DOI: 10.7860/IJARS/2022/53506.2778

Original Article

Radiology Section

Comparison of Demographic Profile and CT Findings in COVID-19 Pneumonia between First and Second Waves of COVID-19 Pandemic: A Retrospective Study

TALING MARI[1], WANGJU SUMNYAN[2], KENJUM RIBA[3], NYAPU SOKI[4]

ABSTRACT

Introduction: The Coronavirus Disease-2019 (COVID-19) pandemic has affected the world in two waves. The human civilisation took a heavy toll in the two waves of pandemic in terms of human deaths, loss of livelihood and socio-economic regression.

Aim: To present the Computed Tomography (CT) thorax findings of COVID-19 pneumonia during peak three months of first and second waves of COVID-19 pandemic and compare the demographic profile, radiological patterns and CT severity scores to document if significant difference exists between the two waves.

Materials and Methods: The present observational, retrospective and single-centric study included all Real-time Reverse Transcription-Polymerase Chain Reaction (RT-PCR) tests proven COVID-19 patients who underwent CT scan during the peak three months of first (August to October 2020) and second (April to June 2021) waves of COVID-19 pandemic at Tomo Riba Institute Health and Medical Sciences, Naharlagun, Arunachal Pradesh, India. A total of 93 and 120 patients were included from the first and second waves, respectively. The demographic profile, radiological pattern based on the Radiological Society of North America (RSNA) consensus statement and CT severity index in COVID-19 pneumonia were compared during the peak three months of first and second waves of the pandemic. Chi-squared and t-test were used for statistical analysis.

Results: The patients affected during the second wave were younger compared to the first wave (mean age of 43 vs 49 years, p=0.001). The patients having moderate or severe COVID-19 pneumonia during the second wave were significantly younger compared to the first wave (mean age of 42 vs 55 years, p<0.001). More females were affected with moderate or severe COVID-19 pneumonia during the second wave compared to the first wave (p=0.017). However, the overall sex difference in COVID-19 pneumonia (including mild category) was not significant with p-value of 0.127. There was same prevalence of radiological patterns in the two waves (p=0.981). The difference in the prevalence of CT severity score was not significant in the two waves (p=0.256).

Conclusion: Similar radiological patterns were observed in the two waves of the pandemic. Younger patients were significantly more affected during the second wave of the pandemic.

Keywords: Computed tomography, Coronavirus disease-2019, Severe acute respiratory syndrome coronavirus-2, Thorax

INTRODUCTION

The COVID-19 is a highly infectious viral disease. The first case of COVID-19 in human was reported in Wuhan, China, in December 2019 [1]. Thereafter, the disease quickly disseminated across the globe. The World Health Organisation (WHO) declared COVID-19 as a pandemic on March 12, 2020 [2]. The COVID-19 pandemic is caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) [3]. The COVID-19 pandemic has scourged the human civilisation and taken a heavy toll in terms of loss of life and livelihood. The pandemic has also resulted in increased mental health issues and poverty. The second wave was overwhelming and crippled the health infrastructure and delivery system of the country. The pandemic also affected the state of Arunachal Pradesh and exposed the vulnerability and deficiencies in our healthcare system.

Till date, the only confirmatory test for the diagnosis of COVID-19 disease is a positive RT-PCR test of the nasopharyngeal swab [4]. The role of non contrast high resolution CT scan of the thorax is increasing in COVID-19 pneumonia. In patients with false negative RT-PCR results, plain high resolution CT thorax is indispensible in early detection of COVID-19 pneumonia. High Resolution Computed Tomography (HRCT) chest helps not only in early detection and grading of severity of COVID-19 pneumonia but also plays a role in triaging and monitoring the response to treatment [5]. The CT severity score provided by the scan can help the treating clinicians to make prompt and effective clinical decisions [6].

Following a multinational consensus in 2020, the Fleischner Society issued a guideline for the role of radiological imaging in COVID-19 disease [7]. According to the consensus, imaging is not recommended for patients with suspected COVID-19 and having mild clinical symptoms. However, imaging is indicated in such patients if there is a chance of disease advancement. The consensus recommends imaging in patient with COVID-19 and negative exacerbation of respiratory profile. They also opined that in an area with limited resource, imaging has a role in medical triage of patients with suspected COVID-19. Imaging can be used to sort out patients presenting with moderate to severe clinical symptoms and a high pretest chance of having the disease.

