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Microscopic and Endoscopic Skull Base Approaches Hands-On Cadaver Course at 30: Historical Vignette

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Key words
- Cadaver
- Course
- Education
- Neurosurgery
- Skull base
- Training

Abbreviations and Acronyms
PASE: Practical Anatomy and Surgical Education

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Laboratory-based cadaveric training is essential for the development and refinement of neurosurgical technical skills in the operating room and has become an integral training component around the world. Postresidency fellowship—the first pillar of skull base surgery training—includes both hands-on clinical care and surgery supervised by an experienced skull base surgeon. Time is spent in a skull base laboratory practicing approaches and developing anatomic mastery. The second pillar includes formal skull-base courses—institutional dissection laboratories provide continuous anatomic and surgical education while complementary annual or semiannual cadaver courses gather recognized experts to share their knowledge and experience in an essential 2- to 3-day setting.

In this paper, we present the history of the longest running annual skull-base cadaver microsurgical course, which was started by Dr. Ossama Al-Mefty: Annual Surgical Approaches to the Skull Base Course. At the Microscopic and Endoscopic Hands-on Cadaver Workshop, held in St. Louis, Missouri, we celebrated its 30th anniversary in April 2019. We also present the impact this course has had on neurosurgery and skull base surgery and on the professional and scientific developments of its participants in particular.

INTRODUCTION

Laboratory-based cadaveric training is essential for neurosurgeons as they develop and refine their technical skills in preparation for the operating room.[1] Laboratory training models are also essential for developing and refining surgical skills, especially in microsurgery.[2] In fact, cadaveric dissection is the nearest form of simulation trainees have to performing surgical procedures on live patients.[3] This fact is acknowledged by those who direct neurosurgical training. A survey sent to the program directors of all 100 neurosurgical residency programs in the United States showed that 95.4% believe laboratory dissection is an integral component of training.[4] This type of training is especially important given that work-hour restrictions and current quality, financial, and legal concerns have reduced resident operative volume and autonomy.[4] Anatomic dissection laboratories provide the best way to develop and maintain surgical skills while assessing surgical competency in a controlled and safe atmosphere.[5] Although many neurosurgeons have used the dissection laboratory to develop their skills, a structured dissection curricula has yet to become a staple in medical education.[5]

Training in a cadaver dissection laboratory is vital to learning the skills required in skull base surgery due to its complexity and the limited number of available patients. Skull base surgery courses are another staple of education in skull base microsurgery. While dissection laboratories have historically been a part of many residency programs in both the United States and globally, neurosurgical cadaveric dissection courses only began developing at the beginning of the new millennium. Dissection laboratories provide continuous daily hands-on anatomic and surgical education, while skull base cadaveric courses are held annually or biannually and usually gather internationally recognized experts from the field who share their knowledge and experiences in a 2- to 3-day setting.

In this paper, we present the history of longest running annual skull base cadaver course: the Annual Al-Mefty Skull Base Approaches Course. A microscopic and endoscopic hands-on cadaver workshop, held in St. Louis, Missouri, celebrated the course's 30th anniversary in April 2019 (Figure 1). We present the impact this course has had on neurosurgery and skull base surgery, as well as on the professional and scientific developments of its participants in particular. Finally,

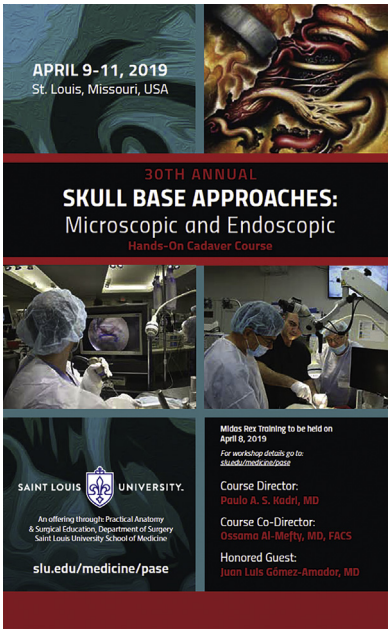

Figure 1. Mailer for the 30th anniversary of the Surgical Approaches to the Skull Base course. (From the private collection of the senior author).

we discuss the possible role of this course as an integral part of neurosurgical education, specifically as it relates to skull base surgery.

