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History of the AANS/CNS Joint Section on Tumors and preface to the 20th anniversary Journal of Neuro-Oncology special issue

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Summary

The Joint Section on Tumors of the American Association of Neurological Surgeons (AANS) and the Congress of Neurological Surgeons (CNS) was formed in 1984, at the suggestion of Dr. Edward R. Laws, Jr. and with Dr. Mark Rosenblum as the first Section Chair. The Joint Section on Tumors is the first professional organization devoted to the study and treatment of brain tumors. Its initial goals were to assist in the education of neurosurgeons in neuro-oncology and to serve as a resource [to the AANS and CNS] and other national groups on the clinical treatment of and research into nervous system tumors. During its 20-year history, the Section has facilitated both open and invited talks at the neurosurgical national meetings, conducted its own Satellite Symposia, and instituted multiple awards and grants. Members have conducted research surveys and national practice pattern studies, and have collected and disseminated information on clinical protocols, research funding opportunities, and fellowships in neurosurgical oncology. Guidelines for brain tumor treatment and for neuro-oncology fellowships for surgeons have been written by Section committees. Studies presented orally at Section meetings, 1999–2002, had a remarkably high rate of full publication compared to other meetings – 73% actuarial at 4 years after presentation. Finally, nationwide in-hospital mortality rates for craniotomy for malignant glioma have fallen from 8 to 2% during the Section's existence. These data suggest that the Section's goals of educating all surgeons in neurosurgical oncology are being successfully met. A bibliography of secondary sources on the history of brain tumor surgery is appended.

Introduction

Welcome to the Section on Tumors 20th Anniversary special issue supplement to the Journal of Neuro-Oncology. Fall 2004 marks the 20th anniversary of the founding of the Joint Tumor Section. In May 2003, Section Chairman Raymond Sawaya developed the idea of creating this special supplement edition of the Journal of Neuro-Oncology as a celebration and commemoration of this important and historic event. It is fitting and appropriate that this special project be published in the Journal of Neuro-Oncology as this publication is the official journal of the Joint Section on Tumors.

The structure and content of the project were worked out between the two project editors (Raymond Sawaya and Mark Linskey) over the summer of 2003. By the last week of September the participation of all main authors had been confirmed and all formal invitations had gone out. Each author had just over three months to put together their manuscript contribution which were all due by January 9, 2004. Prominent and very busy members of the surgical neuro-oncology community cleared their schedules and shifted this particular project to personal priority status in order to complete it in time. The fact that it was successfully

completed without losing a single manuscript to deadline issues, is a testament to their personal commitment both to this project, and to the Section on Tumors. The project editors had only 7 weeks to complete all manuscript reviews, requests for revisions, and revision reviews. All final revised manuscripts went in to the publisher on March 1, 2004 in order to meet a publication schedule to have the issues distributed at the Fall 2004 20th Anniversary celebration.

What you are about to experience is the culmination of a tremendous amount of work and energy on the part of all the authors as well as the project editors. The fact that such a broad, authoritative, and comprehensive treatment of this important subject could be achieved from conception to submission for publication in less than 10 months is truly remarkable. The quality of the finished product speaks for itself.

We begin the preface of this special issue by presenting the first comprehensive summary of the history of the Joint Section on Tumors, compiled by Section Historian Fred Barker. We then introduce the format and subject matter content of both volumes of the special supplement. A bibliography of writings on the history of brain tumor surgery follows for the use and interest of Section members and other readers.

The beginning

The Joint Section on Tumors was initially formed as a section of the Congress of Neurological Surgeons (CNS), on the proposal of Dr. Edward Laws, who was then CNS President-Elect [1]. To organize the new Section Laws recruited Dr. Mark Rosenblum, who then contacted other neurosurgeons with either clinical or laboratory interest in brain tumor treatment. About 10 interested surgeons attended a planning session held in October 1983 at the CNS meeting in Boston. The initial Bylaws were patterned after those of the Cerebrovascular Section, then recently formed.

The Tumor Section was first recognized as a section of the Executive Committee of the CNS and, in December 1984, was also recognized by the Board of Directors of the American Association of Neurological Surgeons (AANS), thus becoming a Joint Section. The first Section Chair was Mark Rosenblum, Michael Apuzzo was Secretary-Treasurer, and the other members of the Executive Committee were Edward Laws, M. Stephen Mahaley, and Harold Young. Two loans of $4000 each were made to the fledgling Section by the CNS and the AANS as seed money [1]. The Section's existence was reflected in the AANS 1985 meeting program (an afternoon session with presentation of 8 open papers – all but one on gliomas, and all but one involving laboratory research – and two symposia, one on skull base approaches and the second on biology and therapy of gliomas).

Although its status as a Joint Section of both the AANS and CNS was unusual at the time, the Tumor Section was one of the last neurosurgical Sections to be formed. The AANS Pediatric Section had been recognized in 1972, followed by Sections on Functional and Stereotactic Surgery (1973), Cerebrovascular Surgery (1976), Spine (1979), Basic Science (1980), Trauma (1984), Sports Medicine (1984), and Pain (1987) [2]. Mark Rosenblum served as Section Chair from the Section's founding until 1991. Subsequent chairs have served for 2-year terms: Dennis Bullard (1991–1993), Peter Black (1993–1995), William Chandler (1995–1997), Mark Bernstein (1997–1999), Joseph Piepmeier (1999–2001), and James Rutka (2001–2003). The current Section chair is Raymond Sawaya and Ronald Warnick is Secretary-Treasurer.

The Section on Tumors has the distinct honor of being the first national physician's professional organization specifically dedicated to the study and treatment of patients with nervous system tumors. It antedates the Society for Neuro-Oncology, founded in 1995, by 11 years, and the Neuro-Oncology Section of the American Academy of Neurology by 10 years (founded 1994).

The Tumor Section's initial goals were "to assist in the education of neurosurgeons in neurooncology and to serve as a resource to [the AANS and CNS] and other national groups on the clinical treatment of and research into nervous system tumors" [3]. Over the 20 years since its formation, the Section has continued to pursue these goals and has added some others, principally the encouragement of brain tumor research. This brief survey of the Section's history will address the following aspects of its activities: education,

awards and grants, guidelines and outcomes research, membership and membership services, and other activities.

Education

Educating neurosurgeons about the specialized topic of treating the tumor patient was one of the Section's initial goals [3]. From the beginning, the section's Executive Committee recognized that this included more than just knowledge about malignant gliomas, and the Section's first workshop was on the treatment of recurrent meningiomas, including talks by Donald Long and Robert Ojemann. Other Section workshop topics in the 1980's included metastatic brain tumors, brachytherapy of malignant gliomas, chordomas, medulloblastomas, spinal cord tumors, neuropathology of gliomas, epidemiology and patterns of care of brain tumors in the US, the biology of tumor growth and tumor development, management of low grade astrocytomas, optic pathway gliomas, and metastatic spinal tumors [4]. Although a workshop at CNS 1990 covered spine tumor management, most have focused on tumors of the brain and skull base. The syllabi from most of these early workshops were collected in a loose-leaf volume and distributed to members in 1991 [4]. These workshops, or symposia, have continued as a prominent feature of the Section's activities at the two national meetings to the present day. In addition, a full-day clinic, "Update on tumors for the general neurosurgeon", organized by Dr. Jeffrey Bruce, is now given before the AANS meeting each year, typically attended by 75–100 neurosurgeons.

In addition to organizing workshops and symposia with invited speakers, the Section rapidly sought and gained a role in selecting the open scientific papers to be presented at the national meetings [5], and succeeded in having a separate afternoon session designated for open papers on tumor-related topics. These sessions are typically moderated by members of the Section's Executive Committee.

During the process of CNS and AANS approval and ratification, the Section initially had agreed not to hold a section meeting of its own that was separate from the two national meetings. This was motivated by concern on the part of the national organizations that organized neurosurgery would become fragmented through the formation of multiple subspecialty Sections, and that attendance at the national meetings would suffer [2]. A 1993 survey, however, showed that the Section membership strongly supported the concept of a separate tumor-related meeting. A Tumor Satellite Symposium attached to the main national meeting was suggested as a solution. In October 1994 the Section held its first satellite symposium in Chicago, immediately following the main CNS meeting. Attendance was 225 people, in excess of the 100 to 150 that had been anticipated. Subsequent satellite meetings have been held in October, 1996 (CNS Montreal), April, 1998 (AANS Philadelphia), April, 2000 (AANS San Francisco), and April, 2002 (AANS Chicago). A special celebration of the Section's twentieth anniversary is planned for the next Satellite Symposium, in October 2004 (CNS San Francisco). In June, 1997 a special satellite meeting was held jointly with the AACR (American Association for Cancer Research) in San Diego [6]. The satellite symposia offer a forum for broader participation by members in both invited and open presentations, and are more widely attended by members of allied disciplines (medical neuro-oncology, radiation oncology, and basic sciences) than are the main national neurosurgical meetings.

Besides meeting activities, other education efforts have also been mounted by the Section, some directed specifically at Section members and others at a more general audience. In the Section's earlier years, abstracts from the NIH PDQ listing of clinical trials for brain tumor patients and monthly "Cancergrams" were distributed to Section members until the NIH halted the service in 1994. A survey of open brain tumor protocols which was compiled by Mark Bernstein for the Section was published in 1993 [7] and distributed to the membership. This function is now served by brief descriptions of new major clinical trials in the Section's newsletter. Another early project was a very comprehensive listing of results of published clinical trials for brain tumors compiled by the late Stephen Mahaley, a neurosurgeon who was an important contributor to the Section's founding and activities before his early death from cancer [8]. The list was published in the Journal of Neuro-Oncology [9] and reprints were distributed to Section members. With the increasing importance of the Internet, the Section has taken a leading role through the "Select Review in Neuro-Oncology" website, organized and edited by Anthony Asher [10]. This service, available

at http://www.neurosurgery.org/tumor/selectreview, abstracts important articles on neuro-oncology from the medical literature for interested readers. More traditional publications endorsed by the Section, and edited and largely written by Section members, have included a textbook of neurooncology (Neuro-Oncology: the Essentials, edited by Bernstein and Berger) [11] and the special issue of the Journal of Neuro-Oncology that contains this article.

Finally, the Section has been active in collecting and distributing information on fellowships in neuro-oncology for graduates of neurosurgical residencies. Surveys of all North American fellowships were distributed to members in approximately 1989 (18 fellowships), 1991 [12], 1994 [13], and 1999 [14]. In addition, a Tumor Section committee under the leadership of William Couldwell and James Rutka has prepared a curriculum and program requirements for fellowships in Neurosurgical Oncology which have been submitted to the Committee of Accreditation of Subspecialty Training of the Society of Neurological Surgeons (the "Senior Society") [15]. At the time of writing (January 2004) it is hoped that the accreditation process will shortly be complete.

