

In Memoriam

A. Earl Walker: Neurosurgeon, Neuroscientist, and Epileptologist

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A. Earl Walker died with gentle swiftness on January 1, 1995, near Tucson, Arizona, as a passenger of a car driven by his wife Agnes. He was 2 months shy of his 88th birthday.

His death marks the departure of a veritable giant whose interests and energies encompassed most areas of neuroscience and extended into psychiatric and endocrinological domains. It is not hollow praise to observe that the medical world has become poorer by the loss of one of its few truly towering personalities. Such giants are seldom seen today because their dimensions are incompatible with the modern medical landscape, which depends on team research efforts and highly focused subspecialties.

THE ACADEMIC CAREER

A. Earl Walker was born in 1907 in Winnipeg, Manitoba, Canada. In 1930, he received his M.D. degree from the University of Alberta in Edmonton. Following an internship at Toronto Western Hospital, he became a resident in neurosurgery at the University of Chicago and later also received addi-



A. Earl Walker in his later years: wisdom and energy.

tional specialty training at the University of Iowa, Yale University, and at academic medical centers in Belgium and the Netherlands. He worked briefly as Chief of Neurology at Framingham, Massachusetts, and thereafter at the University of Chicago until 1947, when he was appointed Head of Division of the Neurological Surgery at Johns Hopkins Medical School and Hospital in Baltimore, Maryland. As the successor to Walter E. Dandy, who, with Cushing, Frazier, and Elsberg, was one of the great pioneers of neurosurgery in North America, he created a new environment for neurosurgery at Hopkins and remained a Chief until his retirement in 1972. This was the most productive and illustrious period of his life. After his retirement from Hopkins, he moved to the climatically more pleasant Southwest to assume the position of a professor for research and teaching in the Department of Neurology at the University of New Mexico School of Medicine at Albuquerque. It was only a year prior to his death when he finally fully retired into private life.

THE YOUNG YEARS IN CHICAGO

I can give only the raw skeleton of an extremely successful professional career. Dr. Walker's excellence showed early during his years of neurosurgical residency in Chicago. During the 1930s and 40s, Chicago was perhaps the "hottest" place in the neurosciences. Dr. Walker sometimes remarked that Percival Bailey, a disciple of Cushing and a pioneer in the classification of brain tumors, had the greatest impact on his professional development. This was due not only to Bailey's surgical proficiency, but also to the width and breadth of his clinical and investigational thinking. When eye problems forced Bailey to lay aside bistoury and microscope, he accepted a position in psychiatry. As a result, Walker felt torn between neurosurgery and psychiatry for some time until he finally settled on the former.

Walker received international attention with publication of his monograph "The Primate Thalamus" (1). His brilliant anatomical studies greatly promoted the understanding of the thalamic afferent and efferent systems. A second major contribution was the observation that topical application of penicillin to brain structures was severely neurotoxic and epileptogenic (2). This discovery must have prevented many cases of seizures and even status epilepticus by interdicting prophylactic postsurgical use of topical penicillin. At the same time, this discovery fortuitously turned into a boon for experimental epilepsy researchers who were provided with a most powerful tool for producing acute cortical epileptogenic foci.

Finally, his observations with Dandy (independently) on congenital atresia of the foramina of Luschka and Magendie, led to recognition of the Dandy-Walker syndrome (3).

A. EARL WALKER AT JOHNS HOPKINS

When Walker arrived at Johns Hopkins at the age of 40 he was immediately confronted with institutional difficulties. In the strongly developed pyramid system of the Johns Hopkins Hospital and in the presence of huge general medical and surgical departments, building a Division of Neurological Surgery within the Department of Surgery proved to be a thorny path. By that time, however, neurosurgery had definitely developed from a pioneering specialty into one with strong neuroscientific overtones that were distinct from issues confronting general surgery.

Walker's neurosurgical achievements during the ensuing years tended to be novel and imaginative, even with regard to the cutaneous incision, which always took into account the special vascular supply of the skin flap.

When I came to Hopkins in 1965, Walker had already begun emphasizing special types of neurosurgery, later called "functional neurosurgery." In addition to epilepsy surgery, Walker had great interest in the neurosurgical treatment of movement disorders. He described, for example, pedunculotomy used for treatment of choreoathetosis (4). In 1965, his interest in stereotaxic interventions, which had been pioneered by Spiegel and Wycis in Philadelphia, was steadily growing and Walker recruited other full-time faculty members to develop new areas for functional neurosurgery.

