SPECT/CT Aids in Appropriate Patient Selection for Lung Cancer Surgery

For many patients diagnosed with lung cancer, particularly those with early-stage non-small cell lung cancer (NSCLC), surgery is a viable option. These procedures range from the removal of the entire lung (pneumonectomy), removal of a lobe (lobectomy) or part of a lobe (segmentectomy or wedge resection), and sleeve resection, typically used for tumors in large airways of the lungs.[1]

However, one of the most important considerations in determining the appropriateness of surgery in lung cancer patients is not only whether the disease has spread beyond the lung to other organs or tissues, but also the patient's lung function. A lung ventilation/perfusion (VQ) scan is often used to measure air and blood flow in the lungs. VQ scans involved the injection of a radioisotope that is then imaged using a nuclear medicine camera.[2]

According to Michael M. Graham, MD, PhD, Professor of Radiology-Division of Nuclear Medicine and Professor of Radiation Oncology at the University of Iowa and a past president of the Society of Nuclear Medicine (2009-2010), SPECT/CT lung imaging helps predict post-operative lung function.

"With excellent lung function, it doesn't matter if the surgeon takes out the entire lung; the patient manages to get along quite well," Dr. Graham explains. "However, in borderline lung function situations, the patient may wind up not coming off the ventilator after surgery. So they are stuck with mechanical ventilation the rest of their life, which is an awful situation."

The main predictor to estimate post-operative lung function is the forced expiratory volume in 1 second (FEV1), or how much volume a patient can blow out after taking a deep breath. "If that number is below 1 liter, that puts the patient in a very precarious situation," Dr. Graham explains. "We would like to see the predicted post-op FEV1 to be greater than 1 liter."

While planar imaging has historically been utilized for estimating post-operative FEV1, the University of Iowa has also used SPECT imaging for this study. The disadvantage of using planar imaging is the lack of anatomic features—it doesn't reflect what the surgeon is going to do, Dr. Graham explains. As the fissures between the lobes run in a diagonal fashion, post-lobectomy lung function can't be predicted based on the horizontal region-of-interest that nuclear medicine physicians create when they segment the lung into upper, middle, and lower lobes. For instance, the middle or upper lobe might be markedly hypo-ventilated, but this information is mixed in with the lower lobe as the lung is segmented.

"The ideal situation would be to acquire the perfusion and ventilation using SPECT imaging and then segment the lower, middle, and upper lobes, on the right and left, so that you could independently report the ventilation and perfusion in those lobes," Dr. Graham says.

Although the software to perform this type of lobar analysis with SPECT/CT has just recently been cleared by the FDA, Dr. Graham is still able to provide an analysis based on his current interpretation that is useful to the surgeons. "We don't need high precision, but I think the surgeons would be more comfortable and they certainly can predict more accurately post-operative FEV1 if we had this type of lobar analysis."