Awards and grants

Another aspect of the Section's early efforts to improve the quality of tumor-related presentations at the national meetings was the institution of awards for the best submitted abstracts [16]. The first Section award was a prize for the best abstract on a basic science research topic submitted by a neurosurgery resident – the Preuss Award. The award is supported by the Preuss Foundation for Brain Tumor Research, founded by Peter Preuss in 1985, and was first given in 1987 (Table 1). Its present value is $1000. Most Preuss Award winning abstracts have represented glioma research. Of the first 16 Preuss Award abstracts (1987–1995), 56% reported research on malignant gliomas, compared to 77% of the next 17 award abstracts (1995–2003).

In 1991 the Section initiated its second award for meeting presentations, the Mahaley Award ($1000; Table 2). Named for M. Stephen Mahaley, Jr., this prize is awarded for the best abstract on a clinical research topic submitted by an established investigator in neuro-oncology. It was initially funded through a combination of donations from the membership and an allocation from Tumor Section general funds [17]. Since 1995 the award has been sponsored by the National Brain Tumor Foundation [18]. The Mahaley Award has recognized work on a broad variety of tumor types: only 8 of 25 award abstracts (32%) were related to gliomas. Other tumor types addressed have included medulloblastomas, acoustic neuromas, meningiomas, pituitary tumors, colloid cysts, germinomas, and studies on general brain tumor populations.

The third award for a meeting presentation, first given at the 1995 CNS meeting, is the Young Investigator Award ($2000; Table 3). Sponsored by the American Brain Tumor Association, this award honors a young faculty member in neurosurgery, in practice for less than 6 years, who has demonstrated outstanding potential for basic science research in the field of neuro-oncology. Like the Preuss Award, most Young Investigator Awards have been given for glioma research (15 of 17, 88%). In 2003, two additional awards for meeting presentations were instituted: the Kluwer/ Journal of Neuro-Oncology award, sponsored by Kluwer Academic Publishers, and the Bittner award, funded through a donation from the Ronald L. Bittner Foundation. Both are given at the annual AANS meeting to high-ranking abstracts in either clinical or basic science.

Other awards also announced at the AANS meeting each year honor cumulative achievement during an individual's entire career. During its 20-year existence, the Section has honored three individuals with Distinguished Service Awards, which are given by the Section for exceptional contributions. For reasons outlined above, these awards were given to Peter Preuss (1990), to Steven Mahaley (1991), and to Mark Rosenblum (1992). The Farber Lectureship, instituted in 1994, is sponsored by the Anne and Jason Farber Foundation and Mr. James Farber (Table 4). Dr. Charles B. Wilson was instrumental in obtaining the funding for the award. The lectureship recognizes a promising new investigator who has achieved significant results early in their career. Awardees have included basic science researchers, neuropathologists, and neuro-oncologists, as well as neurosurgeons. To date, all ten Farber Lectures have

addressed malignant glioma research and/or treatment. The Farber Lecture is delivered alternately at the AANS annual meeting or at the annual meeting of the Society for Neuro-Oncology. Finally, the Ronald L. Bittner Lecture, first given in 2001, is delivered each year by an invited speaker on a tumor-related topic at the AANS meeting.

In addition to awards for accomplishment, one research grant is awarded by the Section each year to a member through a competitive application process. The National Brain Tumor Foundation Translational Research Grant (presently $15,000) is given annually to the best translational research proposal on brain tumors from a section member who is in the first 6 years of their career. It was first awarded in 1996. To date, the awardees have been Jeffrey Bruce, Roberta Glick, James Rutka, Adam Mamelak, Linda Liau, John Yu, Randy Jensen, and Andrew Parsa. The Research Subcommittee of the Section also periodically surveys research funding opportunities to facilitate members' obtaining grants [19]. The most recent such survey, conducted by Ronald Warnick, Corey Raffel, and Roberta Glick, was published in 2003 [20].

Guidelines, surveys, and patterns of care studies

Another of the Tumor Section's early goals was to "serve as a resource" to the parent national neurosurgical organizations, the CNS and AANS, and hence to the national neurosurgical audience at large [3]. Sometimes the Section performs this function very directly, as in 2001 when a statement on cellular telephone use and brain tumor incidence was requested by the AANS president and a reply drafted by James Rutka, Tumor Section Chair [21]. A more formal way in which this goal has been accomplished is through the development of practice guidelines for brain tumor treatment. Practice guidelines are documents intended to guide treatment decisions that are based on an expert panel review of available evidence [22]. The Section's first such guidelines project focused on treatment options for low grade gliomas in adults, and was conducted as a joint project with the American Society of Therapeutic Radiation Oncology in response to a charge from the Guidelines and Outcomes Committee of the AANS. The project began in January, 1994 [23]. The algorithm derived by the Team considered the complexities involved in arriving at a diagnosis of low-grade glioma and on the controversies surrounding decisions for surgery, radiation treatment, or both [24]. The final guidelines were published in 1998 [25]. A similar team compiled guidelines for treatment of single brain metastases which were published in 2000 [26]. Projects currently in progress include guidelines on treatment of high-grade gliomas (nearing completion) and on pituitary adenomas in adults (planning stages).

Another important source of guidance for practitioners is studies of patterns of care. The Section has played an important role in this field. Some studies have surveyed the Section membership directly, such as a recent examination of patterns of postoperative care after stereotactic biopsy in the United States [27]. In this instance, choice of Section membership as the surveyed population resulted in a group of surveyed surgeons in both academic and private practice settings who performed stereotactic biopsies frequently. The results of the survey showed more frequent use of postoperative intensive care unit observation in lower-volume practices [27]. Additional such surveys are tentatively planned.

Two practice pattern studies on a national level, not limited to the Tumor Section membership, have now been conducted by the American College of Surgeons Commission on Cancer (ACS CoC), each time in cooperation with the Tumor Section. The first such study was directed by Steven Mahaley and was published in 1989 [28,29]. A second, more detailed examination of patterns of care for brain tumor patients in the United States was initiated by the ACS CoC in 2000 [30]. Led by Herbert Engelhard, analysis of this in-depth study of national practice is currently in progress.

Another study of results of current care of malignant glioma patients, the Glioma Outcomes project, was recently completed [31]. Endorsed by the Section and conducted and led largely by Section members, this large survey of current treatment outcomes has resulted in multiple publications and abstracts (bibliography at http://www.umassmed.edu/outcomes/glioma/index.cfm?action=bibliography). Between 1997 and 2000, 788 patients treated at 52 clinical sites were enrolled in the study. Analyses have included descriptions of clinical trial enrollment, use of alternative medications, results and complications of treatment, and

correlates and consequences of depression, seizures, and venous thromboembolism in glioma patients, as well as other aspects of glioma treatment [32–35].

Membership and membership services

From the small nucleus of surgeons who formed the Section in 1984, the Section grew rapidly to about 200 active members by 1988. Since that date there has been a slower, but relatively steady growth in the Section's active membership (Figure 1), which currently numbers 538. Throughout the 1990's and early years of this century, the Tumor Section has always been one of the three largest Sections, alternating for largest with the Spine and Cerebrovascular Sections. While the Active Membership forms the Section's core, and pays the lion's share of the dues that form the Section's operating budget, there are five other forms of Section membership available: Associate (for Senior or Lifetime members of the CNS and AANS), International, Resident/Fellow, Adjunct (non-neurosurgical basic researchers and physicians in allied fields such as neuro-oncology and radiation oncology), and Honorary membership, intended for non-neurosurgeons who are leaders in the field [36]. Figure 1 shows that the most rapid growth in membership since 2000 has been in these other categories of membership. This is principally due to a substantial increase in Resident membership (now offered free to residents and fellows), as well as to increased efforts to recruit Adjunct members from neuro-oncology, radiation oncology, and the basic sciences. Since 1999, special receptions to welcome and recruit new members have periodically been held at the annual AANS and CNS meetings, with a focus on encouraging new membership from the resident and Young Neurosurgeons communities [37].

The intangible benefits of Section membership were recently described by Gene Barnett as including "formal acknowledgement of special interest in tumors" and "enhanced credibility with tumor patients and in medicolegal activities" [38]. More tangible benefits of membership in the Section have included distribution to members of the research publications mentioned above, as well as the biannual Section Newsletter, currently edited by Isabelle Germano. The Newsletter (initially simply called the Joint Section on Tumors Newsletter and, since 1999, Tumor News) has long served as a vehicle for publication to the membership of Executive Committee meeting minutes and award-winning abstracts from the national meetings, and for notification about details of upcoming meetings. In recent years there has been an effort to use this medium to notify the membership of important cooperative group clinical trials, as well as for brief review articles about important advances in brain tumor treatment. A more immediate means of communication between Section leaders and membership, and among the membership itself, is the Tumor Section Listserve, available through www.neurosurgery.org/listserv/ index.html.

While the Section's educational activities at the CNS and AANS meetings have been offered freely to all in attendance at the main meetings, only Section members receive discounted registration fees for the Section Satellite meetings. Members have also periodically received discounts on tumor- related books (such as Morantz and Walsh's Brain Tumors: A Comprehensive Text [39], and Sundaresan's Tumors of the Spine [40]). Since 1995, there has been a close relationship between the Section and Kluwer Academic Publishers' Journal of Neuro-Oncology. Section members receive a substantial discount on subscriptions.

Other activities

Another important function of the Section is advocacy for socioeconomic issues of importance to tumor neurosurgeons. These functions have long been subserved by the Washington Committee of the AANS/CNS. In the early years of the Section, the financial news contained in the Newsletter was limited to the Secretary-Treasurer's report on the slow but steady growth of the Section's resources – which have grown from the $8000 seed money to a current level of about $250,000 [41]. The Fall 2000 Newsletter was the first time that the work of the Washington Committee on tumor-related matters received prominent coverage in the newsletter [42], and recurring articles since that time reflect the growing importance of

socioeconomic issues to all neurosurgeons in recent years. The Section now makes an annual financial contribution to support the work of the Washington Committee.

Information on brain tumor patient support groups has also been disseminated frequently through the newsletter. This important aspect of multidisciplinary neuro-oncology practice was tirelessly supported by Sharon Lamb, RN in the earlier years of the Section.

The section and modern neurosurgery

It is interesting in looking back on the Section's early years to reflect on its purposes and goals. Although several authors have sketched the history of the separation of neurosurgery from general surgery as a separate specialty [43–47], the origins of subspecialty Sections within organized neurosurgery during 1972–1987 has received less attention [48–52].

