing made inquiries about electrosurgery to colleagues and especially to Bovie, his primary source of knowledge on the matter. Cushing wrote to Curtis Berman at the Howard A. Kelly Hospital, informing Berman of his success, “I . . . am succeeding in doing things inside the head that I never thought it would be possible to do,” and requesting information, “You probably have had as much experience in electrical surgery, or whatever it is that one should call it, as anyone else and I am writing to ask if you will send me some literature on the subject, so that I may begin to read up on it, for I am as yet a greenhorn.” Berman replied with a list of sources, although he admitted that he had yet to publish on the topic himself and that he was “very far from expert in this subject.” An extensive response from Bovie on the matter indicates that a similar request was made of him. Bovie highlighted the significance of their work in the broader scope.

The electrosurgical methods which have been used in your operating room differ from other electrosurgical methods in that we have combined into one machine both the coagulating and cutting currents, and by a further modulation of the character of the current, we have controlled the degree to which the cut tissues are coagulated, or more correctly expressed, are dehydrated. I believe that this is of the very greatest importance, in fact it is my opinion that this step alone will put electrical surgery on the map. The machine you have used, is in my opinion, the only electrical surgical machine having the necessary variety of currents,—regardless of the claims of manufacturers . . . The progress of electrical surgery has been retarded...
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because manufacturers could not give the surgeon what he needed for they had no way of knowing his problems and the surgeon has not been able to ask the manufacturer for suitable currents because he has not known about the peculiar properties of these high frequency currents. Systematic research of a fundamental nature in the field has not been done. I have been serving as sort of a middle man, and through watching operations on the one hand and studying electrical currents on the other, I have managed to learn a little bit of both ends of the problem. I do feel that we have taken some progressive steps which will not have to be retraced.

Bovie’s insightful remarks would prove true. His improvements of the instrumentation, including the ability to control a wide range of currents through a single lead with easily interchangeable electrodes (Fig. 1), made the use of electrosurgery practical in the operating room. Ideas for many of his improvements resulted from direct observation of what Cushing needed. Indeed, Bovie’s presence in the operating room was crucial to the success of his machine.

Unfortunately, at the same time as this recognition of great progress, it was becoming clear that Bovie would be leaving Harvard. He had sold the patent rights of his apparatus for $1 to the Liebel–Flarsheim Company so that their engineers could invest the time and energy necessary to solve some of the more difficult technical obstacles. To continue applying the electrosurgical techniques in the operating room without Bovie, Cushing needed to establish a close working relationship with Liebel, the president of the company, while heeding Bovie’s insight that the gap between manufacturer and surgeon was electrosurgery’s greatest limiting factor. Beginning a written correspondence that would last for many years, Cushing wrote directly to Liebel: “I consequently am anxious to push this matter along so far as possible between yourself, Dr. Bovie, and myself, and particularly in view of the fact that Dr. Bovie is very possibly long going to leave here for a position in another university.”

Cushing acknowledged the work and expenses Liebel’s company had devoted to the project thus far in making appropriate adjustments as Bovie came up with them. He also clarified his motivations, “I am not, nor is Dr. Bovie, interested in the slightest degree in any financial return. We merely wish to establish the principles of this work which may be put into general application.” Cushing suggested that Liebel visit the Brigham Hospital and observe an operation with Bovie present so that the three could discuss ideas for many of his improvements resulted from direct observation of what Cushing needed.

Meanwhile, Cushing attempted to keep Bovie close. He wrote to Elihu Thomson of the General Electric Company in Lynn, Massachusetts, on Bovie’s behalf. “He is one of those rare geniuses that does not necessarily conform to what universities expect of their somewhat standardized faculty product. . . . Personally, I shall be distressed to see him leave his present field of work, particularly if that call which he is considering should take him to the Middle West.” Cushing asked Thomson if there was a place for Bovie at the General Electric Company. Thomson tried to find something but was unsuccessful. “I am afraid Dr. Bovie would not fit into the work we are doing here in Lynn. . . . To my mind, the proper place for his is in some medical research laboratory, like the Rockefeller Institute.” Cushing had developed a great respect for Bovie and wanted to help him, but one can hardly deny that Cushing had some thoughts of his own progress and the unfavorable consequences of losing Bovie.

Although disappointed not to have made personal contact with Liebel before leaving and afraid that Bovie might already be gone by the time he returned, Cushing set sail for Europe in June 1927. Perhaps the most important event on his agenda was the Macewen Memorial Lecture, which he delivered on June 27. In an eloquently crafted speech Cushing debuted his electrosurgical progress. He discussed a 1922 operation in a patient undertaken without the aid of electrosurgery and one from the previous spring during
which he used Bovie’s apparatus. He then placed the improvements in the context of surgical history. Furthermore, he contrasted two cases of meningiomas to demonstrate the tremendous impact of electrosurgery (Appendix, d).