Based on the HRCT findings, two CT reporting format for COVID-19 pneumonia have been developed. The formats help in standardising the CT reports, to avoid observer variables and to make the reports more easily interpretable. The first is the COVID-19 Reporting and Data System (CO-RADS) comprising of five categories ranging from 1 (negative) to 5 (typical findings) [8]. The other reporting format is the RSNA classification ranging from 1 (negative) to 4 (typical) [9]. These two classifications of CT reporting formats are analogous. Categories 1, 2, 3-4, and 5 of CO-RADS correspond to the categories negative, atypical, indeterminate, and typical of the

RSNA classification system, respectively. Using such standardised reporting format will result in reduction of interobserver disparity and enhance clinico-radiological harmonisation.

This study was done to analyse the radiological pattern of the chest CT findings in COVID-19 during peak three months of the first and second waves of COVID-19 pandemic. The age and sex distribution along with CT radiological patterns and CT severity scores of the patients were analysed and compared for any difference in the two waves of pandemic. Novelty of present study was that this study was conducted in a single tertiary care hospital in the state of Arunachal Pradesh and is a first study of its kind in the north-eastern part of India.

MATERIALS AND METHODS

This was an observational, retrospective and single centric study done in the Department of Radiology and Imaging, TRIHMS, Naharlagun, Arunachal Pradesh, India, during the peak three months of first and second waves. The peak three months of the first wave in the state of Arunachal Pradesh extended from August to October 2020. The peak three months of the second wave extended from April to June 2021. A total of 93 and 120 COVID-19 proven patients who had undergone thorax CT scans during the peak three months of the first and second waves respectively were included in the study.

Inclusion and exclusion criteria: The study included all RT-PCR proven cases of COVID-19 pneumonia who had undergone chest CT scan during the peak three months of first and second waves. The scans with severe motion artefacts were excluded from the study.

The CT scans of the patients referred to the Department of Radiology and Imaging, TRIHMS, Naharlagun, Arunachal Pradesh, India, were done using Siemens Somatom Drive dual source MDCT (128 rows of detectors) scanner and stored in the Picture Archiving Communication System (PACS). The CT images obtained from the PACS were retrospectively analysed.

Image Interpretation

Two radiologists (with at least five years of experience) reviewed the CT images independently and resolved discrepancies by consensus. All images were viewed with both lung (width, 1500 HU; level, 2700 HU) and mediastinal (width, 350 HU; level, 40 HU) window settings.

The RSNA expert consensus document proposes the following terms on reporting HRCT thorax in COVID-19 patients [9]:

Typical appearance

- Peripheral, bilateral, ground glass opacities with or without consolidation or visible intralobular lines (crazy-paving pattern).
- Multifocal ground glass opacities of rounded morphology with or without consolidation or visible intralobular lines (crazy-paving pattern).
- Reverse halo sign or other findings of organising pneumonia (seen later in the disease).

Indeterminate appearance

- Absence of typical features and the presence of the following features: multifocal, diffuse, perihilar, or unilateral ground glass opacity with or without consolidation lacking a specific distribution and that are non rounded or non peripheral.
- Few small ground glass opacities, with a non rounded and non peripheral distribution.

Atypical appearance

- No typical or indeterminate findings with either of the following features: isolated lobar or segmental consolidation without ground glass opacities; discrete small nodules (centrilobular, “tree-in-bud” appearance); lung cavitation; smooth interlobular septal thickening with pleural effusion.

Negative for pneumonia

- No CT evidence of pneumonia.

Study Procedure

The CO-RADS is a standardised CT thorax reporting system and based on the degree of suspicion of COVID-19 infection [8]. The CT severity score [Table/Fig-1] is used to grade the severity of the COVID-19 pneumonia. The grading system gives an individual score on each lobe of the lung according to the percentage of the pulmonary parenchymal involvement [6].

Score	Lobar involvement
1	<5% involvement
2	5-25% involvement
3	26-49% involvement
4	50-75% involvement
5	>75% involvement

[Table/Fig-1]: Individual lobar score based on the percentage of parenchymal involvement.

There are five lobes of the lung. The three lobes within the right lung are upper, middle and lower lobes. The two lobes of the left lung are upper and lower lobes. The scores within each lobe are added to obtain the final severity score. A total score of 1-8 is considered mild. Score of 9-14 is moderate and score of 15-25 is labelled as severe.

The scans were first assessed whether negative or positive for typical findings of COVID-19 pneumonia (bilateral, multilobe, posterior peripheral ground glass opacities) as defined by the RSNA consensus statement [9]. Severity then was calculated based on lung involvement percentage for each patient by scoring the percentage of each lobe involvement individually and given a score from 1 to 5 [6].