Specialization within medicine has been a source of conflict since its earliest appearances. Phenomena characteristic of the emergence of a new medical specialty in modern society [53–58] include (as articulated by Rothstein [59]): (1) a new body of specialized knowledge and/or techniques; (2) population centers large enough to support the new specialists; (3) conditions making restricted practice financially or otherwise rewarding for individual practitioners. The "new body of knowledge or techniques" is clearly critical. Novel technology, whose early adopters form the core of the new specialty, is commonly associated with specialty emergence. The ophthalmoscope, laryngoscope and stethoscope are examples, with parallels in neurology [60]. Greenblatt [44] has argued that Cushing's techniques for intracranial pressure control were the new knowledge responsible for the emergence of neurosurgery as a specialty, when added to existing techniques of anesthesia, asepsis and cerebral localization. Yasargil [61] felt that the emergence of subspecialties within neurosurgery was critically dependent on the operating microscope and other intraoperative technologies. While microsurgical skills did define the careers of many prominent neurosurgeons in the second half of the twentieth century, many of the subspecialty Sections developed along lines drawn as much or more by nonoperative management skills and basic research knowledge – Pediatrics, Cerebrovascular, Tumor, Trauma. Perhaps the Sections first formed in the 1970s and 1980s because critical masses of surgeons then emerged whose practices were predominantly limited to subspecialized areas, and who interacted with similarly specialized allied specialists within their hospitals, rather than because of the appearance of any individually decisive new surgical technologies.

In contrast to a schism within a professional group, splitting one body of practitioners into two, the Tumor Section began with the goal of "assist[ing] in the education of neurosurgeons in neuro-oncology and to serve as a resource to [the AANS and CNS] and other national groups on the clinical treatment of and research into nervous system tumors" [3]. This inclusive policy framed a model of educating all neurosurgeons in the essentials of neurosurgical oncology. The principal means of achieving this laudable goal was to foster strong, diverse open and invited presentations at Section meetings. The success of this policy can be measured in two ways: by examining the meeting presentations themselves, and by studying the actual results of tumor neurosurgery at the community level.

First, the quality of presentations at the Section's meetings has always been felt to be high, as attested both by anecdotal reports [18] and by meeting evaluations (e.g., 90% felt overall meeting was very good or excellent, 80% felt presentations were relevant to their practice [62]). Another means of judging the quality of presentations at scientific meetings is to tally the percentage of presented abstracts that reach full publication in peer-reviewed journals. The average publication rate for medical meetings, by 4 years after the presentation, is 41% – about 46% for oral presentations and 37% for poster presentations [63]. Surgical meetings have lower publication rates. In contrast, the actuarial 4-year publication rate for oral presentations at Tumor Section sessions from the 1999 to 2002 AANS and CNS national meetings was 73% (Figure 2) – among the highest reported for any medical meeting [63,64], far greater than reported from spine [65] or neuroradiology meetings [66], and comparable to the rate reported for the prestigious American Society for Clinical Oncology annual meeting [67].

Are there measurable results from this effort to disseminate knowledge? By the mid-1980s, published mortality rates for malignant glioma craniotomies at specialist centers were about 1% [68– 71]. Figure 3 shows the mortality rate after craniotomy for low-grade glioma at the Mayo Clinic, 1920–1974; mortality rates fell from 30 to 2% [72]. However, the community mortality rate outside of high-volume centers was substantially higher than published rates. Figure 4 shows the population based mortality rate after primary brain tumor craniotomy in the US, 1980–2000 (data from the National Hospital Discharge Survey, National Center for Health Statistics, Centers for Disease Control and Prevention, Hyattsville, MD). In 1984, when the Section was formed, in-hospital operative mortality was nearly 8%. By 2000, mortality community-wide had fallen below 2%. Meanwhile, the annual number of such operations performed in the United States nearly doubled (Figure 5).

Sharing the means to good patient outcomes with general neurosurgeons was the most clearly articulated goal of the Section's founders. These data suggest that this goal is being met. The challenge for the Section's future will be to continue in the same path toward better outcomes for all brain tumor patients, through education and fostering clinical and laboratory research.

The 20th anniversary special issue

The Section on Tumors dedicates a large portion of its presentation sessions at the AANS and CNS, its Tumor Satellite Symposia, and its biannual awards to highlighting the investigative aspects of tumor treatment as well as basic science tumor research. For the 20th Anniversary of the section, Dr. Sawaya envisioned shifting the spotlight to focus specifically on the surgical care of tumor patients. Specifically, he envisioned a comprehensive treatise including all modern clinical techniques of surgical care, covering the clinical care of patients with tumors in all locations of the cranium, brain, spine, spinal cord and peripheral nerves, presented by recognized experts in their respective fields drawn predominantly from the ranks of the Section on Tumors. It was hoped that the final product would serve the triple purposes of, (a) insightful introspection on how far we have come in the surgical care of our tumor patients, (b) providing a comprehensive benchmark describing best current clinical surgical practices, and (c) serving as a viewing portal through which to peer towards things yet to come.

The special supplement edition is divided into two sequential volumes. Each volume of the special supplement edition contains an introductory preface. The first is centered on the history of the Section on Tumors. The second is a personal historical reflection on the development, current status, and future promise of surgical neuro-oncology by our current Section Chairman. Each volume of the special supplement edition also contains 11 papers. Surgical techniques ranging from stereotaxis to endoscopy to microsurgery, from frameless stereotaxis to intra-operative MR imaging, and from brachytherapy to stereotactic radiosurgery are all included. Tumor types addressed include benign and malignant primary brain tumors, metastatic tumors, pediatric tumors, pituitary and pineal region tumors, benign and malignant skull base tumors, spinal cord tumors, osseous spine tumors, and peripheral nerve tumors. Special topics include the evolution of the neurosurgical operating room, clinical trials design and implementation, and developing multidisciplinary brain tumor programs, and neurosurgical delivery of non-surgical therapies.

This special supplemental issue is published as a commemoration of 20 years of existence for the Joint Section on Tumors, and a celebration of clinical progress in the field of surgical neurooncology. We are proud of what we have been able to accomplish so far for the benefit of our patients afflicted with brain, skull base, spine, spinal cord, and peripheral nerve tumors, but we remain profoundly humbled by the realization of what remains to be done. We hope that you will enjoy the results of our project, and that this issue will find its own place in the history of our profession, our societies, and our section. The road goes ever onward. The need is great, and we must hurry to our work.

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References

1. Rosenblum M: How the AANS/CNS Section on Tumors was formed. Tumor News (AANS/CNS Section on Tumors Newsletter) Spring 2000: 15, 2000
2. Garretson HD: Utilization of resources for the maintenance of excellence in neurological surgery. The 1988 American Association of Neurological Surgeons presidential address. J Neurosurg 69: 815–825, 1988
3. Rosenblum M: Chairman's message. Joint Section on Tumors Newsletter April 1991: 1–3, 1991
4. Syllabi of the Joint Section on Tumors. AANS/CNS, Park Ridge, IL, n.d. [1991?]
5. Warnick R: The AANS Abstract Review Process – Everything You Always Wanted To Know, But Were Afraid To Ask. Tumor News (AANS/CNS Section on Tumors Newsletter) Spring 1999: 8, 1999
6. Stiles CD: Cancer of the nervous system. Review of an AACR special conference in cancer research with the Joint Section on Tumors of the AANS/CNS (San Diego, CA, June 7–11, 1997). Biochim Biophys Acta 1377: R1–R10, 1998
7. Bernstein M, Rutka J: Brain tumor protocols in North America. J Neurooncol 17: 231–251, 1993
8. Bigner D: Moses Stephen (Steve) Mahaley Jr, MD, PhD. Joint Section on Tumors Newsletter September 1992: 1–2, 1992
9. Mahaley MS, Jr.: Neuro-oncology index and review (adult primary brain tumors). Radiotherapy, chemotherapy, immunotherapy, photodynamic therapy. J Neurooncol 11: 85–147, 1991
10. Asher AL: The Select Review in Neuro-Oncology. Tumor News (AANS/CNS Section on Tumors Newsletter) Spring 2000: 14–15, 2000
11. Bernstein M, Berger MS (ed): Neuro-Oncology: the Essentials. Thieme Medical Publishers, New York, 2000
12. Walsh JW: Neuro-oncology fellowships. Joint Section on Tumors Newsletter April 1991: 6, 1991
13. Bernstein M, Rutka J: Neuro-oncology fellowships in North America. J Neurooncol 18: 61–68, 1994
14. Couldwell WT, Allis M: Neuro-oncology fellowships in North America. J Neurooncol 41: 89–94, 1999
15. Couldwell WT: Development of neuro-oncology fellowship guidelines. Tumor News (AANS/CNS Section on Tumors Newsletter) Fall 1999: 18, 1999
16. McDermott M: Awards overview. Tumor News (AANS/CNS Section on Tumors Newsletter) Fall 2003: 3, 2003
17. Chandler WF: Joint Section on Tumors Executive Committee Minutes, Vancouver, British Columbia, October 4, 1993. Joint Section on Tumors Newsletter March 1994: 1–2, 1994
18. Black PM: Chairman's address. Joint Section on Tumors Newsletter Spring 1995: 1, 1995
19. Liau L: Research subcommittee report. Tumor News (AANS/CNS Section on Tumors Newsletter) 5–6, 2003
20. Warnick ER, Raffel C, Glick RP: Neuro-oncology research opportunities in North America: results of a survey by the AANS/CNS section on tumors. J Neurooncol 61: 197–201, 2003
21. Cell phone statement response letter. Tumor News (AANS/CNS Section on Tumors Newsletter) Fall 2001: 6, 2001
22. Guyatt G, Rennie D: Users' Guides To The Medical Literature: A Manual For Evidence-Based Clinical Practice. AMA Press, Chicago, 2002
23. Rock JP, Rosenblum M: Guidelines Committee Report. Joint Section on Tumors Newsletter Fall 1995: 1995
24. Bernstein M: Low-grade gliomas: in search of evidence based treatment. Clin Neurosurg 44: 315–330, 1997
25. Low-grade Glioma Guidelines Team: Practice parameters in adults with suspected or known supratentorial nonoptic pathway low-grade glioma. Neurosurg Focus 4: Article 10, 1998
26. Rock JP, Haines S, Recht L, Bernstein M, Sawaya R, Mikkelsen T, Loeffler J: Practice parameters for the management of single brain metastasis. Neurosurg Focus 9: 2, 2000
27. Warnick RE, Longmore LM, Paul CA, Bode LA: Postoperative management of patients after stereotactic biopsy: results of a survey of the AANS/CNS section on tumors and a single institution study. J Neurooncol 62: 289–296, 2003
28. Mahaley MS Jr, Mettlin C, Natarajan N, Laws ER, Jr., Peace BB: National survey of patterns of care for brain tumor patients. J Neurosurg 71: 826–836, 1989
29. Mahaley MS, Jr., Mettlin C, Natarajan N, Laws ER, Jr., Peace BB: Analysis of patterns of care of brain tumor patients in the United States: a study of the Brain Tumor Section of the AANS and the CNS and the Commission on Cancer of the ACS. Clin Neurosurg 36: 347–352, 1990
30. Engelhard HH: Brain Tumor Patient Care Evaluation study. Tumor News (AANS/CNS Section on Tumors Newsletter) Fall 2000: 18, 2000
31. Anderson FA, Jr.: Glioma Outcomes Project Advisory Board: The Glioma Outcomes Project: a resource for measuring and improving glioma outcomes. Neurosurg Focus 4: 8, 1998
32. Laws ER, Parney IF, Huang W, Anderson F, Morris AM, Asher A, Lillehei KO, Bernstein M, Brem H, Sloan A, Berger MS, Chang S: Survival following surgery and prognostic factors for recently diagnosed malignant glioma: data from the Glioma Outcomes Project. J Neurosurg 99: 467–473, 2003
33. Laws ER, Shaffrey ME, Morris A, Anderson FA, Jr.: Surgical management of intracranial gliomas – does radical resection improve outcome? Acta Neurochir Suppl 85: 47–53, 2003
34. Chang SM, Barker FG, 2nd, Schmidt MH, Sloan AE, Kasper R, Phillips L, Shih K, Hariharan S, Berger MS: Clinical trial participation among patients enrolled in the Glioma Outcomes Project. Cancer 94: 2681–2687, 2002
35. Chang SM, Parney IF, McDermott M, Barker FG, 2nd, Schmidt MH, Huang W, Laws ER, Jr., Lillehei KO, Bernstein M, Brem H, Sloan AE, Berger M: Perioperative complications and neurological outcomes of first and second craniotomies among patients enrolled in the Glioma Outcome Project. J Neurosurg 98: 1175–1181, 2003
36. McDermott MW: A close look at Section membership. Tumor News (AANS/CNS Section on Tumors Newsletter) Fall 1999: 14, 1999
37. Lang FF, Jr.: Young Neurosurgeons Committee. Tumor News (AANS/CNS Section on Tumors Newsletter) Spring 2000: 16, 2000
38. Barnett G: Membership benefits of the AANS/CNS Section on Tumors. Tumor News (AANS/CNS Section on Tumors Newsletter) Fall 2003: 6, 2003
39. Morantz RA, Walsh JW (ed): Brain Tumors: A Comprehensive Text. M. Dekker, New York, 1993

