The role of High resolution multidetector computed tomography chest in the differential diagnosis of ground glass opacity in diffuse lung diseases

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ABSTRACT

Background: Ground-glass opacification/opacity is a non-specific sign with a wide etiology including infection, chronic interstitial disease and acute alveolar disease. The use of the term ground glass derives from the industrial technique in glassmaking whereby the surface of normal glass is roughened by grinding it. Subtypes of GGO include nodular, mosaic, crazy paving, diffuse, mosaic, centrilobular, halo sign, and reversed halo sign. A total number of 50 male and female patients were included in the study with age range from 22 to 88 years, and were coming for CT chest study assessment.

Aim of the work: The aim of this study is to implement the importance of HRCT with its reconstruction capabilities in the detection of ground glass lesions in diffuse lung diseases and approach for differential diagnosis.

Material and methods: This cross sectional study involved 50 patients with different chest symtomps include dysnpnea, cough or fever.

Results: This study involved 50 patients, all above 18 years of age and age range are between (22 to 81) years. According to clinical data, among the studied cases there were 43 (86%) with cough, 8 (16%) with fever and 38 (76%) dyspnea. According to ground glass lesion CT morphology and distribution, among the studied cases there were 33 (66%) ill-defined and 13 (26%) well-defined, there were 15 (30%) with central, 25 (50%) with peripheral and 5 (10%) with both central and peripheral (Cp & P) and there were 14 (28%) with patchy and 20 (40%) with homogenous.

Conclusion: HRCT is essential diagnostic tool for diagnosis and characterization of diffuse ground glass opacities. Interstitial lung disease is the most common disease to cause diffuse ground glass opacity followed by inhalation lung disease and pulmonary edema. Multidisciplinary approach with the aid of clinical, laboratory and histopathology were essential to reach the final diagnosis.

Key Words: Ground glass opacification – CT imaging – HRCT – ILD

INTRODUCTION

Ground-glass opacification (GGO) is a descriptive term referring to an area of increased attenuation in the lung on CT with preserved bronchial and vascular markings **(1).**

It is a non-specific sign with a wide etiology. The causes of ground-glass opacities can be divided into acute and chronic. Among the acute causes are infections (atypical bacterial and viral infections), alveolar hemorrhage, pulmonary edema, diffuse alveolar damage, pulmonary embolism, and some neoplasms. Chronic causes include disseminated bronchioloalveolar carcinoma (BAC), interstitial lung disease, connective tissue disease including rheumatoid arthritis, lupus and scleroderma. granulations disease like sarcoidosis **(2).**

GGO tends to be difficult to be identified radiographically especially in mild cases: this is because the differential diagnosis of GGO is mainly based on HRCT **(2).**

Subtypes of GGO include nodular, mosaic, crazy paving, diffuse, mosaic, centrilobular, halo sign, and reversed halo sign **(3).**

A better approach is to identify the key features of the real underlying disease (such as the onset of symptoms, smoking history, presence/absence of fibrosis, or the distribution in the lung parenchyma) **(4).**

The location of the abnormalities can be helpful. Upper zone predominance includes respiratory

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bronchiolitis and Pneumocystis pneumonia. Lower zone predominance includes UIP, NSIP, DIP. Centrilobular distribution includes hypersensitivity pneumonitis, Respiratory bronchiolitis **(3).**

Aim of the work: The aim of this study is to implement the importance of HRCT with its reconstruction capabilities in the detection of ground glass lesions in diffuse lung diseases and approach for differential diagnosis.

MATERIAL AND METHODS

Patients:

- This cross sectional study involved 50 patients with different chest symtomps include dysnpnea, cough or fever.

Inclusion criteria:

- Patients presented by chest symptoms as dyspnea, fever and cough

Exclusion criteria:

- Pregnancy
- CT image contained significant motion artifact

Methods:

A) Patient preparation:

- All patients were subjected to clinical examination with history taking, general and chest examination.
- Those patients were referred to the Radio diagnosis department in el kasr aini Cairo university CT of the chest over a period of 8 months form December 2022 to august 2023

B) Protocol of CT techniques:

- CT chest was done to all patients in the radiology department at Kasr Al-Ainy Hospital, using MSCT 16 Channels using the parameters as displayed in in table (Table 1).