STATISTICAL ANALYSIS

The data obtained were expressed as means, standard deviation and ranges. The chi-squared test and t-test of significance of difference between two means were used for statistical analysis. A p-value <0.05 was considered statistically significant. The statistical analyses were carried out using Statistical Package for the Social Sciences (SPSS) version 16.0.

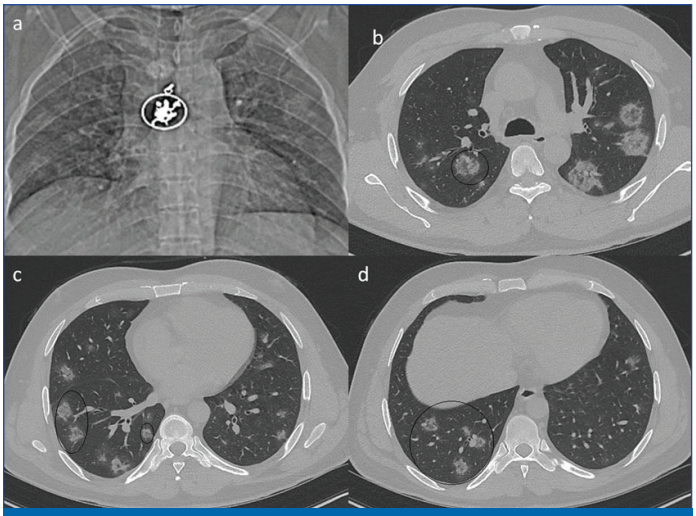
RESULTS

The total thorax CT scans done in TRIHMS during the peak three months (August to October 2020) of the first wave of COVID-19 pandemic was 657. Out of the total 657 (mean age 43.3, SD 15) thorax CT scans during the peak three months of the first wave of COVID-19 pandemic, 93 (14.1%) cases were RT-PCR proven cases of COVID-19 with varying category of imaging findings in accordance with the RSNA expert consensus.

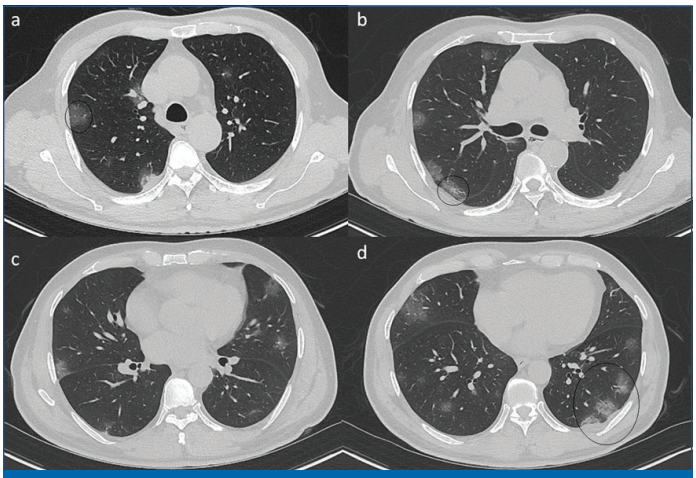
Out of the 864 (mean age 40, SD 17) total thorax CT scans done in TRIHMS during the peak three months (April to June 2021) of the second wave, 120 (13.8%) cases were RT-PCR proven cases of COVID-19 with varying category of CT findings. The number of patients with typical [Table/Fig-2,3], indeterminate [Table/Fig-4], atypical [Table/Fig-5], and CT findings in accordance to RSNA expert consensus during the two waves of the pandemic were obtained and is as given [Table/Fig-6].

The number of patients with mild CT severity score during the first and second waves were 57 (61.3%) and 60 (50%), respectively. The number of patients with moderate CT severity score during the two waves were 21 (22.50%) and 36 (30%), respectively. The number of patients with severe CT severity score were 15 (16%) and 24 (20%), respectively [Table/Fig-6].