40. Sundaresan N (ed): Tumors of the Spine: Diagnosis and Clinical Management. Saunders, Philadelphia, 1990
41. Warnick R: Secretary/Treasurer's Report. Tumor News (AANS/CNS Section on Tumors Newsletter) Fall 2003: 6, 2003
42. Orrico KO: Washington update. Tumor News (AANS/CNS Section on Tumors Newsletter) Fall 2000: 6, 2000
43. Greenblatt SH: Harvey Cushing and the issue of surgical subspecialization: an historical perspective. Surg Neurol 47: 412–413, 1997
44. Greenblatt SH: Harvey Cushing's paradigmatic contribution to neurosurgery and the evolution of his thoughts about specialization. Bull Hist Med 77: 789–822, 2003
45. Canale DJ: William Osler and ''the special field of neurological surgery''. J Neurosurg 70: 759–766, 1989
46. Laws ER: ''Schools'' of neurosurgery: their development and evolution. In: Greenblatt SH, Dagi TF, Epstein MH (eds) The History of Neurosurgery in its Scientific and Professional Contexts. AANS, Park Ridge, IL, 1997, pp 519–528
47. Sachs E: Neurosurgery recognized as a specialty. In: Fifty Years of Neurosurgery. Vantage Press, New York, 1958, pp 68–78
48. Wilkins RH (ed): History of the American Association of Neurological Surgeons, Founded in 1931 as The Harvey Cushing Society. AANS, Park Ridge, IL, 1981
49. Hauber CH, Philips CA: The evolution of organized neurological surgery in the United States. Neurosurgery 36: 814–824; discussion 824–826, 1995
50. Barrow DL, Kondziolka D, Laws ER, Jr., Traynelis VC (eds): Fifty Years Of Neurosurgery: Golden Anniversary Of The Congress Of Neurological Surgeons. Lippincott Williams & Wilkins, Philadelphia, 2000
51. Thompson JM (ed): History Of The Congress Of Neurological Surgeons, 1951–1991. Williams & Wilkins, Baltimore, 1992
52. Smith FP: Archival correspondence regarding the origin of the Harvey Cushing Society: the American Association of Neurological Surgeons. J Neurosurg 81: 950–955, 1994
53. Rosen G: The specialization of medicine with particular reference to ophthalmology. Froben Press, New York, 1944
54. Fye WB: American Cardiology: The History of a Specialty and its College. Johns Hopkins Press, Baltimore, 1996
55. Bynum CL, Nutton V (eds): The Emergence of Modern Cardiology (Supplement 5 to Medical History). Wellcome Institute for the History of Medicine, London, 1985
56. Cooter R: Surgery and Society In Peace And War: Orthopaedics and the Organization of Modern Medicine, 1880–1948. Macmillan, London, 1993
57. King LS: Medicine in the USA: historical vignettes. XXI. Medical practice: specialization. JAMA 251: 1333–1338, 1984
58. Stevens R: Medical Practice in Modern England: The impact of Specialization and State Medicine. Yale University Press, New Haven, 1966
59. Rothstein W: American Physicians in the Nineteenth Century: From Sects to Science. Johns Hopkins University Press, Baltimore, 1972
60. Lanska DJ: The role of technology in neurologic specialization in America. Neurology 48: 1722–1727, 1997
61. Yasargil MG: The history of optical instruments and microneurosurgery, in Barrow DL, Kondziolka D, Laws ER, Jr., Traynelis VC (eds): Fifty Years Of Neurosurgery: Golden Anniversary Of The Congress Of Neurological Surgeons. Lippincott Williams & Wilkins, Philadelphia, 2000, pp 105–142
62. Warnick RE: AANS/CNS Section on Tumors Fourth Biennial Satellite Symposium. Tumor News (AANS/CNS Section on Tumors Newsletter) Fall 2000: 12, 2000
63. von Elm E, Costanza MC, Walder B, Tramer MR: More insight into the fate of biomedical meeting abstracts: a systematic review. BMC Med Res Methodol 3: 12, 2003
64. Scherer RW, Dickersin K, Langenberg P: Full publication of results initially presented in abstracts. A meta-analysis. JAMA 272: 158–162, 1994
65. Wang JC, Yoo S, Delamarter RB: The publication rates of presentations at major Spine Specialty Society meetings (NASS, SRS, ISSLS). Spine 24: 425–427, 1999
66. Marx WF, Cloft HJ, Do HM, Kallmes DF: The fate of neuroradiologic abstracts presented at national meetings in 1993: rate of subsequent publication in peer-reviewed, indexed journals. AJNR Am J Neuroradiol 20: 1173–1177, 1999
67. De Bellefeuille C, Morrison CA, Tannock IF: The fate of abstracts submitted to a cancer meeting: factors which influence presentation and subsequent publication. Ann Oncol 3: 187–191, 1992
68. Salcman M: Historical development of surgery for glial tumors. J Neurooncol 42: 195–204, 1999
69. Ciric I, Ammirati M, Vick N, Mikhael M: Supratentorial gliomas: surgical considerations and immediate postoperative results. Gross total resection versus partial resection. Neurosurgery 21: 21–26, 1987
70. Ammirati M, Vick N, Liao YL, Ciric I, Mikhael M: Effect of the extent of surgical resection on survival and quality of life in patients with supratentorial glioblastomas and anaplastic astrocytomas. Neurosurgery 21: 201–206, 1987
71. Salcman M, Kaplan RS, Ducker TB, Abdo H, Montgomery E: Effect of age and reoperation on survival in the combined modality treatment of malignant astrocytoma. Neurosurgery 10: 454–463, 1982
72. Laws ER, Jr.: Presidential address: Tradition in neurosurgery: doing well what has been done before. Neurosurgery 16: 739–753, 1985

Figure 1. Graph showing active and total membership figures for the AANS/CNS Joint Section on Tumors.

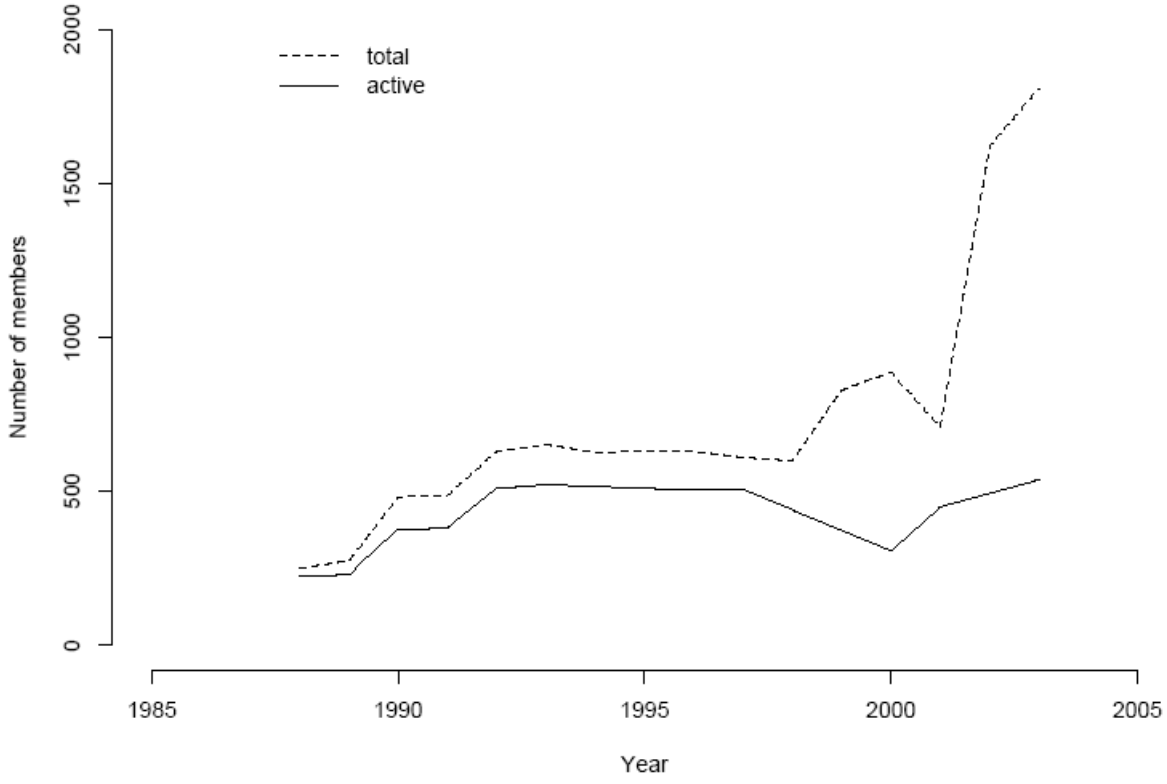

Figure 2. Kaplan-Meier plot of actuarial rate of full publication in MEDLINE-indexed journals of 122 abstracts presented orally at AANS/CNS Joint Section on Tumors sessions at the annual AANS and CNS meetings, 1999-2002. By four years after presentation the actuarial rate of full publication was 73%.

