Development of a Neurosurgical Cadaver Laboratory despite Limited Resources

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Objective: Our neurosurgical program did not have a cadaver laboratory. The need to create one arose following a decrease in elective cranial cases at our institution after Hurricane Maria. Many neurosurgical programs are in countries where financial support for projects such as developing a cadaver research laboratory cannot be expected from their parent institutions. This article describes how, despite limited resources, a neurosurgical cadaver dissection laboratory can be created and maintained to promote resident education and stimulate future research.

Materials and Methods: The University of Puerto Rico Institutional Review Board evaluated and approved the proposal for creating a neurosurgical cadaver laboratory. The process to establish the laboratory was broken into steps. After obtaining the basic materials, the laboratory was created.

Results: The creation of our neurosurgical cadaver laboratory was divided into discrete steps that can be undertaken by any institution with a similar goal. First, a suitable workspace was identified. Second, the surgical instruments and equipment required to perform dissections were obtained. Third, cadaveric specimens for dissection and for practicing surgical approaches were acquired. Last, documentation regarding the laboratory's development was maintained, and an expansion plan was created. We created a dissection laboratory by gathering decommissioned or donated operating room equipment, seeking out contributions from other institutions, and, sometimes, by monetary contribution from the faculty or residents.

Conclusion: Clear goals, interdepartmental collaboration, and a high degree of motivation were essential in creating, despite limited resources, a working neurosurgical cadaver laboratory to improve resident education. [*P R Health Sci J 2022;41(3):153-156*]

Key words: Anatomy, Brain, Cadaver, Dissection, Laboratory, Neurosurgery

The initiative to start a cadaver laboratory at our neurosurgical program arose from the need for a well-organized workspace for residents to study 3-dimensional neuroanatomy and cranial surgical approaches. After Hurricane Maria passed over the island of Puerto Rico on September 20, 2017, there was a significant decrease in elective cranial cases at the University of Puerto Rico, Medical Sciences Campus. Hurricane Maria crossed Puerto Rico as a category four hurricane, causing an estimated $90 billion worth of damage and an estimated mortality of 2,975 individuals (1). Amidst the natural disaster, few hospitals were open and few surgeries could be conducted (2,3). Additionally, the reduction in aneurysm surgery, which has been provoked by newer neuroendovascular approaches, subsequently reduced our residents' surgical exposure to complex aneurysm surgery. The resulting decrease in surgical caseload highlighted the importance of having a supplementary training workshop. Given the situation, concerns that residents were not receiving the proper training to address complex brain pathologies were aroused. Many residencies have created a neurosurgical cadaver laboratory to study essential brain anatomy and practice surgical approaches in a safe and controlled environment (4). We visualized and created an inexpensive but functional workspace for residents. The laboratory provides the residents with quality cadavers, which stimulates their interest in surgical procedures and research. This project aimed to create a well-organized workspace for residents so that they could achieve a 3-dimensional conceptualization of the brain anatomy and get hands-on experience in cranial surgical approaches. Previously published guidelines were used to develop a cadaver laboratory (5,6).

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Materials and Methods

The proposal for creating this cadaver laboratory was evaluated and approved by the Institutional Review Board of the University of Puerto Rico. Protocols for properly handling prepared specimens, chemical exposure, and fire were developed and approved by the university's Institutional Biosafety Committee. After the laboratory was established, an assigned research resident commenced daily cadaver head dissections for a 6-month curriculum rotation to understand the surgical complexities of the cranial vault, brain, and brainstem. The staff of the anatomy laboratory and cadaver donation personnel were responsible for obtaining fresh cadaver specimens and preparing those specimens for dissections. The Klingler technique was used to preserve and dissect the white matter tracts (7,8).

Results

The creation of our neurosurgical cadaver laboratory was divided into discrete steps that can be undertaken by any institution with a similar goal. The first step was to designate a space that would be suitable for a working neurosurgery cadaver laboratory. A laboratory room on the anatomy floor of the Medical Sciences Campus of the University of Puerto Rico was designated as the neurosurgical cadaver laboratory. Institutional regulations for the storage and use of cadaver specimens were followed. A freezer capable of reaching -10 °C was obtained. In addition, the anatomy department provided us with a dedicated specimen storage area in the university's central cadaver laboratory. The second step was to obtain the surgical instruments and minimum equipment required to begin dissections. The equipment and instrument came from multiple sources. Several neurosurgery faculty members and anatomy professors donated dissection instruments and microscopes. The department of biomedical engineering at the medical center gave us some of their decommissioned operating room equipment. An external institution donated the surgical microscope. Equipment and instruments from neighboring laboratories were repurposed to fulfill the same roles as their more expensive counterparts. A manufacturing company (Medtronic) donated a used Midas-Rex drill. A used Mayfield clamp mounted to a stationary table was designed to hold the cadavers' heads. The third step was acquiring cadaver specimens for dissection. The university provided fresh cadaver specimens through the body-donation program. Our school of medicine has a body-donation program that provides cadavers for the anatomy course and supplies other medical schools. As our institution is the only government-funded medical school in Puerto Rico, it has access to unclaimed corpses after their autopsies are concluded.

