



Review article

The genesis of Academic Neurosurgery. Part II: The contribution of Johns Hopkins School of Medicine leaders



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ABSTRACT

This paper describes the influence of the Johns Hopkins School of Medicine on the origin of academic neurosurgery in America. The impact, arising from two of the founders, W Osler and W Halsted, was vehiculated by their direct pupils Harvey Cushing and Walter Dandy. The relationships between all these pioneers (sometimes stormy) are analyzed along with the development of the primitive residency program and the efforts to create the first neurosurgical society (the Society of Neurological Surgeons).

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La génesis de la Neurocirugía Académica. Parte II: La contribución de los líderes de la escuela de Medicina del Johns Hopkins

RESUMEN

Se describe la influencia de los líderes de la escuela de Medicina del Johns Hopkins en la génesis de la Neurocirugía Académica en Norteamérica. Un influjo que surgió de William Osler y William Halsted y se vehiculó a través de Harvey Cushing y Walter Dandy que se formaron en ella en el giro de siglo XIX-XX. Se analizan también las interrelaciones personales y profesionales entre todos ellos, que no siempre fueron armoniosas. Se describen la conformación del primitivo programa de residencia, que se difundió por todo el país, y el debate

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acerca de cuáles debían ser sus contenidos y cuál el número de neurocirujanos a entrenar. También se describen los esfuerzos para crear la primera sociedad neuroquirúrgica en América, la Society of Neurological Surgeons (SNS).

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Introduction

In this second part of the article on the genesis of Academic Neurosurgery we describe the influence of the Johns Hopkins School of Medicine, and more specifically that of two of its founders (the heads of the Departments of Medicine, W. Osler, and Surgery, W. Halsted) on the shaping of the nascent specialty. This institution had been conceived using the principles of the new German university created by Wilhelm von Humboldt and, to a lesser degree, the practical clinical teaching model of the United Kingdom, and it was in this academic context that the undergraduate clinical rotations and the postgraduate formal training proto-programme were modelled, giving rise to the residency system in America. With the lecturers working full-time in attendance, teaching and research, this school was where H. Cushing and W. Dandy completed their training and Wilder Penfield began his. It was unparalleled anywhere in the world at the time.

We describe William Osler's dedicated mentoring and William Halsted's more conventional mentoring of Cushing and Halsted's mentoring of Dandy, along with an account of the personal interrelationships between them, which were not always harmonious. Seemingly inevitable and going hand in hand with the dynamics of the clinical work, ingratitude and disloyalty were then, as they still are today, a reflection of the lack of professionalism in academic medicine and in neurosurgery in particular. We describe the initial difficulties in designing the contents of the training programme for residents, defining the profile (academic or practical) of the neurosurgeon and the ideal number of them, as well as challenges faced to create the first neurosurgical society (the Society of Neurological Surgeons [SNS]) at the end of the Gestational Period.

Osler's mentorship of Cushing

The seminal influence of the Hopkins surgical school, and more specifically that of two of its leaders and creators (Osler and Halsted, who were two of the "Big Four") on the emergence of academic neurosurgery was conveyed through three of its early residents, namely Harvey Cushing, whom we discussed in Part I of the article, and Walter Dandy and Wilder Penfield, who are discussed here.

Osler's mentorship, which was more decisive than that of his direct boss Halsted, was crucial to Cushing's success on the first part of the road to the independence of neurosurgery. We will see later that the support and guidance provided by Osler was based on his personal connections with some of

the leaders in Neurology and Neurosurgery of the day on both sides of the Atlantic. According to John Fulton and Wilder Penfield, Osler "shaped" Cushing's intellect, not only professionally, but also in terms of his humanistic training, including an interest in history and book collecting.^{1,2} The creators and directors of Hopkins, and more specifically Osler, demanded at the beginning of their training experiment that trainees have an appropriate knowledge of humanistic disciplines, including history, because they believed it was essential for the medical profession; training which was initially obligatory for admission to the school.³⁻⁵

Osler recommended that his pupils spend an hour a day reading the classics of Western literature, philosophy and history. Udvarhelyi described how the specific humanities cultivation programme functioned in the early stages at Hopkins, an activity that devolved over time under the pressure of the increasing amount of knowledge to be acquired and clinical activities to be performed (residents even had to do lab work).⁵ While Osler did not explicitly push Cushing towards neurosurgery, he did serve some of the key ingredients to him on a platter, which paved the way and steered him towards it. Let's look at what that influence was and how it came about.

