

# The value of supplemental prone imaging in low-dose CT lung cancer screening. A technical note

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## Abstract

This technical note presents our experience with the additional prone examination of patients during low dose CT lung cancer screening. The prone examination adds only a minor amount of radiation and time to the study and can reduce false positive findings that are gravity-dependent.

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## Introduction

Lung cancer is the leading cause of cancer deaths worldwide and accounts for 18.4% of all cancer fatalities. Overall lung cancer deaths surpass those from breast, colorectal and cervical cancer combined. Only 15% of lung cancer patients survive 5 years after diagnosis because close to 70% of patients have already advanced disease at presentation.

About 20% of adults in the US currently still smoke and contribute to a persistent pool of susceptible people. The US-based National Lung Cancer Screening Trial (NLST) resulted in a 20% lower mortality from lung cancer, compared to screening with chest radiography [1]. The Dutch-Belgian lung-cancer screening trial (NELSON) achieved a 24% reduction in mortality for men and 33% reduction in mortality for women [2]. In a recent meta-analysis of eight randomized-controlled trials covering 90,475 individuals, CT lung cancer screening produced a relative risk reduction of 0.80 corresponding to 19% and an absolute risk reduction of 0.4% (reduction from 2.1% to 1.7% lung cancer deaths) [3].

A problem encountered in lung cancer screening trials is the high number of false-positive studies: a large number of trial participants show evidence of actionable nodules that turn out to represent non calcified granulomatous lesions, intrapulmonary lymph nodes or nodular dependent atelectasis. Additional unsuspected incidental pulmonary findings can be detected, particularly in the dependent parts of the lungs, including interstitial lung disease, as well as large and small airways disease [3] and pleural abnormalities. The purpose of this study was to demonstrate the utility of prone imaging as a routine addition to low-dose CT lung cancer screening examinations.

## Methods

Our Institutional Review Board approved this retrospective, single institution study. We performed a search through our picture archiving and communication system (PACS) for low-dose CT lung cancer screening exams performed between August 2018 and February 2021. At our institution, our full lung cancer CT screening protocol includes a scout view followed by low-dose contiguous helical sections from the thoracic inlet to the upper abdomen in supine and prone positions with a detector width of 0.625 mm and with a reconstructed section thickness of 1.25 mm in the axial plane. Additional maximum intensity projection (MIP) reformatting is performed with 8 mm slab thick-

ness and 2 mm overlap. The CT dose index (CTDI) volume is held constant at 2.9 mGy and the dose-length product (DLP) for the entire examination ranges between 180 mGy-cm and 230 mGy-cm. We routinely perform both supine and prone position imaging on all screening cases as patients are scanned around the clock in our department and at times when no radiologist is on site. Having a single protocol without a radiologist having to selectively add or eliminate a position facilitates patient throughput. Selection criteria for patients who undergo screening at our institution are the same as those suggested by the United States Preventive Services Task Force (USPSTF) and include patients 55 years to 80 years of age with a smoking history of a minimum of 30 pack-years and former smokers who had quit smoking within the prior 15 years, did not have a prior history of lung cancer and were asymptomatic at the time of the screening examination. All low-dose CT lung cancer screening exams were interpreted by a cardiothoracic radiologist with over 45 years of experience.

## Results

190 sequential patient exams were included. Potential interstitial lung abnormalities seen on supine images disappeared on prone images in 65 of these cases, compatible with gravity-dependent changes. In 22 patients the abnormal findings persisted, suggesting true interstitial lung abnormalities, including smoking-related or age-related mild pulmonary fibrosis, usual interstitial pneumonia or combined pulmonary fibrosis and emphysema (Figures 1 to 4). On supine-only images, suspected nodules were present in 14 of 190 cases (Figure 5). When prone images were also assessed, suspected nodules disappeared in 7 of these cases (Figures 6 and 7), likely representing nodular atelectasis or mucus plugs, with the remaining 7, suggesting true nodules, including granulomata, intrapulmonary lymph nodes or rounded atelectases. Differences in detection were statistically significant for both interstitial lung abnormalities ( $p \leq 0.00001$ ) and nodules ( $p = 0.016$ ).