It is natural that not all of Walker's residents felt attracted to such highly specialized neurosurgical interests, especially at the perceived expense of general neurosurgery. This situation, however, was

easily remedied by the presence of highly experienced all-round neurosurgeons on the part-time clinical staff at Hopkins. These included two former disciples of Walter Dandy's last years: the late Dr. Frank Otenasek and Dr. John Chambers. Another less popular feature for residents was Walker's insistence on a minimum of 7 years of training for Americans; foreigner got away with a slightly shorter time. The training program specified years of research intermingled with clinical and surgical activities. Despite its intention, however, the design of the residency program led to a rather meager academic yield in terms of eventual professors of neurosurgery, a phenomenon that is not easily understood when one thinks of Walker's national and international preeminence in those years.

A. EARL WALKER AND BRAIN TRAUMA/POSTTRAUMATIC EPILEPSY

Dr. Walker's military experience confronted him with a major therapeutic challenge: posttraumatic epilepsy. The penetrating brain wounds caused by high-velocity projectiles differ from those caused by closed head injuries. In several major studies, Walker (5-7) presented classical accounts of the development, clinical features, and possible mechanisms of posttraumatic epilepsy.

NEW APPROACHES TO EPILEPSY SURGERY: TEMPORAL LOBECTOMY

Epilepsy surgery was still a novelty at Hopkins when Walker arrived. By the time of my arrival in 1965, seizure surgery was already well developed, and there was a long list of operated patients with intractable seizure disorders who had been treated early on with focal and regional excisions and then, later, using en-bloc-resections of the anterior temporal lobe.

Percival Bailey (8) had performed temporal lobectomies in 1947, removing the anterior 55-70 mm of the temporal lobe but leaving the mesial limbic structures (amygdala, hippocampus) intact. These structures were included, at least partly, in procedures designed by Penfield and Baldwin (9) and Rasmussen and Jasper (10). In the meantime, Walker further modified the Montreal approach (11). Subsequently, Rasmussen introduced a predominantly subpial resective technique for temporal lobectomy, which was further refined in Chicago, Montreal, and Baltimore; this method has become the centerpiece of modern epilepsy surgery with the highest success rate (12-14).

During Walker's tenure at Hopkins, temporal lobe epilepsy had already turned into the most in-

tensely debated issue in epileptology. Small wonder that the enormous variety of ictal and interictal symptoms, ranging from complex motor activity to autonomic changes and psychological-psychiatric aberrations, stimulated the mind of a neuroscientific thinker like Walker. Before returning to this topic, however, special note must be made of Walker's deep interest in electroencephalography, especially as it pertained to the presurgical evaluation of candidates for seizure surgery. None of his surgically treated epilepsy patients were touched before doing a thorough EEG assessment and analysis.

A MASTER OF EEG AND RELATED ELECTROPHYSIOLOGICAL METHODS

Walker's interest in EEG can be dated back to 1937, when he published two "oscillographic studies" of cerebello-cerebral relationships (15,16). He studied responses to intermittent photic stimulation in monkeys (17) and his experience permitted him to write a paper on the clinical value of electroencephalography (18). He reported on EEG changes caused by cerebral concussion (19) and on activated electroencephalography (20). This latter study involved Dr. Curtis Marshall, a talented electroencephalographer who had come to Hopkins with Walker from Chicago. Under Walker's egis Marshall established a fine EEG laboratory, which I had the honor to take over in 1965. Marshall was a wizard of EEG technology, and he collaborated with Walker in a paper describing electrocorticography as a useful adjunct for assessing the functional state of the cerebral cortex during epilepsy surgery (21).

Depth EEG for evaluating candidates for seizure surgery was introduced at Hopkins in 1958, and the first report was delivered at the 1961 International EEG Congress in Rome (22). This elegant work summarized the EEG patterns obtained from a variety of subcortical structures.

When I arrived at Hopkins, I had to familiarize myself rapidly with the technologies of depth and corticographic recordings. Walker's depth electrodes were designed as tresses: bundles of six fine stainless steel strands, each strand having a diameter of 89 μm . The Formvar insulation had to be scratched off for a width of 1 mm to form the recording surface. The recording sites were strategically chosen and four tresses placed through two superior frontal burrholes, with the tips aimed at the orbital-frontal cortex and the amygdala. Utmost care was taken to insure bilateral symmetry of the placements. These tresses formed a powerful cohort of 24 depth recording contacts.

There was no immediate postsurgical "marathon-

recording session" as used by Bancaud at the time in Paris. Instead, prolonged recordings were carried out repeatedly in the regular EEG laboratory, along with various activations including electrical stimulation. If not "cutting edge" technology it was certainly a solid "homemade pie." That is, a reliable technology based on inexpensive components. By virtue of his uncanny knowledge of anatomy and "feel," Walker introduced the tresses using a 20-gauge needle, which was subsequently withdrawn, with free-hand technique. Perhaps surprisingly, most (but not all) implants looked remarkably on target with symmetrical placement. Walker believed that identifying an epileptogenic structure like the amygdala or hippocampus was not a matter of one or two critical millimeters, unlike the extreme precision required for thalamic or basal ganglia implants, for which he did use stereotactic methods.