The influence of Osler's relationship with Neurology on the birth of Academic Neurosurgery

W. Osler began his medical studies in Toronto in 1870 and obtained his doctorate at McGill University in Montreal. He later extended his training on a tour of Europe, beginning at the University of London, where he studied physiology from 1872 to 1873, and then visiting Rudolf Virchow in Berlin, who perhaps shaped his great interest in performing necropsy studies (Osler performed more than 1,000 during his clinical career).^{6,7} He completed his clinical training at hospitals in Berlin and Vienna, and although he was also inspired by English medicine and the English university, Osler grasped like few others the spirit of the new German university, which helped him to design the Hopkins school along with the other "Big Four", W. Halsted, H. Welch and H. Kelly. From English hospitals he took the model of clinical rotations for students (clerks and dressers), and from German academic centres, the need to conduct research without losing sight of the basic sciences and to unite teaching and research.^{3,4,8}

One of the most remarkable facts in Cushing's career was that the development of Neurosurgery achieved by him at Hopkins was not associated with the existence there of a dominant school of Neurology, unlike in Britain, on the European continent or even in Philadelphia at the time, where the neurologists W. Spiller and C.K. Mills were responsible, along with

surgeon C. Frazier, for the development of the nascent American neurosurgery.⁹ The progress in neurosurgery made in New York was dominated by a group of neurologists, who invited the surgeon C. Elsberg to join them at the Neurological Institute in New York in 1909. We should remember here once again that in the early days of his move into neurosurgery, Cushing felt that the surgeon had to assume responsibility to act on the basis of a diagnosis he had made himself, and that he had to study his patients carefully before putting them on the operating table (i.e., do his own neurology). This idea contrasted with that of the neurologist C.K. Mills, who believed that one of the neurologist's tasks was to "supervise and direct the surgical procedures performed on the brain and spinal cord by the surgeon".

It seems certain that Osler conditioned Cushing to adopt this position, which was unorthodox and "irritating" to say the least, in the world of dominant, but stubbornly stagnant, neurology. It may seem paradoxical that the greatest clinician of that historical moment ingrained this idea in someone who was still only a resident and then an assistant in general surgery about to embark on an uncertain path to enthroning the new speciality of neurological surgery. For Canale "it was precisely the unique and special milieu of clinical neurology at Hopkins, in which Osler was the dominant figure, which explained the emergence of the aggressive Cushing in his quest for the new speciality".¹⁰

G. Ebers noted Osler's, and more particularly Hopkins special position in relation to American neurology,⁹ and several historians have highlighted Osler's special significance in the field of neurology in the latter part of the 19th century, which "would not be complete without him". It should be noted here that Osler's own interest in neurology had been developed in Philadelphia by the neurologist W. Mitchell, but no less so by the surgeon W. W. Keen, who was the only one able to operate successfully on the brain in late 19th century America and who soon showed admiration for Cushing. It can be said that Osler "discovered a neurology enlivened by surgery".

When Osler was appointed physician-in-chief of Hopkins Hospital at its opening in 1889, he took charge of three departments, one of which was Neurology. He did not leave this department in other hands until H. Thomas was appointed head and director of training in neurology in 1896, the year of Osler's "intrusion" into the field of neurology and neurosurgery, and when he and Thomas diagnosed a brain tumour (a frontal meningioma) in a patient whom they referred to W.W. Keen to successfully remove it (this was the year Cushing began his residency at Hopkins).

However, Osler's interest in the nascent field of neurosurgery — which he already considered useful for treating some CNS injuries with perhaps sharper and longer vision than all the others present (including Halsted and Cushing himself) — was also based on his connections with William Gowers (considered by many to be the greatest neurologist of all time). Osler, who had been his friend since 1878, visited him in London in 1894 and dedicated his monograph *On Chorea and Choreiform affections*, published that year, to him. London was at that time the epicentre of neurology, and during the same visit Osler attended the resection of a meningioma by Victor Horsley, whom he had also known since 1878, and whose career he followed better than anyone else. This explains why,

in the first edition of his famous 1892 medical text *The Principles and Practice of Medicine*, the best of its time and the most widely read in the world, Osler recommended surgical treatment of brain and spinal cord injuries, citing Horsley's pioneering work.¹¹

But the most influential factor in turning Cushing towards neurosurgery was not Osler's position as physician-in-chief and head of clinical neurology at Hopkins, but, above all, his friendship and advice during the critical seven-year period that comprised the last two years of Cushing's residency (1898-1899), the fourteen months of his stay in Europe (1900-1901) and the interval from 1901 to 1905, when he acted as a kind of spiritual father and sensed as no one else did the potential of Cushing's ambition and restless nature. Osler was unequalled in his ability to encourage others to do a good job.

