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Role of imaging (X-ray & HRCT) chest in diagnosis, management and prognosis of COVID-19 pneumonia

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Abstract

Objective: Our main aim is to have accurate diagnosis using chest x-ray as preliminary investigation in a developing country like India. However HRCT chest is indicated for moderate, severe cases & follow up of patient. The radiological findings are correlated with RT-PCR test & clinical features of covid-19 pneumonia cases.

The case fatality rate in India has declined to 1.94% due to increase in testing rate, taking precautions like mask wearing & sanitizing hands frequently, maintaining social distancing & increase number of dedicated covid hospital in each district of India.

Methods: The clinical features, laboratory & radiological findings were analyzed in 250 covid-19 patients and confirmed by RT-PCR, from 10th May 2020 to 31st August 2020, admitted in our dedicated covid-19 hospitals of G.S. Medical College, Hapur, NCR, India.

Results: The common clinically findings reported in covid-19 pneumonia cases were fever, sore throat, cough, breathlessness, Myalgia, loss of smell & taste.

The initial investigation x-ray chest were done of all patients, 45% patients showed ground glass opacities as haziness. Out of the 250 patients, 32% patients showed bilateral patchy opacities involving peripheral lung. While 68% patients showed bilateral basal lung involvement.

62% patients revealed peripherally lesions in Sub pleural area & bilateral basal region. The CT. lesions were located both in peripheral & central location (32%).

C.T severity scoring (CTSS) is strongly recommended to assess progression or regression of GGO's & consolidative lesions, at the time of admission & follow up.

C.T findings are seen as ground glass opacities, (uni / bilateral), presence of nodules, round & cystic changes, consolidation, reticular pattern, crazy- paving pattern, pleural thickening / effusion, lymphadenopathy, bronchiolectasis.

On HRCT CHEST, 78% patients were reported as multi focal, multiple ground glass opacities located in Sub pleural, mid & basal region. 31% patients showed uni or bilateral patchy consolidation. 52% showed bilateral patchy peripheral location. C.T. severity scores of I.C.U patients were found higher as compare to patients from isolation ward.

Conclusion: X-ray chest plays an initial role in level 1 & level 2 cases with mild findings while HRCT chest is recommended in moderately affected & ICU patients (severe) cases with or without co-morbidities like diabetes, hypertension, COPD, > 60 yrs of age with positive findings in x ray chest involving bilateral 4 or 5 lobes and having strong clinical features.

- There is crucial role of HRCT chest in diagnosis of covid-19 pneumonia, particularly for those patients, who have a negative RT-PCR initially.
- The important role of HRCT chest in diagnosis, severity scoring and for Management of patients, in Prognosis & follow-up.

Keywords: Covid-19 pneumonia, HRCT (High resolution computed tomography), GGO. (Ground glass opacities), consolidation, chest radiography. C T Severity score, ARDS (Acute respiratory distress syndrome)

Introduction

There was reported a highly infection flu like illness disease in Wuhan city in Hubei province of China in the month of December 2019 [1].

Later on the case of this disease found to be noble corona virus disease 2019 or SARS-covid-2 [2].

On 11th March, this disease is designated as covid-19 by W.H.O & declared as a pandemic. After due course of time, disease spread rapidly in most of the countries of the world, causing a global health emergency [3].

The first case of covid-19 in India was reported on 13th January 2020. Initial phase, the patients increased in number slowly & sporadically due to complete lockdown 1 & 2 by central governments.

After unlocked phase 2 & 3, there was upsurge of covid-19 cases in India & now India has the largest number of confirmed Covid-19 cases in Asia & third highest number of confirmed covid-19 positive cases globally after USA & Brazil. [5]

As of August 31st, 2020, the total number of cases in India has reached 3546794 with number of death 63690.

For better diagnosis & treatment of covid-19 positive cases during Global health emergency period our aim is to have through knowledge of x-ray & HRCT chest imaging findings of covid-19 & grading of deadly disease we tried our level best to described the findings in a better way according to the age of patients, severity of disease, staging & follow up. [4]

The Nobel corona virus SARS- covid-2 is the seventh members of the corona viridae family known to infect human beings.

