DISTINCTIVE MANIFESTATIONS OF PULMONARY SARCOIDOSIS ON HIGH RESOLUTION COMPUTED TOMOGRAPHY

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Abstract: Sarcoidosis is a multisystem granulomatous disorder with unknown etiology, poorly understood pathogenesis and variable prevalence. As already mentioned, it can affect any system or organ, but most frequently resides in the lungs, mediastinal and hilar lymph nodes, it is characterized by the presence of non- caseating granulomas, and its diagnosis typically requires histopathological proof. Sarcoidosis is a great mimicker of various thoracic disorders and its evolution and severity are highly variable, ranging from asymptomatic and self- limiting to highly debilitating with development of progressive thoracic disease and cardio- vascular complications, requiring long term therapy.
This study aims to establish a proper and efficient diagnostic approach, give an overview of the typical radiological manifestations of sarcoidosis on high resolution computed tomography (HRCT) and reduce the differential uncertainty.
We thoroughly analyzed 20 HRCT scans of patients diagnosed with sarcoidosis, with mean age of 38.8± 6.91(25 to 51 years old) of both genders. All 20 patients underwent HRCT according to appropriate diagnostic protocol on a 128- slice computed tomography (Siemens Healthineers, USA).
The most frequent findings were bilateral and symmetrical hilar and right para- tracheal lymphadenopathy, often accompanied by parenchymal abnormalities such as multiple small nodules in a peribronchovascular distribution and irregular interstitial thickening. We also encountered some atypical thoracic findings such as asymmetrical lymph node involvement, large alveolar opacities, ground glass opacities and pleural involvement.
High Resolution Computed Tomography is an important diagnostic tool in the accurate evaluation and depiction of many typical and atypical lung parenchymal and extra- parenchymal findings in sarcoidosis, offers the possibility to establish reasonable differential diagnosis, and at the same time, estimates the severity of the parenchymal involvement and predicts future complications.
Keywords: sarcoidosis; non- caseating granulomas; High Resolution Computed Tomography (HRCT); hilar lymphadenopathy; peribronchovascular distribution.

1. INTRODUCTION

Sarcoidosis is a multisystem disease with comprehensive clinical and radiographic manifestations, unrevealed origin and defined by the presence of non- caseating granulomatous inflammation and proliferation of epithelioid cells ***(Colby, 1998).*** Although the disease pathogenesis remains poorly understood, it is believed that it is a result of complex interaction between individual and environmental factors leading to divergence of the immune response ***(Grunewald, 2015).*** To reach a definite diagnosis, a histopathological proof for presence of non- caseating granulomatous inflammation in one or more organs in addition to compatible clinical and radiological attributes and elimination of other causes of granulomatous inflammation is needed; however, in the company of typical findings such as Löfgren's syndrome, Heerfordt's syndrome, lupus pernio and asymptomatic bilateral and symmetrical hilar lymphadenopathy, an accurate diagnosis can be accomplished solely on clinical grounds ***(Bernardinello, 2021).***
Sarcoidosis transpires worldwide, in all age groups and races. Relating precise epidemiology is complicated due to inconsistent diagnostic criteria and variable, at times, asymptomatic disease manifestations ***(Hägerstrand, 1964).*** The disease, although seen in children and elderly, commonly manifests between 20- 40 years of age ***(Miller, 1995; Arkema, 2018).*** There is inconsistent data on gender predominance, although a small female predominance among African-Americans has been reported ***(Cozier, 2016).*** The highest incidence is being reported in African-Americans (36 to 50 per 100,000) and northern European Caucasians (11 to 20 per 100,000), whereas it is lower in Asian populations ***(Ganeshan, 2018).*** Familial clustering of sarcoidosis has been described, that suggests genetic or environmental component ***(Rossides, 2018).***
The disease is mainly benign and resolves spontaneously, so in approximately 50% of the patients there is no need of treatment, whereas one-third of the patients develop chronic or progressive disease and about 5% will eventually die, due to pulmonary or cardiovascular complications ***(Gerke, 2017; Baughman, 2018).***
Sarcoidosis has many different clinical manifestations, but almost all patients exhibit respiratory tract engagement with endobronchial and parenchymal abnormalities, thus the most common symptoms are dyspnea, dry cough and chest discomfort ***(Baughman, 2001).*** The usual targeted sites in almost 10- 30% of patients are skin, eyes, liver,

spleen and peripheral lymph nodes ***(Polverino, 2020),*** whereas more uncommon and with potentially fatal outcome are the cardiac and neurological diseases ***(Trivieri, 2020).*** Non- organ specific conditions such as small fiber neuropathy can be found in as many as 86% and fatigue in more than 90% of patients ***(Voortman, 2019).***