We have already said that Cushing's interest in the nervous system was not clear, or at least had not been definitively awakened when he arrived at Hopkins in 1896. However, it was in the "discovery" of this area of medicine and pathology by someone who wanted to specialise in surgery with the famous Professor W. Halsted that the influential personality of Osler came into play; and it is said that Osler became a close mentor to Cushing in the last two years of his residency. In 1899, he not only advised him against accepting the head of the department of surgery at Case Western Reserve Hospital, but recommended instead that he pay a visit to Europe. We should point out, however, that even before leaving for his European *Wanderjahre*, Cushing had been invited by Keen in 1899 (only four years after completing his undergraduate studies at Harvard) to present his experience with Gasser's resection at the College of Physicians of Philadelphia, which was considered the "Temple of the Elders" in neurology and neurosurgery. The invitation, made by the leaders at the time, was on the recommendation of Osler, who wanted to bring Cushing under Keen's wing.

In any case, it should be noted that Cushing was already choosing centres related to neurology as well as surgery on his European tour, and therefore visited Horsley, Sherrington and Kocher. In his first month in England he met Osler, who was there on a summer visit and who introduced him to local social life by facilitating encounters with "senior" scientists that he might otherwise have missed out on. After working in Kocher's laboratory and spending a month in Turin in the lab of the physiologist Angelo Mosso, where he repeated the Berne experiments, and before returning to America, Cushing went to England, where none other than Horsley, who was very busy and distracted by multiple tasks, advised him to work with Sherrington in Liverpool; a contact that was again facilitated by Osler, also a friend of Sherrington's since 1894. Sherrington was impressed by Cushing's magnificent illustrations of the surgical fields in his operations on the orangutan brain.

Despite what we have just said about Cushing's possible early interest in neurosurgery, we must emphasise that at the time of his excursion to Europe he explicitly stated that he had no intention of pursuing it. This is contradicted by what he said a quarter of a century later in his Presidential Address to the American Association of Neurological Surgeons (AANS), when he recalled how the opportunity to study his first neurological case in 1897, reported a year later in his first formal publication, *Haematomyelia from gunshot wounds of the spine*. A

report of two cases with recovery following symptoms of hemileision of the cord, had launched him on the path of neurosurgery. It has to be said that at the time, that path must have seemed dark and tempestuous. Nevertheless, it should be noted that in a letter written in 1900 to a mutual friend, Osler remarked that “your friend Cushing has opened the book of surgery to a new field”. It is also significant that on his return to Hopkins from England he was summoned in December 1901 by W.W. Keen to give the Mütter Lecture in Philadelphia, in which he described his work in Kocher’s laboratory, and the following year he was again invited to give a lecture on brain tumours.

The Canadian Osler, who closed the curtain on his life in England when he was Regius Professor at Oxford, developed the best of his work in the United States, more particularly at Hopkins, where it is said he led the creation of the famous teaching and research-orientated school. As far back as 1884 after his stay in Germany, Osler had stated, “The wards are clinical laboratories used for the scientific study and treatment of disease, and the assistants under the direction of the teacher carry out research and assist in instruction”, suggesting that the place for training in clinical science was the clinical department.⁶ This view coincided with that of his colleague Halsted, also a visitor to the hospitals of Central Europe (see below), which helped make him shine brighter than any other in his time as a clinician and as a teacher.

Osler’s support of Cushing in taking his first steps in neurosurgery was completed by referring patients to him. Referrals of neurological cases were rare in the 1890s: in 1899 only two patients with brain tumours were operated on at Hopkins and both died, so doctors were reluctant to send patients with this type of disease. However, two of the three patients who died from medullary dysfunction secondary to intracranial hypertension reported by Cushing in the aforementioned Mütter Lecture, two of 15 patients undergoing subtemporal decompression included in the 1905 article, others with trigeminal neuralgia operated on from 1903 to 1904, and the first patient with a spinal tumour (a meningioma) operated on in 1903, were referred to him by Osler.

In 1904 Keen offered Cushing the headship of Jefferson College in Philadelphia, which he declined after consultation with Osler, who believed he should continue to mature in the “Hopkins soup”. But the highlight of the collaboration with Keen was the previously mentioned invitation from Keen to contribute to his book *Surgery. Its Principles and Practice*, which was the first systematic treatise on brain surgery, and which, it is said, helped to crown Cushing as a leader in neurosurgery at a time when he was already attracting students and an increasing number of patients. In the sixth edition of his book “Internal Medicine” in 1905, Osler acknowledged the collaboration of Cushing and Thomas in the section on CNS pathology.¹¹

Cushing’s lack of recognition for Osler

Considering the intense relationship and constant help received from Osler, it is surprising that Cushing barely mentioned him, an omission that has been pointed out by several historians.^{12,13} For example, Canale said that, “Unfortunately, one of the possible sources for solving this enigma, the biography of Osler written by Cushing, reveals nothing about it”,¹⁴

and added, “This unnecessary anonymity left unexplained gaps in the notes written by Cushing from 1900 to 1905”, which were precisely the years of greatest proximity or close relationship between the two¹⁰. Many have wondered about the reason for this omission. Fulton, who wrote Cushing’s biography, also noted the complete absence of Cushing’s comments on the subject, which is intriguing, to say the least, because Osler’s deference to Cushing was constant.^{2,12} According to W. Welch of Hopkins, this was unparalleled among biographers, and reminded him of “the absence of self-reference on the part of St. John in the Gospel he wrote”.

