

The Findings of Pulmonary Nocardiosis on Chest High Resolution Computed Tomography

Single centre experience and review of literature

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ABSTRACT: Objectives: Pulmonary nocardiosis is a rare opportunistic infection that is often encountered in immunocompromised patients, in particular those with the HIV infection and in solid organ transplant recipients. As the number of immunocompromised patients increase, the number of patients with pulmonary nocardiosis is also expected to increase. This study aimed to analyse both the chest high resolution computed tomography (HRCT) findings of patients with confirmed pulmonary nocardiosis and review the imaging features of pulmonary nocardiosis in the literature. **Methods:** This retrospective study was conducted at The Royal Hospital, Muscat, Oman, to identify patients with a diagnosis of pulmonary nocardiosis between January 2006 and January 2019. Accordingly, nine patients with pulmonary nocardiosis were identified, but three patients were excluded as no chest HRCT images were available. Patient clinical presentation was recorded and chest HRCT images were retrospectively reviewed. **Results:** A total of six patients were enrolled in this study. All were male and with a mean age of 41 ± 11 years. Three patients were immunocompromised, two of whom had undergone a renal transplant. The main HRCT findings were cavitory nodules/masses, non-cavitory nodules/masses, septal thickening, centrilobular nodules, ground glass opacities, consolidation, pleural effusion, pleural thickening, enlarged lymph nodes and necrotic lymph nodes. **Conclusion:** Pulmonary nocardiosis shows various findings in a chest CT, the most common of which are pulmonary nodules and masses. Awareness of these findings can help radiologists with a diagnosis in the appropriate clinical settings.

Keywords: Pulmonary Nocardiosis; Computed Tomography; Oman.

ADVANCES IN KNOWLEDGE

- The findings of this study demonstrate that pulmonary nocardiosis can have different findings in chest computed tomography (CT) including pulmonary nodules, masses and consolidation.

APPLICATION TO PATIENT CARE

- This study highlights the most common findings of pulmonary nocardiosis in chest high resolution CT. This can help establish early diagnosis and start treatment without delay.

NOCARDIOSIS IS A RARE INFECTION CAUSED by a group of aerobic, weakly staining, Gram-positive and partially acid-fast bacteria called *Nocardia*, which can be found in water, dust, soil, stagnant matter and decaying vegetation.¹

Humans contract a *Nocardia* infection mainly through inhalation or direct inoculation through the skin. The most susceptible people to nocardiosis are immunocompromised patients, in particular patients with impaired cell immunity such as individuals with the HIV infection and solid organ transplant recipients. Approximately one-third of nocardiosis cases occur in immunocompetent patients.^{2–4} With the increasing number of immunocompromised patients due to advanced transplant procedure, the use of immunotherapies and the increase in the number of patients infected with Human Immunodeficiency Virus, the number of patients suffering from nocardiosis might increase as well.⁵

Clinically, patients with pulmonary nocardiosis present with non-specific symptoms such as fever,

dyspnoea and productive cough, making the clinical diagnosis difficult. If the correct diagnosis can be made early, patients can be started on treatment without delay, thereby preventing the dissemination of the infection to other parts of the body, especially the brain, which is associated with high mortality rates.^{6,7} Therefore, immediate diagnosis and treatment of pulmonary nocardiosis is essential to lower disease morbidity and mortality.

In the literature, there have been a few studies on pulmonary high resolution computed tomography (HRCT) findings in patients with pulmonary nocardiosis.^{2,8–15} Therefore, this study aimed to review the chest HRCT findings in pulmonary nocardiosis and compare the findings with published studies in the literature.

Methods

This retrospective study searched the electronic database of The Royal Hospital, Muscat, Oman, to identify

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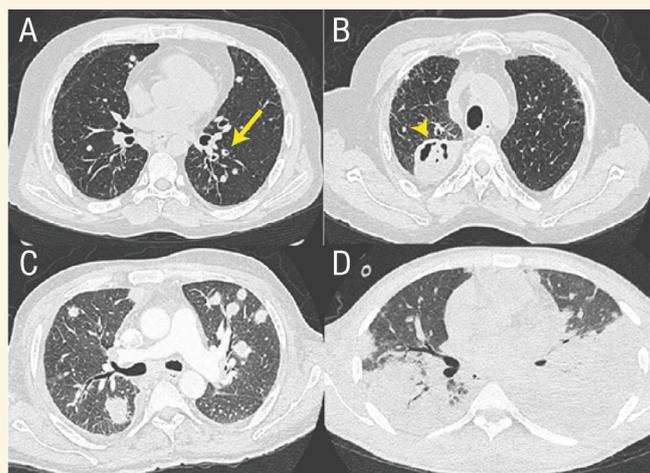


