Radiology: Cardiothoracic Imaging COMMENTARY

Pulmonary Fibrosis: A Guide for the Perplexed

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Pulmonary fibrosis remains a serious cause of morbidity and mortality, with an average survival of 3 to 4 years after diagnosis (1,2). The effort to combat pulmonary fibrosis is not restricted to academic medical centers, community hospitals, and the pharmaceutical industry, as other organizations have targeted pulmonary fibrosis. One such organization is the Pulmonary Fibrosis Foundation (PFF).

Founded in 2000 and headquartered in Chicago, Illinois, the mission of the PFF is to act as a trusted resource for all who are affected by pulmonary fibrosis (3). PFF programs include a care center network, a registry, and patient outreach including a patient communication center, an ambassador program, support groups, and educational materials. A PFF radiology working group has also been formed.

With the development of new and more effective pharmacological therapy for fibrosing lung disease, including idiopathic pulmonary fibrosis (IPF), thin-section chest CT has assumed an ever more central role in assisting the multidisciplinary approach to treatment. Recognition that earlier diagnosis can now lead to better outcomes underscores the need for a standardized and accurate approach to imaging. In this issue, the PFF Radiology Working Group has published a practical guide to assist radiologists in optimizing the performance and interpretation of thin-section chest CT in patients suspected of having IPF (4).

The introduction to this IPF guide addresses the important distinction between the term *interstitial lung disease*, which broadly denotes numerous different diffuse lung diseases, and IPF, which refers to a single well-defined entity. An overview of IPF is provided, including risk factors, typical clinical manifestations, and findings at pulmonary function testing. The traditionally grim prognosis of IPF is also cited.

In the following section, the authors describe briefly the role of chest radiography and MRI in IPF. Chest radiography has the benefit of wide availability but lacks sensitivity, and its primary value is to exclude alternative diagnoses such as pneumonia. The authors note that MRI provides inadequate visualization of the lung interstitium and is mainly used for research purposes in diseases such as sarcoidosis and cystic fibrosis.

Much of the modality overview section is devoted to technical specifications for thin-section CT. Proper patient coaching by technologists is critical to avoid respiratory motion artifacts that can lead to image degradation and misinterpretation. For inspiratory scanning, the authors recommend the use of a section thickness of less than or equal to 1.5 mm with contiguous volumetric imaging to allow for coronal reformats. They note that coronal reformats are valuable to distinguish bronchiolectasis from honeycombing. Maximum intensity projection and minimum intensity imaging can also be useful to identify micronodules and air trapping, respectively. The authors recommend a moderately edge-enhancing kernel and the use of iterative reconstruction in all cases. Finally, for what is defined as a complete scan, the authors advocate two additional acquisitions: an expiratory scan typically performed with noncontiguous parameters to evaluate for small airways disease and prone imaging, which can be useful to distinguish mild subpleural reticular disease from benign dependent atelectasis.

The authors highlight the important role of follow-up thin-section CT imaging in evaluating the course of IPF. Sequential assessment can be done using a subjective or objective approach. The subjective method employs semiquantitative visual methods and has been well-validated for determination of disease progression. However, the lack of precision has encouraged research to develop an objective strategy. One such approach described by the authors combines textural analysis and machine learning techniques to define healthy and abnormal lungs, which can then be correlated with pulmonary function testing and other metrics.

The succeeding section of the article describes the optimal search pattern to use, including inspection of

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See also the article by Hobbs et al in this issue. Conflicts of interest are listed at the end of this article.

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extrapulmonary regions that may shed light on the diagnosis, a description of the anatomic components of the lung parenchyma, and definitions of several abnormal lung findings related to the presence or exclusion of IPF. The latter are derived from the 2008 glossary of imaging terms from the Fleischner Society (5). This is followed by a guide to confusing parenchymal findings.