Osler never claimed to have helped Cushing, while Cushing, for whatever reason, explicitly avoided expressing his gratitude for the help he received. We may never know whether this omission was due to a chauvinistic strategy of defending the prominence of his own success, but it seems unlikely that it was due to simple forgetfulness. In any case, and this is what matters to us, it was a privilege for the neurosurgical community that our speciality was inspired, albeit indirectly and, if you like, stealthily, by the greatest clinician of the time.

The limitations of Harvey Cushing’s professionalism

Reflecting on Cushing’s possible ingratitude towards Osler raises the question of the extent to which he embraced the humanistic values of altruism, empathy, tolerance and generosity his mentor was endowed with, and which, as discussed in Part I of this article, were not echoed in his relationship with his closest collaborators. Perhaps the imitation simply did not go beyond their shared dedication to and rigour at work, interest in history and book collecting, or ability to write well.

In any case, without wishing to pass judgement on this giant of our speciality, it seems fair to say that he was not an example of what is today understood as good professionalism, one of the six major competencies on the Accreditation Council for Graduate Medical Education (ACGME) map that trainees (students and residents) must acquire through operational role modelling in the so-called “hidden curriculum”, and which, apart from radical honesty, includes offering compassionate and empathetic treatment to patients, students and colleagues.^{4,15}

Cushing’s relationship with Halsted, his direct boss and mentor also in the surgical residency, was stormy to say the least, more due to Cushing’s peculiar character and self-centredness than to Halsted’s unstable behaviour and lack of attention to his patients and residents during the period he was impaired by drug addiction. Although Cushing was said not to have been aware of this fact, it is highly probable that he was aware and took advantage of his boss’s weakness and lost respect for him in his day-to-day dealings. It was said that Cushing held onto the information so he could eventually use it as a guillotine to “decapitate” Halsted, whose patients he “preyed on”, to the point that Halsted almost fired him for it. In any case, Cushing took advantage of his boss’s repeated absences from the clinic and the operating theatre to stretch the limits of his own autonomy and maximise his technical training, an option which, to everyone’s good for-

tune, he exploited with insatiable intellectual curiosity and inexhaustible energy (see below).¹⁶

The exaltation of the figure of Cushing is never excessive considering the value of his contributions, but we should not increase the distortion of the so-called “neurosurgical mythology”. And here it is appropriate to quote from a letter to the Editor published in the *Journal of Neurosurgery* in which a neurosurgeon lamented the “Dandy sanctification campaign” that was being launched at the time; in his letter, he argued, “We have had enough of the ‘sanctification’ of Cushing”, adding that, “There are better role models than these for young neurosurgeons, who need to learn that scientific and technical knowledge have to be accompanied by humility and humanity. If Cushing and Dandy had learned and taught this philosophy then they would be worthy of sainthood”. The review by the Argentinian neurosurgeon E. Schijman entitled, “Walter E. Dandy. A 50 años de su muerte” [Walter E. Dandy, 50 years after his death], in which he comments favourably on Dandy’s profile, describes very well Dandy’s misunderstandings with Cushing and Cushing’s reprehensible attitude towards his pupil.¹⁷

Poor professionalism, or even a complete lack of it, which has existed since academic neurosurgery began to evolve, when the elitist members of the SNS maintained an indifferent attitude towards young neurosurgeon candidates (see below), is another example of a recurrent problem in the history of the speciality. The subject has been brought up in numerous Presidential Addresses by prominent members of the AANS and the Congress of Neurological Surgeons (CNS) where they lament the harmful effects of reduced healthcare spending on the quality of patient care, resident learning, staff morale and interprofessional relationships.^{18–22}

In any case, the disagreements between Cushing and Dandy, or Cushing’s lack of recognition of Osler and his ingratitude towards Halsted (see below), reflect the fact that, just as in all the other specialities, the world of neurosurgery was far from being a school of good professionalism. Many obscure aspects of the Halsted-Cushing-Dandy triangle remain unknown, for it is often impossible for the historian to determine the interplay between human or personal affairs and professional development,¹⁶ or, putting it another way, to separate the man from his work, even when that work is clearly better than the man himself. So let’s take a look at their work.

