ISSN 1220-8841 (Print)
ISSN 2344-4959 (Online)

ROMANIAN
NEUROSURGERY

Vol. XXXVI | No. 3 September 2022

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DOI: 10.33962/roneuro-2022-048

Romanian Neurosurgery (2022) XXXVI (3): pp. 279-288
DOI: 10.33962/roneuro-2022-048
www.journals.lapub.co.uk/index.php/roneurosurgery

Notes on the history of Walter Edward Dandy - one of the outstanding fathers of neurosurgery

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Keywords
biographies as topic, history, Walter Edward Dandy, neurosurgery

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ISSN online 2344-4959
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First published
September 2022 by
London Academic Publishing
www.lapub.co.uk

ABSTRACT

Walter Dandy was born in 1886 in Missouri into an immigrant family. From an early age, he stood out as a good and curious student, which led him to study initially at the University of Missouri and later at the John Hopkins School of Medicine where he had the opportunity to develop his potential as a researcher in the Hunterian surgical laboratory, under the tutelage of the prestigious Dr Harvey Cushing. His contributions to medicine as a surgical resident and later neurosurgeon marked a before and after in the history of the modernization of neurosurgery and enriched the knowledge of the anatomical structures of the central nervous system, considering his discovery of ventriculography as "the greatest single contribution to brain surgery", also being the first to successfully perform various surgical procedures, such as the clipping of aneurysms and the resection of tumours of the cerebellopontine and hypophysial angle.

INTRODUCTION

Walter Edward Dandy was born on April 6, 1886 in Sedalia, Missouri as the only child of immigrants John and Rachel Dandy (1,2). Throughout his life he served as a neurosurgeon and scientist, being considered one

of the founders of neurosurgery and contributing innovative ideas in multiple fields of medicine, among which are ventriculography, the description of the circulation of cerebrospinal fluid, acoustic neurinomas, the function of the pituitary and pineal glands, pneumocephalus, Méniére's disease, glossopharyngeal neuralgia, intraventricular tumors, intracranial aneurysms, ruptured intervertebral discs and neuroradiology. He was also credited with the title of "father of neuroendoscopy", which made him the most famous and influential neurosurgeon in the world for 25 years (2-7).

Dandy was associated with the John Hopkins School of Medicine, as it was the place where he obtained his medical training, and later with the hospital of the same name, entering as an intern and remaining there throughout his career as a surgeon, and was associated with other great neurosurgeons even before his graduation as a physician, such as Harvey Cushing, with whom the differences in personalities and ideas that led to their separation and rivalry throughout their careers were very clearly highlighted (1,8,9,10,11). The importance of his contributions to neurosurgery and medicine in general have allowed the evolution of neurosurgery to what is known today, for this reason it is of great importance to remember and commemorate his work.

Early age and medical training

Born and raised in Sedalia, Missouri in 1886, Walter Dandy was the only child of the marriage between John and Rachel Dandy, who were immigrants from England and Ireland respectively, socialist supporters and ardent members of the religious sect called "Plymouth Brethren". John Dandy, his father, immigrated with his wife to the United States two years before Walter was born, in order to work in the railroad industry, where he worked initially as a fireman and later as a locomotive engineer on the Missouri-Kansas-Texas Railroad (1,2,12,13,14,15,16).

As an only child, Walter was instilled with competitiveness and excellence from a very early age, and established a strong and close relationship with his parents, who always supported his decisions and accompanied his greatest achievements, which is why Dandy considered family relationships to be "the best thing in life (7,14,15).

Dandy's childhood was no different from that of other children, he played with his classmates and frequently had disputes with children much older than him (1). He inherited from his father a taste for trains and from a very young age he showed his fascination for baseball, achieving a balance between his studies and baseball games, so much so that one of his roommates referred to him as a "tough student and a tough player" (12,14,17).

Dandy attended public school in Sedalia in a "1-room schoolhouse" along with other immigrant children, from which he graduated in 1903 as the valedictorian of his class and was awarded the title of Valedictorian, thus having the duty of giving the final valedictory address in which he spoke of the importance of education (1,2,7,14,15). Encouraged by his teachers, he entered the University of Missouri in 1903, where, motivated by his interest in learning biology and medicine, he did his laboratory work with Winterton C. Curtis, PhD of Johns Hopkins University, as an assistant in his zoology laboratory at the University of Missouri. This man motivated Dandy to continue his medical training at the Johns Hopkins School of Medicine (1,2,7,14,15).

