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Orgınal Article

Analysis of disturbution of bronchopulmonary segments in covid-19 patients

Covid-19 hastalarında bronkopulmoner segmental dağılımın analizi

Ayşe Gül Kabakci[1*], Yeşim Taşova[2], Memduha Gülhal Bozkir[3]

[1]*Department of Anatomy, Faculty of Medicine, Cukurova University, Adana, Turkiye*
[2] *Infectious Diseases and Clinical Microbiolog, Faculty of Medicine, Cukurova University, Adana, Turkiye*
[3]*Department of Anatomy, Faculty of Medicine, Cukurova University, Adana, Turkiye*

**Corresponding author:*
Dr. Ayşe Gül Kabakcı,Ph.D.

Adress: Ayşe Gül Kabakci, Cukurova University Faculty of Medicine Deparment of Anatomy, Balcalı, Sarıçam, Adana,Turkiye.

E-mail: akabakci@cu.edu.tr
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Highlights

• We found that the lower lobe of the right lung was the most affected from the COVID-19.

• The lower lobe posterior segment was mostly affected in men, while the lower lobe superior and lateral segments were affected in women.

Abstract

Background: Imaging modalities are important in the correct treatment and diagnosis of COVID 19, which causes severe damage to lung tissue. Ground-glass opacity is the most commonly reported imaging finding of COVID-19 pneumonia. Therefore, we aimed to analyze the distribution of bronchopulmonary segments in patients with ground-glass opacities.

Materials and Methods: We included tomography images of 93 patients who were diagnosed as COVID-19 positive during the period when COVID-19 vaccine studies had not yet started. Thorax CT images of patients with COVID-19 were examined in the axial line. In each slice, the presence of ground-glass image of the right and left lungs was examined segment by segment. All slices with ground-glass image were recorded for each patient according to the slices in the Radiopeadia program.

Results: The mean age of patients with ground-glass opacity was 47.05±16.35 years (21-82), 45.77±16.15 years in men and 48.58±16.76 years in women. In addition, the mean age of 36 patients (19 males and 17 females) without ground glass opacity was 44.28±17.53 years. When the right and left lungs were compared by gender, the density of ground-glass opacity was 50.17% in men and 49.83% in women in the right lung, and 56.40% in men and 43.6% in women in the left lung. When the right and left lungs were compared, the presence of ground-glass opacities was observed in 56.18% of the right lung and 43.82% of the left lung. **Conclusion:** In our study, we found that most ground glass opacity appearance were observed in the lower lobe, right lung and in men. We think that this study will be a source of data on the course of the COVID 19 in the medium and long term.

Key Words: Bronchopulmonary segments, COVID-19, Glass opacity, Lung

ÖZ

Amaç: Akciğer dokusunda ciddi hasara neden olduğu görülen COVID 19'un doğru tedavi ve tanısında görüntüleme yöntemleri önemlidir. Buzlu cam opasitesi, COVID-19 pnömonisinin en sık bildirilen görüntüleme bulgusudur. Bu nedenle çalışmamızda buzlu cam opasiteleri olan hastalarda bronkopulmoner segmentlerin dağılımını analiz etmeyi amaçladık.

Gereç ve Yöntem: COVID-19 aşı çalışmalarının henüz başlamadığı dönemde COVID-19 pozitif tanısı alan 93 kişinin tomografi görüntülerini çalışmaya dahil ettik. COVID-19'lu hastaların toraks BT görüntüleri aksiyel hatta incelendi. Her kesitte sağ ve sol akciğerlerin buzlu cam görüntüsünün varlığı segment segment incelendi. Radyopeadya programındaki kesitlere göre her hasta için buzlu cam görüntüsü olan tüm kesitler kaydedildi.

Bulgular: Buzlu cam opasitesi saptananların yaş ortalaması 47.05±16.35 (21-82) yıl olup, erkeklerde 45.77±16.15, kadınlarda 48.58±16.76 idi. Ayrıca, buzlu cam opasitesi bulunmayan 36 kişinin (19 erkek ve 17 kadın) yaş ortalaması 44.28±17.53'tür. Sağ ve sol akciğerler cinsiyete göre karşılaştırıldığında, sağ akciğerde erkeklerde %50,17 ve kadınlarda %49,83, sol akciğerde ise erkeklerde %56,40 ve kadınlarda %43,6 oranında buzlu cam opasitesi yoğunluğu kaydedilmiştir. Sağ ve sol akciğerler karşılaştırıldığında, buzlu cam opasitelerinin varlığı sağ akciğerde %56,18 oranında, sol akciğerde ise %43,82 oranında gözlenmiştir.

