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ASSESSMENT OF AGE AND SEX DIFFERENCE IN RELATION TO CT SCAN FINDINGS IN COVID-19 PNEUMONIA

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ABSTRACT
The novel coronavirus disease (COVID-19) is an acute respiratory syndrome caused by a highly contagious Severe Acute Respiratory Syndrome-Corona virus-2 (SARS-CoV-2). It first emerged in Wuhan, China in late 2019. After that, the outbreak has spread across China to many other countries around the world. The WHO declared the outbreak as a pandemic in March 2020. A wide variety of CT findings in COVID-19 have been reported in the literature. Patients with COVID-19 pneumonia present with the variable extent of disease, ranging from mild involvement affecting less than 10% of the lung parenchyma to severe disease which appears as a white-out lung.
Of 72 patients, 56 patients (77.8%) were males, and 16 (22.2%) patients were females. The proportion of male patients was more when compared to female patients. Male patients had increased CT scores when compared to females. The proportion of the elderly patients (more than 60 years) was more than younger patients. Elderly patients have extensive lung involvement compared to the young. Male patients have a higher CT score when compared to females. In concordance with the literature, Elderly male patients are at higher risk and carry a poor prognosis.

Keywords: *COVID-19, CT Chest, CT Severity Score, CORADS, Ground Glass opacity, Crazy Paving Pattern, Real- Time Polymerase Chain Reaction.*

INTRODUCTION

The novel coronavirus disease (COVID-19) is an acute respiratory syndrome caused by a highly contagious Severe Acute Respiratory Syndrome-Corona virus-2 (SARS-CoV-2) (Zhu *et al.,* 2019). It first emerged in Wuhan, China in late 2019. After that, the outbreak has spread across China to many other countries around the world. The WHO declared the outbreak as a pandemic in March 2020 (Zhu *et al.,* 2019). The most common clinical symptoms are fever, cough, and fatigue (Zhu *et al.,* 2019). Other symptoms include breathlessness and respiratory distress which can lead to ARDS or even death in certain cases (Wang *et al.,* 2020). Chest CT is the key radiological investigation in the diagnostic workup for suspected or infected COVID-19 patients (Zhu *et al.,* 2019).
Computed tomography (CT) plays an important role in the early diagnosis of COVID-19, in the early stages of the disease or with a low viral load, real-time reverse-transcriptase polymerase chain reaction (RT-PCR) may produce initial false-negative results (Gu *et al.,* 2019).
A wide variety of CT findings in COVID-19 have been reported in the literature. Patients with COVID-19 pneumonia present with the variable extent of disease, ranging from mild involvement affecting less than 10% of the lung parenchyma to severe disease which appears as a white-out lung. CT features in COVID-19 pneumonia change over time with the stage and severity of lung infection (Hani *et al.,* 2020).
Gender is a crucial factor for deciding the prognosis in COVID-19 patients. It has been proposed that due to the location of the angiotensin-converting enzyme 2 (ACE2) genes on the X chromosome, and

subsequent higher expression of this gene in men, they are more susceptible to SARS-CoV-2 infection. Moreover, smoking is also associated with higher ACE2 receptor expression, and considering the sex-related patterns of smoking, men are again more susceptible (Moradi *et al.,* 2020). Elderly patients are more likely to have severe clinical manifestations and extensive lung involvement, and fibrotic changes when compared to young patients (Mori *et al.,* 2021). This study is done to assess whether there is any significant difference between genders, age with respect to the CT-scan findings.

MATERIALS AND METHODS

Data source:

The study was a retrospective cross-sectional study carried out in the Department of Radiodiagnosis. Patients who underwent CT Chest during the period of one month, from 1st October to 31st October 2020, during the first pandemic wave in India were the source of data. CT Chest with CORADS-5/6 category or RT PCR positive patients was included in the study. Patients with CT chest who had CORADS 1 to 4 categories and those studies with motion artifacts on images were excluded from the study.

CT scanning protocol:

Non-enhanced CT Chest was performed on 16 slice Philips CTMX16 .To minimize motion artifacts, the patient was asked to hold a breath. CT was performed during a single breath-hold in the supine position. The CT parameters were as follows, tube voltage of 100–120 kV and tube current of 200–300 mAs were used. Obtained CT axial raw images were reconstructed to sagittal and coronal images with a matrix size of 512×512 (slice thickness of 1.0mm). Both lung (width, 1500 HU; level, 2700 HU) and mediastinal (width, 350 HU; level, 40 HU) window settings were used to interpret the CT images. DICOM data were transferred to the picture archiving and communication system (PACS) of the institution and then analyzed on a workstation.

Imaging evaluation

All the images were reviewed by two radiologists. Both of them reviewed each CT scan at the same time and the final report was made after mutual consensus of both the radiologists. If an agreement was not reached, a third radiologist helped to resolve the disagreement. No information about patient outcomes or their clinical conditions was available for them except PCR status. The CT images were defined based upon the CORADS category and PCR status (Prokop *et al.,* 2020) (Table 1).

Each lung is divided into 10 segments (Table 2 and 3). Each segment is given a score of 0 or 1 or 2 depending upon the extent of pulmonary involvement (Table 4). The maximum score for each lung is 20 and for both lungs are 40.

Out Of 308 CT chest studies done in the study period, patients with CORADS score 5 or 6 were 77. 72 patients were included in the study, after the exclusion of five patients due to motion artifacts. The CT data of patients were divided into three groups (Group 1: less than 45 years old; Group 2: 46 to 59 years old; Group 3: elderly patients of age 60 years and above.). Any significant relation between the CT severity score with reference to age and gender was analyzed statistically.

