Research Article

Multi-detector High Resolution CT of Interstitial Lung Disease: Role of Different Post Processing Imaging Techniques

Ehab A. Abdel Gawad, Mahmmoud M. Mounir, Ahmed H. Ahmed Kassem, and Kerria R. Adly .
Department of Radiology, El-Minia Faculty of Medicine.

Abstract
The aim of the study: Is to compare the role of high resolution computed tomography (HRCT) images with that of different post-processing techniques such as minimum intensity projection (MinIP), maximum intensity projection (MIP) & computer-aided analysis in the diagnosis of interstitial lung diseases (ILD). **Patients and methods:** 30 patients (26 females and 4 males) were included in this prospective study that took place over duration of nine months. All patients underwent HRCT of the chest and different post-processing techniques were done too. The positive findings were compared recording which technique was better in detection of every finding of ILD. **Results:** MinIP proved to be an excellent tool in visualization of ground glass opacities; however did not add value in some cases presenting with "Honeycombing". The MIP was superior in the depiction of pulmonary nodules. WITH a significant correlation between visual scoring and computer aided scoring with PFT were found, computer aided quantification showed a more significant and stronger correlation, higher performance and better accuracy. **Conclusion:** MinIP & MIP are multiplanar techniques of HRCT that proved throughout our study to be informative complementary tool increasing the observer confidence and agreement regarding some findings as compared with HRCT alone. CAD is very important in detection of lung density, identifying upper/lower or left/right predominance of ILD affection plus the fact that it's time consuming.

Introduction
Is to compare the role of high resolution computed tomography (HRCT) images with that of different post-processing techniques such as minimum intensity projection (MinIP), maximum intensity projection (MIP) & computer-aided analysis in the diagnosis of interstitial lung diseases (ILD).

HRCT normal anatomy of the lung the pulmonary interstitium:
The pulmonary interstitium is the supporting tissue of the lung. The pulmonary interstitium is constituted by **CENTRAL** (Axial) fiber system (peri-bronchovascular), **PERIPHERAL** fiber system (sub-pleural & inter-lobular septa) and **PARENCHYMATOUS** interstitium (intra-lobular). The three component parts communicate freely. Interstitium is *not visible* on normal HRCT but visible once thickened. (Jawad et al., 2012)

The Secondary Pulmonary Lobule: The secondary pulmonary lobule is defined as the smallest unit of lung structure marginated by connective tissue septa. It is supplied by a group of terminal bronchioles, is irregularly polyhedral in shape and is approximately 1–2.5 cm on each side. (Heitzman, 1984)