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>
> *Dr. Michael M. Graham*

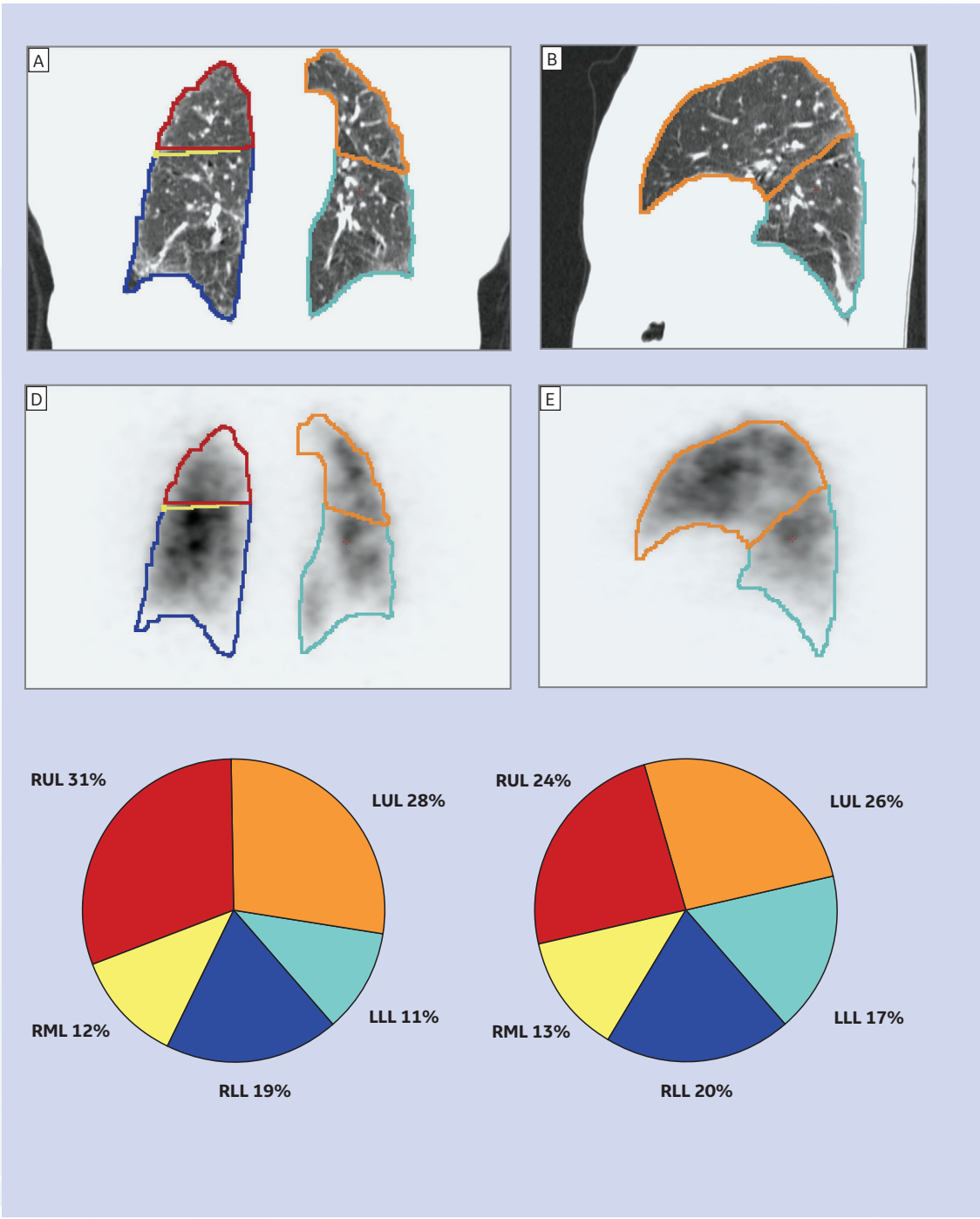
The most significant limiting factor, however, is the absence of Technegas (99mTc-nanoparticles/99mTc-Technegas) as an available ventilation agent in the US. Dr. Graham says it is available and widely used in Europe, but has not received US FDA approval. As a result, many sites in the US utilize Tc-99m DTPA aerosol, a technetium agent, or Xenon-133.

"However, Xenon does not lend itself to doing SPECT imaging, so it won't work. The literature clearly shows that Xenon is not the way to go. DTPA is also not ideal, as it slowly washes out of the lung during the acquisition period," Dr. Graham explains. "So we use Technetium-99m sulfur colloid, which is better than DTPA but not as good as Technegas—but it does work quite well."

Further, Dr. Graham notes that having an automated or semi-automated method for measuring the size of the tumors in 3D would also be useful for predicting a lung cancer patient's post-op outcome. It can be performed on CT, SPECT or PET, or any hybrid combination thereof, and would be useful in assessing response to therapy. With PET, the physicians also look at the degree of uptake in the tumor quantitatively, using SUV, to assess the response of the tumor to treatment. Adding other measures, such as a reproducible and objective measurement of the tumor size, would also be very useful, he adds.

"If we had this software, we would perform our quantitative lung studies with SPECT," Dr. Graham says. "We would have to explain to our surgeons how this differs from the information that we used to give them, but we would start doing that immediately."

