

History of Neurosurgery in Cincinnati



**Henry R. Winkler Center
for the History of the Health Professions**
University of Cincinnati CARE/Crawley Building
April to June, 2009



presented by the
University of Cincinnati
Department of Neurosurgery
and the Mayfield Clinic

1st Electrical Stimulation of the Human Brain



Roberts Bartholow, MD
Neurologist and Surgeon

Chair, Medical Chemistry, Medical College of Ohio*, 1864
Chair, Materia Medica, Medical College of Ohio*, 1867
Dean, Medical College of Ohio*, 1874-1879
President, American Neurological Association, 1881

* later became UC College of Medicine

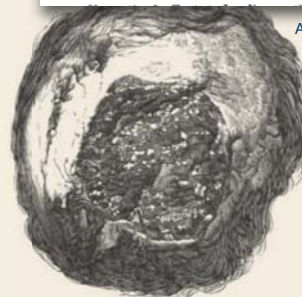
In 1874 Roberts Bartholow, MD, treated a patient named Mary Rafferty, who had a 2-inch hole in her skull caused by a cancerous ulcer. In an electrotherapy room at Good Samaritan Hospital, Bartholow applied a faradic electrical current to sections of Mary's exposed brain (left motor cortex) noticing that the low current caused movements in various parts of her body but did not cause her pain. However, when a higher current was applied, Mary became distressed and had a seizure. She revived and underwent additional experiments, but several days later had a major seizure and died. No one had as yet made similar experiments on an awake human brain. Bartholow published his findings in the American Journal of the Medical Sciences.

The American Medical Association condemned his experiments on Mary Rafferty, calling them "so in conflict with the spirit of our profession, and opposed to our feelings of humanity that we cannot allow them to pass unnoticed." Bartholow publicly apologized in a letter to the British Medical Journal. His interest in electrical therapy did not wane. He later wrote, "Medical electricity: a practical treatise on the applications of electricity to medicine and surgery."

Observation 2. To test faradic reaction of the surface of the dura mater.—Two needles insulated were introduced into left side until their points were well engaged in the dura mater. When the circuit was closed, distinct muscular contractions occurred in the right arm and leg. The arm was thrown out, the fingers extended, and the leg was projected forward. The muscles of the neck were thrown into action, and the head was strongly deflected to the right. These effects were produced by the current from one cup, the wooden cylinder entirely inclosing the bobbin. (Current of least volume and intensity from one cup.)

The same phenomena precisely occurred when the right posterior lobe was acted upon by a current of the same strength. The head was deflected strongly to the left, and the extensors of the left arm and leg were thrown into action.

Am J Med Sci 7:305-313, 1874



Bartholow was a successful author. One of his most important works is "Treatise on Materia Medica and Therapeutics." During his civil war service he wrote "Enlisting and Discharging Soldiers," which was adopted by the war department.

The Hopkins Invasion of 1922

In 1921 the University of Cincinnati was searching for a new head of surgery who would create a world-class surgical section. The position was originally offered to Walter Dandy of Johns Hopkins, who declined. It was then offered to George Heuer, who accepted and became the first Christian R. Holmes Professor of Surgery (1922-1931).

In what became known as the "Hopkins Invasion," Heuer brought the William Halsted method of surgical residency training to Cincinnati, along with several of Halsted's residents. The terms of Heuer's contract, a private ward, and new "standards" of surgery caused fierce local opposition. The full-time faculty concept was thought to exclude local surgeons, who eventually sued the College of Medicine for restricting use of the Cincinnati General Hospital. The Ohio Supreme Court agreed, leading to the creation of Holmes Hospital in 1926 for the faculty's private patients.



"Hopkins Invasion" included Mont Reid, B. Nolan Carter, Max Zininger, Bill Andrus, and Ralph Bowers. Heuer was a "General Surgeon," which for him included neurological and thoracic surgery. He trained under William Halsted and Harvey Cushing, the "father of modern neurosurgery."



Arch Surg 1:368-381, 1920



Heuer's most important contribution to neurosurgery was the frontotemporal craniotomy, initially used to approach chiasmal tumors. It is widely used today to approach tumors and aneurysms. Although Walter Dandy is frequently credited with its invention, his article in 1918 detailing the new approach clearly attributes Heuer, who was serving in World War I when the technique was presented.

At the time surgical specialties were not sufficiently developed to stand apart from general surgery or train their own residents. Halsted's revolutionary residency program set the precedent for surgical training in the U.S. Initially, a prospective resident completed an internship of undefined length. After internship, the residency consisted of 6 years as assistant resident, followed by 2 years as house surgeon. The assistant residency period was further subdivided into clinical and research years. UC became the third post-graduate surgical training program in the U.S., joining the Johns Hopkins and the Peter Bent Brigham hospitals.



Joseph Evans, MD

Frank Mayfield, MD

Specialty-trained Neurosurgeons

In 1937 Joseph Evans and Frank Mayfield were final candidates for a new position to head the neurosurgery division within the UC Department of Surgery. Mont Reid selected Evans for the academic post. Mayfield was about to return home when Sister Theodora offered him a position to start neurosurgery services at Good Samaritan Hospital. He accepted and began his community-based practice. Evans and Mayfield became close personal and professional friends. This partnership and trust was best shown when Mayfield and his partner, Thomas Weaver, were called to serve the war from 1942 to 1945 at Percy Jones General Hospital in Michigan. Evans offered to care for their patients during their absence, and even returned them later.

