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Review Article

Radiographic Findings of Respiratory Diseases

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Abstract

Introduction: In order to diagnose and monitor respiratory illnesses, imaging is crucial. The care of patients and the identification of prognostic variables can be aided by chest radiography, bedside lung ultrasonography, and computed tomography scans are other imaging modalities. Because imaging results are not always specific, it is important to consider a number of potential differential diagnoses. There have only been a few large-scale, controlled comparison trials using various radiological procedures. Initiating a diagnostic examination with a chest X-ray gives a broad orientation and is particularly helpful for detecting pneumonia, malignancy, and chronic obstructive pulmonary disease (COPD). At a far lower radiation dose than before-only 0.2 - 5 mSv-multidetector CT provides almost isotropic spatial resolution. The primary indications for it, according to current recommendations, are tumors, acute pulmonary embolism, pulmonary hypertension, pulmonary fibrosis, severe COPD, and pneumonia in a high-risk patient. The diagnosis of pulmonary embolism, bronchial cancer, pulmonary hypertension, and cystic fibrosis is made using magnetic resonance imaging (MRI).

Aim of the Study: This review article will present both established and suggested radiological techniques as well as recently developed techniques used in the treatment of the most significant lung diseases, highlighting their benefits and drawbacks, frequency of use, financial information, and radiation doses involved.

Methodology: Comprehensive research of radiographic findings of respiratory diseases. PUBMED search engine was the mainly used database for the search process, articles collected from the year 2001 to 2021. The term used in the search were: Chest x-ray, MRI, CT imaging, emphysema, asthma, pleural effusion, tuberculosis, aspiration fibrosis, pneumonia.

Conclusion: It is important to provide appropriate treatment without overusing diagnostic tests; the choice of radiological technology for the detection, staging, follow-up and quantification of lung illness should be based on specific clinical alternatives.

Keywords: *Chest X-Ray; MRI; CT Imaging; Emphysema; Asthma; Pleural Effusion; Tuberculosis; Aspiration Fibrosis; Pneumonia*

Introduction

People all across the world have been impacted by various lung diseases. Lung conditions increase the lungs' susceptibility to specific health issues and air pollution. Lung function is hampered as a result. Emphysema, asthma, pleural effusion, tuberculosis, and other lung conditions, as well as aspiration fibrosis, pneumonia, and lung cancer, can all cause the lungs to lose their adaptability, which reduces the amount of air that can be held in the lungs as a whole. Since lung disease is contagious, it's critical to diagnose the condition and give the patient the right care. Radiology can determine the pattern, location, and geographical distribution of involvement in the diagnosis of lung disease. Complementing traditional chest radiography, computed tomography (CT, now in the form of multidetector CT, MDCT) and magnetic resonance imaging (MRI) tomographic imaging techniques can demonstrate and quantify regionally specific functional processes like perfusion, respiration, and metabolism in addition to morphology. In order to assess illness progression and start necessary therapy modifications or further interventions, MDCT and MRI are frequently utilized in treatment monitoring and disease monitoring [1,2].

Various imaging modalities in respiratory diseases

Chest radiography

Radiologists typically work with chest X-rays to identify and diagnose lung illnesses. Chest X-rays can be used by radiologists to identify and diagnose various illnesses and other disorders. These conditions range from fractures to pericarditis and bronchitis, among many others. More than 2 million operations are conducted annually for lung disease [2].

Chest radiography is considered the most popular type of illness assessment worldwide. About 70% of the lung capacity can be freely visible in at least one projection, in which all anatomical structures in the X-path rays are overlaid on one another. The detection of lung nodules infiltrates and interstitial alterations can, therefore, only be made with a limited degree of sensitivity, making the differential diagnosis of aberrant findings difficult. The conventional film-foil combinations have been replaced by modern, fully digital X-ray equipment that is both fixed and portable [2,3].