Once the laboratory was established, the fourth step involved its utilization and maintenance, with the development of mentoring programs. To study the neurosurgical approaches, the cadaver head was fixed with the Mayfield head holder, and surgical dissection and exposure were performed using surgical loupes or a microscope. The assigned research resident practiced several surgical approaches on the cadaver heads, including the pterional, orbitozygomatic, subtemporal, and lateral infratentorial/supracerebellar. Surgical dissections to the pons via the far lateral, suboccipital, retrosigmoid, and midline-suboccipital trans-fourth ventricular approach were also conducted. An approach to the medulla via the transcondylar route was also practiced. Using the brain specimens that were preserved using the Klingler technique, the corticospinal and the lateral and medial lemniscus tracts were dissected and studied. Each month, several dissection workshops were given to the rest of the residents to improve their techniques and surgical competencies. Faculty members with skull base and microvascular expertise guided the residents through complex and critical approaches. Various research learning opportunities were gained in the creation of this cadaver laboratory. A neurosurgical laboratory, established with a minimum of expenditure, open 24/7, and accessible to residents and research medical students, was developed with the acquired equipment and specimens (Figure 1).

Discussion

Laboratory cadaver dissection has a significant history in neurosurgical training. Researchers have expressed the benefits of having a neurosurgical cadaver laboratory. Such a laboratory is a space where skills and training can be developed to educate residents during their early career and flatten their learning curve (9,10). Laboratory training helps residents learn procedures in an environment that is free from the stress commonly present in the operating room, allowing a margin for error (11). A cadaver laboratory's basic requirements include a well-lit, ventilated room, headframes, operating microscopes, a micro-neurosurgery instrument set, a high-speed drill, a suction machine, a light source, and video recording facilities (11,12). The estimated cost of creating a neurosurgical laboratory is over $100,000. Given the circumstances under which our institution was operating at the time, an investment such as this was not feasible. However, in this article, we have demonstrated how resourcefulness and willpower can significantly reduce the cited startup cost. We showed how the essential elements to start a dedicated cadaver laboratory can be gathered, despite limited resources and no institutional budget.

Although the created laboratory still needed equipment, the standard necessary materials were obtained, and the goal (of creating such a laboratory) was achieved. An endoscope with a camera and monitor was developed to advance the endoscopic training of neurosurgical residents. Berg et al. embraced inexpensive surgical training using expired materials, resulting in decreasing the cost of teaching a surgical resident (13). Bohl et al. developed a surgical skills laboratory that only uses 3-dimensional, printed synthetic training models (14). However, cadaver training laboratories will continue to help residents in middle-income and low-income countries with

Figure 1. Neurosurgical cadaver laboratory with equipment acquired via donations and repurposed discarded materials, including an operating microscope, a Mayfield clamp mounted to a stationary table, a portable suction module, a light source, and an electric Midas-Rex drill with different drill bits.

limited resources, as high-quality synthetic and virtual training models require a heavy initial investment.

In the future, we expect to design a curriculum for the neurosurgical residents that will provide them with hands-on training early in their training (15). Residents are exposed to procedures at different times in their education; thus, laboratory training can help them to learn how to perform diverse surgical approaches and improve their competence in carrying out such operations. The use of structured cadaver laboratory modules can improve technical skills and competency but can also provide uniformity in training. However, some neurosurgical programs have a heavy workload, and residents may have limited time to devote to laboratory training. The program director should approve the curriculum, assigning a motivated faculty member to train and educate the laboratory residents; however, finding such a person is complicated because this individual's interaction requires a great deal of time and effort.

Conclusions

A neurosurgical cadaver laboratory is instrumental in developing surgical skills and neuroanatomical knowledge during neurosurgical training. Creating a working neurosurgical cadaver laboratory with a minimal budget and minimal institutional funding was possible. Despite limited resources, clear goals, interdepartmental collaboration, and a high degree of motivation were essential to improve resident education. The path was not easy, as some issues delayed the laboratory's development. Resource-limited countries can use this model to develop their neurosurgical cadaver laboratories.

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Resumen

Objetivo: Nuestro programa de neurocirugía no contaba con un laboratorio de cadáveres. La necesidad de crear uno surgió luego de una disminución de casos craneales electivos en nuestra institución luego del Huracán María. Muchos programas de neurocirugía se encuentran en países donde sus instituciones matrices no pueden dar el apoyo financiero para proyectos como la creación de un laboratorio neuroquirúrgico de cadáveres. Este artículo describe cómo, a pesar de los recursos limitados, se puede crear y mantener un laboratorio neuroquirúrgico de disección de cadáveres para promover la educación de los residentes y estimular la investigación. Materiales y Métodos: La propuesta de creación de un laboratorio neuroquirúrgico de cadáveres fue evaluada y aprobada por la Junta de Revisión Institucional de la Universidad de Puerto Rico. Los requisitos mínimos para establecer el laboratorio se organizaron en pasos. Luego de obtener los materiales básicos, se creó el laboratorio. Resultados: La creación de nuestro laboratorio neuroquirúrgico de cadáveres se dividió en pasos escalonados que pueden ser seguidos por cualquier institución con un objetivo similar. Primero, se identificó un espacio de trabajo adecuado. Segundo, se adquirieron los instrumentos y equipos quirúrgicos necesarios para hacer las disecciones. Tercero, se adquirieron cadáveres para la disección y la práctica de abordajes quirúrgicos. Por último, se mantuvo la documentación de desarrollo del laboratorio y se desarrolló un plan para ampliar las capacidades del laboratorio. Pudimos crear un laboratorio de disección reuniendo equipo de quirófano retirado o donado, obteniendo donaciones de otras instituciones y, a veces, con aportación monetaria de profesores y residentes. Conclusiones: Objetivos claros, colaboración interdepartamental y un alto grado de motivación fueron esenciales para crear un laboratorio neuroquirúrgico de cadáveres en funcionamiento para mejorar la educación de los residentes a pesar de los recursos limitados.

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