MATERIALS AND METHODS

We analyzed the archives of the Al-Mefty Surgical Approaches Microscopic and Endoscopic Hands-On Cadaver Course, which was held at and sponsored by the Practical Anatomy and Surgical Education (PASE) at St. Louis University Medical School from 1990 to 2019. Demographic analysis of the participants was performed. Their age, sex, current, and past positions in departments of neurosurgery and neurosurgical societies and academic achievements were included in the analysis. For each participant and faculty member, we completed a Google Scholar (Google, Mountain View, California, USA) search in April 2019 and identified published articles, including many of which were published after the faculty made their first appearance at the course. We also used Google.com to search the Internet for every participant and faculty member to find their current affiliations and positions.

RESULTS

Background of Surgical Approaches to the Skull Base Course

Brief Biography of the Course Founder. Ossama Al-Mefty (Figure 2) was born in Damascus, Syria and completed medical school in Damascus. He then entered residency for neurosurgery at West Virginia University Medical Center, which he completed in 1978. Following residency, he worked in Richmond, Virginia and then moved to Saudi Arabia to become the acting chairman of the Neurosciences Department at King Faisal Specialist Hospital in Riyadh, Saudi Arabia. It was during his time at King Faisal Specialist Hospital that his interest in surgical treatment for skull base pathologies was born. He returned to the United States and became a faculty member of the University of Mississippi Medical Center in Jackson, Mississippi (1989–1991), where he was promoted to Professor of Neurosurgery. He subsequently joined the faculty at Loyola University Medical Center in Chicago, Illinois from 1991–1992. In 1993, he was recruited to become Professor and Chairman of Neurosurgery at the University of Arkansas for Medical Sciences, where he served until 2009. He serves currently as the Director of the Skull Base Surgery program at Brigham and Women's Hospital in Boston, Massachusetts.[6]

Dr. Al-Mefty is an acknowledged pioneer in skull base surgery, his primary area of interest and expertise. His scientific contributions are reflected in more than 500 publications including 11 books, 120 book chapters, and 325 peer-reviewed journal articles with 9900-plus citations (as of November 21, 2019).[7,8] He has participated in over 1000 presentations worldwide and in 90 Visiting Professorships in national and international universities. He has also been a faculty member and director for at least 360 different workshops and hands-on courses. He has been honored by prestigious neurosurgical lectureships and awards including the First Sugita Memorial Lecture, the Penfield Lecture,

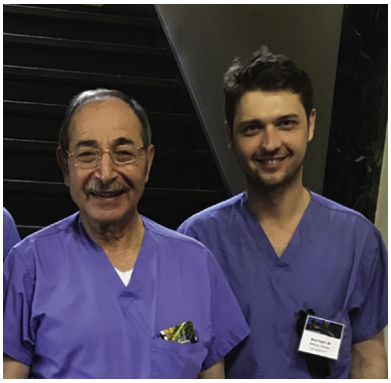

Figure 2. Dr. Ossama Al Mefty (left) with first author (right). (From the private collection of the senior author).

the Olivecrona Award, the Vilhelm Magnus Medal in recognition of his outstanding contributions to the neurosurgical field, the Cushing Medal for excellence and innovation, and the Medal of Honor from the World Federation of Neurological Surgeons. The core of his legacy is pioneering, developing, and refining new approaches to lesions of the skull base, such as the cranio-orbital zygomatic, petrosal approach transcondylar, and anterior clivectomy approaches.

Establishment of the Course. In 1984, the first Microneurosurgery at the Base of the Brain Workshop and Symposium was held in San Francisco, California. Faculty members included Albert Rhoton, Robert Spetzler, Ossama Al-Mefty, M. Gazi Yasargil, and Jules Hardy (Figure 3). The symposium was held annually for the next 5 years until it was replaced by the Surgical Approaches to the Skull Base course, which has been held in its current form without interruption each year since 1990 at the PASE facility at the St. Louis University School of Medicine. During its 30 years of existence, the course has gathered experts in skull base surgery from all over the world and has provided an important foundation in the development of the field internationally (Figure 4).

Current Skull Base Cadaver Course

Structure. The annual course always precedes the annual meeting of the American Association of Neurological Surgery,

Figure 3. List of faculty and participants of the first Microneurosurgery at the Base of the Brain Workshop and Symposium in San Francisco in 1984. (From the private collection of the senior author).

making it a convenient opportunity for participants and faculty to attend both events. The course is a hands-on cadaver course that typically lasts 3 days. The course director from 1990–2015 was Dr. Al-Mefty. Beginning in 2015, Dr. Al-Mefty and Dr. Paulo Kadri (Figure 5) codirected the course until Dr. Kadri became the Course Director in 2016.

