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Pictorial Review

The development of pulmonary aspergillosis and its histologic, clinical, and radiologic manifestations

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Pulmonary syndromes following exposure to *Aspergillus* sp. have a variety of clinical and radiological manifestations. The radiological manifestations mirror the pathophysiological response to *Aspergillus* sp., which is linked closely to the patient's immune status. The plethora of terms in the literature can be confusing and their application with relevance to radiological imaging may subsequently result in inadequate or non-specific classification. In this review, we aim to provide a simplified and up-to-date approach to the recognition of the imaging manifestations of pulmonary aspergillosis, using correlation with histopathological and clinical descriptors. This will enable the radiologist to utilise the imaging findings to instigate clinically useful and appropriate management for those patients at risk of significant morbidity and mortality.

Introduction

Pulmonary syndromes in response to *Aspergillus* sp., often due to *Aspergillus fumigatus*, a fungus ubiquitous in the environment, have a range of clinical manifestations. The extent of lung involvement depends on both host factors (namely the patient's immune status and any pre-existing lung damage) and fungal factors (the inhaled conidial load and virulence of the organism; Fig 1). The incidence of pulmonary aspergillosis has risen as a result of greater clinical awareness, improved detection, and an increasing number of susceptible individuals. The radiologist can contribute to improving the patient's clinical course by early recognition of the varied and sometimes subtle imaging features using computed tomography (CT) as a crucial diagnostic tool.

The myriad of subtypes used in classifying pulmonary aspergillosis can cause confusion. More recently the focus has been on elucidation, and applicable literature, e.g., Denning *et al.*, have utilised patient symptoms, pathological features, and imaging findings as part of the diagnostic criteria.[1,2] The present pictorial review builds on this foundation, detailing the classical imaging manifestations of each *Aspergillus* infection subtype (Fig 2): (1) simple aspergillomas; (2) chronic pulmonary aspergillosis (CPA), which encompasses entities such as chronic cavitary pulmonary aspergillosis (CCPA), chronic necrotising pulmonary aspergillosis (CNPA), and chronic fibrosing aspergillosis; (3) allergic, non-invasive aspergillosis, i.e., allergic

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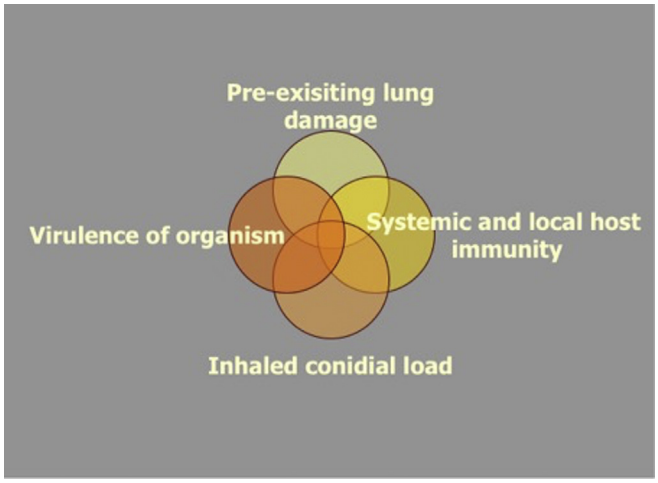

Figure 1 Schematic illustration of the interplay between various host, environmental and organism factors in determining the clinical manifestations of *Aspergillus* infection.

bronchopulmonary aspergillosis (ABPA); and (4) invasive aspergillosis, which comprises angio-invasive aspergillosis and airways-invasive aspergillosis.

Simple aspergillomas

Aspergilloma (mycetoma) is a fungal ball containing intertwined hyphae, blood, and inflammatory products, formed by superinfection of a pre-existing lung cavity.[3] *Aspergillus fumigatus* is the typical causative microorganism, although other *Aspergillus* spp. may manifest similarly. An upper lobe predilection is common as cavity formation is frequently secondary to previous mycobacterial disease, although pulmonary abscesses, sarcoidosis, bullae, cystic lung disease, or granulomatosis with polyangiitis are also predisposing factors.[3,4] Occasionally, healthy lungs are affected.

