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A Multimedia Dissection Module for Scalp, Meninges, and Dural Partitions

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Abstract

Introduction: For students beginning their medical education, the neuroscience curriculum is frequently seen as the most difficult, and many express an aversion to the topic. A major reason for this aversion amongst learners is the perceived complexity of neuroanatomy. By means of a video tutorial, this module aims to help students feel confident with the cadaveric dissection and identification of key anatomical structures as well as improve comprehension of associated clinical correlations presented for the scalp, meninges, and dural partitions. **Methods:** The authors expanded upon an established neuroscience curriculum, designed for first-year medical students, with the addition of a dissection video tutorial. A survey was provided to all students for feedback. **Results:** Of 36 students who participated in the survey, a majority (72%, $n = 26$) rated the video tutorial 5 out of 5 for helpfulness, and 53% ($n = 19$) rated the video 4 out of 5 for perceived confidence after viewing prior to the dissection. Most students viewed the tutorial only once prior to the dissection. **Discussion:** This video tutorial focuses on the structures and clinical correlations related to the scalp, meninges, and dura; provides useful graphics for identification of checklisted structures for predissection preparation; and serves as a succinct step-by-step guide for the dissection and as a study aid for review. Its addition to the already established curriculum was well received by the student group, a majority of whom found it helpful and had a high level of perceived confidence prior to the start of the dissection.

Keywords

Dissection, Cadaver, Anatomy, Neuroanatomy, Brain, Neurosciences, Medical School, Cranial, Neurosurgery, Video Tutorial

Educational Objectives

By the end of this educational module, students will be able to:

1. Successfully complete the dissection/removal of the brain from the cranial cavity.
2. Identify checklisted structures in the scalp, skull, meninges, and dural partitions of a human cadaver and explain/recall key anatomical relationships.
3. Explain the neuroanatomical clinical correlations that have been presented throughout the provided and suggested learning material.

Introduction

The optimal moment for improving the integration of basic neuroscience and neuroanatomy to prepare for the future application of knowledge during medical education is within the preclerkship years.¹ Several studies have suggested that both international and US medical students and residents have an aversion to neurology-related academia, or *neurophobia*, and many have difficulty with the diagnosis and management of patients with related diseases.¹⁻³ One of the major reasons behind this aversion is the perceived complexity of neuroanatomy amongst learners.¹

In 1969, Edgar Dale first developed the cone of experience, a visual description of how certain experiences affect learning retention.⁴ Passive types of learning include learning via reading, hearing, and seeing. In Dale's model, reading and verbal learning are seen as the least effective methods, with only 10%-20% of individuals retaining the material.⁵ Active learning, on the other hand, involves input from

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Appendices

- A. Predissection Questionnaire.docx
- B. Dissection 1 Written Instructions and Images.pdf
- C. Dissection 1 Video Tutorial .mp4
- D. Tools for Dissection 1.jpeg
- E. Postdissection Review Slides.pptx
- F. Individually Labeled Images folder
- G. Answers References for Predissection Questionnaire.docx

All appendices are peer reviewed as integral parts of the Original Publication.

multiple sources as well as actual participation in an activity and provides the best learning retention.⁴ Dale, however, believed that in order to provide meaningful active-learning experiences, students should first be presented with concrete knowledge via the passive-learning modalities.⁴

A variety of approaches to medical and anatomical teaching have been utilized, and it is hard to know which of these is most effective.⁶⁻¹⁷ A conventional and rather antiquated approach to education assumes that learners are uniform in how they approach the processing and organization of new information.⁵ Others believe that teaching strategies geared towards adult learners and their individual learning styles will improve retention and application of new material.^{18,19} However, Loo defined an *effective learner* as someone who is able to utilize many different types of learning experiences, and educators should utilize a variety of methods to encourage learner adaptation.¹⁸

Computer-aided learning (CAL) has been increasingly utilized to improve the visualization of lesson material and deepen the approach to learning.^{20,21} The addition of visual material, such as the use of video, can enhance the learning experience by demonstrating procedural techniques that are difficult to relay in writing and provide students an alternative method of learning, which can increase retention of information up to twofold.^{5,22,23} Neuroanatomy video demonstrations using anatomic models and cadavers have been successfully implemented by Sarikcioglu, Senol, Yildirim, and Hizay for many years.¹⁶

With minimal adaptations, this dissection and postdissection review slide set have been implemented and continually improved upon over many years as part of the medical school curriculum at the Uniformed Services University (USU), teaching upwards of 180 students (approximately 45 groups of four students) annually, with up to 15 faculty and fourth-year medical student teaching assistants as instructors.

