COVID-19 CT Severity and Handedness: Is There a Relation?

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Abstract

Background: Both human laterality and the COVID-19 pandemic are popular subjects for scientific research studies. Diverse studies are still being performed in both areas. Imaging, especially computerized tomography (CT), plays an important role in the diagnosis and follow-up of COVID-19 pneumonia cases, as well as defining the disease severity. In the current study, we mainly aim to define the distribution of the laterality among COVID-19 cases. Also, we intend to investigate the possible effect of laterality on disease severity and the relation of the laterality with the tracheal anatomy.

Methods: Patients who had been diagnosed with COVID-19 and who accepted to participate in the study between January 2020 and December 2020 were included. Handedness of the patients was defined using an adapted version of the Edinburg Handedness Inventory. CT images were used to define disease severity and measure bronchial angles.

Results: The mean age of the study population was 59.69 ± 16.92 years (19-98 years). Seventy-seven patients were male (43.70%) and 99 patients were female (56.30%). Of the group, 161 patients were right-handed (91.50%) and 15 patients were left-handed (8.50%). Mean bronchial angles did not differ significantly according to handedness. No significant correlation was detected between severity scores (for each lobe and total scores) and bronchial angles.

Conclusion: The handedness ratio of COVID-19 pneumonia patients was similar to that of the general population. We could not define a significant relation between handedness and pneumonia severity, either. Branching angles of the bronchus did not differ significantly with the handedness, and pneumonia severity was not related to the bronchial branching angles.

Keywords: Handedness, laterality, COVID-19, severity, CT, angle

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the cause of the novel coronavirus disease (COVID-19) which was classified as a pandemic by the World Health Organization in March 2020. Since its first onset in Wuhan, China, COVID-19 has been affecting millions of people and has caused high mortalilty.[1]

Laterality can be defined as the development of specialized functioning in each hemisphere of the brain or in the side of the body which each controls. The most common example of laterality is handedness, which can be defined as the tendency to choose one hand over the other to perform everyday activities.[2]

Both human laterality and the COVID-19 pandemic are popular subjects for scientific research studies. Diverse studies are still being performed in both areas. As far as we know, there is no study in English in the literature to evaluate the possible relationship between COVID-19 cases and their laterality.

Imaging, especially computerized tomography (CT), plays an important role in the diagnosis and follow-up of COVID-19 pneumonia cases, as well as in defining the disease severity.[3] In the current study, we mainly aim to define the distribution of the laterality among COVID-19 cases. We also intend to investigate the possible effect of laterality on disease severity, in addition to the relation of the laterality with tracheal anatomy.

Materials and Methods

Approval for this study was granted by the Institutional Review Board. Informed consent was acquired from all the participants.

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Table 1. CT Severity Scoring

CT Severity Score	Extent of Lesions for Each Lung Lobe (%)
0	0
1	<5
2	5–25
3	25–50
4	50–75
5	>75

Scores were defined for each lobe and the sum of the scores of the lobes
constitute the total lung score.
Total score scale: 0–25.
CT, computerized tomography.

Patients who had been diagnosed with COVID-19 and who accepted to participate in the study between June 2020 and December 2020 were included. Those patients who did not have an appropriate CT image and who could not complete the below-mentioned questionnaire were then excluded (213 patients). The study population consisted of 176 patients.

Handedness of the patients was defined by using an adapted version of the Edinburg Handedness Inventory (Supplement 1).[4] Age and gender data were also recorded.

CT images were used to define disease severity. Disease severity of the patients was defined for each lung segment, and the sum of the severity values was then used to define a final severity score. CT severity scores were calculated using Pan et al.'s method[5] (Table 1) (Figure 1). In addition, the tracheal angles were measured using CT images: 2 angles for the right lung (the angles between upper lobe bronchi and intermediate bronchi, and the intermediate bronchi and lower lobe bronchi), and 1 angle for the left lung (the angle between upper and lower lobe bronchus) (Figure 2). Two radiologists defined angles and CT severity scores together, and with consensus.

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) for Windows 20 software (IBM SPSS Inc., Chicago, IL, USA). Normal distribution of the data was evaluated with the Kolmogorov–Smirnov test. Descriptive statistics of the data are presented with n (%), and for non-normalized variables are shown as "median (min-max or 25-75 percentiles)," and normal distributions are shown as "mean ± SD". Difference in the normally distributed variables between groups was evaluated with the Student's t-test. Categorical variables between groups were evaluated with the chi-square test. Correlations between variables were analyzed with Pearson's correlation coefficient.

A 2-tailed value of $P < .05$ was considered statistically significant.