Numerous lung disorders have been recognized by the use of chest radiography. There are at least three quadrants involved in bilateral, diffuse, patchy, or homogeneous lung opacities that cannot be adequately explained by pleural effusion, atelectasis, or nodules. There is a lot of interobserver agreement, but the best method of interpreting chest radiographs is still not clearly established. However, radiographic results are a crucial component of the diagnosis. The Berlin definition statement actually highlighted the limitations of chest radiographs and suggested that the requirements for chest radiographs be better clarified by developing a series of example radiographs [4].

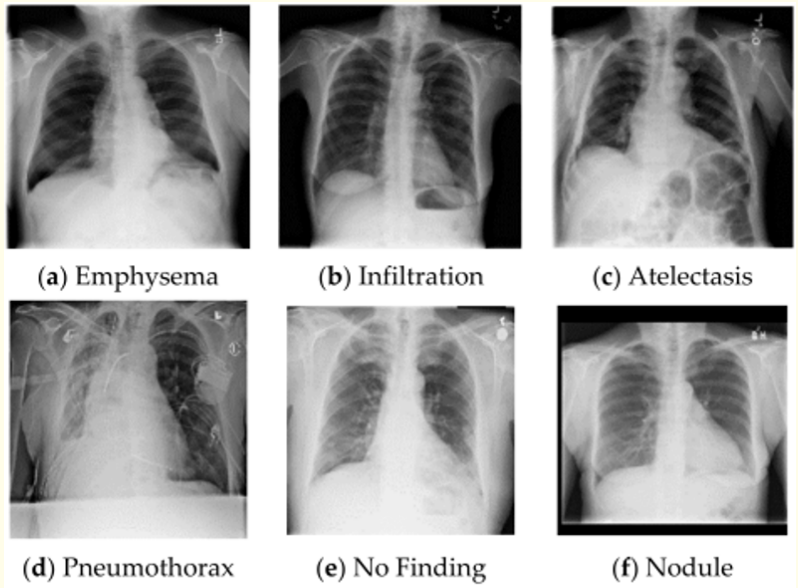

Figure 1: *Showing characteristic features of lung diseases; cardiomegaly, atelectasis, consolidation, edema, effusion, emphysema, hernia, fibrosis, mass, nodule, infiltration pleural thickening, pneumonia, and pneumothorax [4].*

Computed tomography

Multidetector CT (MDCT), which is widely accessible and has a high, practically isotropic resolution (pixel size 0.5 to 1 mm in every spatial direction). The acquisition duration is between 1 and 10 seconds; thus, even in patients who are dyspneic or unwilling to participate, almost artifact-free images can be captured. Since MDCT offers continuous imaging for the same radiation dosage, it has largely supplanted the formerly common incremental "high-resolution CT" (HRCT), which substantially simplifies disease monitoring. According to various studies, intravenous contrast agents are necessary for lung nodules discovered during the follow-up of extrathoracic original malignancies, as well as for airway and lung parenchymal illness. Conversely, intravenous contrast tests are necessary for the staging of bronchial cancer, assessment of blood vessels, and cardiopulmonary interaction [6].

Magnetic resonance imaging (MRI)

Structure and function are combined in MRI. Rapid sequences, parallel imaging, respiratory and ECG triggering, and fast sequences are used to generate clinically useful MRI investigations of the lung. The majority of lung disorders are marked by an increase in tissue, blood, and/or air displacement, which raises the signal on an MRI [7].

MRI allows for the supplementary functional analysis of perfusion, ventilation, respiratory mechanics, cardiac action, and blood flow in addition to morphology. With increased knowledge of the relationship between the heart and the lungs, a chest MRI should include both the heart and the lung, for example, using "one-stop" diagnostic imaging in those with pulmonary hypertension. The spatial resolution and study acquisition time (15 to 30 minutes) of MRI are drawbacks (pixel size approximately 2 mm) [7].

Diseases specific radiographic findings

Pneumonia

In addition to the history, clinical observations, and results of laboratory tests, radiographic evidence of infiltration is crucial for the diagnosis of pneumonia. Chest radiography in two planes is the preferred approach for treating outpatient-acquired pneumonia, per German recommendations (recommended grade B) [8].

