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Guided Laparoscopic Video Tutorials for Medical Student Instruction in Abdominal Anatomy

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Abstract

Introduction: As technological advances present new forms of media to anatomy educators involved in medical education, there is opportunity to expand on traditional dissection of embalmed cadavers. At the University of California, San Francisco School of Medicine, the surgery and anatomy departments collaborated to create guided video tutorials using laparoscopic surgical footage to teach the anatomy of the lesser sac and gastroesophageal junction. **Methods:** These tutorials are instructional adjuncts to a laparoscopy session on fresh cadavers with first-year medical students. Students view the videos on their own before attending the anatomy lab. The anatomy lab includes six 30-minute sessions, in which approximately 22 students at a time leave their cadaver lab to participate in this laparoscopy session taught by colorectal surgeons and general surgery residents. **Results:** Learner interest and satisfaction was measured through a postsession survey. Nearly all respondents indicated that the videos helped them learn the anatomy of the gastroesophageal junction and lesser sac, and were a valuable addition to dissection of embalmed cadavers. A second session was conducted with first-year medical students in which a pretest and posttest were administered before and after a screening of the tutorial on the gastroesophageal junction. Learners' average scores on the test improved from 39% to 88% after watching the video. **Discussion:** These data indicate that learners appreciate the incorporation of laparoscopy and video tutorials into anatomy education. These data further corroborate the measures of student enthusiasm, and support the value of the tutorials in short-term acquisition of anatomic knowledge.

Keywords

General Surgery, Anatomy, Abdominal Anatomy, Multimedia Learning, Video Tutorials, Colon and Rectal Surgery

Educational Objectives

By the end of this session, learners will be able to:

1. Recognize the following structures in laparoscopic video from multiple vantage points: esophagus, diaphragm, stomach, spleen, greater and lesser omentum, liver, duodenum, pancreas, and transverse colon.
2. Describe the spatial relationship of the gastroesophageal junction to the diaphragm, abdominal cavity, and the mediastinum.
3. Delineate the borders of the lesser sac and explain its spatial relationship with its surrounding structures.

Introduction

Anatomy education at medical schools in the U.S. focuses on the dissection of embalmed human cadavers. While this allows for detailed observation of many structural relationships, it possesses substantial limitations. For one, the embalming process markedly alters the appearance and texture of tissue. In addition, cadaveric open dissection allows learners to use landmarks and perspectives not reflective of the operative experience or replicable in living patients. Further, observation of pathology is limited to those conditions the cadavers had at the time of their deaths. Educators have attempted a

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Appendices

- A. Stomach Lesser Sac.mp4
- B. Esophagus.mp4
- C. Laparoscopic Anatomy Video Citations.docx
- D. Laparoscopic Anatomy Fresh Cadaver Lab Guide.docx
- E. Anatomy Survey Results.csv
- F. Anatomy Survey Handout.docx
- G. Pretest-Posttest Question Bank.docx
- H. Pretest-Posttest Answer Key.docx
- I. Pretest-Posttest Results.xlsx

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

number of supplemental approaches to mitigate these shortcomings. Fresh cadavers maintain the appearance and quality of live tissue, but are expensive, decay rapidly, and carry infection risk. Embalming methods that preserve color and texture have been developed, but are costly and not widely available.^{1,2} In contrast, virtual reality simulators, software, and applications continue to improve and are becoming more accepted as supplements to traditional dissection methods.³⁻⁶

There is a substantial body of literature on the value of multimedia instruction in a classroom setting. A recent meta-analysis revealed that animation had a marked effect on learner retention when compared directly to teaching with still images.⁷ This effect was especially pronounced when visualizations played a representational role rather than a decorative one, and when the animations were realistic. The effect was also noted when visualizations were used to help learners acquire procedural-motor knowledge. A subsequent study found a synergistic effect on teaching procedural content when still images are used to reinforce material presented in video form.⁸ Further, Mayer incorporated these and other concepts to develop an evidence-based framework for the design of multimedia-based learning in medical education.⁹ In applying ideas from this literature to our alternative approach of teaching abdominal anatomy to first-time medical student learners, we aimed to optimize essential and generative processing, as these cognitive processes allow for representation of the material in working memory, thus helping learners better understand the material.