Evans



The "1936 Class" - the first group of young neurosurgeons trained by Dr. William Penfield and Dr. Bill Conley at Michigan before the opening of the Western Neurological Institute - 1936. Seated: L. to right: Douglas Brown, Bill Conley, Bernard J. de Zure, Frederick Lutz, George J. Lusk, Joseph P. Evans, Joseph Greenbaum, Paul H. Smith, William Penfield, William D. Edwards, and William B. Conley.



Charles Aring, Joseph Evans and Mark Scheinker
(Evans son in front)

Evans was a true physician-scientist, ever wanting to know the cause and mechanism of disease, not just its treatment. He and neurologist Charles Aring established a neuropathology laboratory, and both acted as neuropathologists for the hospital until 1940, when I. Mark Scheinker was recruited.

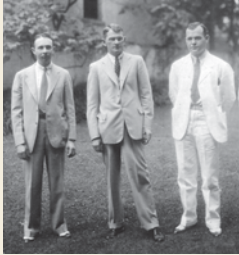
Evans had a keen interest in head injury. The pioneer work of Evans's Cincinnati team (Frank Espey, Henry Ryder, and Boris Podolsky), in the recording of intracranial pressure (ICP) on a continuous basis involved one of the earliest uses of computers in medicine. Espey introduced Evans to the electronic measurement of pressure. Ryder developed an experimental model in monkeys, using strain gauge recordings from the lateral ventricle, lumbar subarachnoid space, and cardiovascular system. They examined the effect on ICP of alterations in blood volume, CSF volume, and brain compartment volume. After extending the work to humans, they were able to quantitate the relationship between ICP and cerebral blood flow.

Today, an eponymous award is given in his honor: Joseph P. Evans, MD Award in Neurosurgery is presented in recognition of outstanding service to the community, commitment to the profession, and embodiment of the highest ideals of teacher, practitioner, student, citizen and friend.

Joseph Evans Awardees

- | | |
|-----------------------------|----------------------------------|
| 1990 Bert McBride, MD | 1997 James Steers, MBBS, FRCS |
| 1991 James Nichols, Jr., MD | 1998 Stewart B. Dunsker, MD |
| 1992 Michael McWhorter, MD | 1999 Ernesto Martinez Duhart, MD |
| 1993 Isao Yamamoto, MD | 2000 John M. Tew, Jr., MD |
| 1994 Henry Lattinville, MD | 2001 Kensuke Kurokawa, MD |
| 1995 Richard Budde, MD | 2002 Set Shababian, MD |
| 1996 Raymond Sawaya, MD | 2003 Thomas S. Berger, MD |

Frank Henderson Mayfield, MD



Gayle Crutchfield, Claude Coleman, and Frank Mayfield



Mayfield served at Percy Jones General Hospital under General Norman Kirk (front row, center) from 1942-1945 and achieved rank of Lt. Colonel.

Frank Mayfield was planning a career in public health until neurosurgery caught his interest. At the Medical College of Virginia, he was a student of Claude Coleman. Mayfield is best known for his clinical interests in peripheral nerve and spine injuries, development of neurosurgical instruments, and medical politics.

In 1937 Mayfield moved to Cincinnati from Louisville to establish neurosurgery services at Good Samaritan Hospital. Within a year Mayfield had so many patients that he was often working 90 hours a week, with 7 to 8 cases a day and frequent late-night trips to rural hospitals. He had a driver and slept en route. He had to carry a large bag of neurosurgical instruments everywhere he operated. This sparked his ingenuity to invent instruments for the new field of neurosurgery.

Soon after arriving in Cincinnati, Mayfield was called to war. He served as Chief of Neurosurgery at Percy Jones General Hospital. More than 25,000 cases of major nerve injuries were treated during this time. Senator Bob Dole was a patient.

After the war, Mayfield focused on resident education and assumed leadership roles in numerous medical associations. His clinical practice and partnership rapidly expanded. In the 1960's Ohio law allowed limited partnerships but not professional corporations. Taxation and malpractice insurance led the group to challenge the IRS and file for incorporation. In 1971 Mayfield, Lotspeich, Hunter and Budde, Ltd. became the first physician group in Ohio to incorporate.

In 1973, upon his 65th birthday and by pre-arrangement, Mayfield yielded control of the practice. The group renamed the practice Mayfield Neurological Institute, Inc. in his honor. Today it is known as the Mayfield Clinic & Spine Institute.



The group partnership was named (Frank) Mayfield, (Edgar) Lotspeich, (Curwood) Hunter and (Richard) Budde, Inc. in 1971



Matters of Medical Education & Medical Practice

Perhaps Frank Mayfield's greatest local political impact was his three-decade crusade to defuse the town versus gown conflicts between the University and its private hospital competitors. In 1951 Mayor Cash asked Mayfield to join the UC Board of Directors with one charge – to make the community hospitals surrounding the University of Cincinnati College of Medicine and Cincinnati General Hospital a part of the University Center. In 1967 Mayfield drafted a Master Plan for Walter Langsam, President of the University. At the time, UC was not ready for such a plan. Not until 1982 did changes in leadership allow elements of Mayfield's Master Plan to come to fruition.