The CT imaging features included in the study are 1.Groundglass opacities (GGO), 2.Consolidation, 3.Crazy paving pattern, 4. Sub pleural bands, 5.Fibrotic bands, 6.Mediastinal lymphadenopathy (short-axis diameter more than 10 mm). The first three were counted for CT severity score (CTSS). GGO is defined as densities that are seen around the vessel and small airways with visualization of underlying lung parenchyma (Figure 1) (Gao *et al.,* 2017). Consolidation is defined as increased densities with obscuration of underlying lung parenchyma (Walker *et al.,* 2014) (Figure 2). A crazy-paving pattern is the presence of GGO with interlobular septal thickening (Rossi *et al.,* 2003) (Figure 3). Subpleural lines are thin curvilinear densities seen parallel to the pleural surface (Hansell *et al.,* 2008) (Figure 4). Fibrotic bands are linear thick (1 to3 mm) irregular densities that are not oriented parallel to the pleural surface (Hansell *et al.,* 2008).

Statistical Analysis

Qualitative data was represented in form of frequency and percentage. Among Qualitative data, Nominal data included are Gender, Extent of involvement of each segment (More than 50% involvement, Less than 50% involvement, and No involvement) and thereby entire Lung, ten lung segments on each side (Apical, Anterior, Posterior, Medial, Lateral, Superior, Anterobasal, Posterobasal, Medial basal and Lateral basal) and five CT findings (Consolidation, Ground Glass Opacity, Crazy Paving Pattern, Fibrosis, and Lymphadenopathy).

Association between qualitative variables was assessed by Chi-Square test, with Continuity Correction for all 2 X 2 tables and by Fisher's exact test for all 2 X 2 tables where Chi-Square test was not valid due to small counts. In presence of small counts in tables with more than two rows &/or columns, adjacent row &/or Column data was pooled & Chi-Square Test reapplied. Continuity Correction was applied for all 2 X 2 tables after pooling of data (e.g., Association between Right Lung Anterobasal involvement (More than 50% involvement, less than 50% involvement, and No involvement) and Gender (Female and Male).

Among Qualitative data, the Ordinal data included CT Severity Score (Right lung, Left Lung, and Total) and was represented using Mean ± SD and Median & IQR (Interquartile range). Comparison of Ordinal data measured between qualitative variable Gender (Female and Male) was done using Mann-Whitney Test.

Comparison of Ordinal data measured between qualitative variable Age-groups, with three sub-groups (aged < 45, 45 to 59 and 60 &>) was done using Kruskal-Wallis One Way Analysis of Variance on Ranks. If the p-value of Kruskal-Wallis One Way Analysis of Variance on Ranks was statistically significant, Dunn’s post hoc test for pair-wise comparison was applied.

Quantitative data included Age of the Cases and was represented using Mean ± SD and Median & IQR (Interquartile range). Comparison of Age in years, measured between binomial qualitative variable Gender (Female and male), was done using Mann–Whitney U tests the data failed ‘Normality’ test.

Results were graphically represented where deemed necessary. Appropriate statistical software, including but not restricted to MS Excel, PSPP version 1.4.1 / 5 September 2020; was used for statistical analysis. Graphical representation was done in the MS Excel package included in Microsoft Office 365. An alpha value (p-value) of <=0.05 was used as the cut-off for statistical significance.

RESULTS

Of 72 patients, 56 patients (77.8%) were males, and 16(22.2%) patients were females. Although the proportion of male patients were more when compared to female patients this difference is not statistically significant. 28(38.9%) patients belong to the age group of 60 and above, 19 patients (26.4%) are between 45 and 59; 25(34.7%) remaining patients belong to less than 45 years age group. Elderly patients more than 60 years are more when compared to the patients less than 45 years of age. The mean age of the patients was 51.7 years. The mean age for the female patients (49.81years) was less when compared to that of male patients (52.36 years). But the difference in mean age between the male and female patients was not statistically significant.

Among 16 female patients, 6 (37.5%) patients belong to more than or equal to 60 years of age, while five patients(31.3%) belong to each group of less than 45 years and in between 45 to 59 years. Among 56 male patients, 22 (39.3%) patients belong to 60 years and above groups, followed by 20 (35.7%) patients belong less than 45 years groups while the remaining 14(25%) patients belong to 45 to 59 years age groups. In both male and female patients, patients more than 60 years form the major group. Although the proportion of the elderly patients (more than 60 years) were more than younger patients, the difference was not statistically significant.

The average score obtained for the right lung was 6.20 out of 20 with an SD of ±4.59and for the left lung was 6.0 out of 20 with an SD of ±4.62. The total average score was 12.14 with an SD of ±9.01. The average score for the right lung was slightly more than the left lung. The CTSS obtained in the study was 37 out of 40. The maximum score for the right and left lungs were 18 and 19 respectively. The maximum score of the left lung was slightly more than the right lung.

The average CT severity scores (CTSS) of right (6.24), Left (6.11) and both lungs (12.27) in male patients were higher when compared to that of female patients is 6.06,6.11 and 11.69 in the right, left and both lungs respectively. The average score of male patients was more than that of female patients and the difference was not statistically significant. The maximum total score for the female patient was 37 out of 40 and the maximum total score for the male patient was 30 out of 40. The maximum score of the female patient was 20 percent more than male patient. Categorizing the CT severity score by age, average total score and right lung CT score were more for the age group of 45 to 59, while left lung scores were more for the age group of 60 and above. The difference is statistically significant with p value of ≤0.05.(Table 5). In general elderly patients had higher scores when compared to young patients.

Regarding the involvement of particular lung lobes, superior segment of the bilateral lower lobes showed involvement more than 50 % (30.6% on the right side and 29.22% percent on the left side) in nearly one-third of the cases (Table 6). The next most commonly involved segment was the posterior basal segment. In the right upper lobe, the posterior segment was more involved than the anterior segment (9.7%vs.4.2%). In the right middle lobe, lateral segments were more involved than the medial segment (6.9% vs. 5.6%). In the left upper lobe, the posterior segment was more involved than the apical segment (9.7%vs 2.8%). Among segments of the bilateral lower lobe, Antero-basal and medial basal segments were least involved (73.6% and 66.7%). The least involved segment in the whole lung was anterior basal segment (Left-73.6% - Right 80.6%) followed by apical segment (Left- 54.2%, Right-56.9%).