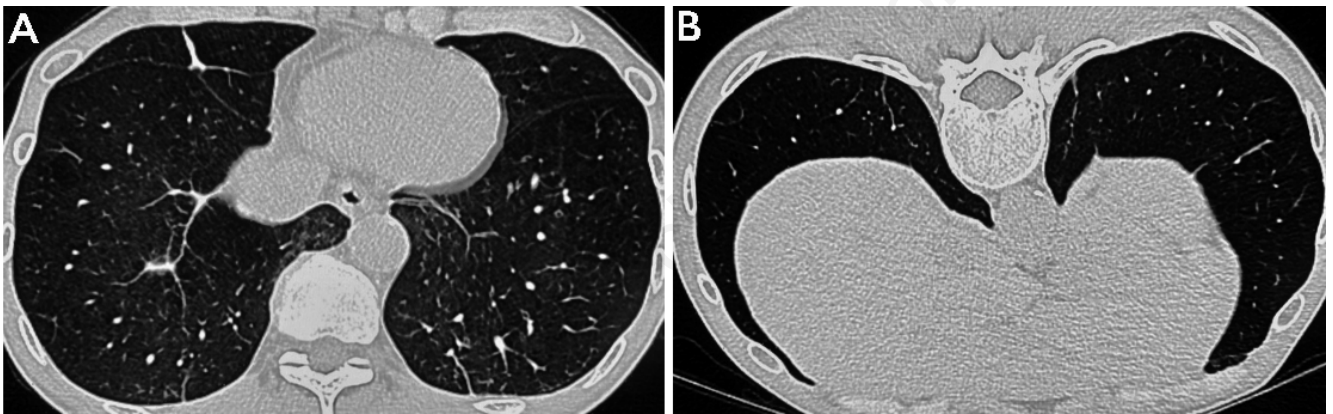


Figure 1. CT scan in supine (A) and prone (B) position display bilateral lower lobe linear opacities, initially thought to represent plate-like atelectases: they persist on the prone study and turn out to represent linear scars.

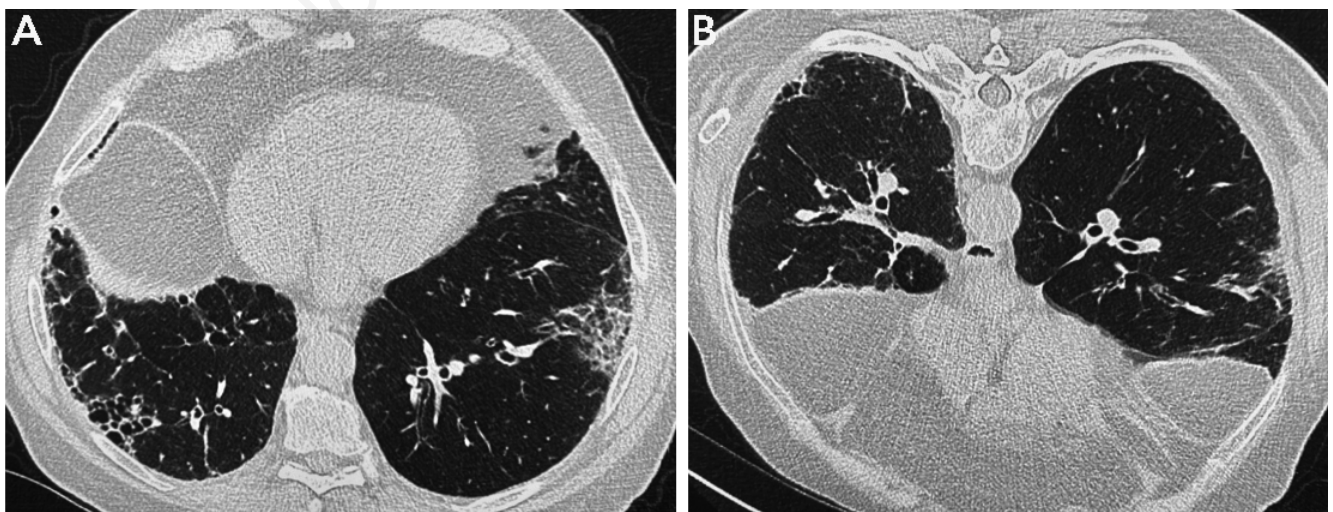


Figure 2. CT scan in supine (A) and prone (B) position show bilateral pulmonary fibrosis in a usual interstitial pneumonia pattern with right-sided honeycombing and left basal persistent focal ground-glass opacity likely due to fine interstitial pulmonary fibrosis.