In 1907 Dandy participated as a candidate for a Rhodes Scholarship to study at Oxford, passing the exams and winning the scholarship. However, he turned it down because in communication with Sir William Osler, professor of medicine in England, he suggested that he finish medicine at Hopkins and later do postgraduate studies abroad (1,2,7,14,16). In the same year, following the suggestions of Osler and Curtis, he entered the second year of medical school at Hopkins, because they recognized part of what he had studied at the University of Missouri, and it was not until 1910 that he received his degree from the John Hopkins School of Medicine (1,2,7,14,15,16).

Medical training

While studying at Johns Hopkins School of Medicine, Walter Dandy was strongly attracted to anatomy and went to work as a trainee in the laboratory of Franklin P. Mall, professor of anatomy at Johns Hopkins and founder of embryology, who upon seeing Dandy's skills in drawing and dissection, assigned him as his work the representation of the youngest human embryo he preserved, this work of Dandy was published shortly before finishing medical school and for which he was awarded a Master's degree, the embryo is still known as the "Dandy Embryo" (2,14).

After being awarded his medical degree in 1910, Dandy was assigned by the famous surgeon Dr. William Halsted to begin his surgical training by doing research work under Harvey Cushing at the Hunterian Surgical Laboratory, an experimental laboratory for surgical procedures on animals, because Halsted was impressed by Dandy's skills and relentless performance in his final year of medical school. A year after his assignment, Walter moved up to become Cushing's clinical assistant until 1916 (1,2,4,7,12,14,16,18).

At the time of Dandy's arrival at the Hunterian Laboratory, Cushing was conducting research on the function of the pituitary gland and it is at this time that, guided by Cushing, Dandy made studies on the irrigation and innervation of the pituitary glands of animals such as dogs and cats, such work earned him his second and third publications, in company with Emil Goetsch "The blood supply of the pituitary body" in 1911 and alone "The nervous supply of the pituitary body" in 1913 (1,2,7,14).

At the beginning of 1911, a great conflict began between the teacher Harvey Cushing and the trainee Walter Dandy, generated in the first instance by a controversy that was maintained in the results of a work that consisted in producing glucosuria by stimulation of the sympathetic nerves, in which Dandy affirmed that the stimulation produced a great glycosuria, something that made Cushing irritable, later Dandy corrected that by inhibiting the sympathetic stimulation the glycosuria continued to be produced, so Cushing commented "Dandy, nobody could think of something like that, except you" (1,2). Despite this altercation, Dandy was appointed months later as Cushing's clinical assistant, ensuring his tenure at the Laboratory and interested in investigating hydrocephalus using canines for his experiments, however, the conflict developed a tense and discordant atmosphere between the master and his apprentice, which lasted until the end of Cushing's life (1,12,14).

In 1912, an assistant resident in Pediatrics, Kenneth D. Blackfan, collaborated with Dandy in his research on hydrocephalus, this work led in 1914 to excellent results where they showed the physiology of cerebrospinal fluid and classified hydrocephalus into two types: obstructive and communicating (1,4,7).

In late 1912, Dr. Harvey Cushing leaves Johns Hopkins Hospital with the goal of going to Boston to give the Chair of Surgery at Harvard University. With this news, Walter assumed that, like all the other clinical assistants, Cushing would take him and he would have to move to Harvard, however, Cushing clearly stated that Dandy would not be going with him (1,2,7,12). Dandy was angered by Cushing's manner and, even more so, by the fact that he had previously turned down the position to join Dr. Halsted's surgical staff at Johns Hopkins, so he thought his career was totally over (1,4,7). However, Walter was rescued by the Hospital administrator at the time, Dr. Winford Smith, who provided him with a room to occupy while Dr. Halsted returned from a trip and could decide on his situation, who did not hesitate to reinstate Dandy in his position as Assistant Resident in General Surgery, after looking at his research on hydrocephalus (1,7).

After his reinstatement in 1914, Halstead encouraged him to investigate the pineal gland, and it was not until 1915 that he published the results of complete pinealectomies performed on dogs, with no effects on the physical well-being of the animals used (1). Dandy continued to work as an intern and assistant resident until 1916, when he finally adopted the title of surgical resident, which he held for approximately two years, until 1918, when he was appointed general surgeon. From that time on, all neurological patients at Johns Hopkins Hospital were attended by Dr. Dandy because of his great skill and surgical technique (1,2,7,14,18).

In 1921 he was appointed associate professor of surgery at Johns Hopkins Hospital and ten years later he was clinical professor of neurosurgery (14). Until the year of his death, he devoted himself to establishing a neurosurgical residency program at the hospital as a continuation of the strong neurosurgical department that Harvey Cushing had left behind (18).