In the right upper lobe, the posterior segment of the right upper lobe was more commonly involved in male patients (10.7% vs. 6.3%). The apical segment of the right upper lobe was not involved in 50 percent of the cases in both male and female patients. Male patients showed slightly more predilection towards the lateral segment of the right middle lobe (7.1% vs. 3.6) when compared to female patients (6.3% vs. 12.5%). In the left upper lobe, the posterior segment was more commonly involved in both male and female patients (8.9% and 12.4%), while an apical segment of the left upper lobe was typically spared in 50 percent of the male patients and 68.7% of the female patients (Table 7). Among male patients, the inferior lingular segment was more involved than the superior lingular segment (12.5% vs. 3.6%), the female patient showed equal involvement of both superior and inferior lingular segment (18.8%). Male patient had more involvement of the superior segment (33.9%) of the left lower lobe followed by posterior basal segment (16.1%). Female patients had preferential involvement of the lateral basal segment (18.8%) of the left lower lobe followed by equal involvement of superior and posterior basal segments (12.5%).

Extent of involvement of each segment with respect to the age group was evaluated. On right lung, superior segment of lower lobe showed an involvement of 60% in age group less than 45 years, 63.2% in age between 45 and 59 and 78.6% in patients of age 60 and above. These data show that extent of involvement increases with the increase in the age. Association was found to be statistically significant (p-value= 0.046). Rest of the right lung segments did not show any statistically significant association between extent and age (Table 8). Two segments of the left lung, Anterobasal and medial basal segments show significant association between extent of involvement and age. Left Anterobasal segment show an involvement of 8% below 45 years, whereas 35.7% involvement in age group 60 and above. Involvement was statistically significant (p-value=0.036). Left medial basal segment shows involvement of 16% below 45 years, 31.6% between 45 and 59, and 50% in age 60 and above. Significant association was found between extent of involvement and age with respect to medial basal segment of left lung (p-value= 0.032). These two segments of left lung show more extent of involvement in the advanced age. Other segments of left lung show no significant association between extent and age.

The most common CT pattern was Ground Glass opacities seen in 76.4% of the patients. The next most common findings were the presence of subpleural bands in nearly 38.9% of the patients, followed by consolidation in 34.7% of the patients. Only 4 patients (5.6%) had lymphadenopathy (Table 9). The consolidation pattern was seen in 10% more cases in females rather than males (43.8% vs. 32.1%).

Ground glass opacity was seen in 10% more in males when compared to females (78% vs. 68%). Subpleural bands were seen in 10% more in males than females (41.1% vs. 31.3%). While the incidence of fibrotic bands was 4 times more common in males rather than females (26.8% vs. 6.3%) (Table10).

Consolidation pattern was most common seen in 45 to 59 years age (47.4%), then followed by <45 years

(32%) age. On contrary, ground-glass opacity was commonly seen in >60 years of age followed by 45 to 59 years age and then <45 years. Subpleural bands and fibrotic bands were also common in patients more than 60 years of age (Table 11). Although Male patients had increased CT scores when compared to females, on further analysis, it was found that the extent of particular lobe involvement had no significant association with gender.

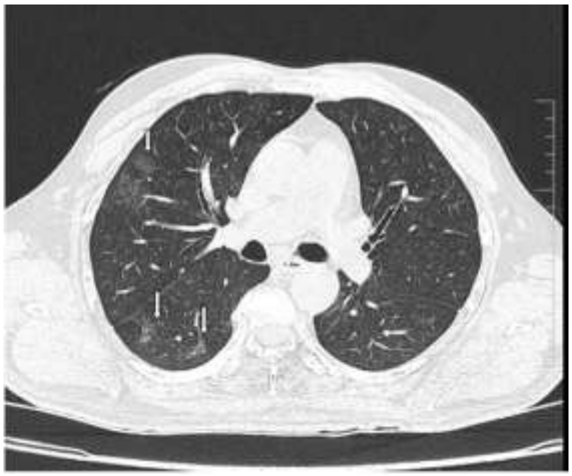

Figure 1: CT axial section lung window show multifocal areas of Ground glass opacity (White arrows) in the right middle and lower lobe.

Figure 2: CT axial section in lung window shows multifocal areas of peripheral subpleural consolidation (White arrows) in the right lung.

Figure 2: CT axial section lung window show multifocal areas of crazy paving pattern.

Figure 2: CT axial section shows bilateral linear subpleural lines(short white arrows) and ground glass in right middle lobe and superior segment of the bilateral lower lobes(Long arrow heads).

Table 1: CORADS category based upon the CT findings and PCR status

CORADS category	Level of suspicion	CT findings
CORADS 1	No	Normal or Non infectious abnormalities
CORADS 2	Low	Abnormalities consistent with infections other than COVID-19
CORADS 3	Intermediate	Unclear whether COVID-19 is present
CORADS 4	High	Abnormalities suspicious for COVID-19
CORADS 5	Very high	Typical COVID-19
CORADS 6	PCR positive	

Table 2: Segment-wise division of the Right lung

Segment	Right Lung
1	Right upper lobe- Apical segment.
2	Right upper lobe- Anterior segment.
3	Right upper lobe- Posterior segment.
4	Right Middle lobe- Medial segment.
5	Right Middle lobe- Lateral segment.
6	Right Lower lobe- Superior segment.
7	Right Lower lobe- Anterior basal segment.
8	Right Lower lobe- Posterior basal segment.
9	Right Lower lobe- Medial basal segment.
10	Right Lower lobe- Lateral basal segment.