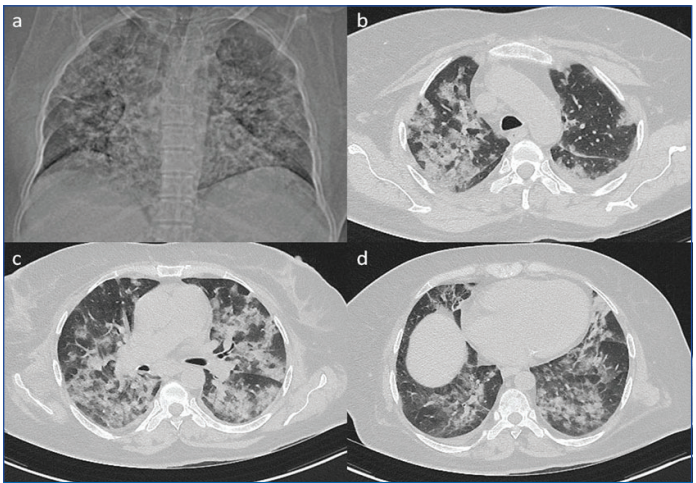
The patients affected during the second wave were statistically younger compared to the first wave (43 vs 49, p=0.001) [Table/Fig-6]. Moreover, the patients having moderate or severe COVID-19 pneumonia during the second wave were significantly younger compared to the first wave (42 vs 55, p<0.001). More females were affected with moderate or severe COVID-19 pneumonia



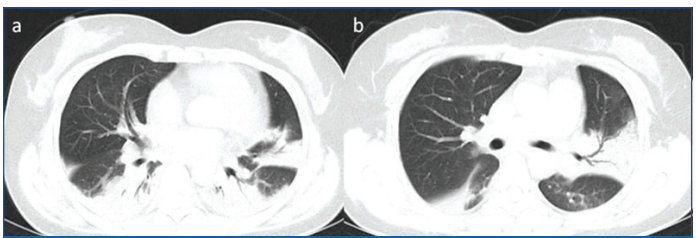
[Table/Fig-2]: CT with "typical" pattern: a) Plain CXR shows multiple rounded opacities with peripheral predominance of the lesions; b, c and d) CT scan axial images shows rounded lesions within the peripheral parenchyma with reverse halo sign (encircled).



[Table/Fig-3]: CT with "typical" pattern: a, b, c and d) axial CT images showing multiple areas of ground glassing with associated septal thickening. Note the peripheral location and rounded configuration of the lesions encircled).



[Table/Fig-4]: CT with "indeterminate" pattern: a) CXR shows patchy and confluent opacities within both lungs; b, c and d) axial CT images showing patchy and confluent areas of ground glassing and consolidations. Few lesions show rounded configuration. Subpleural bands are also noted.



[Table/Fig-5]: CT with "atypical" pattern: a and b) axial CT images showing segmental areas of consolidation. No ground glassing seen.

Parameters		First wave CT scans n	First wave CT scans (%)	Second wave CT scans n	Second wave CT scans (%)	p-value
Total thorax CT		657		864		
COVID-19		93	14.15%	120	13.88%	
RSNA expert consensus	Negative	3	3.2%	3	2.5%	0.981**
	Atypical	6	6.4%	9	7.5%	
	Indeterminate	21	22.5%	27	22.5%	
	Typical	63	67.7%	81	67.5%	
CT severity score	Mild	57	61.3%	60	50%	0.256**
	Moderate	21	22.50%	36	30%	
	Severe	15	16.1%	24	20%	
Age (years)	Mean±SD	49±13		43±12		0.001*
	Range	25-75		21-60		
Sex	Male	63	67.7%	69	57.50%	0.127**
	Female	30	32.2%	51	42.50%	

[Table/Fig-6]: Comparison of the CT thorax findings during the first and second waves of the COVID-19 pandemic.
*The p-value was obtained using t-test; **The p-value was obtained using chi-squared test

during the second wave compared to the first wave (p=0.017) [Table/Fig-7]. There was no significant difference in the prevalence of the radiological patterns based on RSNA expert consensus in the two waves (p=0.981). The difference in the prevalence of CT severity score was also not significant in the two waves (p=0.256) [Table/Fig-6].

Parameters		First wave	Second wave	p-value
Age (mean±SD)		55±12.5	42±11	0.001*
Range		25-75	25-64	
Sex (%)	M	30 (83.33%)	36 (60%)	0.017**
	F	6 (16.66%)	24 (40%)	

[Table/Fig-7]: Demographic profile of combined moderate and severe CT scores.
*The p-value was obtained using t-test; **The p-value was obtained using Chi-squared test

DISCUSSION

In the present study, it was observed that older (age ranging from 45-75 years) people were mainly affected during the first wave of COVID-19 infection. Younger adults (ranging from 25-64 years) were significantly vulnerable in the second wave (43 vs 49, p=0.001). The patients having moderate or severe COVID-19 pneumonia during the second wave were significantly younger compared to the first wave (42 vs. 55, p<0.001). There are no obvious scientific explanations for the vulnerability of younger generation to the infection during the second wave. The vaccination priority for the elderly could partly be responsible for the age difference in incidence during the second wave. However, an important observation that evolved during the pandemic was the individual variability in risk of getting infected, severity of the infection and the ability to withstand the infection [10].