Table 1: NECT technique:

	Siemens Scope (CTAWP92544) MSCT
Scout	○ 130 Kv ○ 25 mA ○ Holding breath
Scan type	Helical
Detector Row	16
slice Thickness	1.5 mm
Interval	0.75 mm
FOV	320 mm from root of the neck to level of renal arteries.
kV	130
mA	250
Exposure time Per rotation	0.6 s
Total exposure time	9 sec

- All volumetric CT chest assessed at lung window WW 1500 WL -500, and mediastinal window with window width 400 and window level 40.

Study design

Cross sectional study

Data Analysis:

Two radiologists reviewed the MSCT chest images along with the clinical data, laboratory data, and previous radiology reports.

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0**. (**Armonk, NY: IBM Corp**)** Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation, median and interquartile range (IQR). Significance of the obtained results was judged at the 5% level.

RESULTS

This study involved 50 patients, all above 18 years of age and age range are between (22 to 81) years. Mean age of the studied cases was 47.46 (±15.34 SD) with range (22-81) years, among the studied cases there were 29 (58%) females and 21 (42%) males

According to clinical data, among the studied cases there were 43 (86%) with cough, 8 (16%) with fever and 38 (76%) dyspnea.

According to ground glass lesion CT morphology and distribution, among the studied cases there were ٣٣ (٦٦%) ill-defined and 13 (26%) well-defined, there were 15 (30%) with central, 25 (50%) with peripheral and 5 (10%) with both central and peripheral (Cp & P) and there were 14 (28%) with patchy and 20 (40%) with homogenous.

Associated CT chest findings, among the studied cases there were 40 (80%) with fibrosis, 6 (12%) with honeycombing, 6 (12%) with centrilobular nodule, 8 (16%) with air-trapping, 4 (8%) with bronchial disease, 13 (26%) with bronchiectasis, 10 (20%) with plural effusion, 3 (6%) with pericardial effusion, 4 (8%) with

consolidation, 10 (20%) with cardiomegaly and 3 (6%) with pulmonary hypertension, table 3.

The clinical and radiological diagnosis of the studied cases, there were 9 (18%) with pulmonary edema, 20 (40%) with interstitial lung disease, 10 (20%) with inhalation, 4 (8%) with autoimmune, 5 (10%) with inflammatory and 2 (4%) with others.

Correlation of the final diagnosis with main CT findings: In case of pulmonary edema, 88.9% of cases showed ill defined lesion with 55.6% appeared homogenous and 88.9% showed central distribution. In case of interstitial lung disease, 90% of lesions were ill defined, 50% were patchy and 50% were homogenous, and 90% were peripheral. Regarding inhalation lung disease, 50% of lesions were ill defined and 50% were well defined, 60% were homogenous, and 60% showed central and peripheral distribution. Regarding autoimmune disease, 100% of cases showed ill defined ground glass lesions with 75% were homogenous lesions with peripheral distribution. Regarding diffuse inflammatory diseases, 60% of cases showed well defined ground glass lesions, with 80% were patchy and 60% showed central and peripheral distribution. Other lesions were post traumatic pulmonary contusions and bronchoalveolar carcinoma (table 2).

Table 2: Relation between final diagnosis and radiological finding

	Final Diagnosis						χ^2	**p**
	PE	ILD	Inhalation	Autoimmune	Inflammatory	Others		
Radiological finding/ number of cases	9	20	10	4	5	2		
Ill-defined	8	18	5	4	2	0	6.972	0.223
Well-defined	1	2	5	0	3	2	16.794	0.005*
Central	8	2	3	1	0	0	26.005	<0.001*
Peripheral	1	18	3	3	2	0	17.244	0.004*
Both (central &peripheral)	0	0	4	0	3	2	13.333	0.020*
Patchy	4	10	4	1	4	2	5.826	0.324
Homogenous	5	10	6	3	1	0	8.032	0.154