Understanding the difficulty that neuroanatomical education poses, the authors felt that their own current curriculum needed to be augmented to make better use of recent technological updates to the university's anatomical laboratory, which largely consisted of the addition of CAL technologies. This laboratory improvement encouraged the incorporation of a video tutorial into the predissection preparation material. As a result, the authors created a stand-alone module for the scalp, meninges, and dural partitions dissection. The new video content provided additional visual and auditory experiences (passive learning) for students prior to the dissection and removal of the cadaveric brain in order to allow them to more easily identify key anatomical structures, to improve comprehension of associated clinical correlations, and to offer a more meaningful active-learning experience.

To the authors' knowledge, this is currently the only dissection module with a video dissection tutorial that directly demonstrates the dissection of the brain from the cranial cavity and the identification of important neuroanatomy structures and their clinical importance. There are other similar brain anatomy tutorials within the *MedEdPORTAL* library that alone are valuable resources²⁴⁻²⁶; however, this module builds upon the work started by those authors and enhances the educational learning process for this neuroanatomy dissection module.

CAL, as described earlier, is being utilized more in current approaches to neuroanatomy education, and the use of video plays an important role. Some of the earlier resources lack a video component, which, if included, based on the authors' experience, could improve these resources and learner retention of information presented.^{24,25} Rae, Oliver, Casey, and Cork developed a brain anatomy dissection focusing more on deeper brain structures, as opposed to the more superficial structures covered in this module, but their resource lacks labeling of hard-to-identify structures and orientation of the video within the dissection video tutorial itself.²⁶ Based on postdissection survey responses received in this module, these details are important and requested by students. Video content produced in a manner that incorporates student feedback and allows learners to more easily identify key neuroanatomical structures may improve learner confidence and comprehension of associated clinical correlations, as well as providing a more meaningful and productive learning experience.

Methods

In order to fulfill all of the expected learning objectives, the provided resource files and associated documents (Appendices A-G) should be considered as a complete package rather than as stand-alone components and, as such, should be used all-inclusively.

Target Audience

The target audience for this resource is preclerkship medical students, as well as graduate or upper-level undergraduate students in nursing, allied health professions, or other anatomy programs, with the following prerequisites:

- Introductory or intermediate level of basic anatomy and anatomical terminology (does not need to include previous exposure to neuroanatomy).
- Basic knowledge about the function of the brain.
- Note: This module was designed as part of a larger neurosciences preclerkship education for medical students.

Materials Needed

Below is a list of the items necessary for each group of four students to complete the dissections.

- Anatomy textbooks^{27,28}: The referenced textbooks were used for suggested reading (see Appendix B) to provide relevant clinical associations and further highlight the anatomy being taught in the module.
- One cadaver (upper torso and head intact).
- One dried human skull or realistic anatomical model.
- One red biohazard bag for collection of dissection products. Be sure to dispose of cadaver products appropriately per individual institutional guidelines.
- Personal protective equipment: nitrile gloves, eye protection, scrubs, lab coats/aprons, and face masks.
- Tools for Dissection 1 (see Appendix D).

Prior to the dissection, students were encouraged to study the material provided to them (see Appendices A-C) in order to guide dissection preparation. Students first completed the predissection questionnaire (Appendix A) to assess their current level of knowledge. They were also given a list of suggested readings and written step-by-step instructions with the list of structures to be identified during the dissection (Appendix B). In addition, students watched the newly incorporated video tutorial (Appendix C), which allowed them to visualize each major step of the dissection, as well as many of the checklisted structures, in order to emulate these steps and better visualize structures during their own cadaver and brain specimen dissections.

