3D printed model of the mediastinum for cardiothoracic surgery resident education

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Purpose
Mediastinoscopy remains the gold standard for mediastinal lymph node staging, but residents are performing fewer of them with the development of endobronchial ultrasound. We hypothesized that a three-dimensional (3D) printed model of the mediastinum would be an effective tool for teaching residents the anatomy and techniques for mediastinoscopy.

Methods
Computed tomography images were segmented using Materialise Mimics (Materialise, Leuven, Belgium), and a color model of the mediastinum was 3D printed using a Stratasys J735 (Stratasys, Eden Prairie, MN). The sternum was printed so it could be detached from the model to increase visibility of the mediastinal structures, and a pretracheal space was created to fit a video mediastinoscope (Figure 1).

Figure 1. The final 3D-printed model of the mediastinum, (A) from the anterior right side and (B) from the right side with mediastinoscope inserted.

For two years, residents and attendings were asked to provide an online skills assessment after every mediastinoscopy. During the second year, all residents received standardized instruction for mediastinoscopy using the 3D model, and the model was available in the operating room for review (Figures 2 and 3).

Resident self assessment and attending assessment scores were compared between the residents taught with and without the 3D model.

Results
There were 51 resident self assessments and 65 attending assessments completed over two years. (Residents and attendings could complete more than one assessment). General surgery, integrated cardiac residents, and traditional thoracic and cardiac track fellows were included.

Residents taught with the 3D model (n=22) were more likely to respond “well” or “very well” for three of the four self assessment questions. Attendings were more likely to respond “very well” to two of the assessment questions. (Figure 4)

Figure 4. Resident self assessments (A) and attending assessments (B) comparing instruction without and with the 3D model.

Conclusion
A novel, 3D printed model of the mediastinum was an effective tool for teaching cardiothoracic surgery residents the anatomy and techniques for mediastinoscopy, as measured by resident self assessment and attending assessment. 3D printing is a promising technology with many potential applications in cardiothoracic surgery resident education.

Figure 2. Teaching sessions using the 3D model and the video mediastinoscope.

Figure 3. View of the carina in the 3D model using the video mediastinoscope.

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