Material & Methods

Selection of Patients

This retrospective study is conducted at Radiodiagnosis Department, with the cooperation from isolation wards & ICU ward from Medicine Department, under the Guidance of CMS, AND ADDL. CMS, from 10th May to 31st August

2020.

The written consent is obtained from each patient & approved by the institutional Ethical committee.

On admission, patient’s history record, Oxygen saturation & thermal screening done & then tested for RT-PCR. Due to getting report after long interval of time, meanwhile the patient’s x-ray chest is advised initially. If found positive findings in x-ray chest, the patient undergo for HRCT chest depending upon the severity of disease for more accurate staging & CT severity scoring in Radio-Diagnosis department on 16 slice GE CT scan (-REVOLUTION ACT).

HRCT chest settings are as follows 120 k, automatic tube current -440- ma, multi-planar reconstruction in coronal & sagittal planes, Slice Thickness is 1 or 2 mm.

Follow up of HRCT chest is advised for severe grade and critical/ICU patients at the time of discharge to assess the prognosis of patient.

Table 1: Demographic Characteristics of Patients

Age Group (in years)	Male	Female	Total	p- value	Group
20-30	49	18	67	0.8108	Group A
31-40	45	20	65		Group B
41-50	56	22	78		Group C
> 50	28	12	40		Group D
Total	178	72	250		