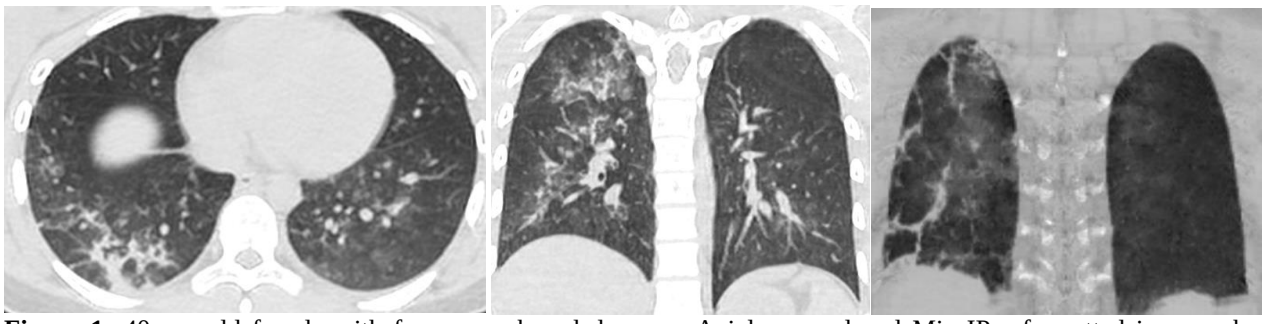

Figure 1: 40year old female with fever, cough and dyspnea. Axial, coronal and Min-IP reformatted images shows Bilateral more lower lobe and peripheral patchy ground glass densities with parenchymal and subpleural bands. Laboratory, Radiological and clinical diagnosis confirmed COVID19 pneumonia.

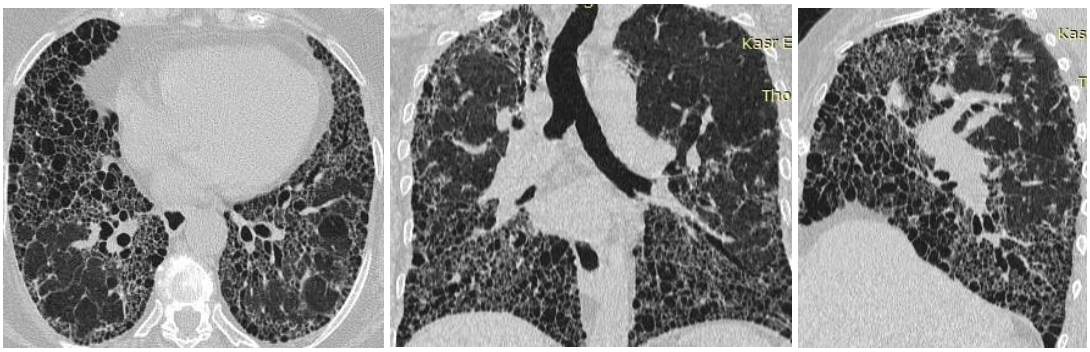

Figure 2: 65 years old male with cough, fever and dyspnea. Axial, coronal reformatted and sagittal image shows ill defined ground glass attenuation mainly peripheral, honeycombing, reticulations, interlobular septal thickening with traction bronchiectatic and bronchiolectatic changes. CT picture suggesting of UIP.

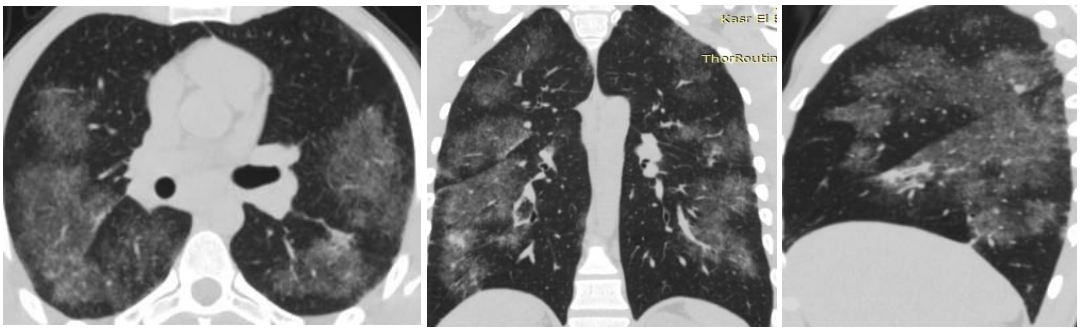

Figure 3: 27 year old male complaining of cough and dyspnea diagnosed as sarcoidosis. Axial, coronal and sagittal reformatted images on lung window shows bilateral pulmonary patchy mainly central ground glass opacities with subpleural and subfissural nodules.

