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Computed Tomography Score in Covid-19 Pneumonia: Prognosis Prediction and Impact on Management

DR. HIRAL PAREKH [1], DR.SANJAY PARMAR [2]
1 PROFESSOR AND HEAD OF DEPARTMEENT
2 SECOND YEAR RESIDENT
Department of radiodiagnosis, shri M.P.Shah medical college and shri gurugobind Singh Government hospital, Jamnagar.
Corresponding author: Dr. Sanjay Parmar
Resident, Department of radiodiagnosis, Shree M.P.Shah medical college and Shri gurugobind Singh Government hospital, P.N.Marg, Jamnagar, Gujrat , India: 361008

Abstract
Objective: association of HRCT chest involvement score in COVID-19 infections with clinical severity and outcome of patients. HRCT chest helps to identify hidden cases of COVID-19 pneumonia which helps to prevent further transmission. Methods: This was retrospective study carried out from October 24, 2020, until april 28, 2020 consists of 147 patients including suspicious and positive RT-PCR for COVID-19 pneumonia. Each scan were reported with involvement score and categorized as mild, moderate and severe as per score range. Results: In our study ground glass opacity was found in every patient. The association between CT score and final outcome has significant association as score rises. Conclusion: Hight the CT involvement score higher the mortality. This can be used to triage patients while limited resources are available.

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I. Introduction

There might not be any country in world where cases of COVID-19 pneumonia is not present.[1] The sensitivity of throat swab for COVID-19 pneumonia is about 40-70%.[2-5] The reason for such low and variable sensitivity may be due to inadequate sample, difficulties in transportation in remote areas, limited resources and limitation of test kit itself. HRCT chest may be more reliable, practical and easy method as compared to RT-PCR test when viral load is low. There may be false negative test in early stage when visible parenchymal changes in HRCT chest is seen [3-4]. The RT-PCR test should be repeated after positive finding in HRCT chest. The time interval between first negative and subsequent positive RT-PCR test is about 4 to 5 days[3].HRCT chest is very crucial in patient management when RT-PCR kits availability is limited.

II. Methods And Materials

Patient profile

A retrospective study was carried out from October 24, 2020, to april 28, 2021, in G.G. Hospital, Jamnagar. The patient inclusion criteria were symptoms suspicious of COVID-19 pneumonia, positive RT-PCR test and CT findings of viral pneumonia. A total of 147 consecutive patients were studied. The exclusion criteria were patients with known lung malignancy. No such patients were found in our study. Our study was approved by the ethics committee and exempted from written informed consent. Patient demographics, specific clinical information and co-morbidities were recorded. CT was performed in a dedicated CT machine for all Covid-19 suspects with all precautionary measures to avoid cross-infection. The nasopharyngeal/oropharyngeal swabs were obtained for the RT- PCR test to confirm the infection. The HRCT chest findings were reported as per the Radiological Society of North America Consensus Statement.[13] In the cases with typical or indeterminate [13] imaging finding for COVID- 19 and first RT-PCR was negative, a second throat swab for RT-PCR was obtained. After two consecutive negative RT-PCR results these patients were considered negative for COVID-19 infection but were advised home quarantine for 14 days. COVID-19 patients with mild symptoms were discharged from our hospital and sent to isolation canters. Patients with severe symptoms were admitted.

CT protocol

All CT examinations were obtained with the dedicated CT scanner for Covid-19 suspects using GE bright speed 16 CT system helical mode scanner. The tube voltage was at 120 kVp, and tube current was set to

dose of 200-250 mAs. The images were obtained from the thyroid gland level up to the level of the pancreas. No contrast was given. The scan was captured in the end-inspiratory phase, whenever it was possible for the patient to hold the breath adequately. The slice thickness was 0.8 mm. The images were reported by two radiologists in consensus, having more than 10 years of experience in chest radiology, in both lung (window width 1500 Hounsfield unit, HU; level, −700 HU) and mediastinal (window width 350 HU; level, 40 HU) settings. Multiplanar reconstructions in the coronal, sagittal, and oblique planes were also performed and read in addition to the axial sections whenever required. The radiologists were blinded to clinical findings.

