

ORIGINAL ARTICLE

VARIATIONS IN SPECTRUM OF COVID-19 CT FINDINGS AND ITS SEVERITY SCORING IN A TERTIARY CARE HOSPITAL OF BAHAWALPUR, SOUTHERN PUNJAB PAKISTAN

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Background: Recently the Coronavirus pandemic presented with different manifestations in different parts of the world, both on clinical examinations and on imaging. CT Scanning (CT Scan) chest is used for detailed evaluation of the different characteristic patterns determining the depth of disease. The study is aimed to assess the variations in spectrum of Covid-19 CT findings and relating severity (CT Severity Score) with the Clinical Symptoms in Bahawal Victoria Hospital, Bahawalpur. **Methods:** In this cross-sectional study, patients referred to radiology department from outdoor for COVID screening were included from 1st May to 30th June 2020. Mean age range of patients was calculated, while presenting complaints and co-morbidities were tabulated in frequencies and percentages after analysis. Severity of symptoms and CT findings were correlated with biochemical and haematological tests. **Results:** Patients' age range from 25 to 85 years with 62% males and 38% females. Statistically no significant difference was observed in CTSS on gender basis. As sensitivity of RT PCR is about 70%, negative cases cannot be considered disease free and this is seen in this study as CT findings suggestive of COVID are seen in these patients. Using 40-point CT-SS, 11 patients had a score of >19 with severe diseases, while 14 patients had common disease with a score range of 11–18 and 35 patients had <10 score with mild or no symptoms. **Conclusion:** In this study, a spectrum of patchy ground glass opacities, bilateral peripheral predominantly lower lung consolidations were observed. Quantitative analysis of inflammatory process as occurring in lungs in Coronavirus Disease 2019, using 40-point CTSS scoring on Imaging could provide a timely and objective approach towards identifying patients requiring intensive care and hospitalisation.

Keywords: COVID-19; Corona virus; CTSS (CT Severity Score); Ground-glass opacity

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INTRODUCTION

An unknown pneumonia with identical clinical findings suggesting viral aetiology struck the world in the beginning of year 2020. It appeared to have emerged in a bulk of population in Wuhan, China during December 2019. A virus was isolated from respiratory pathway using a Real-time fluorescence polymerase chain reaction (RT-PCR), named as 'Severe Acute Respiratory Syndrome Coronavirus-2' (SARS-CoV-2) while disease was labelled as Coronavirus Disease 2019 (COVID-19). Overwhelming effects of disease have become evident with each passing day, as the pandemic continues to spread across the globe. The pattern of the disease extent and severity however continues to be a mystery. COVID-19 has variable outcomes in all individuals irrespective of gender and age, occupation and geographical boundaries. Disease spectrum of positive cases is variable from asymptomatic mild to critically ill patients requiring artificial respiration and ventilators to ultimate mortality.¹ The treatment regime depends on the extent of disease severity. Radiological imaging can

be an effective tool to assess conditions responsible for chest symptoms. Although Chest X-rays have always been the first line of investigation in suspected cases, however minor changes are usually not detected.² The better CT resolution can be helpful in early diagnosis of initially negative chest X-ray with clinical suspicion of COVID-19. Thus, objective of this study is to retrospectively study the CT features in patients with COVID-19 at our institution.³ Although CT is not recommended as screening modality for the diagnosis of COVID-19, yet it has contributed in clinical management and understanding of the disease. As by German Radiological Society, lung involvement extent, early recognition of the pneumonia associated complications and monitoring progression in critical to severe cases are aided and assessed by initial CT. Research is still underway to define the utility of CT in COVID-19 pneumonia.⁴ Early recognition of the disease pattern is essential for the management, as the time interval to develop complications from initial symptoms was short amongst the initial patients diagnosed with COVID-19 pneumonia.⁵ The lung damage as on visual assessment on CT scans has

been proven valuable in determining the prognostic implications.⁶ CTSS is providing a quantitative guide on patients condition for appropriate future management.