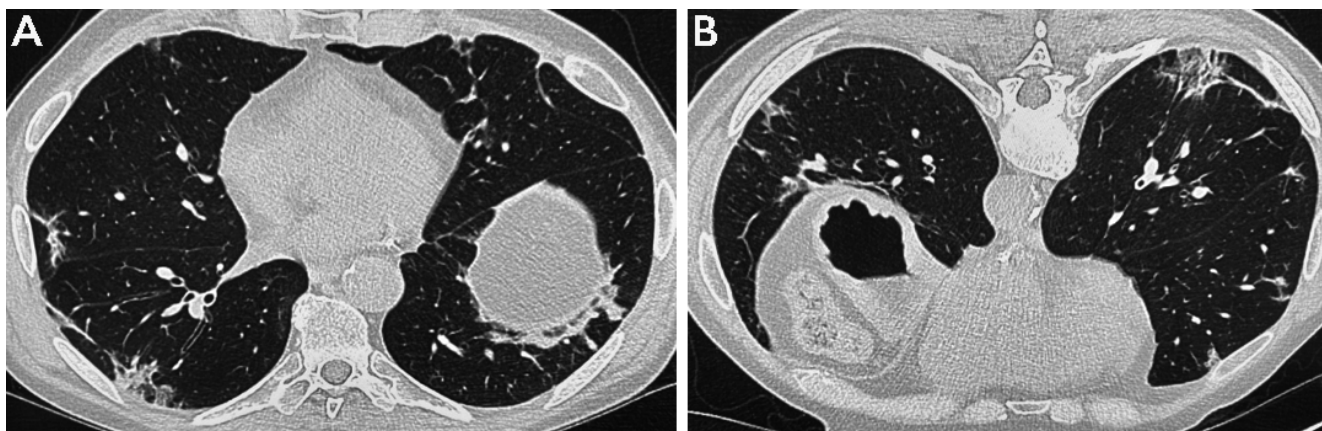


Figure 3. CT scan in supine (A) and prone (B) position show bilateral lower lobe, right middle lobe and left upper lobe subpleural foci of consolidation and ground-glass opacification compatible with multifocal organizing pneumonia in this asymptomatic patient.