For our approach, we chose to incorporate the unique anatomic views made available in laparoscopic surgical videos. Laparoscopy is a minimally invasive surgical technique that involves the placement of a camera and instruments into the body through small incisions. Laparoscopy in fresh frozen cadavers allows for views similar to those witnessed in the operating room, and has been used effectively in undergraduate and graduate medical education.¹⁰⁻¹⁴

This approach of using video collected during laparoscopic procedures has been independently used to improve learner understanding of anatomy.^{13,15} While video-editing software has been used to edit and annotate laparoscopic footage, and such videos have been widely presented on platforms such as YouTube, available videos often run at real-time pace with few stop points and diagrams to aid learner retention. Furthermore, the vast majority of laparoscopic YouTube videos are targeted at experienced learners and surgeons rather than at the introductory-level student. In the literature, we have encountered relatively few studies of anatomic video tutorials, or examples of anatomic videos designed for use in medical education curricula.

After a needs assessment conducted by the Department of Surgery at the University of California, San Francisco, School of Medicine (UCSF) revealed a large interest in using surgical footage to enhance anatomy curricula, we set out to develop video tutorials using our extensive library of abdominal procedures, current video editing software, and cognitive theories of multimedia learning. We subsequently measured medical student enthusiasm and the reported efficacy of the videos as an adjunct to a laparoscopic anatomy session conducted with fresh cadavers as part of the UCSF undergraduate medical curriculum.

The multimedia content developed for this project consists of two guided video tutorials intended for first-year medical students, or students otherwise learning detailed abdominal anatomy for the first time. Prior knowledge of abdominal anatomy is not a prerequisite. While the ideal context for implementation is in conjunction with a laparoscopy demonstration on fresh cadavers, these videos have value as a standalone supplement to a cadaver-based anatomy lab.

Methods

The target audience for this resource is first- or second-year medical students with introductory-level anatomy knowledge and little if any prior experience with laparoscopy or general surgery. Given this, students who are concurrently enrolled in an abdominal anatomy course and an anatomy course with

cadaveric and laparoscopy components would be ideal learners.

Creation of Tutorials

We collected de-identified laparoscopic footage from surgical procedures previously performed at UCSF. We selected procedures demonstrating the anatomy of the gastroesophageal junction, diaphragm, and the anatomy of the lesser sac, and edited them using Final Cut Pro X. One of the authors narrated the tutorial. The narration pauses at critical junctures with text and anatomic images closely overlaid to highlight key structures and relationships. As per Mayer, these strategies allow learners the opportunity to manage essential processing and foster generative processing.⁹ Images are open-access or used with permission and demonstrate the aforementioned anatomic relationships. A list of image citations by video time stamp is provided in Appendix C. Freeze frames were utilized to focus on complex structures and display comprehension questions to encourage active processing by learners.⁹ The final versions of these video tutorials are included as Appendix A (stomach and lesser sac) and Appendix B (gastroesophageal junction). Each video has its own goals and objectives present at the start of the video. The UCSF Institutional Review Board approved this study as exempt prior to any data collection.

Measuring Student Learning

Our initial session did not include a pretest or posttest; however, we subsequently created a bank of six questions and administered these a second round of first-year medical students in the surgery interest group at UCSF who chose to stay after a session of their elective to participate in our learning activity. In this session, students answered six questions on the gastroesophageal junction, watched the gastroesophageal junction tutorial, and then answered the same six questions. The maximum score was 12 points, with multiple points available for questions with multiple parts. The student scores from these questions are located in Appendix I. Pretest and posttest means were calculated and compared using the paired *t* test in R computing software. Following this analysis, the pretest and posttest questions were expanded to 12 questions to incorporate information relevant to the stomach and lesser sac tutorial (Appendix G). The answer key to these questions is located in Appendix H.

Logistics

Two days prior to the first scheduled abdominal anatomy lab, the videos and the pretest should be sent to the students via a file-sharing service such as Dropbox, with instructions that students complete the pretest before watching the videos, and that they should turn in this completed document during their laparoscopy session. Alternatively, students can download these materials from MedEdPORTAL. Students need to watch both videos prior to the lab session, and they can be viewed on personal computers using standard media player software.

The anatomy lab includes six 30-minute sessions, in which approximately 22 students at a time leave their cadaver lab to participate in this laparoscopy session taught by colorectal surgeons and general surgery residents. We have made a laboratory guide available to instructors (Appendix D) that includes session learning objectives and suggestions for implementation and for navigation inside the abdomen.

Following the laparoscopy session, students should be given the survey (Appendix F) to capture their opinions both on the video tutorials they just viewed, and on the general use of laparoscopic videos for medical student anatomy education. Using a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*) students respond to questions regarding the usefulness of the tutorials and pullout session. There is also an area to provide open-ended feedback. Feedback data from the original sample is located in Appendix E. Finally, the students are administered the posttest (Appendix G).

Results

Of the 127 medical students attending the anatomy lab, 64 (50.3%) completed the survey. The survey results are displayed in the [Table](#). Overall, students responded very positively to the video tutorials. When asked if the videos were influential in various aspects of the curriculum, the students agreed or strongly

agreed across all of the categories. Nearly all respondents (98.4%) felt the videos were a valuable addition to cadaveric dissection, and 86.0% wished for access to additional surgical videos throughout the anatomy course.