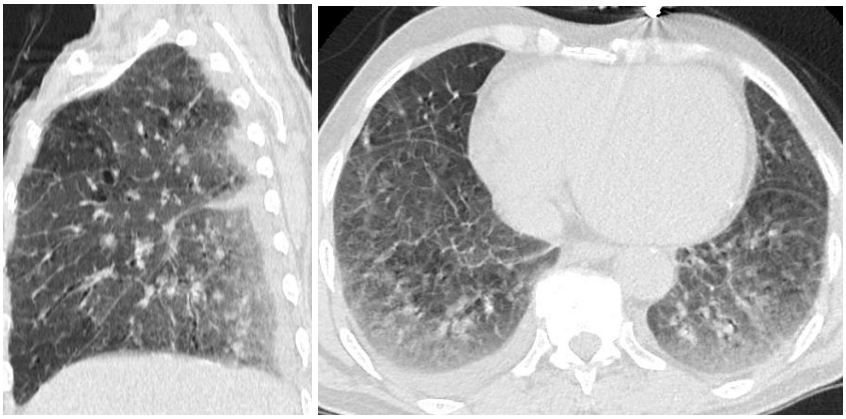

Figure 4: 53 year-old male patient known cardiac disease complaining of cough and dyspnea. Axial and sagittal reformatted images of chest CT showing ground glass veiling (ill-defined and peripheral dependent), associated prominent smooth interlobular septations. Case of bilateral interstitial pulmonary edema.

DISCUSSION

Diagnosis and detection of lung GGO lesions have improved with the introduction of HRCT **(5).** GGO can suggest early underlying lung cancer, which in most cases can be a bronchiole-alveolar carcinoma (BAC) and an adenocarcinoma with a BAC component **(6).** It also may be seen in cases as localized fibrosis or organized pneumonia **(7).**

In the present study, the mean age of the studied cases was 47.46 (±15.34 SD) with range (22-81) years, among the studied cases there were 29 (58%) females and 21 (42%) males. **Shah et al. (8)** reported that GGO was 43.3% in females and 56.7% in males with a mean age of 51.4 years.

In this study, among the studied cases there were 43 (86%) with cough, 8 (16%) with fever and 38 (76%) dyspnea. That was nearly in agreement with **Zaki et al. (9)** who reported that, the most common complaint was cough that presented in 18 patients (60%), 13 patients with dyspnea (43.3%), 11 patients with fever (36.7%). Moreover, **Yu et al. (10)** stated that the most common symptoms in GGO were chest pain (59.4%) followed by cough (53.7%) then dyspnea (33.9%).

In this study, the most common cause of diffuse GGO was interstitial lung disease in 40% of cases, followed by inhalation disease in 20% of cases, pulmonary edema in 18% of cases, followed by inflammatory and autoimmune diseases. **Miller et al. (4)** stated that the causes of diffuse GGO, diffuse alveolar hemorrhage (DAH), non-cardiogenic pulmonary edema, and cardiogenic pulmonary edema accounted for 19 percent of all acute alveolar cases, chronic diffuse interstitial lung disorders were in 27 percent of the causes of diffuse GGO. GGO was frequently associated with acute atypical pneumonia and diffuse infections particularly Pneumocystis carinii pneumonia (PCP) .