This also holds true for the initial diagnosis of hospital-acquired pneumonia in patients with immunocompetent status (strong recommendation, evidence level C) (48h after hospital admission). For patients at higher risk, such as those with ventilation-associated pneumonia or the immune-compromised, non-contrast low-dose MDCT is recommended for the detection and characterization of infiltrates because the positive predictive value of chest radiography in comparison to CT is only 27% [9].

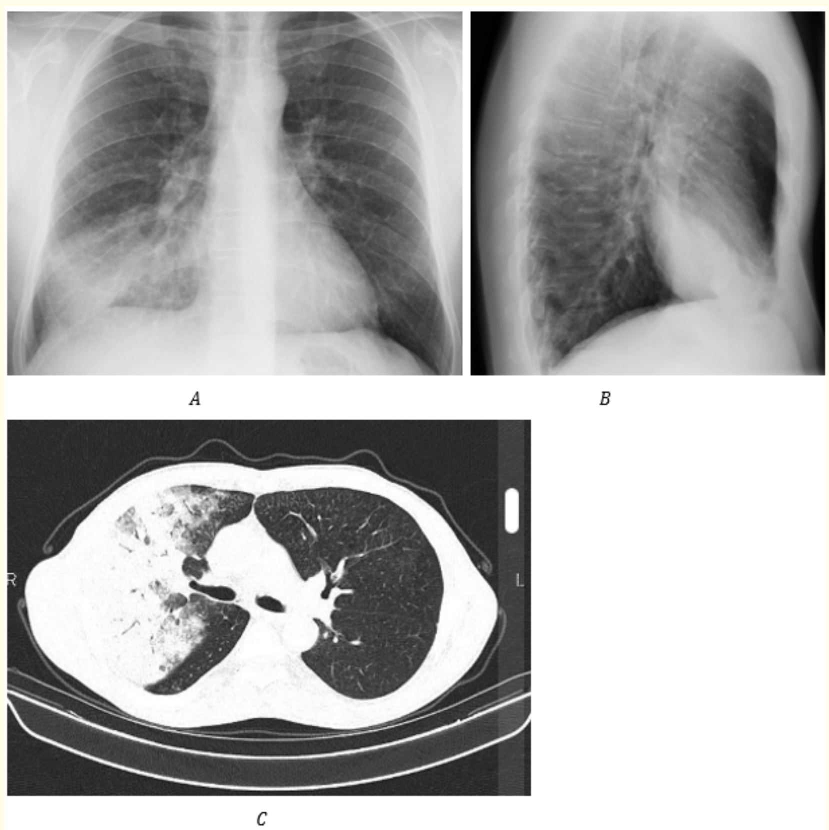

Figure 2: *Showing (a) Frontal and (B) Lateral chest radiograph for pneumonia, (C) MDCT to detect infiltrates [10].*

Bronchial carcinoma

The chest radiograph is frequently the first imaging modality to indicate the diagnosis of bronchogenic carcinoma due to its extensive availability, including to primary care physicians. Lung cancer can appear as a simple spiculated lump, but it can also be detected by other symptoms, including persistent pneumonia or lobar collapse. When a large contralateral mediastinal adenopathy or an apparent bony lesion is found, additional imaging may not always be required. However, chest CT scanning is frequently required due to the chest radiographs' poor sensitivity in detecting mediastinal lymph node metastases and chest wall and mediastinal invasion [11].

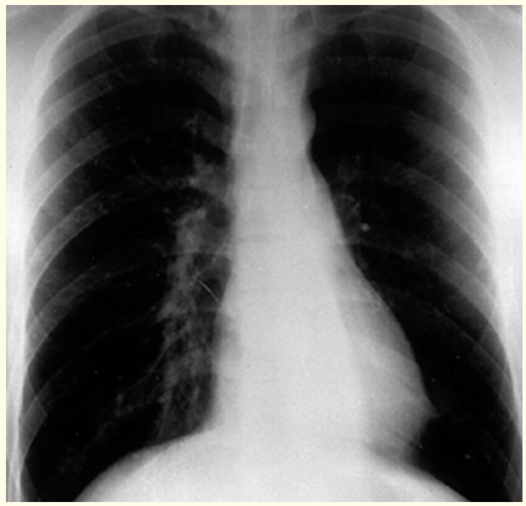

Figure 3: *Showing chest radiograph with findings; increased retrocardiac density as a result of the hilum being displaced inferiomedially and the left lower lobe collapsing, suggestive of bronchial carcinoma [11].*

The diagnostic features of lung nodules, such as arteriovenous fistulae, rounded atelectasis, fungal balls, mucoid impaction, and infarcts, can be seen on a CT scan. This diagnostic procedure is further improved by high-resolution scanning. Another advantage is that CT scanning can assess the entire thorax when a nodule is being assessed [11].