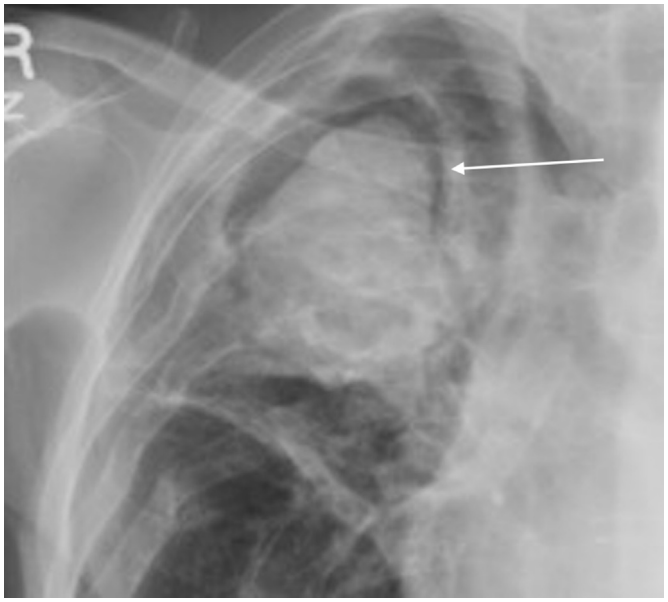

Figure 3 Chest radiograph showing large right upper zone cavity with 'air crescent' (white arrow) on the background of apical fibrosis.

Chest radiography will show the mycetoma as a single cavity containing a mobile mass associated with surrounding 'monod' or 'air crescent' sign[5] (Fig 3). The 'air crescent' sign, as an imaging descriptor, is also used in the recovery phase of angio-invasive aspergillosis (see later) and although they should not be confused, the term is used interchangeably by many to refer to both pathological processes. Moving the patient between serial imaging studies will emphasise the mobility of the fungal ball, which is characteristic for this entity.[3]

CT supersedes radiography in diagnostic accuracy during early infection, showing thickening of the cavity wall, adjacent pleural thickening, and detached fungal fronds prior to visualisation of a discrete intra-cavitatory lesion (Fig 4), and as these changes are often reversible, early

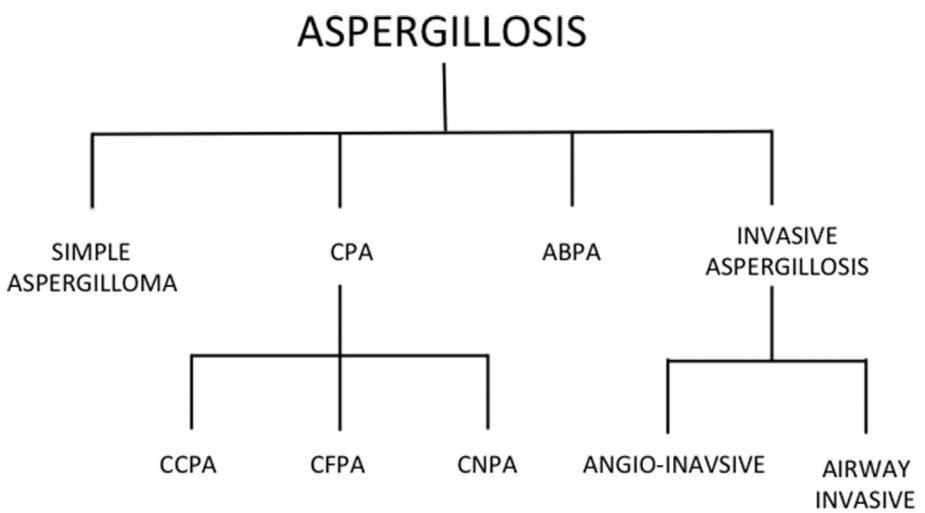

Figure 2 Flow diagram showing the subtypes of pulmonary *Aspergillus* syndromes and explanation of the abbreviations, i.e., CPA, CCPA, CFPA, CNPA, and ABPA.

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