Clinical and scientific contributions

Ventriculography and neuroradiology

Among the many contributions made by Dandy, the procedure called ventriculography (2) is considered to be the most important. His studies in this area began in 1916, in which, together with his associate George Heuer MD, he showed the usefulness of x-rays for the diagnosis of pituitary tumors and calcified intracranial masses, such as aneurysms with calcification (4,7,18). However, this new finding was of no use to them because diagnosis of tumors by

this means was late, so they agreed that another method for early detection of these intracranial entities was going to be necessary, and this method was likely to be more than plain radiography because the neurological lesions had densities similar to those of normal brain (4,7,18).

Subsequently, they had 3 cases of patients with non-calcified tumors that were visualized with x-rays because they were located inside the paranasal sinuses, they then noticed that it was possible to visualize them because they were delineated with air, which contrasted with the tumor tissue (4,7). From this originated the idea that it was going to be possible to locate tumors by x-ray if the ventricles were filled with exogenously administered materials, so Dandy tested the injection of various radio-opaque dyes into animals, in his words "various solutions and suspensions used in pyelography: thorium, potassium, iodide, collargol, argirol, bismuth subnitrate and subcarbonate", finding that this gave excellent delineation. Unfortunately, however, he discovered that these substances were harmful to nerve tissue, as the animals that were injected always had fatal outcomes, producing "marked edema, serosanguinous exudate and petechial hemorrhages" (4,8,18,19,20). From this research Dandy concluded that it was unlikely to find a substance that would be so harmless as to warrant injection into the nervous system, and that ventriculography might therefore be possible using only "the substitution of a gas for cerebrospinal fluid" (7,19).

In 1917 Dandy, having already heard from Dr. Halsted about the ability of intestinal gas to detail abdominal X-rays, had the opportunity to be in contact with a patient with an intestinal perforation and consequent pneumoperitoneum, who had an abdominal X-ray in which the separation of the liver and diaphragm by a collection of air was seen in detail (4,7,8,18). This finding was surprising to Dandy, who published an article on this radiographic phenomenon ("pneumoperitoneum"), which had a major influence on his inventiveness and led him to suggest the injection of air into the ventricles, i.e., pneumoventriculography (18,21).

To perform the procedure, a small hole was made in the calvaria, subjecting the patient to local anesthesia, then a needle was inserted into the lateral ventricle and cerebrospinal fluid was extracted, replacing the same volume that was extracted with air. Once the air was injected, the patient was taken to the X-ray room and several frontal and lateral X-rays were taken (7,20).

By 1919, Dandy had already performed his innovative technique in several patients, being able to demonstrate not only intraventricular lesions, but also lesions of the cerebral subarachnoid spaces, as well as the localization of spinal tumors (7). Thus, Dandy was the first to perform pneumomyelography (22). Acceptance of radiographic studies of the nervous system was slow and there were many conservatives who were slow to accept this new technique, and Dr. Harvey Cushing disapproved of the procedure, commenting that he was reluctant to accept the new technique as he felt it might discourage neurosurgeons from training sufficiently and performing the thorough neurological examination, once again highlighting the rivalry between the two (7,18). However, Dandy's introduction of pneumoventriculography, fluroscopy of the ventricles, air encephalography and pneumomyelography revolutionized the radiological diagnosis of diseases of the nervous system (4,19,20,22,23).

Hydrocephalus and cerebrospinal fluid drainage

After graduating from John Hopkins School of Medicine in 1910, Dandy dedicated himself to researching hydrocephalus, in this process he associated with Dr. Kenneth Blackfan, pediatrician, who published in 1914 the first extensive study on the subject, from this and during the next 8 years approximately (1914-1922) published about 17 articles on this disease (1,24,25,26). In the initial study, he detailed for the first time the subtypes of hydrocephalus, classifying it as non-communicating (obstructive) and communicating, as well as proposed the surgical technique of removing the choroid plexus for the treatment of this type of hydrocephalus (24,27). Dandy emphasized the etiology, objecting that although it could be idiopathic in nature, they recognized that the condition could be the result of blockage at several sites and it was this that they documented in their paper (24).

As for the description of cerebrospinal fluid circulation, Dandy was the first to do so in his research on hydrocephalus. He developed a study that he published with his associate, Dr. Blackfan, in

December 1913, which was the first to describe the circulation and absorption of CSF in non-communicative hydrocephalus (24,27). This was achieved using canine models, to which he obstructed Silvio's aqueduct and subsequently evaluated their behavior and the possible symptoms that appeared, observing lethargy and vomiting as the first symptoms. Additionally, they observed the trajectory of the cerebrospinal fluid and its absorption when stained with phenolsulfonphthalein, a test used to verify whether the obstruction was in the aqueduct of Sylvius or in the foramina of Luschka and Magendie, He was able to visualize a suspension of granules injected into the subarachnoid space that did not pass freely into the blood, and with this Dandy became the first to observe that the problem was the lack of CSF absorption in the lateral ventricles (1,2,24,25,27,28,29).