ILD: Pathogensis, HRCT Patterns

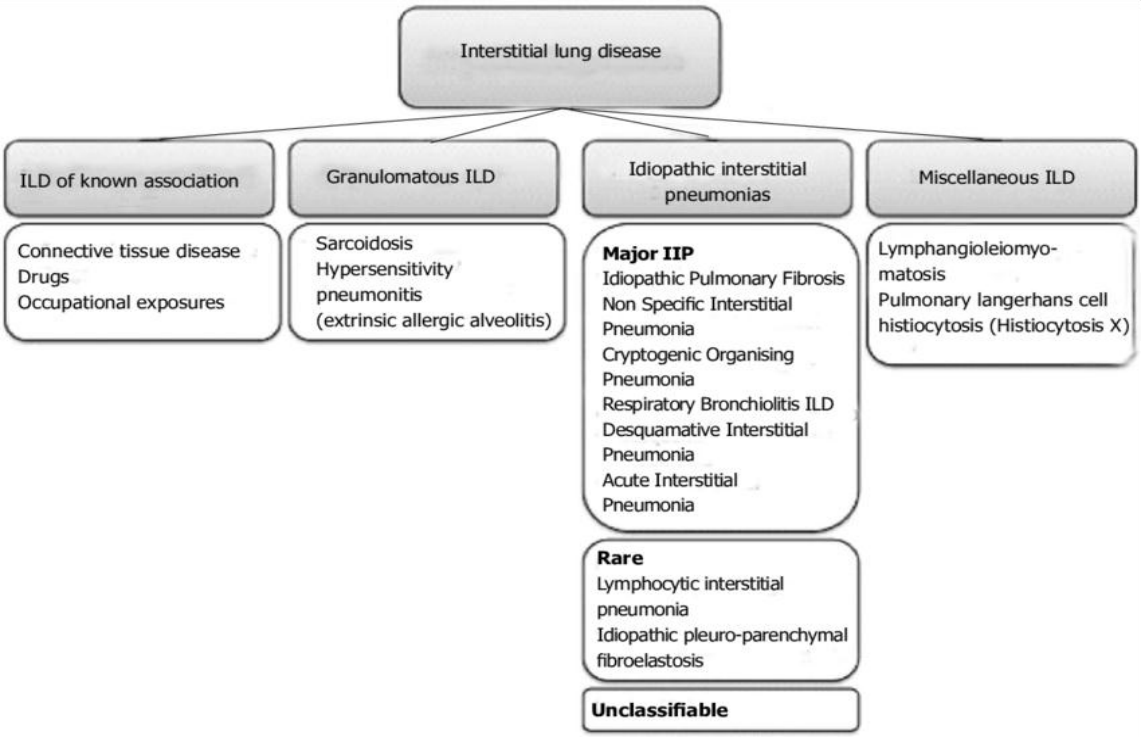


Fig.1: ATS (American Thoracic Society) Classification of ILD (Troy, 2015)

1- Increased Lung Attenuation:

1. Ground-glass opacity (GGO) (Jawad et al., 2012)
2. Consolidation opacity (Hansell, 2005)

2- Decreased Lung Attenuation:

1. Pulmonary Cysts (Lee, 2002)
2. Honeycombing (Heppleston, 1956)

3- Nodular Pattern.
4- Linear Pattern.
5- Combination of Patterns.

HRCT Post-processing Techniques ***(Beigelman-Aubry, 2005)***

I) Two-dimensional Reformation
*Minimum Intensity Projection (MinIP)

*Maximum Intensity Projection (MIP)
II) Three-dimensional Reformation
*Volume Intensity Projection (VIP)

*Volume Rendering (VR)
III) Computer-Aided Detection (CAD)

Methodology

After the approval from the hospital ethical committee and informing the individual patients, 30 patients were incorporated in this prospective clinical study that was conducted at the Radiology Department, El-Minia University Hospital in the time period from September 2018 to June 2019.

- ***Inclusion criteria:*** Adult patients (> 18 years old) with suspected interstitial lung disease (ILD) based on history, clinical examination and pulmonary function tests.
- ***Exclusion criteria:***
  - < 18 years old patients.
  - Pregnant patients if present.
  - End stage ILD.
- ***All patients were subjected to***
  1- History. 2- Revision of the clinical data from patient sheet.
  3- Pulmonary Function Tests. 4- MDCT of the Chest without contrast.

- ***All images were reviewed for the detection of the following:***

1. ***Ground Glass Opacities.***

2. ***Fibrotic Changes.***
3. ***Cysts.***
4. ***Reticulations.***
5. ***Nodules.***
6. ***Cavitations.***
7. ***Honey Combing.***
8. ***Consolidation***

❖ ***FEV1 Categorization:*** ***(Tafuro and Corradi, 2016)***

- Restrictive ventilatory defect was defined on spirometeric findings of FEV1/FVC ratio > 70% and FVC <80% predicted.
- Severity classified functionally based on FEV1 results;
  - > / = 70 → Mild.
  - 69 - 50 → Moderate.
  - < / = 49 → Sever.

❖ ***Visual Scoring***

- It was done according to number of segments affected in both lung fields &the finding on each segment was given a score from 1 to 4 as follows; (Salaffi et al., 2015)

  Ground Glass Opacities → 1
  Cysts → 2
  Fibrotic Changes & Reticulations → 3
  Honey Combing → 4

