

Introducing Medical Students to the Burgeoning Field of Neuroplastic Surgery

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"In these days when science is clearly in the saddle and when our knowledge of disease is advancing at a breathless pace, we are apt to forget that not all can ride and that he also serves who waits and who applies what the horseman discovers."
– Harvey Cushing

"Standardization of our educational systems is apt to stamp out individualism and defeat the very ends of education by leveling the product down rather than up."
– Harvey Cushing

The nascent field of neuroplastic and reconstructive surgery represents the best of cranial neurosurgery and craniofacial plastic surgery, demonstrating the synergism achievable with interdisciplinary care models that is not possible when surgical specialties function in silos.^{1,2} Since its inception this decade, the field has experienced enormous growth and several noteworthy milestones. At Johns Hopkins, the Multidisciplinary Adult Cranioplasty Center was established in 2012, accelerating collaborative efforts between neurosurgeons and plastic surgeons leading to advances including the pericranial-onlay cranioplasty technique,³ dual-purpose craniofacial implants,⁴ and better understanding the Syndrome of the Trephined.⁵

More recently, the newly-established section of Neuroplastic Surgery reported multiple first-in-human experiences, including successful integration of hydrocephalus shunt devices, neuromodulation devices, and wireless intracranial pressure monitoring devices within customized cranial implants.^{6–8} Our institution also developed a formal fellowship in Neuroplastic and Reconstructive Surgery, approved by our office for Graduate Medical Education in 2016. We have since trained several fellows who are poised to be leaders in the field: Dr. Gabriel Santiago, Dr. Amir Wolff, Dr. Tamir Shay, and Dr. Kerry-Ann Mitchell. In 2018, the Society of Neuroplastic Surgery was formed, and the same year, the specialty was recognized by the Journal of Craniofacial Surgery with a dedicated inaugural issue and official affiliation.¹ Even more advances are on the horizon, with new technologies, collaborations, companies, patents, and more promising to exploit the untapped potential of cranioplasty and functional cranial implants.

As we reflect fondly on the field's recent past, we must take a prudent look toward its future in order to ensure its continued growth and sustainability. Indeed, we noted in a previous Special Editorial in this Journal that Dr. Joseph Murray, Nobel Laureate and

trailblazer in plastic surgery, once remarked "educating young surgeons is the key to keeping our specialty alive."¹ While these educational efforts were previously considered largely in the context of resident and fellow training, we now note that growing our young field to its fullest potential will involve extending this outreach even further, to our most junior trainees: medical students.

This outreach is a natural progression of existing efforts to engage medical students in neurosurgery and plastic surgery. The academic and surgical literature suggests a few best practices to keep in mind during these endeavors. Exposure should occur early in medical school, given that students often make specialty choices before beginning clinical rotations. Opportunities to develop mentored relationships (with faculty and residents) and participate in meaningful research⁹ should be made readily available, particularly in the research-heavy fields of neurosurgery and plastic surgery. Finally, wherever possible, hands-on surgical opportunities should be provided, given their demonstrated appeal to medical students.^{10–12} Though resource-intensive, opportunities in the gross anatomy lab may be particularly high-yield in garnering student interest in surgical subspecialties and potentially bolstering subsequent match rates.¹³

We recognized one such opportunity to engage medical students in neuroplastic surgery during the recent Selected Topics in Neuroplastic and Reconstructive Surgery 2-day symposium at Harvard Medical School. Since the inaugural symposium 5 years ago, the event has grown substantially to bring together physicians, researchers, trainees, patients, and industry partners in a collaborative atmosphere seeking to advance the field in pursuit of better patient care. By incorporating medical students into the existing framework of the conference, we were able to provide them with valuable exposure to our young field in a relatively low-resource manner.