- 1938 Founding member, American Academy of Neurological Surgery
- 1942-45 Served in U.S. Army, Percy Jones General Hospital
- 1942 President, American Academy of Neurological Surgery
- 1947 President, Ohio State Neurosurgical Society
- 1951 President, Academy of Medicine of Cincinnati
- 1951 Board of Directors, University of Cincinnati (until 1967)
- 1958 Appointed to American Board of Neurological Surgery
- 1962 Chairman, American Board of Neurological Surgery
- 1964 President, Harvey Cushing Society
- 1965 "Mayfield Proclamation" declared AANS spokesman for neurosurgery
- 1968 Alternate Delegate to American Medical Association from Ohio State Medical Association
- 1969 Distinguished Service Award, American Board of Neurological Surgery
- 1971-76 Delegate to American Medical Association from American Association of Neurological Surgeons
- 1973 Partners named the corporation Mayfield Neurological Institute



Essentials of the Master Plan

- 1) Change the admissions policy of the Cincinnati General Hospital to allow care of private patients (at the time only indigent patient care was provided and used for teaching purposes).
- 2) Conversion of the faculty to full time status to increase time spent teaching students.
- 3) Services of the faculty to be provided by the University on a group basis.

- 1976 "Man of the Year," Ohio State Neurosurgical Society
- 1976 Establishment of the Mayfield Education & Research Fund
- 1977 First recipient of Harvey Cushing Medal, American Association of Neurological Surgeons
- 1979 "Honored Guest," Congress of Neurological Surgeons
- 1979 Distinguished Service Award, American Medical Association
- 1980 "Great Living Cincinnati," Cincinnati Chamber of Commerce Award
- 1981 Distinguished Service Award, Society of Neurological Surgeons
- 1982 "Neurosurgeon of the Year," Surgical Neurology
- 1982 Dedication of the Mayfield Center for Surgical Neurology, Good Samaritan Hospital, Cincinnati
- 1982 First recipient of Louis Nippert Award, Christ Hospital
- 1982 Mayfield-Aring Neuroscience Symposium established
- 1983 "The Mayfield Award" established by Congress of Neurological Surgeons; annual resident research award in spine
- 1989 Frank H. Mayfield Society established (alumni association)

“The three A’s of a successful practice still determine a physician’s capacity of influence on political issues. Availability, Affability and Ability are the order of importance in which patients measure their respect and affection for their physicians.

Patients are the physician’s political constituency; deserve and keep their respect and affection. They will then in turn influence legislation as you wish. At this late stage in life, my thoughts on patient care are perhaps more valuable than any concept I may have on pending political issues or problems.

Doctor, your telephone is your front door; be sure that the one who answers it is committed primarily to patients’ welfare rather than to your protection.”

–Frank H. Mayfield, MD



Frank H. Mayfield, MD, Portrait Bust, bronze
John Hebenstreit, sculptor

“When in the course of human events the overwhelming majority of a group accepts certain matters as factual, it is appropriate for the elected leader of that group to proclaim those conditions as fact. Therefore, in view of conditions cited and with the approval of the Board of Directors, I, Frank H. Mayfield, President, do hereby proclaim The Harvey Cushing Society to be in fact the official organization representing the neurological surgeons of the United States.”*

Mayfield Proclamation, April 12, 1965

–Frank H. Mayfield, MD

**In 1967 The Harvey Cushing Society changed its name to The American Association of Neurological Surgeons (AANS).*

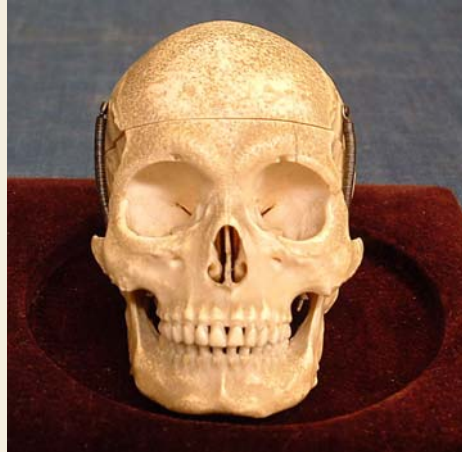


Mayfield was honored with the first Harvey Cushing Medal for distinguished service at the AANS annual meeting in 1977.