Despite Walker's openness to technological progress, there was a quaint conservatism in his work "What I can do with my own hands, what can be done with simple homemade technology, let it be done this way. Why should I use new, expensive, commercially built apparatus?" This attitude certainly reveals a part of his maverick spirit: tackling clinical or scientific problems by plain and simple means. This was his maxim: first comes the idea or thought, then the technical tool. For him, tools were just to assist in doing the job; they should be practical and void of any lavishness.

Although I initially had great trepidation when I began working with Walker in the operating room or performing my first depth recordings for him, my concerns were foundless. He was a wonderful collaborator, and we spent many hours discussing cases: to operate or not; which brain areas to resect, how much tissue was it necessary to remove to control seizures. Dr. Walker's critical, insightful but humane thinking was a high point of our work together.

TRESSES VERSUS PROBES

In the late 1960s, Dr. Charles D. Ray joined the neurosurgical faculty at Hopkins. He had come from the Mayo Clinic where he had developed a cerebral depth probe made of platinized platinum. It was somewhat bulky, with 18 sites serving as EEG electrodes. This technical masterpiece was in some respect well ahead of its time as it had a hollow core intended for the evaluation of neurochemical tissue changes (23). With some reluctance, Walker permitted Ray to use the probe, despite misgivings that its size would foster infection of hemorrhage. The RIM

probe (for "Ray-IBM-Mayo") yielded good results, but within a decade these very expensive reusable probes were banished when transmission of the Jakob-Creutzfeldt pathogenic agent was observed in Europe (24). This story illustrates that Walker was not dogmatic in matters of controversy or differences of opinion; he had an uncanny feel for problems of new technology, and a belief that more expensive tools are not necessarily better.

TEMPORAL LOBE EPILEPSY: PSYCHIATRIC AND PSYCHOLOGICAL FACTORS

Before I arrived at Hopkins, Dr. Walker had hired a fine neuropsychiatrist from Switzerland, Dr. Dietrich Blumer. Blumer was appointed to the Hopkins faculty and entrusted with clinical and academic work on psychiatric aspects of temporal lobe epilepsy. Not much earlier, Gastaut and his co-workers in Marseille had emphasized the hyposexuality of patients with this type of seizure disorder.

From Blumer's work with Walker emerged a view of persons with temporal lobe epilepsy as irritable, and sometimes aggressive (although not violent), with depressed libido and potency ("Make war, not love!" as Blumer used to remark in a jocular vein). A fascinating aspect of these observations was that they stood in diametric opposition to the experimental Kluver-Bücy syndrome in which monkeys became docile and hypersexual after bilateral removal of the temporal lobes. Much of this work is summarized in the 1967 study of Blumer and Walker (25).

EXPERIMENTAL WORK IN EPILEPTOLOGY

Walker's research work was based to a large extent on studies of experimental epilepsy in cats and, in later years, in macaca mulatta monkeys. This work chiefly concentrated on the sequence of events involved in generation and spread of the epileptic discharge (topical penicillin) and subacute to chronic (alumina cream) models. Strategically placed depth electrodes permitted recording from the most important neocortical and limbic regions, as well as from basal ganglia, thalamus, and cerebellum. Topical strychnine and electrical stimulation were also used to produce seizures in other experiments (26-32).

Walker was especially interested in the rules of epileptic discharge propagation, and the relative contributions of cortical and subcortical structures. This work led to the concept of cerebral structures having either low or high thresholds for epileptic activity. As an example, the thalamus had been thought to be a highly epileptogenic structure be-

cause of Penfield's "centrencephalic" theory of generalized epilepsy (33). Walker remained skeptical about the centrencephalic concept, and his own depth EEG data obtained in a few patients with generalized spike-wave activity supported his view that 3/s spike-wave discharges are not a projection from the thalamus to the cortex.

In contrast, he found that limbic structures such as hippocampus and amygdala were invariably low threshold areas for seizures, as was the caudate nucleus.

RECOGNITION AND HONORS

The world of neurology and neuroscience did not fail to recognize Walker's achievements. He was elected president of both the American Association of Neurological Surgeons and the American Neurological Association. This unique achievement validated the fact that his work was of equal importance to neurology and neurosurgery. Curiously, he was never President of the American Epilepsy Society. He was President of the ILAE from 1949 to 1953, and he presided over the World Federation of Neurology. Walker's interest in electroencephalography and related fields led to active participation in and eventually, in 1955, to the presidency of the American EEG Society. And he held numerous memberships and honorary memberships in professional societies around the world!

Walker's durable health permitted strenuous transcontinental travel followed by immediate resumption of a full schedule, including in the operating room, after his return to Baltimore. Needless to say his travel was sometimes necessitated by honoring requests for consultation concerning the neurosurgical problem of a dignitary.