2. IMAGING FINDINGS

Chest imaging is a key factor in the diagnosis of sarcoidosis, and all patients suspected for sarcoidosis should undergo chest X-ray, which tends to be abnormal in up to 90% of cases, and will typically exhibit bilateral, symmetrical hilar lymphadenopathy with/ without parenchymal abnormalities ***(Figure 1).*** Chest x-ray is less sensitive for depicting thoracic manifestations in sarcoidosis. Despite constraints, the Scadding criteria have been used for decades in the staging of sarcoidosis ***(Scadding, 1961).*** Stage I, according to Scadding is defined by the presence of bilateral hilar lymphadenopathy and no parenchymal involvement, whereas stage IV consists of upper-lobe predominant fibrotic changes with lung volume loss.

Patterns of lymphadenopathy include the 1-2-3 sign or Garland triad which is a symmetrical hilar nodal involvement, as well as right paratracheal involvement, and it has high sensitivity on chest x-ray ***(Figure 1).***

In other instances, nodes tend to be very large and not abutting the cardiac silhouette, opposed to lymphoma, where nodes are usually continuous with the pericardial outline. After certain amount of time, up to 20% of intrathoracic nodes calcify with variable calcifications: punctate, amorphous or eggshell ***(Figure 2).***

On the other hand, chest x- ray patterns of pulmonary disease include bilateral and symmetrical reticulo- nodular or nodular opacities, encountered in 75- 90% of patients staged II and III , with middle and upper zone distribution, sometimes resembling miliary opacities. Atypical findings that can be evaluated are alveolar/ airspace opacities or nodules and masses (sarcoid galaxy sign) which are more common in older patients and created by coalescence of multiple ill-defined nodules.

Figure 1. Symmetrical bilateral hilar and right para- tracheal lymphadenopathy in sarcoidosis patient referred to as 1-2-3 sign or Garland triad.

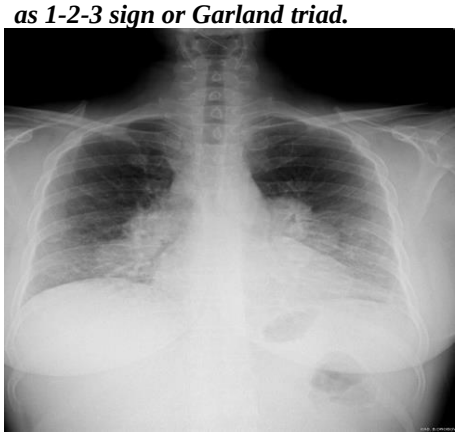
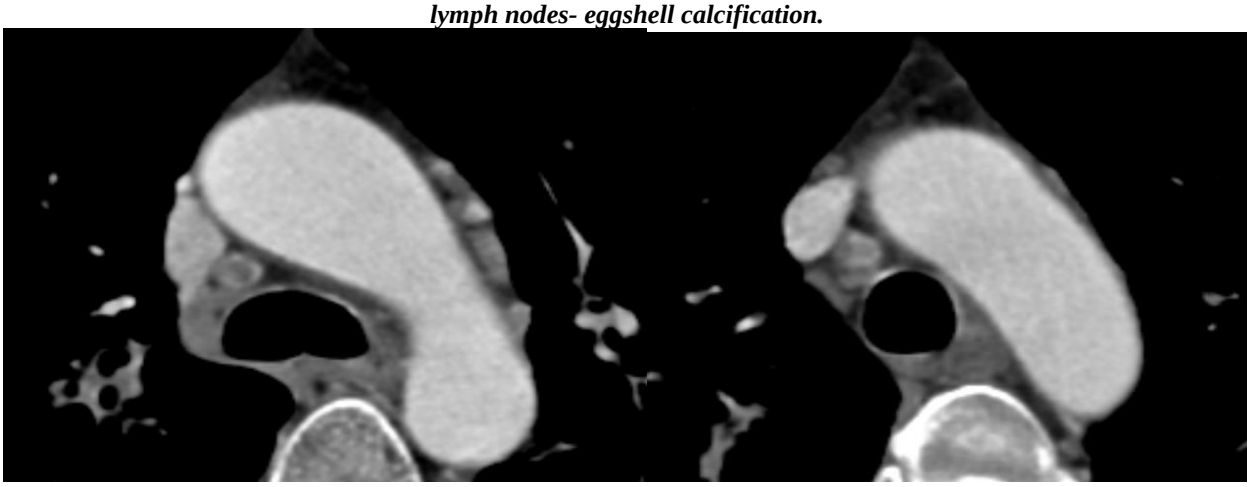


Figure 2. Shell-like, peripheral calcifications up to 2 mm thick, present in the peripheral zone of at least two lymph nodes- eggshell calcification.