Table 3: Segment-wise division of the Left lung

Segment	Left Lung
1	Left upper lobe- Apical segment.
2	Left upper lobe- Anterior segment.
3	Left upper lobe- Posterior segment.
4	Left Middle lobe- Medial segment.
5	Left Middle lobe- Lateral segment.
6	Left Lower lobe- Superior segment.
7	Left Lower lobe- Anterior basal segment.
8	Left Lower lobe- Posterior basal segment.
9	Left Lower lobe- Medial basal segment.
10	Left Lower lobe- Lateral basal segment.

Table 4: CT score for each segment based upon the percentage of involvement

Percentage of involvement	Score
No involvement	0
less than 50% involvement	1
more than 50% involvement	2

Table 5: CT score with respect to the age-wise distribution

Variables #	Age-group	Mean	SD	Median	IQR	Chi-Square	p-value
Right Lung/20	**< 45**	4.75	3.92	4.50	8.00	3.933	0.140
	45 to 59	7.68	5.57	9.00	9.00	Difference is not significant	
	60 &>	6.43	4.18	6.50	5.00		
Left Lung/20	**< 45**	4.08	3.65	4.00	7.00	6.496	0.039
	45 to 59	6.89	5.42	7.00	9.00	**Difference is significant.** p value of ≤0.05	
	60 &>	7.11	4.40	7.50	8.00		
Total Score/40	**< 45**	8.64	7.48	7.00	16.00	5.477	0.065
	45 to 59	14.58	10.76	16.00	16.00	Difference is not significant	
	60 &>	13.61	8.29	15.00	13.00		

Table 6: Segment-wise involvement percentage in the CT scan

S.No.	Segment	No involvement	Less than 50%	More than 50%
1.	Apical segment of RUL	41(56.9%)	28(38.9)	3(4.2%)
2.	Anterior segment of RUL	33(45.8%)	38(52.8%)	1(1.4%)
3.	Posterior segment of RUL	29(40.3%)	36(50%)	7(9.7%)
4	Medial segment of RML	37(51.4%)	31(43.1%)	4(5.6%)
5	Lateral segment of the RML	30(41.7%)	37(51.4%)	5(6.9%)
6	Superior segment of the RLL	23(30.6%)	27(37.5%)	22(30.6%)
7	Antero-basal segment of the RLL	58(80.6%)	11(15.3%)	3(4.2%)
8	Postero-basal segment of the RLL	28(38.9%)	31(43.9%)	13(18.1%)
9	Medial-basal segment of the RLL	36(50%)	32(44.4%)	4(5.6%)
10	Lateral-basal segment of the RLL	31(43.7%)	34(47.9%)	6(8.5%)
11	Apical segment of LUL	39(54.2%)	31(43.1%)	2(2.8%)
12	Anterior segment of LUL	43(59.7%)	25(34.7%)	4(5.6%)
13	Posterior segment of LUL	28(38.9%)	37(51.4%)	7(9.7%)
14	Superior Lingular segment	30(41.7%)	37(51.4%)	5(6.9%)
15	Inferior lingular segment	33(45.8%)	29(40.3%)	10(13.9%)
16	Superior segment of the LLL	27(37.5%)	24(33.3%)	21(29.2%)
17	Antero-basal segment of the LLL	53(73.6%)	17(23.6%)	2(2.8%)
18	Postero-basal segment of the LLL	24(33.3%)	37(51.4%)	11(15.3%)
19	Medial-basal segment of the LLL	48(66.7%)	22(30.6%)	2(2.8%)
20	Lateral-basal segment of the LLL	32(44.4%)	32(44.4%)	8(11.1%)

Table 7: Segment-wise involvement percentage in the CT scan with respect to gender

S. No.	Segment	Gender	More than 50%	Less than 50%	No involvement
1.	Apical segment of RUL	Male	2(3.6%)	21(37.5%)	33(58.9%)
		Female	1(6.3%)	7(43.7%)	8(50.0%)
2.	Anterior segment of RUL	Male	0(%)	30(53.6%)	26(43.4%)
		Female	1(6.3%)	8(50%)	7(43.7%)
3.	Posterior segment of RUL	Male	6(10.7%)	29(51.8%)	21(37.5%)
		Female	1(6.3%)	7(43.7%)	8(50.0%)
4	Medial segment of RML	Male	2(3.6%)	26(46.4%)	28(50%)
		Female	2(12.5%)	5(31.3%)	9(56.3%)
5	Lateral segment of the RML	Male	4(7.1%)	28(50%)	24(42.9%)
		Female	1(6.3%)	9(56.3%)	6(37.5%)
6	Superior segment of the RLL	Male	17(30.4%)	23(41.1%)	16(28.6%)
		Female	5(31.3%)	4(25.0%)	7(43.8%)
7	Antero-basal segment of the RLL	Male	1(1.8%)	8(14.3%)	47(83.9%)
		Female	2(12.5%)	3(18.8%)	11(68.8%)
8	Postero-basal segment of the RLL	Male	12(21.4%)	25(44.6%)	19(33.9%)
		Female	1(6.3%)	6(37.5%)	9(56.3%)
9	Medial-basal segment of the RLL	Male	3(5.4%)	25(44.6%)	28(50%)
		Female	1(6.3%)	7(43.7%)	8(50%)
10	Lateral-basal segment of the RLL	Male	4(7.3%)	27(49.1%)	24(43.7%)
		Female	2(12.5%)	7(43.8%)	7(43.8%)
11	Apical segment of LUL	Male	1(1.8%)	27(48.2%)	28(50%)
		Female	1(6.3%)	4(25.0%)	11(68.8%)
12	Anterior segment of LUL	Male	3(5.4%)	19(33.9%)	34(60.7%)
		Female	1(6.3%)	6(37.5%)	9(56.3%)
13	Posterior segment of LUL	Male	5(8.9%)	30(53.6%)	21(37.5%)
		Female	2(12.4%)	7(43.8%)	7(43.8%)
14	Superior Lingular segment	Male	2(3.6%)	31(55.4%)	23(41.1%)
		Female	3(18.8%)	6(37.5%)	7(43.7%)
15	Inferior lingular segment	Male	7(12.5%)	24(42.9%)	25(44.6%)
		Female	3(18.8%)	5(31.3%)	8(50.0%)
16	Superior segment of the LLL	Male	19(33.9%)	19(33.9%)	18(32.1%)
		Female	2(12.5%)	5(31.3%)	9(56.3%)
17	Antero-basal segment of the LLL	Male	1(1.8%)	14(25.0%)	41(73.2%)
		Female	1(6.3%)	3(18.8%)	12(75%)
18	Postero-basal segment of the LLL	Male	9(16.1%)	31(55.4%)	16(28.6%)
		Female	2(12.5%)	6(37.5%)	8(50%)
19	Medial-basal segment of the LLL	Male	1(1.8%)	16(28.6%)	39(69.6%)
		Female	1(6.3%)	6(37.5%)	9(56.3%)
20	Lateral-basal segment of the LLL	Male	5(8.9%)	27(48.2%)	24(42.9%)
		Female	1(18.8%)	6(31.2%)	9(50%)