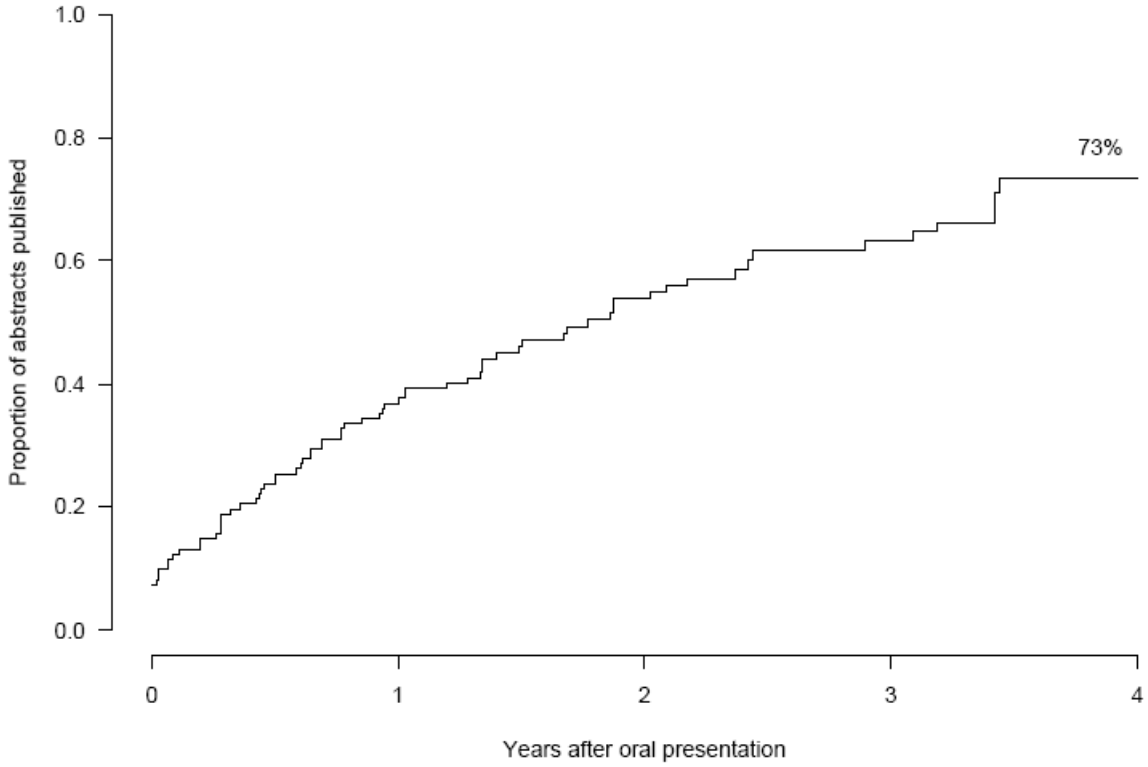

Figure 3. Graph showing postoperative mortality rates after low-grade glioma operations at the Mayo Clinic, Rochester, MN, 1920-1974. Reproduced from [72].

Figure 4. Population-based in-hospital mortality rate after craniotomy for primary malignant brain tumors in United States hospitals, 1980-2000. Arrow indicates 1984, the founding date of the Tumor Section. Based on data from the National Hospital Discharge Survey (National Center for Health Statistics, Centers for Disease Control and Prevention, Hyattsville, MD). Between 1984 and 2000 the operative mortality rate fell from almost 8% to 2%.

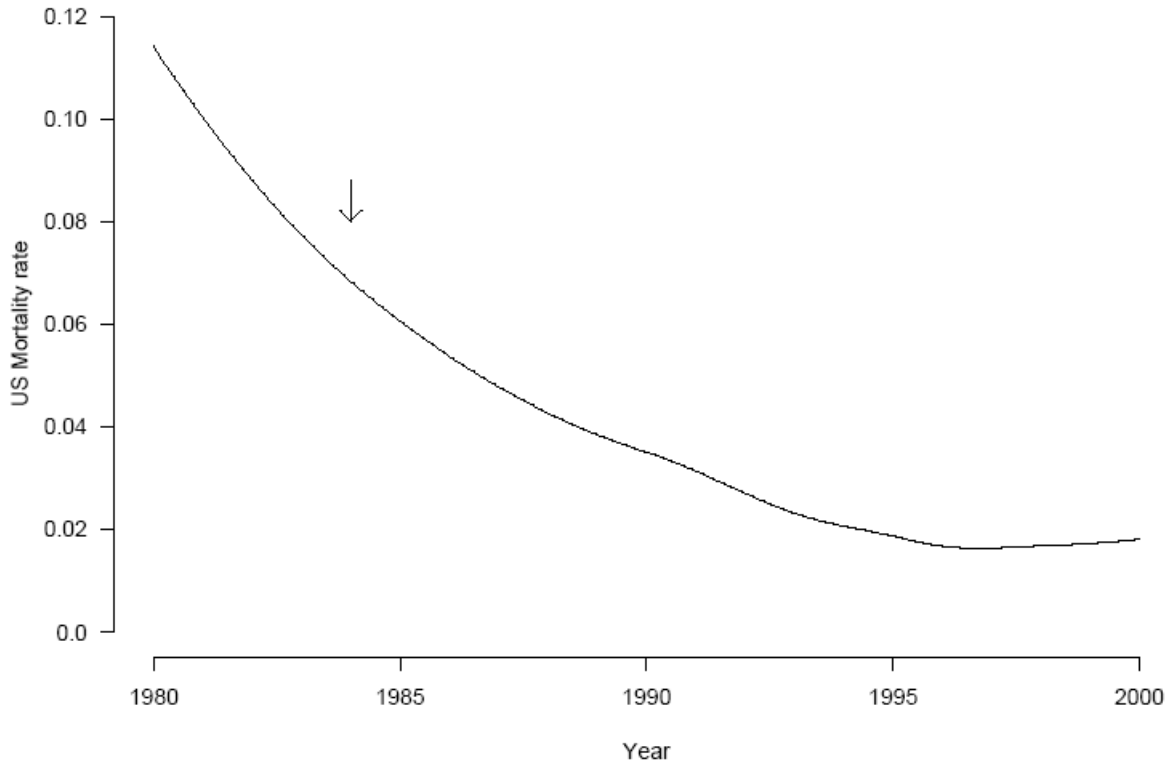

Figure 5. Total annual number of craniotomies for primary malignant brain tumors in the United States, 1984-2000. Arrow indicates 1984, the founding date of the Tumor Section. Based on data from the National Hospital Discharge Survey (National Center for Health Statistics, Centers for Disease Control and Prevention, Hyattsville, MD). Between 1984 and 2000 the number of such operations performed annually in the United States almost doubled.

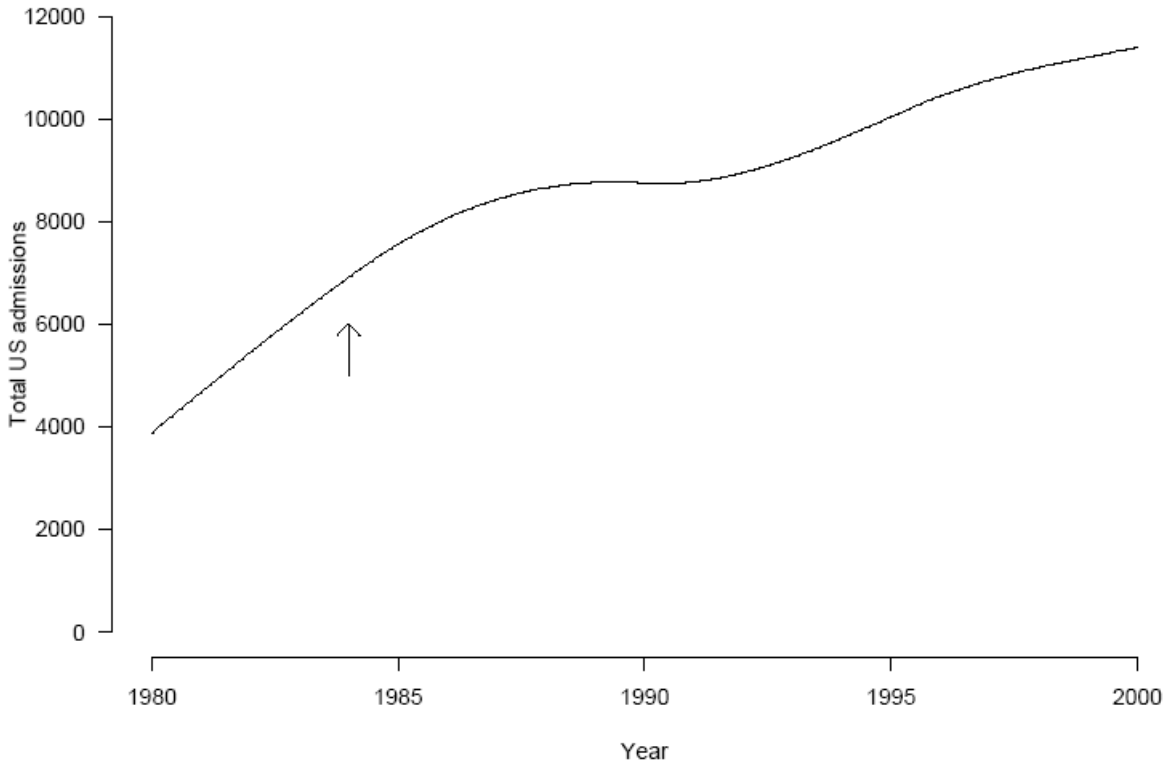

Table 1. Preuss Resident Award winners.

1987	John Zovickian Corey Raffel
1988	Charles Wrobel
1989	Jacob Rachlin Ian Pollack
1990	Charles Gordon Alfred Bowles
1991	William Couldwell Douglas Kondziolka
1992	Douglas Brockmeyer Mark Linskey
1993	Frederick Lang Michael Haglund
1994	Kamal Thapar Eric Flores
1995	John Brayton John Yu
1996	Margaret Wallenfriedman Barry Birch
1997	Andrew Metzger Walter Jean
1998	Matthias Feldkamp Bob Carter
1999	Sandeep Kunwar Terrence Julien
2000	Amy Heimberger Michael Taylor
2001	Jeffrey Leonard Andrew Parsa
2002	Jorge Gonzalez-Martinez Loi Phuong
2003	Markus Bredel John Y. K. Lee

Table 2. Mahaley Award winners.

