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A spotlight on cadaveric dissection in neurosurgical training: The perspective of the EANS young neurosurgeons committee

To the Editor

Cadaveric dissection is believed to be a key cornerstone in surgical education and practice, fostering the acquisition of anatomical knowledge and operative understanding required for neurosurgeons. Inspired and elevated by the pioneering work of Professor Albert L. Rhoton Jr., anatomical studies continue to have a central role in enhancing knowledge and proficiency of neurosurgical trainees (Matsushima et al., 2018a).

As the Young Neurosurgeons' Committee of the European Association of Neurosurgical Societies (EANS), we aim to highlight the pivotal role of cadaveric dissection in neurosurgical training and its future educational perspectives.

1. Enhancing anatomical knowledge

Cadaveric dissection offers a unique opportunity for trainees to explore the complexity of neuroanatomy in a safe but realistic environment. Performing meticulous dissections, young neurosurgeons can develop a better understanding of the three-dimensional (3D) relationships between neural structures, improving their spatial perception as well as microsurgical dexterity. Further, this hands-on experience allows trainees to appreciate the tactile feedback and nuances of tissue handling, providing a solid foundation for decision-making during surgical procedures.

The philosophy of Prof. Rhoton, "We want perfect anatomical dissections, because we want perfect surgical operations," as he eloquently instilled in his fellows and students, symbolizes a crucial purpose of specimen employment (Matsushima et al., 2018b). Although time-consuming and complex, conducting exquisitely detailed dissections – and documenting these specimens in high-quality images and cutting-edge formats – fosters a comprehensive enhancement of surgical skills and ultimately improves patient care.

Cadaveric dissection not only facilitates individual skill development but also provides the opportunity for team-based learning, along with the acquisition of shared knowledge. Through collaborative anatomical studies, trainees can exchange ideas, discuss anatomical variations, and develop innovative approaches to surgical challenges. This teamwork-oriented environment promotes a culture of continuous learning and mutual support, mirroring the multidisciplinary nature of modern neurosurgical practice.

Over the years, the EANS has strongly supported cadaveric training in the European scenario (Moiraghi et al., 2020; EANS Hands-on Courses). A dedicated EANS hands-on section and several EANS hands-on courses have been established since 2012. These courses have aimed to methodically cover the areas of interest in neurosurgical training through tailored hands-on activities. They are designed to provide valuable educational experience at all levels, from young neurosurgeons in the early years of their training to seasoned neurosurgeons looking to brush up on specific approaches or widen their subspecialty knowledge. These courses include the EANS hands-on course - Lyon, cranial and spinal step I and II courses, regular and advanced microsurgery courses, the skull base section course, the white matter dissection course, and many others. (EANS Hands-on Courses)

The environment of neurosurgical training has changed over the last decades, partly due to implementation of working hours regulations for trainees with subsequent reduction in case load, and an increased emphasis on elevated quality standards (Stienen et al., 2020). Further, the high cost of cadaveric specimens, in combination with logistical and ethical considerations, often restricts the availability of cadaveric dissection opportunities across Europe (Zoia et al., 2022). As a result, there is a growing need to explore and develop alternative methods for effectively training young neurosurgeons from a surgical standpoint.

2. Future perspectives

Given recent technological advancements, specimen dissection can be captured with 3D acquisition techniques for educational purposes. Stereoscopic images, 3D videos, 3D printing, and interactive 3D models are widely used to allow us to critically perceive the 3D anatomical relationships between neural structures. Such an approach provides a more realistic anatomical view instead of the limited, 2-dimensional images we are used to from textbooks (Vezirska et al., 2022).

Photogrammetry, a technique that captures a 360-degree scan of an object and converts it into a 3D digital file, has emerged as a valuable tool in anatomical education (Krogager et al., 2024). This innovative tool allows learners to navigate 3D models on their laptops or mobile devices, enabling interactive exploration of complex anatomical structures and surgical approaches in a realistic and immersive fashion. Notably, these models can be accessed on open-access platforms – such as the 3D Atlas of Neurological Surgery® (3D Atlas of Neurological Surgery) – thus providing easily accessible means of anatomical education. Further, 3D digital files can be visualized using augmented and virtual reality (VR), enhancing learners' engagement and immersion (Trandzhiev et al., 2024). Incorporating VR into neuroanatomical education offers several advantages over traditional 3D techniques, particularly in addressing challenges associated with working on specimens over an extended time period. These challenges include the drying out or deterioration of anatomical specimens over time, as well as the irreversible tissue damage caused by dissecting superficial layers to access deeper structures. With VR technology, learners can overcome these obstacles. VR allows them to reexamine any dissection layer at any time throughout their course, providing the flexibility to analyze structures

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repeatedly in self-study or multilayer scenarios. Moreover, learners can actively engage by taking notes in the virtual environment, thereby reinforcing their knowledge and understanding. However, from a surgical standpoint, cadaveric dissection remains the most realistic way to practice haptics and appreciate nuances of tissue handling.