Image analysis

Qualitative and quantitative assessment of CT images were done. The HRCT chest was assessed for the presence of ground-glass opacities (GGOs), consolidation, crazy paving pattern, reverse halo sign, vessel engorgement, architectural distortion with subpleural bands, nodular infiltrates, tree in bud patter and cavitation. Hilar, mediastinal lymphadenopathy and pleural abnormalities were also assessed. The reporting pattern suggested by the Radiological Society of North America Consensus Statement was followed.[6] When GGO was associated with septal thickening, it was called a crazy-paving pattern. Consolidation was defined as homogenous opacification of the lung parenchyma with obscuration of the underlying vessels with or without air bronchogram. Reversed halo sign was characterized by a central GGO or low attenuation surrounded by denser air space consolidation in the shape of a crescent or a ring. Fibrosis, volume loss, and subpleural fibrotic strands were noted as architectural distortion and subpleural bands. Dilatation of the subsegmental vessels to 3 mm or more was read as vessel engorgement. The tree in bud pattern was identified as multiple areas of centrilobular nodules with a linear branching pattern.

CT involvement score (CT-IS)

Score 1 – < 5% involvement.
Score 2 – 5–25% involvement.
Score 3 – 26–49% involvement.
Score 4 – 50–75% involvement.
Score 5 – >75% involvement.

The total CT-IS was the sum of the individual lobar scores ranging from 0 (no involvement) to 25 (maximum involvement, when all the five lobes showed more than 75% involvement). The overall lung scores out of 25 was classified as mild, moderate, and severe, depending on the score range. The score between 0 and 9 was taken as a mild disease, 10–17 was taken as moderate disease, and the score range of 18–25 was taken as severe disease.

Statistical analysis

Descriptive statistical analysis was performed to calculate the means with corresponding standard deviation (SD). The test of proportion was used to compare the different proportions, and the chi-square test was performed to find the associations. The receiver operating characteristic (ROC) curve was used to find the value of CT-IS in predicting the disease outcome. Death or hospital admission requiring advance life support was taken as critical disease outcome. The value of $p < 0.05$ was considered statistically significant.

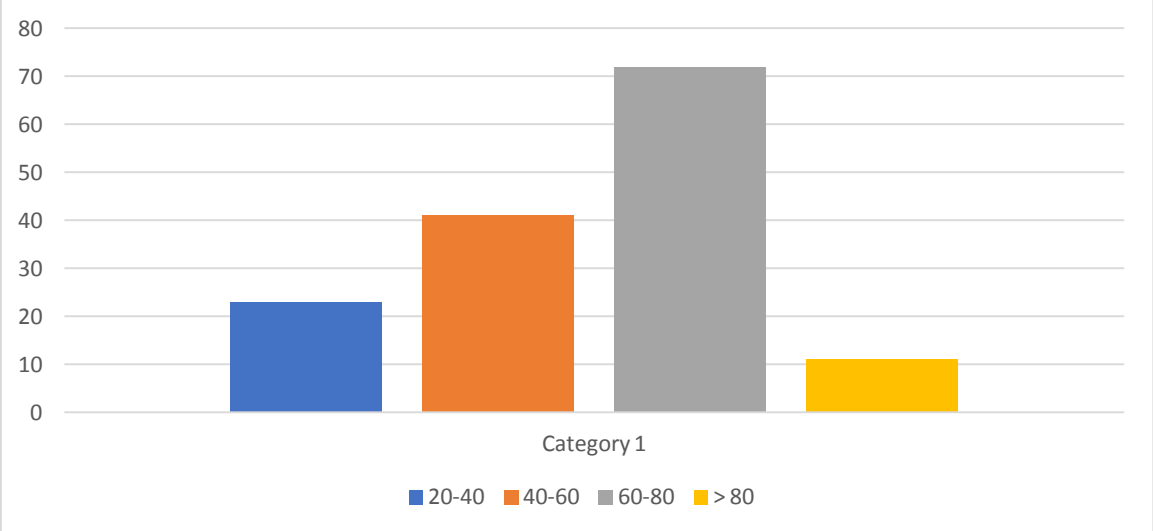


Figure 1: Bar diagram showing age range and numbers of patients (n= 147). The X axis shows age range in years and Y axis indicates number of COVID patients in that age group.