Figure 1: A & B: Computed tomography (CT) scan (lung window setting) of the chest of a 42-year-old male post-renal transplant patient showing bilateral multiple pulmonary nodules of variable sizes; some of the nodules show central cavitation (arrow) and a cavitary mass in the posterior segment of the right upper lobe (arrowhead). C: CT scan of the chest of a 59-year-old male patient with pulmonary nocardiosis (lung window setting) showing bilateral multiple pulmonary nodules of various sizes; some of the nodules show a ground glass halo. D: CT scan of the chest of a 28-year-old male patient (lung window setting) with glomerulonephritis on steroids showing bilateral lower lobe consolidation and bilateral pleural effusions.

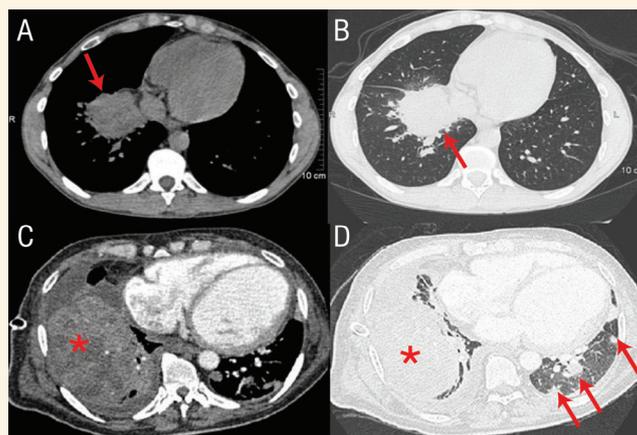


Figure 2: Computed tomography (CT) chest scan of a 29-year-old male post-renal transplant patient showing a mass surrounded by ground glass halo in the right lower lobe (arrow) in the (A) mediastinal window and (B) lung window. CT chest scan of a 59-year-old male with pulmonary nocardiosis showing a mass with areas of low attenuation in the right lower lobe (asterisk) associated with a right pleural effusion. Pulmonary nodules are also seen in the left lower lobe in the (C) mediastinal window and (D) lung window (arrows).

patients with a confirmed diagnosis of pulmonary nocardiosis who were treated between January 2006 and January 2019. Accordingly, nine patients with pulmonary nocardiosis were identified, but three were excluded as they did not have chest CT findings.

Clinical presentations at the time of presentation and related medical history were documented. The HRCT images were reviewed by a cardiothoracic radiologist and evaluated for consolidation, centrilobular nodules, nodules/masses, ground-glass opacities, interlobular septal thickening, bronchial wall thickening, cavitation, enlarged hilar/mediastinal lymph node(s) (defined as having a diameter of >1 cm) and pleural

thickening/effusion. Extra-thoracic findings were also recorded, if present. The chest HRCT findings were defined according to the glossary of terms for thoracic imaging proposed by the Fleischner Society.¹⁶

The Scientific Research Committee of The Royal Hospital, Muscat, Oman approved this retrospective single institution study and has waived informed consent (SRC#8/20 19).

Results

All six included patients with pulmonary nocardiosis were males and aged between 29–59 years (mean

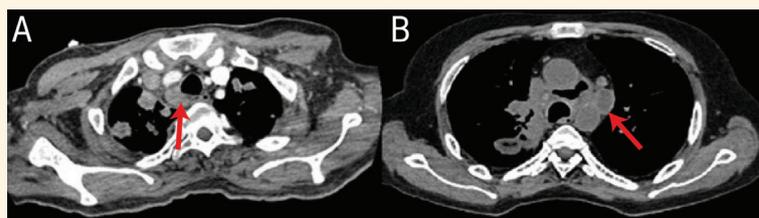


Figure 3: Computed tomography chest scan in the mediastinal window of a (A) 59-year-old male with pulmonary nocardiosis showing a right paratracheal lymph node (arrow) and a (B) 42-year-old male with pulmonary nocardiosis showing a necrotic mediastinal lymph node (arrow).