Thoracic contrast-enhanced the 2010 German recommendations state that the most important method for staging bronchial cancer is MDCT (recommendation grade A). Because of the strong, soft tissue contrast, MRI can more accurately discriminate between post stenotic atelectasis and central tumor portions, which is crucial when determining the radiation therapy target volume, for example. The guidelines also suggest using MRI as a dynamic examination tool to evaluate infiltrations of the mediastinum or chest wall. When a tumor is in contact with the spine or has a superior sulcus tumor (Pancoast tumor), MRI should be performed specifically as part of preoperative preparation [12].

Vascular conditions

The diagnosis of acute pulmonary embolism (APE) has been universally accepted as being made using contrast-enhanced MDCT, which has the highest sensitivity (83% to 100%) and specificity (89% to 97%) and is readily available. In addition, scintigraphy and invasive angiography have been replaced as the primary imaging procedure in the current German guidelines. In order to detect a central pulmonary embolism within a few seconds, this investigation should be performed first without the introduction of contrast material and using contrast-rich fast imaging sequences. If the MRI does not reveal a central pulmonary embolism, it is continued as a perfusion study and MR angiography [13].

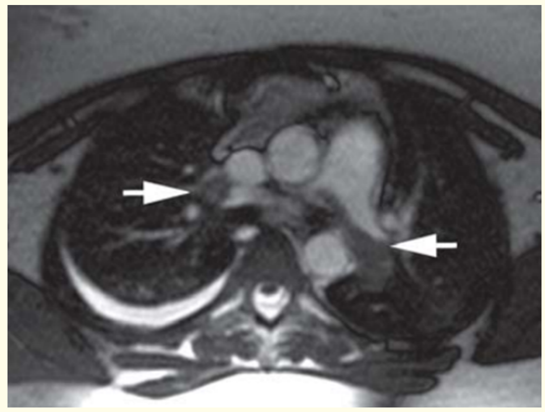

Figure 4: Showing without the use of contrast, axial MRI reveals central and peripheral filling abnormalities in the pulmonary artery, some of which are partial (arrows), equivalent to a large pulmonary embolism [10].

Obstructive airway disease

The likelihood of survival among fair-skinned individuals with cystic fibrosis, which is the most prevalent life-limiting autosomal recessive disease, depends on how severely the lung is affected. It is still up for debate as to whether and at what ages standard diagnostic imaging should be undertaken [14].

According to German recommendations, depending on local competence and the clinical condition, a chest radiograph, MDCT, and MRI should be performed (recommendation grade B). When it comes to detecting typical lung alterations, MDCT is more accurate than a chest radiograph. As a method for identifying problems or tracking the progression of the disease, MRI is rapidly taking the place of MDCT [15].

This, with clinical significance, displays the typical bronchiectasis alterations, including wall thickening, mucus plugging, and infiltrates (referred to as "plus pathologies" on MRI). Additionally, Euler-Liljestrand reflex-based MR perfusion imaging demonstrates the possibility of reversible perfusion and breathing impairment. Given the possibility of high cumulative lifetime radiation, the need for radiation-free diagnostics utilizing MRI is extremely important [15].

