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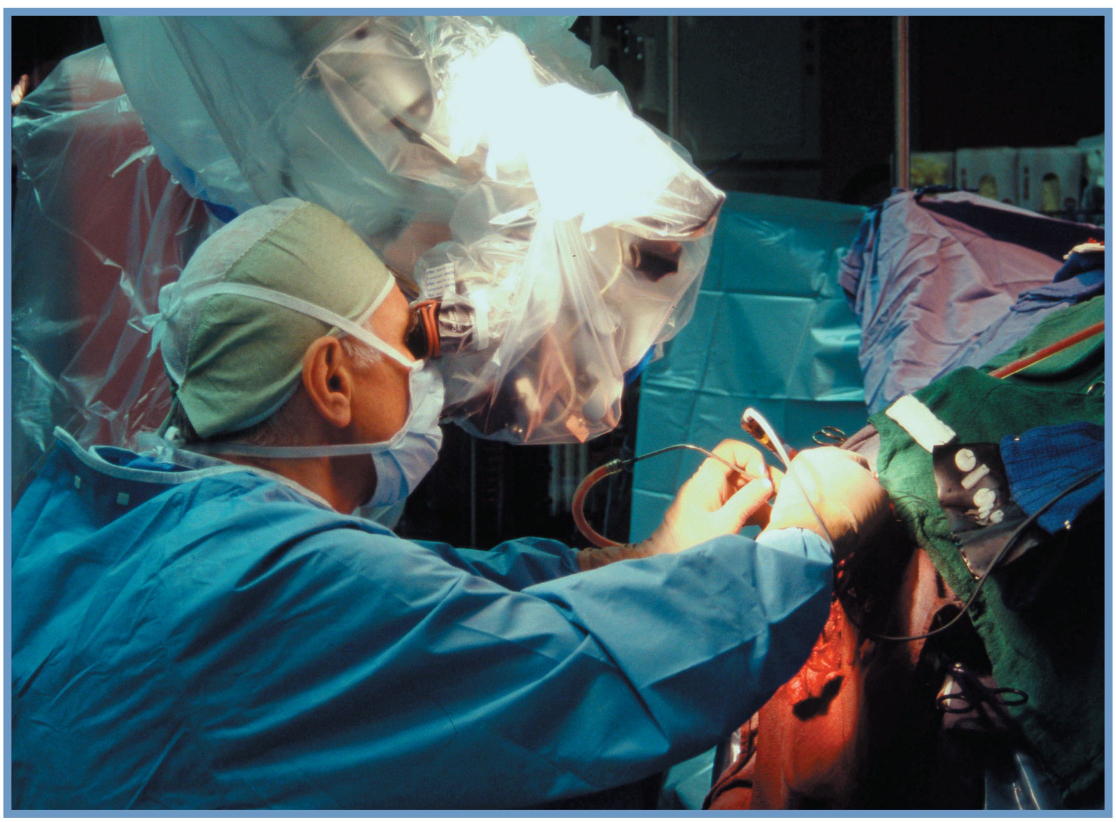
Turkish Neurosurgery

Official Journal of the Turkish Neurosurgical Society



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Volume: 36 Special Issue in Memoriam Prof. M. Gazi Yaşargil Year: 2026

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Turkish Neurosurgery periodically publishes the following papers: Research (Original Investigation, Clinical and Experimental Studies), Review Article, Case Report, Letter to Editor, Technical Note and Turkish Neuro-Excursion.

Our mission is providing a scientific forum relevant to neurosurgeons and health care providers.

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D. Example of thesis

Kanpolat Y: Experimental percutaneous access to the trigeminal ganglion and the histopathological evaluation of radiofrequency thermic lesion (Unpublished dissertation), Ankara: Ankara University, 1978:1- 52

E. Software

Epi Info [computer program]. Version 6. Atlanta: Centers for Disease Control and Prevention, 1994

F. Online journals

Friedman SA. Preeclampsia: A review of the role of prostaglandins. Obstet Gynecol [serial online]. January 1988;71:22-37. Available from: BRS Information Technologies, McLean, VA. Accessed December 15, 1990

G. Database

CANCERNET-PDQ [database online]. Bethesda, MD: National Cancer Institute, 1996. Updated March 29, 1996

H. World Wide Web

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Biswas, SS. ChatGPT-for-Research-and-Publication-A-Step-by-Step Guide. (https://meridian.allenpress.com/jppt/article/28/6/576/496601/ChatGPT-for-Research-and-Publication-A-Step-by)(https://doi.org/10.5863/1551-6776-28.6.576)

Ramoni D, Sgura C, Liberale L, Montecucco F, Ioannidis JPA, Carbone F. Artificial intelligence in scientific medical writing: Legitimate and deceptive uses and ethical concerns. European Journal of Internal Medicine, Volume 127, 31 - 35

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The editorial office checks the paper's composition and arrangement against the journal's Author Guidelines - Instruction to the Authors (http://turkishneurosurgery.org.tr/static.php?id=7) - to make sure it includes the required sections and stylizations.

3. Evaluation by the Editor-in-Chief (EIC)

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7. Review is Conducted

The reviewer sets time aside to read the paper several times. The first read is used to form an initial impression of the work. If major problems are found at this stage, the reviewer may feel comfortable rejecting the paper without further work. Otherwise they will read the paper several more times, taking notes so as to build a detailed point-by-point review. The review is then submitted to the journal, with a recommendation to accept or reject it – or else with a request for revision (either major or minor) before it is reconsidered.

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The SE considers all the returned reviews before making an overall decision. If the reviews differ widely, the editor may invite an additional reviewer so as to get an extra opinion before making a decision.

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Turkish Neurosurgery

Volume: 36 Special Issue in Memoriam Prof. M. Gazi Yaşargil Year: 2026

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Editorial

M. Gazi Yaşargil (1925–2025): A Life of Devotion and a Living Lineage

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INTRODUCTION

There are surgeons who master a craft, and there are surgeons who reorganise the boundaries of that craft itself. To write of Professor M. Gazi Yaşargil is to write about the latter, an exceedingly rare surgeon who, more than any other of his century, defined what neurosurgery is.

Professor Yaşargil passed on 10 June 2025, at the age of ninety-nine, only weeks before witnessing a whole century that was devoted to the neurosurgery. The journal Neurosurgery, of the Congress of Neurological Surgeons, named him in 1999 the *“Man of the Century (1950–1999)”,* an honored recognition which was conferred on account of numerous achievements that reshaped our understanding of what neurosurgery can be.

His contributions are architectural rather than incremental to the field. Although the task of enumerating his achievements is hardly possible in a single page, a small glimpse might be possible. With the operative microscope, he altered the scale at which neurosurgical thought becomes possible. Through microneurosurgical techniques, he reframed how neural tissue can be handled. His cerebrovascular work, including microsurgical aneurysm clipping, the first extracranial–intracranial bypass, the approach to arteriovenous malformations, redefined what had been thought inoperable. Prof. Gazi Yaşargil taught that the brain itself, by utilizing the principle of natural corridors, offers the least harmful route to any deep-seated disease. The instruments bearing his name now sit on every microneurosurgical tray in the world.

The neurosurgeons gathered here are not admirers. They are the participants of a living lineage, the colleagues, pupils and visitors who firsthand experienced how microsurgery became the global standard of operative care. Their judgments, gestures, and unwritten culture of mentorship are the substance most at risk of disappearing once the generation that knew him directly is itself gone. The present issue offers a glimpse of this universal inheritance.

The school he founded did not close with his passing. The discipline he taught is now ours to keep, to transmit, and to deserve.

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Invited Special Article

In the Presence of a Giant: Reflections on Prof. M. Gazi Yaşargil's Life, Humanity, and a Conversation with Francis Crick

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ABSTRACT

Prof. M. Gazi Yaşargil's influence on modern neurosurgery is immeasurable—technically, scientifically, and humanistically. Yet those who had the privilege of working closely with him know that his greatest contributions were not limited to the microscope. During my fellowship at the University of Arkansas for Medical Sciences (2002–2004), under the mentorship of Prof. Ossama Al-Mefty, I had the extraordinary opportunity to observe Prof. Yaşargil in the operating room, in the laboratory, during lectures, on academic travels, and in private life alongside Mrs. Dianne Yaşargil. These experiences shaped my career and worldview in ways I continue to discover years later. Among the countless memories, one stands alone as a testament to his intellectual courage and humility: a 2003 visit to the Salk Institute, where he engaged in an elegant discussion on consciousness with Nobel Laureate Francis Crick. Their exchange—on the claustrum, neuroanatomy, and the nature of awareness—revealed the depth of Prof. Yaşargil's understanding of the human brain and his unyielding commitment to truth, even in the presence of another scientific titan. This reflection offers personal recollections of a man whose legacy endures not only through his technical revolutions, but through the humanistic and philosophical compass he imparted to generations of neurosurgeons.

INTRODUCTION

To write about Prof. M. Gazi Yaşargil is to attempt the impossible.

How does one capture a life so profoundly intertwined with the very fabric of modern neurosurgery? How does one honor a person whose scientific contributions, surgical innovations, and philosophical depth have transformed not only an entire specialty, but also the personal trajectories of those fortunate enough to walk beside him?

My journey with Prof. Yaşargil began in 2002, just after I completed my neurosurgical training and arrived in Little Rock, Arkansas, to pursue a fellowship under Prof. Ossama Al-Mefty. At that time, Yaşargil had already been recognized worldwide as the father of microneurosurgery—a legend whose books, techniques, and surgical philosophy formed the backbone of our discipline. But the man I came to know was far more than the icon described in textbooks. He was a polymath, a humanist, a philosopher, and a deeply compassionate soul. His presence was at once commanding and gentle, and his intellectual curiosity seemed to expand rather than diminish with age.

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During those two fellowship years (2002–2004), I followed him closely—assisting in academic papers, helping prepare his lectures, observing his surgeries, and accompanying him and Mrs. Dianne on academic activities and personal travels across the United States, Turkey, Finland, and Switzerland. These experiences profoundly shaped my career and my understanding of medicine, humanity, and the delicate art of healing.

Among all the memories, one stands out in crystalline clarity: a conversation between Prof. Yaşargil and Nobel Laureate Francis Crick at the Salk Institute in 2003. In that moment, I witnessed a meeting not simply of two brilliant minds, but of two worlds—molecular biology and microneurosurgery—converging on the timeless question of human consciousness.

EARLY MENTORSHIP AND THE LITTLE ROCK YEARS

Little Rock in the early 2000s was a remarkable place. UAMS, under the leadership of Prof. Al-Mefty, had become a center of excellence for skull base surgery and a refuge for aspiring neurosurgeons from around the world (Figure 1). To this environment arrived the Yaşargils—Prof. Gazi and Mrs. Dianne—whose presence elevated every corridor, every conference room, and every operating theatre.

Prof. Al-Mefty's mentorship was itself transformative, but having Prof. Yaşargil in the same department was akin to learning violin in the presence of Paganini, or, as a Brazilian, to learn to play soccer in the presence of Pelé. His humility made him approachable; his intellect made him awe-inspiring.

What struck me early on was how seamlessly he integrated scientific rigor with humanistic reflection. A conversation with him could begin with the vascular supply of the insula, travel through Nietzsche's writings, detour through quantum physics, and end with a comment about the beauty of a Turkish folk melody. His mind was a constellation—each star connected to another by invisible threads of curiosity.

Working with him was an immersion in the essence of neurosurgery: precision, patience, respect for the brain's internal logic, and devotion to the patient's dignity. But beyond the technical aspects, he taught us to see—to see neuroanatomy as architecture, surgery as choreography, and healing as a moral act.

A LIFE SHARED WITH MRS. DIANNE

It is impossible to speak about Prof. Yaşargil without acknowledging the extraordinary presence of Mrs. Dianne Yaşargil. She was his partner in every sense—surgical, emotional, intellectual, and social. As his surgical assistant and nurse for decades, she shared his devotion to excellence and his meticulous approach. Outside the hospital, she embodied warmth and hospitality, bridging the intense world of the operating room with the humanity that sustains it.

Figure 1: Prof. Yasargil, Prof. Al-Mefty and me, in the last picture we had together at Professor's apartment with the view of his beloved Istanbul (2023).

Their relationship offered us a lesson often overlooked in medicine: behind every great surgeon stands a pillar of stability, affection, and shared purpose. Through countless dinners, travel days, and quiet conversations, I came to see how deeply interwoven their lives were—an alliance that allowed Prof. Yaşargil to become who he was.

A FAMILY BOND: GABRIELA AND THE YAŞARGILS

There is another layer to my memories of those years—one that extends beyond academic life and into the warmth of genuine human connection. My wife, Gabriela, developed an immediate and profound bond with both Prof. Yaşargil and Mrs. Dianne. The origin of this bond was deeply personal: Gabriela's father survived a basilar tip aneurysm thanks to the very microneurosurgical techniques that Prof. Yaşargil introduced to the world.

The first time she met Professor, she approached him with heartfelt emotion and expressed her gratitude for what his work had meant for her family. It was a brief moment, but one filled with sincerity. From that day forward, the Yaşargils embraced her with genuine affection, treating her not simply as the spouse of a fellow, but as someone sacred to their hearts.

This warmth extended to all of us. Prof. Yaşargil often referred to me—and to colleagues like Dr. Ali Krisht, Dr. Ügur Türe, and Dr. Niklaus Krayenbühl—as his "grandchildren." It was a term he used with a smile, a reflection of the deep, familial mentorship he cultivated. A photograph of the four of us—Gabriela, myself, Prof. Yaşargil, and Mrs. Dianne—remains one of our most treasured memories (Figure 2).

THE SALK INSTITUTE, 2003: A MEETING OF GIANTS

Among the many travels I was fortunate to share with the Yaşargils, the visit to the Salk Institute in San Diego remains unforgettable.

It was 2003. Prof. Yaşargil had been invited to give a talk, and among the attendees was Francis Crick—already world-famous for discovering the structure of DNA, and at that time deeply engaged in neuroscience, particularly the search for the neural basis of consciousness. His later work with Christof Koch centered on the role of the claustrum, which he hypothesized might function as the conductor of consciousness—integrating perceptions into a unified experience.

After a brief tour of the beautiful Salt Institute facilities with Prof. Laurence F. Marshall, Crick invited Prof. Yaşargil to have lunch at the garden. I had the privilege to accompany them (Figure 3).

The two men sat facing each other in the bright Salk cafeteria—simple trays, quiet voices, a Pacific breeze entering through the courtyard—and yet the moment felt monumental. Here were two minds that had defined entire fields, engaged not in competition but in curiosity.

Crick began describing his theory: the claustrum, a thin sheet of gray matter between the insula and putamen, reciprocally connected to nearly every cortical region, might be essential to conscious awareness.

Prof. Yaşargil listened attentively, respectfully, as he always did. Then he spoke—calmly, elegantly:

Figure 2: Prof. M. Gazi Yaşargil, Gabriela Kadri, Mrs Dianne Yaşargil, and me. San Diego, 2003.

Figure 3: Prof. Yaşargil, Prof. Francis Crick, his secretary and me. Courtyard of the Salk Institute, La Jolla, California—site of the 2003 conversation between Yaşargil and Crick (2003).

"If the claustrum were the sole seat of consciousness, I would have removed consciousness from several of my patients."

He explained that his microsurgical techniques had allowed him to operate extensively around the insula and the extreme capsule—often opening corridors that required the removal or manipulation of the claustrum. Yet none of these patients had lost their consciousness as a result.

Crick paused.

He did not resist the challenge.

Instead, he smiled—delighted, it seemed, by the honest counterpoint.

Their exchange was not a debate. It was a scientific dance between two giants who shared a devotion to truth. One approached consciousness from molecular biology and computational neuroscience; the other from the lived experience of thousands of hours inside the human brain.

That conversation marked me deeply. It revealed that true greatness lies not in dominating a discussion, but in engaging openly, humbly, and without ego—even when addressing the fundamental mysteries of the mind.

MORE THAN A SURGEON: THE HUMANIST

Prof. Yaşargil was a surgeon-philosopher in the purest sense.

His conversations effortlessly bridged neuroanatomy, history, art, theology, and physics. He often spoke of Greek philosophers, Middle Eastern poets, and European intellectuals, weaving together cultural traditions with the scientific pursuit of understanding the human condition.

Traveling with him felt like attending a living university.

In Turkey, he taught us the origins of certain instruments, words, and surgical traditions.

In Finland, he showed us the legacy of early neurosurgical meetings and collaborations.

In Switzerland, he guided us through the Zurich that had shaped his professional identity—a city whose precision mirrored his own surgical thinking.

Through these experiences, I came to appreciate that neurosurgery is not merely a discipline of the hands, but a discipline of the mind and spirit. He exhorted us to cultivate discipline, humility, aesthetic sensibility, and compassion—to strive not only for technical mastery but for moral refinement.

A LEGACY THAT TRANSCENDS TECHNIQUE

Prof. Yaşargil's technical contributions are well known—the pterional approach, the sylvian fissure dissection, microneurosurgical instrumentation, the arachnoid-based strategy, his monumental multi-volume Microneurosurgery series. These achievements alone would have secured his place in history.

But to those of us who trained beside him, his greatest teachings were these:

- **Respect the brain as a living, sacred structure.**
- **Let humility guide every movement of your hands.**
- **Prepare your mind before you touch the microscope.**
- **Surgery is not a battle, but a dialogue with nature.**
- **And above all, honor the patient—always.**

As he approached one hundred years of life, he remained intellectually vibrant, curious, and engaged—proof that a mind fueled by curiosity never ages.

CONCLUSION

Ten days before reaching a century of life, Prof. M. Gazi Yaşargil departed from this world. Yet his presence remains unmistakably alive in neurosurgical theaters across the globe, in the minds he shaped, and in the surgical philosophies he forged.

For me, his legacy is deeply personal.

It lives in my operative decisions, in my respect for neuroanatomy, in my compassion for patients, and in my ongoing search for meaning within the biological structures we treat.

To have walked a small stretch of road beside him—alongside Mrs. Dianne and the remarkable team in Little Rock—was a privilege beyond measure.

To share his laughter, his stories, his teachings, and even a historic lunch with Francis Crick was to witness the rarest combination of brilliance and humility.

Prof. Yaşargil taught us how to operate.

But more importantly—he taught us how to be.

His influence endures in every generation of neurosurgeons who continues to carry forward his spirit of excellence, curiosity, and humanity.