Overall, we believe that VR represents a valuable adjunct to traditional cadaveric-based learning methods.

These cutting-edge 3D techniques hold great potential and represent a promising avenue for neuroanatomy learning. As such, the EANS Young Neurosurgeons' Committee actively supports and promotes the use of the 3D Atlas of Neurological Surgery®, a digital collection of photorealistic dissection-based interactive 3D models (3D Atlas of Neurological Surgery).

3. Final remarks

Cadaveric dissection remains a crucial tool for neurosurgical trainees, embodying the legacy of Prof. Rhoton and his pioneering work in advancing neuroanatomy. Through this hands-on experience, young neurosurgeons can gain a comprehensive understanding of neuroanatomy, refine their surgical skills, and foster collaboration within the field.

As the EANS Young Neurosurgeons' Committee, we firmly believe that integrating cadaveric dissection into neurosurgical training is fundamental to raise competent and compassionate neurosurgeons. Likewise, we advocate for the continued support and recognition of innovative technological tools providing advanced neuroanatomical visualization as a valuable component of neurosurgical education. Such cutting-edge methods can enhance traditional neuroanatomical teaching methods or even provide advanced neuroanatomical training when the option of cadaveric dissection is limited.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Fabio Torregrossa*
Department of Neurologic Surgery, Mayo Clinic, Rochester, MN, USA
Mayo Clinic Rhoton Neurosurgery and Otolaryngology Surgical Anatomy Program, Rochester, MN, USA
Neurosurgical Unit, Department of Biomedicine, Neurosciences and Advanced Diagnostics (BiND), University of Palermo, Palermo, Italy

Maria Peris-Celda
Department of Neurologic Surgery, Mayo Clinic, Rochester, MN, USA
Mayo Clinic Rhoton Neurosurgery and Otolaryngology Surgical Anatomy Program, Rochester, MN, USA

Toma Spiriev
Department of Neurosurgery, Acibadem CityClinic Tokuda Hospital Sofia, Bulgaria

Cesare Zoia
Neurosurgery Unit, Ospedale Moriggia Pelascini, Gravedona, Italy

Evangelos Drosos
Salfort Royal NHS Foundation Trust, Manchester, USA

Cristina Aldea
Department of Neurosurgery, Cluj County Emergency Hospital, University of Medicine and Pharmacy Iuliu Hatieganu, Cluj-Napoca, Romania

Jiri Bartek
Department of Clinical Neuroscience, Karolinska Institutet and Department of Neurosurgery, Karolinska University Hospital, Stockholm, Sweden & Department of Neurosurgery, Rigshospitalet, Copenhagen, Denmark

Marlies Bauer
Department of Neurosurgery, Medical University of Innsbruck, Innsbruck, Austria

Diogo Belo
Neurosurgery Department, Centro Hospitalar Lisboa Norte (CHLN), Lisbon, Portugal

Daniela Stastna
Addenbrooke's Hospital, Cambridge University Hospitals, Cambridge, USA

Stanislav Kaprovoy
Burdenko Neurosurgical Center, Department of Spinal and Peripheral Nerve Surgery, Department of International Affairs, Moscow, Russia

Milan Lepic
Clinic for Neurosurgery, Military Medical Academy, Belgrade, Serbia

Laura Lippa
Department of Neurosurgery, ASST Ospedale Niguarda, Milano, Italy

Malte Mohme
Department of Neurosurgery, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

Stefan Motov
Department of Neurosurgery and Spine Center of Eastern Switzerland, Cantonal Hospital St.Gallen, St.Gallen, Switzerland

Michael Schwake
Department of Neurosurgery, University Hospital Muenster, Germany

Felix Stengel
Department of Neurosurgery and Spine Center of Eastern Switzerland, Cantonal Hospital St.Gallen, St.Gallen, Switzerland

Gerardo Iacopino, Giovanni Grasso
Neurosurgical Unit, Department of Biomedicine, Neurosciences and Advanced Diagnostics (BiND), University of Palermo, Palermo, Italy

Maria L. Gandìa-Gonzàlez
Department of Neurosurgery, Hospital Universitario La Paz, Idipaz, Madrid, Spain
University Autonomous of Madrid, Spain

Torstein R. Meling
Department of Neurosurgery, The National Hospital, Rigshospitalet, Copenhagen, Denmark

Giovanni Raffa
Department of Biomedical and Dental Sciences and Morphofunctional Imaging, Unit of Neurosurgery, University of Messina, Messina, Italy

* Corresponding author. Department of Neurosurgery, Rhoton Neurosurgery and Otolaryngology Surgical Anatomy Program, Mayo Clinic, 200 1s St SW, 55902, Rochester, MN, USA.
E-mail address: fabio.torregrossa@unipa.it (F. Torregrossa).

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