Courtesy the private collection of Frank H. Mayfield, III

Ivory Skull of Samuel David Gross, MD

This ivory skull was hand-carved out of a single block of ivory by a grateful Japanese physician for Samuel Gross, who was then Chairman of Surgery at the University of Pennsylvania. Samuel Gross and Weir Mitchell sponsored Dr. William Osler to the Chair of Medicine at the University of Pennsylvania in 1885. Dr. Gross died in 1889, and his widow, Grace Revere (great-granddaughter of Paul Revere), married Dr. Osler in 1891. The ivory skull, given to Sir William Osler by his wife, Grace Revere Osler, sat on his office desk for many years. When Osler died, the skull was willed to Thomas McCrae, Professor of Medicine at Jefferson Medical School. McCrae co-authored with Osler the multi-volume "System of Medicine." McCrae married Osler's niece, Amy McCrae, sister of Dr. Osler Abbott's mother. Thomas McCrae then willed the skull to Osler Abbott (who trained in Cincinnati). The ivory skull was given to Frank Mayfield in 1965 in appreciation of the surgical care Abbott received. Mayfield donated the ivory skull to the UC History Library in 1978 because of its connections to Cincinnati history.



Gross was in Cincinnati from 1833 to 1839 as Demonstrator of Anatomy at the Medical College of Ohio. Two years later he joined the faculty of the Medical Department of Cincinnati College as Professor of Pathological Anatomy. He created the first systematic study of morbid anatomy in the U. S. With materials supplied by the slaughterhouses, he wrote his landmark work, *Elements of Pathological Anatomy*.



The Gross Clinic, painted by Thomas Eakins in 1875, depicts Samuel D. Gross and members of his "clinic" performing surgery on a young man. Gross has turned to address his students in the surgical amphitheater at Jefferson Medical College, where he was Professor of Surgery 1856-1882.

MAYFIELD® Aneurysm Clip and Clip Applier

The Cincinnati Post, Thursday October 25, 1967

Bicentennial capsule



Dr. Frank Mayfield, left, and surgical clip designer George Kees inspect the device in 1970 photo.

Artist's masterpiece saved lives
In preparation for Cincinnati's bicentennial, The Post is publishing stories of the city's history. This is part of a series on inventions and discoveries.

A Cincinnati surgeon, frustrated because he couldn't repair brain aneurysms in many patients, turned to his medical artist in 1964 for help.

The surgeon, Dr. Frank Mayfield, told George Kees he needed a clip to put around the neck of an aneurysm—a ballooning of an artery, which can burst and obliterate parts of the brain. Blood pressure makes the arterial wall balloon outward much as a football can be made while wearing a rubber shoe. Storage from an aneurysm can cause a sudden bursting of the wall, which is hemorrhage, a severe stroke or death.

Kees went to work with silver, a fine steel stainless steel and, in three years, had designed the Mayfield clip, which later was tested by surgeons as one of the major contributions to neurosurgery in 1965.

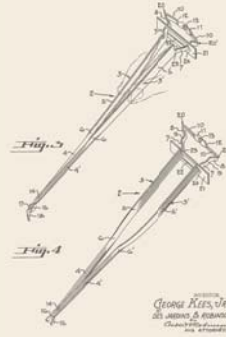
The stainless steel clip was somewhat similar to a history-maker clip. The applier was similar to forceps. When pressure is exerted on the applier handles it forces the attached clip ends open. A steel strip drops into slots to lock the applier in position. For application of the clip deep to the brain, pressure on the applier then releases the lock, and permits the clip to lock on the aneurysm neck.

For accuracy, the staple device was a way to save lives.

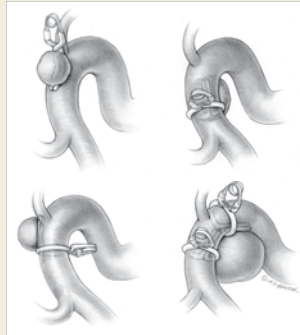
The clips also were used in the U.S. space program to secure wires before soldering.

Kees, now 65, still has completed some years ago but continues to work for the new owners at the White, K.C. plant, the state's largest safety manufacturers 400 different types of surgical clips and produces up to 10,000 a year.

In 1952 Frank Mayfield and George Kees developed the spring cross-leg aneurysm clip and a clip applier that afforded tweezer dexterity for trial and error in clip placement. The applier grasps the clip and holds the legs open by way of a drop lock on its proximal end. The drop lock is automatically released when the applier is compressed. Shortly after its invention, a California surgeon called in desperate hopes of securing the clips in time to use them during an upcoming operation on actress Patricia Neal. Mayfield told the surgeon to contact the props man on the set of the TV show, *Ben Casey*, where their use had been featured in a recent episode.

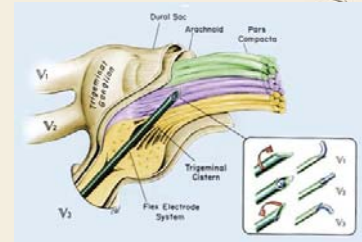
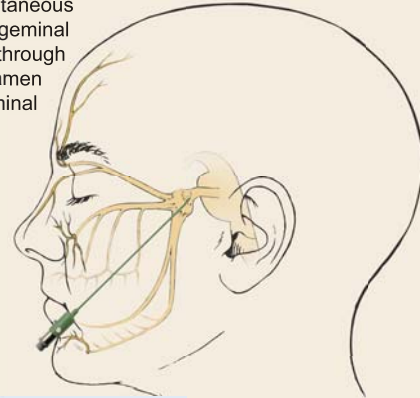


GEORGE KEES, JR.
225 W. 10TH ST. S.W.
CINCINNATI, OHIO 45202



TEW® Curved Electrode Kit

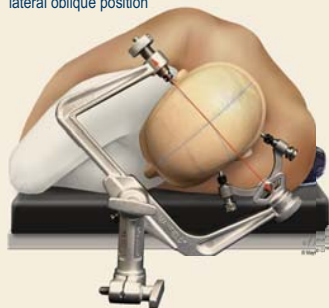
In 1974 John Tew and Eric Cosman developed the TEW curved electrode for percutaneous radiofrequency (RF) treatment of trigeminal neuralgia. The electrode is passed through the cheek and then through the foramen ovale in the skull to reach the trigeminal nerve root. Once positioned, an electrical current heats the area of the nerve causing pain. The lesion stops the pain.