REFERENCES

1. Teive HAG: On the centenary of the birth of Francis H. C. Crick – from physics to genetics and neuroscience. Arq Neuropsiquiatr 74:351–353, 2016.
2. Yaşargil MG: Microneurosurgery Volumes I–IV. Stuttgart: Thieme; 1984–1996.
3. Yaşargil MG, Kadri PAS, Yasargil DCH: Microsurgery for malignant gliomas. J Neurooncol 69: 67–81, 2004.

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Invited Special Article

The Professor We Knew

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ABSTRACT

Microsurgery is a remarkable gift that Professor Yaşargil has bestowed upon humanity, revolutionizing the field of surgery and opening up new possibilities for potential cure. In his brilliant career, Professor Yaşargil after his retirement from the chairmanship at the University of Zurich, he was accepted the invitation to join the department of neurosurgery at the University of Arkansas for Medical Sciences. We reflect on these very special years during which we had the opportunity to witness not only his devotion to microneurosurgery, and his scholarly scientific indulgence, but also his humanistic attributes. He touched the lives of so many through the years.

KEYWORDS: M Gazi Yaşargil, Little Rock, Microneurosurgery

"There are very few people who ever lived to have the opportunity to create a true revolution in science, to change the paradigm in such a way that everything is new, and everything is fresh, and that some of the old challenges are completely eradicated, and some of the new challenges are things that we never would have dreamed of. This is what professor Yaşargil ; you have created for us, a scientific revolution, a new paradigm, not only in neurosurgery, and I have heard you speak about this, but in the concept that goes with it; micro technique, the whole concept of understanding the anatomy of the brain in a new way that makes it approachable for us to deal with things that we never dreamed would be in the province of our beloved field of neurosurgery. We all love neurosurgery. We love being Neurosurgeons, and what you have given us is something beyond that, something to truly treasure, and God willing to further improve upon in our small way." (Figure 1).

– Dr. Edward R. Laws, 2005 (5)

Figure 1: A) Dr Laws speech at the president of the World Federation at 13th world congress in Marrakech, Morocco. **B)** photograph at the 80th birthday celebration during the same event as the attendants in thousands sang "Happy Birthday" to professor Yaşargil, each in their own native tongue.

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Dr Laws' words eloquently express professor Yaşargil 's legacy and his monumental contribution in transforming the art of surgery to the height of microneurosurgery. In Little Rock, small and distant bastion of tranquility in the center of the country, we have had the fortune to spend 16 years with a special relation and interaction with professor Yaşargil that transcended our specialty and working borders to an oasis of humanity, intellectual curiosity, and visionary thoughts. They were unparalleled inspiring and fulfilling years. Yaşargil 's scientific and neurosurgical contributions are well known to the world and everlasting. In these few lines, we touch on some aspects. We were so fortunate and privileged to learn, witness, and interact with him.

MICRONEUROSURGERY WILL NEVER DIE

As daring as professor Yaşargil was, he frequently expressed his looming fear that microneurosurgery will be abandoned. Nowadays, we are witnessing changes in paradigms of patient management, explosion of technology, re-engineering of healthcare delivery, advances in biology. Many are welcomed progress. The changes also are in the attitude and the aspiration of physicians. Surgical treatment is taking, sadly, the backseat to new practices marching under the banner of minimally invasive and futuristic treatment many without verification of effectiveness. Cure replaced with control. Algorithms and soon artificial intelligence, skew the physician's judgement and dictate the treatment along preset biases. The current foggy atmosphere of neurosurgery makes one realize how critical and influential professor Yaşargil was in upholding the value and superiority of microneurosurgery. It was, like he so often said "a human brain that is operating on a human brain". It is not a pathway, it is not an approach, it is not a device, and it is not a statistic; as been stated, "Yaşargil exemplifies the "Operative Neurosurgeon" in whom a brilliant mind and devoted soul guide gifted hands. Microneurosurgery is the culmination of art, science, and ethics. It is the masterful execution of a well thought out plan of profound knowledge of anatomy and ever excelling with experience." (2). His thrive for excellence was a relentless pursue of a better technique. Thus, the area which he thought needed improvement, he would encourage us to find betterment. No better example than Dr. Krisht taking basilar aneurysm clipping to a higher level (4).

Millions of lives were saved by microneurosurgery and more to be cured in the future. Microneurosurgery was the road Professor Yaşargil has paved for us to follow. It has no end. Microneurosurgery is flourishing in several esteemed centers around the world. In Little Rock, Yaşargil 's Legacy live and thrive at the Arkansas Neuroscience Institute established by Dr. Ali Krisht (Figure 2). Microneurosurgery will never die. "It's in the book, read it!" as Yaşargil repeatedly proclaimed (Figure 3).

Figure 2: Composite photo depicting the Arkansas Neuroscience Institute at CHI St. Vincent in Little Rock, Arkansas that hosts Yaşargil's neurosurgical research & education center. Including as he had always urged a microsurgical lab.

HEALER

"We must help." Yaşargil utterness dealing with every patient. He believed that medicine is a mission, not a job; and that every patient deserves his full dedication. He is a doctor, not a mere technician. He built that bond of trust with the patients and their families by his full commitment to the wellbeing and interest of every matter surrounding the patient's illness. He knew that to really help patients, the doctor needs to be at his best including not only possessing outstanding knowledge or experience but attending to the patient's and the family's emotional needs. He cared and they knew it. He spent hours in the original encounter. He stationed himself at the bedside of the ICU till the patient sailed to safety. He knew and studied every test and was liberal in asking other experts of any aspect of the patient's care. This devotion was manifested by the solemn belief that the surgeon must be at his best, and that microneurosurgery was mastering both the normal and pathological anatomy and acquiring the skills in laboratory practice. He could not fathom how a surgeon would operate on a human brain without profound knowledge of the anatomy. To merely hold a wand and drive through to a computer target was incomprehensible to him. He teasingly used to say "frameless (stereotactic navigation) for the brainless"; not dismissing the value of technological innovation but stressing the fundamental knowledge of anatomy. He urged the research fellows to learn and study the intrinsic anatomy of the brain by fiber dissection technique, while tempering their total immersion into learning the anatomy of the skull-base. To him, brain anatomy was more critical than bone anatomy. The fruit of this emphasis became the advanced field of microneurosurgery based on intrinsic anatomy of the brain as mastered and taught by professors U. Ture, N. Krayenbhul and P. Kadri (Figure 4).

Helping patients best, to him, was to perform a flawless surgery with fine outcome. That needed to continuously perform better operation. Thus, it was essential for any neurosurgeon to undertake operations on brain is to earnestly practice the techniques of microneurosurgery in the laboratory. That lab practice was an absolute must for any person seeking to be a neurosurgeon. The microneurosurgery lab in Zurich is renowned for his graduates whose many became master surgeons and world leaders of neurosurgery. He urged the establishment of a microneurosurgery lab at the University of Arkansas and cultivated fellows to practice and study in the lab, many of whom today, are renowned and leader neurosurgeons (Figure 5). A particular lab endeavor that captured his interest is when Dr. E. Aboud had created an innovative model of having circulating blood like fluid in the cadaver which made lab practice closer to real time surgery (Figure 6) (1).

Figure 3: The 4 volume books of professor Yaşargil that he presented to Dr Al-Mefty. Yaşargil for years worked on his Microneurosurgery books. It is an encyclopedic embodiment of the field of microneurosurgery. It is and will remain the reliable guide to neurosurgeons.

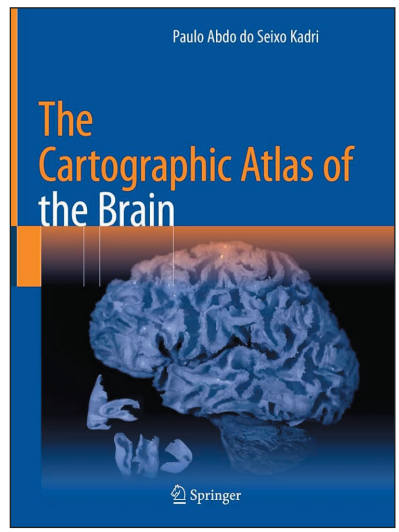

Figure 4: Dr Paulo Kadri's seminal book "The Cartographic Atlas of the Brain" stemmed by Prof. Yaşargil urging Dr. Kadri to learn intrinsic brain anatomy.

Figure 5: Lab demonstration was his prime push to every neurosurgeon and enthusiastically lead the demonstrations on every occasion.

Figure 6: Professor Yaşargil and Dr. Emad Aboud practicing on the “Aboud Live Cadaver Model.”

FAMILY

Most neurosurgeons knew Yaşargil as the stern, serious, all-work, devoted scholar thriving for perfection. There was a side of him that we were so blessed to enjoy: the caring professor. In the atmosphere of trust and respect, Yaşargil would let down his guard and ease his worries (Figure 7). Ms. Dianne Yaşargil , who was always by and on his side, had essential contribution to the success and remarkable era of neurosurgery during Yaşargil ’s years in Little Rock. Diane’s grace, however, was radiating and felt among all of us, surpassing her great professional role.

Yaşargil enjoyed himself and all the others present around enjoyed him. He poured his knowledge of art, history, and philosophy on the grown-ups among us while he inspired the young and entertained the children (Figure 8).

The man with the big vision, tireless pursuit of excellence, demanding the best out of everyone, had a big heart and played with the children.

It could be all summed up by the dedication of the Operative Atlas of Meningiomas to Professor Yaşargil : “To Professor M. Gazi Yaşargil – his brilliant mind changed the world of neurosurgery, his gifted hands changed the world of so many patients, and his caring heart changed my world.” (3).

Figure 7: Professor Yaşargil in a conference at his early time in the department of neurosurgery at University of Arkansas Medical Sciences beaming with happiness, joking with dr Al-Mefty.

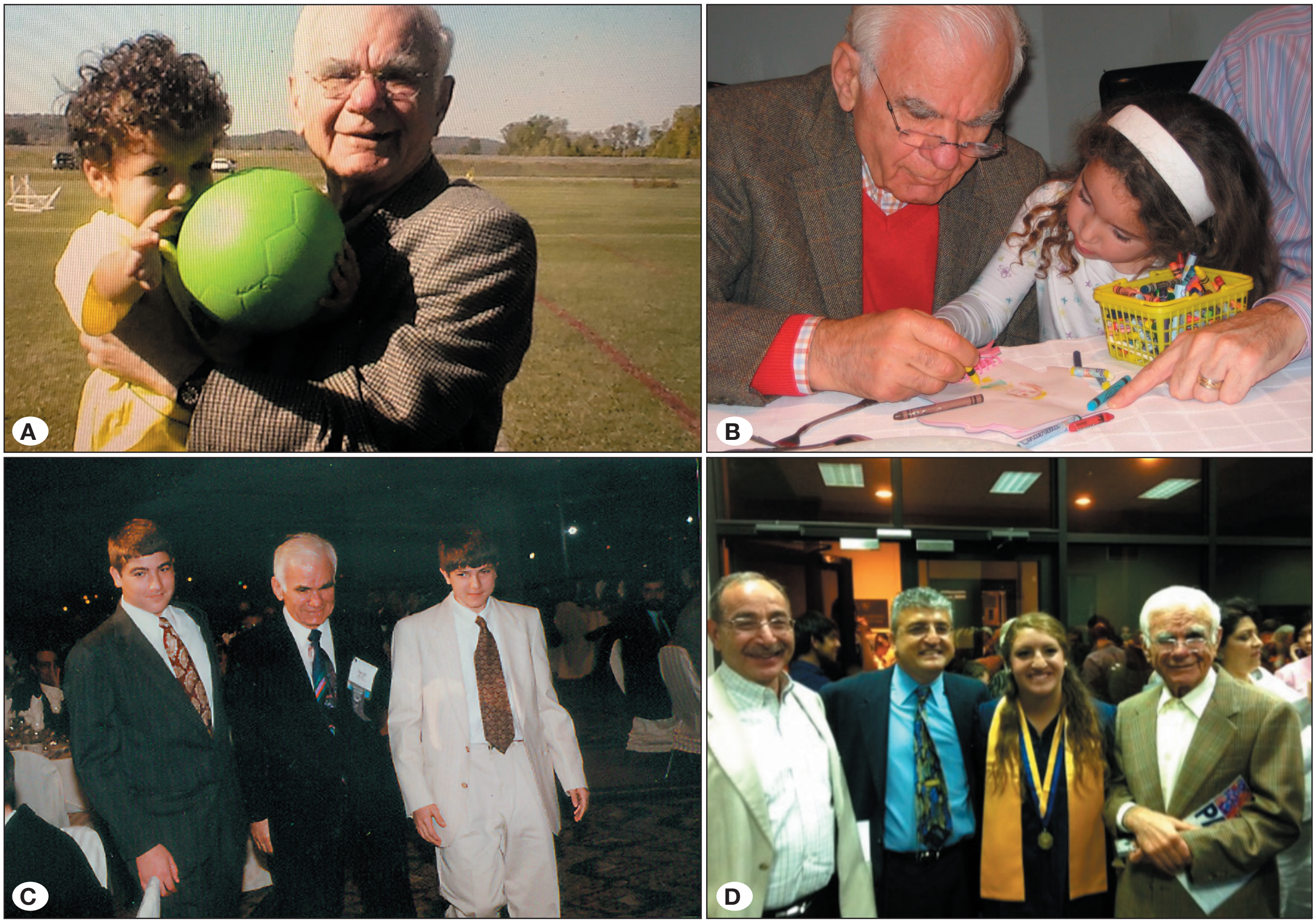

Figure 8: A) Photograph of professor Yaşargil playing with Dr. Ali Krisht's son Hasun on the soccer field, **B)** Professor Yaşargil following the instruction for coloring with Leila, granddaughter of Dr. Al-Mefty, **C)** At the skull base society meeting in Little Rock 1996, the young Kaith and Rami Al-Mefty walked professor Yaşargil to the podium. Certainly, they were inspired to become neurosurgeons like him. **D)** Professor Yaşargil always celebrated the family's success, as seen here, celebrating the graduation of Geenah Krisht.

REFERENCES

1. Aboud E, Al-Mefty O, Yaşargil MG: New laboratory model for neurosurgical training that simulates live surgery. J Neurosurg 97: 1367-1372, 2002. doi: 10.3171/jns.2002.97.6.1367. PMID: 12507135.
2. Al-Mefty O: M. Gazi Yaşargil: the time in Little Rock. Neurosurgery 45: 1019-1024, 1999. doi: 10.1097/00006123-199911000-00013. PMID: 10549923.
3. Al-Mefty O: Operative atlas of meningiomas. New York: Thieme, 1998.
4. Krisht AF, Basma J, Kayssi AR: Advanced micro-neurosurgery in treating basilar aneurysms. In: Neuroanatomy guidance to successful neurosurgical interventions: the torch of neurosurgical excellence. Cham: Springer Nature Switzerland; 2024:157–165.
5. Laws ER Jr: Remarks delivered at the celebration of M. Gazi Yaşargil's 80th birthday, 13th World Congress of Neurosurgery; 2005 June; Marrakesh, Morocco.

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Invited Special Article

Professor Mahmut Gazi Yasargil: Memories from Little Rock 1994-2003

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This invitation by the Turkish Neurosurgery Journal Co-Editors Professors Oguz Baran and Hayri Kertmen to contribute to the special journal issue on Professor M. Gazi Yasargil provides an immense honor for me to reflect on my time working with him over a 9-year period (1994-2003) at the Department of Neurosurgery, University of Arkansas for Medical Sciences (UAMS), Little Rock, AR, USA (Figure 1).

I was invited to come to Little Rock by Professor Al-Mefty to spend 6 months as part of an observational research skull base fellowship. I came after the conclusion of my Bosnian-Herzegovinian neurosurgical residency, at the end of the war in Bosnia and Herzegovina. I had endured many hardships and witnessed the cruel destruction of my country. It was surreal to land in the Little Rock airport on August 3rd, 1994 in the late afternoon. Dr Almefty greeted me at the airport and took me to dinner on the way to the dormitory. We went to dinner at a local Mexican restaurant, and he mentioned that Professor Yasargil has just arrived

Figure 1: Aerial view of university of Arkansas for Medical Sciences (UAMS)

in town to join the program. I knew that Professor Yasargil, as Professor Al-Mefty mentioned that night, "with his introduction of microsurgery, had propelled neurosurgery into the modern era from dark ages." A potential meeting with such a well known figure in neurosurgery was unfathomable for a young, recently graduated neurosurgeon from Sarajevo, Bosnia and Herzegovina.

The next morning, while walking into Dr Almefty's office to complete the onboarding paperwork, I introduced myself to the Professor. Although I was very intimidated by the event, I remember that he introduced himself to me as "Yasargil." We spent some 30 minutes in conversation. He told me that he never visited Bosnia and Herzegovina, although he remembered his family's stories of his grandmother who was born in Sarajevo. He was proud of his Bosnian roots, as he often mentioned that his family is of "Bosniac" ancestry.

He also mentioned that he recently retired from practice in Zurich and that many chairmen, whom he considered his trainees, had invited him to work in USA. None of these options had ever materialized into viable options. He said Dr Almefty only visited him in Zurich for a few days, however was the only one to provide him with a position. Later I learned that Dr Almefty presented the opportunity of hiring Yasargil to the University of Arkansas Medical Sciences leadership, who agreed on principle. However, the limiting step was him getting an Arkansas neurosurgical license, an impossible task for someone who did not complete neurosurgical training in the USA. Somehow, Professor Almefty did the unimaginable. The president of the Arkansas Medical Board at that time was Dr Ray Jouett, a famous and very respected neurosurgeon in Little Rock (Figure 2). Dr Jouett pulled some impossible strings and sealed the deal. This magnificent task extended the professional neurosurgical life of Professor Yasargil for some 30 years. This allowed him to present his incredible work and teaching talents not only to his contemporaries in Little Rock at various levels, but also to the global neurosurgical community. Among the many incredible neurosurgical accomplishments of Dr Al-Mefty, this would prove to be one of most important ones.

Figure 2: Dr Ray Jouett (1928-2018), respected neurosurgeon from Little Rock, AR served 20 years as a Chairman of Arkansas State Medical Board, which granted Professor Yasargil an Arkansas neurosurgical license during his tenure.

Three years later, Professor Yasargil would be named the neurosurgeon of the second half of 20th Century by the Neurosurgery Journal (Figure 3).