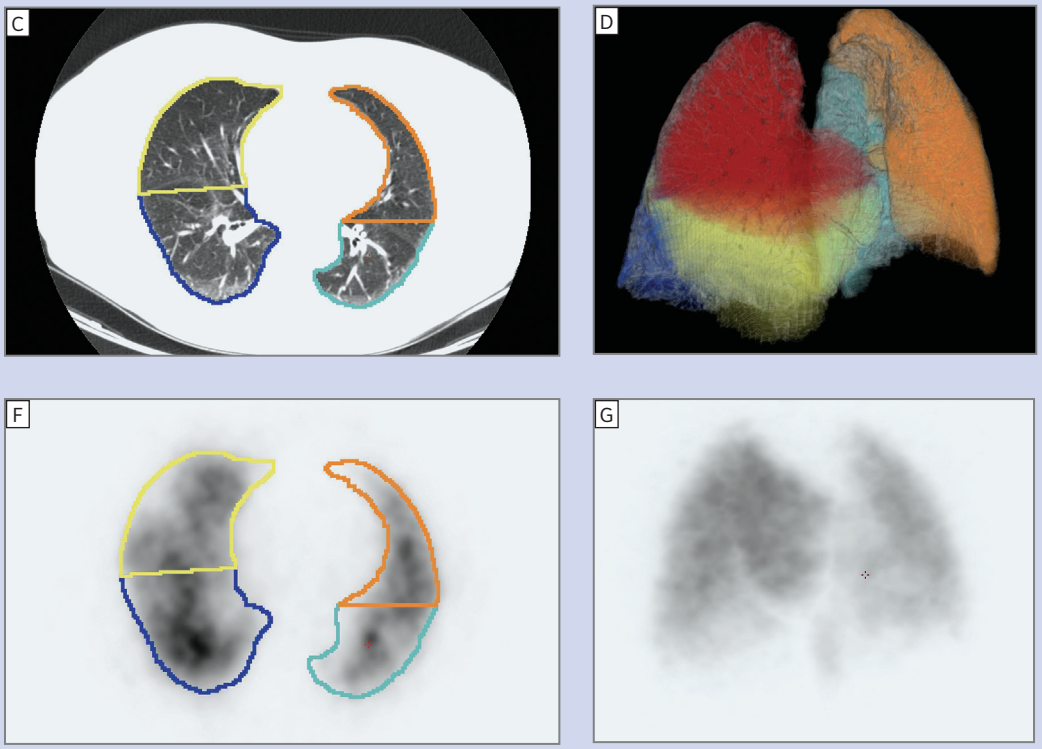
Dr. Graham explains that since the vast majority of lung scans at the University of Iowa are performed using SPECT, it would be very easy to migrate these studies to SPECT/CT.



However, he is also concerned regarding the low utilization of lung SPECT and SPECT/CT in the US. In the US, Dr. Graham estimates only 10% of sites are using SPECT imaging, while in Europe, Canada, and Australia that number jumps to 26-65%.[3] This chasm may partially result from differing guidelines between the SNMMI and the EANM.

"Version 4 of the SNM guidelines for lung scintigraphy published a few years ago[4] recommended planar over SPECT. At the same time, the European society published their guidelines saying just the opposite[5]," Dr. Graham says. While he believes the tide is turning toward the use of SPECT or SPECT/CT and away from planar imaging in the US for lung imaging, there is a need for continued education among nuclear medicine physicians on the value of SPECT imaging. He also believes that clinical studies published in surgery and pulmonary peer-reviewed journals—not just nuclear medicine—could help drive higher appropriate utilization of SPECT or SPECT/CT.

"By performing diagnostic CT in nuclear medicine, it would be advantageous for a one-stop shop," Dr. Graham adds. "The perfusion-ventilation along with a high-resolution diagnostic CT would be useful to help guide the surgeon." ■



	Right				Left		
	RUL	RML	RLL	Total	LUL	LLL	Total
Counts (kcts)	31% 2678	12% 1022	19% 1638	61% 5338	28% 2415	11% 995	39% 3410
Volume (ml)	24% 554	13% 299	20% 470	57% 1323	26% 594	17% 404	43% 999

Figure 1. Example of a lung segmentation study demonstrating the assessment of lung lobe fractions using both high-resolution CT and perfusion. (A-C) CT coronal, sagittal, and transaxial superimposed with fissures; (D) hybrid CT with IRNC perfusion 3D; (E-H) IRNC perfusion coronal, sagittal, transaxial, and MIP. Pie charts (left to right) show lobar counts distribution and lobar volume distribution; table depicts values of lobar distribution.

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