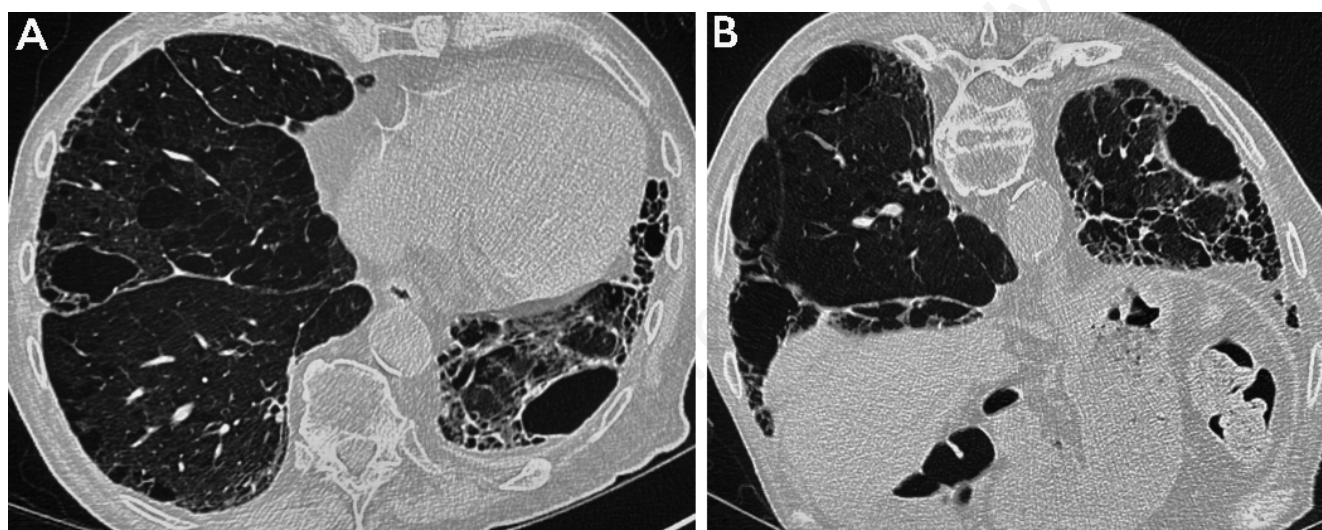


Figure 4. CT scan in supine (A) and prone (B) position show bilateral pulmonary fibrosis and honeycombing in combination