The crux of the article is a description of the imaging findings of IPF and the usual interstitial pneumonia (UIP) pattern, as well as the diagnostic categories of IPF on thin-section CT scans. Importantly, the authors note that the UIP pattern can be found in conditions other than IPF, including connective tissue diseases, drug hypersensitivity, and chronic hypersensitivity pneumonitis. An imaging differential diagnosis for IPF is provided, consisting of entities such as nonspecific interstitial pneumonitis, hypersensitivity pneumonitis, and sarcoidosis, among others. The role of histologic findings is emphasized, and the authors explain the integration of the radiographic, histologic, and clinical information to arrive at a final diagnosis.

The final sections of the article detail the key elements that should be included in the radiology report, including findings of IPF or alternative diagnoses and evidence for disease evolution and the role of radiologic and pathologic findings in concert with the clinical picture to arrive at a treatment course in the context of a multidisciplinary discussion. The article is accompanied by several tables outlining the imaging findings in IPF and other diseases, differences between the two major recent guidelines on IPF, and approaches to structured reporting. Numerous supporting images cover the full range of IPF appearances and competing diagnoses.

With respect to technical specifications of thin-section CT, it is worth mentioning a few additional considerations. The advantages of acquiring reformatted imaging go beyond the ability to distinguish honeycombing and bronchiolectasis. Coronal reconstructions, in particular, allow for assessment of lung volumes and provide a surrogate marker of pulmonary function tests. For example, a patient with typical IPF would be expected to have diminished lung volumes, whereas the lung volumes would be closer to normal in a patient with combined pulmonary emphysema and fibrosis. Equally important, coronal reconstructions permit a more optimal assessment than axial images of the cranial-caudal distribution of disease, frequently permitting distinction of basilar-predominant processes such as IPF and upper lung–predominant diseases such as sarcoidosis.

For CT scan protocols, the authors note that a "complete" scan includes expiratory and prone imaging in addition to standard inspiratory supine imaging. While it would be ideal to include these additional acquisitions, the reality is that they are often not routinely obtained when the clinical indication suggests a high suspicion of IPF, particularly in a busy clinical practice. Optimizing expiratory scans can be challenging due to lack of compliance with breathing instruction and resultant difficulty in maintaining an expiratory phase. Moreover, air trapping, the main reason for expiratory scanning in UIP, is frequently visible on inspiratory scans. Prone imaging requires that the patient remain on their stomach for a considerable length of time, a position difficult to maintain in patients who are short of breath. In the large majority of cases, the pathologic findings are sufficiently evident on inspiratory supine imaging to obviate prone imaging.

The information in this article is to a considerable extent a synthesis of two guideline articles published in 2018, one from the Fleischner Society and the other a multisociety document led by the American Thoracic Society (1,2). The authors note the overall similarity between the two guidelines. They point to a key difference in the diagnostic strategy part of the recommendations in the setting of an unknown cause of disease and probable UIP pattern at thin-section CT. Beyond that, while the differences between the two statements in the image categories of UIP are not large, one item of categorization that may cause inconsistent interpretation is in the distribution component of the indeterminate for UIP category, which the Fleischner Society statement describes as "variable or diffuse; not predominantly subpleural or basal" and the ATS-led guideline denotes as "subpleural and basal predominant."

Relative to the multidisciplinary diagnosis group, although the reference standard for determining a final diagnosis remains open to debate, and the repeatability from one institution to the next when faced the same data has yet to be shown convincingly, the exercise is nevertheless worthwhile. Much is revealed during a review of the data by different medical specialists. However, it is important that the radiologist participant understand the particular dynamics and interplay within their multidisciplinary group and recognize that the final diagnosis depends on more than just objective science.

The development of antifibrotic medications in recent years provides an unparalleled opportunity to slow the progression of IPF, heightening the importance of a precise imaging diagnosis. This timely article provides a comprehensive overview of imaging and its integration into the algorithm for the diagnosis and treatment of IPF. The document will be of use to all radiologists and, in particular, community practitioners who it will assist in navigating the bewildering array of diagnostic possibilities on thin-section CT scans.

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