As for treatment, Dandy worked on surgical procedures based on three principles: reducing CSF formation at its source, relieving the obstruction in the ventricular system and diverting the fluid to another location in the body where it can be absorbed or excreted. The first procedure for obstructive hydrocephalus was first observed on January 21, 1915, while for communicating hydrocephalus it was on February 6, 1918, three years later (2,24,25,27,29).

In 1918 Dandy published the technique of choroid plexectomy to communicate hydrocephalus, "Based on simple, fundamental, physiological and surgical principles", this procedure involved the removal of the choroid plexuses of the lateral ventricles, the main site of CSF formation (24,30). The surgery proposed by Dandy was performed through a frontal approach, cutting a window in the anterior wall of the third ventricle, thus releasing retained CSF directly into the ventricles while creating an opening for fluid into the chiasmatic cistern (25,26,30,31). By 1920, using ventriculography to determine the precise location of the obstruction, if found to be in the aqueduct of Sylvius, Dandy was forcing a small tube through the aqueduct to assist in reforming the canal, which would be removed two or three weeks later in a second operation (25,26,30,31). The striking feature of these early publications is the high mortality rate. There was more than 50% operative/immediate postoperative mortality, and few patients survived beyond a few months (24).

Neuroendoscopy

Another area of interest that Dandy researched was neuroendoscopy, and he was extremely curious about how things could be improved, which is why he strove to improve the instruments available to neurosurgeons (5). By the 1920s, he began to try to use cystoscopes in his operations to remove the choroid plexus, noting that he could visualize the lateral ventricles, the foramen of Monro, the choroid plexus and even vascular structures of the ventricle walls, results that greatly excited the researcher, giving rise to the concept of "ventriculoscopy" (5,32,33).

Then, in 1922, Dandy attempted to replace his routine dilator with a cystoscope and a small ventriculoscope; however, the results of these early interventions fell short of his expectations because he was unable to properly remove the choroid plexuses using these tools, so he had to return to the standard nasal dilator and forceps. In the face of this disappointment, he stated that "the instruments, in their relatively primitive construction, were not completely adaptable" for use in a neurointervention (5,32,33).

However, Dandy continued his research by consulting gynecologist Howard Kelly, the "father of cystoscopy," for assistance, who lent him one of his small cystoscopes for use in intraventricular surgery (5). This tool proved to be superior to any he had used before, so, making certain modifications to the original, in 1923 he asked the Wappler Electric Co. to help him design his reinvented version of the ventriculoscope (5,33). 10 years later, in 1932, the neurosurgeon had overcome the obstacles he had encountered in his first attempt with the ventriculoscope, and was able to perform choroid plexus resection surgeries with this instrument as routine procedures (5,33). Two years later, Tracy Putnam adapted a urethroscope for endoscopic electrocautery and successfully removed the choroid plexus without resection, so Dandy adopted Putnam's use of coagulation instead of clipping in his own endoscopic choroid plexectomies, using a probe similar to Putnam's that could pass through the endoscope (5).

Finally, Dandy felt that neuroendoscopic procedures were limited by instrumentation and illumination, noting in his book Surgery of the Brain, published in 1945, that their usefulness was restricted to young children and infants, as well as for

tumors found incidentally during plexectomies (5,33).

Aneurysms and neurovascular surgery

Dandy had a fascination with anomalies of the cerebral vascular tree, which is why this was one of his focuses (2). His research in this area began with his work with Dr. Heuer on the localization of intracranial tumors, as well as other research of the same era, such as frontotemporal craniotomy for optic chiasm lesions and pituitary tumors, which gave him the opportunity to visualize the cerebral vascular anatomy and provided him with the means he needed to approach and cut intracranial aneurysms (2,26,34). In 1928 he published an article dealing with venous anomalies and angiomas of the brain, and in the same year he recorded 8 cases of congenital arteriovenous aneurysms, and in 1929 he operated on middle cerebral aneurysms, but his first results were poor (2,35).

Dandy's first isolation of a carotid cavernous fistula resulted in 1934, proving a valuable treatment option for carotid ligation lesions and introducing his work on aneurysms of the circle of Willis (2). He maintained that the only hope for the patient with an aneurysm would be treatment that would clip or trap the neck of the anomaly, so 3 years later, on March 23, 1937, he succeeded in applying a silver clip to an internal carotid aneurysm, a procedure he successfully completed, marking a milestone in neurosurgery (2,34,35,36,37).

Dandy's work on aneurysms ended in 1944 when he published his book entitled "Intracranial Arterial Aneurysms" (34).