A very uncommon manifestation is peripheral cavitation or pulmonary fibrosis that can be seen in 20- 25% of patients suffering end stage disease. The pulmonary fibrosis has a predilection for upper and middle lung zones and is usually presented by permanent coarse linear opacities radiating laterally from the hilum upward and outward and causing hilar elevation and traction bronchiectasis.

High resolution CT (HRCT) is more sensitive than chest X-ray and provides a precise assessment of the hilar, mediastinal and parenchymal abnormalities. The most typical HRCT feature in sarcoidosis is the presence of well-delineated micronodules distributed in a perilymphatic mode, along the broncho-vascular bundle, veins, fissures and pleura, with mid to upper lung zone predominance. A highly suggestive HRCT feature of pulmonary sarcoidosis is the coalescing of micronodules in larger conglomerates, thus resembling a mass, and distorting the lung parenchyma. When these conglomerates are being surrounded by micronodules, they resemble a "galaxy sign" ***(Figures 3, 4, 5).***

Additionally, HRCT can also demonstrate ground glass opacities, septal and non- septal lines and in up to 20% of patients who develop pulmonary fibrosis, it can manifest as architectural distortion, traction bronchiectasis, honeycombing and linear scarring. The complications of the fibrotic type pulmonary sarcoidosis include pulmonary hypertension, mycetoma, and hemoptysis that are rare but potentially life threatening manifestation.

Figure 3. Typical bilateral hilar and right para- tracheal lymphadenopathy in the sarcoidosis patient from Figure 1, demonstrated on axial and coronal CT views.

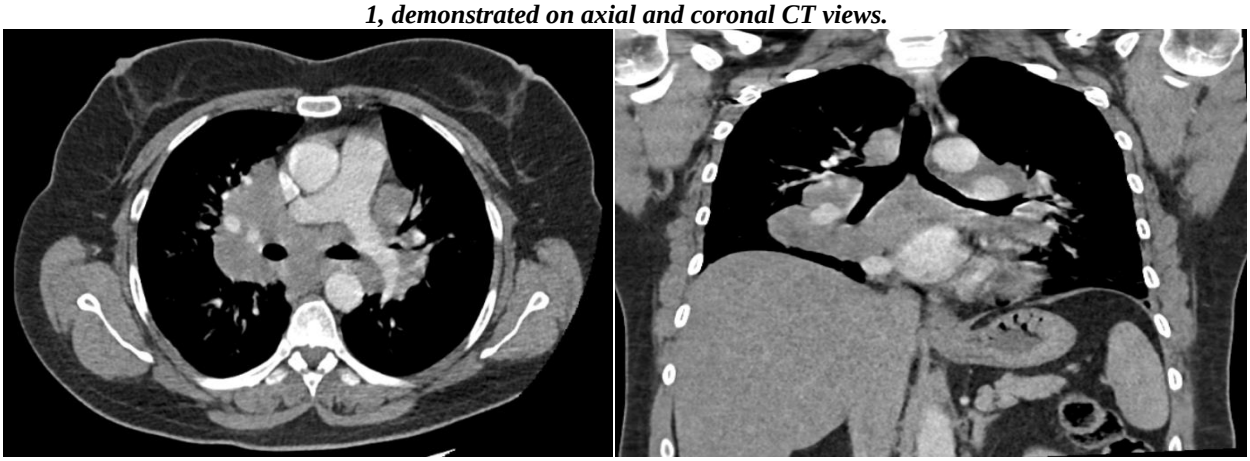


Figure 4. Mosaic attenuation due to granulomatous bronchiolitis, perilymphatic irregular nodular thickening in an upper/ mid lung distribution and many nodules measuring up to 1cm, some of which contain air bronchograms.