with bullous lung disease.

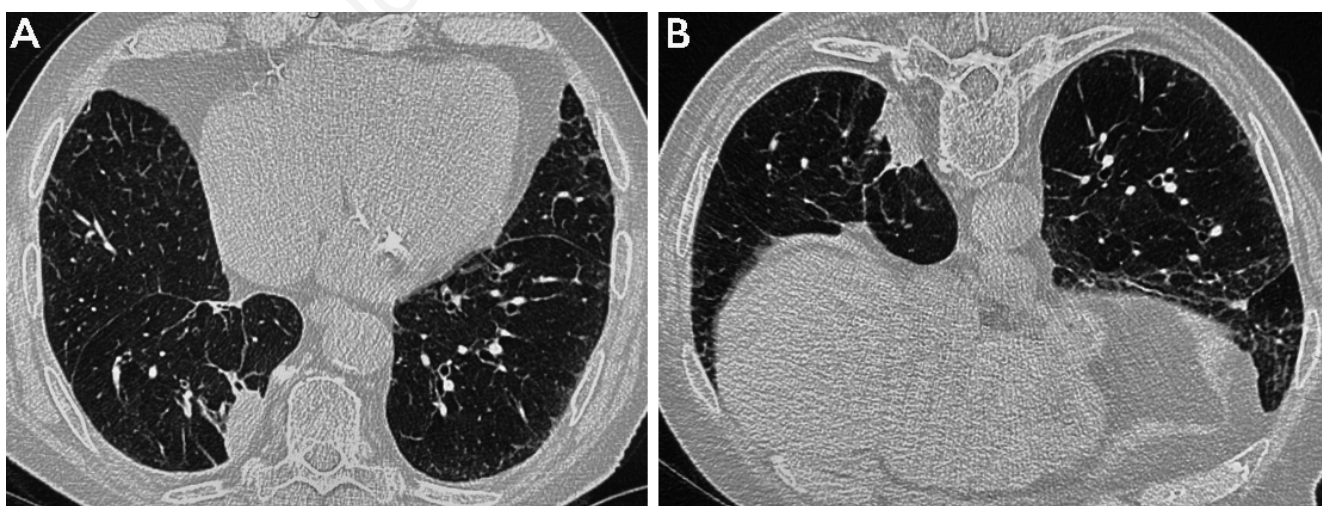
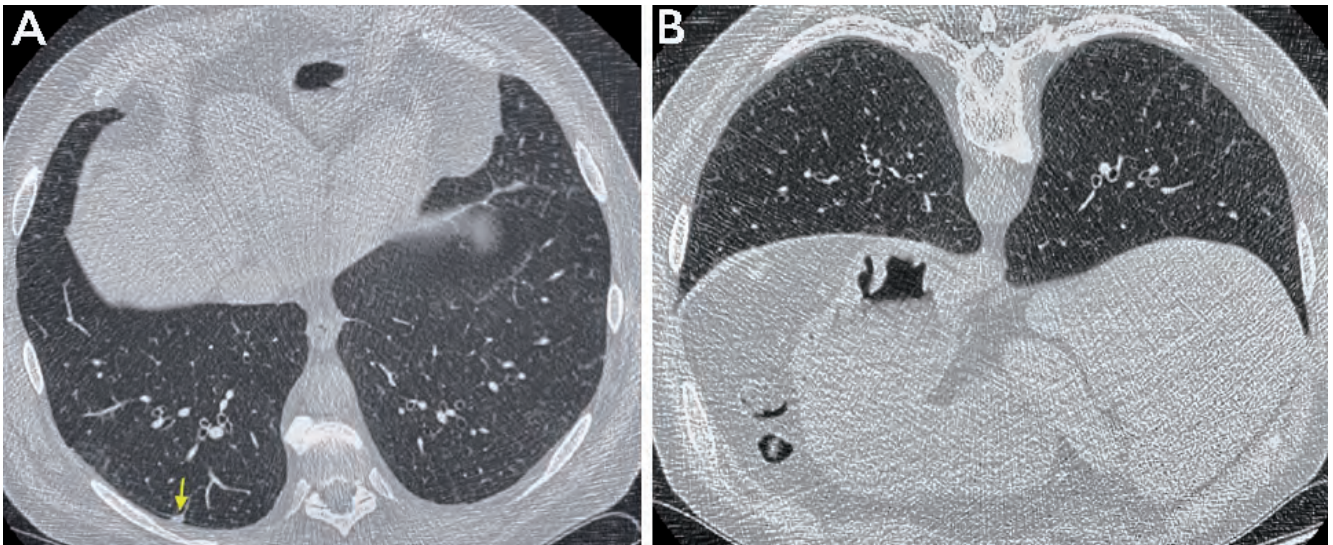
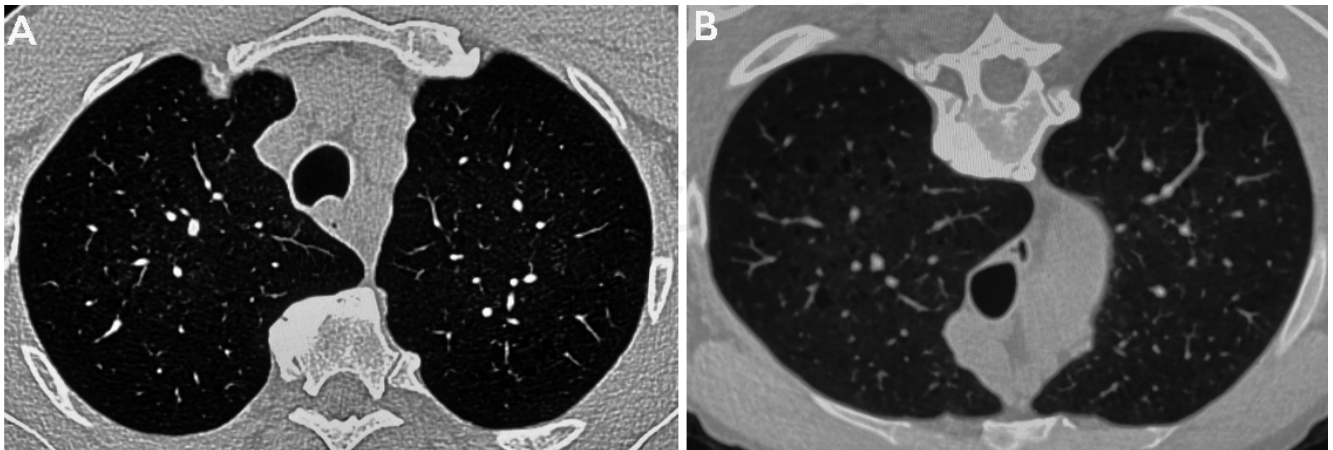