1991	James Melisi
1992	Robert Sanford Mark Bernstein
1993	Georg Noren John Schneider
1994	Shlomi Constantini Albino Bricolo
1995	Wolfgang Koos Robert Selker
1996	William Hitselberger Walter Hall
1997	Douglas Kondziolka Fred Barker
1998	Prem Pillay Byron Young
1999	Douglas Kondziolka Bruce Pollock
2000	Robert Weil Ronald Warnick
2001	Yutaka Sawamura Hae-Dong Jho
2002	Joung Lee Gene Barnett
2003	Marcus Ware Franco DeMonte

Table 3. ABTA Young Investigator Award winners.

1995	Douglas Laske
1996	Liliana Goumnerova William Broaddus
1997	N. Scott Litofsky Ian Pollack
1998	Michael Hsiao Eric Elowitz
1999	Walter Stummer Quentin Malone
2000	Karen Aboody John Yu
2001	Türker Kiliç Randy Jensen
2002	Howard Weiner Russell Lonser
2003	Moneeb Ehtesham Qingze Wu

Table 4. Farber Lecturers.

1994	Webster Cavenee
1995	Philip Gutin
1996	Gregory Cairncross
1997	Peter Burger
1998	Mark Israel
1999	Edward Oldfield
2000	Stuart Grossman
2001	Robert Martuza
2002	Abhijit Guha
2003	David Louis

Appendix A. Bibliography of secondary sources on the history of brain tumor surgery

In 1890, in the second book ever written on brain tumors, Philip Knapp admitted that the literature on brain tumor surgery had become too large for him to tabulate, and by 1917 Harvey Cushing found the same to be true of the literature on acoustic neuromas. Over the century since Knapp the literature on the topic of brain tumors has become very large indeed. The bibliographer has the additional problem of the innumerable closely-allied topics which must be included or excluded – topics such as the history of neurosurgical technique, neuropathology and neuroradiology, pediatric and stereotactic neurosurgery, radiation treatment and chemotherapy, the biographies of famous surgeons, and so on.

This bibliography is principally limited to secondary sources, or articles and books about the history of brain tumor surgery, rather than attempting to list the primary sources themselves. An exception has been made for books on brain tumor surgery before 1940, because these works often contained extensive bibliographies of contemporary literature. Brief annotations have been added for some works. The selection is biased toward sources not indexed in MEDLINE (book chapters, articles before 1966) and is limited to intracranial tumors.

General works on brain tumors

Most books and articles in this section are general treatises on brain tumor treatment. Histories of technical advances include 23, 33 and 41 (general), 31, 44 and 48 (Cushing), 38 and 52 (Bovie), and 39 (microsurgery). Articles 46, 49, 51 and 54 concern pediatric tumor surgery. Articles 45 and 53 are helpful bibliographies on neurosurgical history. The fullest enumeration of primary articles on early brain tumor surgery is probably the listings in the various editions of the Index-Catalogue to the Surgeon-General's Collection.

1. Bramwell B: Intracranial Tumours. Edinburgh: Pentland, 1888. 270 pages. The first book on brain tumors; chapter on surgery by Arthur Hare.
2. Knapp PC: The Pathology, Diagnosis and Treatment of Intra-cranial Growths. Boston: Rockwell & Churchill, 1891. 72 cases, 62 references. An influential sequel was: Knapp PC. The results of operation for the removal of brain tumors. Bost Med Surg J 154: 124–6, 1906.
3. Starr MA: Brain Surgery. New York: William Wood & Co., 1893. Chapter on brain tumors. List of 97 cases based on Knapp, supplemented.
4. Chipault A: Chirurgie ope´ ratoire du syste` me nerveux. Vol. 1. Paris: Rueff, 1894. Extensive chapter on brain tumors, with table of 135 brain tumors and 70 skull tumors operated.
5. Auvray M: Les tumeurs ce´ re´ brales. Paris: Bailliere et Fils, 1896. 466 pages. Bibliography with 100 references, but scanty details on the publications.
6. Broca A, Maubrac P: Traite´ de chirurgie ce´ re´ brale. Paris: Masson, 1896. Chapter on brain tumors.
7. Bruns L: Die Geschwu¨ lste des Nervensystems. Berlin: S. Karger, 1897. 388 pages. Revised 1908.
8. Oppenheim H: Beitra¨ ge zur Diagnostik und Therapie der Geschwu¨ lste im bereich des zentralen Nervensystems. Berlin: S. Karger, 1897. 193 pages.
9. Chipault A: L'e´ tat actuel de la chirurgie nerveuse. Paris: Rueff, 1902-03. Country-by-country descriptions of the state of the neurosurgical art in about 40 countries, with thousands of references. Brain tumors are covered in detail in most chapters. For example, Keen's chapter on the United States has notes on 99 brain tumor operations.
10. Blackburn IW: Intracranial Tumors Among the Insane. Washington: Government Printing Office, 1903.
11. Bru¨ nniche E: Studier over Hjaernesvulsternes Behandlung.

Kobenhavn: Schubotheske Forlag, 1903. In Danish. 305 references.
12. Duret H: Les tumeurs de l'encephale. Paris: Felix Alcan, 1905. 835 pages. Tabulates 400 operated cases.
13. Mills CK, Frazier CH, de Schweinitz GE, Weisenburg TH, Lodholz E: Tumors of the Cerebellum. New York: A. R. Elliott, 1905. Reprinted from N Y Med J and Phila Med J. This and the following item concentrated on American cases.
14. Mills CK, Frazier CH, Spiller WG, de Schweinitz GE, Weisenburg TH: Tumors of the Cerebrum. Philadelphia: E. Pennock, 1906. Reprinted from U Penn Med Bull.
15. Wyllie J: Tumours of the Cerebellum. London: H.K. Lewis, 1908.
16. Be´ rard A: Diagnostic et traitement des tumeurs du cervelet et de la fosse ce´ re´ belleuse. Lyon: P. Grange et Refoubelet, 1910. 176 pages. Doctoral thesis.
17. Henschen F: U¨ ber Geschwu¨ lste der hinteren Scha¨ delgrube insbesondere des Kleinhirnbru¨ ckenwinkels. Jena: Gustav Fischer, 1910. Tabulates 136 cases of unilateral and 16 of bilateral acoustic neuroma. Extensive bibliography.
18. Tooth HH: The treatment of tumors of the brain and the indications for operation. Tr Internat Congr Med London 11/1: 161–257, 1913. The only comprehensive description of Victor Horsley's brain tumor practice and results.
19. Christiansen V: Les tumeurs du cerveau. Paris: Masson, 1921. 2nd edition, 1925. Translation of Hjernesvulster (Danish).
20. Olivecrona H: Die Chirurgische Behandlung der Gehirntumoren. Berlin: Julius Springer, 1927.
21. Purves-Stewart J: Intracranial Tumours and Some Errors in their Diagnosis. Oxford: Blackwell Scientific, 1927. Based on personal cases.
22. Puusepp LM: Die Tumoren des Gehirns; ihre Symptomatologie, Diagnostik und operative Behandlung, auf Grund einer Beobachten. Tartu: Kru¨ ger, 1929. 2 vol., 726 pages.
23. Rogers L: The history of craniotomy: an account of the methods which have been practiced and the instruments used for opening the human skull during life. Ann Med Hist 2 (n.s.): 495–514, 1930. 145 references. Mostly about premodern neurosurgery.
24. Courville CB: Intracranial Tumors. Their Pathology, Symptomatology, Diagnosis and Prognosis. Providence, RI: Snow & Farnham, 1931. 176 references.
25. Davidoff LM: Brain Tumors. Their Pathology, Symptomatology, Diagnosis and Prognosis. Utica, NY: State Hospitals Press, 1931. 204 references.
26. de Martel T, Guillaume J: Les tumeurs ce´ re´ brales. Paris: G. Doin, 1931.
27. Sachs E: The Diagnosis and Treatment of Brain Tumors. St. Louis: Mosby, 1931.
28. Bailey P: Intracranial Tumors. Springfield, IL: Charles C. Thomas, 1933. Bibliography with 421 references, increased to 521 for 2nd edition, 1948.
29. de Martel T, Guillaume J: Les tumeurs de la loge ce´ re´ belleuse. Fosse ce´ re´ brale poste´ rieure. Diagnostic et traitement. Paris: G. Doin, 1934.
30. Browder J: Advances in neurological surgery during the past fifty years. Am J Surg 51: 164–187, 1941.
31. Horrax G: Some of Harvey's Cushing's contributions to neurological surgery. J Neurosurg 1: 3–22, 1944. On Cushing's technique.
32. Green RE: Surgery of the posterior fossa, in Walker AE (ed): A History of Neurological Surgery. Williams & Wilkins, Baltimore, 1951, pp 114–133.
33. Walker AE (ed): A History of Neurological Surgery. Baltimore: Williams & Wilkins, 1951. Chapters on neurosurgical technique include much material on tumors.
34. Scarff JE: Fifty years of neurosurgery, 1905–1955. Int Abstr Surg 101: 417–513, 1955. Much on brain tumors.
35. Petit-Dutaillis P: L'evolution de la chirurgie des lesions