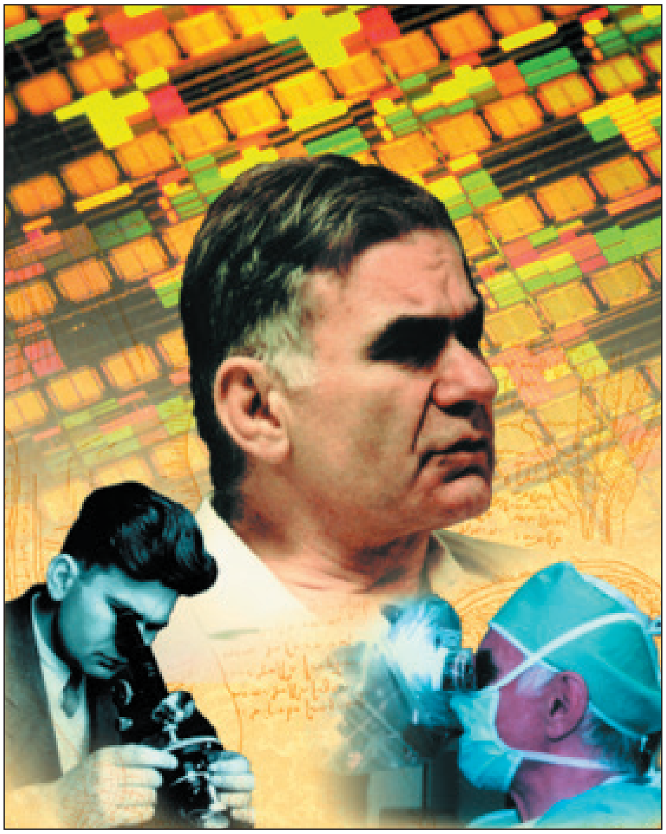

Figure 3: Cover of Neurosurgery Journal dedicated issue on proclaiming M. Gazi Yasargil Neurosurgeon of second half of 19 century signed to me by Professor Yasargil

This memorable event was celebrated at the Gala Dinner and Reception hosted at Little Rock Country Club (Figure 4).

At that time, I joined Dr Luis Borba, a neurosurgeon from Curitiba, Brazil who came several months before me to the program, as a research skull base fellow. We worked in a small makeshift skull base lab on the ninth floor of the hospital. We would often fight over one "good" microscope to fine tune our dissection approaches. A few months later, Dr Ugur Ture, a neurosurgeon from Istanbul, Turkey, joined us to create the "original research trio" of young neurosurgeons. This trio would go on to experience incredible neurosurgical journeys in the decades to follow. While Dr Borba returned to Curitiba, Brazil and dr Ture to Istanbul, Turkey, I developed my neurosurgical carrier in USA, but stayed closely connected with Sarajevo University Clinical Center Department of Neurosurgery where I started my neurosurgical journey (Figure 5).

Figure 4: Picture of then UAMS neurosurgery residents taken at Yasargil Neurosurgeon of the Century Gala at Little Rock Country Club 1999- left to right Drs Muhammed Elnabtity, David Wrubel, Robert Ingraham, Kenan Arnautovic, Wade Ceola and Azedine Medhkour

Figure 5: Dr Ugur Ture, Dr Luis Borba and Dr Kenan Arnautovic photo taken in 1994 (above) and in 2023 during St. Louis Almefty Skull Base Course.

Dr Ture worked on research projects more with Dr Yasargil, while Dr Borba and I worked predominantly with Dr Almefty. Both professors would visit us at the lab daily, often late at night, to discuss various projects (Figure 6).

We spend numerous days, weeks, and months in Professors Yasargil and Almefty's operating theaters, observing their surgeries. I remember that Professor Almefty was the first to perform closures for Professors Yasargil, which was a great sign of respect and admiration. For us youngsters, this was a great lesson in humility and respect of the neurosurgical hierarchy (Figure 7).

Figure 6: My photo taken during dissections under the "good" microscope in the UAMS neurosurgery skull base lab. Please note the "less favorable" dissection microscope on the left.

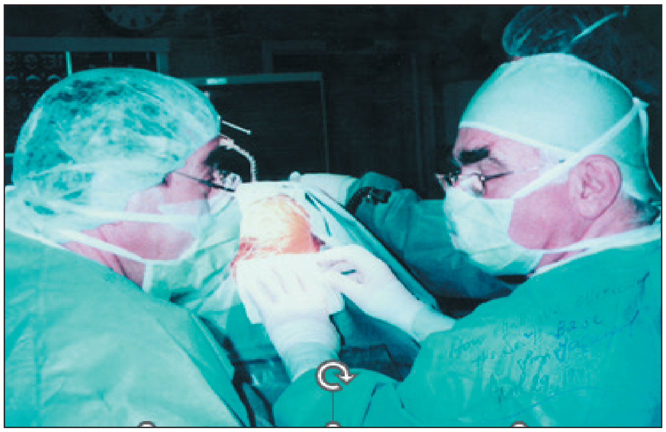

Figure 7: Professors Al-Mefty (left) and Yasargil (right) during the first surgery done in Little Rock when Professor Al-Mefty closed for Professor Yasargil. Photo is signed by Professor Yasargil to me

Later, surgical closures were performed by younger neurosurgery attendings in the department, most frequently Drs Krisht, Pait, Boop, Teo, Malik, Abdelrauf, among others. It was interesting and enlightening to watch these young attendings grow professionally over time, under the wing of two great professors. Afterwards, the closures would be performed by residents and for some reason, the professor frequently asked me to close cases for him. It was of pleasure that during the closures of Professor Yasargil's cases, I would work with Ms Dianne Yasargil. After the surgery, I would dictate his operative report based on the sketches of the procedure that he would draw for me. I kept many of these drawings, which I still treasure today (Figure 8).

One of the policies of Professor Almefty was to have frequent, often bimonthly, visiting professors from USA and around the world. I was introduced to Professors Jane, Kurze, Malis, Hakuba, Menezis, Pop, Hernesniemi, Spetzler, among many others. I will never forget attending the exciting neurosurgical discussions of Professors Yasargil and Almefty along with these famous lecturers. The department became the Mecca of neurosurgery, and I remember scores of neurosurgery visitors from all over the world. They would spend anywhere from 1 week to one year or more with us, many repeating their visits. One of the benefits for the three of us, research fellows at that time, was developing lifelong friendships and relationships with neurosurgeons all over the World (Figures 9, 10 and 11).

I spent many hours with Dr Yasargil in various roles. I had to repeat neurosurgery residency in the USA, as this was the only pathway to practice neurosurgery. As a resident, my task was to provide daily updates to the attendings about their patients. Professor Yasargil was keen to have detailed reports on his patients. The reports were mostly great, with good patient progress, but on occasion they were not. The professor did not like to hear those less favorable updates and would become grouchy. We, the residents, learned over time how to minimize the "bad" updates.

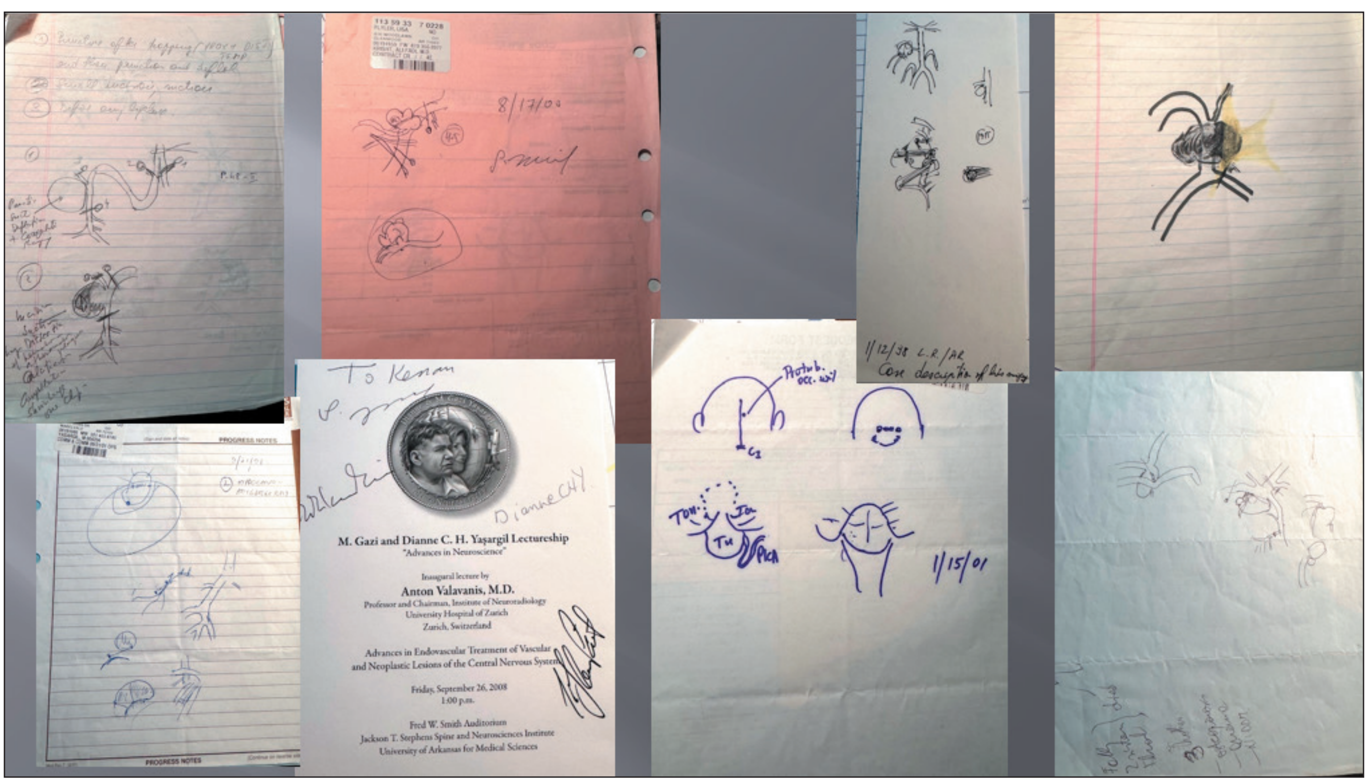

Figure 8: Professor Yasargil signed operative drawings for my operative dictations of his cases.

Figure 9: Visiting Professorship of Professor John Jane.

Figure 10: Visiting Professorship of Professor Theodore Kurze. Photo taken in our skull base lab.

Figure 11: Visiting Professorship of Professor Ed Laws.

Once, there was a discussion about how neurosurgeons enjoy doing great cases. He stated that he never felt particular pleasure doing neurosurgery. I do not remember Professor Yasargil having a proper breakfast or lunch during the working days. However, I have seen him enjoying apples and on occasion oranges instead.

He also told me the story of the Leyla retractor. As a child, his oldest daughter Leyla, played with her mother's pearls and accidentally broke the string. The pearls spread all over the floor and she started crying. The professor sat down with her on the floor and told her, "let's fix this together." He took the string, tied it, and started re-assembling the pearls. At that moment he noticed that whenever he pulled the string, the pearls became rigid. There, he got idea for the Leyla retractor and named it after his daughter. Interestingly, I never saw him use the Leyla retractor during his surgeries (Figure 12).

Once I asked him how he detects the border between a glioma and normal brain tissue when the texture is similar. He told me that his best guidance is his knowledge of brain anatomy. He would also listen to the suction, as tumor sounds different than brain tissue under suction. There were also tactile differences between normal brain and tumor he emphasized.

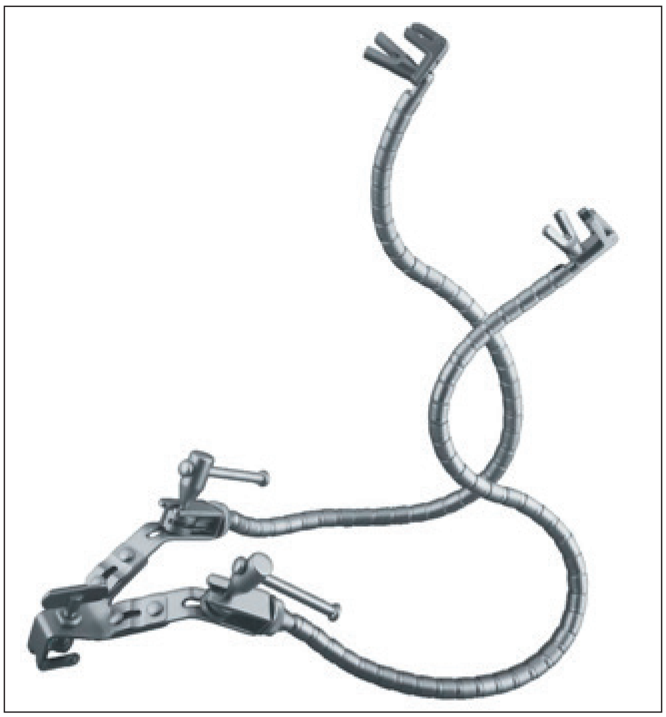

Figure 12: Photo of Leyla retractor in rigid position.

On a personal note, he felt some geographical bond with me due to his Bosnian family heritage. He found out that my grandfather Hidayet's first cousins, my aunts Meserreta and Asifa, were his first cousins on father's side. On that occasion, after finding out our distant family relationship of the 7th degree, he gifted me his signed photo and "Microsurgery, Part IV B"- his newest book at that time (Figure 13).

I met him for the last time in Istanbul, Turkiye in 2017 during the World Federation of Neurosurgical Societies (WFNS) Congress (Figure 14).

Often, during my surgeries, memories of my interactions with Professor Yasargil come to mind. Using the Yasargil bipolars with their progressive lengths and tip sizes, controlled suctions of different sizes and lengths, micro scissors of progressive lengths, sizes and direction, the Yasargil surgical chair, semi mobile armrest, and many other instruments are part of my regular surgical armamentarium (Figure 15).

His surgical philosophy shaped mine. His personal story of a young man from Turkey, who endured difficult times furthering his education and career development in Germany and Switzerland, broke social, language and cultural barriers, and became a transforming figure in neurosurgery. He was a teacher for neurosurgeons across the world and always served as an inspiration to me in my American neurosurgical journey. He will forever live in the hearts and minds of neurosurgeons across the world.

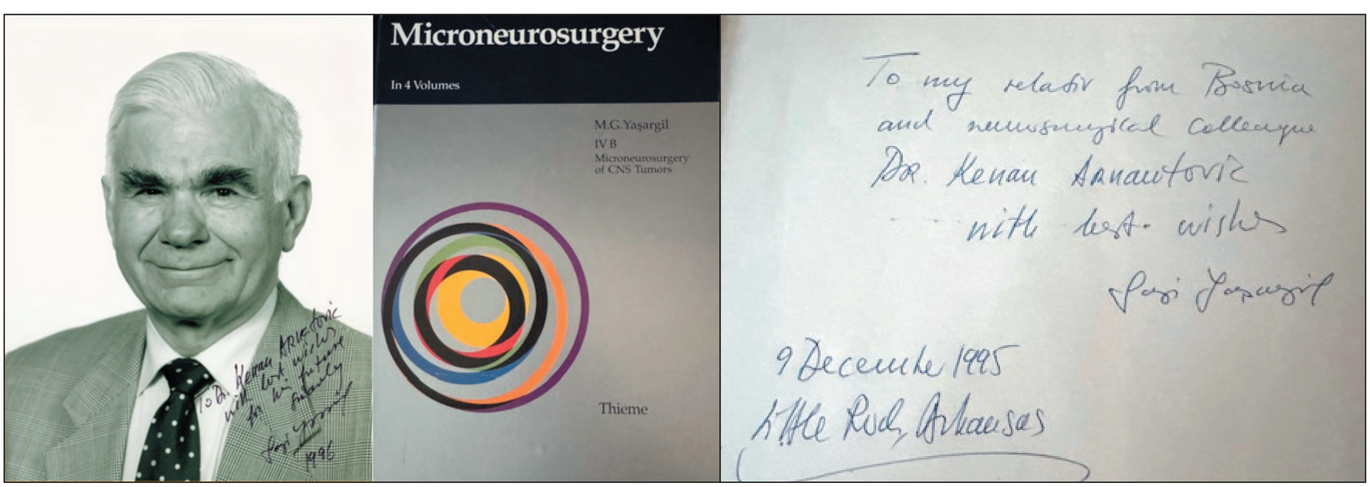

Figure 13: Signed personal photo and Microneurosurgery Volume IV B book by Professor Yasargil to his "relative from Bosnia."

Figure 14: Last time I saw Professor Yasargil at Istanbul Convention Center in 2017.

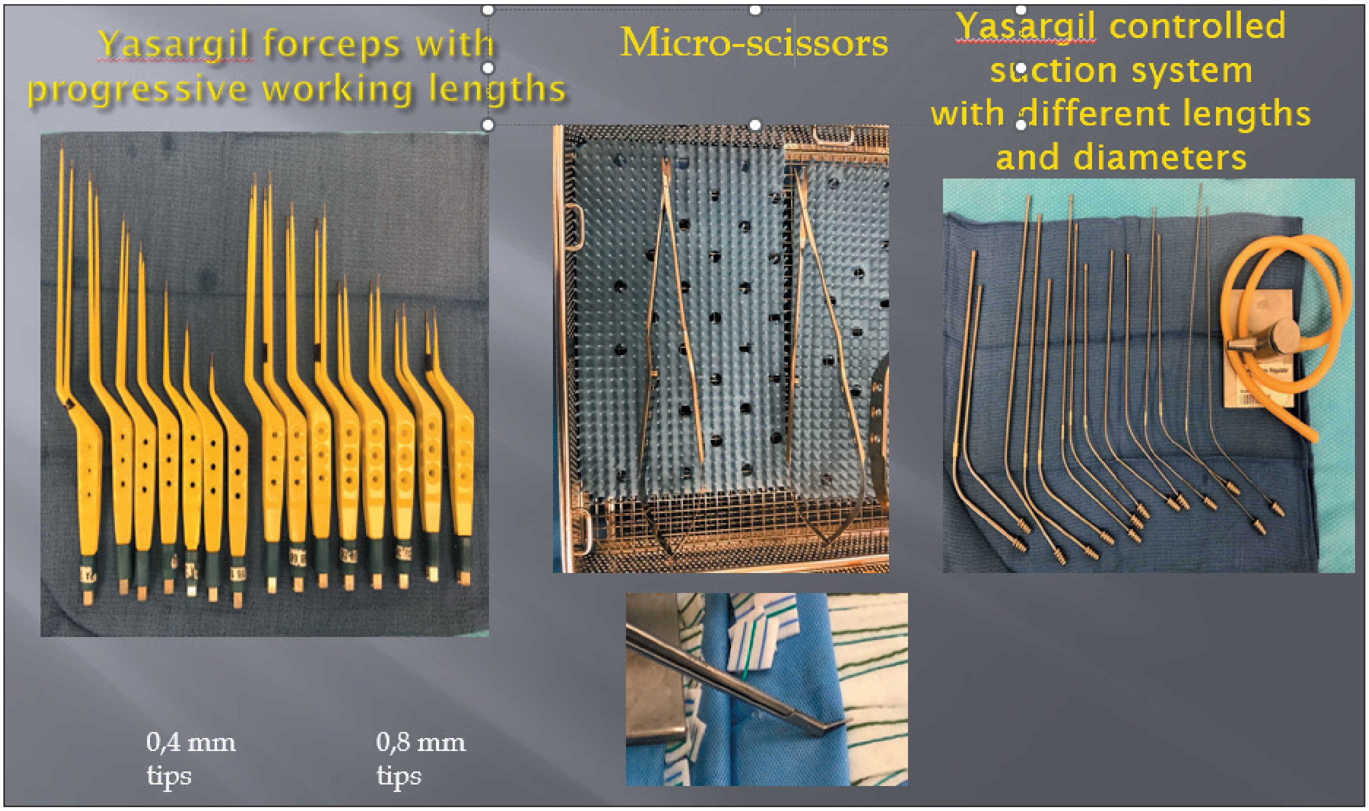

Figure 15: Photo of my regular surgical table with Professor Yasargil instruments.