Cushing described a patient with a bilateral olfactory groove meningioma whose inaccessibility would have rendered it inoperable before the availability of the electrosurgical apparatus. Cushing completed this case in one session, while preserving the bone flap and leaving only an invisible scar. “This was not a procedure to be done hurriedly, nor could it possibly have been carried through in a single session by any other method I can conceive of.”4 Cushing used the enucleation technique, first scooping out the inside of the tumor and eventually detaching the outer shell. The process was tedious despite the use of the loop. Most importantly, however, the operation was not delayed by any major effort to maintain hemostasis. Cushing noted that only in the area of attachment of the mass “was any troublesome bleeding encountered, and it was easily controlled by using a desiccating current which charred the dura and, at the same time, it was to be hoped, destroyed any remaining nests of tumor cells which remained adherent to it.”4 The electrosurgical unit was not a cure-all and it did not make this operation easy by any means. Nevertheless, it made the operation possible (Figs. 2–4).

The Slowing Down of Progress

When Cushing returned from Europe in early August, he was anxious to learn the state of the new apparatus and to resume his practice. Although Liebel had promised to send the prototype machine following the May American Medical Association convention, he had not followed through on his word (Appendix, e). More than a week later, Liebel wrote Cushing apologetically, explaining the delays but saying that he hoped to have the machine for Cushing before Bovie’s departure, which was now scheduled for early September. Cushing was sympathetic to Liebel’s position, although his patience wore thin as time went on, as clearly indicated in his September 21, 1927 letter.

Both Bovie and I had understood that it was to be here, D.V., before he left on September 1st. Meanwhile, I am put to it to know what to do. I can’t continue to draw upon the
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Huntington Hospital now that Dr. Bovie has left. I suppose I might let the matter drop and go back to our old methods, which would be rather humiliating after what I had said about electrosurgery in my Macewen address, a copy of which I shall send you.

Liebel’s response was apologetic once again, “I am very much put out about the awful mess I have put you into . . . and I think I made a big mistake by holding you up until we could have it absolutely perfect. I hardly realized how serious this thing was until returning here and reading your Macewen address, and then realizing that you were without a machine.” Despite additional promises to send the machine and accompany it to Boston, Liebel had trouble getting the apparatus back together. Cushing’s frustration is revealed in a letter to Bovie.

I wish to thunder you were still here. I have been having a poor time with this electrosurgical business and have begun to doubt whether I will ever get anything out of Liebel.

Meanwhile our conjoint paper hangs fire. I have had a lot of good cases but find I can’t do half as much with them as when you were at the helm. . . . I shall never forgive these people here for letting you get away.

Cushing was discouraged, but remembering Liebel was performing this service as a favor, he tried to remain patient.

The apparatus was finally shipped to Cushing on January 14, 1928. Cushing continued to correspond with Bovie and on mentioning a technical difficulty, Bovie would promptly write you. . . .

Revealing Progress to the World

After much delay, the manuscript describing Cushing’s use of Bovie’s apparatus in neurosurgery was finally submitted and published in December 1928.1 In this paper, Cushing clearly defined his progress and impressed many fellow surgeons. Calvin Weaver, a neurosurgeon from Atlanta, wrote Cushing a letter, “I believe that this is the most important and outstanding improvement that has been made in brain surgery in many years; in fact, I believe that it is going to revolutionize this fast growing speciality.” Many surgeons wrote Cushing to request more information on the principles of electrosurgery, which Bovie did not include in his introductory note (Appendix, f).

The issue became more complicated when Fayer, of the Wappler Electric Company in Long Island, NY, wrote the editors of Surgery, Gynecology, and Obstetrics, claiming that beginning in 1924 he had developed a machine with the qualities of Bovie’s and that “there are reasons that make us believe that Dr. Bovie knew of our developments, but aside from these, it would have been fair and proper if Dr. Bovie had not entirely ignored all the many publications on this subject prior to his discovery such as those of Geo. A. Wyeth, Howard A. Kelly, and Grant E. Ward (Appendix, g).” Cushing did not want to have any involvement in the matter: “On my part as a physician, I am afraid I have no interest whatsoever and less patience with what seems to be annoying you—the question of patent rights.” Cushing wrote to Wyeth, “My apologies if I would have offended you and Howard Kelly and Clark and others who have been pioneers in electrosurgery by not having mentioned you all by name. This was not my purpose in writing the article.” Wyeth had been surprised that Cushing had not mentioned electrosurgery’s pioneers and felt that some of Bovie’s statements were misleading. He stated, “I am quite sure, Doctor, that no one knows better than yourself that something more than work, something of life itself, goes into the development of new medical or surgical procedures and into their long, slow testing-out . . . a burden of responsibility is laid upon those who write for the profession to give credit where credit is due.” On receipt of an additional apology and explanation from Cushing (Appendix, h), Wyeth was ready to forgive and forget the matter, although opined that “Bovie sought credit for original work which had been done years before by others, and that (although he doubtless gave you the best advice he had) he obviously failed to give you the benefit of the best knowledge available (Appendix, i).” To put an official end to the matter, Howard Kelly, who was much more educated on the matter, offered to write a paper on the development of electrosurgery for Surgery, Gynecology, and Obstetrics.