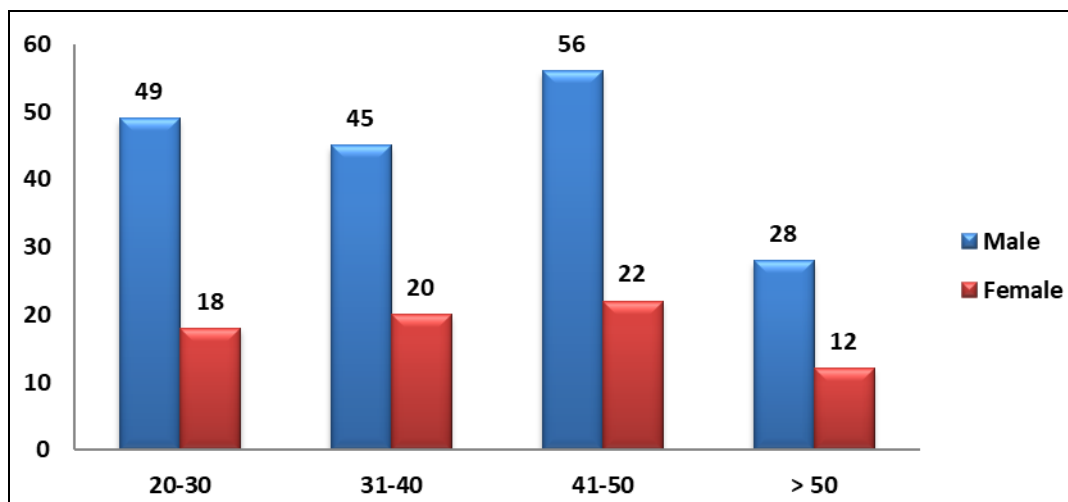


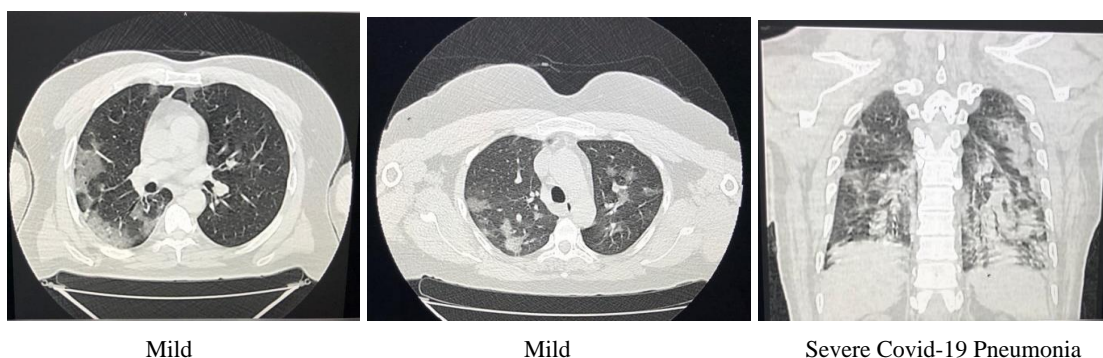
Fig 1: Sex Distribution

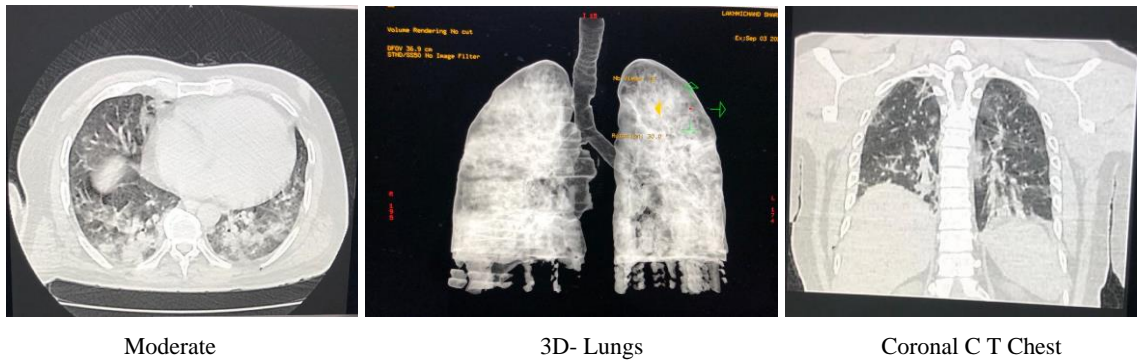
HRCT Review

HRCT images were analyzed by three Radiologist with 25, 14 & 5 years of experience.

THE TWO Radiologist reported the images while 2nd

opinion was taken from faculty in the department in each case of C T Reports & also in equivocal findings or disagreement for reaching final conclusion.





HRCT chest scans are evaluated for the following features. (4)

1. Unilateral or bilateral pulmonary lesions.
2. Distribution of lesion – Subpleural (peripheral), Central or Both .
3. Initial location of the lesions.
4. Lobe involvement.

RUL LUL
 RML LLL
 RLL

5. Patterns of lesions, Patchy opacity, Nodular opacity, Attenuation value, Ground Glass Opacities (GGO's), Consolidation, Mixed Ground Glass Opacities + Consolidation
6. Other signs, Pleural thickening, Pleural effusion, Lymphadenopathy, Reticular pattern, Crazy paving pattern, Cavitation, Bronchiolitis. Pericardial effusion.

C. T. S. S.

A Semi-Quantitatively study is performed in these all mild, moderate & severe types of patients admitted for assessment of grading of Covid-19 pneumonia disease.

During initial and follow up scans, a semi-quantitative C.T severity scoring method is applied to assess quantitatively the pulmonary lobes involvement of all lesions & their patterns.

Five lobes of the lung are assessed based on following criteria.

- Grade 0 - No involvement
- Grade 1 - <5% involvement
- Grade 2 - 5 – 25% involvement
- Grade 3 - 26-49% involvement

- Grade 4 - 50 – 75% involvement
- Grade 5-> 75% involvement.

The HRCT severity score consisted of sum of all five lobes scores and ranged from 0 (No involvement) to 25 (Maximum involvement).

The number of lesions, their location with number of lobes involved and patterns of lesions, resolving lesions. (6)

Criteria for referring Patients to higher centres are as follows:- old age > 60 years with co-morbidities with moderate to severe pneumonia , non resolving consolidation after 3-5 days of vigorous treatment, progressive Radiographic deterioration on follow up, poor prognosis, not responding to antiviral , steroid therapy, oxygen therapy and ventilator support.

RT – PCR

(Real time reverse transcription polymerase chain reaction) Even though the RT –PCR is the most sensitive technique to detect early SARS – COV 2 infection.

