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Commentary: Is the juice worth the squeeze?

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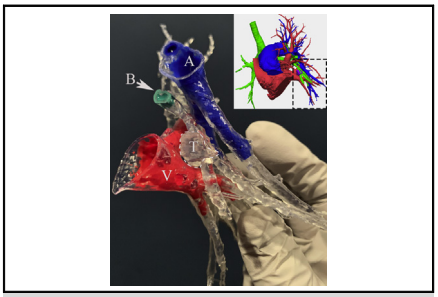

Three-dimensional model of the left lower lobe airway and vasculature.

CENTRAL MESSAGE

Three-dimensional modeling is resource-intensive for thoracic cases, but this is improving. Some surgeons may benefit by assimilating this complex imagery to enhance their operative techniques.

In this issue of the *Journal*, Mun and colleagues[1] present an interesting case report of 2 anatomic variations for which 3-dimensional (3D) modeling aided surgical planning and execution. This technology is steadily making inroads into surgery but requires considerable equipment and human resources to produce and view clinically useful models. Is the effort worth it? Well, it depends.

First, there is an investment of hardware, software, training, and information technology coordination to link and process data obtained from high-resolution computed tomography (CT) images. The 3D models are generated by linking the surfaces of various anatomic structures from thin slice to slice (segmenting) into a mesh.[2] The computer often must be shown which elements of similar radiodensity are related and then what structures should be included in the model. Although some software packages are more automated, generally a considerable amount of time is needed to accomplish this. If surgeons are lucky, the aforementioned resources may already be in place at their institutions as part of enhanced CT scan software packages.

Once created, the model is presented for interpretation in a format that that varies by the surgeon's needs or preferences. Some only need a mouse to rotate the model on a 2D-dimensional screen while others may benefit from a 3D monitor or wearing a virtual reality headset to manipulate the images. Additional software-based work refines the 3D mesh into a printable physical model that has the greatest reliability of communicating complex anatomy for surgical planning.[3] It can also be used as a patient teaching tool as well as dangled near the operative field for immediate reference during a case.

Some institutions have embraced this effort. Figure 1 was printed at my hospital to help plan a left anterior basal segmentectomy for a carcinoid tumor. We purchased the Myrian platform in surgery for this work; however, this was created by dedicated Food and Drug Administration–approved workflow in the radiology department using Materialise Mimics (segmentation] and Materialise 3-matic to create the STL file for 3D printing (Formlabs Ecosystem) using philanthropic grant support.

Although complex tumors can take hours, cases like that shown in Figure 1 average 1 hour for segmentation and an additional hour for STL preparation by an experienced radiologist. Each model is printed overnight within approximately 12 hours. The print is then postprocessed manually the next day, which usually takes 1 to 2 hours of manpower. Although resource-intensive, the technology has improved; in our earlier reports, it took 10 hours of work just to segment a pulmonary model.[4] Unfortunately, the models cannot yet be readily converted to the deflated lung state on which we operate; however, if surgeons can spare lungs by better planning and avoidance of vascular complications, it probably is worth the cost.

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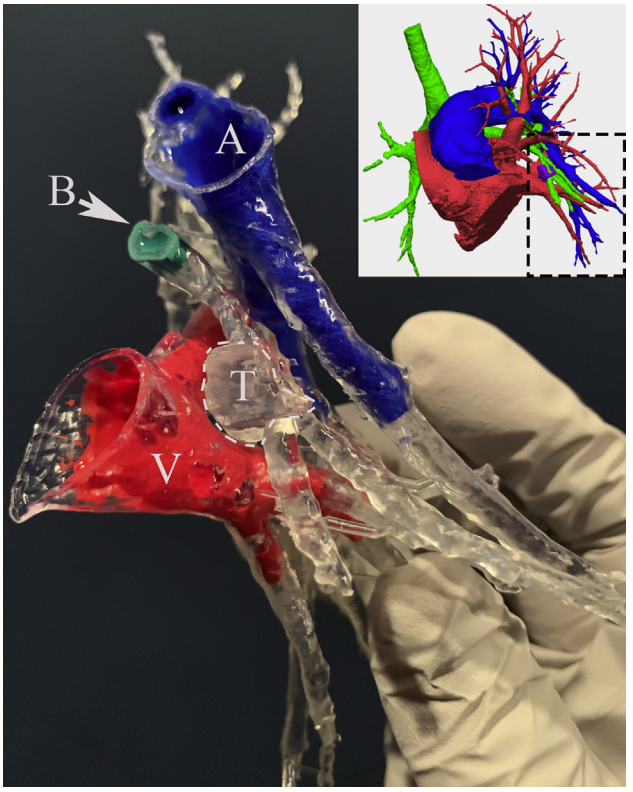

FIGURE 1. 3D printed model of the left lower lobe segmental anatomy portion of a larger rendering (*Inset*). A, Pulmonary artery. B, Lower lobe bronchus orifice. T, tumor in anterior segmental bronchus; V, inferior pulmonary vein. (Original images courtesy of Dr Larson Hsu.)

While we appreciate the need to support common categories of workplace diversity, it is important to note that neurocognitive optical processing differs among individuals and changes with age.[5] Thus, surgeons or administrators might not appreciate how enabling this technology could be for some of their colleagues and may fail to support it.

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