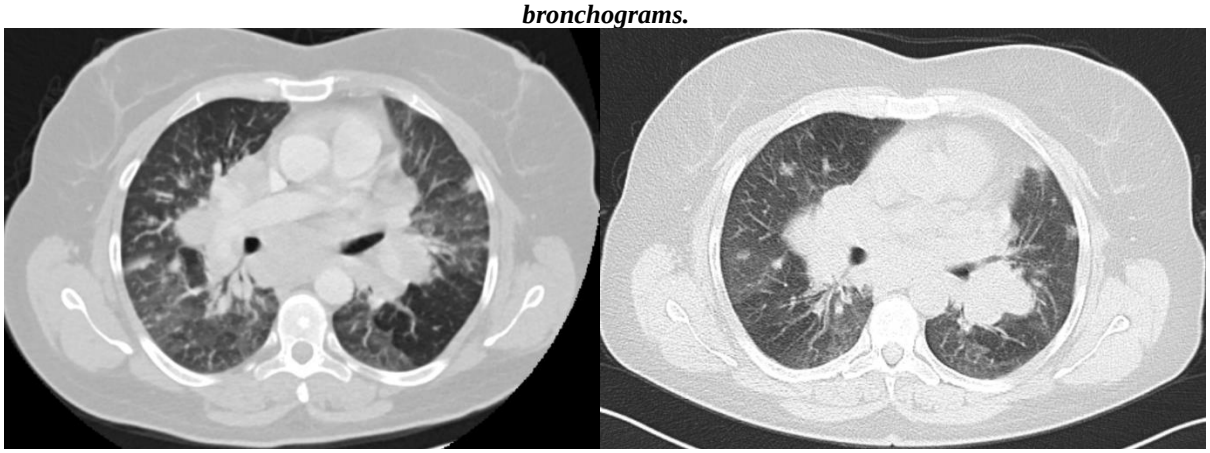
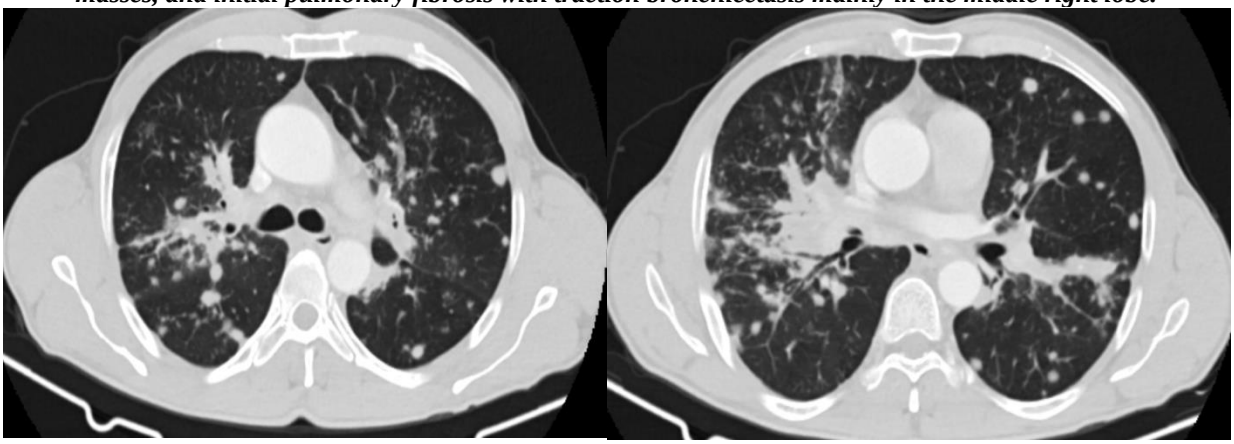


Figure 5. Perilymphatic irregular nodular thickening involving the central, as well as the peripheral interstitum, many nodules measuring up to 2cm, some of which show air bronchograms and confluence in more irregular masses, and initial pulmonary fibrosis with traction bronchiectasis mainly in the middle right lobe.



The 20 patients from our study group, underwent HRCT according to appropriate diagnostic protocol on a 128- slice computed tomography (Siemens Healthineers, USA) and a detailed assessment. Our study group presented with the mean age of 38.8± 6.91(25 to 51 years old) and included both genders. 55% of our patients were male, and 45% female. The most frequent findings we encountered were bilateral and symmetrical hilar and right para- tracheal lymphadenopathy (in 70% of patients), often accompanied by parenchymal abnormalities such as multiple small nodules in a peribronchovascular distribution (45%) and irregular interstitial thickening (20%). We also encountered some atypical thoracic findings such as asymmetrical lymph node involvement (15%), large alveolar opacities (25%), ground glass opacities (30%) and pleural involvement (10%). There were two cases (10%) with the "galaxy sign" which was very suggestive of sarcoidosis. In only 7 patients (35%) there was either incipient or pronounced fibrosis with typical architectural distortion, traction bronchiectasis and linear scarring in mid and upper lung zones. Two of the patients with pronounced fibrosis due to end stage sarcoidosis had indirect CT signs of pulmonary arterial hypertension.

3. CONCLUSION

High Resolution Computed Tomography is an important diagnostic tool in the accurate evaluation and depiction of many typical and atypical lung parenchymal and extra- parenchymal findings in sarcoidosis, it offers the possibility to establish reasonable differential diagnosis, and at the same time, estimates the severity of the parenchymal involvement and predicts future complications.

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