The viral RNA from the nasal / throat swab specimens was extracted by the Magna LC pure & magna pure LC total nucleic acid isolation Kit. For real time quantitative RT – PCR assays a 20 ul reaction volumes containing 12 ul of HPA (human pneumonia associated coronavirus LC Mg – sol & 0.5 ml of HPA, coronavirus LC internal control were thermal cycled by a light cycler at 50 °C for 10 mm for RT reaction, at 95 °C for 10 minute for denaturation & followed by 45 cycles of amplification at 95 °C for 25, 55 °C for 125 & 72 °C for 10 s.

The definite diagnosis of coronavirus disease 2019(COVID – 19) is based on the viral isolation or positive result of polymerase chain reaction (PCR) from nasal or throat Swab.

[12] The test showed sensitivity of 82.5%.

Table 2: Abnormal Pulmonary Findings On X Ray Chest

Group	Age group(in years)	Normal	Haziness early GGO	GGO	Consolidation									
						Uni	Bi	Ret	Crazy-paving	PT	PE	LN	Nodular	Cystic
A	20-30	26	25	28	11	12	18	9	1	3	-	-	2	-
B	31-40	21	31	38	13	13	32	11	4	9	2	4	6	2
C	41-50	16	16	26	18	10	40	14	9	14	9	6	8	5
D	>50	12	11	23	24	7	43	17	11	18	14	9	13	4
		75	83	115	66	42	133	51	25	44	25	19	29	11

Table 3: Lobar Distribution of Lungs on X ray Chest

Age Group	Total	RUL	LUL	Total	RLL	LLL	Total	RML	L LING.
20-30	16	6	10	37	11	26	35	15	20
31-40	16	5	11	36	14	22	23	12	11
41-50	21	7	14	54	22	32	50	24	26
> 50	9	3	6	26	12	14	21	10	11
Total	62	21	41	153	59	94	129	61	68

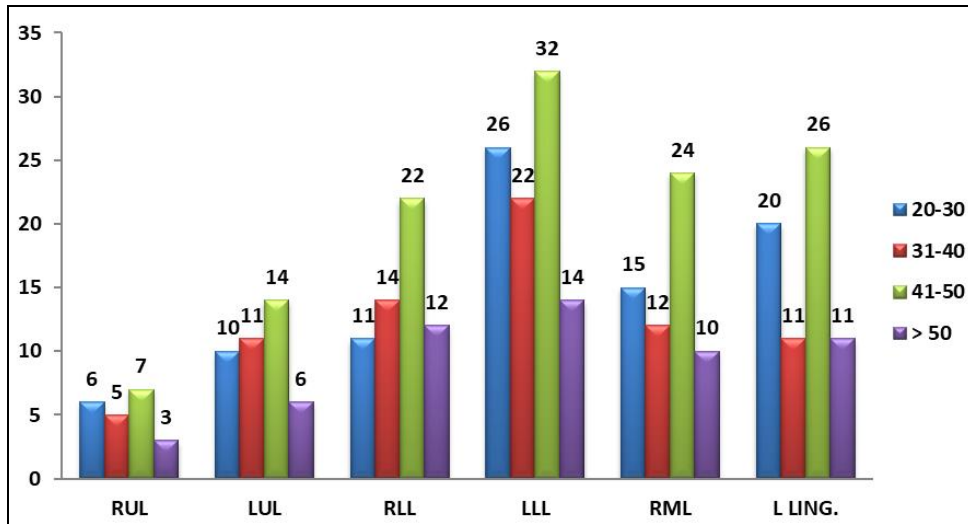
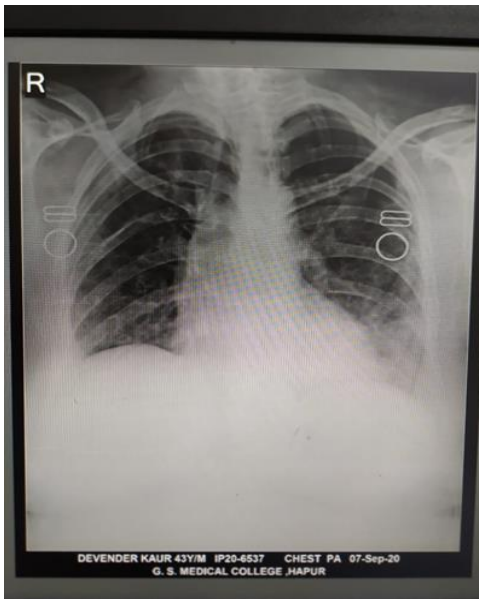