There was no significant difference in the prevalence of the radiological patterns based on RSNA expert consensus in the two waves (p=0.981). Therefore, the study further validates the RSNA expert consensus on the radiological findings in COVID-19 pneumonia. The difference in the prevalence of CT severity score was also not significant in the two waves (p=0.256).

The findings correspond with other reports of larger number of younger and female patients being infected in the second wave [10]. Hippich M et al., showed marked increase of SARS-CoV-2 exposure rate in children during the second wave based a public health antibody screening [11]. Kumar G et al., documented that the patients affected in the second wave of the COVID-19 pandemic were younger, presented with breathlessness in higher frequency and suffered from lesser co-morbidities as compared to the first wave [12]. However, a study by Mahendra M et al., demonstrated

an increased positivity rate in older age group in the second wave as compared to the first wave based on a secondary data analysis of around 0.5 million RT-PCR tests conducted in COVID-19 diagnostic laboratory in eastern Uttar Pradesh [13]. It has been found that male patients affected with COVID-19 have more chance of requiring intensive treatment unit admission and higher odds of death compared to females [14]. Quaresima V et al., concluded in a study in Italy that the risk for death was similar for both males and females once hospitalised [15].

The second wave of the pandemic showed an increase in number of cases due to several factors. Many studies conducted all over India identified double and triple mutations of SARS-CoV-2 which appeared to be more pathogenic and transmissible compared to initial strains. Moya A et al., in their study concluded that there is a reciprocal relationship between the population density and chances of viral mutation [16]. In India, overpopulation with lack of streamlined policy and proper implementation has led to several virus mutations [10]. The mutant virus has a shorter incubation period and is more transmissible. The Indian public has shown a blatant disregard towards the 'COVID-19 Appropriate Behaviours'. The quality of masks available and used in our country is highly questionable. The more expensive N-95 masks are less used. The people in our country favour the use of cheaper and local made cloth mask which can be reused and often the same worn out masks are repeatedly used [17].

The study shows the changing trend in the COVID-19 pandemic in the two waves. Analysis and study of these trends will help in making necessary clinical and policy decisions to effectively combat further waves of the pandemic.

Limitation(s)

However, the study has many limitations. It is a retrospective study and the sample size is not large. The study did not take into consideration the inherent variability, in disease vulnerability, immunological status of the patients, the presence of co-morbidities and the time lapse between the onset of symptoms and CT scan. The study considered only the baseline CT findings and did not follow the evolution and changes of the radiological findings over time from the disease onset.

CONCLUSION(S)

The present study found that COVID-19 pneumonia affected the younger people significantly in the second wave when compared with the first wave of the pandemic. Moderate and severe COVID-19 pneumonia were seen amongst the younger age population and female sex during the second wave of the pandemic with statistical significance when compared with the first wave. The sex disparity in COVID-19 pneumonia and male sex vulnerability for the disease may also be changing with further mutation of the SARS-CoV-2. This also further validates the role of standard reporting system in imaging of COVID-19 pneumonia.

Acknowledgement

All the authors were involved in analysis of the HRCT scans. All of them contributed in writing and finalising the manuscript.

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PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Radiodiagnosis, TRIHMS, Itanagar, Arunachal Pradesh, India.
2. Associate Professor, Department of Radiodiagnosis, TRIHMS, Itanagar, Arunachal Pradesh, India.
3. Senior Resident, Department of Radiodiagnosis, TRIHMS, Itanagar, Arunachal Pradesh, India.
4. Senior Resident, Department of Radiodiagnosis, TRIHMS, Itanagar, Arunachal Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Wangju Sumnyan,
First RCC Building, Tani Colony, Chimpu-1, Papum Pare,
Itanagar-791113, Arunachal Pradesh, India.
E-mail: sumnyanwang@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Dec 03, 2021
- Manual Googling: Feb 18, 2021
- iThenticate Software: Feb 25, 2022 (19%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval Obtained for this study? NA
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Dec 01, 2021**
Date of Peer Review: **Dec 29, 2021**
Date of Acceptance: **Feb 19, 2022**
Date of Publishing: **Apr 01, 2022**