With that obstacle in the past, Cushing and Liebel continued to press on. By January 1931, Liebel had succeeded in making a machine operable by one man alone, which al-
so included numerous improvements that reflected Cushing’s desires over the years. Liebel had witnessed first-hand, as he often accompanied new machines to their delivery to ensure proper use, the impact of Cushing’s work in all fields of surgery. He wrote Cushing, “You surely started something when you got into electrosurgery because they are following in your tracks in all other specialties now.” Indeed, Cushing did for electrosurgery what he had done for neurosurgery: his careful thorough technique redefined the field and set the precedent for safe and successful operations.

Conclusions

In the fall of 1926, Harvey Cushing was searching for the means to control blood loss in brain operations and William Bovie was waiting for a respected surgeon to use the advancements in electrosurgery. As he had done several other times in his life, Cushing recognized the potential in what was, at least for him, a new technology. He subsequently embraced this technology, and through discipline and teamwork—lessons learned while young—Cushing forever broadened the scope of neurosurgery and put electrosurgery on the map. Cushing was aware of his role in history, of the significance of his contributions, and of the potential for them to be overshadowed by what was to come. As he stated in his Macewen lecture,

> It gives me great satisfaction to realize how delighted those masters of technique, Theodore Kocher and W. S. Halsted, who laid such stress on the importance of painstaking hemostasis in surgical work, would have been to have seen some of this new surgery, which is as bloodless compared to the surgical methods they perfected as theirs was bloodless compared to that of their contemporaries and predecessors.

Cushing, who conquered neurosurgery’s great obstacles, lives on as the profession he defined continues, nearly a century later, to utilize advancements he made. Neurosurgery and Harvey Cushing will forever be linked, and electrosurgery is a crucial part of his legacy.

Appendix

a) Ironically, the close nature of Cushing and Bovie’s collaboration during these months meant that they communicated verbally and therefore had less written correspondence. Unfortunately, this fact limits our ability to analyze their collaboration during this period, to what Cushing wrote in the 1928 publication.

b) Liebel cited an example of his company junking $10,000 worth of machines because they had developed and released an improved model, thus making the first obsolete. They did not delay release until the models already manufactured were sold, as would be the practice if profit were their primary goal. Liebel to Cushing, April 23, 1927. Harvey Williams Cushing Papers.

c) Liebel stated, “I consider it very essential for an apparatus designer to know his anatomy perfectly . . . I am pretty well posted on the anatomy of all parts of the body except the brain . . . . I have always felt that that was a part which a wise man would religiously let alone.” Liebel to Cushing, April 23, 1927. Harvey Williams Cushing Papers.

d) He chose to talk about meningiomas because their operative difficulty clearly demonstrates the advantages of electrosurgical techniques. Also, Macewen’s first monumental surgical patient most likely had suffered from a meningioma.

e) Cushing wrote Liebel on his return, “I have just come back from abroad and hoped that I might find the new electro-surgical apparatus. Do please let me know how things stand and whether I may expect it from you.” Cushing to Liebel, August 2, 1927. Harvey Williams Cushing Papers.

f) Bovie also did not approve of one of Cushing’s assistants, McLean, writing an article on the subject, because Bovie believed the right was his.

g) Fayer claimed to have filed for a patent in August 1924 and to have been issued one on December 18, 1928.

h) Cushing had originally intended to include the names of electrosurgery’s pioneers but believed he had inadequate knowledge to do their contributions justice. Cushing to Wyeth, February 21, 1929. Harvey Williams Cushing Papers.

i) Wyeth cites Cushing’s concerns for electrical burn and infection as having been addressed in previous publications which Wyeth believed Bovie should have known because these problems were well established in the literature. Wyeth to Cushing, February 27, 1929. Harvey Williams Cushing Papers.

References


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