Fig 2: Lobar Distribution of Lungs on X ray Chest

Mild Covid-19 Pneumonia



(Left Basal)

Moderate Covid-19



Bilateral Basal consolidation (Right>Left)



Bilateral Basal peripheral (Opacities)



Severe Covid-19 Pneumonia

Results

a. Clinical manifestation: Total 250 COVID -19 positive patients were selected. The average time interval between the onset of symptoms & hospital admission was 5 to 7 days +/- 3 days The average age was 43 Years, most of the patients were male (70%) The most common symptoms at the initial stage of disease were fever (74%) sore throat (34%) cough (44%) and breathlessness (36%)^[10]

Most of the patients had lymphopenia (62%) & increased reactive protein (41%). According to the experts, it was found that many individuals with SARS – COV 2 infection remained asymptomatic (30%)/mildly symptomatic for a prolonged period & kept in isolation ward.

A South Korean study published in medical journal JAMA internal medicine, has found that asymptomatic patients of COVID – 19 spread the virus similar to the symptomatic patients.

X-ray Chest Findings: - 5 Point Scale

- Grade 1 - Negative findings (normal).
- Grade 2 - unilateral Patchy Atelectasis, Hyperinflation/or Bronchial wall thickening.
- Grade 3-bilateral Focal patchy opacities (consolidation) involving basal region,
- Grade 4 - Multifocal consolidation
- Grade 5 - Diffuse Alveolar consolidation

Lesion Analysis

Laterality ----Right lung/ Left lung, Zonal Distribution – uppr, mid & lower (basal) Peripheral, Central or Both
 Shape – Patchy, Nodular, Segmental & Lobar
 Density –Ground glass opacity (20%), Consolidation (80%)
 Table 1 - Demographics & symptoms of patients infected with COVID – 19 pneumonia

Gender

- Male - 175 CASES
- Female - 75 CASES
- Age years (20 -66 years)
- Mean age 43 years
- Clinical History – Symptomatic 70%
- Asymptomatic 30%
- Kim *et al.* observed 213 covid-19 patients in south korea and found that 19% remained asymptomatic.

Clinical symptoms

- Fever 74%
- Sore throat 34%

- Cough 44%
- Sputum production 32%
- Bodyache 34%
- Chest pain 22%
- Breathlessness 36%
- Diarrhoea 9%

Biochemical

- Lymphopenia 62%
- C- reactive protein 41%
- Positive RT –PCR 100%

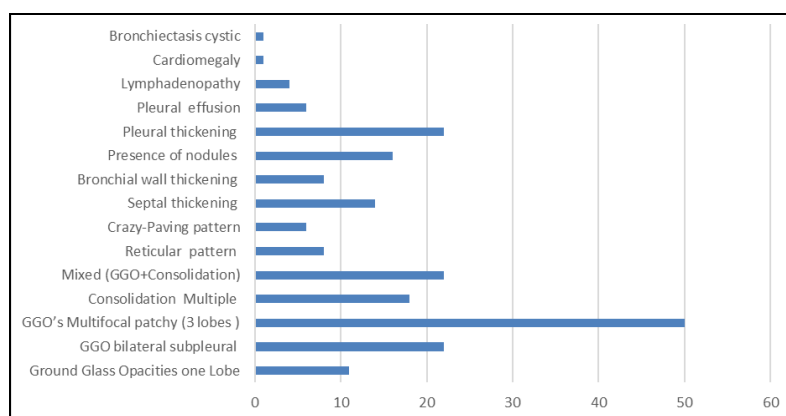
Imaging findings: - HRCT CHEST (75 cases)