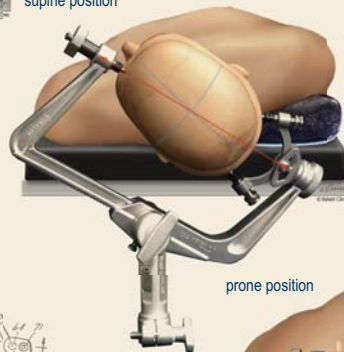
MAYFIELD® Headrest & Skull Clamp

In 1967 Mayfield and Kees developed the MAYFIELD Horseshoe and General Purpose Headrests, based on Mayfield's experience in a dental chair. The padded headrests were designed to cradle and stabilize the head off the end of the operating table and allow the surgeon better access during surgery. Subsequently, in 1973, a three-pin skull clamp was designed to rigidly affix a patient's head to the operating table during craniotomy drilling and delicate surgery. The Mayfield Headrest and Skull Clamp System are the most common and widely used neurosurgical instruments today.

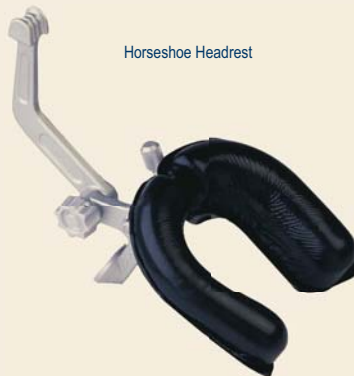
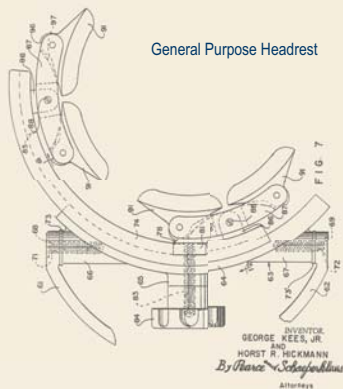
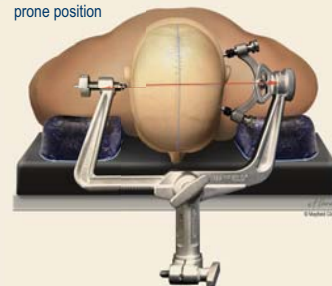
lateral oblique position



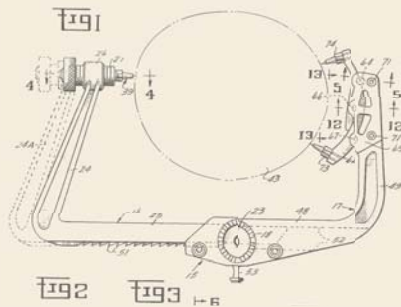
supine position



prone position

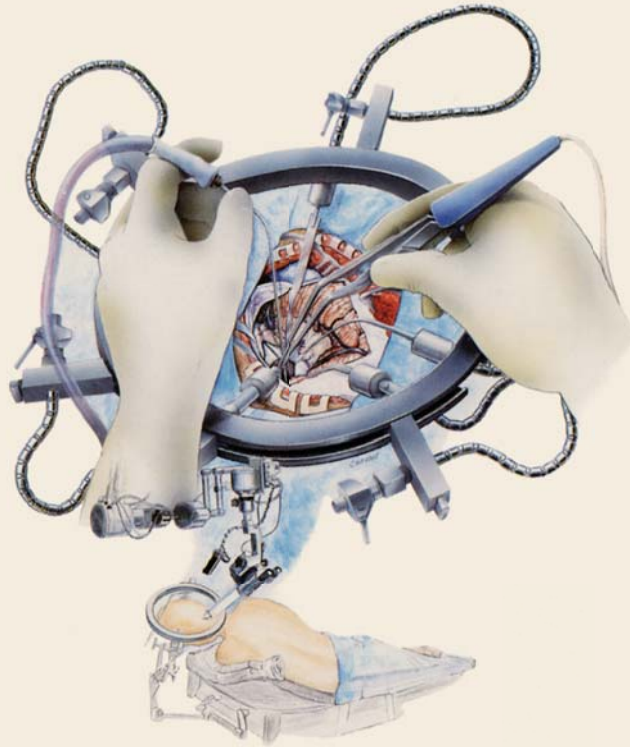
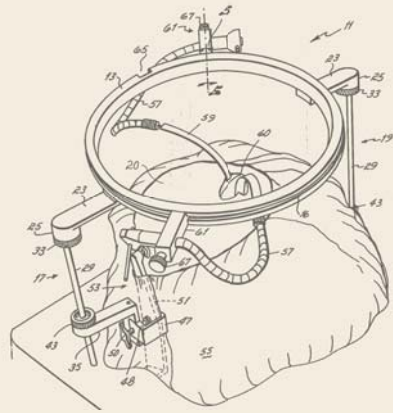


Skull Clamp



BUDDE® Halo Brain Retractor

In 1981 Richard Budde and Jim Day developed the Budde Halo Brain Retractor System. The halo is a circular frame that enables surgeons to rest their hands comfortably while the self-retaining retractors gently hold brain tissue apart from the operating site.