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Invited Special Article

Madison Microneurosurgery Initiative: A Tribute to Professor M. Gazi Yaşargil's Legacy in Microvascular Surgery Training. Part I – A Brief History of Microsurgery and Yaşargil's Contributions

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ABSTRACT

In the late 1960s, Professor M. Gazi Yaşargil began to systematically incorporate microsurgery into neurosurgical practice, grounded in anatomical expertise and intensive, systematic laboratory training followed by clinical application. Using the operative microscope, he introduced microsurgical techniques and redefined surgical anatomy that had long existed but remained largely unseen. By exploiting natural cisternal pathways to achieve pure lesionectomy, he reintroduced operability for complex pathologies and established new standards in modern neurosurgery. Yaşargil's early contributions to microvascular training and neurosurgical practice exemplify enduring principles from which neurosurgical professionals at all stages can continue to draw guidance. Our exposure to his work—through lectures, publications, and personal communications—profoundly shaped our own approach to neurosurgery and ultimately informed the philosophy underlying our global neurosurgery efforts, embodied in the Madison Microneurosurgery Initiative. This manuscript reviews the historical foundations of microneurosurgery through Yaşargil's early career, his formative laboratory work in Burlington, Vermont, and the systematic clinical implementation of microsurgery in Zurich, distilling key lessons derived from these pioneering experiences. A companion manuscript (Part II) describes how these principles were translated into structured curricula and implemented through contemporary microsurgical training and our global neurosurgery efforts.

KEYWORDS: Donaghy, History, Jacobson, Laboratory training, Microvascular surgery, Yaşargil

ABBREVIATIONS: MMI: Madison Microneurosurgery Initiative, **AVM:** Arteriovenous malformation, **MCA:** Middle cerebral artery, **UVM:** University of Vermont, **STA:** Superficial temporal artery, **EC:** Extracranial, **IC:** Intracranial

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The better we see, the more we know. The more we know, the better we see (28, 37).

(M. Gazi Yaşargil)

"The better we see, the more we know" reflects the concept that improvements in tools and techniques—whether through the surgical microscope or the development of new approaches—reveal details that were previously unrecognized and, in turn, expand our understanding.

"The more we know, the better we see" completes the cycle: expanding understanding reshapes perception. As knowledge deepens, we better appreciate subtle details, define critical relationships, and perceive anatomical structures with greater clarity; what was once hidden comes into view.

Yaşargil's incorporation of microsurgery into neurosurgical practice exemplifies this reciprocal principle. Through meticulous visualization using the operative microscope, he introduced microsurgical techniques and redefined surgical anatomy that had long existed but remained largely unseen. This advancement allowed neurosurgeons to use natural cisternal pathways to achieve pure lesionectomy with unprecedented precision, re-introducing operability and establishing new standards in modern neurosurgery.

Our exposure to Yaşargil's work—through his lectures, publications, and personal communications—allowed us to gradually appreciate the breadth and depth of his contributions to the field of neurosurgery. As our understanding evolved, it refined our perception, revealing additional layers of insight that continued to shape our approach to the field. This reciprocal process of learning and perception ultimately shaped the philosophy underlying our global neurosurgery outreach efforts, embodied in the Madison Microneurosurgery Initiative (MMI).

A thorough understanding of the lasting influence of Yaşargil's legacy on our approach requires a detailed exploration of his early career, the birth of microsurgery, and his foundational contributions—particularly the innovations that reshaped microsurgical practice and established core principles of microsurgical training.

EARLY CAREER OF YAŞARGIL

Following high school education in Ankara, Turkey, Yaşargil began his medical education at the Friedrich Schiller University in Jena, Germany and completed his medical degree at the University of Basel in Switzerland. Early in his education, he studied anatomy at the renowned Institute of Anatomy at the Friedrich Schiller University (28). In 1945, under the guidance of Professor Adolf Portmann, he performed microscopic transpalatinal exploration and selective removal of the intermediate lobe of the frog hypophysis. This experience marked his first encounter with microsurgery (28).

Additionally, Yaşargil spent three intensive months at the Institute of Anatomy "Vesalianum" in Basel under the mentorship of Dr. Klingler, where he learned the white matter fiber dissection known as Klingler method and examined the internal architecture of the brain. He continued refining his fiber dissection skills and deepen his understanding of internal neuroanatomy over the subsequent three years, using specimens he had borrowed from Basel (28). During these years, he extensively studied Brain and Spinal Cord (26), and the Atlas Cerebri Humani (20). In addition, Yaşargil extensively studied Walter E. Dandy's Surgery of the Brain book German edition before his residency start in Zurich. On January 4, 1953 he began his neurosurgical training under Professor Hugo Krayenbühl in Zurich (28).

In 1957, Yaşargil received training in stereotactic surgery in Freiburg with Professors Th. Riechert, H. Hassler, and Fr. Mundinger, subsequently introducing these techniques in Zurich and performing more than 800 procedures by 1965 (28,30). In 1958, he spent four weeks in Paris training with Professor J. Talairach, where he learned stereotactic approaches to the treatment of epilepsy. He further expanded his physiological understanding of the central nervous system through training with Professor Niels A. Lassen in Copenhagen on local cerebral hemodynamics and with Professor Nils Lundberg in Lund on intracranial pressure monitoring (28).

Driven by his interest in cerebral vascularization, Yaşargil conducted extensive studies on neurovascular anatomy, examining anatomical variations and collateral pathways in 200 injected cadaveric brains (400 hemispheres). He explored the integration of stereotactic and endovascular techniques, including iron particle injection for targeted occlusion of aneurysms and arteriovenous malformations (AVMs), as well as the use of polymerizing substances in saccular aneurysms (28,35). Concurrently, he angiographically analyzed more than 100 orbital lesions, collateral cerebral circulation, and the lenticulostriate arteries (35). Alongside this cranial work, he treated 12 spinal AVMs, developed substantial expertise in spinal disc surgery, and designed a telescopic screw (28).

By 1965, at the age of 40, Yaşargil had devoted 22 years to medicine, including 13 years in neurosurgery, and had performed approximately 3,000 operations. His expertise extended to stereotactic surgery, with experience in more than 900 cases, and to neuroradiology, having conducted roughly 9,000 transcutaneous and stereoscopic angiographic studies of the carotid, vertebral, and orbital vessels. In parallel, together with Professor Hugo Krayenbühl, he had published 82 papers, authored four monographs, and contributed chapters to three additional monographs (35).

THE ADVENT OF MICROSURGERY

The operating microscope was first introduced into clinical surgery in 1921 by the otolaryngologist Carl Olof Nylen in Stockholm (21). Its application was subsequently advanced by pioneers in otolaryngology—including Holmgren, Wullstein, Shambaugh, and House—as well as by ophthalmic surgeons such as Perritt, Harms, and Barraquer, before its adoption in neurosurgery. In 1957, Theodore Kurze became the first to employ the operating microscope in a neurosurgical procedure (19). Subsequent applications included aneurysm surgery and, by the mid-1960s, vestibular schwannoma surgery (2,34-36).

MICROVASCULAR SURGERY IN BURLINGTON, VERMONT

While pioneering microsurgical efforts in the United States initially emerged on the West Coast in the late 1950s, parallel work was underway on the East Coast at the University of Vermont (UVM). Following his appointment as Associate Professor and Director of Surgical Research at the UVM in 1959, Julius H. Jacobson collaborated with W. H. McMillan to study procedures requiring carotid denervation in canine models (12,13). They demonstrated that excision of the carotid artery followed by reanastomosis achieved approximately 70% patency in 3-mm vessels without optical aids—at a time when successful anastomosis of 6-mm arteries was not yet feasible (13). They recognized that the primary obstacle was inadequate visualization, noting that "*the eye not being able to see well enough to guide the hand properly*" (12,13,15). Various optical aids, including magnifying loupes, were subsequently employed, but outcomes remained unsatisfactory (13,16,25). A pivotal moment occurred when Jacobson observed an otolaryngology colleague using an operating microscope in the operating room at Mary Fletcher Hospital—an experience he later recalled from his residency at Presbyterian Hospital in New York (13).

Recognizing the limitations of available surgical instruments, Jacobson purchased fine jewelry forceps from a local jeweler—tools he described as "s*uperior to anything in the surgical armamentarium*" (12). When combined with the operating microscope, these instruments enabled 100% patency in microvascular arterial anastomoses involving vessels ranging from 3.2-mm to 1.4-mm in diameter (12,17,18,35,36). With further refinement, consistent patency was later achieved in vessels as small as 1-mm (14,38).

Meanwhile, in 1959 at the same institution, Dr. R.M. Peardon Donaghy encountered a patient with a middle cerebral artery (MCA) embolus; the case, managed with medical therapy only, ended in frustration because of lack of experience with embolectomy (2,4,6). This event, together with Donaghy's "Orlab Concept," marked the beginning of microneurovascular research in the Neurosurgical Laboratory at the UVM. Shortly thereafter, Jacobson, who had already published his seminal work (18), demonstrated the advantages of the operating microscope to Donaghy and strongly advocated its use in such cases (2,4).

Following intensive experimental laboratory work using an operative microscope, the first microsurgical MCA endarterectomy was performed in Burlington on August 4, 1960, by Donaghy and Jacobson, with limited success (2,7,13,25). Over the following six years, eight additional embolectomies or endarterectomies were performed, with only two achieving technical success (2,35,36). Reflecting on these early efforts in 1967, Donaghy noted: "*we feel in the past seven years since this work was begun we have progressed but little, but have progressed none the less, and hope that knowledge gained from our confreres will lead to even greater progress during the next seven years*" (4).

MICROSURGERY IN ZURICH

The microsurgical work of Drs. House and Kurze was well received in Zurich (28). In late 1963, a Zeiss binocular diploscope was acquired by the Department of Neurosurgery in Zurich and used in a limited number of cases, including facial nerve anastomosis and lumbar spine surgery. However, because of its cumbersome mobility and the absence of structured laboratory training, it could not be effectively adapted for broader surgical applications and was soon abandoned (28,29,30,35). In 1966, it was replaced by the Zeiss OPMI-1 (35).

Yaşargil later recalled his early experience using the operating microscope in spine surgery with Dr. Eric Zander as follows:

> *"Gazi, you are doing the surgery now." I was shocked. "Okay," I started. I started on the left side, opened the paraspinal muscles, and stopped. I said, "Dr. Zander, that's it—this is what I can do. I don't have the moral power. This is too much to start doing everything. I know what I can do, but I do not have experience."*
>
> *In the afternoon, he told Dr. Krayenbühl during a discussion. He said Gazi had a hesitation to operate further. The reaction of Krayenbühl was important for me—for everybody. He said, "This is a good sign. He is going to be a good surgeon, because we should not run in."*
>
> *I said, "We have no training facilities. We never had any laboratory. I didn't have any idea about the spinal musculature and the bones. I just watched it. But watching was not under the microscope at all" (37).*

In late 1963, Ake Senning asked Yaşargil to perform an embolectomy on a 17-year-old girl who had, after open cardiac surgery, developed right-sided hemiplegia due to an embolus occluding the left central sulcus artery (approximately 1–1.5 mm) (28,30,35). Yaşargil later reflected on this encounter as follows:

> *"Professor Senning insisted that I immediately remove the embolus. He was very upset by my hesitant behavior and my explanation of incompetence given my lack of laboratory experience with microvascular surgery" (35).*

From these early experiences, Yaşargil drew a lasting lesson: surgical innovation must be grounded in thorough, intensive laboratory training before application in the clinical practice.

Similar to Donaghy's experience in 1959, the MCA embolectomy case stimulated Yaşargil's growing interest in structured microsurgical laboratory training, ultimately led him to Burlington, Vermont, in 1965 (28,30,35). At the age of 40, Yaşargil left an established clinical and research career in Zurich and arrived in Burlington in October 1965 with his wife and three children. By then, Jacobson had already left Burlington.

YAŞARGIL IN BURLINGTON, VERMONT

When Yaşargil arrived in Burlington, he already had a clear plan to pursue microvascular surgery training. He outlined a structured training program focused on developing microvascular techniques for cortical artery embolectomy; performing extra- and intracranial bypass for internal carotid artery occlusion; establishing middle cerebral artery bypass grafting; and exploring bypass procedures involving the superior sagittal sinus (30).

His extensive experience in anatomy, clinical practice, and research had prepared him for the next stage of his career—a point later underscored by Jacobson, who recalled:

> *One day in 1965, a young Turkish neurosurgeon, M. Gazi Yaşargil, appeared at Mount Sinai. He turned out to be the hardest working man whom I have ever encountered. You may recall that Sir William Osler stated that the magic word of medicine was work which "makes the dull student bright, the bright student brilliant, and the brilliant student steady." By that definition, Leonard Malis and M. Gazi Yaşargil are "steady" (13).*

It is important to note that Yaşargil's visit to Burlington was not limited to learning microvascular techniques. He also served as a visiting professor, sharing his clinical expertise, particularly in vascular malformations, with residents—a contribution often been underrecognized (23).

Yaşargil's early work focused on the patch technique for embolectomy in small vessels; as his experience expanded, he developed techniques of his own that enabled him to perform a wide range of vascular procedures, including multiple forms of anastomosis, vessel duplication and loop formation, vein and synthetic grafting, and patch repair (Figure 1) (3,7,28,29,39).

Figure 1: Building on extensive prior experience and instruction from highly skilled mentors, Yaşargil rapidly mastered the fundamentals of microvascular anastomosis. Yaşargil with his main teacher in microtechniques, Ms. Esther 'Jackie' Roberts, RN in Burlington, Vermont, February 8, 1966. Reproduced courtesy of Fletcher Allen Health Care Records, Special Collections, University of Vermont Library.

On February 2, 1966, Yaşargil attempted a common carotid–MCA bypass using a femoral artery and jugular vein graft. Although the procedure was technically successful, the graft subsequently thrombosed. These early results led him to revise his strategy and adopt the superficial temporal artery (STA) as the donor vessel, thereby avoiding an additional anastomosis (7,35). From March 30 to September 1966, he successfully performed 33 STA-MCA bypass operations in mongrel dogs (30,33,35).

The purchase of a small bipolar coagulator ($120), rather than a new Bovie unit ($500), represented a turning point in his experimental efforts. It enabled precise hemostasis and played a key role in the safe and effective application of microsurgical techniques in neurosurgery (28).

Beyond the technical aspects of microvascular anastomosis, Yaşargil recognized the critical role of regional cerebral blood flow assessment in determining the indication for bypass surgery. He believed that accurate pre- and postoperative assessment of cerebral perfusion as essential for establishing appropriate surgical indications, although such measurements were not technically feasible at the time (32). The results of the Extracranial (EC)–Intracranial (IC) Bypass Study published in 1985 later validated his concerns, demonstrating that bypass surgery should not be performed without proper indications in stroke management (11,28).

After six months of laboratory work, Yaşargil visited major centers across the United States and Canada in the summer of 1966 to share his experience in microvascular surgery and assess contemporary microvascular surgical practice in general, vascular, plastic, and neurosurgery (30,36,39). In those centers, he presented 16-mm color films of his laboratory work in Burlington, footage of 12 spinal AVM surgeries performed without microsurgical aids in Zurich, and angiographic studies from 110 patients with orbital lesions, along with his work on cerebral arterial collateral circulation and the lenticulostriate arteries (28,35,39).

During this tour, Yaşargil recognized the need for a dedicated meeting to unite colleagues working on microvascular surgery techniques. Accordingly, a conference was held in Burlington, Vermont, on October 6–7, 1966, attended by approximately 60 surgeons from four specialties—vascular, plastic, reconstructive, and neurosurgery. The meeting was honored by the presence of Dr. Krayenbühl, who observed Yaşargil's laboratory work firsthand and became convinced that microsurgical techniques and bipolar coagulation should be routinely incorporated into neurosurgical practice (35). The proceedings were subsequently published as a monograph (5).

This initial meeting was followed by a series of neurosurgical conferences, beginning with one held on April 13–15, 1967, at the University of California, Los Angeles. During this meeting, Yaşargil demonstrated the combined use of the operating microscope and bipolar coagulation in a spinal AVM operation in collaboration with Dr. Rand, marking the first clinical application of microtechniques (7,30). The conference proceedings were subsequently published in another monograph (24).

YAŞARGIL BACK IN ZURICH

"Dr. Yaşargil went back to Zurich in 1967 where his work is already legendary" (7). Following 14 months of intensive laboratory work in Burlington, this return marked a decisive transition, as his experimental experience had demonstrated that microsurgical techniques could—and should—be routinely applied in neurosurgical practice. Yaşargil later emphasized that his meticulous laboratory work in Burlington provided the skills necessary for safe application of these techniques in humans (28).