expansives de la moelle et surtout du cerveau. Progr Med 88: 355–369, 1960.
36. Tonnis W, Muller W: Uber einen Hirntumor aus spatromischer zeit, in: Medicinae et artibus: Festschrift fur Prof. Dr. med. Wilhelm Katner zu seinem 65. Geburtstag. Dusseldorf, 1968, pp 179–80.
37. Novak D: Radiological diagnosis of brain tumors – a historical review. Proc XXIII Int Congress Hist Med 1974.
38. Beatty WK: William T. Bovie, inventor and teacher. Trans Stud Coll Physicians Phila 5: 138–44, 1979.
39. Donaghy RM: The history of microsurgery in neurosurgery. Clin Neurosurg 26: 619–25, 1979.
40. Wertheimer P, David M, Sindou M, et al.: Naissance et croissance de la neurochirurgie. Neurochirurgie 25: 247–63, 1979. 481 references. Much on brain tumors and a brief chapter on pituitary.
41. Pait TG, Dennis MW, Laws ER, Jr., Rizzoli HV, Azzam CJ: The history of the neurosurgical engine. Neurosurgery 28: 111–129, 1991.
42. Pearce JM: The first attempts at removal of brain tumors, in Rose FC, Bynum WF (ed): Historical aspects of the neurosciences. Raven, New York, 1982, pp 239–42.
43. Sironi VA: Contributo alla storia della neurochirurgia in Italia: considerazioni sui primi tentativi di asportazione di tumori cerebrali alla fine dell ’800 ed agli inizi del ’900, in Galeazzi O (ed): Medicina e storia. Il lavoro editorale, Ancona, 1986, pp 2: 151–7.
44. Moore MR, Rossitch E, Jr., Black PM: The development of neurosurgical techniques: the postoperative notes and sketches of Dr. Harvey Cushing. Acta Neurochir 101: 93–9, 1989.
45. Rhee YK: History of neurosurgery [bibliography]. Washington, D.C.: National Library of Medicine, 1989. A bibliography of articles on the history of neurosurgery.
46. Canale DJ, Longo LD: Harvey Cushing and pediatric neurosurgery. Neurosurgery 27: 602–10; discussion 610–1, 1990.
47. Rossitch E, Jr., Moore MR, Alexander Ed, Black PM: Historical vignette. The neurosurgeon’s neurosurgeon: Cushing operates on a Penfield. Surg Neurol 33: 150–3, 1990.
48. Light RU: The contributions of Harvey Cushing to the techniques of neurosurgery. Surg Neurol 35: 69–73, 1991.
49. Sathi S, Rossitch E, Jr., Moore MR, Black PM: Harvey Cushing’s postoperative sketches of pediatric brain tumors. Childs Nerv Syst 7: 56–8, 1991.
50. Moore MR: Cushing’s surgical sketches of gliomas, in Black PM (ed): The surgical art of Harvey Cushing. AANS, Park Ridge, IL, 1992, pp 71–124.
51. Cohen AR: The history of fourth ventricular surgery, in Cohen AR (ed): Surgery of the Fourth Ventricle. Blackwell Science, Oxford, 1996, pp 3–19.
52. O’Connor JL, Bloom DA: William T. Bovie and electrosurgery. Surgery 119: 390–396, 1996.
53. Goodrich JT: Standard bibliography and biography in the history of neurosurgery and the neurosciences, in Greenblatt SH (ed): A History of Neurosurgery in its Scientific and Professional Contexts. AANS, Park Ridge, IL, 1997, pp 581–4. Lists standard sources on the history of neurosurgery.
54. Cohen-Gadol AA, Spencer DD: Inauguration of pediatric neurosurgery by Harvey W. Cushing: his contributions to the surgery of posterior fossa tumors in children. J Neurosurg (Pediatrics 2) 100: 225–231, 2004.

History of glioma surgery

Many articles in this section (1–4, 6, 9) describe the 1885 operation by Godlee, under Bennett's direction, that is generally accepted as the first resection of a glioma guided by cerebral localization. Articles 13 and 19 offer the broadest perspective.

1. Power DA: Some bygone operations in surgery. VIII. The first localized cerebral tumor. Br J Surg 19: 523–526, 1932.
2. Trotter W: A landmark in modern neurology [Sir Rickman Godlee operation]. Lancet 2: 1207, 1934.
3. Bramwell E: Alexander Hughes Bennett and the first recorded case in which an intracranial tumour was removed by operation. Edinburgh Med J 42: 312–315, 1935.
4. Feiling A: Appendix II [the Sir Rickman Godlee operation], in: A History of the Maida Vale Hospital for Nervous Diseases. Butterworth, London, 1958, pp 47–63. A collection of articles regarding the operation, including pieces from the Lancet and The Times both from the time of operation and at the 50th anniversary jubilee.
5. Ljunggren B: The case of George Gershwin. Neurosurgery 10: 733–6, 1982.
6. Kirkpatrick DB: The first primary brain-tumor operation. J Neurosurg 61: 809–13, 1984.
7. Bailey OT: Genesis of the Percival Bailey-Cushing classification of gliomas. Pediatr Neurosci 12: 261–5, 1985.
8. Critchley M: 1884–1984, a century of endeavour, in: The Citadel of the Senses, and Other Essays. Raven, New York, 1986, pp. 98–108.
9. Davis CH, Bradford R: A surgical history of Maida Vale Hospital, in Walker MD, Thomas DGT (eds): Biology of Brain Tumour. Martinus Nijhoff, Boston, 1986, pp 245–9.
10. Weir B: The American centennial of brain tumor surgery. Neurosurgery 22: 986–93, 1988.
11. Mennel HD: Grading of intracranial tumors following the WHO classification. Neurosurg Rev 14: 249–260, 1991.
12. McLean AJ: Brain tumors always die: a satiric parade. 1937. Surg Neurol 39: 99–100, 1993.
13. Selby R: The surgical treatment of cerebral glioblastoma multiforme: an historical review. J Neurooncol 18: 175–82, 1994.
14. Greenblatt SH: The role of brain tumors in the establishment of modern neurosurgery. Med Health R I 79: 207–9, 1996.
15. Schiller F: Early approaches to brain tumors. Neurosurgery 38: 1023–30, 1996. An eclectic article about the neglected period of brain tumor history before Cushing.
16. Schulder M, Loeffler JS, Howes AE, Alexander E, 3rd, Black PM: Historical vignette: The radium bomb: Harvey Cushing and the interstitial irradiation of gliomas. J Neurosurg 84: 530–2, 1996.
17. Keller T. The first primary brain tumor operation in America. Surg Neurol 45: 463–6, 1996. On Hirschfelder and Morse's 1886 San Francisco operation.
18. Saris S: Intracranial tumors: the evolution of treatment, in Greenblatt SH (ed): A History of Neurosurgery: In Its Scientific and Professional Contexts. AANS, Park Ridge, IL, 1997, pp 247–258.
19. Salcman M: Historical development of surgery for glial tumors. J Neurooncol 42: 195–204, 1999.
20. Black PM, Black CT: History of neurosurgery for intracranial mass lesions. Neurosurg Clin N Am 12: 1–9, vii, 2001.

Meningiomas

Cushing's contributions (1, 2) are masterly. The story of his multiple operations on General Wood is told in articles 3, 5, and 18, as well as in a chapter in Cushing's Meningiomas. Other early operations include those of Pecchioli (7), Durante (2, 6), and Keen (8, 9, 19). Articles 11, 12 and 14 are broad overviews.

1. Cushing H: Historical and terminological, in: Meningiomas: Their Classification, Regional Behaviour, Life History, and Surgical End Results. Charles C. Thomas, Springfield, IL, 1938, pp 3–18. 531 references.
2. Cushing H, Eisenhardt L: Notes on the first reasonably successful removal of an intracranial tumor. Bull Los Angeles Neurol Soc 3: 95–97, 1938. On Durante's case.
3. Berland T: Saving the brain of General Wood. Today's Health 44: 28–33, 90, 1966. Famous case of Cushing's.
4. Mironovich NI: (The first operations on meningiomas of the brain in Russia). Vopr Neirokhir 30: 50–1, 1966.
5. Ljunggren B: The case of General Wood. J Neurosurg 56: 471–4, 1982.
6. Guidetti B: Francesco Durante. June 29, 1844 to October 2, 1934. Surg Neurol 20: 1–3, 1983.
7. Giuffre R: Successful radical removal of an intracranial meningioma in 1835 by Professor Pecchioli of Siena. J Neurosurg 60: 47–51, 1984.
8. Bingham WF: W.W. Keen and the dawn of American neurosurgery. J Neurosurg 64: 705–12, 1986.
9. Weir B: The American centennial of brain tumor surgery. Neurosurgery 22: 986–93, 1988.
10. Bakay L: Cruveilhier on meningiomas (1829–1842). Surg Neurol 32: 159–64, 1989.
11. al-Rodhan NR, Laws ER, Jr.: Meningioma: a historical study of the tumor and its surgical management. Neurosurgery 26: 832–46, 1990.
12. al-Rodhan NR, Laws ER, Jr.: The history of intracranial meningiomas, in al-Mefty O (ed): Meningiomas. Raven, New York, 1991, pp 1–7.
13. Anderson T: A medieval example of meningiomatous hyperostosis. Br J Neurosurg 5: 499–504, 1991.
14. Bakay L: The history of surgery of meningiomas, in Schmidek HH (ed): Meningiomas and their Surgical Management. W.B. Saunders, Philadelphia, 1991, pp 173–180.
15. Siegelman ES, Mishkin MM, Taveras JM: Past, present, and future of radiology of meningioma. Radiographics 11: 899–910, 1991.
16. Anderson T: An example of meningiomatous hyperostosis from medieval Rochester. Med Hist 36: 207–13, 1992.
17. Black PM: Cushing's surgical sketches of meningiomas, in Black PM (ed): The Surgical Art of Harvey Cushing. AANS, Park Ridge, IL, 1992, pp 35–70.
18. Rolak LA, Rolak B: Leonard Wood: The physician who was almost President of the United States. J Med Biogr 6: 35–8, 1998.
19. Rovit RL, Couldwell WT: A man for all seasons: W.W. Keen. Neurosurgery 50: 181–90, 2002.

Acoustic neuroma and cerebellopontine angle

Many of the publications on the history of acoustic tumor surgery have been written by surgical pioneers, such as Cushing (1) and House (8, 14, 18). Articles 2, 12 and 18 are comprehensive.