Ohio Medical Instrument Co.

Kees designed and made instruments in the carriage house (garage) behind the Mayfield offices at 506 Oak Street in Cincinnati. From a simple machine shop the business grew. In 1978 Budde, Mayfield and other physicians created the Ohio Medical Instrument Company (OMI), which is owned today by Integra Life Sciences and still manufactures the Mayfield Skull Clamp and Budde Halo Retractor systems.

Top-rated Neurosurgery Education Center — 93 Residents and 60 Fellows

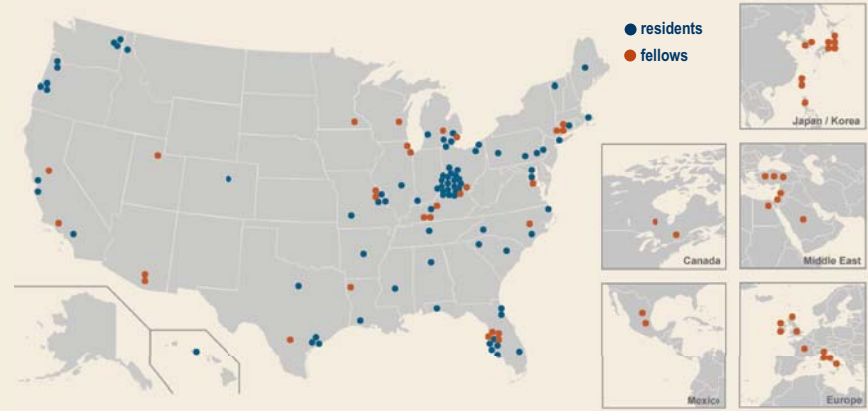
1948: Evans and Mayfield created a joint neurosurgical residency program to enable residents to rotate and benefit from the strengths of both the University (Cincinnati General Hospital) under Evans's leadership and the community hospitals (Good Samaritan and Christ) under Mayfield's leadership.

1969: Mayfield recruited Marcus Wigser, John Tew and Stewart Dunsker to join his group practice and establish a separate residency program at Good Samaritan and Christ hospitals.

1972: Mayfield's training program was officially approved as a free-standing non-university-based residency program. Cincinnati now had two neurosurgical training programs: one at UC / Children's under McLaurin's leadership and the other at Good Samaritan and Christ under Mayfield's leadership.

1982: John Tew, appointed the first Frank H. Mayfield Chair of Neurosurgery, reunited the programs into a Department of Neurosurgery at UC and Mayfield Clinic.

Today: The department continues with 21 residents and 7 fellows at University, Children's, Christ, Good Samaritan and Veteran's hospitals.



University and Children's Faculty 1978
MacMillan, Alexander, Martin, Fischer, Barrett, McLaurin, Hummel,
Stevenson, Hasselgren, Helmeworth, Sugerman, Keifer,
Gonzalez, Schreiber, McDonough, Fritzen, Coth,
Munda, ... - - - - - Fifer



Good Samaritan and Christ Faculty 1978
Hunter, McBride, Mayfield, Gjemmen (visitor), Jasing, Garmston (visitor), Tew, Campbell,
Budd, McWhorter, Manalis, Berger, Lukin, Shabbabian, Gullerman, Keller, Greiner,
Dunsker, Hall, McKnight, Saud, Ongkiko, Yamamoto, Thomas, Lin, Robb, Ahlra, Lotsepich

The Chairmen of Neurosurgery



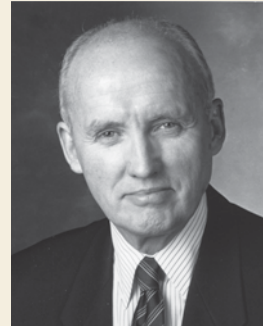
1937-1954 Joseph P. Evans, MD

A student of Wilder Penfield and William Cone, Evans is best known for his research in head injury and his wise collaboration with Mayfield to expose residents to a wide range of surgical cases at community hospitals. His research team was one of the first to record intracranial pressure continuously and to quantitate the relationship between ICP and cerebral blood flow. Evans served as chair of neurosurgery until 1954, when he accepted a position at the University of Chicago.