FROM THE MICROSURGICAL LABORATORY TO THE OPERATING THEATRE

The routine clinical application of microtechniques in Zurich began on January 18, 1967, with the removal of a glioma and clipping of an aneurysm in the same session (35,36). These techniques were rapidly adopted across the full spectrum of neurosurgical practice, including reconstruction of occluded intracranial arteries and the treatment of aneurysms, AVMs, cavernomas, extrinsic and intrinsic tumors, as well as spinal lesions (28,36,39). This broad application emphasizes that training in microvascular surgery extends beyond bypass procedures, enhancing outcomes across diverse neurosurgical operations through shared microsurgical skills developed in the laboratory.

On October 30, 1967, Yaşargil performed the first EC–to–IC STA–MCA bypass, one day before Donaghy carried out a same procedure in Burlington (2,7,28,35). Notably, although routine microsurgical practice had already been established in Zurich, Yaşargil waited nearly ten months before applying this technique clinically. He later explained this deliberate decision as follows:

> "*My forbearance was due to the fact that I did not want to discredit the technique of this operation by choosing a case with questionable indications. I thus waited for an ideal case*" (30).

Until 1973, Yaşargil performed 35 STA-MCA bypass procedures with considerable apprehension and hesitation, as indications were not yet well defined (31). The absence of reliable methods to assess cerebral tissue viability and measure cerebral blood flow limited appropriate patient selection, and even by 1999, definitive indications remained incompletely established (28,38). From 1973 onward, younger colleagues—Drs. Yonekawa, Zumstein, and Imhof—performed these operations under his guidance, completing an additional 200 cases through 1993 (30,35).

ZURICH MICROSURGICAL LABORATORY

After returning to Zurich, Yaşargil continued his experimental research in microvascular surgery at the Brain Research Institute, alongside an intensive clinical practice (1,8-10,22,27). In November 1968, the second microneurosurgery conference and the first hands-on microsurgical course were organized in Zurich, an event Yaşargil later recalled as follows:

> *"The third microsurgical conference and first hands-on microsurgical course were held in the pathology department of University Hospital, Zurich, in November 1968. We expected 20–40 participants and had borrowed 10 operating microscopes from the Zeiss Company and bought some jewelers' instruments for the course. To our great surprise, we experienced the arrival of 186 neurosurgeons from Europe, Canada, and the US—a great number of them being chairmen of neurosurgery departments" (35).*

In this initial course, Yaşargil emphasized that hands-on instruction alone was insufficient and that prolonged laboratory practice was essential before applying microsurgical techniques in clinical settings. He later recalled:

> *"In hands-on courses the microtechniques of tissue dissection, bone drilling, bipolar coagulation, and suturing were demonstrated and practiced. Colleagues were encouraged to continue practicing in the laboratory for a long period of time until they achieved competence in the application of microtechniques, before performing surgery on patients" (35).*

Proceedings of this conference were published as another monograph (34).

In 1972, the program moved to a modern animal laboratory equipped with 10 Zeiss OPMI-1 microscopes (28). By 1999, more than 4,000 surgeons from various specialties had been trained in microsurgical techniques in this laboratory and had completed the Zurich Microsurgery Course—initially under Yaşargil's leadership until 1971, subsequently under Drs. Yonekawa and Nishikawa, and over four decades under Rosmarie Frick, Nursing Assistant (28,40). Under her leadership, the Zurich Microsurgery Course was also conducted in some other countries, including Türkiye, where the first author completed the course and observe multiple courses between 2017 and 2019.

In summary, the pioneering work of Yaşargil established microneurosurgery not only as a technical innovation, but as a disciplined educational paradigm grounded in meticulous anatomical study, systematic laboratory training, and judicious clinical application. His experiences demonstrated that sustained, hands-on laboratory practice is essential for the safe and effective adoption of microsurgical techniques. These historical foundations yielded enduring lessons that continue to inform contemporary microsurgical education and practice. Building on these lessons, Part II of this series describes how the principles derived from Yaşargil's legacy were translated into structured training curricula and implemented through contemporary microsurgical training models and global neurosurgery efforts.

Declarations

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AUTHORSHIP CONTRIBUTION

Study conception and design: AK, MKB

Data collection: AK

Analysis and interpretation of results: AK

Draft manuscript preparation: AK

Critical revision of the article: AK

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REFERENCES

1. Crowell RM, Yaşargil MG: Experimental microvascular autografting. J Neurosurg 31: 101-104, 1969. https://doi.org/10.3171/jns.1969.31.1.0101
2. Donaghy RMP: History of micro-neurosurgery. In: Wilkins RH, Rengachary SS (eds), Neurosurgery, volume 1. McGraw-Hill New York, NY, 1996: 37-42
3. Donaghy RMP: Interview with RMP Donaghy Re: Dr. M.G. Yaşargil. In: Neurosurgery UDo (ed), 1966
4. Donaghy PR: Patch and by-pass in microangeional surgery. In: Donaghy PR, Yaşargil MG (eds), Micro-vascular surgery: Report of first conference, Oct. 6 - 7, 1966, Mary Fletcher Hospital, Burlington, Vermont. Georg Thieme Verlag Stuttgart, 1967
5. Donaghy RP, Yaşargil MG: Micro-vascular surgery. Report of first conference, October 6-7, 1966 Mary Fletcher Hospital, Burlington, Vermont. Georg Thieme Verlag Stuttgart, 1967

6. Donaghy RM, Yasargil G: Microangeional surgery and its techniques. Prog Brain Res 30: 263-267, 1968. https://doi.org/10.1016/S0079-6123(08)61469-7
7. Donaghy RM: The history of microsurgery in neurosurgery. Clin Neurosurg 26: 619-625, 1979. https://doi.org/10.1093/neurosurgery/26.cn_suppl_1.619
8. Flamm ES, Yaşargil MG, Ransohof J: Alteration of experimental cerebral vasospasm by adrenergic-blockade. J Neurosurg 37: 294-301, 1972. https://doi.org/10.3171/jns.1972.37.3.0294
9. Fox JL, Yaşargil MG: Experimental effect of direct electrical current on intracranial-arteries and blood-brain-barrier. J Neurosurg 41: 582-589, 1974. https://doi.org/10.3171/jns.1974.41.5.0582
10. Guerrisi R, Yaşargil MG: Experimental study on artificially made aneurysms with the aid of the microscope, in rats and rabbits. Minerva Neurochir 14: 140-144, 1970.
11. Group TEIBS: Failure of extracranial–intracranial arterial bypass to reduce the risk of ischemic stroke. N Engl J Med 313: 1191-1200, 1985. https://doi.org/10.1056/NEJM198511073131904
12. Jacobson J: The development of microsurgical technique. In: Donaghy PR, Yaşargil MG (eds), Micro-vascular surgery: Report of first conference, Oct. 6 - 7, 1966, Mary Fletcher Hospital, Burlington, Vermont. Georg Thieme Verlag Stuttgart, 1967
13. Jacobson JH 2nd: The early days of microsurgery in Vermont. Mt Sinai J Med 64: 160-163, 1997.
14. Jacobson JH 2nd: Microsurgery. Curr Probl Surg 8: 1-56, 1971. https://doi.org/10.1016/S0011-3840(71)80006-0
15. Jacobson JH 2nd, Suarez EL: Microvascular surgery. Dis Chest 41: 220-224, 1962. https://doi.org/10.1378/chest.41.2.220
16. Jacobson JH, Suarez EL, Schumacher GA, Flanagan M, Donaghy RMP, Wallman LJ: Microsurgery as an aid to middle cerebral artery endarterectomy. J Neurosurg 19: 108-115, 1962. https://doi.org/10.3171/jns.1962.19.2.0108
17. Jacobson JH, Suarez EL: Microsurgery - application to organ transplantation. Transactions American Society for Artificial Internal Organs 7: 301-305, 1961.
18. Jacobson JH, Suarez EL: Microsurgery in anastomosis of small vessels. Surg Forum 11: 243-246, 1960
19. Kurze T: Microtechniques in neurological surgery. Neurosurgery 11: 128-137, 1965. https://doi.org/10.1093/neurosurgery/11.CN_suppl_1.128
20. Ludwig E, Klingler J: Atlas Cerebri Humani. Basel: S. Karger; 1956.
21. Nylen CO: The microscope in aural surgery, its first use and later development. Acta oto-laryngologica. Supplementum 116: 226-240, 1954. https://doi.org/10.3109/00016485409130299
22. Peerless SJ, Yaşargil MG: Adrenergic innervation of cerebral blood vessels in rabbit. J Neurosurg 35: 148-154, 1971. https://doi.org/10.3171/jns.1971.35.2.0148
23. Progress MF: International Neurosurgery. Mary Fletcher Progress 1966.
24. Rand RW: Microneurosurgery. CV Mosby St. Louis, MO, 1969
25. Tamai S: How the seed of microvascular surgery that was sown by Prof. Julius H. Jacobson in 1960 germinated and blossomed. J Reconstr Microsurg 40: e1-e5, 2024. https://doi.org/10.1055/s-0043-1768221
26. Villiger E, Ludwig E: Gehirn und Rückenmark. Basel: Benno Schwabe & Co, 1946.
27. Young PH, Yaşargil MG: Use of small diameter synthetic grafts in carotid bypasses in rats. J Microsurg 3: 3-6, 1981. https://doi.org/10.1002/micr.1920030103
28. Yaşargil MG: A legacy of microneurosurgery: memoirs, lessons, and axioms. Neurosurgery 45: 1025, 1999. https://doi.org/10.1097/00006123-199911000-00014
29. Yaşargil MG: From the microsurgical laboratory to the operating theatre. Acta Neurochir 147: 465-468, 2005. https://doi.org/10.1007/s00701-005-0519-1
30. Yaşargil MG: History of microneurosurgery. In: Spetzler RF (ed), Cerebral revascularization for stroke. Georg Thieme Verlag Stuttgart, 1976.
31. Yaşargil MG: Intracranial microsurgery. Proc R Soc Med 65: 15-16, 1972. https://doi.org/10.1177/003591577206500106
32. Yaşargil MG: Interview Dr. M.G. Yaşargil Neurosurgeon, Zurich, Switzerland. In: Neurosurgery UDo (ed), 1966
33. Yaşargil MG: Microneurosurgery: Principles, applications, and training. In: Sindou M (ed), Practical Handbook of Neurosurgery From Leading Neurosurgeons. Springer Verlag New York, NY, 2009: 79-94
34. Yaşargil MG: Microsurgery: applied to neurosurgery. Georg Thieme Verlag Stuttgart, 1969
35. Yaşargil MG: Personal considerations on the history of microneurosurgery. J Neurosurg 112: 1163-1175, 2010. https://doi.org/10.3171/2010.3.JNS091124a
36. Yaşargil MG: The history of optical instruments and microneurosurgery. In: Barrow DL, Kondziolka DS, Laws ER, Traynelis VC (eds), Fifty Years of Neurosurgery. Lippincott Williams & Wilkins Baltimore, MD, 2000
37. Yaşargil MG. The constituents of microneurosurgery. 16th World Congress of Neurosurgery (WFNS 2017) Istanbul, Türkiye, 2017
38. Yaşargil MG, Krayenbuhl HA, Jacobson JH: Microneurosurgical arterial reconstruction. Surgery 67: 221-233, 1970.
39. Yasargil MG: The advent of microsurgery. Mt Sinai J Med 64: 164-165, 1997.
40. Yonekawa Y, Frick R, Roth P, Taub E, Imhof H-G: Laboratory training in microsurgical techniques and microvascular anastomosis. Operative Techniques in Neurosurgery 3: 149-158, 1999. https://doi.org/10.1016/S1092-440X(99)80007-3

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Invited Special Article

Madison Microneurosurgery Initiative: A Tribute to Professor M. Gazi Yaşargil's Legacy in Microvascular Surgery Training. Part II – Principles Applied and Practices Implemented

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ABSTRACT

Building on the historical foundations established by Professor M. Gazi Yaşargil and early microsurgical pioneers, as summarized in Part I, this manuscript focuses on the lessons derived from their early experiences and examines how these lessons were translated into guiding principles and contemporary microsurgical training practices. It then describes how these principles informed structured microsurgical training models and were implemented on a global scale through outreach efforts within the Madison Microneurosurgery Initiative. Through basic and advanced equipment donations, offline, live-streamed, and in-person educational support strategies, and sustained mentorship, microsurgical laboratory training has been established in 86 centers across 45 low- and middle-income countries. Our experience demonstrates that effective microsurgical training can be achieved through thoughtful application of foundational principles rather than reliance on high-cost or technologically sophisticated infrastructure. Together, the integration of historical lessons with contemporary application illustrates how Yaşargil's foundational principles continue to guide sustainable microsurgical training across diverse institutional and resource settings.

KEYWORDS: Global neurosurgery, Laboratory training, Madison Microneurosurgery Initiative, Microvascular surgery, Yaşargil

ABBREVIATIONS: MMCA: Middle cerebral artery, **EC:** Extracranial, **IC:** Intracranial, **BMBTC:** Baskaya Microvascular Bypass Training Curriculum, **MOST:** Madison Objective Self-Assessment Tool, **LMICs:** Low- and middle-income countries, **MMI:** Madison Microneurosurgery Initiative

The pioneering era of microsurgery established not only new operative techniques, but also a disciplined educational framework grounded in systematic laboratory training. While Part I reviewed the historical development of microsurgery through Yaşargil's foundational contributions, the present manuscript shifts focus to the practical lessons derived from those early experiences. This work provides a structured framework for understanding how microsurgical skills should be taught, learned, and sustained, and outlines how these principles were translated into contemporary training models and implemented across diverse institutional and resource settings in low- and middle-income countries within the field of global neurosurgery.

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LESSONS LEARNED

1. Problem-Driven Innovation

A few years apart, both Donaghy and Yaşargil confronted the same clinical problem: middle cerebral artery (MCA) embolectomy. Donaghy, at the age of 50, reframed this challenge as a research question and devoted sustained laboratory effort to the development of microvascular techniques. Yaşargil followed a similar course, stepping away from a demanding clinical and research career at age 40 to commit himself to intensive daily laboratory work in the United States. This disciplined approach led to the acquisition of new operative skills using the operating microscope, which were subsequently applied in clinical practice and ultimately reshaped neurosurgery practice. Their experiences illustrate a core principle: transformative surgical innovation arises when clearly defined clinical problems are addressed through rigorous laboratory experimentation, perseverance, and long-term preparation.

2. Why Microvascular Surgery Training Matters

From October 1965 to November 1966, Yaşargil spent 14 months in Burlington, Vermont, first mastering the existing state of microvascular practice and then advancing it through his own solutions. This extensive laboratory training, combined with his deep anatomical knowledge and prior surgical experience, enabled the systematic introduction of microsurgical techniques across the entire spectrum of neurosurgical practice. Using the operating microscope, bipolar coagulation, and refined microsurgical instrument sets, he applied these techniques routinely in clinical practice.

Yaşargil's experience demonstrates that structured training in microvascular anastomosis is essential not only for vascular procedures, but also as a foundational skill set for a broad range of microsurgical operations. Yaşargil always emphasized the unique role of microvascular training in developing atraumatic microsurgical technique, stating:

> *"Perfection of atraumatic microsurgical technique is best acquired by operating on small-diameter blood vessels (0.8 mm to 1.5 mm) in animals" (29).*

Reflecting on his laboratory experience, he further noted:

> *"The operations I performed on mongrel dogs included re constructions of cortical arteries (patch, graft), operations on the basilar artery via the transclival approach, anastomosis of the carotid to the basilar artery and the lingual artery to the MCA, EC-IC bypass grafts using lengths of femoral artery, and the superficial temporal artery-MCA bypass. They were extremely difficult and tedious operations, but they helped me to develop the necessary skills I needed to apply the technique to humans" (21).*

Following the early clinical implementation of bypass techniques, these methods were widely applied for various indications in the ensuing years, until publication of the Extracranial (EC))–Intracranial (IC) Bypass Cooperative Study in 1985 (3). As the study did not demonstrate efficacy of EC–IC bypass in ischemic stroke prevention, training and routine practice of microvascular anastomosis neglected (29).

3. Microvascular Surgery Training Basics

As the need for microvascular surgery training became clear, key questions emerged regarding training methods, laboratory setup, instructors, trainees, and duration of practice. These issues were extensively addressed in the work of Yaşargil and other microsurgical pioneers, whose publications provide clear guidance for establishing structured microsurgical training programs.

Instrumentation

Instrumentation is critical for successful outcomes; however, it is neither the sole determinant of success nor required to be technologically advanced or costly. In the early years of microsurgery, no instruments were specifically designed for microsurgical use. Julius H. Jacobson addressed this limitation by introducing jeweler's forceps. Even after three decades of practice, he continued to obtain such forceps from jewelry stores in New York at approximately one-twentieth the cost charged by surgical suppliers (9). To assess their suitability for microsurgical use, he devised a simple functional test, stating that *"a useful functional test of a forceps is its ability to pull out a single hair from the back of the hand without the hair slipping or being severed"* (8,10,11).

Donaghy also introduced his own set of microsurgical instruments, which were initially tested in laboratory training and subsequently used in clinical practice (Figure 1) (5,18).

Similarly, Yaşargil relied solely on "jeweler's forceps, a corner broken from a razor blade as a mini-knife, and a sharpened injection needle" during his laboratory experience in Burlington. He also expressed dissatisfaction with the surgical instruments available during the early clinical application of microsurgery and noted that he obtained fine-tipped forceps in six different tip sizes from a watchmaker's shop for only a few dollars (21).

Together, these experiences illustrate that effective microsurgical instrumentation depends less on cost or technological sophistication than on suitability, precision, and thoughtful selection.

Figure 1: Donaghy's original microsurgical instrument set, displayed in front of the R. M. Peardon Donaghy Microvascular and Skull Base Laboratory, Given Building, University of Vermont, illustrating that precise microsurgical technique depends on instrument suitability rather than complexity. Reproduced courtesy of the first author.

Optical Aids and Microscopes

Early in his microvascular anastomosis practice, Jacobson used surgical loupes and simple magnifying devices, which proved inadequate due to limited magnification, illumination, and depth perception. He concluded that precise manipulation of vessels smaller than 3 mm required higher magnification (20×–40×), stereoscopic vision, and coaxial illumination (12,13). These requirements define the fundamental optical principles of microsurgery, all of which were mentioned by Yaşargil and already met by early operative microscopes (23-25,27).

The optical lens quality underlying modern operative microscopes has changed little since the late nineteenth century, when Ernst Abbe, Carl Zeiss, and Otto Schott perfected lens production in Jena, Germany (24,26). These foundational advances enabled the development of early operative microscopes that fulfilled the fundamental optical requirements of microsurgery, and the serial production of the Zeiss OPMI-1 in 1953 therefore marked the beginning of a new era in microsurgery. Subsequent innovations focused primarily on ergonomics, mobility, and functionality rather than fundamental improvements in optical quality.