MATERIAL AND METHODS

This cross-sectional descriptive study was conducted by the Radiology and Pathology Departments of Bahawal Victoria Hospital from May 1st to June 30th 2020, after taking the ethical review committee approval. Patients were referred from the Flu clinic which was set up in medical outdoor of hospital for COVID screening and management. Patients suspected for COVID-19 with history of contact or travel and /or clinical manifestations of COVID-19 were included in study. Patients with typical symptoms (fever, cough, flu, malaise and shortness of breath), atypical symptoms (GIT upset, anosmia, eye symptom, confusion, body rash) and those having overlapping symptoms were entered into *Proforma*. Nasopharyngeal swabs from suspected patients were tested by using RT-PCR in the Biosafety Level 3 lab which was specially setup for COVID-19 testing in Bahawalpur. Patients with history of tuberculosis and chronic obstructive lung disease were excluded from the study. Also, blood samples for blood complete picture, AST, ALT and C-reactive protein were taken and tested in the pathology laboratory. Blood chemistry tests were run on Backman CU680 and haematology tests were run on 5-part haematology analyser.

Using Trial Fifth Edition" Diagnosis and Treatment Program of Pneumonia of New Coronavirus Infection" recommended by China's National Health Commission in February 2020, the patients categorised as minimal, common, severe and critical disease. Asymptomatic cases with no or subtle clinical manifestations and without evidence of lung infiltrates on radiography were classified as minimal disease. Fever and respiratory symptoms plus opacities on chest images were common cases. The severe cases included patients with respiratory distress, reduced blood oxygen saturation and critically ill on mechanical ventilation that require ICU monitoring.

The common CT findings included ground glass patchy opacities, consolidation, crazy paving, vascular dilatation, sub pleural bands and architectural distortion. Uncommon CT findings included cavitation, pleural effusion and bronchial thickening. Overlapping CT findings of both groups and normal CT scan images were also studied.

Initially proposed CT severity score (CT-SS) for assessing COVID-19 burden on the lung used opacification as a marker for extension of the disease in the lungs.¹ The CT-SS is a derived adaptation of

technique previously described for Common CT findings that matched with clinical and laboratory findings in individuals after SARs exposure. Anatomically the 18 lung segments, were divided into 20 regions by sub-dividing left upper lobe (apical posterior) segment into apical and posterior and left lower lobe (anteromedial basal) segment into anterior and basal components. Presence of patchy Opacities were subjectively evaluated on chest CT and given scores: 0, 1, and 2 if parenchymal opacification involved 0%, less than 50%, or equal or more than 50% of each region. The sum of the individual score was summed up to give CTSS, ranging from 0 to 40 points.

CT images were reviewed by two consultants with more than 05 years of experience in chest radiology. Using a window width of 1600 HU and window level of (-500 HU), images were viewed. CT scan was performed on a Toshiba Aquilion 64-detector Scanner, in supine position. Images were acquired in a single inspiratory breath-hold. The range for imaging extended from upper thoracic inlet to costophrenic angle lower limit. The different tube parameters were as follows: 120KVp, 300mAs, rotation time -0.5 second; pitch -1.0; slice thickness – 10 mm; interslice: 05 mm. Reconstruction at 1 mm thickness with interval of 1 mm, if required.

IBM SPSS version 23 was used for entering and analysing data. Continuous variables were presented as medians and compared by Mann-Whitney U test. Chi-square or Fisher exact test was used for categoric variables which were presented as numbers and percentages. $p < 0.05$ was considered statistically significant.

RESULTS

Clinical findings, laboratory results and demographics of patients are summarized in table-1. Patient's age ranged from 25 to 85 years with 62% males and 38% females. Leucocytosis was seen in 15 (25%) of patients and lymphopenia was observed in 17 (28.3%). CRP and liver enzymes were increased in 66.7% and 45% respectively. There is no statistically significant difference seen in laboratory results due to gender. As sensitivity of RT PCR is about 70%, negative cases cannot be considered disease free and this is seen in this study as CT findings suggest COVID as seen in these patients.

In total, there were 33 (55%) PCR positive, while 27 (45%) PCR –negative cases in this study. On CT scan out of 36 patients (60%) cases have common CT findings, 18 (30%) were PCR positive with 14 (23%) having typical symptoms. In 12 (20%) cases with uncommon CT findings, 7(11%) were PCR positive and 6 (10%) had typical symptoms. In 12 (20%) patients with overlapping CT findings 8

(13%) were PCR +ve and 7(11%) had typical symptoms.

Using CT-severity score, 11 patients had a score >19 (18.3%) labelled as severe disease. 14(23.3%) patients had common disease (moderate) with range of 11–18 CTSS, while 35 (58.3%) patients had <10 score with mild symptoms. 2 (3.3%) patients had CTSS of 0 with uncommon findings of pleural effusion and lymphadenopathy, and 2(3%) patients had CTSS of 01 with common CT findings and typical symptoms.