III. Results

Demographics and clinical analysis.

The bar diagram (Figure 1) shows the number of patients in different age range of COVID-19 cases. The mean age (Mean ± SD) of the patients was 52 ± 17 years with a range of 22–88 years. Most of the patients (54.9%) were in the age group between 40 and 80 years. The ratio of male and female (Male: Female) was 3.0:1.0, with 75.5 % of the patients were males, while 24.5 % were females. Fever (49.6%) followed by cough (33.3%), and breathlessness (34.6%) were most common among the symptoms of Covid-19 infection.

SYMPTOMS	NUMBERS OF PATIENTS	PERCENTAGE (%)
FEVER	73	49.6
COUGH	49	33.3
BREATHLESSNESS	51	34.6
WEAKNESS/BODYACHE	36	24.4
SORETHROAT	33	22.4
HEADACHE	29	19.72
LOSS OF SMELL	8	5.4
DIARRHOEA	3	2.1

TABLE NO. 1 SHOWS SYMPTOMTS AND NUMBERS OF PATIENTS PRESENTS WITH THEM.

Table 1 enumerates all the symptoms. Many patients had more than one symptom. The mean duration of symptoms (Mean ± SD) of the patients at presentation was 6.1 ± 2.3 days, with a range of 1–15 days and the median was 4 days. Many patients had co-morbidities.

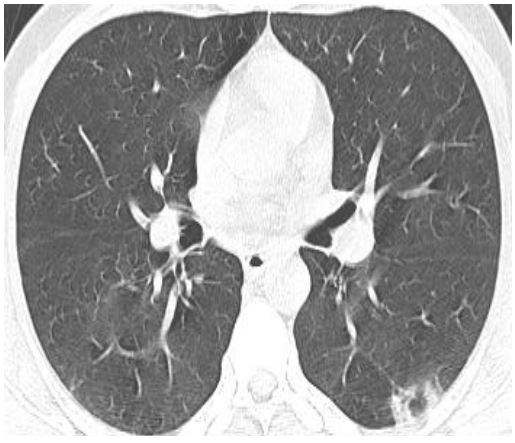
COMORBIDITY	NUMBER OF PATIENTS	PERCENTAGE (%)
DIABETES	43	29.2
HYPERTENSION	24	16.32
CEREBROVASCULAR/CARDIOVASCULAR DISEASE	9	6.1
MALIGNANCY OTHER THAN LUNG MALIGNANCY	3	2.04
CHRONIC RENAL DISEASES	2	1.8
CHRONIC LIVER DISEASE	6	4.08
INFLAMMATORY BOWEL DISEASE	0	0
CHRONIC OBSTRUCTIVE PULMONARY DISEASE	14	9.5

TABLE NO. 2 SHOWS TYPES OF COMORBID CONDITIONS AND NUMBER OF PATIENTS.

Table 2 shows the type of comorbidity and the number of patients having it. 53 patients (36.05%) had one or more comorbidities. 46 patients (31.29%) had no co-morbidity. Two patients (2.8%) had chronic renal disease. Three patients (2.04%) had malignancy other than lung malignancy. 24 (16.32%) patients had hypertension and 43 (29.2%) patients had diabetes. Patients presenting with mild symptoms (63.3%) were more than those with severe presentation (36.9%). Hospital admission was advised in 75.5 % of patients, and 24.5 % of the patients were offered isolation. 11 patients died (7.48%), 41 (34.5%) patients required oxygen, intravenous medications, or life support measures, while 95 (64.52%) required only minor symptomatic treatment.