Table. Survey Results

Item	<i>M (SD)^a</i>	% agree or strongly agree
Helped me learn the anatomy of the gastroesophageal junction and diaphragm.	4.37 (±0.58)	95.3
Helped me learn the anatomy of the lesser sac.	4.33 (±0.59)	93.8
Valuable addition to dissection of cadavers.	4.53 (±0.53)	98.4
Helped understand aspects of anatomy not able to be learned through dissection of cadavers.	4.30 (±0.71)	86
Helped me identify structures during the laparoscopic session.	4.48 (±0.56)	96.9
Would like more surgical videos available during anatomy.	4.48 (±0.59)	95.3
Interested in a laparoscopic anatomy elective.	4.31 (±0.82)	77.4
Made more interested in surgery as a career.	3.77 (±1.06)	54.8

^aFive-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).

Additional comments supported the above findings. Students indicated that the tutorials helped them gain a strong understanding of the fresh cadaver laparoscopic demonstration. They also indicated that they enjoyed seeing anatomy in a more clinically applicable setting. Examples of such comments included the following:

- “The videos were a really great way to see the anatomy in a more clinical and applicable setting; would love more for other areas!”
- “It was very helpful to have exposure before the session; much more useful time during the session once I knew what to expect!”
- “I liked having the picture images placed next to the videos. That helped orient me and connect the dots.”
- “Awesome!”

Of 60 medical students in the surgery interest group attending their elective session, 33 (55%) chose to participate in our activity and completed identical pre-and posttests before and after watching the tutorial on the gastroesophageal junction. The test had a maximum score of 12 out of 12. No student scored worse on the pretest than the posttest, and improvements from across the two tests ranged from 1 to 11 points (8.3% to 91.7% improvement). On average, the students scored 39.4% ($SD = \pm 16.3\%$) on the pretest, and 88.1% ($SD = \pm 10.2\%$) on the posttest. Using a paired *t* test, the difference in scores of 48.7% ($SD = \pm 19.8\%$) between these two tests was significant ($p < .0001$).

Discussion

The increased prevalence of laparoscopic surgery, coupled with the increased use of video recording during these procedures and the availability of video editing technology, can provide anatomic educators with a valuable set of instructional resources. Although video of procedures has been effectively incorporated into instruction,^{12,13} there is little published work on video tutorials that apply video-editing software and multimedia-specific educational principles. We have created tutorials that incorporate graphics, text, intermittent comprehension questions, freeze frames, anatomical illustrations, and audio narrations that guide the novice viewer through laparoscopic views of the abdominal anatomy. Students can view these videos using readily available technology allowing for inexpensive and reliable access. When paired with a live demonstration in fresh cadavers, students are enthusiastic about this approach, and their interest in anatomy, laparoscopy, and surgery as a career is deepened. These results illustrate that video tutorials can enrich the educational experience when used in conjunction with a cadaveric anatomy lab.

Students strongly indicated that the videos helped them understand aspects of anatomy they were unable to learn about through dissection of cadavers, and that the videos helped them identify structures through a laparoscope in real-time. These findings suggest the potential application of video tutorials as a standalone resource for learning aspects of the abdominal anatomy outside a cadaver lab. These tutorials may also be of great value to students learning surgical anatomy in the operating room as part of a surgical core clerkship or elective.

In the follow-up study conducted after the original lab session, we found a dramatic improvement in pretest/posttest results after students watched the tutorial on the gastroesophageal junction. While there was likely a priming effect from viewing the questions before watching the video, the end result was highly encouraging, with all students improving their scores and half the group recording perfect scores or missing only one question. These quantitative measures corroborate the high scores in learner enthusiasm and perceived value recorded in the initial session, and provide further evidence of the value of the tutorials in short-term retention of anatomic information.

There are several limitations to this study. The near-unanimous support among respondents excluded students who did not watch the tutorial, chose not to attend anatomy lab, or did not complete the survey. Such students may reflect a sample of medical students for whom tutorials are either not valued or not preferred. Similarly, in the second administration of this module where pretests and posttests were used, some students in the elective chose not to participate in our learning activity; this group that may have approached our method with lower enthusiasm and would have potentially improved less dramatically. Further work is needed to quantify whether incorporation of similar tutorials has an effect on long-term educational outcomes in addition to short-term ones. Finally, additional work is warranted to provide effective tutorials for these anatomical areas as well as others, across the various levels of medical and surgical education.

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Ethical Approval

This publication contains data obtained from human subjects and received ethical approval.

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