The predominant pattern of Ground glass opacities was seen in 90% of cases while consolidation was noted in 80% of cases with typical findings. In 11 patients that had a score >19, 8 cases (13%) required oxygen support and were followed up after 03 weeks and they showed resolving consolidations and sub pleural reticulations on CT scan, with reduced CTSS. The overall mortality in our study is 0%. Thirty-eight (63%) of patients had an existing co-morbidity such as Diabetes, Hypertension and/or Cardiac issues. 73% of cases had a direct exposure to a COVID case.

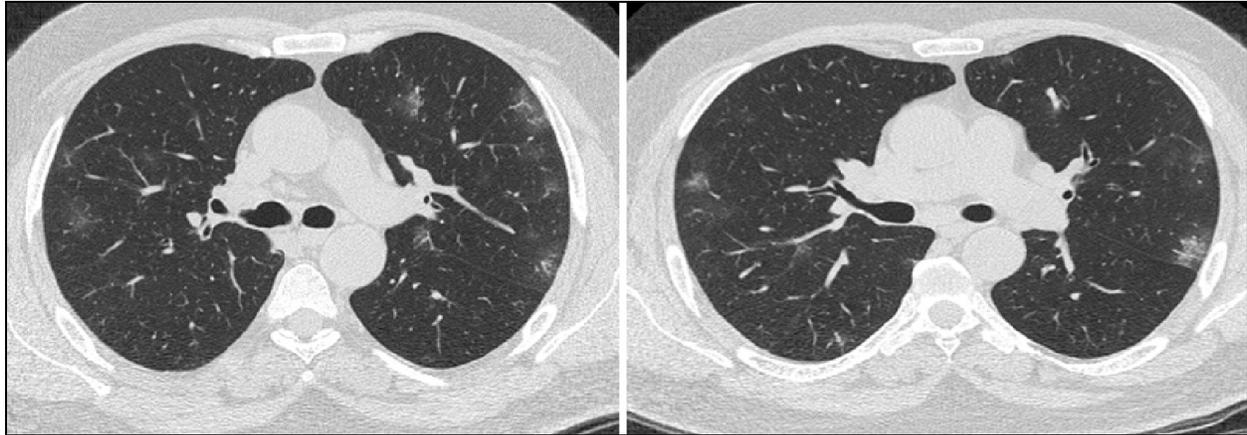


Figure-1: Peripheral ground glass opacities in a 45-year-old male with fever and cough CTSS 7

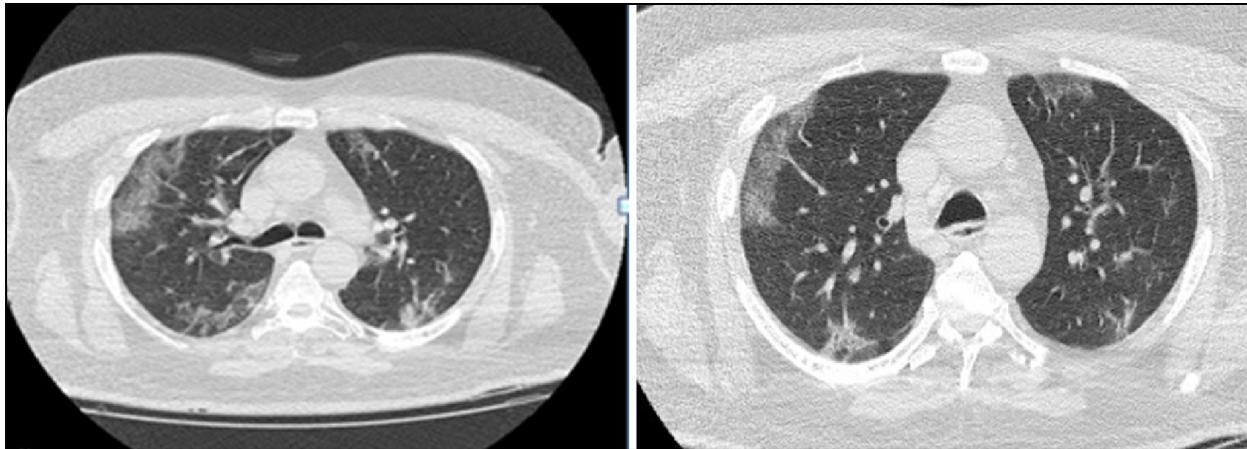


Figure-2: Peripheral opacities with septal thickening, consolidation in a 58 years old patient with typical symptoms. CTSS-15