Other contributions

We cannot overlook Dandy's contributions to the physiology of the pituitary gland, as well as his research on the resection of its tumors. His research on animal models in which he resected the pituitary gland showed that these animals suffered from growth retardation and diabetes insipidus (2,14). Dandy performed his first pituitary surgery on July 13, 1912, still during his residency and in the absence of Dr. Cushing, his mentor, and in his lifetime he performed four times as many pituitary surgeries as Cushing, despite Cushing being his predecessor (14). He was also the first to use a transcranial approach to this gland, with better results than the traditional approach (2,14).

Similarly, his contribution to the resection of vestibular schwannomas, following his discovery of ventriculography, which he used as a diagnostic method for these tumors; Dandy thought to improve the technique described by Cushing in order to reduce the mortality rate, so in 1922 he published a preliminary report on his first successful operation in which he obtained a total resection margin for this tumor, the case had occurred 5 years earlier (38,39). In this report, he described his new method of approach, by means of a bilateral suboccipital flap, first removing the inner portion of the growth, as described by Cushing, but then meticulously cutting the veins and arteries surrounding the capsule, and finally separating the capsule carefully from the brainstem (38). However, Dandy did not cite Cushing's 1917 monograph on acoustic neurinomas, so the latter was offended and refused to accept the new technique (38,39). Finally, in 1934 Dandy described a more refined technique for the resection of tumors of the cerebellopontine angle with a less invasive unilateral unilateral suboccipital approach (38,40).

And as well as these we can mention the resection of pineal gland tumors and their physiology, the resection of tumors of the orbit, his intervention in brain trauma by devising a helmet for baseball players to protect them from blows to the head by balls, herniated discs, douloureux tic and trigeminal neuralgia, tumors of the third ventricle and Meniere's disease (1,2,11,17,28,41–46).

Personal life

Physically, Dandy used to be described as a man a little short in stature, with large hands, small feet, a high-pitched voice and somewhat stocky, but as time went by, the one characteristic that people who interacted with him never forgot was his piercing blue eyes (1). His classmates in medical school remember him as a guy with remarkable skill and determination when it came to work, also commenting that Dandy took very little time to spend with his friends on Saturday nights (2). While in residency, in the operating room he was described as bold with very confident hand movements, in addition, he liked to maintain a very strict protocol that consisted in that only the resident could talk to him, in case the resident assistant or the intern had any concerns they should communicate first with the resident, this behavior of Dandy could fluctuate

depending on the situation, if everything went well he was very easy to work with, in case something went wrong he would yell or throw the surgical instruments (1,13,15).

Most of the time Dandy appeared distant and cold, however, he was always kind to those doctors, residents, interns or patients who had financial problems, always with a great willingness to help them financially (1). Dandy's daughter, Kathleen Louise, related that her father's personality could be confusing for many people, however, the secret was in understanding the personalities of Walter Dandy's parents. Kathleen refers that he inherited the kindness and gentleness of his father, but at the same time the frankness and bad temper of his mother, therefore these opposite traits were in conflict and people usually ended up seeing only one side of the coin, but those who delved a little deeper could find the good side of his father (15).

That loving side of Walter Dandy can be seen in his interaction with his family. He always proved to be a loving father, a good husband and son (13). His relationship with his parents was very close. Throughout medical school and the years of his residency at Hopkins Hospital, he communicated weekly through letters, many of which recount Dandy's rivalry with Dr. Harvey Cushing (16). Dandy said that most of his neurosurgeon colleagues did not like him and apparently he was very suspicious of Harvey Cushing, because besides Cushing, Walter had controversies with different surgeons such as Charles Frazier, Temple Fay and Loyel Davis (1).

As a child, Dandy was a big baseball fan and player, during his years at the University of Missouri he would escape from his dorm to play night games, even while in residency with Dr. Cushing he managed to play three times a week, being so good that he became captain of the Johns Hopkins baseball team (17). Dandy wrote to his parents, giving merit to baseball, saying that thanks to this game he was able to refine his surgical technique and his skill with his hands became much greater (17). In addition to baseball, Dandy was attracted to trains, a taste instilled in him by his father since he was very young. In his spare time he would travel to New York by train to watch baseball games and on the way he would take advantage of the silence and comfort of the train to write his articles (15,17).

In Dandy's surgical career, one of his most significant early cases was related to the dangerous "beanballs", which consisted of a baseball player being hit in the head with a baseball, the patient suffering from a large cyst on the skull as a result of the traumatic impact, Therefore, when Dandy was asked thirty years later to work on a protective cover for baseball players' heads, he did not hesitate for a second to accept it, enthusiastic about his love of baseball and his professional attitude (15,17).