Results

The mean age of the study participants was 59.69 ± 16.92 years. The mean ages of the right-handed and left-handed participants were similar (59.93 ± 16.89 vs. 57.13 ± 17.68, respectively; $P = .540$). Seventy-seven patients were male (43.70%) and 99 patients were female (56.30%). Gender distributions were similar for right-handed and left-handed subgroups ($P = .390$) (Table 2).
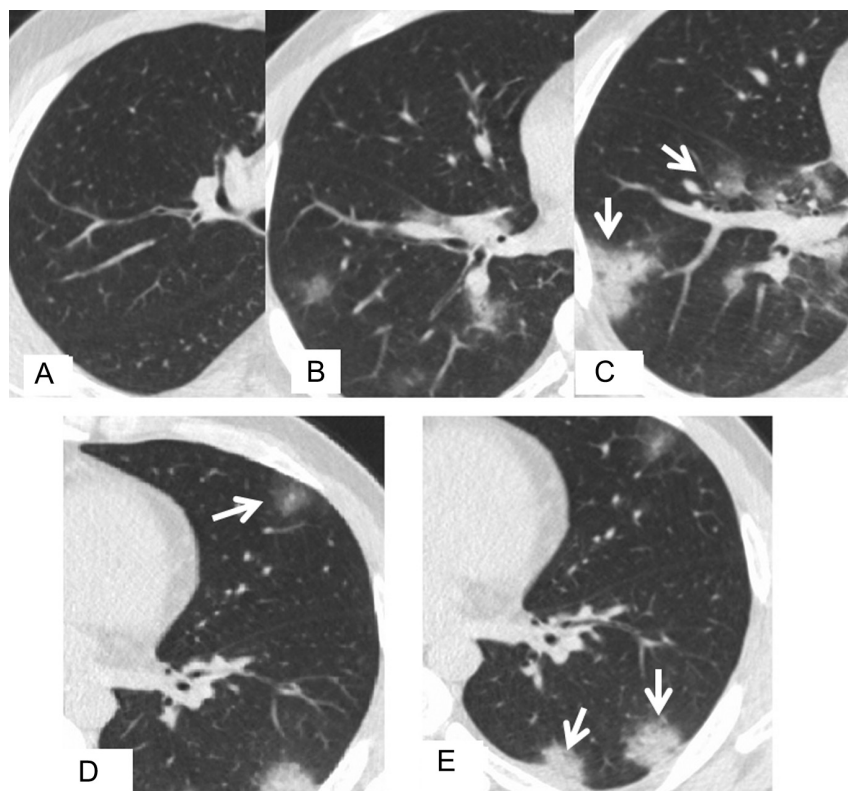

Figure 1. CT severity scoring. (A and B) No infiltration is present at right upper and middle lobe, (C) 26–50% of the right lower lobe is infiltrated, (D) 5–25% of the left upper lobe is infiltrated, (E) 26–50% of the left lower lobe is infiltrated. The total CT severity score of the patient is 8.

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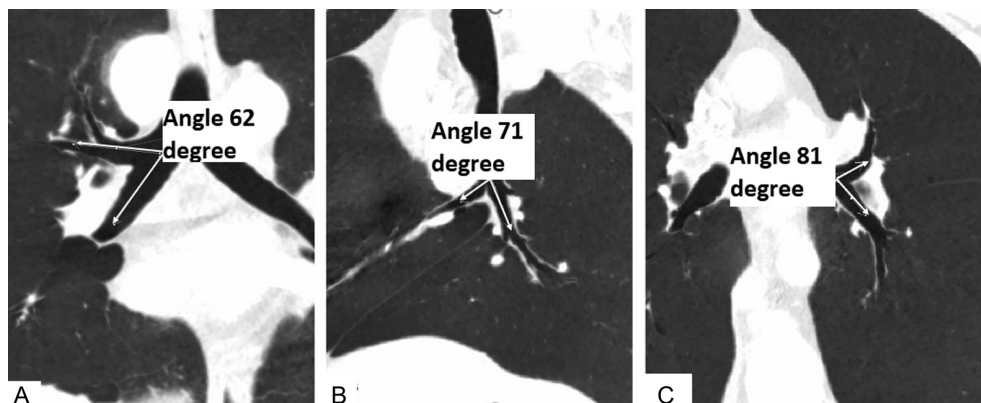

Figure 2. Measurement of bronchial angles. (A) The angle between right upper lobe bronchi and intermediate bronchi, (B) the angle between right intermediate bronchi and lower lobe bronchi, and (C) the angle between left upper and lower lobe bronchus.

Among the participants, 161 patients were right-handed (91.50%) and 15 patients were left-handed (8.50%). Details about the laterality indexes of the patients can be seen in Table 3.