Table 1: Clinical characteristics of patients with pulmonary nocardiosis (N = 6)

Characteristic	n (%)
Mean age \pm SD in years (range)	41 \pm 11 (29–59)
Underlying condition	
Diabetes	1 (16.7)
Glomerulonephritis	2 (33.3)
Interstitial lung disease	1 (16.7)
Renal transplant	2 (33.3)
Smoking	1 (16.7)
Gastrobronchial fistula	1 (16.7)
Bronchiectasis	1 (16.7)
Presenting symptoms	
Fever	6 (100)
Cough	5 (83.3)
Chest pain	3 (50.0)
Sputum	3 (50.0)
Haemoptysis	3 (50.0)
Dyspnea	3 (50.0)
Diagnosis	
Bronchial lavage	1 (16.7)
CT guided biopsy	1 (16.7)
Sputum microscopy	1 (16.7)
Open lung biopsy	1 (16.7)
Pleural effusion analysis	1 (16.7)

SD = standard deviation; CT = computed tomography.

age: 41 \pm 11 years). Three patients were immunocompromised, two of whom had undergone a renal transplant and one was on corticosteroids. Of the immunocompetent patients, one had bronchiectasis and one had gastrobronchial fistula as a complication of gastric sleeve surgery. All patients had respiratory symptoms, including fever (n = 6, 100%) and cough (n = 5, 83.3%), sputum production (n = 3, 50%), dyspnoea (n = 3, 50%) and chest pain (n = 3, 50%) [Table 1].

Table 2: Chest computed tomography findings of patient with pulmonary nocardiosis (N = 6)

Finding	n (%)
Consolidation	1 (16.7)
Masses	1 (16.7)
Nodules	2 (33.3)
Cavity	1 (16.7)
Cavitary mass	3 (50.0)
Cavitary nodule	1 (16.7)
Halo sign	2 (33.3)
Ground glass opacities	2 (33.3)
Centrilobular nodules	3 (50)
Septal thickening	4 (66.7)
Bronchial wall thickening	5 (83.3)
Pleural effusion	3 (50.0)
Pleural thickening	1 (16.7)
Enlarged lymph nodes	4 (66.7)
Necrotic lymph nodes	2 (33.3)

The most common CT findings were cavitary nodules/masses (n = 4, 66.7%) [Figures 1A and B], non-cavitary nodules/masses (n = 3, 50%) [Figures 1C and 2], septal thickening (n = 4, 66.7%), centrilobular nodules (n = 3, 50%), ground glass opacities (n = 2, 33.3%) and consolidation (n = 1, 16.7%) [Figure 1D]. Four patients (66.7%) had enlarged lymph nodes, two of whom had necrotic lymph nodes [Figure 3 and Table 2]. This study also summarised the studies with more than two cases that reviewed the radiological features of pulmonary nocardiosis since 1995.^{2,8–11,13–15} [Table 3].

Discussion

Nocardiosis is a rare disease that frequently affects immunocompromised patients, especially patients with impaired cellular immunity related to HIV infection and solid organ transplantation. However, approx-

Table 3: Summary of the chest computed tomography findings of reported cases of pulmonary nocardiosis

Author and year of publication	Number of cases	Consolidation	Consolidation with cavitation	Nodules/masses	Cavitation	Cavitary nodules	Halo sign	Ground glass opacities	Centrilobular nodules	Septal thickening	Crazy paving pattern	Bronchiectasis	Bronchial wall thickening	Pleural effusion	Pleural thickening	Lymph nodes	Chest wall extension	Necrotic lymph nodes
Buckley <i>et al.</i> ¹³ (1995)	24	8	-	20	8	-	-	-	-	-	-	-	-	-	7	-	-	-
Yoon <i>et al.</i> ⁸ (1995)	5	4	-	3	-	-	-	-	-	-	-	-	-	4	-	-	3	-
Blackmon <i>et al.</i> ¹⁴ (2011)	53	39	-	41	21	-	6	-	-	-	-	7	-	-	-	8	-	-
Oszoyoglu <i>et al.</i> ¹¹ (2007)	7	1	1	5	-	2	-	1	-	1	-	-	-	-	-	-	-	-
Sato <i>et al.</i> ¹⁰ (2016)	18	6	-	17	12	-	-	14	0	14	-	-	1	2	-	-	-	-
Tsujimoto <i>et al.</i> ⁹ (2012)	7	1	-	5	1	-	-	6	1	6	5	4	5	4	-	-	-	-
Mehrian <i>et al.</i> ¹⁵ (2015)	25	19	-	24	13	-	-	8	-	1	-	12	-	3	10	4	-	-
Liu <i>et al.</i> ² (2017)	9	8	-	6	-	-	2	4	4	4	-	4	-	4	-	2	-	-
Total	148	86	1	121	55	3	8	33	5	26	5	27	16	17	17	14	3	0