This principle is exemplified by the continued clinical use of a Yaşargil–Malis prototype free-floating, counterbalanced operative microscope originally developed in 1972 (27). Despite relying on optical principles and lens systems perfected decades earlier by Zeiss engineers, this microscope has supported state-of-the-art microsurgical procedures for decades through ergonomic and functional enhancements alone. It was used clinically by Yaşargil from 1973 to 1993 in Zurich and has remained in active clinical use by Dr. Uğur Türe since 2008 in Istanbul (7,27). During fellowship training at Yeditepe University, the first author directly observed its continued clinical use, allowing first-hand appreciation of the fundamental optical and ergonomic principles of operative microscope design. The microscope was equipped with a mouth switch and ocular heating and was later supplemented with a 4K 3D recording system, which was not available in contemporary commercial microscopes at the time of its introduction.

4. Who Is Qualified to Teach Microvascular Surgery Techniques?

The early history of microsurgery demonstrates that excellence in teaching does not require a medical degree, rather, it demands technical mastery, extensive laboratory training, and sustained dedication. As illustrated by the careers of Esther "Jackie" Roberts, RN, Dr. Donaghy's OR scrub nurse, in Burlington and Rosmarie Frick, Nursing Assistant, in Zurich, effective microsurgical educators emerged through prolonged laboratory training, meticulous technique, and long-term commitment to teaching.

Ms. Roberts learned microvascular anastomosis techniques directly from Drs. Donaghy, Jacobson, and Suarez and played a crucial role in transferring these techniques from the laboratory to the operating room alongside Dr. Donaghy. Over the course of her career, she trained several hundred microsurgeons, including Yaşargil, and nurses in Burlington, many of whom later established microsurgical training centers around the world (18). In recognition of her pivotal contributions, Yaşargil dedicated his first book on microsurgery to her together with the operating room nurses of Zurich (25).

Similarly, Ms. Frick played a central role in microsurgical education in Zurich. Over several decades, she trained thousands of visiting surgeons—including Dr. Uğur Türe—through the Zurich Microsurgery Course and traveled internationally to teach microvascular anastomosis techniques originally developed and refined by Yaşargil (21). Her sustained efforts ensured continuity, standardization, and global dissemination of microsurgical skills across generations and continents. In recognition of her contributions, Dr. Uğur Türe honored her with an honorary doctorate from Yeditepe University in 2017.

It should also be recognized that, at the outset, no established experts existed to teach microsurgical techniques. Early pioneers devoted years to experimentation, failure, and refinement in laboratory settings before applying these methods clinically. We are fortunate that these pioneers shared their experiences through conferences, proceedings, publications, textbooks, and direct instruction, thereby multiplying the impact of their work. As illustrated by Yaşargil's experience, foundational microvascular techniques that took years to master in Burlington, were subsequently learned and applied by others within weeks under structured guidance.

5. Who Is Qualified to Practice Microvascular Surgery?

Historical experience, as demonstrated by the cases of Ms. Roberts and Ms. Frick, shows that success in microvascular surgery training depends on dedication, patience, and sustained concentration rather than professional title.

Our own experience further supports this observation. Thomas M. Staniszewski, an undergraduate student, trained using a basic microsurgery kit guided exclusively by offline instructional videos and achieved one of the most significant performance improvements within the Baskaya Microvascular Bypass Training Curriculum (BMBTC) observed in our laboratory (Figure 2A,B). His progress highlights the impact of disciplined practice and structured guidance, even in the absence of a medical background.

A similar observation was made during the Istanbul Yaşargil Microneurosurgery Course in 2023, where a 13-year-old high school student (Beren Erol), with parental consent and approval of the course instructor, participated out of curiosity and interest in exploring a future career path. Following an initial demonstration by Ms. Frick, course instructor, at the main station and continuous supervision and verbal guidance by the first author (Figure 2C), she practiced knot tying using an stereo microscope for the first time (Figure 2D). On the following day, she performed two end-to-end anastomoses on a prepared rat model that had expired during anesthesia (Figure 2E). Through stepwise instruction and continuous verbal guidance, she demonstrated exemplary technical performance notable for her level of experience.

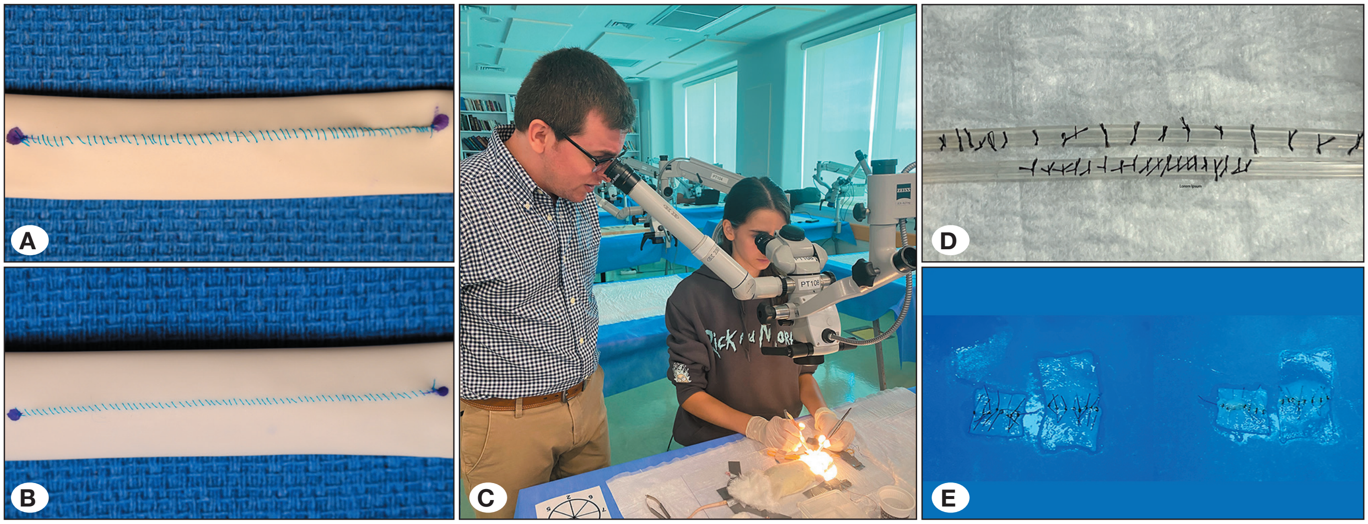

Figure 2: End products from training sessions completed by Thomas M. Staniszewski and Beren Erol **(A)** First practice of continuous suturing on a 6-cm Penrose drain (6-0 suture). **(B)** Tenth practice of continuous suturing on a 6-cm Penrose drain (7-0 suture). **(C)** A 13-year-old high school student (Beren Erol) performs an end-to-end anastomosis on a rat carotid artery under continuous verbal guidance from the first author, who observes the operative field through the assistant observer tube. **(D)** Knot-tying practice demonstrating the first attempt using 6-0 suture (top) and the second attempt using 7-0 suture (bottom). **(E)** End-to-end anastomosis practice on the rat carotid artery (10-0 suture): first (left) and second (right) attempts, with vessels opened to demonstrate the outer surface (top) and inner surface (bottom).

Together, these examples reinforce a consistent lesson drawn from both historical precedent and contemporary practice: the foundational techniques of microsurgery can be taught to individuals of diverse backgrounds when appropriate supervision, structured training, and sufficient dedication are present.

6. How Long Should Laboratory Training Last?

Basic microsurgical training requires sustained practice to convert early procedural familiarity into durable technical skill. Introductory courses provide an essential foundation by teaching the technical steps and principles of microvascular anastomosis, which can often be applied after only a few attempts. However, such courses do not, by themselves, confer true microsurgical skill. The development of refined hand–eye coordination, tissue handling, and consistency requires prolonged, structured laboratory training. Without continued practice, newly acquired microsurgical knowledge and performance may deteriorate within weeks.

Yaşargil consistently emphasized that systematic training in neuroanatomy and microsurgical technique is essential, advising young surgeons to devote at least one year to intensive laboratory training before progressing beyond basic procedures (22). Within this broader educational framework, microvascular anastomosis training constitutes only one component; however, it remains a uniquely demanding and indispensable element of comprehensive microsurgical education.

PRINCIPLES APPLIED

Lessons from the historical development of microsurgery and the experiences of its pioneers define enduring principles that can be deliberately applied to contemporary microsurgical training. When translated into practice, these principles provide a structured framework for teaching, learning, and assessing microsurgical skills across both local and global settings.

The Başkaya Laboratory Fellowship Program

Initiated by Mustafa K. Başkaya in 2006, the Başkaya Laboratory Fellowship Program offers immersive, longitudinal training that integrates microsurgical skill acquisition with neuroanatomy, cadaveric dissection, and clinical observation (15,20). Centered on hands-on laboratory practice, the program combines structured BMBTC training, objective self-assessment, and progressive cadaveric and clinical exposure within a mentorship-driven framework that supports trainees from diverse backgrounds and training levels.

The Başkaya Microvascular Bypass Training Curriculum

The BMBTC was developed to provide a structured, progressive approach to microsuturing and microvascular anastomosis training. Informed by the intensive laboratory training models of early microsurgery—particularly those of Yaşargil and Donaghy—the curriculum emphasizes microsuturing as a fundamental, transferable skill across neurosurgical practice. Introduced by Mustafa K. Başkaya in 2006 and revised in 2021, BMBTC employs a stepwise progression from synthetic models to biological microvascular anastomosis, enabling gradual adaptation to increasing technical complexity, finer sutures, and higher magnification (16,17). This staged design reinforces deliberate practice, standardization, and effective skill transfer from laboratory to clinical microsurgery.

Madison Objective Self-Assessment Tool (MOST)

MOST was developed around foundational principles of surgical education that emphasize self-assessment, systematic training, and professional competence. Max Brödel emphasized that learning is incomplete without self-investigation, requiring the ability to critically evaluate one's own work, while Yaşargil stressed that true competence arises from systematic laboratory training and objective qualification.

Guided by these principles, MOST was created through a focused review of the microsurgical training literature, identifying key qualitative and quantitative performance metrics and integrating them into a structured, user-friendly self-assessment tool (14,16,17). By enabling trainees to objectively evaluate microsurgical end products against standardized reference values, MOST supports deliberate practice, continuous improvement, and responsible skill acquisition, particularly in settings with limited expert supervision.

Basic Microvascular Surgery Training Kit

We developed a basic training kit to apply core principles of microsurgical training using cost-effective, high-quality equipment (Figure 3). Systematic evaluation of surplus tabletop microscopes, light sources, and basic instruments showed that high-quality microvascular training is achievable when essential optical and functional requirements are met. The kit prioritizes magnification, stereoscopic vision, illumination, and instrument suitability, enabling structured practice across diverse training settings (14,17).

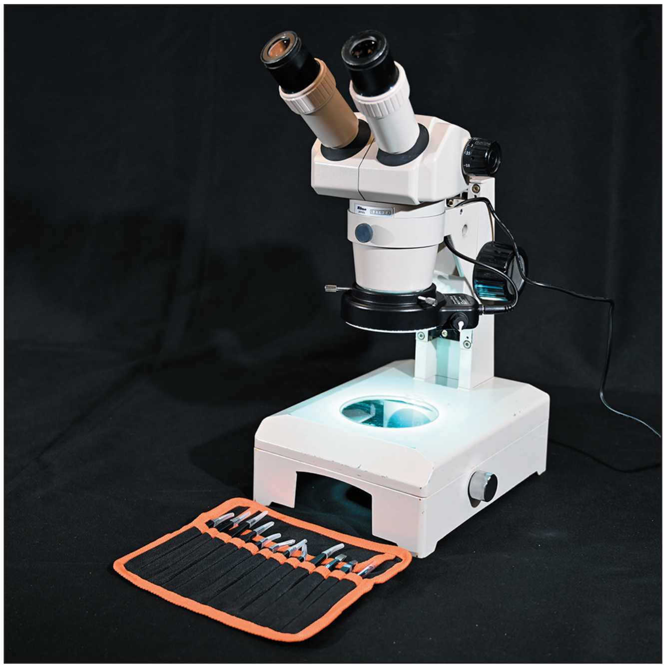

Figure 3: Basic microvascular surgery training kit for microvascular anastomosis practice. Components include a tabletop stereoscopic microscope with high optical quality and magnification (available for as low as $13.50), an LED light source (as low as $25), and basic tweezer set (as low as $10).

PRACTICES IMPLEMENTED

Global Neurosurgery

Neurosurgery has been global since its inception, with knowledge advancing through international training and exchange. Harvey Cushing and Yaşargil exemplified this model, which enabled the dissemination, refinement, and multiplication of microsurgical techniques across generations and centers worldwide (1,21,29).

While the term global neurosurgery has gained prominence only in the past decade, the concept itself is longstanding (19). Since the late 1960s, initiatives such as the Foundation for International Education in Neurosurgery have addressed disparities in neurosurgical care, increasingly emphasizing sustainable capacity building, structured training, and local empowerment over short-term knowledge transfer (3,4).

Although initially less accessible, surgeons from low- and middle-income countries (LMICs) participated in early microsurgical knowledge exchange. The 4th Microneurosurgery Conference, held in Montreal and Burlington, welcomed participants from 23 countries, including Thailand, India, Kenya, South Africa, Chile, and Venezuela, who later contributed to the formative development of microneurosurgery and disseminated these techniques within their home institutions (Figure 4) (2).

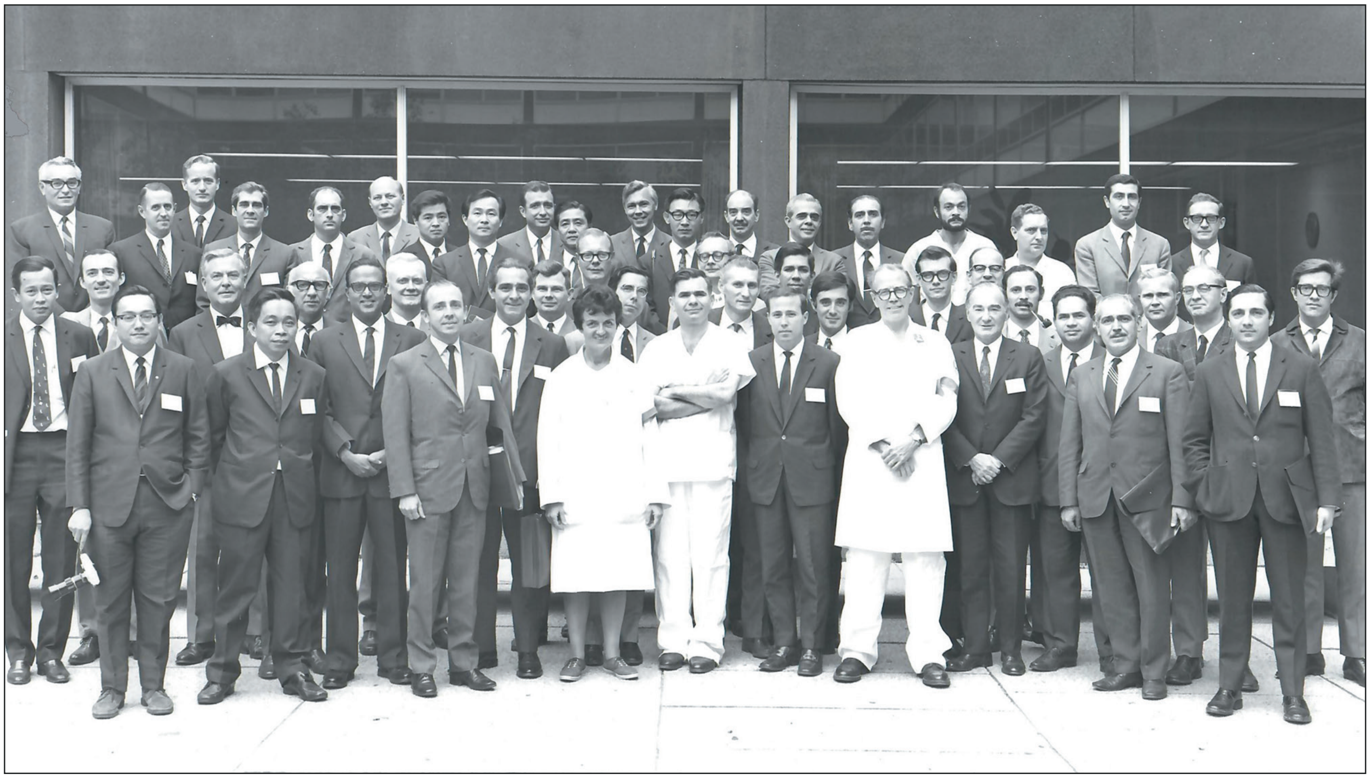

Figure 4: Group photograph of neurosurgeons who attended the 4th Microneurosurgery Conference, taken in Burlington. Fifty neurosurgeons from 23 countries participated in the meeting, held at the University of Montreal (September 29–30, 1969) and the University of Vermont (October 1–3, 1969). Reproduced courtesy of the first author.

Challenges in Global Microsurgical Laboratory Training

Although microsurgical techniques have reshaped neurosurgery for decades, their global adoption remains uneven. Limited laboratory infrastructure and trained personnel—rather than lack of published knowledge—continue to restrict access to hands-on microsurgical training, particularly in LMICs, where microneurosurgery often remains the primary treatment option.

Madison Microneurosurgery Initiative (MMI)

Recognizing the persistent global gap in microsurgical training, M. Gazi Yaşargil articulated a direct call to action during his address at the 2019 World Federation of Neurosurgical Societies Congress. Reflecting on his earlier experiences, he stated:

> *"In the 1990s, I visited Dr. Feng in China and saw their perfection in practicing bypass techniques on mice. I discussed with my colleagues the need to establish an initiative to spread these techniques to all departments. But I didn't have the time and energy to do it." He concluded with a broader appeal to the neurosurgical community: "I hope this congress brings responsible colleagues together to revisit this issue—because time is asking for this" (28)*

Motivated by this call and personal experience in microsurgical training (Figure 5), the MMI was established by the first author under the guidance of Drs. Mustafa K. Başkaya and Robert J. Dempsey to translate Yaşargil's vision into practice through structured, accessible, and sustainable microsurgical training for global dissemination (14-17).