Normal H R C T chest 10

Number of lesions	92
Unilateral (one lobe)	11
Bilateral LL	26
Three lobe involvement	32
Four lobes involvement	23
Five lobes involvement	13
Lesion distribution -	
Sub pleural	44
Centro parenchymal	26
Mixed type	22
Location of lesion	
Upper lobe	11
Middle lobe	21
Lower lobe	38
Scattered distribution	24
Panlobular	13

Table 4: Incidence of various Radiological findings on HRCT chest in Covid-19 Pneumonia (13)

Hrct Chest Findings	Number Of Patients
Ground Glass Opacities one Lobe	11
GGO bilateral subpleural	22
GGO's Multifocal patchy (3 lobes)	50
Consolidation Multiple	18
Mixed (GGO+Consolidation)	22
Reticular pattern	08
Crazy-Paving pattern	06
Septal thickening	14
Bronchial wall thickening	08
Presence of nodules	16
Pleural thickening	22
Pleural effusion	6
Lymphadenopathy	4
Cardiomegaly	1
Bronchiectasis cystic	1



Number of Patients

Conclusion

Most patients (about 80%) recover from disease without any special treatment especially for children & young adults.

Tomlins *et al* (UK) reported that less than half of patients discharged during 3 weeks time. Around one in every five people who are infected with covid-19 develop difficulty in breathing & require hospital admission. Gupta *et al* documented a mean age 40.3 years with male preponderance (66.7%) and 43.9% of individuals were asymptomatic. Xiao *et al* confirmed median age was 58 in wuhan, china and 51.2% were male. (8)The median period of RT-PCR results to turn negative was 20 days. [12]

Liu *et al* at wuhan in early days of pandemic, median age was 50 years, 46.13 were male, 38.42 were positive by RT-PCR. [15]

People who are aged above 60 years & with co-morbidities like diabetes hypertension COPD are among those who are at greater risk for covid-19, data till date suggests that 80% of infections are mild symptomatic or asymptomatic (30%), 15% are exposed to severe infection, requiring ventilation.

In India there are 30 asymptomatic cases to every symptomatic patient tested positive & 20 out of 80 untested due to poor contact – tracing & limited understanding of disease & avoid protection such as wearing mask, no proper social distancing & poor hand sanitization.

According to CMAAO (confederation of medical association of Asia & Oceania), for every three symptomatic covid-19 patients, there are 100 asymptomatic patients in Asia.

HRCT scan demonstrated typical abnormalities of covid-19 pneumonia in 65 cases 11 patients had a single lesion on initial scan, (26) had double lesions mainly, the most of the patients – showed bilateral basal distribution (lower lobe) in 38 patients.

Majority of patients (32%) revealed bilateral sub-pleural/peripheral patchy lesions while 22% patients showed centro-parenchymal lesions. 32 patients showed three lobe involvement, 23 had four lobes affected & 13 patients had five lobes affected. [13]

Patchy bilateral multifocal GGO's scattered lesions are seen involving mid and basal regions in 50 patients (78%).

24% patients showed pleural thickening while 13% patients revealed pleural effusion. 20 cases (31%) revealed uni or bilateral patchy consolidation on HRCT scan. 4 cases showed lymphadenopathy & one patient demonstrated cystic bronchiectasis (Bilateral). Early presentation on CT scan was sub-pleural patchy ground glass opacities. Later on, diffuse multifocal patchy ground glass opacities are seen, few of them are mixed with consolidation in one or more lobes. [14] The lesions showed resolution at absorption stage (2 to 3 weeks).