A phenomenal memory assisted him in his work as member or chairperson of various hospital, university, national, and international committees. His wisdom, vision, and sense of detail were evident in this tedious work. In this manner, Walker was capable of giving new direction to neurosurgical and neuroscientific activities that had far-reaching implications. Walker was deeply interested in the history of neurology and neurosurgery. Trephine holes in the skulls of prehistoric humans fascinated him during his numerous journeys to South America, but he was also interested in the beginnings of neurosurgery in North America, Europe, and Asia, as reflected in a monograph on the history of neurosurgery (34).

A. EARL WALKER—THE MAN

Walker was a complicated personality, even though there were islands of simplicity in the sea of

complexity. He impressed first by his appearance: a tall and very handsome man with a rather high-pitched voice, impeccably dressed if not in laboratory coat or surgical garb. Behind the facade of kindness and friendliness was an unmistakable lord-like demeanor that discouraged closeness. No one approached Walker on a buddy-buddy basis. I learned the hard way not to ask dumb questions. After his return from a lengthy voyage around the world with prolonged stays in various countries, I asked him what he had liked best. The answer was exactly what this triviality deserved: "Those cool nights in Australia." He was invariably kind to patients and they loved him in return, regardless of social class and rank.

As the Division chairman, Walker was willing to give surprising amounts of his time to other members of the faculty, as well as residents and students. His use of time was exemplary ("truly great people usually have time for others"). Indignation and disappointment never gave way to anger or outbursts of wrath; supreme self-control would prevent him from audible ire. When angry, inflections in his voice and a slight reddening of his face were the signals that had to be heeded by co-workers. Despite his hauteur, Walker had a good sense of humor, and a good story could trigger an outburst of hearty laughter. These moments made him more human and gave warmth to the image of an otherwise remote person.

Walker was a constant source of inspiration for faculty colleagues. Resident surgeons, however, tended to be excessively awed by his towering personality. He was not the favorite professor of medical students who often resented his irony and sarcasm. They got revenge in their own way, however, through the naughty weapons of the "Pithotomy Club."

His personal life was not surprisingly overshadowed by his involvement in the vast array of professional activities. His home was lovely and not chosen with the intention to impress others by rich external dimensions. Tragedy struck when one of his four children was killed by a freak accident: a school bus went out of control and rolled over his son. Walker came to Hopkins that same day, wordless and with gray complexion, to seek consolation in work. After a painful divorce, he remarried later finding a wife who added great happiness to his years in New Mexico.

THE LAST YEARS AT JOHNS HOPKINS

A cloud of sadness and unfulfillment hovered over the last decade of Dr. Walker's activities at

Hopkins. His feelings for this great medical institution were ambivalent. Like the prophet without honor in his own country, Walker did not receive the same adulation at Hopkins that he was given nationwide and all over the world. There must have been an odd antagonism of chemistries between this giant of neurosurgery and Johns Hopkins, the medical giant. There remain unfathomable elements in their relationship as in many other facets of Walker's life and personality.

In 1967, an unforgettable symposium was organized at Hopkins in honor of Walker's 60th birthday. The cast of participants was a Who's Who in the world of neurosurgery and neuroscience. At the final banquet, when asked what motivated him to achieve so much in his lifetime, he smiled and said: "Because it was so much fun!" I think that this answer came from his heart, but I could never be sure that he was not making a trivial response to what he considered a silly question.

Following that celebration, Walker gradually slipped into the position of a "lame duck" chairman. His personal work, however, was filled with new plans and visions. His greatest hope, creating a "visual prosthesis" for the blind by means of meaningful electrical stimulation of the calcarine cortex, never materialized. Nonetheless, he continued to make productive studies of the subjective experimental phenomena elicited by electrical stimulation of human limbic structures.

Also in those years, Walker made outstanding contributions to the ethical and medical issues associated with brain death. These resulted in a widely cited monograph (35,36). His tenure at the University of New Mexico was likely highly productive and his list of published works exceeded the 400 mark, including 10 books. The Georges Schaltenbrand-Percival Bailey atlas *Stereotaxy of the Human Brain*, a work of enormous dimension, was re-edited in 1982 by Schaltenbrand and Walker (37).

EPILOGUE

With Walker's passing, we mourn the death of a man of unique interests and competence. Scientific curiosity was his most powerful drive; neither political power nor wealth influenced him greatly, although he enjoyed fame as the reward for his unceasing labor. His body of work remains. It may not be congruent with the molecular biological direction of modern neuroscience, but much of it will prove to be useful to future scientists interested in system biology. The work of our present elite is threatened by politicians, regulators, and business managers. Giants such as A. Earl Walker serve to remind us that there are greater goals and role models.

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