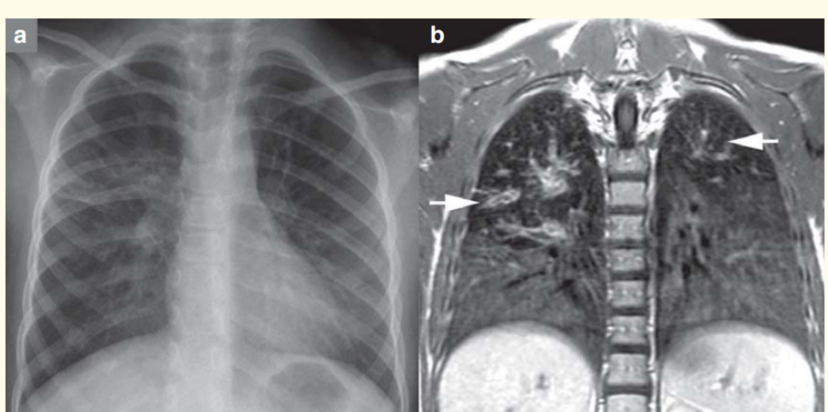

Figure 5: Showing a) Chest radiograph, (b) MRI, the higher lobes (arrows) of the T1-weighted contrast studies demonstrate evident bronchial wall thickening with varicose bronchiectasis, and there is less signal apically than basally [10].

Chest radiography should be done as the initial investigation in patients with smoking-related COPD, according to the recommendation. Thin-slice, non-contrast MDCT is advised to investigate the need for endoscopic or surgical treatment of severe pulmonary emphysema and to plan these. This enables the quantification of the emphysema's severity and distribution as well as the evaluation of the integrity of the lobar fissures. In cases where bronchial cancer is suspected, MDCT is also preferred [16].

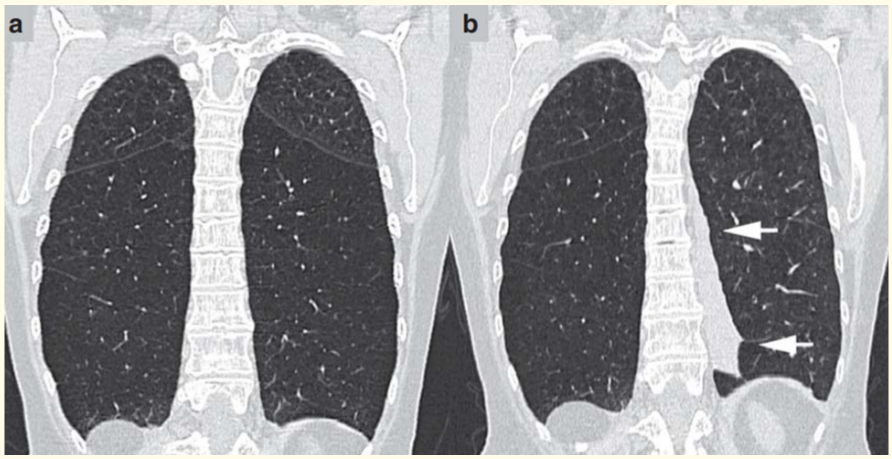

Figure 6: *Showing a) Multidetector computed tomography (MDCT) without the use of contrast material and with coronary reconstruction, demonstrating extremely severe centrilobular pulmonary emphysema, with the bottom lobe being the most evident. The target structure for endoscopic pulmonary volume reduction was determined to be the left lower lobe with an intact lobar fissure. b) Three months after the intervention, the results showed that the treated segments 8 - 10 on the left side had atelectasis (arrows) [10].*

Diffuse interstitial lung disease-pulmonary fibrosis

The single gold standard-histology-has been dropped in favor of interdisciplinary diagnostic procedures (pneumology, radiology, and pathology) for the diagnosis of idiopathic pulmonary fibrosis (IPF) since 2011, concurrent with the revision of international and national guidelines. These procedures are primarily based on the predominating pattern of MDCT (non-contrast, slice thickness 2 mm). The primary signal is the pattern of typical interstitial pneumonia (UIP), which has a honeycomb structure with traction bronchiectasis that predominates in the dorsobasal periphery. IPF can be accurately diagnosed without histological proof if this is observed together with the normal clinical appearance, and other explanations have been ruled out [17].

Conclusion

It is important to provide appropriate treatment without overusing diagnostic tests; the choice of radiological technology for the detection, staging, follow-up, and quantification of lung illness should be based on the specific clinical alternatives.

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