Lectures, demonstrations, and hands-on practical approaches encompass important training elements of skull base techniques including the cranioorbital zygomatic approach,[9] the cavernous sinus approaches,[10] the middle fossa-anterior petrosal approach, mastoidectomy, temporal bone dissection, the posterior petrosal approach,[9,11-14] endoscopic approaches, the transcondylar approach with entry to the brainstem,[15] and surgical approach to jugular foramen.[15,16] Some of these approaches were first introduced clinically by Dr. Al-Mefty. The typical course consists of a lecture with a 3-dimensional prosection demonstration by a single course faculty member, followed by hands-on laboratory work. Two participants usually share one working station complete with a cadaver, operative microscope, and microinstruments. The cadaveric specimens at PASE are of the highest quality and are formalin fixed with latex-injected vasculature, which allows for precise anatomic dissections. Faculty surgeons actively supervise dissections after demonstrating surgical approaches. The day typically concludes with a case discussion session in which faculty and participants bring their own cases pertaining to the topic of dissection that day. The lively informal discussions allow for spirited opinions and critiques to be shared. Participants are also encouraged to take an active role in this session.

Analysis of Faculty and Participants

To date, 71 faculty members from 11 countries have participated from the United States, Brazil, Turkey, Lebanon, Syria, Japan, Switzerland, Germany, Argentina, France, and Slovenia (Figure 5). Faculty members have included renowned neurosurgeons, such as Mahmut Gazi Yaşargil, Evandro de Oliveira, Paul H. Young, Laligam N. Sekhar, Takeshi Kawase, Akira Hakuba, Ali Krisht, Vinko V. Dolenc, Helmut Bertalanffy, and Sebastien Froelich. Thirty-three faculty members have attended courses 4 or more times as instructors.

A total of 1063 participants from 69 countries have completed the course (Figure 6A)—477 participants (44.9%) were from the United States and Canada. Twenty-six of the participants eventually became course faculty. The median age of participants at the time of their first participation was 34.8 years. There were 1006 males (94.6%) and 57 females (5.36%). Of the 1063 participants, 390 (36.7%) became neurosurgery professors, directors, and department chairpersons. Of these 390 participants, there are currently 131 (12.32%) directors of skull base surgery divisions or programs.

The median age of the faculty members at the time of becoming faculty in the course for the first time was 39.35 years. Twenty-seven of the 71 faculty members are neurosurgical department directors, and 29 of them are professors of neurosurgery.

Impact of the Course

This course is, to our knowledge, the longest running hands-on cadaver course in neurosurgery and has educated several generations of neurosurgeons over the past 30 years (see Figure 6B). It has

Figure 4. Dr. Paulo Kadri, current director of the Surgical Approaches to the Skull Base course. (Image sent with permission to use by Dr. Kadri to the senior author).

provided a forum for the world's most renowned skull base neurosurgeons to discuss different surgical approaches, tactics, and pitfalls and yielded several of the first publications on skull base cadaver laboratory equipment and on training organization in such environments.[2] The international character of the course has led to its recognition worldwide as a premier training activity for modern skull base surgeons.

Based on our Google Scholar search, we found that participants published a total of 1560 skull base surgery-related articles in English language peer-reviewed journals subsequent to their attendance in the course. Publications cover the entire spectrum of skull base surgery including orbital pathology; anterior, lateral, and posterior skull base surgery; complications of skull base surgery; and pediatric skull base surgery and surgery of the cranial nerves.[12,13,17-32] Course alumni and faculty have authored 11 papers with Dr. Al-Mefty that have graced the covers of the *Journal of Neurosurgery* (Figure 7).

Of the 1063 course participants, 390 (36.7%) of them have become leaders and teachers in skull base neurosurgery. They have acquired academic positions and titles in the United States and around the world, including neurosurgery professors, directors, department chairpersons, directors or chairpersons of a skull base surgery division or department, and neurosurgical society presidents.

SURGICAL APPROACHES TO THE SKULL BASE
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Figure 7. A composite of *Journal of Neurosurgery* covers featuring articles published by course participants with Dr. Al-Mefty over the years.

unique setting exposes the participants and faculty to different philosophies toward solving complex problems of the skull base.

Duty-hour limitations established by the Accreditation Council of Graduate Medical Education have caused all medical specialties to reevaluate their curricula, but surgical specialties have been most affected.[5] These limitations have had an adverse effect on surgical training experience.[35] Work-hour limitations, combined with a lack of anatomic knowledge of the skull base, pose a significant problem in acquiring the vital expertise needed in the field of skull base surgery. Hands-on teaching in the laboratory is thus more important than ever before.