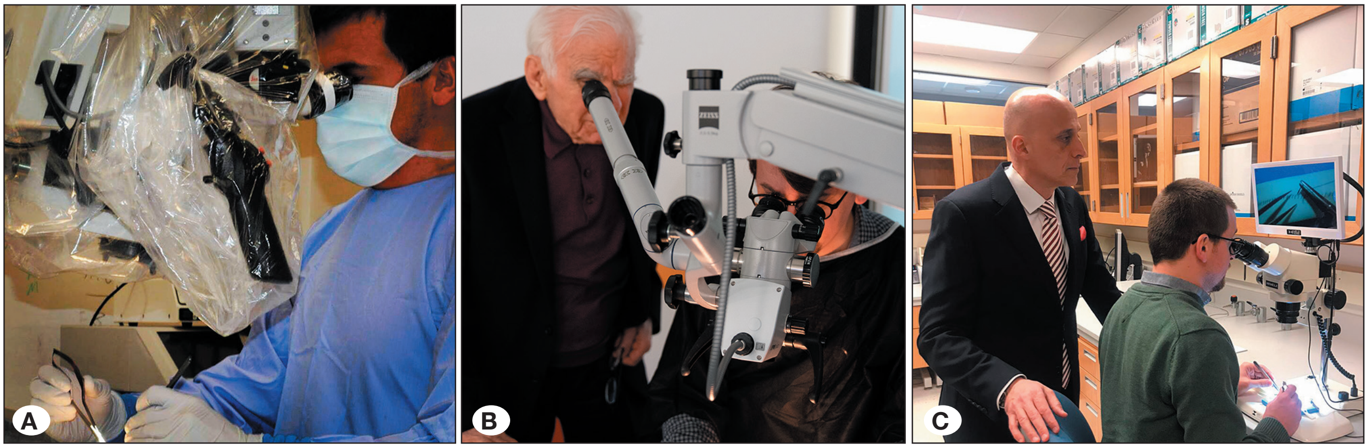

Figure 5: Representative microsurgical laboratory training experiences of the first author. **(A)** Initial microsurgical laboratory training during the summer of 2013, undertaken while the first author was a medical student at Istanbul University during a visiting research period at the Mustafa K. Başkaya Laboratory. Training included arachnoid membrane and vessel dissection and cleaning on more than 20 cerebral hemispheres used for a research study (3) (Madison, Wisconsin). **(B)** Yaşargil observing the first author during microvascular anastomosis training through the observer tube of the operating microscope at the 10th Istanbul Yaşargil Microneurosurgery Course, Part I (Microanastomosis), instructed by Rosmarie Frick at Yeditepe University Koşuyolu Hospital (June 2019, Istanbul, Turkey). **(C)** Continued hands-on microsurgical laboratory training under Mustafa K. Başkaya beginning in October 2019 (photograph from early 2020, Madison, Wisconsin).

The conceptualization and implementation of the MMI were further shaped by the extensive experience of Drs. Mustafa K. Başkaya and Robert J. Dempsey in laboratory-based microsurgical education and global neurosurgery, the department's international fellowship program, and the first author's direct academic interaction with Yaşargil during fellowship training at Yeditepe University. This first-hand exposure to the foundational era of microneurosurgery and its underlying philosophy provided historical continuity and perspective, which have continued to inform the first author's vision and subsequent work. In addition, the first author was exposed on a daily basis to the clinical and laboratory practices of two master microneurosurgeons—spending approximately 2.5 years with Dr. Uğur Türe at Yeditepe University and, since October 2019, with Mustafa K. Başkaya at the University of Wisconsin–Madison—observing the direct translation of sustained laboratory training into contemporary microsurgical practice, an experience that further shaped the first author's vision and subsequent work.

Microsurgery Training Kit Donations

Through the MMI donation program, basic microsurgery training kits were distributed to 86 centers across 45 LMICs in Africa, Asia, Europe, North America, and South America (Figure 6) (14,17). In total, 173 microscopes, including 169 basic stereo microscopes with high-quality optics, three Zeiss OPMI-1 operative microscopes, and one colposcope, together with associated training kits, advanced training and surgical instrument sets, were donated by the end of 2025. All microscopes were initially

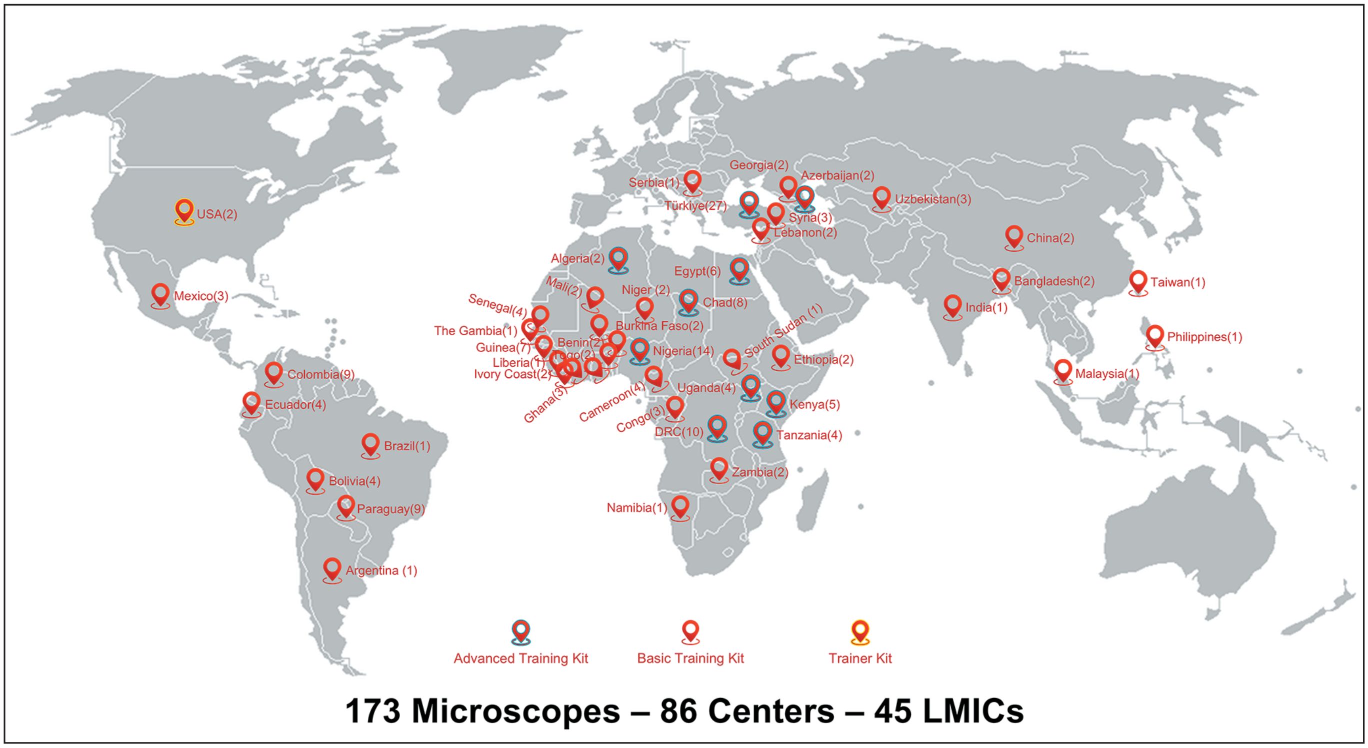

Figure 6: World map illustrating the global distribution of microsurgery training kits donated through the MMI. Each of the 45 LMICs supported is labeled with the corresponding number of microsurgery training kits donated. By the end of 2025, a total of 173 microsurgery training kits had been distributed, highlighting the scale and geographic breadth of global microsurgical capacity-building efforts.

purchased by the first author, with retrospective reimbursement for 22 units provided by one non-governmental organization and one individual donor. Delivery and distribution were accomplished through collaboration with multiple individuals and non-governmental organizations, as well as the direct logistical efforts of the first author. Kit allocation ranged from single units supporting emerging programs to larger distributions at institutional training laboratories, reflecting a capacity-building strategy tailored to local needs.

Offline Training Support

To complement equipment donations, MMI provided participating centers with offline training resources, structured BMBTC and MOST demonstration videos, designed to enable basic microsurgical training and self-assessment without expert supervision (14,16,17). These materials allow trainees to independently acquire foundational techniques and evaluate their results using MOST, without reliance on on-site expertise. The same offline resources have been used routinely in our laboratory for more than three years to support visiting scholars, facilitating independent practice and reinforcing teaching skills required for trainees who will establish and lead microsurgical training programs upon returning to their home institutions. Together, kit donations and offline resources support self-directed practice, objective performance evaluation, and iterative improvement, providing a practical framework for establishing and sustaining local microsurgical training programs.

Live-Streamed Training Support

To extend mentorship beyond physical boundaries and reinforce local training efforts, MMI implemented live-streamed microsurgical training sessions focused on microanastomosis techniques based on the BMBTC and supported by MOST. Following training kit distribution, 12 live-streamed sessions were conducted with faculty and participants from Türkiye, Paraguay, Lebanon, Bangladesh, and Chad, collectively training over a hundred neurosurgeons (14,16,17). These sessions integrated didactic lectures on the historical foundations and contemporary relevance of microsurgical training with real-time demonstrations and interactive discussion. All sessions were recorded and shared with participants, enabling offline review and supporting sustained, independent microsurgical training at participating institutions.

In-Person Training Support

To further support selected partner centers and encourage local microsurgical training initiatives, we developed the Slingshot Program, a mobile, no-cost, hands-on basic microvascular anastomosis training model. The first author traveled with 10–15 microscope workstations to partner institutions or convened participants from multiple LMICs at a single host center (Boston, USA) to deliver intensive in-person training focused on foundational microanastomosis techniques. Through this program, 16 Slingshot courses were conducted across seven countries (Türkiye, Georgia, Azerbaijan, Paraguay, Mexico, the Democratic Republic of Congo, and the United States), training more than 300 participants from multiple surgical specialties, including neurosurgery, general surgery, orthopedics, and plastic surgery. At each site with a residency program, training kits and self-directed educational resources were donated to support continued practice and local capacity building following course completion.

The design and execution of the Slingshot Program deliberately echo the principles underlying the first hands-on microsurgical course organized by Yaşargil in Zurich in 1968. As Yaşargil recalled, that inaugural course was conducted not in a dedicated surgical laboratory but in the pathology department, using borrowed operating microscopes from Zeiss and basic jeweler's instruments (26). Similarly, the Slingshot Program relies on basic yet functionally high optic quality microscopes, portable training setups assembled independently rather than institutionally owned, and nontraditional training spaces, most commonly conference rooms adapted for hands-on practice. In place of some jeweler's forceps, we used our cost-effective tweezer sets for microsurgical training. These shared characteristics reflect a common principle: effective microsurgical education depends not on sophisticated infrastructure, but on thoughtful adaptation of available resources to create focused, hands-on learning environments.

Operative Microscope and Surgical Equipment Donations

Inspired by the pioneering era of microsurgery, we identified and procured high-quality Zeiss operative microscopes (OPMI-1) originally manufactured between the 1950s and 1970s, a period during which such systems were widely used in high-income countries for routine clinical neurosurgical practice. Acquired through surplus sources for $270, $68, and $150, these microscopes were designed for durability, mechanical reliability, and stable optical performance, with minimal reliance on complex electronics and low maintenance requirements. Following cleaning, refurbishment, and basic upgrades to enable video recording, the microscopes were donated to partner centers in Chad, Guinea, and Nigeria.

In the Nigerian example, the recipient fellow completed structured microsurgical laboratory training using the BMBTC and cadaveric dissections covering major cranial approaches in our laboratory before returning to his home institution with the donated microscope (Figure 7,8). To facilitate transport, all microscopes were fully disassembled, and only the optical head and articulated arm were transported in standard suitcases, as the original bases were prohibitively heavy. This limitation necessitated the local design and fabrication of new supporting bases, an adaptation that was successfully implemented in both Chad and Nigeria. In Chad, the donated microscope has already been integrated into routine clinical neurosurgical practice, while similar sustainable clinical implementation is ongoing at the remaining centers under locally adapted conditions.

Figure 7: The first author is shown testing the Zeiss OPMI-1 operating microscope on a full-body cadaver prepared in a laboratory setting simulating the operating room environment. A visiting neurosurgeon from Nigeria subsequently completed training in various microsurgical and skull base approaches using this microscope, with procedures recorded through the attached camera system. Upon completion of training and prior to returning to his home institution, the same operative microscope and advanced neurosurgical instrument sets were donated to support his clinical practice in Nigeria.

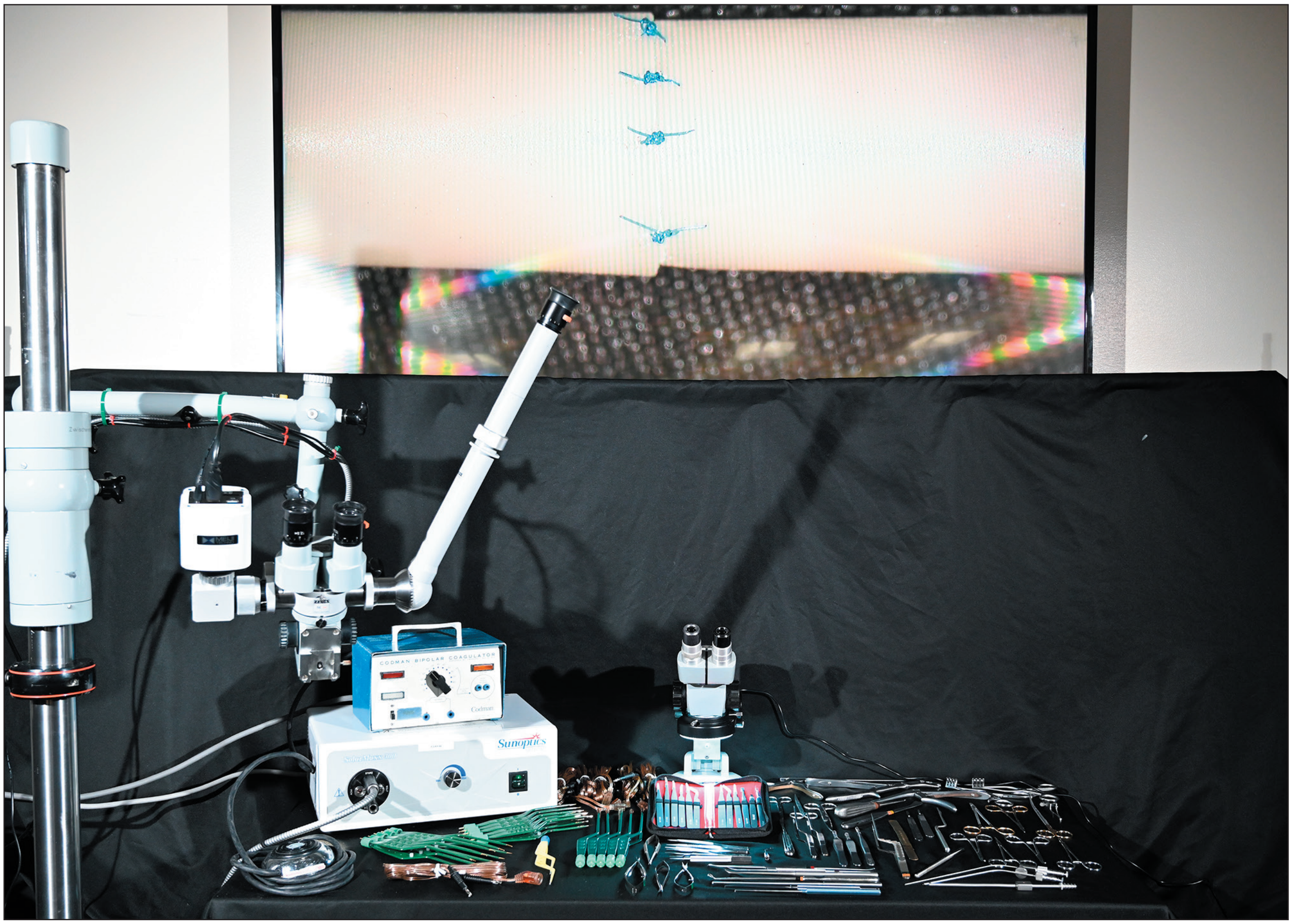

Figure 8: Operative microscope and surgical equipment donated following laboratory-based training. Shown is a Zeiss OPMI-1 operative microscope updated with a recording camera and an external xenon light source, together with a Malis bipolar coagulator and 15 gold-tip bipolar forceps of varying sizes and lengths. The setup also includes a basic microsurgery training kit and advanced neurosurgical instrument sets. On the wall-mounted monitor, a Penrose drain positioned under the operating microscope is visualized and projected in real time via the microscope camera, illustrating integrated microsurgical training and video documentation. This complete setup was used for training in our laboratory and subsequently donated in its entirety to a visiting neurosurgeon from Nigeria.

In parallel with operative microscope donations, extensive sets of high-quality advanced neurosurgical instruments were donated to these and additional partner centers to enable the performance of complex microsurgical procedures using state-of-the-art instrumentation. Compared with the limited instrument sets available during the pioneering era of microsurgery, these comprehensive modern sets substantially enhance operative capability when paired with durable microscopes, reinforcing the translation of laboratory training into contemporary clinical practice.

Advocacy

A core component of the MMI has been sustained advocacy for laboratory-based microsurgical training. This advocacy has taken multiple forms, including peer-reviewed publications, online webinar platforms, and presentations at national and international neurosurgical meetings such as the American Association of Neurological Surgeons, Congress of Neurological Surgeons, World Federation of Neurosurgical Societies, European Association of Neurosurgical Societies, and Continental Association of African Neurosurgical Societies. Through these venues, we have aimed to share practical experience, lower perceived barriers to entry, and reinforce the enduring value of structured laboratory training.

This effort directly echoes the lifelong mission articulated by Yaşargil, who stated:

> *"The quintessence of my 33-year-long mission has been to convince my neurosurgical colleagues (Figs. 15A and 17-22) of the absolute necessity of laboratory training in microtechniques before their application to humans in the operating room" (21).*

Figure 9: Presentation of the 2024 Global Neurosurgery Paper Award at the annual Congress of Neurological Surgeons Meeting on October 12, 2025, in Los Angeles, California. Shown from left to right are Mustafa K. Başkaya, MD, the first author holding the award, and Robert J. Dempsey, MD, following the award presentation.