Once the dissection was completed, students were instructed to study the relevant postdissection review slides (Appendix E). This resource was included to aid students with self-study of the completed dissection by reinforcing the identification of checklisted structures and their key anatomical relationships, and it featured questions for the application of learned concepts from the suggested readings, video tutorial, and dissection. It should be noted that editing of this file would disrupt the internal links within the animations of the review slide presentation, and therefore, editing is strongly discouraged.

Logistics

This dissection was intended to be completed during a single 2-hour block with students divided into groups of four. A hemisectioned cadaver, intact at least from the shoulders up, was required for each group of students. The cadaver (with upper torso and head intact) had to be able to be stabilized when

positioned upright. Sectioning the cadaver through the thorax accomplished this best. Wooden blocks or similar objects were also useful for stabilization when not in an upright position. The brain was dissected from the cranial cavity, a very technical dissection. Some groups might need an additional hour for this dissection, which should be made available either immediately following the scheduled lab time or on group members' own time, as available. Setup and cleanup time for this dissection varied depending on the availability of faculty and students' ability to maintain an orderly dissection area as well as the amount of cleaning supplies and facilities available for use.

Data Gathering

The students were not aware of the postdissection survey prior to or during the dissection period. After the dissection was completed, all 171 students were provided with an online 5-point Likert-scale survey via email and asked to voluntarily provide feedback if they had watched the video. The survey was created to assess the helpfulness of the video, viewer confidence, and number of times the video was viewed prior to and after the dissection.

Results

A total of 36 students (21%) responded to the survey request. Table 1 shows that the majority of respondent students (72%, $n = 26$) rated the video tutorial 5 out of 5 (5 = *completely helpful*) when asked, "How helpful did you find the video was in preparing you for the dissection?" When asked, "How confident were you before the dissection after watching the video?" 53% ($n = 19$) of respondent students rated the video 4 out of 5 (5 = *completely confident*). Additionally, the authors looked at how frequently students viewed the video to prepare for the dissection and for further self-study (Table 2).

Table 1. Qualitative Learner Feedback for Video

Question	1—Not Helpful	2	3	4	5—Completely Helpful
How helpful did you find the video was in preparing you for the dissection?	0	0	1	9	26
	1—Not Confident	2	3	4	5—Completely Confident
How confident were you before the dissection after watching the video?	0	2	8	19	7

Table 2. Video Viewing Frequency

Question	1 Time	2 Times	3 Times	4 Times	≥5 Times
How many times did you view it prior to the dissection?	25	10	1	0	0
How many times did you view it as a study tool for the exam?	26	7	3	0	0

Comments

Comments regarding the dissection video tutorial were primarily positive. Many students appreciated the quality of the video and the level of detail of the dissection steps and structures mentioned. Some examples of comments include the following:

- "I liked that it was a step-by-step example of how to dissect, compared to the dissector [written instructions], which just shows snap-shots of what it should look like."
- "It was awesome seeing how the dissection was supposed to be done before we went in and did it for ourselves. I am a visual learner, and the videos helped me visualize the dissection better."
- "Broke down everything in an organized and fluent matter with tips on how to succeed in our own dissection."
- "I liked the tips about procedural things in addition to viewing the check-listed items. Since this dissection was a lot more involved than others we had recently, it was a huge relief to be able to watch the video and understand what I was going to do the next day. Learning structures along the way was a huge plus!"
- "Being able to build a 3D image of structures in my mind before going into lab, seeing proper techniques demonstrated."

The greatest amount of feedback regarding improvements focused on improving the labeling of structures and their anatomical orientation in the video. Additionally, students asked for more videos for the other neuroanatomy dissections. Some examples of recommendations for improvement include the following:

- “Labeling or having captions. Sometimes I couldn’t catch the name without the sound on.”
- “Maybe label anterior, posterior, etc. or other structures when the camera is zoomed in for reference.”
- “It would be great if the items reviewed appeared in type with arrows clearly designating locations.”
- “Having more of a prosection-type component would be helpful for exam studying.”
- “Having videos for all labs that cover all of the dissections.”