According to **Zaki et al. (9)** reported that, the common site of pulmonary ground-glass opacity was the right upper lobe 36.6%, then the right middle lobe 30%, followed by the left upper lobe 26.7%, then the right lower lobe 20%, then lingual 16.7%, and lastly left lower lobe 13.3%. Diffuse distribution was the most common pattern seen in 15 patients accounting for around 50%, lobular or patchy pattern was next seen in 8 patients accounting for around 26.7% lastly, and nodular pattern was seen in 7 patients accounting for around 23.3%.**Yu et al. (10)** reported that the location of GGO in the right upper lobe was 26%, the right middle lobe was 19.8%, the left upper lobe was 17.9%, the right lower lobe 14.2%, the lingula 14.2%, and the left lower lobe 7.5%. According to **Shah et al. (8)**, GGI was most commonly homogenously diffuse distributed (43%), followed by lobular (41%) and nodular (16%).

In this study 5 cases presented with inflammatory diseases, they were ill-defined or well defined, more patchy with central and peripheral distribution. Associated finding of fibrosis, honeycombing, centrilobular nodule, air trapping and bronchial disease reported followed by pleural effusion and consolidation. According to **Zaki et al. (9)** reported that bacterial or viral pneumonitis were found in 10% of patients gave history of fever, and CT findings was mainly in the form of patchy ground-glass attenuation or consolidation , associated findings as air trapping and septal thickening could be detected.

In this study we had 20 cases presented with interstitial lung disease, they had the distribution of the presence of both ill-defined more than well-defined with a predominance of peripheral location and a relatively equal distribution of patchy and homogeneous patterns, associated findings of fibrosis and traction bronchiectasis was in most of the cases followed by honeycombing, others as centrilobular nodules, consolidation, cardiomegaly, pulmonary hypertension were observed. **Zaki et al. (9)** study on GGO showed ILD with diffuse lobular or patchy ground-glass attenuation and reticular lung patterns were found in 16.7% of cases followed by diffuse pulmonary fibrosis complicated by bronchiectasis and honeycombing were seen in 13.3% of cases.

In this study, 10 cases diagnosed as inhalation lung disease, they showed mostly homogenous ill defined ground glass opacities with central and peripheral distributions. Associated findings of air trapping more than fibrosis and centrilobular nodules followed by bronchial disease, bronchiectasis. **More et al. (11)** stated that in hypersensitivity pneumonitis due to Bird fanciers, the common CT features were ground-glass areas in (68%) of cases.

In this study one case with pulmonary contusions. According to **Zaki et al. (9)** reported that pulmonary alveolar hemorrhage due to trauma was in 6.7% of cases with GGO.

In this study 9 cases presented with pulmonary edema, they had the distribution of both ill-defined and well-defined radiological findings, with a predominance of central location and a relatively low number of peripheral distribution. Associated findings noted of cardiomegaly, pleural effusion, and pericardial effusion. According to **Zaki et al. (9)** reported that patients with diffuse GGO were presented as cardiogenic pulmonary edema associated with cardiac chamber enlargement was seen in 10% of cases. A study found that diffuse GGO was present in 29% of patients with acute PE on chest CT scans **(12).**

In this study, 4 cases presented with autoimmune diagnosis (two were rheumatoid, 1 systemic lupus erythromatosis, and 1 scleroderma presened with diffuse GGO presence of ill-defined opacities with mostly predominance of peripheral location. Associated finding of bronchiectasis, fibrosis and honeycombing, centrilobular nodule, pericardial effusion and pleural effusion noticed. **Ishii et al. (13)** concluded that, typical HRCT scan findings for autoimmune PAP patients showed GGO with a patchy geographic pattern, subpleural sparing, crazy-paving appearance, and predominance in the lower lung field. **Kim et al. (6)** found that diffuse GGO was present in 30% of patients with RA-associated interstitial lung disease on chest CT scans. **Fumery et al. (14)** found that diffuse GGO was present in 53% of patients with IBD-related lung disease on chest CT scans.

CONCLUSION

HRCT is essential diagnostic tool for diagnosis and characterization of diffuse ground glass opacities. Interstitial lung disease is the most common disease to cause diffuse ground glass opacity followed by inhalation lung disease and pulmonary edema. Multidisciplinary approach with the aid of clinical, laboratory and histopathology were essential to reach the final diagnosis.