With the growth of technology and the restriction of work hours in surgical education, there has been an increase in use of simulation including virtual reality, robotics, telemedicine, and gaming. Subsequently, there is an increasing body of literature that describes the use of high-fidelity surgical training models, which is challenging the long-held notion that cadavers provide the best medium for postgraduate surgical skills training.[36] A recently published survey, for example, showed that pooled residents and attending neurosurgeons, in their opinion, subjectively believed that high-fidelity synthetic models were superior to cadavers as a surgical skills teaching platform.[36] Nonetheless, program directors believe laboratory dissection plays an integral role in neurosurgical training and is currently associated with a greater educational benefit than simulation.[4] The use of simulation has shifted the learning of basic surgical skills to the laboratory and away from the operating room, severely restricting the amount of time spent in the operating room for the acquisition of complex surgical skills.[37]

Despite the advent of modern technology and evolved teaching methods, dissection continues to remain a cornerstone of anatomy curriculum.[38] Although innovative measures for simulation training of surgery are appearing, there are also the realizations that basic anatomy training should be reinforced and cadaver dissection is of utmost importance for surgical techniques.[39] But the lack of validated skills assessment tools has prevented current studies from associating cadaveric training with improvements in operating skills,[40] which would better illustrate the benefit to trainees.

Most residency programs in the United States (93.8%) incorporate laboratory dissection into resident training with 1–3 (36.1%) or 4–6 (39.3%) sessions annually.[4] Most residency programs in the United States have their own cadaver dissection laboratories including several well-known dissection laboratories that specialize in skull base dissection and regularly perform internal or external courses. The course in St. Louis has remained the longest continuously running course in a 30-year time period.

Skull base surgery is a relatively recent set of surgical concepts in neurosurgical history as most of its surgical techniques have been described within the past century.[41] The ideal skull base surgeon is a disciple of microsurgery, understands oncological principles, is familiar with principles of cerebrovascular surgery, is able to perform both open and endoscopic approaches, can offer patients the best approach for their pathology, understands indications, is able to choose the best reconstruction for the defect, and is prepared to deal with emergencies that require a transition from an endoscopic to an open approach.[42] Two pillars of this continuous training are constant work in

the microsurgical laboratory and participation in skull base courses.

The idea that surgical knowledge is gained through continuous work in the dissection laboratory initially led to the development of the first courses. An advantage of a skull base course is that the course setting enables a wide spectrum of approaches to be demonstrated for the participants by experts in a short period of time. Knowledge gained in the course should serve as a motivation for individual training and mastering of the approach.

Addition of Endoscopic Techniques Education to This Course

As surgeons increasingly embrace endonasal approaches, experience with some skull base approaches may diminish.[42] An additional value of this course is that it has responded to changes in skull base surgery, driven by both new technologies and newly developed as training should always adopt, learn, and master new techniques. Endoscopic and traditional "open" skull base techniques are complementary and not mutually exclusive. After many years of teaching solely open-skull approaches, the course began including endoscopic and endonasal approaches to the anterior skull base as part of the curriculum in 2013. Dr. John A. Jane, Jr. was the first endoscopic skull base faculty, followed by many others. These approaches—like the open approaches—are taught by world leaders in endoscopic skull base surgery. An added benefit is that the course allows skull base surgeon participants to become more skillful at approaches that are less frequently needed and, therefore, done infrequently in the patient population. In this way, this course allows surgeons to practice and become more familiar with these less common approaches in a safe and academic environment.

One final intangible consequence of the course has been, for participants and faculty alike, the development of a network of like-minded and committed skull base trainees and experts with international reach.

CONCLUSION

The Ossama Al-Mefty Microscopic and Endoscopic Skull Base Approaches Hands-On Cadaver Course in PASE, St. Louis, Missouri, has become a world-renowned training course and microsurgical training program that emphasizes the knowledge and skills necessary to perform precise, successful, and safe surgery. Its impact on world neurosurgery has been real, and its place as one of the cornerstones of skull base surgical education is well earned. Throughout the 30 years of its existence, it has educated more than 1000 neurosurgeons from all over the world, many of whom have since become local and international leaders and teachers in skull base neurosurgery. The course has inspired numerous publications, and many other contributions to the field, and continues to highlight the pivotal role played by cadaver-based instruction.

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Last but not least, we would like to thank our mentor and teacher, Dr. Al-Mefty, for teaching us all of the following: skull-base techniques and approaches during the past 3 decades, the importance of preoperative preparation and careful review of all available diagnostic studies, the importance of patience during the long hours of skull-base surgeries and the necessary sacrifices to be made for the sake of the best outcomes for our patients, the importance of early recognition of complications in skull-base surgery in order to manage them and minimize their impact, the sacred relationship between the neurosurgeon and the patient, and the importance of embracing collegiality among neurosurgeons worldwide.

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