Marriage and family

In 1923, Walter was already known for his far-reaching research in the field of neurosurgery and his position at the hospital was that of associate professor of surgery; that same year, days before an academic trip to Europe to study with European doctors, Dandy met Sadie, a 22-year-old dietetic social worker from the same Johns Hopkins Hospital, at the entrance of an elevator (1,15).

Sadie and her friends had already seen the Hopkins surgeons play tennis on the hospital courts and considered Walter a "good catch." Some time later, Sadie and Walter began dating and meeting in places away from the hospital in order to avoid any kind of rumor (15). When Walter Dandy returned from his trip to Europe, he and Sadie were married and a year later they had their first child, Walter Jr.; later in 1927, a second child, Mary Ellen, was born; in 1928 Kathleen Louise and finally in 1935 the last daughter, Margaret, was born (15).

Dandy's stress at work was reduced when he played baseball, tennis or golf, and sometimes his great passion for trains meant that he could only relax by sitting and watching the cars go by on the tracks at Union Station or by riding them and writing articles in his Roomette, in order to be relaxed and away from the noise of the hospital (15,17).

Although he was a somewhat strict father, he never stopped being loving to his children, his home was a refuge in which he isolated himself from his busy work to live a home life with his children and wife (15). Dinnertime at Dandy's house consisted of the children being at the table by 6 p.m. to receive dinner promptly, properly cleaned and with good manners at mealtime. The topic of conversation was led by Dandy, talking excitedly about some tumor removed from one of his surgeries of the day or how stressful neurosurgery can be for the patient's family members (15). After being listened to at dinner, Walter always listened eagerly to his children's experiences throughout the day, which is why he was

always remembered as a warm and playful father. He often invented games to amuse the children, for example, on certain occasions they would sit on the sofa and try to spit plum seeds into the fireplace (15).

At the end of dinner, he would go into his room to change his clothes and the moment he would shake out his pants, coins would fall out of his pockets and the children would rush to pick them up and put them in their pockets. At other times he would simply lie down on the sofa and ask little Mary Ellen to lie in his arms for most of the night (15). In his home office, Walter kept a photo of himself and another man in tennis clothes, However, Sudie suggested to his children not to ask questions about the man in the photo and that they should only know that his name was Harvey Cushing (15). Dandy often took Walter Jr. to the hospital to see him operate, perhaps these acts influenced the boy to follow in his father's footsteps, as he later became a great anesthesiologist (15).

Hobbies and Pastimes

Dr. Walter Dandy spent his free time playing golf and bridge, most of the time with his family (47). Also from a very young age he was taken by his father to play baseball, so he became a fan of this sport, so that after his studies, Dr. Dandy, identified a natural association between baseball and medical practice for the reduction of brain injuries related to the incline. This history further supports the unique position of neurosurgeons to leverage clinical knowledge, inform innovation, and expand service to society (48). Many claim he was an expert in history and had a particular fascination with the American Civil War (47).

Death

In April 1946, Dandy was with his young daughter Margaret, in his backyard garden, when a pain in his chest caused him to stop the work he was doing, when Dandy's doctor was called, he diagnosed a "heart attack", he recovered, went home and 17 days later could not resist a second event and died on April 18, 1946 at Johns Hopkins Hospital (1,15).

Dandy Walter's story demonstrates that research in surgery and neurosurgery quickly changed the management and prognosis of certain diseases, which naturally have a chaotic course and are fatal. Today, these initiatives in the field of surgical sciences need to be highlighted in order to continue contributing to human development and the field of medicine (49-55). Above all, the fact that this author began his career in research from the beginning of his career in medicine, enhancing his skills as a physician and resident (52,53,55); skills that must be replicated today, to advance rapidly in the problems that afflict global health.