Discussion

Neuroanatomy is a particularly difficult topic for medical students to learn and fully comprehend, as it includes the identification of difficult, often hidden structures. The provided dissection module is only a small component of a larger neuroscience preclerkship curriculum at USU. While it is intended to be an in-depth stand-alone resource, there are many anatomical structures that are deliberately not covered. The neuroanatomical structures that are highlighted in this dissection are included because of their relevance to future clinical applications, based on the extensive experience of the neuroanatomy educators at USU. The authors created this module with its expanded video tutorial in hopes of decreasing neurophobia amongst learners. The majority of students who responded to the survey indicated that the video was “completely helpful” and that because of it, they had a high amount of confidence prior to the dissection. Student respondents also indicated that a majority watched the video only once prior to dissection and once again prior to an anatomy exam. This may be an early indication as to the efficacy of the video, but it may also be a product of a significant selection bias in the surveyed population and requires further validation. However, based on the overall positive feedback obtained from students, it appears that the video tutorial was well received by those who viewed it. The authors believe that with further investigation, this dissection module will show objective improvement in future students’ ability to more easily master this challenging content.

Video editing was critical to the success of the video tutorial used in the module. The dissection was first recorded in its entirety using a camcorder and tripod. The camera was positioned from whichever viewpoint most adequately captured the key steps and structures, which was most frequently the surgeon’s viewpoint. The video content was edited using iMovie (Apple Inc., Cupertino, CA) and Premier PRO CC (Adobe Systems Inc., San Jose, CA). A video script was written based upon the written dissection instructions and the video content. The audio was recorded and then synched over the video. Screenshots with orientation labeling (A [anterior], P [posterior], L [left], R [right], Cranial, Caudal), arrows, highlighting, and text were inserted into the video tutorial to provide easier recognition of video orientation and identification of hard-to-identify structures. In order to improve the video tutorial, modifications were made based on comments from the student surveys prior to submission.

Limitations

There are significant limitations to the presentation of data within this module. The collected data relied solely on the subjective opinions of student confidence in a voluntary survey, which had a low response rate and a potential source of selection bias. Additionally, the authors did not compare the performance between students who utilized the video tutorial for their predissection preparation and those who did not. As a result, objective learning criteria were not assessed, and the true efficacy of the video tutorial remains unknown. Subsequent investigations should attempt to capture a higher response rate, ideally including all students who view or do not view the video, and compare subjective confidence scores with pre- and postdissection objective data (e.g., predissection questionnaires and exam scores).

Additionally, while the authors attempted to provide an all-inclusive list of required materials for the dissection (see Methods section & Appendix D), these items might not be readily available in all anatomy labs and would thus make the dissection more difficult to complete. This resource is a detailed dissection

and gross anatomy identification module that requires support from an anatomical cadaver curator, volunteer faculty, and student teaching assistants to successfully implement. It is helpful to have as many instructors as possible circulating around the lab during the dissection to assist the students and answer questions, as some steps of the dissection may require the assistance of an instructor prior to proceeding. It is advised that prior to implementation, each course director practice each dissection with every member of the faculty who will be assisting, as a group, in order to ensure a smooth process. In the authors' experience as anatomical instructors, practicing the dissection as a group beforehand has been most beneficial for educator preparation.

Future Direction

The authors are in the process of developing an assessment tool that addresses the limitations of this investigation and plan to implement video tutorials and additional data collection for this module and additional dissections in the coming academic years. The ultimate goal is to similarly expand all of the dissections within the entire neuroscience preclerkship curriculum at USU to include video tutorial content. Based on the feedback for this module, the authors anticipate that additional video tutorials will enhance each student's ability to complete further dissections with ease and confidence. Plans for future publications are ongoing.

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Ethical Approval

Uniformed Services University Institutional Review Board approved this study.

Disclaimer

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