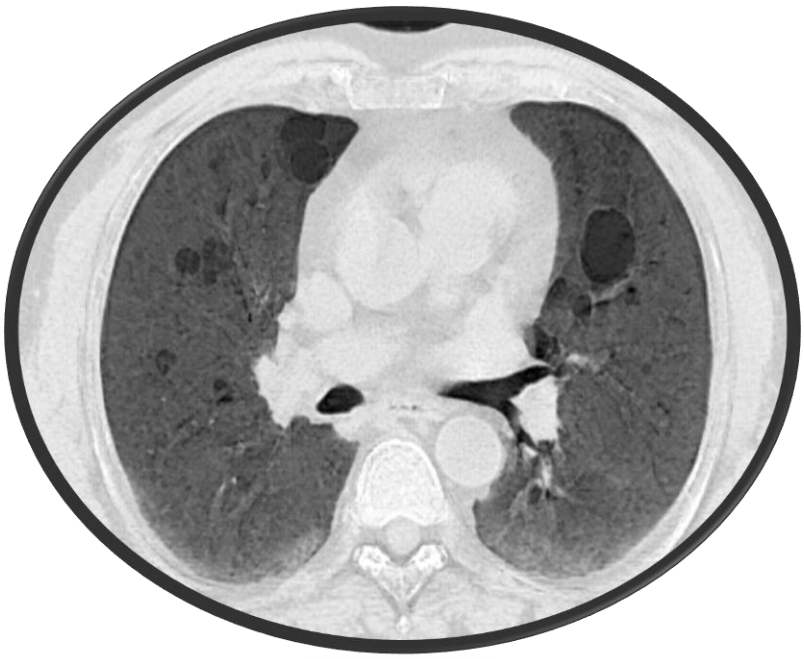
- If one segment has two findings or more, we consider the score of the higher finding.

Results

1- There is a fair negative significant correlation between visual scoring &FEV1.
2- There is a strong positive significant correlation between visual scoring &whole lung density.
3- There is a fair negative significant correlation between CAD whole lung density &FEV1.
4- CAD whole lung density had better accuracy than visual scoring.
5- Computer aided quantification showed a more significant and stronger correlation, higher performance and better accuracy.
6- MinIP is better in detection of GGO, fibrotic changes &cysts
7- HRCT is better in detection of bronchiatitic changes & Honey Combing.
8- MIP is better in detection of nodules.