William Halsted and his influence on the incorporation of the German university model in North America and the creation of academic neurosurgery

Like Cushing, Halsted had excelled from the beginning of his career. Even as a house officer in New York, he introduced the charting of pulse, respiratory rate and temperature on ward visits (a merit usually attributed exclusively to Osler). Moreover, he performed one of the first transfusions (of his own blood to his sister with post-partum shock) and the first cholecystectomy in America (on his mother on the kitchen table). But his most important contributions were not only his gentle handling of tissues, the introduction of regional blocks and

surgical rubber gloves, but also his contribution to the teaching of residents by combining an academic approach to clinical problems with a new method of rigorous surgical training.^{3,4}

On his two-year visit to Europe, Halsted had met people such as Volkman, Chiari, Billroth and Kocher and on his return home, he said he was impressed by the standard and organisation of the great Central European surgical centres, and especially by the affiliation between the great teaching hospitals and universities in Germany, as well as by the academic-scholarly approach to clinical problems there, an approach that fitted in with his own ideas for training young surgeons. Halsted would adhere with particular vehemence to the German training system, which placed emphasis on the integration of basic sciences with instruction in clinical practice by fulltime lecturers in the framework of the university-linked hospital. Moreover, he was impressed by the spirit of competition among trainee surgeons that encouraged the brightest and hardest working.^{3,4,8}

Halsted, who worked as a student in the experimental laboratory and attended numerous post-mortem examinations and surgical operations at Bellevue in New York, reported in 1904 how during his first 15 years at Hopkins he had developed his surgical training programme strictly on a scientific basis; and how surgery, which had progressed more in the previous 20 years than in the preceding centuries, had laid its scientific foundations. Halsted’s purpose in creating his programme was to create a school of surgery that would spread the highest principles and attributes of the surgical art to the rest of the world.^{8,23} He wanted to train teachers and not merely competent surgeons, and said that the surgical resident “should be the best”, adding, “We need a system, and we shall surely have it, which will provide not only surgeons, but surgeons of the highest type, men who will stimulate the first youths of our country to study surgery and devote their energy and lives to raising the standard of surgical science”.

Halsted’s residents were said to “work 24 hours a day, seven days a week and every week of the year except for two weeks’ holiday”, because in addition to attending to their duties on the ward and in the operating theatre in the mornings, they were required to undertake original research in the laboratory in the afternoons, while also keeping abreast with work in surgical pathology and bacteriology, as well as physiology as far as they could. Halsted stated, “You are expected to do original experimental work in addition to your work on the ward and in the operating theatre, and to keep in close touch with surgical pathology, bacteriology and as far as possible with physiology”, a recommendation supported by his own example reflected in his two-volume *Surgical Papers*.¹⁶

In any case, Halsted was one of those who “taught by example rather than by precept”; he was “not very absorbing” and rather lax in his demands because “once the principles were instilled he left his residents to it”, to the point of being criticised for neglect. He was also a good mentor, and despite the “legend” about his dubious attitude to Cushing’s early inclination towards neurosurgery, the initial recommendation for Cushing to go into orthopaedics was well-intentioned, because this was the most promising surgical field and because he did not believe in the future of neurosurgery at the time. When Cushing asked him for permission to devote himself to neurosurgery, Halsted replied:

"Why, Dr Cushing, we have only had two cases of brain tumour in the last year" (both patients died after the operation). But if he said this when Cushing's results were still disastrous, his attitude became supportive and encouraging when they improved, and it was he who advised him to do the pituitary studies. In any case, on Cushing's return from his European tour in 1901, Halsted commissioned him to attend to neurological cases, telling him, "*All right, the field is yours*".

The average length of training for a house officer to reach the position of chief resident with Halsted was eight to nine years (six as an assistant and two as a house surgeon), but from the outset there was no guarantee of ever completing the residency. Halsted always defended the pyramid system of Residency in which only the most capable survived until they reached the top of the pyramid. Seventeen chief residents were trained at Hopkins (Cushing - who was the fifth - and Dandy among them) and, of these, only four went into private practice. The remaining 13 took up academic posts at Yale, Duke, the Peter Bent Brigham and other services that were populated by Halsted-trained residents, in turn generating 166 chief residents, 85 of whom became lecturers at academic centres and spread the Halstedian concept of academic surgical training to the rest of the country and Europe.⁸ This dispersal ensured the preservation and transmission of the new surgical knowledge that was rapidly accumulating at that time. Halsted's legacy was "the training of the surgeon".

Halsted's other distinguished disciple in the field of neurosurgery: Walter Dandy

Born in 1886, Dandy entered Hopkins medical school, graduating in 1910 to work with Cushing, first as a student assistant, then as a resident in 1911. Like all Hopkins residents, Dandy spent his first year at the Hunterian Laboratory, where, inspired by Cushing, he studied the innervation and vascularisation of the pituitary gland in cats and dogs, which he later reported in two papers published in 1911 and 1913.²⁴ It was precisely in the laboratory that personal disagreements between Dandy and Cushing began, because of Dandy's observations on the link between glucosuria and pituitary function and, in particular, because of the excellent results obtained with the study of experimental hydrocephalus. Cushing's professional jealousy was later repeated because of the surgical innovations introduced by Dandy, such as the successful radical removal of acoustic neurinomas or pinealomas. Dandy went so far as to formally accuse Cushing of "an evident absence of scientific judgement and seriousness",¹⁶ and the disagreements lasted a lifetime, despite a lukewarm late reconciliation. Upon moving to Boston in 1912, Cushing did not invite Dandy to join him, but years later Dandy thought it worked to his advantage, because "the enmity spurred him on to constant self-improvement".