The mean total CT severity score of the population was 5.91 ± 3.75. Details about CT severity scores can be seen in Table 4. Mean total severity scores did not change according to handedness (right-handed 5.85 ± 3.68 vs. left-handed 6.60 ± 4.45, P = .074). For both lungs, the lower lobes had the highest mean severity score. For both right-handed and left-handed participants, the lower lobes had the highest mean severity score. Mean total CT severity scores and CT severity scores of the lobes did not differ significantly between genders.

Mean bronchial angles of the population can be seen in Table 5. Mean angle between right intermediate and lower lobe bronchus was lower in females than males (57.96 ± 12.87 vs. 63.73 ± 16.34, P = .032); other bronchial angles did not differ significantly between genders (right upper–intermediate bronchus; male, 75.73 ± 11.76 vs. female, 76.91 ± 12.64; P = .610) (left upper and lower lobe bronchi; male 54.14 ± 18.86 vs. female, 50.63 ± 14.21; P = .160). Mean bronchial angles did not differ significantly according to handedness (Table 6). No significant correlation was detected between severity scores (for each lobe and total scores) and bronchial angles (P = .110).

Table 2. Age and Gender Data According to Handedness

	Right-Handed	Left-Handed	P
Age (mean ± SD)	59.93 ± 16.89	57.13 ± 17.68	.540
Gender (M/F)	38/50	39/49	.390

SD, standard deviation; M, male; F, female.

Table 3. Laterality Indexes of the Participants

Right-Handed		Left-Handed	
	n (%)		n (%)
48 ≤ LI < 60	13 (7.3%)	−54 ≤ LI < −42	4 (2.27%)
60 ≤ LI < 68	8 (4.54%)		
80 ≤ LI < 84	32 (18.18%)	−83 ≤ LI < −76	9 (5.11%)
88 ≤ LI < 92	35 (19.88%)		
92 ≤ LI < 95	43 (24.43%)	−92 ≤ LI < −90	2 (1.13%)
95 ≤ LI < 100	40 (22.72%)		

LI, laterality indexes.

Table 4. Mean CT Severity Scores of the Study Population

Right Lung		Left Lung	
Mean ± Standard Deviation		Mean ± Standard Deviation	
Upper lobe	0.97 ± 0.85	Upper lobe	1.03 ± 0.79
Middle lobe	1.01 ± 0.79		
Lower lobe	1.47 ± 1.04	Lower lobe	1.44 ± 0.9

Table 5. Mean Bronchial Angles

Bronchial Angles (Mean ± Standard Deviation, Degree)	
Right upper lobe bronchi–intermediate bronchi	76.39 ± 12.24
Right intermediate bronchi–lower lobe bronchi	60.48 ± 14.73
Left upper–lower lobe bronchus	52.16 ± 16.45

Discussion

Handedness and laterality, and their direct or indirect effects on diverse health problems have been examined.[6–8] As far as we know, there is no other study in English in the literature to examine the possible relationship between handedness and COVID-19 severity. According to the results of the current study, we cannot detect any significant correlation between the severity of COVID-19 pneumonia and handedness. In addition, we cannot define any relation between handedness and measured tracheal angles.

The reverse transcriptase-polymerase chain reaction (RT-PCR) is the most important test to diagnose COVID-19. However, it is challenged by limited laboratory facilities and

Table 6. Mean Bronchial Angles According to Handedness

Bronchial Angles	Mean ± Standard Deviation, Degree		
	Right-Handed	Left-Handed	P
Right upper lobe bronchi–intermediate bronchi	76.34 ± 12.31	76.93 ± 11.93	.970
Right intermediate bronchi–lower lobe bronchi	60.44 ± 14.64	60.93 ± 16.22	.900
Left upper–lower lobe bronchus	52.43 ± 16.74	49.27 ± 13	.470

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adequately acquired swabs. In addition, chest X-ray examinations generally fail to reveal lung changes related to COVID-19. Chest CT is quite successful in showing the parenchymal lung abnormalities in COVID-19 cases, even in early stages of the disease. Thus, CT has become a primary method in the diagnosis and follow-up of COVID-19 cases.[9] Along with the diagnosis and follow-up, CT has been proven to be effective in defining the severity and predicting the prognosis of COVID-19 pneumonia cases.[10]

Laterality, and its most widely known component, handedness, are important variants among the population. According to previous studies, approximately 10% of the population is left-handed.[11,12] In the current study, the ratio of left-handedness among patients with COVID-19 is 8.5%, similar to data in the literature. We intended to investigate a possible relation between handedness and disease severity of COVID-19 pneumonia via a successful imaging method, CT. According to the results of the CT imaging, severity level of the pneumonia did not change according to the handedness of the patients. In the literature, COVID-19 pneumonia was defined to affect the lower lobes more frequently and severely.[13] Our results were similar with the literature reports; the most severe involvement was detected in the lower lobes, independent of handedness.