1. Cushing H: Surgical treatment, in: Tumors of the Nervus Acusticus. W. B. Saunders, Philadelphia & London, 1917, pp. 244–278. 215 references, ‘‘about a third’’ of those Cushing traced.
2. Vozza JV: Historiographical commentary concerning the knowledge of the acoustic tumors. Rev Laryngol (Bordeaux) 86: 253–61, 1965. Comprehensive; 49 references.
3. Glasscock ME, 3rd: History of the diagnosis and treatment of acoustic neuroma. Arch Otolaryngol 88: 578–85, 1968.
4. Jongkees LB: Some remarks on the history of transtemporal bone acoustic neuroma surgery. Arch Otolaryngol 89: 316–8, 1969.
5. Miehlke A: A history of the surgery of the facial nerve, in: Surgery of the Facial Nerve. Urban & Schwartzenberg, Munchen, 1973, pp 3–7.
6. Suarez Nieto C: (Historical development of the diagnosis and treatment of neurinomas of the acoustic nerve). Acta Otorinolaryngol Iber Am 24: 48–88, 1973.
7. Izquierdo JM: (Descriptive history of neurosurgical procedures in the treatment of acoustic neurinomas). Rev Esp Otoneurooftalmol Neurocir 35: 63–81, 1977.
8. House WF: History of the development of the translabyrinthine approach. In: Silverstein H, Norrell (eds). Neurological Surgery of the Ear. Birmingham, AL: Asculapius, 1977. Vol 1, pp 235–238. Personal narrative by a pioneer.
9. Hoogland GA: Some historical remarks on acoustic neuroma. Adv Otorhinolaryngol 34: 3–7, 1984.
10. Penzholz H: Development and present state of cerebellopontine angle surgery from the neuro- and otosurgical point of view. Arch Otorhinolaryngol 240: 167–74, 1984.
11. Harner SG: Acoustic neuromas: yesterday, today, and tomorrow. N Y State J Med 87: 640–1, 1987.
12. Moskowitz N, Long DM. Acoustic neurinomas – historical review of a century of operative series. Neurosurg Q 1: 2–18, 1991. 141 references, reviewing 127 series (almost 11,000 patients).
13. Glasscock ME, 3rd: The history of glomus tumors – a personal perspective. Laryngoscope 103: 3–6, 1993.
14. House WF: The acoustic neuroma saga. J Laryngol Otol 109: 367–8, 1995.
15. Ramsden RT: The bloody angle: 100 years of acoustic neuroma surgery. J R Soc Med 88: 464P–468P, 1995.
16. Ramsden RT: ‘A brilliant surgical result, the first recorded’: Annandale’s case, 3 May 1895. J Laryngol Otol 109: 369–73, 1995.
17. Ahn MS, Jackler RK, Lustig LR: The early history of the neurofibromatosis. Evolution of the concept of neurofibromatosis type 2. Arch Otolaryngol Head Neck Surg 122: 1240–9, 1996.
18. House WF: A history of acoustic tumor surgery: 1800–1960, and Glasscock ME, 3rd, Bohrer PS, Steenerson RL: A history of acoustic tumor surgery: 1961-present. In: House WR, Luetje CM, Doyle KJ (eds). Acoustic Tumors: Diagnosis and Management, 2nd edition. San Diego: Singular Publishing, 1997. Pages 1–19, 21–26. Minimal changes from the four-chapter version in the first edition (1979).
19. Goodrich JT: A millennium review of skull base surgery. Childs Nerv Syst 16: 669–85, 2000.

Pituitary

The history of pituitary disorders and their surgical treatment has been well served by many authors. Cushing's historical summary (1), an overview of his technical contributions (12), his early Cushing's disease patient "Minnie G". (25, 35) and the followup results of his lifetime series (3, 5) are central. Articles 7 and 20 are very full historical treatments; 33 and 34 are more accessible, skillful modern overviews.

1. Cushing H: Treatment, in: The Pituitary Body and its Disorders. J. B. Lippincott, Philadelphia & London, 1912, pp 291–322. Tabulates 43 surgical cases.
2. Cope VZ: The pituitary fossa, and the methods of surgical approach thereto. Br J Surg 4: 107–144, 1916.
3. Henderson WR: The pituitary adenomata. A follow-up study of the surgical results in 338 cases (Dr. Harvey Cushing's series). Br J Surg 1939.
4. Johnson HC: Surgery of the hypophysis, in Walker AE (ed): A History of Neurological Surgery. Williams & Wilkins, Baltimore, 1951, pp 152–77.
5. German WJ, Flanigan S: Pituitary adenomas: a follow-up study of the Cushing series. Clin Neurosurg 10: 72–81, 1964.
6. Simmer HH: The beginnings of endocrinology, in Debus AG (ed): Medicine in Seventeenth Century England: a Symposium Held at UCLA in Honor of C.D. O'Malley. University of California Press, Berkeley, 1974, pp 215–236.
7. Landolt AM, Strebel P: Technique of transsphenoidal operation for pituitary adenomas. Adv Tech Stand Neurosurg 7: 119–176, 1980. Comprehensive and extensively illustrated.
8. Landolt AM, Zachmann M: The Irish giant: new observations concerning the nature of his ailment. Lancet 1: 1311–2, 1980.
9. Laws ER, Jr.: Functional pituitary tumors. The neurosurgeon and neuroendocrinology. Clin Neurosurg 27: 3–18, 1980.
10. Zervas NT: Reflections on the surgery of the pituitary. Clin Neurosurg 27: 124–32, 1980.
11. Hamlin H: Oskar Hirsch. Surg Neurol 16: 391–3, 1981.
12. Rosegay H: Cushing's legacy to transsphenoidal surgery. J Neurosurg 54: 448–54, 1981.
13. Schonwetter HP: (History of acromegaly, with special reference to its early history in the canton of Glarus). Gesnerus 39: 369–93, 1982.
14. Pothe H: (Historical development of surgical approaches to the sella turcica). Zentralbl Neurochir 44: 151–4, 1983.
15. Molino-Negro P: Jules Hardy M.D. Surg Neurol 22: 109–12, 1984.
16. Satoh O: Transsphenoidal surgery for pituitary tumors: a review (Jpn). No Shinkei Geka 12: 7–26, 1984.
17. Udvarhelyi GB: Pioneers in transsphenoidal pituitary surgery. J Neurosurg 62: 790, 1985.
18. Welbourn RB: The evolution of transsphenoidal pituitary microsurgery. Surgery 100: 1185–90, 1986.
19. Rush C, Shaw JF: With Sharp Compassion: Norman Dott, Freeman Surgeon of Edinburgh. Aberdeen: Aberdeen University Press, 1990. Biography of Cushing's pupil best known for pituitary surgery.
20. Welbourn RB: The pituitary, in Welbourn RB (ed): The History of Endocrine Surgery. Praeger, New York, 1990, pp 89–145.
21. Medvei VC: The history of Cushing's disease: a controversial tale. J R Soc Med 84: 363–6, 1991.
22. Riedel M: Die Akromegalie. Ihre Erforschung im Vorfeld der modernen Endokrinologie. Medizinhistorisches J 27: 320–339, 1992.
23. Medvei VC: The History of Clinical Endocrinology: A

Comprehensive Account of Endocrinology from Earliest Times to the Present Day. Carnforth, Lancs: Parthenon, 1993.
24. Brunori A, Bruni P, Delitala A, Chiappetta F: Acromegaly and pituitary tumors: early anatomoclinical observations. Surg Neurol 44: 83–7, 1995.
25. Carney JA: The search for Harvey Cushing's patient, Minnie G, and the cause of her hypercortisolism. Am J Surg Pathol 19: 100–8, 1995.
26. Landolt AM: History of pituitary surgery, in Greenblatt SH (ed): A History of Neurosurgery: In Its Scientific and Professional Contexts. AANS, Park Ridge, IL, 1997, pp 373–400.
27. Artico M, Pastore FS, Fraioli B, Giuffre R: The contribution of Davide Giordano (1864–1954) to pituitary surgery: the transglabellar-nasal approach. Neurosurgery 42: 909–11, 1998.
28. Landolt AM: Development of pituitary adenoma treatment–a critical essay. Pituitary 2: 103–12, 1999.
29. Pait TG, Arnautovic KI: The pituitary: historical notes, in Krisht AF, Tindall GT (ed): Pituitary Disorders: Comprehensive Management. Lippincott Williams & Wilkins, 1999, pp 3–19.
30. Lindholm J: Cushing's syndrome: historical aspects. Pituitary 3: 97–104, 2000.
31. Jane JA, Jr., Thapar K, Laws ER, Jr.: Acromegaly: historical perspectives and current therapy. J Neurooncol 54: 129–37, 2001.
32. Landolt AM: History of pituitary surgery from the technical aspect. Neurosurg Clin N Am 12: 37–44, 2001.
33. Lanzino G, Laws ER, Jr.: Pioneers in the development of transsphenoidal surgery: Theodor Kocher, Oskar Hirsch, and Norman Dott. J Neurosurg 95: 1097–103, 2001.
34. Liu JK, Das K, Weiss MH, Laws ER, Jr., Couldwell WT: The history and evolution of transsphenoidal surgery. J Neurosurg 95: 1083–96, 2001.
35. Lanzino G, Maartens NF, Laws ER, Jr.: Cushing's case XLV: Minnie G. J Neurosurg 97: 231–4, 2002.
36. Teramoto A: (Progress in studies of endocrinology and metabolism in the field of internal medicine in the last 100 years: Therapy for patients with pituitary neoplasm). Nippon Naika Gakkai Zasshi 91: 1081–4, 2002.
37. Lanzino G, Laws ER, Jr.: Key personalities in the development and popularization of the transsphenoidal approach to pituitary tumors: an historical overview. Neurosurg Clin N Am 14: 1–10, 2003.
38. Pollock JR, Akinwunmi J, Scaravilli F, Powell MP: Transcranial surgery for pituitary tumors performed by Sir Victor Horsley. Neurosurgery 52: 914–25; discussion 925–6, 2003.

Pineal tumors

Much writing on the pineal has concerned its famous role as the seat of the soul in Descartes' writings (8–10, 12, 14). Surgical histories include articles 5, 7, and especially 11.

1. Thomson AF: Surgery of the third ventricle, in Walker AE (ed): A History of Neurological Surgery. Williams & Wilkins, Baltimore, 1951, pp 136–149.
2. Kappers JA: The mammalian pineal gland, a survey. Acta Neurochir (Wien) 34: 109–49, 1976.
3. Kappers JA: Short history of pineal discovery and research. Prog Brain Res 52: 3–22, 1979.
4. Borit A: History of tumors of the pineal region. Am J Surg Pathol 5: 613–20, 1981. Mostly on pathology.

5. Zulch KJ: Reflections on the surgery of the pineal gland (a glimpse into the past). Gleanings from medical history. Neurosurg Rev 4: 159–63, 1981. Comprehensive and wellreferenced.
6. Pendl G: The surgery of pineal lesions – historical perspective, in Neuwelt EA (ed): Diagnosis and Treatment of Pineal Region Tumors. Williams & Wilkins, Baltimore, 1984, pp 139–154.
7. Rosegay H: The Krause operations. J Neurosurg 76: 1032–6, 1992.
8. Finger S: Descartes and the pineal gland in animals: a frequent misinterpretation. J Hist Neurosci 4: 166–82, 1995.
9. Schiller F: Pineal gland, perennial puzzle. J Hist Neurosci 4: 155–65, 1995.
10. Smith CU: Descartes' pineal neuropsychology. Brain Cogn 36: 57–72, 1998.
11. Wilkins RH: History of surgery of the third ventricular region, in Apuzzo ML (ed): Surgery of the Third Ventricle. ed 2. Williams & Wilkins, Baltimore, 1998, pp 3–35. The best single source on pineal and third ventricle surgery: extensively illustrated, comprehensive, well-referenced.
12. George B, Carpentier A, Evans J, Apuzzo ML: Rene Descartes: mind, reason, and challenging assumptions. Neurosurgery 47: 244–9, 2000.
13. Le Gars D, Lejeune JP: [Introduction and history of surgery of the third ventricle]. Neurochirurgie 46: 137–40, 2000.
14. Lokhorst GJ, Kaitaro TT: The originality of Descartes' theory about the pineal gland. J Hist Neurosci 10: 6–18, 2001.

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