References

1. Alper MG. Three pioneers in the early history of neuroradiology: The Snyder lecture. Doc Ophthalmol. 1999; 98(1):29–49.
2. Campbell E. Walter E. Dandy-surgeon, 1886-1946. J Neurosurg. 1951; 8(3):249-62.
3. Long DM. A century of change in neurosurgery at Johns Hopkins: 1889-1989. J Neurosurg. 1989; 71(5 I):635–8.
4. Gutierrez C. The birth and growth of Neuroradiology in the USA. Neuroradiology. 1981; 21:227–37.
5. Hsu W, Li KW, Bookland M, Jallo GI. Keyhole to the brain: Walter Dandy and neuroendoscopy - Historical vignette. J Neurosurg Pediatr. 2009; 3(5):439–42.
6. Sherman IJ, Kretzer RM, Tamargo RJ. Personal recollections of Walter E. Dandy and his Brain Team. J Neurosurg. 2006; 105(3):487–93.
7. Erik Kilgore AE. Walter Dandy and the History of ventriculography. 1995; 194:657–60.
8. Sampath P, Long DM, Brem H, Yasui T. The Hunterian Neurosurgical Laboratory: The first 100 years of neurosurgical research. Neurosurgery. 2000; 46(1):184–95.
9. Woodhall B. Walter Dandy, M.D.: personal reminiscences. Neurosurgery. 1979; 4(1):3-6.
10. Tait J. The Cushing-Dandy conflict - Two powerful personalities that were best not to collide! World Neurosurg. 2015; 83(1):11–2.
11. Pearce JMS. Walter Edward Dandy (1886–1946). J Med Biogr. 2006; 14(3):127–8.
12. Kelly PJ. Dandy of Johns Hopkins. Mayo Clin Proc. 1985; 60(3):215–6.
13. Olch PD. Book Reviews. Journal of the History of Medicine and Allied Sciences. 1985; 40(3):366-367.
14. Corsello A, Di Dalmazi G, Pani F, Chalan P, Salvatori R, Caturegli P. Walter E. Dandy: his contributions to pituitary surgery in the context of the overall Johns Hopkins Hospital experience. Pituitary. 2017; 20(6):683–91.
15. Dandy Marmaduke ME Ile. Walter Dandy (1886-1946): A Personal Retrospective. Neurosurgery. 2015; 77(4):501–8.
16. Patz MD, Laws ER, Thomas AJ. The Cushing-Dandy conflict - The Dandy family perception of the discord. World Neurosurg. 2015; 83(1):69–73
17. Brewster R, Bi WL, Smith TR, Gormley WB, Dunn IF, Laws ER. The neurosurgeon as baseball fan and inventor: Walter Dandy and the batter's helmet. Neurosurg Focus. 2015; 39(1):E9.