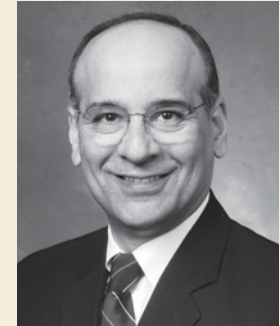
1954-1982 Robert L. McLaurin, MD

A student of Bill Scoville and Ben Whitcomb, McLaurin is best known for his interest in head injury and pediatric neurosurgery. He established and directed pediatric neurosurgery at Children's Hospital and was a founder and chairman of the AANS/CNS Pediatric Neurosurgery Section. Today he supports pediatric research with a generous endowment to the Cincinnati Children's Hospital Medical Center – the Robert L. and Sarah J. McLaurin Neurosciences Research Fund.



1982-2002 John M. Tew, Jr., MD

A student of William Sweet, Donald Matson and Gazi Yasargil, Tew became a world leader in trigeminal neuralgia, tumors and vascular disorders of the brain. Tew's treatises on Microneurosurgery are used internationally. He united the community and UC residency programs into a single department and became the first Mayfield Professor. Mindful of Mayfield's integrative vision, Tew's leadership united UC's separate departments behind a single mission for a UC Neuroscience Institute, which celebrates a successful decade in 2009.



2002-present Raj K. Narayan, MD

A student of Donald Becker, Narayan is best known for his interest in traumatic brain injury and clinical research. He expanded the residency program to 3 residents per year. He serves as chair of the American Brain Injury Consortium and was awarded a grant from the U.S. Department of Defense to study traumatic brain injury and post-traumatic stress disorder. Under his leadership the clinical trials program was expanded and a neurocritical care program was established at University Hospital.

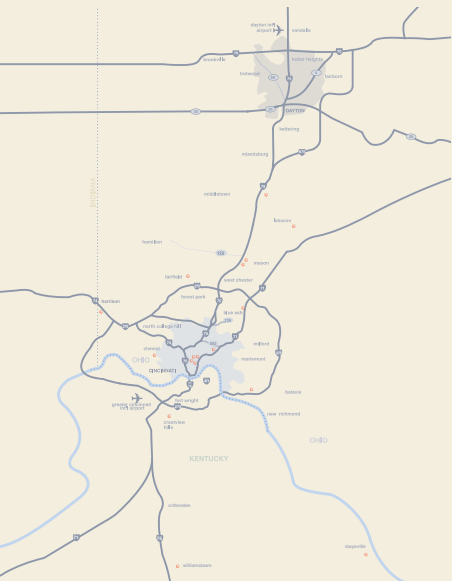
UC – Mayfield Relationship

When the separate residency programs were reunited in 1982, the stage was set to establish a shared academic-private practice department within the University of Cincinnati. Finally, Frank Mayfield's dream (Master Plan) of integrating clinical and teaching services – at least in neurosurgery – was realized.

The relationship between the UC Department of Neurosurgery and the Mayfield Clinic is a unique synergy of university and private practice functioning as a single unit. At most universities, the private practice is part of the academic department. At UC – Mayfield, the academic department is symbiotic with the private practice. The academic Chairman reports to both the Dean of the College of Medicine and the Mayfield Clinic Board of Directors. They are stronger together than alone, extending a broad reach to serve the Greater Cincinnati community and beyond.

Models of collaborative teamwork between the Department of Neurosurgery, Mayfield Clinic and other UC departments include:

- **Mayfield Imaging Center** (1999) A free-standing MRI center in Northern Kentucky where neurosurgeons and neuroradiologists are on-site for consultation during scans.
- **Priority Consult** (2002) An innovative spine patient triage program that is now used in more than 30 centers across the U.S. Programs for other diseases are in development.
- **Precision Radiotherapy Center** (2003) A free-standing stereotactic radiotherapy center in West Chester that is a national model for other programs around the country.
- **Mayfield Clinic Spine Surgery Center** (2007) One of the first free-standing, same-day spine centers in the country.



Mayfield Clinic is one of the largest neurosurgery practices in the U.S., with 17 office locations throughout Greater Cincinnati and Northern Kentucky.



Department of Neurosurgery faculty include 25 neurosurgeons, 3 neurointensivists, 1 interventional radiologist, and 4 researchers.