Dandy's interest in the nervous system came from the school's anatomy teacher Franklin Mall, and his initial focus was on the absorption of CSF through the pleural and abdominal membranes and the passage of dyes into the lymphatic system, blood and urine, as well as the influence of the animal's position on the rate of absorption. At the age of 27 he published with Blackfan his classic and seminal papers on CSF circulation and hydrocephalus, which he

induced by obstruction of the intraventricular pathways or by removal of the choroid plexus and arachnoid granulations, thus establishing the differentiation between communicating and non-communicating types, and the use of choroidectomy and ventriculostomy of the 3rd ventricle.

In 1913 Halsted told Dandy that he would, "never do anything equal to this again. Few men make more than one great contribution to medicine". But he was wrong because in 1918, at the age of 32, Dandy published in the *Annals of Surgery* the technique of ventriculography, which he practised on 20 children, and a year later pneumoencephalography for the localisation of expansive processes and tumours (it should be remembered that until then only the displacement of the pineal gland, when calcified, was used to determine which side a tumour was on, as angiography was not yet available). Dandy, who was considered by many as the "best in neurosurgery", improved almost all technical aspects of surgery of intracranial and spinal processes (see his classic text *The Brain*) by reducing the mortality rates of founders such as Horsley, Eiselsberg and Krause to 10%, which as late as 1913 were 67%, 77% and 84%, respectively.²⁴ It was said that in contrast to the meticulous Halsted and Cushing, he was "a quick surgeon" who paid little attention to haemostasis; according to him, "the vessels fear the neurosurgeon".

The contribution of Wilder Penfield and his disciples to establishing academic neurosurgery

When we speak of the creation of academic neurosurgery, we must add the Canadian Wilder Penfield to the figures of the above-mentioned Hopkins pioneers. He also began his training there and later trained a series of residents who contributed significantly to the transformation of neurosurgery from an empirical practice into a scientific discipline. His specific contribution was to systematise the practice of experimental neurosurgery by working in the university clinic at the Royal Victoria Hospital of McGill University, a centre also established on the advice of W. Osler, which had excellent facilities, including its own university printing press, and where clinical practice was integrated with teaching and research.²⁵

Penfield, who like Cushing was mentored by Osler (Osler again!!), graduated from Hopkins' school in 1918 and went on to become Cushing's house officer at Peter Bent Brigham. Cushing tried to retain him, but Penfield refused the offer, without ever making clear his reasons. He probably wanted to find his own way, and also differed with Cushing on "philosophical questions". Penfield believed that neurosurgery required the support of neurology and neuropathology, and so he went to work in the laboratories of Sherrington in Liverpool and Pio del Rio Hortega in Madrid. Early in his career he worked at Queen Square in London with Percy Sargent, who was particularly interested in post-traumatic epilepsy, and he completed his surgical training at Columbia by founding a neuropathology laboratory at New York Presbyterian Hospital. Apart from his studies on cortical scarring and epileptogenesis, he developed numerous lines of research, such as the study of the innervation of the cerebral vascular tree, the regulation of cerebral flow and diencephalic function.

After his stay in Madrid, in 1924 he transferred the pathology study methods of the Spanish school of histopathology to Montreal, where he established a training programme in neurosurgery with an 18-month internship, including six months of neurology, neurosurgery and mixed medical and surgical disciplines, followed by two years of residency. He also introduced another innovation that was “prophetic” at the time — the offer of fellowships in neuropathology, neuroanatomy and neurophysiology. Admission to a fellowship depended on each candidate’s ability to develop independent research; in reality it was a “hypothesis-driven” research programme that Penfield devised in the laboratories of Sherrington and Del Rio Hortega, with his own research study of epileptogenic scarring being a masterly example. Some of those who trained with Dandy at Hopkins and with Cushing at Brigham, such as H. Naffziger, sent their residents to rotate with Penfield to acquire more specific research training.²⁵

While it can be said that Academic Neurosurgery began in the United States with Cushing and Dandy, who conducted experimental laboratory work early in their careers, that research was descriptive and did not have the impact and effectiveness of Penfield’s in instilling a culture of basic experimentation in trainees.