BILATERAL PERIPHERAL GGO

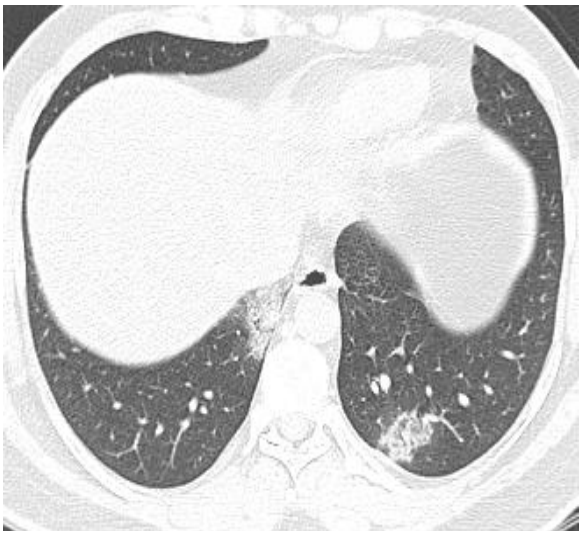
REVERSE HALO SIGN



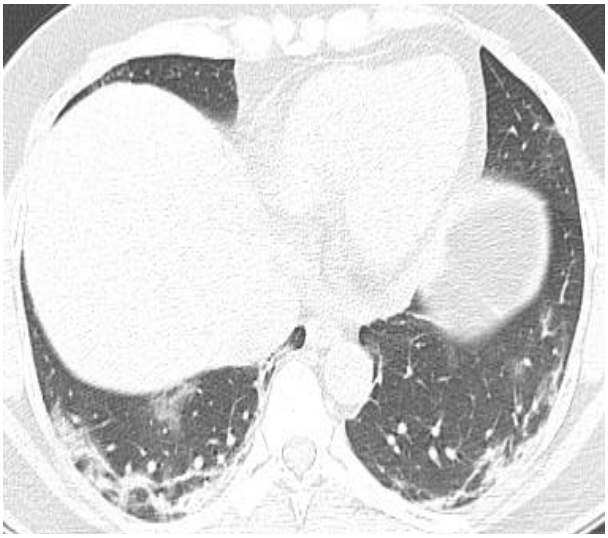
CRAZY PAVING PATTERN

CONSOLIDATION IN BASAL SEGMENTS

GGO WITH VASCULAR PROMINANCE



PARENCHYMAL BANDS IN BASAL SEGMENTS



LUNG FINDING	PATIENTS	PERCENTAGE (%)
GGO	147	100
Crazy paving pattern	52	35.37
Consolidation	59	31.29
Reverse halo sign	37	25.17
Vascular engorgement	101	68.70
Subpleural bands	39	26.53
Centrilobular/tree in bud pattern	7	4.76

TABLE NO. 3- SHOWS VARIOUS MORPHOLOGICAL CT FINDING IN COVID -19 PNEUMONIA.

CT analysis.

GGO (Table 3) was the most prevalent finding, present in 100% of our cases, followed by vessel engorgement and consolidation.

DISTRIBUTION PATTERN	PATIENTS	PERCENTAGE (%)
BILATERAL LUNG INVOLVEMENT	126	85.71
PERIPHERAL DISTRIBUTION	129	87.75
LOWER LOBE PREDOMINANCE	131	89.11
PLEURAL EFFUSION	3	1.9
MEDIASSTINAL LYMPHADENOPATHY	2	1.36

TABLE NO. 4- SHOWS DISTRIBUTION PATTERN OF LUNG OPACITIES/PLEURAL AND MEDIASTINAL ABNORMALITIES.

The opacities were distributed predominantly in peripheral location (Table 4) and with lower lobar predominance. The ROC curve (Figure 4) shows the value of CT-IS in predicting COVID-19disease outcomes.

