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Teaching cross-sectional anatomy in parallel with gross anatomy through a curriculum incorporating CT scanning of cadavers

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Introduction:

Navigating and interpreting cross-sectional medical image sets are important skills used by most physicians to apply anatomical knowledge to patient care. However, few medical schools provide formal instruction in understanding cross-sectional anatomy, which requires active interaction with medical image sets and synthesis of three-dimensional understandings from multiple two-dimensional images. For these reasons, a curriculum was developed in which the medical school gross anatomy cadavers were CT scanned prior to dissection, and CT images of specific cadavers were correlated both to labelled atlas images and to direct structural observations of those same cadavers during dissection.

Figure 1: Transportation of cadavers from the gross anatomy lab to the clinical CT scanner. A. Freight elevator. B. Underground utility tunnel. C. Hospital freight elevator. D. CT scanner.

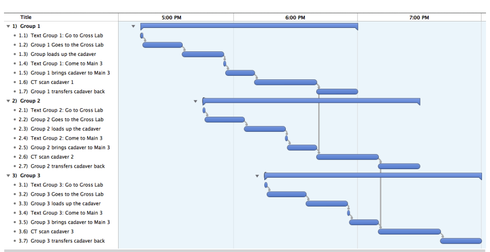

Figure 2: Transportation and scanning schedule. Groups were intricately timed so that multiple groups overlapped during the lab introduction session, transportation to the CT scanner, scanning, and transportation back to the lab.

Description of innovative practice:

In this ongoing educational initiative, 32 gross anatomy cadavers were CT scanned just prior to the start of the medical school gross anatomy course. Each group of about 7 students was assigned a specific evening time for "cadaver call" when they reported to the gross anatomy dissection lab, received a short introduction to the lab, and helped transport their cadaver to the Department of Radiology, located in a separate hospital building. The CT images were uploaded to an online medical image hosting service, image32.com, which allowed the students to access the cadaver CT images from any computer and from any location.

In an afternoon workshop early in the course, the students were given instruction in active image navigation and analysis, including the skills of image scrolling, zooming, panning, and grayscale rewindowing. Radiology learning objectives were provided to parallel each musculoskeletal dissection module, including a list of structures to compare on labelled cross-sectional atlas images, the cadaver CT images, and the cadaver directly during dissection.

On 5 occasions during morning dissection sessions, a radiology teaching group of 1 attending and 11 first-year radiology residents visited the gross anatomy dissection lab for about 2 hours, to facilitate the learning of imaging anatomy, demonstrate radiology-anatomy correlations, and discuss the unique imaging findings of each cadaver. The students were tested with 4 cross-sectional images on their musculoskeletal practical exam, where structures on cadaver CT images were presented as unknowns.

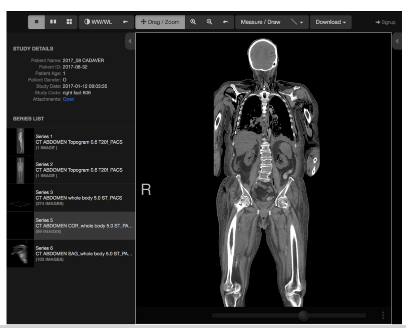

Figure 3: Simple user-friendly interface of image32.com.

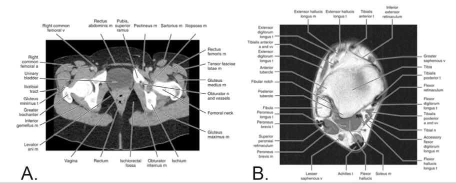

Figure 4: Examples of labelled cross-sectional atlas images.

Learning objectives:

- Recognize normal musculoskeletal structures and landmarks on cross-sectional CT images.
- Navigate CT data sets in axial, coronal, and sagittal planes, to mentally synthesize three-dimensional understandings of individual cadaveric structures, and correlate these understandings to the same structures observed directly during dissection.

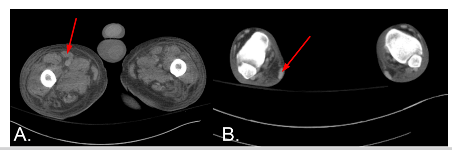

Figure 5: Examples of practical exam questions using CT images.

Student perceptions of the course:

Prior to CT scanning the cadavers, a brief online pre-course survey was administered, asking students to rate their perceptions of the imaging curriculum from 0 to 10. At the conclusion of the course, a brief online post-course survey was given to the students, with the same questions asked again, and a free-text box to give general feedback or ideas for improvement. Average interest in learning to interpret radiologic images, and comfort viewing and interacting with CT images, both had increased significantly at the end of the course.

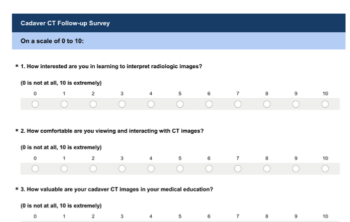

Figure 6: Pre-course and post-course survey questions.

Reflective critique:

Several opportunities to improve this educational initiative were discovered. First, radiology team visits to the gross anatomy lab during dissection sessions could be better coordinated so that each group receives more uniform teaching. After the course, student perceptions of the value of cadaver CT imaging in their education decreased significantly from an extremely high pre-course average. Ideally, this high level of initial enthusiasm would be maintained throughout the course. In free-text responses, many students indicated a desire for radiology modules to parallel pulmonary, gastrointestinal and reproductive dissection sessions, and these additional modules may further enhance the value of this educational approach.

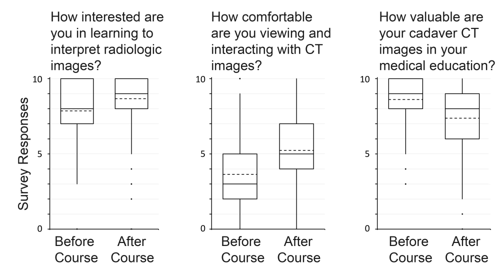

Figure 7: Box-and-whisker plots of survey responses. Dashed lines indicate means. All changes in means were significant ($p < 0.01$).

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