The evolving of the training system for surgical house officers in North America

Until the opening of Hopkins in the late 1880s there was no formal or regulated training in surgery, either in Europe or in the United States, and those who practised the surgical art were self-taught, trained simply through an apprenticeship alongside surgeons who may or may not have been competent or qualified to teach. At the 1907 meeting of the American College of Surgeons, Duddley Allen emphasised something already well known: that there was no training more valuable than serving as a good surgeon’s assistant in a hospital for a period long enough to observe the broad spectrum of diseases and to have the opportunity to participate in related operations (the apprenticeship).²⁶ At the turn of the 20th century, however, most neurosurgeon candidates got little more than limited surgical training in their brief visits to some pioneering clinic; not without some scorn, it was said of them, “They come, stay a short time as observers and return to their clinics invested as neurosurgeons”. Most of those who entered the services stayed for a year or a little more, and only a few reached the top in terms of the ideal training. As a result, the elitist and selective programmes at Hopkins and Brigham began to be criticised.

The first modification of the Halstedian pyramidal residency system was introduced by Edward Churchill, who replaced it with the so-called rectangular system, whereby all those admitted could complete their residency. Churchill’s criticism of the pyramid system was that: 1) it created poorly trained surgeons (those who stayed only a year or a little more, who were the most numerous); and 2) it made training dependent on a single individual, the dominant master,

whose relationship with the trainees was unscientific and anti-intellectual.²⁶ The third article in our series explains how in 1931, when he was ward chief at Mass General, Churchill developed a new three-year preceptorship model based on the experience at the Pennsylvania hospital, which had resisted the pressure of the Halstedian system. This was the nucleus for what would, with variations, become the system for resident training throughout the 20th century.

We should stress that Duddley proposed at the same time, and for the first time, verifying the level of competence achieved by house officers at the end of their training; a task which, according to him, should be undertaken by an accredited body or corporation, which would draw up the examination and award the qualification (in this case the College).²⁶ This heralded the creation of the American Board of Neurological Surgery (ABNS), which did not come into being until 1940.

Resident training in the Gestational Period, and establishing manpower needs

It should be noted that in this phase the pioneers had put almost all their efforts into solving what seemed to be insurmountable technical problems, but that, remarkably, they succeeded in making the speciality an academic one because the technical improvement was accompanied from the beginning by an equally incipient research in basic sciences, and by a protosystem of formal training of house officers. The quality of the training reached levels of excellence at Hopkins and spread to a few other hospitals, although not without difficulty; in 1913 William Welch complained that the diffusion of the model they had created in Baltimore “was being slower than expected”. As there was still no professional corporation or society that could make general organisational proposals, no standardised residency programme had been established that could be used in all the services that took on house officers.

With regard to the type of training, at that point, without any decision having yet been made on what was essential and desirable for the house officer to learn or master, there were two schools of thought: those who believed that aspiring neurosurgeons “should have an essentially practical knowledge of clinical neurology, psychiatric disorders and neuropathology”; and those who believed they should devote two long years to clinical neurology, another to neurophysiology, and six months to each of the branches of neuroanatomy, neurophysiology, neuroradiology and neuro-ophthalmology. Most neurosurgeons did not think it necessary to know minute anatomical details, nor to understand the obscure pathophysiological phenomena underlying neurosurgical diseases; it was said that, “tumours and other gross lesions do not respect the fineness of the pathways and their borders, and the neurosurgical technique of the time could not discriminate beyond the gross or macroscopic changes affecting the structures involved”.

What the neurosurgeon valued was knowledge of “surgical neurology, surgical physiology and surgical pathology, essen-

tially”, and it was therefore accepted that additional detailed knowledge related to “the numerous and lush collateral branches” of surgery and neurology was only supplementary. In a saying that was very popular at the time, many neurosurgeons asked, “Why do we need all this knowledge if we have the Lipiodol”, meaning that once the mass to be removed (which displaced or blocked the passage of the positive contrast on the X-ray) was located, everything else was superfluous. Similarly, but surprisingly, there are those nowadays who wonder why certain “fancy” theoretical knowledge is needed if CT and MRI are available.

It was argued that, in actual practice, the necessary competence to “handle oneself surgically” could be acquired in the framework of the neurosurgical training itself, during which the young neurosurgeon should and could learn to interpret the few diagnostic tests available, such as the primitive radiological studies of plain X-ray, positive contrast ventriculography and pneumoencephalography, and physiological ones such as EEG, together with microscopic preparations of the excised specimens.

In contrast to the more pragmatic proposals on the training of the young neurosurgeon, there were other more sophisticated proposals put forward by some academic leaders (such as Bucy, Walshe and Bailey),²⁷ who recommended an extensive mastery of the basic sciences. However, it was accepted that training could be tailored according to each trainee’s wishes, depending on whether they planned to practise neurosurgery privately in a community hospital, for which a basic training in neurology would suffice, or wanted to pursue an academic career, in which case they should also contemplate studies in neurophysiology and other subjects.