CT-IS	MILD (0 - 9)	MODERATE (10-17)	SEVERE (18- 25)
TOTAL PATIENTS	62	56	29
AGE	42	46	51
SEX (%)	M-39	M- 34	M-16
TOTAL RECOVERED	61	53	22
RECOVERED WITH MILD MEDICAL CARE	59	32	14
RECOVERED WITH CRITICAL MEDICAL CARE.	2	21	8
DECEASED	1	3	7

TABLE SHOWS PATIENTS WITH CT-IS IN DIFFERENT RANGE WITH PATIENT DEMOGRAPHICS AND CLINICAL OUTCOMES

Value of CT-IS for predicting disease severity was found to be 10.28. Nearly half (62, 42.17%) of our patients had a CT-IS below 10, in the mild range {0–9}. The rest of the patients (85, 57.43%) had CT-IS of 10 and above and were further divided into the moderate range {10–17} and severe range {18–25}. The total number of patients in the moderate category was 56 (38.09%), while 29 (19.72%) patients were in the severe category. In the patients having CT-IS in the mild range, 1 (1.61%, 1/62) patient died, and 2 patients (3.2 %, 2/65) required critical supportive medical treatment. This is significantly less than the moderate/severe CT-IS score range. In the moderate category CT-IS, 3(5.35 %, 3/56) patient died, and 21 (37.5%, 21/56) patients required critical medical care. The mortality was statistically significant when compared to severe category. 7 (24.13%, 7/29) patients died in the severe range of the CT-IS, and 8 (27.58%, 8 /29) patients required critical medical attention. . Overall, CT-IS correlates well with patient clinical outcomes, including mortality. There was a significant association between higher CT-IS and the final grievous outcome of the patients. A statistically significant increasing association of mortality and requirement of critical medical care was observed with the rising value of CT-IS. The median time between CT scan and death of the patient was 10 days.

IV. DISCUSSION

It is very important to diagnose COVID-19 infection in early stage to prevents its transmission and management of symptoms. Important steps in containment of virus and patients management are depending upon diagnosis [8-10]. Chest x ray has very low sensitivity and specificity leads to high number of false negative results. [11] the sensitivity of HRCT chest is more than chest x ray. [12-13] In our study we have studied HRCT chest scan of 142 patients whose RT-PCR result was positive qualitatively and quantitatively. We have given each scan CT score. There was a significant association was found between high CT score and clinical outcome, mortality.

High age and associated co-morbidities increase the risk of acquiring COVID-19 pneumonia and its severity.[13] The most dominant symptoms was fever (49.8 %) and cough (34 %) in our study. Old age and associated morbidities associated patients has high mortality. The recent literature has described characteristic features of COVID-19 pneumonia and includes GGOs (61–100%), bilateral involvement (73–86%) and peripheral distribution (39–84%). Consolidation and crazy paving pattern are also common findings.

Majority of patients have multiple lobe involvement with lobar lobe predominance. We found GGOs in 100% of our patients, which was the hallmark finding in our patients. Consolidation was present in about 32 % of our cases. The distribution was predominantly peripheral (88%) and lower lobar (89%).

Most peculiar HRCT feature was vascular prominence of subsegmental pulmonary vessels which was noticed in 68 % of our patients. [14,15] This is probably due to pro-inflammatory factors. Architectural distortion, subpleural bands, and reverse halo sign were also noticed in COVID-19 infection [17] in our study. We qualitatively reported scan as typical, indeterminate, or atypical based on Radiological Society of North America consensus guidelines. If HRCT finding suggestive of indeterminate or typical finding of COVID-19 pneumonia than second throat sample within 48 hours of first negative sample is collected.

HRCT chest finding in other atypical viral infection is overlap with COVID-19 pneumonia. So it is very difficult to distinguish COVID-19 pneumonia from other atypical viral pneumonia on imaging [19-20]. Mediastinal lymphadenopathy and pleural effusion are very rare finding in COVID-19 pneumonia [18]. In current scenario, it is wise to consider finding of atypical viral pneumonia as COVID-19 pneumonia unless proven.

In our patients having atypical CT findings, three patients (2.1%, 3/142) had pleural effusion, and two patients had mediastinal lymphadenopathy. While pneumothorax was reported in one patient with confirmed COVID-19 infection in a study. However, cause of pneumothorax in COVID-19 pneumonia could not be correlated.

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