During the first day of the symposium, medical students eagerly listened to talks and networked with faculty leaders in the field. Several gave oral presentations on their research in neuroplastic surgery, and one won the award for best abstract and oral presentation. The second day of the symposium featured the highlight for students: a morning cadaver lab at the Boston Bioskills Lab covering cranioplasty and emerging technologies in the field. Because an emerging body of literature suggests that anatomy labs are fertile ground to recruit students to surgical specialties,¹³ we held an additional 2.5-hour cadaver lab specifically for medical students at the conclusion of the normally scheduled morning cadaver lab.

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A total of 7 Johns Hopkins medical students participated in the morning (symposium-wide session) and afternoon (medical student-specific session) cadaver labs, and 6 Harvard medical students joined for the afternoon session. Students were surveyed at the conclusion of the afternoon session with a 100% response rate. There were 6 males and 7 females. Mean age was 24.2 years old. Students' top specialty interests were neurosurgery (n = 9), plastic surgery (n = 2), orthopedic surgery (n = 1), and cardiology (n = 1). Motivations for attendance included learning more about neurosurgery, plastic surgery, and their integration; hands-on experience; learning new techniques/skills; and gaining exposure to innovation. Barriers to attendance included travel and lodging costs.

During the morning cadaver session, there were 8 stations, each with a cadaveric head, faculty/fellow instructor, operating room nurse, and trainees. Instructor: trainee ratio was approximately 1:4. With close guidance, students performed a variety of classic neurosurgical approaches (eg, pterional, retrosigmoid, and orbitozygomatic) from start to finish. This included positioning, incision, dissection, burr hole placement, craniotome use, durotomy, and anatomical exploration. They then received training on bone flap placement as well as low-profile hydrocephalus shunt valve device placement within customized cranial implants. Based on individual trainee interests, at some stations, dissections further explored the orbit, cavernous sinus, and cerebellopontine angle.

The afternoon session had fewer resources but offered an intimate, student-friendly environment under the tutelage of a neurosurgery attending. There were 2 stations, each with 2 cadaveric heads and 1 operating drill. Harvard students, who were not in attendance for the morning session, performed a pterional craniotomy and Sylvian fissure dissection under the guidance of the neurosurgery attending, exploring key bony and anatomic landmarks. Hopkins students, who were present for the morning session, performed a retrosigmoid craniotomy and exploration of the cerebellopontine angle under the guidance of a post-doctoral fellow in neurosurgery.

Students had overwhelmingly positive feedback about both the morning and afternoon sessions. When asked to describe their favorite aspects of the experience, every respondent specifically mentioned the hands-on, practical nature of the event and/or the interactive, attentive faculty instruction on anatomy and surgical approaches. Students found neurosurgeons to be friendly and collaborative, and they were fascinated by innovations in neuroplastics. Some students noted that they developed a new interest in neurosurgery, while others reinforced existing interests. Opportunities to improve the event were related to the lower-resource nature of the afternoon session and included a request for more operative tools and anatomic specimens. When asked if they would take the course again, all students responded with a resounding yes, with multiple comments that the experience was a highlight of medical school. All respondents indicated that they would recommend the course to a classmate (Fig. 1).

Our experience indicates that medical students had a positive experience being introduced to neuroplastic surgery through a weekend symposium. Consistent with prior literature, our cohort found cadaver lab opportunities to be particularly engaging and instructive. We plan for the add-on medical student-specific cadaver lab session to become an institutionalized portion of future symposia, including at next year's event in Baltimore. We will strive to continue bringing medical students to engage with our specialty; we propose that other conferences and academic departments would do well to similarly incorporate students into existing training opportunities whenever possible. Students relish these opportunities, and they can be arranged in a relatively low-resource manner. There may be a very high return on this investment, as these very students may eventually take the reins and carry our burgeoning field into the next generation.



FIGURE 1. Photographs taken during morning and afternoon cadaver labs at the Fifth Annual Neuroplastic and Reconstructive Surgery Symposium held at Harvard Medical School in Boston, Massachusetts (November 2-3, 2019).

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