The debate about the ideal number of neurosurgeons (manpower) was also raised for the first time in this Period, with a marked gap between the small number recommended by the leaders of the elitist Society of Neurological Surgeons, and the growing mass of aspiring practitioners anxiously knocking at their doors. The “seniors” did not foresee the explosive development of the speciality, nor the immediate and continuing increase in the need for neurosurgeons. Cushing and his colleagues in the new Society did not believe that a large number of practitioners would be conducive to the advancement of the speciality, preferring to restrict training to a few “with a creative spirit dedicated body and soul to the task”, whose intellectual work would enable them to find their way navigating uncertain frontiers. According to Martson, Cushing’s fear was that if the new field was not intellectually cultivated through research, neurosurgery would suffer and even devolve,²⁸ in a scenario like the one described by Bergland 50 years later and discussed in more detail in the second paper of our series²⁹.

The dilemma between “hands-on” neurosurgery and Academic Neurosurgery, already raised in the early years of our speciality, remained an issue throughout the 20th century and is still alive today in the 21st. Although they are not, strictly speaking, mutually exclusive, these alternatives continue in the present, when pressure from managed care corporations compromises the funding of research and teaching

traditionally undertaken by academic neurosurgeons, causing frustration and some moral disarmament among members of learned societies, corporations and educational planning agencies.

The creation of the first professional association (Scientific Society) to complete the academic profile of neurosurgery

To complete the academic profile of neurosurgery at the end of the Gestational Period, all that was missing was the creation of a neurosurgical society that would serve as a forum for communication, discussion and planning of the development of the speciality, and ideally have its own journal in which to publish the results of clinical or laboratory research. Cushing and Dandy had to publish in journals such as *JAMA*, the *Johns Hopkins Hospital Bulletin*, *Annals Surgery*, *Archives Surgery* and other equally reputable journals. The importance of the association of the cultivators of a scientific discipline to ensure its continued development was clearly demonstrated at the above-mentioned meeting of the American College of Surgeons in 1919, where the existence of the new speciality of Neurosurgery was formally declared and those involved agreed to hold regular meetings to exchange information.³⁰ The propensity to associate to meet common needs through group interaction has been characteristic of the USA, a country called “the nation of associations”, where complex and gigantic institutions of voluntary origin sprang up to take on functions which in other nations were reserved for the government or the state.

In 1920, only five months after that meeting of the American College of Surgeons, a few neurosurgeons with a special interest in education met at the Peter Bent Brigham in Boston and formed the Society of Neurological Surgeons.^{30,31} Cushing, who acted as host, accepted the role of President, stating that the essential purpose of the association was to “...discuss our problems and compare our results...”, and that its founding objectives were: 1) To develop the field of neurosurgery; and 2) To educate the medical profession, and more particularly surgeons, that neurosurgery required special training in addition to that required for general surgery.³⁰

The twice-yearly meetings of the early society lasted one day, including a morning operating session hosted by the local host, and an afternoon session at which some papers were presented by the organiser and his collaborators. These meetings were attended by the active members (11 at the beginning) and a very limited number of guests sponsored by them, from whom the very few new members were elected. This meant that the society functioned as a private club, which was impenetrable to the growing number of neurosurgeons who began to push at its doors. In the second article of this series, we see how the increase in that pressure over the following twenty or so years forced the creation of new societies, such as the Harvey Cushing Society of 1932 and others with larger memberships.

In any event, the relative immaturity of the Society of Neurological Surgeons meant it was not able to create its own organ of expression (the *Journal of Neurosurgery* did not appear

until 25 years later), or structure the training programme by including some form of teaching instruction and examination to test the level of competence achieved by trainees (a function assumed by the ABNS from 1940 onwards), or plan the practice of clinical and experimental research, the approach to which was artisanal or done on an individual basis. The same was true for the administrative management of the services, which was of minimal complexity and did not generate friction at local or national level.

Conclusion

The Gestational Period saw the development in North America of a neurosurgical practice that was already safely progressing within the framework of its recent independence, a semi-structured training programme for house officers only accessible to the lucky few, and an inward-looking neurosurgical society that wanted to keep the number of neurosurgeons to a bare minimum and which failed to create its own organ of expression (a periodical journal). The nascent speciality had total autonomy and it did not come under pressure from the administration until the early 1930s, when Harvey Cushing, who was part of a national committee for Socio-Economic Affairs, spoke out against the interference of administrators in the affairs of neurosurgery; the harassment started then and steadily increased, reappearing with varying intensity over the following twenty or thirty years until the organisation of medical practice was taken over.^{18,19,21,22} In the second and third articles of this series, we examine how serious the confrontation is in the 21st century and look at its negative effect on resident training and staff morale, with this being a struggle that complicates the very survival of neurosurgery as we know it.

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