Table 8: Segment-wise involvement in the CT scan with respect to the age

S.no	Segment	Percentage of involvement	<45 years	45 to 59 Years	>60 years
1.	Apical segment of RUL	More than 50%	1(4%)	2(10.5%)	0(0.0%)
		Less than 50%	7(28%)	7(36.8%)	14(50%)
		No involvement	17(68%)	10(52.6%)	14(50%)
2.	Anterior segment of RUL	More than 50%	0(0.0%)	1(5.3%)	0(0.0%)
		Less than 50%	11(44.0%)	12(63.2%)	15(53.6%)
		No involvement	14(56.0%	6(31.6%)	13(46.4%)
3.	Posterior segment of RUL	More than 50%	1(4.0%)	3(15.8%)	3(10.7%)
		Less than 50%	12(48.0%)	10(52.6%)	14(50.0%)
		No involvement	12(48.0%)	6(31.6%)	11(39.3%)
4	Medial segment of RML	More than 50%	0(0.0%)	1(5.3%)	3(10.7%)
		Less than 50%	8(32.0%)	12(63.2%)	11(39.3%)
		No involvement	17(68.0%)	6(31.6%)	14(50.0%)
5	Lateral segment of the RML	More than 50%	0(0.0%)	1(5.3%)	4(14.3%)
		Less than 50%	11(44.0%)	11(57.9%)	15(53.6%)
		No involvement	14(56.0%)	7(36.8%)	9(32.1%)
6	Superior segment of the RLL (Significant)	More than 50%	**7(28.0%)**	**9(47.4%)**	**6(21.4%)**
		Less than 50%	**8(32.0%)**	**3(15.8%)**	**16(57.1%)**
		No involvement	**10(40.0%)**	**7(36.8%)**	**6(21.4%)**
7	Antero-basal segment of the RLL	More than 50%	0(0.0%)	2(10.5%)	1(3.6%)
		Less than 50%	2(8.0%)	4(21.1%)	5(17.9%)
		No involvement	23(92.0%)	13(68.4%)	22(78.6%)
8	Postero-basal segment of the RLL	More than 50%	3(12.0%)	6(31.6%)	4(14.3%)
		Less than 50%	9(36.0%)	7(36.8%)	15(53.6%)
		No involvement	13(52.0%)	6(31.6%)	9(32.1%)
9	Medial-basal segment of the RLL	More than 50%	1(4.0%)	1(5.3%)	2(7.1%)
		Less than 50%	10(40.0%)	11(57.9%)	11(39.3%)
		No involvement	14(56.0%)	7(36.8%)	15(53.6%)
10	Lateral-basal segment of the RLL	More than 50%	0(0.0%)	4(22.2%)	2(7.1%)
		Less than 50%	10(40.0%)	8(44.4%)	16(57.1%)
		No involvement	15(60.0%	6(33.3%	10(35.7%
11	Apical segment of LUL	More than 50%	0(0.0%)	2(10.5%)	0(0.0%)
		Less than 50%	8(32.0%)	7(36.8%)	16(57.1%)
		No involvement	17(68.0%)	10(52.6%)	12(42.9%)
12	Anterior segment of LUL	More than 50%	1(4.0%)	1(5.3%)	2(7.1%)
		Less than 50%	6(24.0%)	5(26.3%)	14(50.0%)
		No involvement	18(72.0%)	13(68.4%)	12(42.9%)
13	Posterior segment of LUL	More than 50%	0(0.0%)	3(15.8%)	4(14.3%)
		Less than 50%	12(48.0%)	10(52.6%)	15(53.6%)
		No involvement	13(52.0%)	6(31.6%)	9(32.1%)
14	Superior Lingular segment	More than 50%	0(0.0%)	2(10.5%)	3(10.7%)
		Less than 50%	12(48.0%)	10(52.6%)	15(53.6%)
		No involvement	13(52.0%)	7(36.8%)	10(35.7%)
15	Inferior lingular segment	More than 50%	1(4.0%)	4(21.1%)	5(17.9%)
		Less than 50%	10(40.0%)	8(42.1%)	11(39.3%)