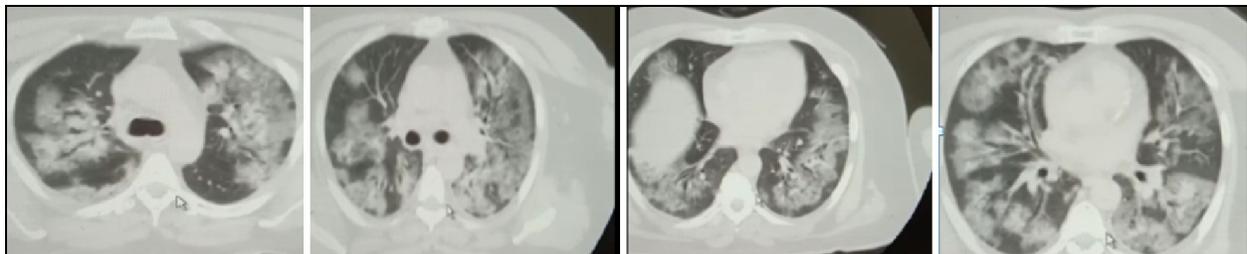


Figure-3: Bilateral extensive consolidations, Crazy paving and traction bronchiectasis in a 65-year patient with severe respiratory symptoms

Table -1: Demographics, clinical features and laboratory tests in patients with COVID-19

Feature	All patients (n=60)	%
Sex		
Male	37	61.7
female	23	38.3
Age (years)		
Mean	49.8	
range	25-85	
Age groups		
21-40	18	30
41-60	28	46.7
>60	14	23.3
History of exposure		
Present	44	73.3
absent	16	26.7
Comorbidity		
Present	38	63.3
absent	22	36.7
Symptoms		
Typical	37	61.7
atypical	23	38.3
rRT PCR		
positive	33	55
negative	27	45
X-ray Findings		
Abnormal	31	51.7
Unremarkable	29	48.3
CT Findings		
Common findings	36	60
Uncommon findings	12	20
Combination of both	12	20
WBC (x10⁹/L)		
<4	12	20
4-10	33	55
>10	15	25
Lymphocyte count (x10⁹/L)		
Reduced	17	28.3
normal	43	71.7
CRP (<0.05mg/dl)		
Increased	40	66.7
Normal	20	33.3
ALT (U/L)		
<40	25	41.7
>40	35	58.3
AST (U/L)		
<40	27	45
>40	33	55

Table-2: Correlation of typical and atypical symptoms with CT severity is shown

CTSS Range	Typical symptoms		Atypical Symptoms	
	No. of patients	%age	No. of patients	%age
0-10	23	38	12	20
11-18	07	11	07	11
> 19	07	11	04	06
Total	37		23	

Table-3: CT Severity Score (CTSS) categorised into following disease groups

Disease Groups	CT Severity Score (CTSS)	No of patients (n)
Mild	(0-10)	35
Moderate	(11-18)	14
Severe	(>19)	11

DISCUSSION

By the start of the year 2020, the WHO declared COVID-19 as the Pandemic, deserving international attention. Since then, world-wide cases of COVID-19 pneumonia with human to-human transmission have been reported.⁷ In Pakistan and especially the tertiary care hospital of Southern Punjab, received a fairly large population with suspicion of COVID 19. Due to limited PCR kits and delaying of results, high clinical suspicion was isolated in wards. Sensitivity of the PCR test may be insufficient to reliably exclude COVID-19.⁷ CXR also has a low sensitivity and it is difficult to distinguish between COVID 19 and other viral pneumonias purely on CXR findings.³ CT scan has proved to be a preferred imaging modality regarding early detection as well as disease complications.²

Our study demonstrates that chest CT can play a crucial role in early diagnosis of COVID-19, even in patients with a negative RT-PCR.