Figure 5. CT scan in supine (A) and prone (B) position demonstrate a right lower lobe rounded atelectasis with overall loss of volume in the entire right lower lobe and fine reticular opacities throughout both lower lobes, the right middle lobe and the lingula.





**Figure 6.** A) CT scan in supine position displays a small subpleural nodule in the posterobasal segment of the right lower lobe (arrow). B) Same patient, CT scan in prone position shows the disappearance of the subpleural right lower lobe nodule.



**Figure 7.** A) CT in supine position shows a non-obstructive posterior mass in the trachea. B) Same patient in prone position shows disappearance of the tracheal mass, likely representing a mucous plug or esophageal imprint.

## Discussion

The results of the National Lung Cancer Screening Trial and NELSON trial have found a meaningful reduction in lung cancer mortality.

A lung cancer screening demonstration project in VHA facilities showed that development and implementation of a comprehensive lung cancer screening program is a complex undertaking since most patients will have findings that require follow-up. Only a minority of these screened persons will have early-stage cancers [4]. Of 2016 persons screened, 1257 or 59.7% had nodules and 1184 or 56.2% required tracking, 42 or 2% required further evaluation but only 31 (1.5%) had lung cancer. A variety of other findings, including emphysema, interstitial lung disease, airways abnormalities and coronary calcifications were detected on CT scans in 857 patients (40.7%).

Interstitial lung abnormalities and small airways abnormalities are relatively frequent and occur in 4-9% of smokers and 5-25% of screened individuals [5,6]. Most likely, are respiratory bronchioli-

tis and early pulmonary fibrosis with or without suggestion of UIP/IPF. Some of these abnormalities have a predilection for the subpleural, dependent regions of the lung, particularly the lung bases. These findings have to be differentiated from dependent, gravity-induced alterations in the lower lung regions that include ground-glass opacities due to increased blood perfusion and decreased size of alveoli (Figures 8 and 9) as well as curvilinear or linear parenchymal bands and subpleural nodules, likely representing subsegmental atelectasis (Figure 10).

## Conclusions

Prone low-dose CT scans can differentiate dependent transient pleuro-parenchymal changes seen on supine scans, from fixed abnormalities and actionable pulmonary nodules with the aim of reducing the high rate of false positive pathologic findings and potential complications from lung cancer screening [1].



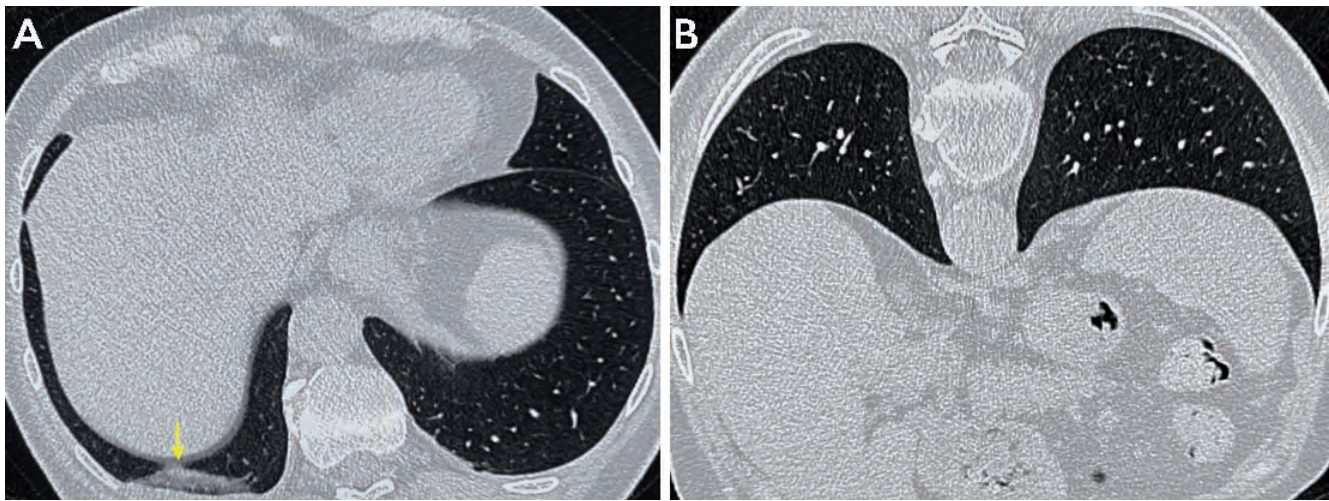


Figure 8. A) CT scan in supine position shows homogeneous, unilateral ground-glass and consolidate opacity in the posterobasal segment of the right lower lobe. B) Same patient in prone position displays the transient nature of the right lower lobe parenchymal opacity.