		No involvement	14(56.0%)	7(36.8%)	12(42.9%)
16	Superior segment of the LLL	More than 50%	6(24.0%)	6(31.6%)	9(32.1%)
		Less than 50%	7(28.0%)	6(31.6%)	11(39.3%)
		No involvement	12(48.0%)	7(36.8%)	8(28.6%)
17	Antero-basal segment of the LLL(Significant)	More than 50%	**0(0.0%)**	**2(10.5%)**	**0(0.0%)**
		Less than 50%	**2(8.0%)**	**5(26.3%)**	**10(35.7%)**
		No involvement	**23 (92.0%)**	**12(63.2%)**	**18(64.3%)**
18	Postero-basal segment of the LLL	More than 50%	2(8.0%)	4(21.1%)	5(17.9%)
		Less than 50%	11(44.0%)	9(47.4%)	17(60.7%)
		No involvement	12(48.0%)	6(31.6%)	6(21.4%)
19	Medial-basal segment of the LLL(Significant)	More than 50%	**0(0.0%)**	**1(5.3%)**	**1(3.6%)**
		Less than 50%	**4(16.0%)**	**5(26.3%)**	**13(46.4%)**
		No involvement	**21(84.0%))**	**13(68.4%)**	**14(50.0%)**
20	Lateral-basal segment of the LLL	More than 50%	0(0.0%)	3(15.8%)	5(17.9%)
		Less than 50%	10(40.0%)	10(52.6%)	12(42.9%)
		No involvement	15(60.0%)	6(31.6%)	11(39.3%)

Table 9: Different type of the CT patterns in COVID-19 patients

S. No.	Type of pattern	Present	Absent
1.	Consolidation	25(34.7%)	47(65.3%)
2.	Ground Glass opacity	55(76.4%)	17(23.6%)
3.	Crazy Paving Pattern	12(16.7%)	60(83.3%)
4.	Sub pleural Bands	28(38.9%)	44(61.1%)
5.	Fibrotic bands	16(22.2%)	56(77.8%)
6	Lymphadenopathy	4(5.6%)	68(94.4%)

Table 10: Different type of the CT patterns with respect to Gender

S. No.	Type of pattern	Gender	Present	Absent
1	Consolidation	Male	18(32.1%)	38(67.9%)
		Female	7(43.8%)	9(56.2%)
2	Ground Glass opacity	Male	44(78.6%)	12(21.4%)
		Female	11(68.8%)	5(31.2%)
3	Crazy Paving Pattern	Male	8(14.3%)	48(85.7%)
		Female	4(25%)	12(75%)
4	Sub pleural Bands	Male	23(41.1%)	33(58.9%)
		Female	5(31.3%)	11(68.7%)
5	Fibrotic bands	Male	15(26.8%)	41(73.2%)
		Female	1(6.3%)	15(9.7%)
6	Lymphadenopathy	Male	3(5.4%)	53(94.6%)
		Female	1(6.3%)	15(93.7%)

Table 11: Different type of the CT patterns with respect to the gender

S. No.	Type of pattern	Status	<45 years	45 to 59 Years	>60 years
1	Consolidation	Present	8(32.0%)	9(47.4%)	8(28.6%)
		Absent	17(68.0%)	10(52.6%)	20(71.4%)
2	Ground Glass opacity	Present	16(64.0%)	14(73.7%)	25(89.3%)
		Absent	9(36.0%)	5(26.3%)	3(10.7%)
3	Crazy Paving Pattern	Present	2(8.0%)	5(26.3%)	5(17.9%)
		Absent	23(92.0%)	14(73.7%)	23(82.1%)
4	Sub pleural Bands	Present	8(32.0%)	6(31.6%)	14(50.0%)
		Absent	17(68.0%)	13(68.4%)	14(50.0%)
5	Fibrotic bands	Present	6(24.0%)	3(15.8%)	7(25.0%)
		Absent	19(76.0%)	16(84.2%)	21(75.0%)
6	Lymphadenopathy	Present	2(8.0%)	0(0.0%)	2(7.1%)
		Absent	23(92.0%)	19(100.0%)	26(92.9%)

Table 12: Evolution of CT patterns in COVID-19

S. No.	Stage	CT features
1	Early stage (0–4days)	Few Subpleural Ground-glass opacities.
2	Acute (Progressive 5–8 days)	Increase in GGO's with Consolidation and fewcrazy paving patterns.
3	Chronic (Peak 9–13 days)	Decrease in GGO, progressive transformation of GGO into multifocal consolidation.
4	Resolving/ Absorption (After 14 days)	Subpleural bands and multiple fibrotic bands.

DISCUSSION

SARS-CoV is a coronavirus that caused a Severe acute respiratory syndrome (SARS) outbreak in 2003. It is structurally similar to SARS-CoV-2, a single-stranded RNA virus that causes COVID-19 disease (Zhu *et al.*, 2020). The mean diameter of the SARS-CoV-2 virus ranges from 82to 94 nanometers, without including the spikes (Neuman *et al.*, 2020). When compared to similar coronaviruses like SARS viruses or Middle East Respiratory Syndrome (MERS), SARS-CoV-2 is more contagious and less deadly (Hu *et al.*, 2020]. Subtle variation in minute molecular features leads to differences in the diseases caused by these viruses. Various adaptations evolved, which led to easier entry into the cell and then intense viral replication (Bakhshandeh *et al.*, 2021). These factors contributed to the virulence of SARS-CoV-2 more than structurally related ones. Newer viral strains have multiple variations of their surface protein (Harvey *et al.*, 2021). The frequent antigenic mutation of the virus makes people more easily infected and makes it too difficult to control. Mutant strains are more contagious and transmissible, thereby worsening the scenario (Xu *et al.*, 2020, Chan *et al.*, 2020). And it also plays an important role development of vaccines (Noh *et al.*, 2021).

Corona viruses such as SARS-CoV and MERS-CoV are zoonotic diseases. Intermediate hosts were bats in the case of SARS-CoV and camel in MERS-CoV (Ye *et al.,* 2020). The SARS-CoV-2 virus is a spherical shaped virus with an outer envelope, coated with multiple spikes on its surface and stalk-like projections with the round ending. Latter called receptor-binding domain (RBD) aid in receptor binding on host cells. RBD facilitates entry of the virus into the host cells by binding to angiotensin-converting enzyme-2 (ACE-2) receptor seen in various vital organs like the heart, lungs, kidneys, and bowel (Lan *et al.,*, 2020).