Considering that COVID-19 pneumonia is a respiratory disease, spreading within the respiratory tract, we hypothesized that bronchial angles measured from the branching points of the bronchus could be related to disease severity. Additionally, in order to confirm the results about handedness, we also investigated the correlation between handedness and bronchial angles. We could not find any significant relationship between handedness and bronchial angles or bronchial angles and disease severity. There are no other similar studies examining the relationship between bronchial angles/branching and handedness, and the current study might add interesting information to the literature in this aspect. Moreover, as far as we know, there is no other similar study to offer information about bronchial branching structure and the severity of COVID-19 pneumonia. It is stated that the diameter of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is between 60 nm and 140 nm, which means that it can easily reach the alveolar septum, alveolar wall, and interlobular septum.[14] The small diameter could explain the lack of any relationship between CT severity and bronchial angles.

According to the results of the current study, the mean angle between right intermediate and lower lobe bronchus is lower in females; on the other hand, we cannot define a significant difference between the severity scores of the mentioned lobes. It can be concluded that the difference in bronchial angle does not have any influence on disease severity. Further studies with larger populations are still needed to confirm the relationship between gender and branching angles of the bronchus.

This study has some limitations worth mentioning. The size of the study population could be increased for more reliability. Comparing the results with the results in healthy subjects could increase the reliability of the data; however, considering the normal course of the pandemic, defining healthy but asymptomatic patients is a difficult process with a high cost. In addition to handedness, the other components of laterality can be included in the evaluation process. Two radiologists defined

angles and CT severity scores together and with consensus, as a result of which we cannot offer any interobserver reliability data. Assessing the measurements blindly and presenting interobserver variability data can increase the reliability of further similar studies.

Conclusion

According to our first and preliminary results, the handedness ratio of COVID-19 pneumonia patients was similar to that of the general population. We cannot define a significant relationship between handedness and pneumonia severity, either. Branching angles of the bronchus do not differ significantly with the handedness, and pneumonia severity is not related with bronchial branching angles.

Ethics Committee Approval: Approval for this study was granted by the Institutional Review Board.

Informed Consent: Informed consent was acquired from all the participants.

Peer Review: Externally peer-reviewed.

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References

1. Zhu N, Zhang D, Wang W et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med*. 2020;382(8):727-733. [CrossRef]
2. Corballis M. *Human Laterality*. Elsevier, USA; 2012.
3. Li Y, Xia L. Coronavirus disease 2019 (COVID-19): role of chest CT in diagnosis and management. *AJR Am J Roentgenol*. 2020;214(6):1280-1286. [CrossRef]
4. Oldfield RC. The assessment and analysis of handedness: the Edinburgh inventory. *Neuropsychologia*. 1971;9(1):97-113. [CrossRef]90067-4)
5. Pan F, Ye T, Sun P et al. Time course of lung changes at chest CT during recovery from coronavirus disease 2019 (COVID-19). *Radiology*. 2020;295(3):715-721. [CrossRef]
6. Bryson FM, Grimshaw GM, Wilson MS. The role of intellectual openness in the relationship between hand preference and positive schizotypy. *Laterality*. 2009;14(5):441-456. [CrossRef]
7. Walsh A, McDowall J, Grimshaw GM. Hemispheric specialization for emotional word processing is a function of SSRI responsiveness. *Brain Cogn*. 2010;74(3):332-340. [CrossRef]
8. Najt P, Bayer U, Hausmann M. Atypical lateralisation in emotional prosody in men with schizotypy. *Laterality*. 2012;17(5):533-548. [CrossRef]
9. Yang Q, Liu Q, Xu H, Lu H, Liu S, Li H. Imaging of coronavirus disease 2019: A Chinese expert consensus statement. *European journal of radiology*. 2020;127:109008. [CrossRef]

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10. Yang R, Li X, Liu H, et al. Chest CT severity score: an imaging tool for assessing severe COVID-19. *Radiol Cardiothorac Imaging*. 2020;2(2):e200047. [CrossRef]

11. Papadatou-Pastou M, Ntolka E, Schmitz J et al. Human handedness: A meta-analysis. *Psychol Bull*. 2020;146(6):481-524. [CrossRef]

12. Hardyck C, Petrinovich LF. Left-handedness. *Psychol Bull*. 1977;84(3):385-404. [CrossRef]

13. Hafez MA. The mean severity score and its correlation with common computed tomography chest manifestations in Egyptian patients with COVID-2019 pneumonia. *Egypt J Rad Nucl Med*. 2020;51(1):1-9.

14. Kim EA, Lee KS, Primack SL et al. Viral pneumonias in adults: radiologic and pathologic findings. *RadioGraphics*. 2002;22(Spec No):S137-S149. [CrossRef]