Case Presentation

Case 1

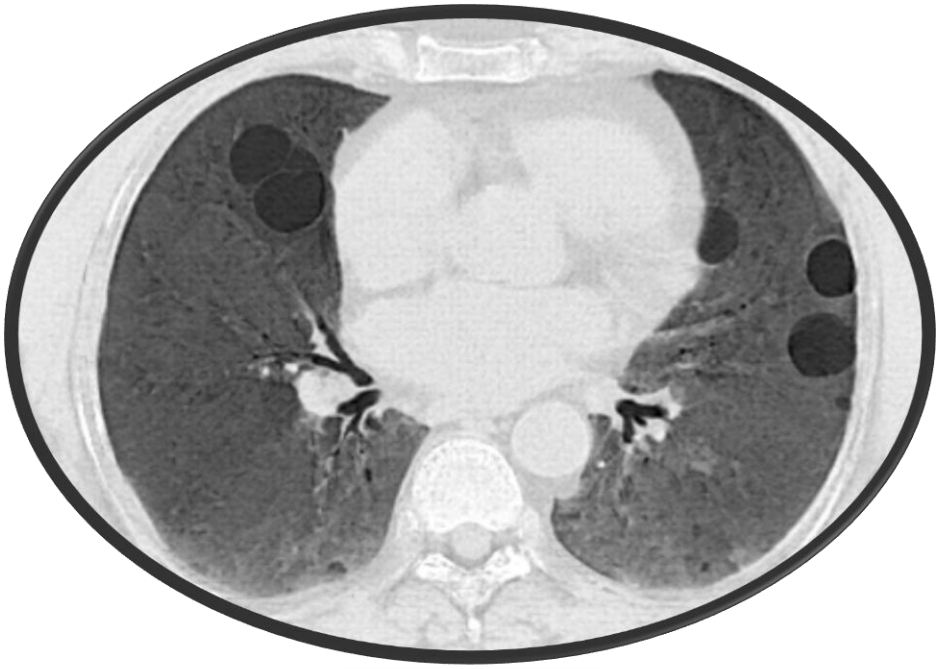


Axial cut of MinIP showing cysts

A ***B***

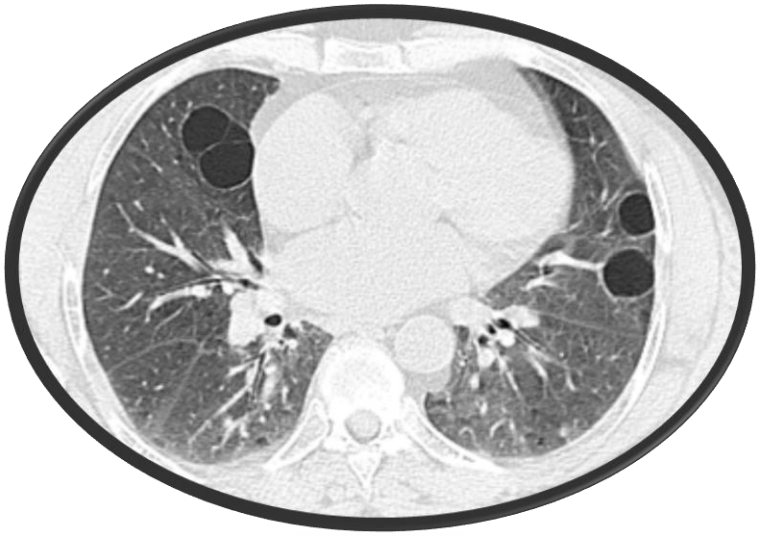
Axial cut of HRCT showing cysts

Cysts were evident equally in both MinIP & HRCT in this case, while GGO are more evident in MinIP.



Axial cut of MinIP showing Reticulations

C *D*



Axial cut of HRCT showing Reticulations

Reticulations appear more evident in HRCT than in MinIP, with evidence of GGO more in MinIP.

Discussion

Processing and reconstruction of new techniques like Min IP might somewhat prolong time & increase complexity of evaluation of HRCT examination, but, information that will be gained from these techniques is beneficial.
lung densitometry enables an automatic complete evaluation of all (typically 300–350 thin contiguous/overlapped sections of whole lung parenchyma that are now in few seconds obtained in a single breath-hold with MDCT scanners. **Third**, thanks to the automatic segmentation of lung tissue& software computation of density, the time required for lung densitometry is generally shorter as compared to visual scoring.

Direct comparison of CT densitometry with visual score in patients with pulmonary fibrosis showed that the former is more reproducible, more sensitive for assessment of diffuse lung changes than visual semi-quantitative assessment.

References

1. JAWAD, H., CHUNG, J. H., LYNCH, D. A. & NEWELL, J. D. 2012. Radiological approach to interstitial lung disease: a guide for the nonradiologist. Clinics in chest medicine, 33, 11-26.
2. SALAFFI, F., CAROTTI, M., BOSELLO, S., CIAPETTI, A., GUTIERREZ, M., BICHISECCHI, E., GIUSEPPETTI, G. & FERRACCIOLI, G. 2015. Computer-aided quantification of interstitial lung disease from high resolution computed tomography images in systemic sclerosis: correlation with visual reader-based score and physiologic tests. BioMed research international, 2015.
3. TAFURO, F. & CORRADI, M. 2016. An approach to interpreting restrictive spirometric pattern results in occupational settings. La Medicina del lavoro, 107, 419-436.
4. Heitzman ER. The lung: radiologic-pathologic correlations: Mosby Incorpo-rated; 1984.
5. Troy L, Corte T. Interstitial lung disease in 2015: where are we now? Australian family physician. 2015;44(8):546.
6. Hansell D, Armstrong P, Lynch D, McAdams H. Basic HRCT patterns of lung disease. Hansell DM, Armstong P, Lynch DA, McAdams, eds Imaging of Diseases of the Chest Philadelphia, Elsevier Mosby. 2005:69-181.
7. Lee K-H, Lee JS, Lynch DA, Song K-S, Lim T-H. The radiologic differential diagnosis of diffuse lung diseases characterized by multiple cysts or cavities. Journal of computer assisted tomography. 2002;26(1):5-12.
8. Heppleston A. The pathology of honeycomb lung. Thorax. 1956;11(2):77.