COVID-19 is an airborne droplet infection and can spread through physical contact also. Infected people can be asymptomatic without any disease manifestations. Such asymptomatic carriers harbor viruses which leads to person-to-person transmission and this forms a potential source of the COVID-19 infection (Bai *et al.,* 2020, Rothe *et al.,* 2020, Hu *et al.,* 2020). However, these carriers can have radiological abnormalities (Tabata *et al.,* 2020). The incubation period ranges between 2 to 7 days with the median being 4 days and can reach a maximum of 24 days (Guan *et al.,* 2020).

Real-time polymerase chain reaction (RT-PCR) or sequencing is the standard microbiological investigation for laboratory confirmation of COVID-19 (Hani C *et al.,* 2020). Although RT-PCR is considered a standard diagnostic tool for the detection of SARS-CoV-2, certain limitations exist with this method due to less availability, error in sampling, and technical errors. The higher sensitivity of chest CT over RT-PCR has been reported by certain studies (Moradi *et al.*, 2020). CT scan is a simple and sensitive investigation, which plays an important role in the screening, diagnosis, and evaluation of severity (Moradi *et al.,* 2020). The sensitivity of the RT-PCR test for COVID-19 infection ranges between 50–62%. Diagnosis can be missed in a substantial number of patients. The sensitivity of the RT-PCR test for COVID-19 infection ranges between 50–62% (He *et al.,* 2020). The accuracy of this diagnostic test depends on patient factors like the source of the sample and viral load, procedure-related factors, processing factors, and sensitivity of the diagnostic kits (Chan *et al.,* 2020). CT is beyond all these limitations. CT scan is widely used and time-saving when compared to RT-PCR tests. Further, it detects other asymptomatic but significant conditions like congenital cystic adenomatoid malformation (Kathar Hussain *et al.,* 2021). Chest CT had a sensitivity of 97% in detecting COVID-19 pneumonia (Yuan *et al.*, 2020). In addition to clinical and lab investigations, CT is the key imaging modality for diagnosis and assessment of severity (Yuan *et al.*, 2020, Zhao *et al.*, 2020, Li *et al.*, 2020). A significant correlation was found between CT scan findings including the extent of lung involvement and positive PCR test result. As CTSS increases the PCR test is more likely to be positive (Al-Mosawe *et al.,* 2020).

COVID-19 virus has a propensity to affect any age. Current literature states that the median age of COVID-19 infected patients is 47–59 years and in the case of the female gender it is 41.9–45.7% (Renuka *et al.,* 2021). The mean age of the patient is 51.7%in this study, and female patients constitute only 22% percentage of the total patients. Most of the COVID-19 patients in this study group were in their fourth to sixth decades of life. The presence of co-morbid conditions like diabetes mellitus, hypertension, chronic obstructive pulmonary disease, and treatment with ACE2-increasing drugs worsens the COVID-19 disease. The presence of COPD is also a poor prognostic factor (Wang *et al.*, 2020). According to a retrospective study involving patients in Wuhan, China, males required more intensive care management than females, which indicates gender-based severity (Xu B *et al.*, ., 2020). Similarly, Jin et al reported that the male sex has significant severity and mortality. The male gender is affected by COVID more than females (Renuka *et al.,* 2021). Males are more symptomatic or susceptible to COVID-19 disease, necessitating hospital-based care (Moradi *et al.,* 2020).

The virus attacks peripheral vascular structures and bronchial trees initially. This raises the intra-alveolar pressure resulting in exudation, seen as subpleural GGO and halo sign on CT. As the disease progresses, thickening of the interlobular septa and increased exudation of the alveolus occurs leading to a crazy-paving pattern. On further progression, alveolar consolidation and mixed GGO patterns are formed due to the thickened lobular septum limiting the absorption of the alveolar exudates (Wang *et al.*, 2020).

Chest CT plays a key role in the diagnosis and management of COVID-positive patients. It also acts as a prognostic indicator. The typical CT findings of COVID-19 patients are 1. Multiple ground-glass opacities which are patchy sub-segmental, or segmental, bilateral predominantly sub-pleural. 2. Multi lobar patchy consolidation which may be sub-segmental, or segmental, and predominantly sub-pleural. 3. Multilobar consolidation with associated reticulation resulting in a crazy-paving pattern (Wang *et al.*, 2020). Other findings in the CT chest are 1.Dilatation of vessels within the opacity, 2.Interlobar septal thickening, 3. Nodules, 4. Adjacent pleural thickening, and 5. Honeycomb pattern, 6.Pulmonary nodules with halo sign, 7. Air bronchogram, 8. Reverse halo sign, and 9. Cavitation. 10. Lymphadenopathy and 11. White-out lung (Wang *et al.*, 2020, Gu *et al.*, 2019, Hani *et al.*, 2020, Renuka *et al.*, 2021).

On Radio-pathological correlation, the lung abnormalities on CT are classified into four stages based on the evolution of COVID-19 disease (Table12). The transformation of GGO into linear consolidation is initial process which progresses towards organizing pneumonia. Actually, this is the response to lung injury due to multiple factors including infection, radiation or drug induced pneumonitis. Transition from one stage to another stage is always overlapping. So overlap of the findings is a common finding on CT.In early stage, interstitial alveolar wall inflammation is seen, with no interstitial fibrosis. Intact internal tissue structure of the alveoli is seen. On progression of the disease, inflammation decreases and fibrosis ensues. At this stage, GGO gradually transforms into reticular type of opacity on CT with presence of air bronchogram. Further, at this stage, Vacuolation occurs which leads to focal bronchiectasis. CT findings of particular stage are the reflection of the underlying pathological basis (Zhu *et al.*, 2019, Gu *et al.*, 2019).