Prognosis

Among the 250 patients admitted in isolation ward & ICU with available follow up on x-ray chest & HRCT chest, 30% patients (75) from isolation ward were detected normal or symptoms free without any pulmonary involvement hence discharged when patients became symptoms free for consecutive 3 days. 175 cases found with abnormal findings. Out of 175 cases, 100 patients were discharged after getting mild treatment within the period of 10 days. [16]. 30% of patients (75) had undergone HRCT Chest because of having moderate symptoms, 10 patients were discharged due to having mild to moderate clinical symptoms without

pulmonary involvement after getting treatment in isolation ward for a period of 10 days, 65 cases showed abnormal HRCT CHEST findings as multiple ground glass opacities/consolidations with pleural thickening were admitted in ICU & later on 65% patients discharged if remains symptoms free for 3 days after vigorous medication. 15% of patients were required medication plus high oxygen therapy and 5% were needed ventilation support. 15% patients not responding to treatment, oxygen therapy and ventilation support were shifted to Level 3 Hospital, as there were progression of disease on HRCT even after giving high flow oxygen, anti-viral drugs, steroids and ventilation support & developed ARDS. [11]

ICU patients with ARDS usually had high C.T severity scoring >more than 15 & involve 3 to 5 lobes. Such types of cases [8] are referred for level 3 hospital for further high level treatment like plasma therapy.

Discussion

The covid-19 pneumonia outbreak highlights the need for early diagnosis, isolation & proper treatment and follow – up. The sensitivity of the HRCT was 97.2% while sensitivity of initial RT – PCR was 83.3%. & of X-ray chest (CR) was 47.4% (due to deficient in detection of GGO's).

Our study reveals x-ray chest (CR) can play a major role in early diagnosis of covid-19 pneumonia as screening procedure especially in patients with quarantine (Level I) & isolation ward (Level II) with mild symptoms or patients with negative first RT-PCR test.

Patients with positive x-ray findings such as ground glass opacity (haziness) with pleural thickening / or mild consolidation with pleural effusion even with a negative RT-PCR (1st) should be admitted in isolation / quarantine ward. [9]

The HRCT CHEST imaging features of covid-19 pneumonia are not specific when compared to both H1N1 & SARS and MERS, hence role of RT-PCR required for confirmation of covid-19 pneumonia.

Multifocal bilateral ground glass opacities with a sub pleural peripheral distribution / or bilateral basal (lower lobe) Consolidation of lungs (78%) were demonstrated in most of our patients. [7]

Role of x-ray chest & HRCT chest were to differentiate the progression or regression of the lesions, there by help in determining the prognosis and follow –up.

Most of the patients (65%) discharged from ICU after regression of lesions & patients became asymptomatic for consecutive three to five days.

On comparison of isolation ward patients from ICU, the number of lesions were few patchy & peripheral in location while ICU patients had multiple bilateral basal ground glass opacities/consolidation with pleural & septal thickening with more lobar involvements.

In the study by Salehi *et al*, the frequencies of the different C T abnormalities were as follows –

Ground glass opacities were observed in 78% of patients and consolidation in 31.8%, Bilateral and peripheral distribution in 32% of patients, Recent updates of corona cases in India as on 31st August 2020, Total cases 3.61 million, 73297 new cases in a day, total deaths in India were 58390, 69% male and 31% females, 36% deaths reported in age groups between 45-60 years, 51% deaths were reported in people above 60 years of age and fatality rate is 1.78% while recovery rate is 76.15%

Conclusion

X-ray chest (CR) and HRCT chest Imaging are valuable tools in early diagnosis of COVID – 19 pneumonia and especially in asymptomatic patients with negative RT-PCR, HRCT chest is also useful for follow up & staging/C.T. severity Scoring of covid-19 – Pneumonia.

X ray chest screening is advisable for mild symptomatic (Level -1) cases with RT-PCR positive but found deficient in detecting ground glass opacity in approximately 50% positive cases of covid-19 Pneumonia.

Conflict of Interest – No conflict of interest.

Informed Consent – Written informed consent is taken.

Ethical Approval – Already taken from ethical committee

Study subject or cohort overlap- No such study reported before.

Methodology

- Retrospective
- Cross sectional , MPR and 3 D study HRCT Chest on 16 Slice C T Scan from GE
- X-ray chest PA view on (Computerized radiography, allengers) on Portable Bed Side X ray machine.
- Performed at one institution.- GS medical college & Hospitals, Distt – Hapur UP, India.

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