List of abbreviations

BAC: Bronchioloalveolar carcinoma
CT: Computed tomography
DIP: Desquamative interstitial pneumonia.
GGO: Ground-glass opacification
HRCT: High resolution computed tomography.
ILD: Interstitial lung disease.
MINIP: Minimum intensity projection.
MSCT: Multislice computed tomography.
NECT: Non enhanced contrast computed tomography.
NSIP: Nonspecific interstitial pneumonia.
UIP: Usual interstitial pneumonia.

Declarations:

The type of manuscript

Original articles

The total number of pages (20 page) , total number of photographs (four figures) and word counts separately for abstract (253 word) and for the text (2188 word), word counts for introduction (204 word) and discussion (985 word)

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Conflict of interests

The authors declare that they have no conflict of interests.

Ethics approval and consent to participate

No individual data included in the study.

The study was approved by the Research Ethics Committee of the Faculty of Medicine at Cairo University; reference number: Code: MS-441-2022.

All patients included in this study gave written informed consent to participate in this research.

Consent for publication

Not applicable

Availability of data and material

The datasets used and/or analyzed during the study are available upon reasonable request.

REFERENCES

1. Hansell DM, Bankier AA, MacMahon H et-al. (2008) Fleischner Society: glossary of terms for thoracic imaging. Radiology. 246 (3): 697-
2. Hewitt MG, Miller WT, Reilly TJ, Simpson S. (2014)The relative frequencies of causes of widespread ground-glass opacity: a retrospective cohort. Eur J Radiol. ;83:1970–1976. doi: 10.1016/j.ejrad.2014.06.025
3. Walker CM, Chung JH (2019). Müller's imaging of the chest (2nd ed.). Philadelphia, PA: Elsevier. pp. 109–137. ISBN 978-0-323-53179-5. OCLC 1051135278.
4. Miller W, Shah R (2005): Isolated Diffuse Groundglass Opacity in Thoracic CT: Causes and clinical presentations. AJR., 184: 613–622.
5. Grenier P, Beigelman-Aubry C, Fetita C et al. (2002): New frontiers in CT imaging of airways disease. Eur Radiol., 12:1022–44.
6. Kim H, Shim Y, Lee K et al. (2007): Persistent pulmonary nodular ground-glass opacity at thin-section CT: histopathologic comparisons. Radiology, 245:267- 75.
7. Nakajima R, Yokose T, Kakinuma R (2002): Localized pure ground-glass opacity on highresolution CT: histologic characteristics. J Comput Assist Tomogr., 26:323–9.
8. Shah R, Miller W (2003): Widespread ground-glass opacity in consecutive cases: does lobular distribution assist diagnosis? AJR., 180:965 –968.
9. Zaki RS, Dawoud OA, Ahmed AF, Salem AF. (2022) Role of High-Resolution Multidetector Computed Tomography in Characterization of Pulmonary Ground Glass Opacity. The Egyptian Journal of Hospital Medicine. Jul 1;88(1):2758-65.
10. Yu H, Liu S, Zhang C et al. (2018): Computed tomography and pathology evaluation of lung groundglass opacity. Exp Ther Med., 16(6): 5305–5309.
11. Morell F, Roger A, Reyes L et al. (2008): Bird Fancier's Lung: A Series of 86 Patients. Medicine (Baltimore), 87(2):110-30.
12. Koc ZP, Ulusoy S, Kocacelebi K, et al. (2021) The impact of acute pulmonary embolism on chest computed tomography in COVID-19 patients. Eur J Radiol.;136:109585.
13. Ishii H, Trapnell BC, Tazawa R, Inoue Y, Akira M, Kogure Y, Tomii K, Takada T, Hojo M, Ichiwata T, Goto H, Nakata K; (2009) Japanese Center of the Rare Lung Disease Consortium. Comparative study of high-resolution CT findings between autoimmune and secondary pulmonary alveolar proteinosis. Chest. Nov;136(5):1348-1355.
14. Fumery M, Pineton de Chambrun G, Stefanescu C, et al. (2019) lung disease in inflammatory bowel diseases: results of a multinational survey. Inflamm Bowel Dis.;25(5):802-810.