Our study showed that even the patients with a first negative PCR, displayed typical CT pattern (45% of total cases) that is consistent with the earlier study done by Zhao W *et al.*¹⁸

Although the CT imaging features of COVID pneumonia are not really specific when compared with both H1N1 and SARS, However Common CT findings of Multifocal, bilateral patchy ground-glass opacities (GGO) in peripheral sub-pleural distribution were found in most of our patient (Figure-1 and 2), in accordance with studies analysis done earlier.⁹ Common CT findings were often found in patients with moderate and severe disease. Patients with mild and moderate disease have a good prognosis. However, in cases where COVID-pneumonia develops to severity with complications like pulmonary oedema respiratory failure, eventually cause death.⁸ Therefore, it is very important to accurately classify the CT findings and administer rapid clinical interventions accordingly.⁹ 63% of patients in our study had an existing co-morbidity and 73% of cases were directly exposed to disease and 46% of cases were 40-60 years of age. From previous studies, it has been shown that older age groups and co-existing comorbidities are risk factors responsible for poor prognosis.¹⁰

CT imaging of asymptomatic cases with COVID-19 pneumonia has definite characteristics. As some patients might progress rapidly in the short term, it is essential to do surveillance of asymptomatic patients with COVID-19.¹¹

In our study asymptomatic and mild cases showed more GGO as compared to consolidation which corresponds to typical common pattern described before.¹²

In advanced diseases alveolar and interstitial infiltration by inflammatory cells causes alveolar damage leading to overall picture of consolidation on CT examination.¹³ As the time between onset of symptoms and initial chest CT increases, some CT findings are observed with increasing frequency, like consolidations bilaterally and peripheral lung, greater total lung involvement, linear opacities, crazy-paving pattern and reverse halo sign. These findings were also observed in patients who had moderate symptoms and required oxygen support (Figure-3) Uncommon chest CT findings, including pleural effusions, lymphadenopathy, pulmonary nodules, and lung cavitation, are rare.¹⁴ In a previous study series of 121 symptomatic patients, a normal CT was found in 56% of patients scanned within 2 days of symptom onset, whereas normal scans were observed in only 9% and 4% of patients. This is consistent with our results, where 2 cases normal. Similarly, only 01 PCR positive patients had a normal CT. Therefore, radiographic abnormalities are almost certain to be present on CT where most cases were obtained following 5–6 days of symptoms.¹⁵

Almost all cases presented after 4-5 day of symptoms and had positive CT findings. Keeping these facts in mind, Radiologic organizations have also taken steps or issued guidelines to ensure the safe, appropriate use of medical imaging with in patients who did not have classical CT features.¹⁶ Therefore, our results show that Ground Glass Opacity and consolidation were two main signs on CT images of COVID-19 lesions present in majority of cases.¹⁷ "Initial CT" scores can be helpful to speculate complications. Severe manifestation on CT at an early stage may indicate poor prognosis for older patients with COVID-19.¹⁸

The patients having relatively severe symptoms were older than the asymptomatic or mild cases. However, the percentage of underlying disease was not significantly different in these groups, this probably could be due to viral load which may be more of a reflection of the severity and extent of COVID-19 pneumonia.¹⁸ Follow-up CT findings showed progressive resolution in opacifications, regressing consolidation, interstitial thickening, fibrous strips, and air bronchograms, compared with initial CT.¹⁹ Using 40-point CT-severity score 11 patients had >19, which was previously studied by Yang¹, as the cut off to label severe cases. It is worth mentioning that the severe disease group patients were followed up and showed segment wise improvement in disease and subsequent less CTSS. Mortality in our study was zero and almost complete recovery at the time of this compilation of results. RSNA chest CT classification system (Four categories) for reporting is being extensively used

and recently COVID-19 Reporting and Data System CO-RADS, developed by the Dutch Radiological Society, provides a framework that builds on other reporting schemes for COVID-19 increasing suspicion for pulmonary involvement of COVID-19 on non-contrast chest CT. It provides very good performance for predicting COVID-19 in patients with moderate to severe symptoms, however we find 40-point CTSS is still very helpful in follow up cases with diminishing opacities segment wise.²⁰ This semi-quantitative method for assessing severity of COVID-19 in the initial chest CT is simple and easy way in follow up of patients.

CONCLUSION

The severity and spectrum of COVID 19 CT findings in our population is almost similar to the earlier studies. CT-SS 40-point scoring is potentially useful in accelerating triage of patients in need for hospital admission. We foresee that such approach could have significance in scenarios combining high patient volumes and limited healthcare resources or PCR testing capabilities.

AUTHORS' CONTRIBUTION

SN: Conceptualization, literature search, write-up, proof reading, data analysis. LS: Conceptualization, data analysis, interpretation. FM: Literature search, proof reading. KS: Data collection, interpretation.

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