imately one-third of patients with nocardiosis are immunocompetent, which is concordant with this study's findings where three out of the six enrolled patients were immunocompetent.^{3,17,18}

Pulmonary nocardiosis usually occurs through the direct inhalation of the *Nocardia* species.¹⁸ Patients with pulmonary nocardiosis usually have non-specific symptoms, making the clinical diagnosis difficult. The definitive diagnosis is usually based on histopathologic examination and/or culture, which are time-consuming. However, difficulty in isolation and the slow growth of *Nocardia* delay the diagnosis and initiation of the appropriate treatment, leading to disease dissemination and an increase in the morbidity and mortality related to the disease.^{2,6,7}

Various HRCT findings of pulmonary nocardiosis have been reported in the literature, including consolidation with or without cavitation, cavitary and non-cavitary pulmonary nodules/masses, ground glass opacities, centrilobular nodules, interlobular septal thickening, a crazy paving pattern, pleural effusion and chest wall extension. The results of these studies show that the most common HRCT findings are nodules/masses with or without cavitation. The largest study by Blackmon *et al.* examined 53 patients with pulmonary nocardiosis; the most common findings by chest CT

were airspace disease and nodules.¹⁴ Oszoyoglu *et al.* analysed seven cases of pulmonary nocardiosis after lung transplantation and found that the most common chest HRCT finding was pulmonary nodules, seen in 71% of the patients.¹¹ Sato *et al.* reported HRCT findings of 18 patients with pulmonary nocardiosis and found that 94.4% patients had a nodule or mass, 77.8% had ground-glass opacity and 77.8% had interlobular septal thickening.¹⁰ Tsujimoto *et al.* found that ground glass opacity and septal thickening were the most common findings seen in 85.7% of the patients, followed by bronchial wall thickening and crazy paving, as seen in 71.4% of the cases.⁹ Mehrian *et al.* analysed 25 patients and found that the most common HRCT findings were pulmonary nodules (96%) and consolidation (76%).¹⁵ More recently, Liu *et al.* described nine patients with pulmonary nocardiosis and found that eight of them had consolidation, of which three had cavitation and six had masses/nodules, of which three had cavitation.²

In the present study, the most common CT findings of pulmonary nocardiosis were lung nodules/masses, of which four showed cavitation. Four patients had septal thickening and three had centrilobular nodules. The current findings are similar to what has been reported in the literature; however, necrotic lymph nodes were noted in two patients as well, a

finding that has not been previously reported in the literature.

The differential diagnosis for pulmonary nocardiosis includes other causes of lung consolidation, cavitation and nodules such as other infections, vasculitis and malignancy. Pulmonary actinomycosis is a lung infection that can have similar radiological findings as pulmonary nocardiosis. However, patients with actinomycosis are usually immunocompetent, have poor dentition and are at a higher risk of aspirating infected oropharyngeal secretions. Pulmonary tuberculosis is another pulmonary infection that can present with cavitation, however it tends to involve the apical segments of the upper lobes and superior segments of the lower lobes and these are usually associated tree-in-bud nodules. In the clinical setting of pulmonary infection, nocardiosis should be considered as a differential diagnosis of pulmonary nodules and masses.

Conclusion

Pulmonary nocardiosis is a rare infection that commonly occurs in patients with impaired cell-mediated immunity, but can also be seen in immunocompetent patients. In the chest HRCT, pulmonary nocardiosis shows a wide spectrum of findings, most commonly lung nodules/masses with or without cavitation. In the appropriate clinical setting, the radiologist should include pulmonary nocardiosis in the differential diagnosis of pulmonary nodules and masses.

AUTHORS' CONTRIBUTION

RU supervised the work and drafted the manuscript. NP reviewed and edited the manuscript and MB collected the data and revised the manuscript. All authors approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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