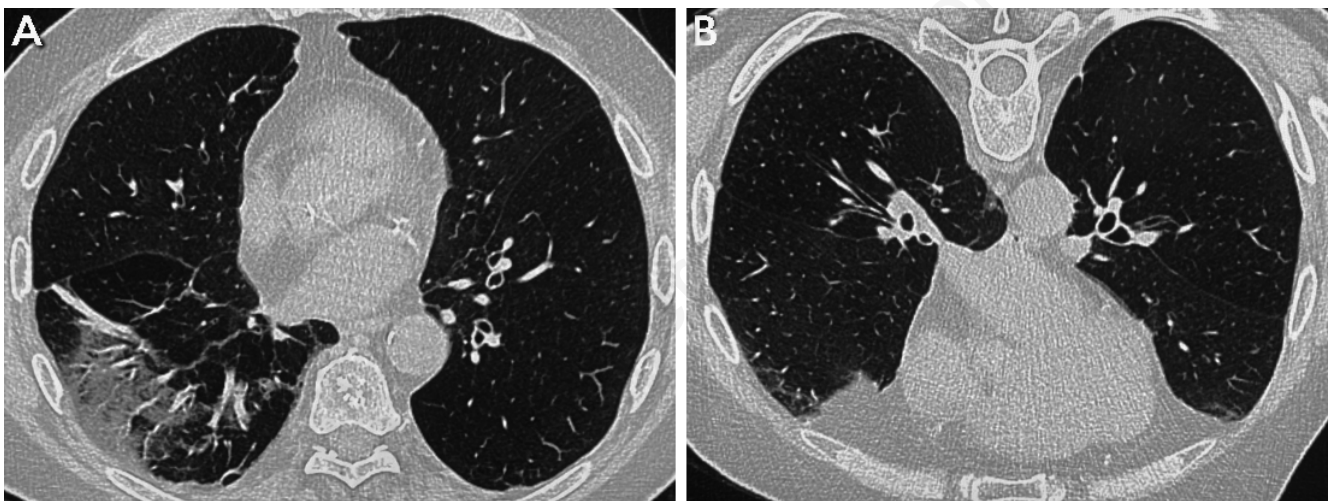


Figure 9. A) CT scan in supine position shows right lower lobe opacification suspicious for pneumonia. B) Same patient in prone position demonstrates marked clearing of the mixed ground-glass and consolidative right basal opacity.

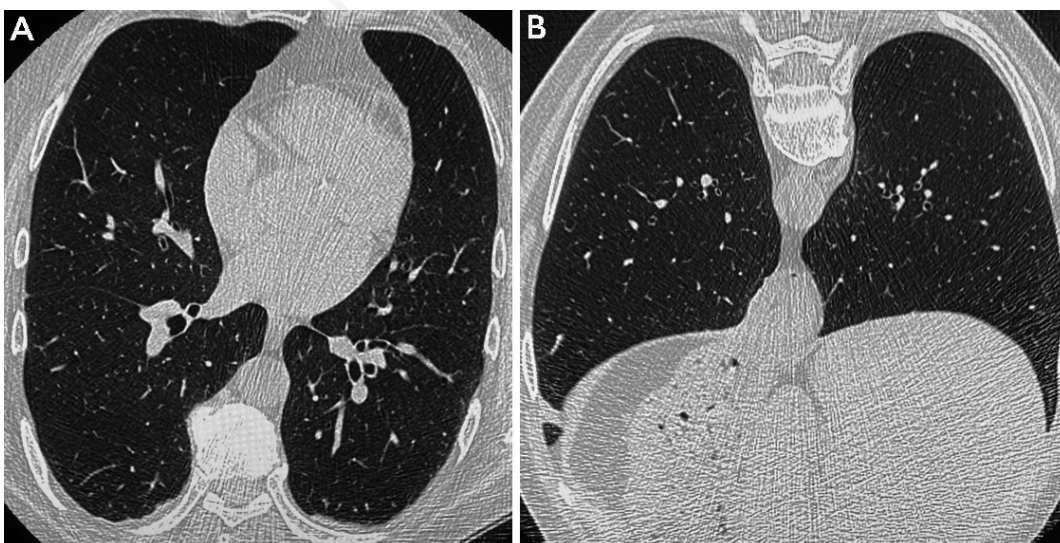


Figure 10. A) CT in supine position shows bilateral posterior irregular pleural thickening. B) Same patient in prone position shows resolution of the presumed pleural thickening most likely due to subpleural plate-like atelectasis.

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