18. da Mota Gomes M. From the wax cast of brain ventricles (1508-9) by Leonardo da Vinci to air cast ventriculography (1918) by Walter E. Dandy. Rev Neurol (Paris). 2020; 1918:9–12.
19. Dandy WE. Ventriculography Following the Injection of Air into the cerebral ventricles. Ann Surg. 1918; 68(1):5-11.
20. Dandy WE. Localization or Elimination of Cerebral Tumors By Ventriculography. Surg Gynecol Obstet. 1920; 30:329-342.
21. Dandy WE. Pneumoperitoneum: a method of detecting intestinal perforation-an aid in abdominal diagnosis. Ann Surg. 1919; 70(3):378-83.
22. Dandy WE. Röntgenography of the Brain After the Injection of Air Into the Spinal Canal. Ann Surg. 1919; 70(4):397–403.
23. Lutters B, Koehler PJ. Cerebral pneumography and the 20th century localization of brain tumours. Brain. 2018; 141(3):927–33.
24. Rachel RA. Surgical treatment of hydrocephalus: A historical perspective. Pediatr Neurosurg. 1999; 30(6):296–304.
25. Dandy W, Kenneth B. Internal Hydrocephalus an experimental, clincal and pathological study. Am J Dis Child. 1914; 8:406–482.
26. Dandy WE, Blacfan KD. Internal hydrocephalus: second paper. Am J Dis Child. 1917; 14(6):424–443
27. Blitz AM, Ahmed AK, Rigamonti D. Founder of modern hydrocephalus diagnosis and therapy: Walter Dandy at the Johns Hopkins Hospital. J Neurosurg. 2019; 131(4):1046–51.
28. Rizzoli H. Dandy's Contributions to the Foundation of Neurological Surgery. Pediatr Neurosurg. 1988; 13:316–22.
29. Walter E Dandy KB. An Experimental and Clinical Study of Internal Hydrocephalus. South Med J. 1913; 6(12):791–4.
30. Dandy WE. Extirpation of the choroid plexus of the lateral ventricles in communicating hydrocephalus. Ann Surg. 1918; 68(6):569-79.
31. Davidoff LM. Treatment of hydrocephalus: historical review and description of a new method. Arch Surg. 1929; 18(4):1737–1762.
32. Demerdash A, Rocque BG, Johnston J, Rozzelle CJ, Yalcin B, Oskouian R, et al. Endoscopic third ventriculostomy: A historical review. Br J Neurosurg. 2017; 31(1):28-32.
33. Zada G, Liu C, Apuzzo MLJ. "through the looking glass": Optical physics, issues, and the evolution of neuroendoscopy. World Neurosurg. 2013; 79(S-2):S3–13.
34. Kretzer RM, Coon AL, Tamargo RJ. Walter E. Dandy's contributions to vascular neurosurgery: Historical vignette. J Neurosurg. 2010; 112(6):1182–91.
35. Horwitz NH. Walter Edward Dandy (1886-1946). Neurosurgery. 1997; 40(1):211-5.
36. Louw DF, Asfora WT, Sutherland GR. A brief history of aneurysm clips. Neurosurg Focus. 2001; 11(2):1–4.
37. Lai LT, O'Neill AH. History, Evolution, and Continuing Innovations of Intracranial Aneurysm Surgery. World Neurosurg. 2017; 102:673–81.
38. Akard W, Tubbs RS, Seymour ZA, Hitselberger WE, Cohen-Gadol AA. Evolution of techniques for the resection of vestibular schwannomas: From saving life to saving function - Historical vignette. J Neurosurg. 2009; 110(4):642–7.
39. Flamm E. New observations of the Dandy-Cushing controversy. Neurosurgery. 1994; 35(4):737–40.
40. Dandy WE. Removal of Cerebellopontile (Acoustic) Tumors Through a Unilateral Approach. Arch Surg. 1934; 29(3):337.
41. Black PM, Black CT. History of neurosurgery for intracranial mass lesions. Neurosurg Clin N Am. 2001; 12(1):1-9,
42. Pinkus RL. Innovation in neurosurgery: Walter Dandy in his day. Neurosurgery. 1984; 14(5):623-31.
43. Weinstein JS, Burchiel KJ. Dandy's disc. Neurosurgery. 2009; 65(1):201–5.
44. Cohen-Gadol AA, Geryk B, Binder DK, Tubbs RS. Conquering the third ventricular chamber: Historical vignette. J Neurosurg. 2009; 111(3):590–9.
45. Patel SK, Liu JK. Overview and History of Trigeminal Neuralgia. Neurosurg Clin N Am. 2016; 27(3):265–76.
46. Morone PJ, Dewan MC, Zuckerman SL, Tubbs RS, Singer RJ. Craniometrics and Ventricular Access: A Review of Kocher's, Kaufman's, Paine's, Menovksy's, Tubbs', Keen's, Frazier's, Dandy's, and Sanchez's Points. Oper Neurosurg. 2019; 0(0):1–9.
47. Bhattacharyya KB. Walter Edward Dandy (1886-1946): The epitome of adroitness and dexterity in Neurosurgery. Neurol India 2018; 66:304-307
48. Jusue-Torres I, Prabhu VC, Jones GA. Dandy's hemispherectomies: historical vignette. J Neurosurg. 2021; Online ahead of print.
49. Pérez-Fontalvo NM, De Arco-Aragón MA, Jimenez-García JDC, Lozada-Martinez ID. Molecular and computational research in low- and middle-income countries: Development is close at hand. J Taibah Univ Med Sci. 2021; 16(6):948-949.
50. Lozada-Martinez ID, Ortega-Sierra MG, Hernández-Morales EY, Gonzales-Méndez R, Mejias-Riverón K, Argüello-Manrique M, et al. Letter to the Editor. Latin American collaboration in international neurotrauma registries: a strategy from the academy. J Neurosurg. 2022 Mar 11:1-2.
51. Nuñez-Gamez JA, Medina-Bravo PA, Piñeros-López NF, Contreras GA, Rosero-Burgos ME, Lozada-Martínez ID, et al. Global outcomes, surgical teams and COVID-19 pandemic: Will the same objectives of global surgery persist? Ann Med Surg (Lond). 2021; 71:103002.
52. Lozada-Martinez ID, Carvajal-Bautista J, Picón-Jaimes YA, Dominguez-Alvarado G, Cabrera-Vargas LF, Torregrosa-Almonacid L, et al. Surgical research in Colombia part 1: Scientific and academic productivity of the Colombian research groups in surgery. Ann Med Surg (Lond). 2022; 77:103667.
53. Mass-Hernández LM, Acevedo-Aguilar LM, Lozada-

Martínez ID, Osorio-Agudelo LS, Maya-Betancourth JGEM, Paz-Echeverry OA, et al. Undergraduate research in medicine: A summary of the evidence on problems, solutions and outcomes. Ann Med Surg (Lond). 2022; 74:103280.

54. Silva-Rued ML, Ramírez-Romero A, Guerra-Maestre LR, Forero-Hollmann ÁM, Lozada-Martínez ID. The need to develop specialized surgical centers: the evidence that surgical diseases cannot wait. Int J Surg. 2021; 92:106036.
55. Llamas-Nieves A, Maiguel-Lapeira J, Lozada-Martinez I, Torres-Llinas D, Moscote-Salazar L. The desire to publish a scientific article and the difficulties of publishing it in a high-quality neurosurgery scientific journal. J Neurosurg Sci. 2022; 66(2):163-164.