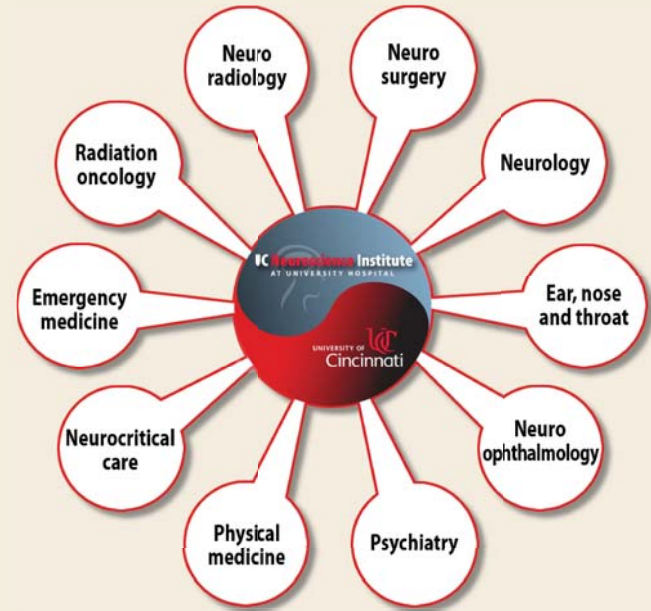
Tradition of Collaboration

Healthcare delivery has changed dramatically since the early 1930's, when neurosurgeons first arrived in Cincinnati. Individual physician practices have evolved into large group medical institutions, e.g., UC Physicians. Medicaid, managed care, and high-deductible plans have changed patient access to healthcare. University-based hospitals have evolved from indigent-only care to tertiary referral centers. By working together, the UC College of Medicine, University Hospital, Health Alliance, and UC Physicians, have extended Heuer and Mayfield's dream of teamwork and quality care to all neuroscience specialties through the UC Neuroscience Institute (UCNI).

Established in 1998, UCNI is a center of excellence located at University Hospital with seven disease-based centers. A model for integrated clinical care, education, and research:

- Physicians bring expertise and leadership
- College of Medicine brings education and research
- University Hospital brings technology, world-class facilities, and services

Featuring centers of excellence in stroke, brain tumors, epilepsy, Parkinson's disease, multiple sclerosis, neurotrauma, and neurofunctional disorders, UCNI is the region's only integrated group practice in neurological disease. A tradition in education and research ensures that its vision to lead the advance in neurological care is being accomplished.

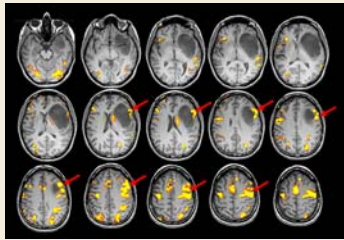


Tradition of Innovation

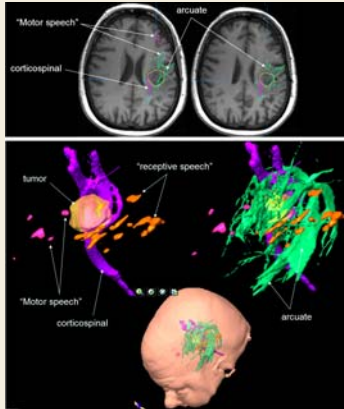
In the past decade Cincinnati neurosurgeons have partnered with industry to develop new instruments and technology: endoscopes, surgical lasers, image-guided surgery, intraoperative MRI, robotics, stereotactic radiosurgery, and a vast array of minimally invasive techniques for spine (e.g., AxialLIF Lumbar Fusion) and cranial surgery (e.g., Endoscopic-assisted Keyhole Craniotomy).

One of neurosurgery's most significant collaborations has been with UC's Radiology Department. Under Robert Lukin's leadership, the past three decades have seen rapid changes in neuroradiology. New computer-based imaging techniques have shifted the role of medical imaging from one of mere diagnosis to one of function, biology and interventional treatment. The UC Center for Imaging Research Center (UCCIR) is pioneering new brain imaging methods: functional MRI, diffusion tensor imaging (DTI), and MR spectroscopy of brain metabolism. In 2003 Set Shababian at West Image brought the first high-field (3 Tesla) MRI for patient use to Cincinnati. Later that year a 4 Tesla MRI for research use was installed at UCCIR.

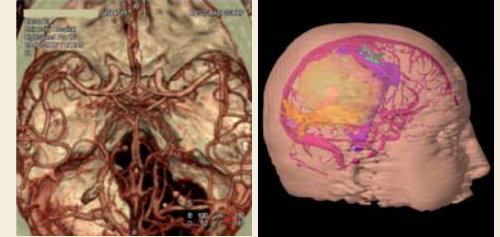
Image-guided surgery (IGS). Used in the OR during surgery, fMRI and DTI are integrated into image-guided systems like BrainLAB iPlan® allowing neurosurgeons to navigate and remove tumors to the greatest extent possible without harming critical areas. Over the years, UC-Mayfield neurosurgeons have helped develop the Operating Arm System (OAS), the Optical Tracking System (OTS), the Mayfield ACCISS System, and the Hitachi intraoperative MRI/operating room suite.



Functional MRI (fMRI) detects differences in blood oxygen levels when areas of the brain perform a specific tasks such as speaking, reading, or moving arms/legs.

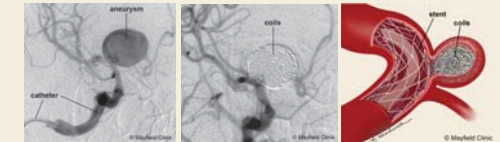


Diffusion Tensor Imaging (DTI) detects the white-matter tracts in the brain. White-matter tracts are the nerve axons that connect different areas of the brain.



Computed Tomography Angiogram (CTA) allows 3D rotation of the blood vessels to view aneurysms and other malformations in 360 degrees.

CTA and functional MRI images can be fused to view blood vessels in relation to specific functional areas of the brain.



Computerized angiography and image-guided catheterization allow surgeons and interventional radiologists to obliterate aneurysms without open surgery. Through a flexible catheter inserted into an artery in the groin, coils accomplish from the inside what a surgical clip would accomplish from the outside: they stop blood from flowing into the aneurysm.