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Commentary: Through the looking glass—radiomics and evaluation of early lung cancer

Ashok Muniappan, MD

“We are drowning in information, while starving for wisdom.”

—E. O. Wilson,

Consilience: The Unity of Knowledge, 1998

In this issue of the *Journal*, Yoshiyasu and colleagues¹ report that a radiomics technique was effective in identifying less-invasive adenocarcinomas that may be suitable for sublobar resection. In a cohort of 212 resected lung adenocarcinomas, their quantitative imaging analysis and CART (classification and regression tree) model was highly accurate in predicting which lesions were less invasive (either adenocarcinoma in situ or minimally invasive adenocarcinoma rather than invasive). The imaging analysis of preoperative noncontrast computed tomography scans of the chest quantitated 7 radiographic features: tumor volume, solid volume percentage, mean computed tomography Hounsfield unit value, variance, kurtosis, skewness, and entropy. The last 4 of these variables are standard statistical “first-order” measures of individual voxels (a point in 3-dimensional space), which are features not readily appreciated by the naked eye and require the “looking glass” of computerized image analysis. Of these variables, only tumor volume, solid volume percentage, skewness, and entropy were significant and independent predictors of tumor invasiveness and used in their predictive model.

Although the study is a good illustration of the potential for radiomics and heralds an era in which surgeons will increasingly offer “personalized” options for individual tumors, several significant barriers to widespread adoption of this technique should be acknowledged. Uniform image-acquisition

Alice steps through the looking glass. Illustrated by John Tenniel (1820-1914).

CENTRAL MESSAGE

Radiomics is a relatively new and evolving technique for predicting tumor characteristics. Advanced imaging analysis of preoperative CT scans may identify less-invasive pulmonary adenocarcinomas.

parameters, accurate and reproducible tumor segmentation (outlining the tumor borders), relevant feature extraction (more than 500 different imaging features underpin some radiomics studies), robust model training and validation (ideally using large and external datasets for testing), and finally standardized reporting are all lacking at present, despite the first such studies appearing more than a decade ago.² More sophisticated studies require massive datasets for training, and barriers to collaboration and sharing of imaging results from multiple centers is a particular challenge for radiomics.

Even after overcoming these obstacles, ultimately, radiomics will have to prove its worth by demonstrating that patient outcomes are improved. It is only a hypothesis that performing sublobar resection for less-invasive tumors selected by radiomics will be noninferior or superior to current practice. We are still awaiting the results of CALGB 140503 and JCOG 0802 to establish whether sublobar resection is appropriate for smaller and peripheral non-small cell lung cancers. These trials were started more than a decade ago and notably used standard imaging parameters and biopsy results to determine eligibility. One suspects post hoc analysis with radiomics of these trials will be informative and guide the implementation of advanced imaging analysis in lung cancer surgery.

As the use of radiomics in routine clinical practice will take some time, it is perhaps helpful to pause and examine how heuristics guide surgeons and patients in the selection of an operation at present.³ It is incredible how, in a matter of 15 to 30 minutes, surgeons and patients may arrive at an operative

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plan that factors in imaging characteristics, patient comorbidities, patient age, and yes, surgeon ability. Informing these heuristics are clinical studies, guidelines, and the individual surgeon's training and experience. If radiomics is to make a difference and encroach on current standards for decision-making, it will have to be simple to apply and clearly result in improved decisions or else face slow adoption.

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Commentary: Fear not the rise of the machines

Scott I. Reznik, MD

Contemporary medicine and computers have become irrevocably intertwined. Every image, note, and order flows through a microprocessor. Many physicians hate their computers, and some fear that we will become slaves to technology or be replaced by it.¹ We should harness the capabilities of machines to see what our eyes cannot so we can make the decisions that the machines cannot. Artificial intelligence has not yet reliably surpassed the ability of clinicians, but the day is coming.²

Yoshiyasu and colleagues³ in this issue of the *Journal* describe the use of radiomics to differentiate between less-invasive adenocarcinomas such as adenocarcinoma in situ or minimally invasive adenocarcinoma from more-invasive cancers with an acceptable degree of sensitivity and specificity. Increasing use of computed tomography screening and incidentally detected nodules have left thoracic surgeons with therapeutic dilemmas. In the case of partially solid nodules, pretherapy knowledge that a particular lesion is an adenocarcinoma in situ or minimally invasive adenocarcinoma allows for greater flexibility in treatment planning. Many of these nodules can be difficult to localize and may require complex anatomic resections when they might be safely followed or treated

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CENTRAL MESSAGE

Computers are omnipresent in modern medicine. We should harness the ability of computers to detect what our eyes cannot and use that data to make better decisions for our patients.

nonoperatively. The authors provide a primer on radiomics and describe the process of quantifying several radiomic variables that cannot be discerned by the human eye but efficiently performed by a computer, such as variance, kurtosis, skewness, and entropy.

Yoshiyasu and colleagues created a model that combined 2 traditional “eyeball” variables (percent solid and tumor volume) with 2 “advanced” variables (entropy and skewness). Not surprisingly, the most important variable in the model is percent solid. This model was highly accurate at predicting less-invasive cancers.³ This technique appears easily scalable and applicable to an increasing number of patients with ground-glass opacities or semi-solid nodules in whom the decision to offer sublobar or nonanatomic resection may subject the patient to possible undertreatment, which would then force the patient and surgeon to consider reoperation if greater than minimally invasive adenocarcinoma is

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