In studies done by Zhu T et al, ground-glass opacities are the most common pattern seen in COVID-19 pneumonia and the next common is consolidation (Zhu *et al.*, 2019, Gu Q *et al.*, 2019). This study has similar results in CT patterns. According to Al-Mosawe *et al.*, the most common pattern was ground-glass opacities, seen in 79%.this is followed by subpleural bands in 37 %, pulmonary architectural distortion in 34%, and crazy paving appearance in 28 patients (Al-Mosawe *et al.*, 2020). Frequency distribution is nearly similar to this study Severe disease involves the entire lung lobe. Such involvement is mostly seen in the right lower lobe (Zhu *et al.*, 2019). The most common involved lobe is the lower lobe. Among lower lobe segments, the superior segment is more involved. In a series of 85 patients with radiological findings of COVID-19 disease, the lower lobe was involved predominantly in 85.88% (Renuka *et al.*, 2021).

Wang J *et al.* et al in their study found that GGO is predominant in younger patients and consolidation in the elderly. This finding is contrary to the finding in this study, as GGO is a predominant pattern as age increases. At the same time, extensive involvement of the lungs with increased CTSS was present in their study. This is consistently seen in our findings also . Apart from GGO and consolidation, Elderly patients have bronchiectasis and pleural thickening. Li *et al.*, described more incidences of linear opacities in elderly patients than younger patients . Liu K et al in their study reported the presence of severe CT lung changes in elderly patients with co-morbid diseases and age-related changes. More lobes are affected in the elderly than the young. The incidence of subpleural lesions is more in the elder age group other findings include crazy paving pattern, bronchodilatation, and pleural thickening. The findings are similar to this study.

Gu *et al.*, (2020) concluded that gender has no significant association with the type of CT findings studied. These results are similar to our study. The elderly have a high ratio of subpleural line and pleural thickness which point towards pulmonary fibrosis. The presence of a higher ratio in elderly patients is similar to the results of this study. The etiology behind these CT findings are weak immune status, age-related decrease in lung function, reduced lung compliance mainly due to atelectasis and fibrotic changes. These factors are more common in the elderly than in young patients (Zhu *et al.*, 2019). A higher incidence of severe COVID-19 disease seen in the elderly group may be associated with advanced age and co-morbidities like diabetes mellitus and hypertension. In presence of these co-morbid conditions, progression of the disease occurs more in the older patients than in the young (Wang *et al.*, 2020). COVID-19 can lead to exacerbation of pre-existing chronic lung diseases such as interstitial lung disease. The results of this study show higher CTSS in the elderly when compared to the younger age group. However, no statistically significant association was found (Moradi *et al.*, 2020). On contrary, various studies have reported a positive correlation of CTSS with increasing age (Al-Mosawe *et al.*, 2020).

CT-scores were higher in men compared with women (Percivale *et al.*, 2021) an observational and multicentric study done in China reported the prevalence of COVID-19as 0.31/100,000 and0.27/100,000 in males and females respectively (Yi *et al.*, 2020). These study findings have been consistent with our study. In a large series of 1099 hospitalized COVID-19patients in china, male patients comprised 58%. Among intensive care unit patients in New York City, only 33.5% of them were females (Percivale *et al.*, 2021). These studies mention that the female gender is less affected than males, with lesser prevalence. Males have an unfavorable prognosis and have a propensity for higher CTSS. Gender-based variation was observed in the distribution of opacities. A significant difference between men and women was seen. Peripheral distribution of opacities is a common finding in men whereas women had peri broncho-vascular distribution of opacities. Lower CTSS in females may be explained by hormonal mechanisms. In females, estrogen is immunoprotective and activation of estrogen receptors leads to decreased viral transcription and increased immunity whereas androgen receptor signaling in male patients has an opposite effect on immune status (Moradi *et al.*, 2020).

This study show male patients have higher CT score when compared to female, but our study shows no statistically significant association. A study done by Al-Mosawe *et al.*, concluded that Higher CTSS significantly correlates with the male gender (Al-Mosawe *et al.*, 2020), In their study, Percivale *et al.*, 35.3%of females had COVID-19 pneumonia in the total study population . In a meta-analysis based on 42 studies conducted in the Hubei province of China, Fu *et al.*, (2020) reported a median proportion of male patients of 56.5% . Women had a lower probability for the intensive care unit admission and at the same time higher probability for discharge to home. Moreover, the mortality rate was lower in females. An institutional study done in Italy found that fatality was more in males regardless of age. In a study involving 8910 patients, males were then 60% and the survival rate was low in males (75.2) compared to females (34.8) (Percivale *et al.*, 2021).

Similar to this study, Male patients always have higher CTSS when compared to females. Al-Mosawe et al demonstrated a positive correlation between raise in CT severity score and male gender. This is consistent with many other studies that reported predilection of COVID-19 infection to affect males more than females. Further, the male gender tends to have more severity. Whether man-made or natural, COVID-19 has caused and continues to cause havoc to the human race. This is in line with the phrase "survival of fittest" first used by Herbert Spencer in his principles of Biology after reading the Charles Darwin's book in "The origin of species" (Wikipedia.org. 2021).

CONCLUSIONS

Elderly patients have extensive lung involvement compared to the young. Male patients have a higher CT score when compared to females. In concordance with the literature, Elderly male patients are at higher risk and carry a poor prognosis. The most common pattern seen in COVID- 19 pneumonia is the ground-glass opacity. Elderly patients had more subpleural bands and fibrotic bands when compared to the young.

Limitation

This study was done during the first wave of COVID-19, age and sex distribution may be different in subsequent waves. The relatively small sample size, single-center data collection, and retrospective nature of the study are the limitations of the study. Follow-up was not done due to technical and time constraints. Clinical outcome and follow-up can give further information regarding the age and gender influence on COVID-19.

List of abbreviations

COVID-19- coronavirus disease 2019
ARDS- Acute respiratory distress syndrome
CT-Computed tomography
RT-PCR- Reverse-transcriptase polymerase chain reaction
PCR-polymerase chain reaction

CTSS- CT severity score
RUL- Right Upper lobe
RML-Right Middle lobe
RLL- Right Lower lobe
LUL-Left Upper lobe
LLL- Left lower lobe

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