Even for Yaşargil, advancing this message required decades of persistence. Recognizing these challenges, our advocacy has focused not only on emphasizing the importance of laboratory training, but also on removing practical obstacles by providing accessible training kits, structured curricula, objective assessment tool, and direct instructional support. Our approach emphasizes capacity building rather than short-term intervention, enabling institutions to independently initiate and sustain microsurgical laboratory training.

In summary, the MMI has translated foundational microsurgical principles into practical, scalable training strategies implemented across 86 centers in 45 LMICs. Guided by our direct field experience—and inspired by the pioneering achievements and educational philosophy of Yaşargil, as well as encouraged by his guidance—these efforts demonstrate how microsurgical principles can be effectively applied on a global scale. Through training kit donations, offline and live-streamed training support, in-person hands-on programs, and operative microscope training and donations, we have shown that effective microsurgical education can be achieved through thoughtful adaptation of available resources. Our ultimate goal is to publish, inspire, and guide, enabling colleagues worldwide to draw from our experience and initiate similar programs in their own institutions. This process is already underway, as multiple centers have reached out following our initial publications to adapt and apply these principles within their local contexts.

In reflecting on the broader meaning of our efforts, we are mindful that progress in microsurgery has always been built incrementally, through disciplined training and perseverance across generations. Yaşargil once captured this philosophy metaphorically while describing a climb in the Swiss Alps: *"I accomplished a micro-climb on a well-installed pathway in the Swiss Alps (Stoos, 1600 m). To the younger generation, I wish courage and hard work to pass to higher levels"*. We believe that our work represents another small step forward on this well-installed pathway—as a commitment to his achievements and an effort aimed at enabling future surgeons and institutions worldwide to ascend further through structured training, sustained effort, and shared responsibility. In this context, we consider the selection of our initial publication as the 2024 Global Neurosurgery Paper by the Congress of Neurological Surgeons to reflect the enduring relevance of Yaşargil's legacy rather than individual achievement (Figure 9).

Declarations

Funding: The authors declare no competing financial interests and no sources of funding or support for this work.

Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Disclosure: The authors declare no competing interests.

AUTHORSHIP CONTRIBUTION

Study conception and design: AK, MKB
Data collection: AK
Analysis and interpretation of results: AK
Draft manuscript preparation: AK
Critical revision of the article: AK
All authors (AK, MKB) reviewed the results and approved the final version of the manuscript.

REFERENCES

1. Alexander E Jr, Alexander E 3rd: German Influences on the Work of Harvey Cushing, the Pioneer of Neurosurgery in America. Neurosurgery 9: 501-505, 1981. https://doi.org/10.1227/00006123-198111000-00002
2. Care Pa: International micro-neurosurgery course. Progress and Care 19 1969.
3. Dempsey RJ, Nakaji P: Foundation for International Education in Neurological Surgery (FIENS) global health and neurosurgical volunteerism. Neurosurgery 73: 1070-1071, 2013. https://doi.org/10.1227/neu.0000000000000136
4. Dempsey RJ: Global neurosurgery: the role of the individual neurosurgeon, the Foundation for International Education in Neurological Surgery, and “service through education” to address worldwide need. Neurosurg Focus 45: E19, 2018. https://doi.org/10.3171/2018.7.Focus18363
5. Donaghy RMP: History of micro-neurosurgery. In: Wilkins RH, Rengachary SS (eds) Neurosurgery. vol 1. McGraw-Hill New York, NY, 1996: 37-42
6. Group TEIBS: Failure of extracranial–intracranial arterial bypass to reduce the risk of ischemic stroke. N Engl J Med 313: 1191-1200, 1985. https://doi.org/10.1056/NEJM198511073131904
7. Harput MV, Ture U: Commentary: First-in-man clinical experience using a high-definition 3-dimensional exoscope system for microneurosurgery. Oper Neurosurg 17: E85-E87, 2019. https://doi.org/10.1093/ons/opz067
8. Jacobson J: The development of microsurgical technique. In: Donaghy PR, Yaşargil MG (eds) Micro-vascular surgery: Report of first conference, Oct. 6 - 7, 1966, Mary Fletcher Hospital, Burlington, Vermont. Georg Thieme Verlag Stuttgart, 1967.
9. Jacobson JH: The early days of microsurgery in Vermont. Mt Sinai J Med 64: 160-163, 1997.
10. Jacobson JH: Microsurgery. Curr Probl Surg 8: 1-56, 1971. https://doi.org/10.1016/S0011-3840(71)80006-0
11. Jacobson JH: Microsurgical Technique. In: Cooper P (ed) The Craft of Surgery. Little, Brown and Company Boston, 1964: 826-847.
12. Jacobson JH, Suarez EL: Microsurgery - application to organ transplantation. Trans Am Soc Artif Intern Organs 7: 301-305, 1961.
13. Jacobson JH, Suarez EL: Microsurgery in anastomosis of small vessels. Surg Forum 11: 243-246, 1960.
14. Keles A, Cancela AA, Moussalem CK, Kessely YC, Malazonia Z, Shah JM, Gurbuz MS, Gasimov T, Adekanmbi A, Bari MS, Dumot C, Oriola GG, Golidtum JPU, Bin Mohd Nor MA, Omar AH, Ozaydin B, Patel NJ, Dempsey RJ, Baskaya MK: A novel approach for free, affordable, and sustainable microsurgery laboratory training for low-and middle-income countries: University of Wisconsin-Madison Microneurosurgery Laboratory experience. Neurosurgery 94: 1311-1323, 2024. https://doi.org/10.1227/neu.0000000000002814
15. Keles A, Bozdag S, Ozaydin B, Dempsey RJ, Baskaya MK: Addressing global microneurosurgery education and laboratory training during and after the COVID-19 pandemic: from challenges to innovations. Neurosurg Focus 58: E11, 2025. https://doi.org/10.3171/2024.12.FOCUS24829
16. Keles A, Dumot C, Hatipoglu Majernik G, Chebel R, Gurbuz MS, Gasimov TA, Oriola GG, Elbayomy AM, Acitores Cancela A, Erginoglu U, Ozaydin B, Martinez Santos JL, Baskaya MK: Madison objective self-assessment tool: a reliable and user-friendly approach for objective self-assessment in microvascular anastomosis training. Neurosurg Pract 6: e000181, 2025. https://doi.org/10.1227/neuprac.0000000000000181
17. Keles A, Greeneway GP, Dempsey RJ, Baskaya MK: Establishing microsurgery skills laboratories in low-and middle-income countries with integrated remote teaching: a novel approach. Neurosurgery Clinics 35: 449-463, 2024. https://doi.org/10.1016/j.nec.2024.05.007
18. Maroon JC, Roberts E, Numoto M, Donaghy RP: Microvascular surgery: simplified instrumentation. J Neurosurg 38: 119-124, 1973. https://doi.org/10.3171/jns.1973.38.1.0119
19. Paradie E, Warman PI, Waguia-Kouam R, Seas A, Qiu L, Shlobin NA, Carpenter K, Hughes J, von Isenburg M, Haglund MM, Fuller AT, Ukachukwu AK: The scope, growth, and inequities of the global neurosurgery literature: A bibliometric analysis. World Neurosurg 167: E670-E684, 2022. https://doi.org/10.1016/j.wneu.2022.08.074
20. Sayyahmelli S, Kessely YC, Chen X, Aycan A, Feldman S, Dempsey RJ, Baskaya MK: From Ibni Sina (Avicenna) to present, history of international fellowship and observership: University of Wisconsin-Madison experience. Turk Neurosurg 30: 159-162, 2020. https://doi.org/10.5137/1019-5149.Jtn.28738-19.0
21. Yaşargil MG: A legacy of microneurosurgery: memoirs, lessons, and axioms. Neurosurgery 45: 1025, 1999. https://doi.org/10.1097/00006123-199911000-00014
22. Yaşargil MG: From the microsurgical laboratory to the operating theatre. Acta Neurochir 147: 465-468, 2005. https://doi.org/10.1007/s00701-005-0519-1
23. Yaşargil MG: Intracranial microsurgery. Proc R Soc Med 65:15-16, 1972. https://doi.org/10.1177/003591577206500106
24. Yaşargil MG: Microneurosurgery: Principles, applications, and training. In: Sindou M (ed), Practical Handbook of Neurosurgery From Leading Neurosurgeons. Springer Verlag New York, NY, 2009: 79-94
25. Yaşargil MG: Microsurgery: applied to neurosurgery. Georg Thieme Verlag Stuttgart, 1969
26. Yaşargil MG: Personal considerations on the history of microneurosurgery. J Neurosurg 112: 1163-1175, 2010. https://doi.org/10.3171/2010.3.JNS091124a.
27. Yaşargil MG: The history of optical instruments and microneurosurgery. In: Barrow DL, Kondziolka DS, Laws ER, Traynelis VC (eds), Fifty Years of Neurosurgery. Lippincott Williams & Wilkins Baltimore, MD, 2000
28. Yaşargil M: Plenary Session. 2019 WFNS Special World Congress Beijing, China, 2019
29. Yonekawa Y, Frick R, Roth P, Taub E, Imhof H-G: Laboratory training in microsurgical techniques and microvascular anastomosis. Operative Techniques in Neurosurgery 3: 149-158, 1999. https://doi.org/10.1016/S1092-440X(99)80007-3

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Invited Special Article

In Memoriam: Professor M. Gazi Yaşargil

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I consider it an honor to have been included among those asked to write and honor the memory of Gazi Yaşargil (Figure 1). My first encounter with him occurred when I was a student at Northwestern University Medical School. I worked in the laboratory of Dr. Bucy, who was a giant in academic neurosurgery at that time, and I attended every neurosurgery meeting and lecture. When I asked Dr. Bucy to recommend a place where I could gain some international exposure to a prominent neurosurgical center, he recommended Zurich, Switzerland, where his good friend Hugo Krayenbuel was in charge, and where there was a rising star named Gazi Yaşargil.

Even though, as a fourth-year medical student, I was incapable of appreciating the subtleties of microsurgery, it became very apparent to me that microsurgery was a powerful technique for achieving maximal surgical results. I remember vividly an occasion on which Professor Krayenbuhl, having operated on a pituitary tumor, was very satisfied with what he had removed through a craniotomy but then asked Gazi to bring his microscope to see whether he could remove more tumor. It was most instructive to see how much more tumor Gazi removed. Although Krayenbuhl was very much an autocratic chief, as was common during that time, and frequently treated his staff in a dismissive manner, he recognized Yaşargil's promise and supported his vision interna-

Figure 1: Gazi Yaşargil as visiting professor at Barrow Neurological Institute.

tionally. My visit to Zurich was very formative, and I was convinced that my future endeavor would be to dedicate myself to this new specialty of microneurosurgery.

During my residency at the University of California in San Francisco, I convinced my chief, Dr. Charles Wilson, to allow me to spend six months in Europe visiting three neurosurgical centers. The first was in Munich, where I did some research with Dr. Peter Schmidek at the Max Planck Institute. My wife and I formed a lifelong friendship with Peter. The second neurosurgical center that I visited was in Vienna, where I became a close friend of Professor Wolfgang Koos, with whom I collaborated on several books and atlases. And the third visit was to Zurich, where Gazi was now chief, and I was in a much better position to appreciate the artistry of his surgery (Figure 2). I made it my goal to copy to the very best of my abilities his surgical technique. It was a great visit, punctuated with watching prominent neurosurgeons be kicked out of Yaşargil's operating room for talking or for getting up from the little bench to which all visitors were assigned. Yaşargil's short fuse was always present and could be ignited with the smallest provocation. It was part of who he was, but he also used this intensity to focus on his surgical challenges and routinely achieved success where others failed. The word "genius" has become overused but is appropriately applied to Gazi Yaşargil (Figure 3).

Dr. Joe Maroon, president of the Congress of Neurological Surgeons (CNS), invited Gazi to be the honored guest for the meeting in New Orleans in 1986. Joe assigned Nancy and me to be the hosts for the Yaşargils. This required being sure there were fresh apples in his presidential suite and being available for any request that the Yaşargils might make. As it turned out, the CNS had a black-tie dinner, and Gazi did not have appropriate attire; thus, Nancy and I took them to get measured to rent a tuxedo and buy a shirt, shoes, tie, and so on, all on CNS's dime (Figure 4).

The shop sent the tuxedo to the hotel the next day by cab. Nancy was waiting in front of the hotel to receive it; however, the cab driver went to the service entry instead, called Yaşargil's room, and asked him to come down to get the tux. Gazi instead told the driver "I don't do that," which made the driver upset, and he left mad (and with the tuxedo). In the meantime, Nancy became concerned since the cab had not arrived where she was waiting; finally, she asked the staff and was told that a cab had indeed come and left. They were able to contact the driver, and he returned and was mollified with a big tip. A stressful episode for my lovely wife!

There was one evening that was free, so we invited the Yaşargils to our travel club dinner (Figure 5). Gazi and Diane greatly enjoyed the relaxed atmosphere with our friends, and for many years thereafter he would comment on how much he had enjoyed this evening and the camaraderie that was present.

Figure 2: The Yaşargils and Spetzlers in Brazil at the spectacular Iguazu falls.

Figure 3: In Morocco on the occasion of Gazi Yaşargil's 80th birthday.

Figure 4: Gazi Yaşargil in his tuxedo in New Orleans at the CNS meeting in 1986.

Gazi was the visiting professor at the Barrow Neurological Institute in Phoenix several years later, where he stayed with us and was a most gracious guest (Figure 6). For years, he would bring gifts to me for our two children. Our paths crossed many times during the years. He was blessed to have Diane at his side. Not only was she the ultimate scrub nurse, but she was also extremely gracious and frequently smoothed over social upsets instigated by her mercurial husband. For me personally, he was always my neurosurgical idol, whose surgical virtuosity remained my elusive goal. He is and will be missed, but his legacy has affected our field in such a way that countless patients have benefitted from the innovations he brought and the surgical techniques that are imitated worldwide. He remains my neurosurgical idol.

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Figure 5: At our travel club dinner in New Orleans.

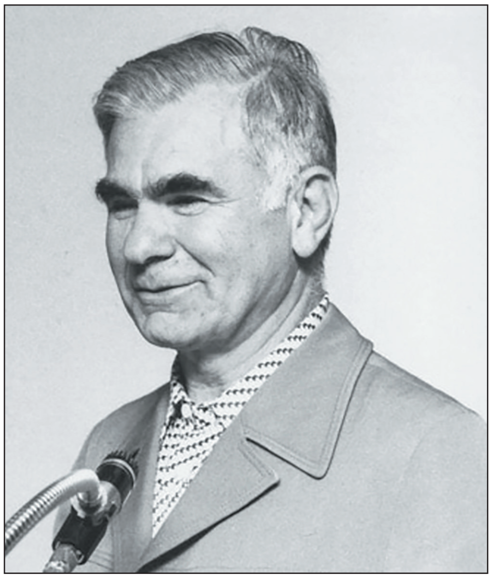

Figure 6: Gazi Yaşargil had a sly, clever sense of humor that can be appreciated in this picture taken during his visit to Phoenix.

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Invited Special Article

To be an Intelectual of the Brain

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The year is 2025… after June 10th…

On a sunny day in Stäfa, Zurich—amid the joyful shouts of children playing by the lake, surrounded by sunflowers—we are speaking about you. We are remembering your life, your plans, your contributions—your “magnificent century,” shaped by your labor, your sweat, and your intellect.

“Children grow up the day their fathers leave”…

June 10, 2025…

It feels as though that day is also the beginning of my own journey in this vast world.

This story, in truth, begins with a disappointment in 1990…

At that time, I was a young resident in my twenties. I did not yet fully understand what lay ahead, but sensed that the road to understanding would be long and difficult. In my hand was a simple two-line address in Zurich—Prof. Dr. M. Gazi Yaşargil, a name spoken everywhere with reverence.

On one side stood the fear of the unknown—the obstacles, the sacrifices, what would have to be left behind. On the other, I placed my hopes into a short letter and sent it to you, uncertain whether I would ever be accepted. Years later, when I told you how devastated I had been to receive your reply—“Unfortunately, the period you wish to come is not suitable…”— When I later told you about it, it made you smile slightly. I remember it as if it were yesterday.

If being an intellectual of the brain means making the problems of humanity your own, then you embodied that ideal. You dedicated a century to this cause. In striving to help every patient, you sacrificed your personal life for the advancement of neurosurgery—and never once complained. We are all witnesses to this.

Sometimes I wonder: what did a young resident in their twenties mean to you in those years? There were dozens, hundreds of students in your school, and yet you devoted yourself to each one—tirelessly, relentlessly—for decades.

From now on, every sentence you spoke will need to be reconsidered, every word revisited. We will continue to work to carry your teachings forward. Because you achieved not only the difficult, but the seemingly impossible, I will always strive to honor the promise I made—to do my part.

You once said: “Everyone has a story, and each is difficult in its own way… but not impossible.” Perhaps that is why you never had time to feel the weariness of years. You were right: “Our work is an endless preoccupation—we do not even fully know what we are fighting against. It is a war with no final victory. We are not commanders, but soldiers, fighting with infinite patience.” And also: “The neurosurgeon’s brain is the product of millions of years of evolution, and that collective intellectual power is focused on saving one patient’s brain at a time.”

From you, I learned that even in failure, there are lessons—and that those lessons belong to future patients. I understood that to know, one must strive; to strive, one must question; and that our work must be done with integrity in the present—not postponed "for the sake of those who come after us."

You illuminated future centuries within your own.

In my journey—one that began by observing your surgeries—your presence beside me in every operation for twenty years after 2005 was a gift beyond measure. I often feared betraying your trust, yet I never allowed myself to step back.

This may seem like your story, but it is also the shared destiny of those who shape human history. It is the story of individuals who carry light within them, who work for humanity, who transform the impossible into reality, and who strive to spread that light.

Through your life, you showed us that doubt is only the beginning; that what is visible is the easiest part to grasp; and that true understanding lies in perceiving—and feeling—what is unseen, without ever departing from the scientific, ethical, and moral path.

I am grateful to have shared an eternal time with you, the last "soldier" of an unending struggle, armored by time itself, prepared for every battle with what felt like a blessing from another era.

For the words I never spoke, and for the letters I never wrote, I want to confess this: by allowing me to walk beside you, you did more than guide my path—you saved my life.

I am grateful for the courage you gave me to seek answers, to test my limits, and to discover the purpose I will carry forward.

It has been an honor beyond measure.

And for that, I am grateful to life itself.

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Editorial

Invited Special Articles