Sonuç: Çalışmamızda en fazla buzlu cam görünümünün alt lobda, sağ akciğerde ve erkeklerde tutulum gösterdiğini bulduk. Bu çalışmanın orta ve uzun vadede COVID 19'un seyri hakkında veri kaynağı oluşturacağını düşünüyoruz.

Anahtar Kelimeler: Bronkopulmoner segmentler, COVID-19, Buzlu cam görüntüsü, Akciğer

Introduction

There have been approximately 8 million confirmed cases and more than 425,000 confirmed deaths due to COVID-19, a large family of viruses that can cause serious illness (1). In many countries, CT is the important method for identifying and triaging COVID-19 patients. The first study on chest CT findings of COVID-19 was published in January 2020. In the study, it was revealed that most of the hospitalized patients with bilateral lung involvement had ground glass opacities (GGO) (2).

Intense acute respiratory syndrome has been reported in studies to cause serious damage to lung tissue. Therefore, CT imaging is important in accelerating the evaluation for correct treatment. Moreover, in the literature, studies have been conducted on clinical, epidemiological features and potential risk factors in patients with COVID-19 with a poor prognosis by clinicians (3-5)

Ground glass opacity is the most common finding of COVID-19 pneumonia with a rate of 40-83% on imaging (6). For this reason, we included patients who were followed up and treated in our hospital, diagnosed with COVID-19 with lung CT examination. The evaluations were made according to gender. In the bronchopulmonary segmental distribution examinations in our study, we aimed to reveal intensive the pulmonary prognostication during the period when COVID-19 vaccine studies had not yet started. We think that this study will guide both the current pandemic situation and future pandemics by creating basic data. Because, thanks to past pandemics, preparations can be made against possible pandemics again. In addition, there are data on long-term pulmonary sequelae after COVID-19 in studies investigating the radiologic findings of COVID-19 in the lung in the literature (7). In this study, our aim was to establish a basis with CT findings for the comparison of short- and long-term segmental lung involvement after COVID-19 before and after vaccine administration.

Material and Method

This study was conducted retrospectively. The informed consent was waived due to the retrospective nature of the study and the assessment utilized anonymous research findings. CT images were interpreted by the same infectious specialist and lung segmental distribution was made by the same anatomists. The relevant guidelines and regulations were strictly followed when conducting the study. Ethic committee approval for the study were obtained from Cukurova University Medical Faculty, Non-invasive clinical research Ethic Board (132/30). In addition, necessary permissions were obtained from the Department of Infectious Diseases and Clinical Microbiology. The experimental procedures were conducted in accordance with the Declaration of Helsinki.

Study Design

First of all, a list of patients who were diagnosed with COVID-19 in March, 2020-July, 2020 from the Department of Infection And Clinical Microbiology was obtained. This list included 93 people who were COVID-19 positive and had a CT image. Secondly, the presence of GGO in the CT images of the COVID-19 positive people on this list in the Department of Infectious Diseases and Clinical Microbiology was checked. It was determined that 57 of 93 people with glass opacities in the CT images. Assessment of anatomical lung segment was performed on CT images (Toshiba Aquilion™ PRIME; Otawara, Japan).

Computed Tomography Protocol

Firstly, a list of patients who were diagnosed with Covid-19 positive from the Infection and Clinical Microbiology Department. Secondly, CT images were randomly selected from the archive for our retrospective study. All CT images were obtained using a 160-slice MDCT scanner (Toshiba Aquilion™ PRIME; Otawara, Japan). Thoracic CT images of patients with COVID-19 were examined on the axial line.

Bronchopulmonary Segments Analysis

First, the presence of GGO was determined in each segment of the right and left lung lobes of each patient. The segment to which the detected GGO presence corresponded was recorded using Radiopedia (Radiopaedia.org) program. Confirmation of the segment name according to the Radiopedia program ensured the objectivity of the analysis (Figure 1). Radiopaedia is a program that aims to educate radiologists, other healthcare professionals and medical students accurately and free of charge in all areas related to the practice of medical imaging. The naming of the segments in the three lobes of the right lung are as follows; upper lobe: apical, posterior, anterior, middle lobe: lateral, medial and lower lobe: superior, medial, anterior, lateral, posterior. In addition, the naming of the segments in the left lung; upper lobe: apicoposterior, anterior, superior lingular, inferior lingular and lower lobe: superior, anteromedial, lateral, posterior (Figure 1).

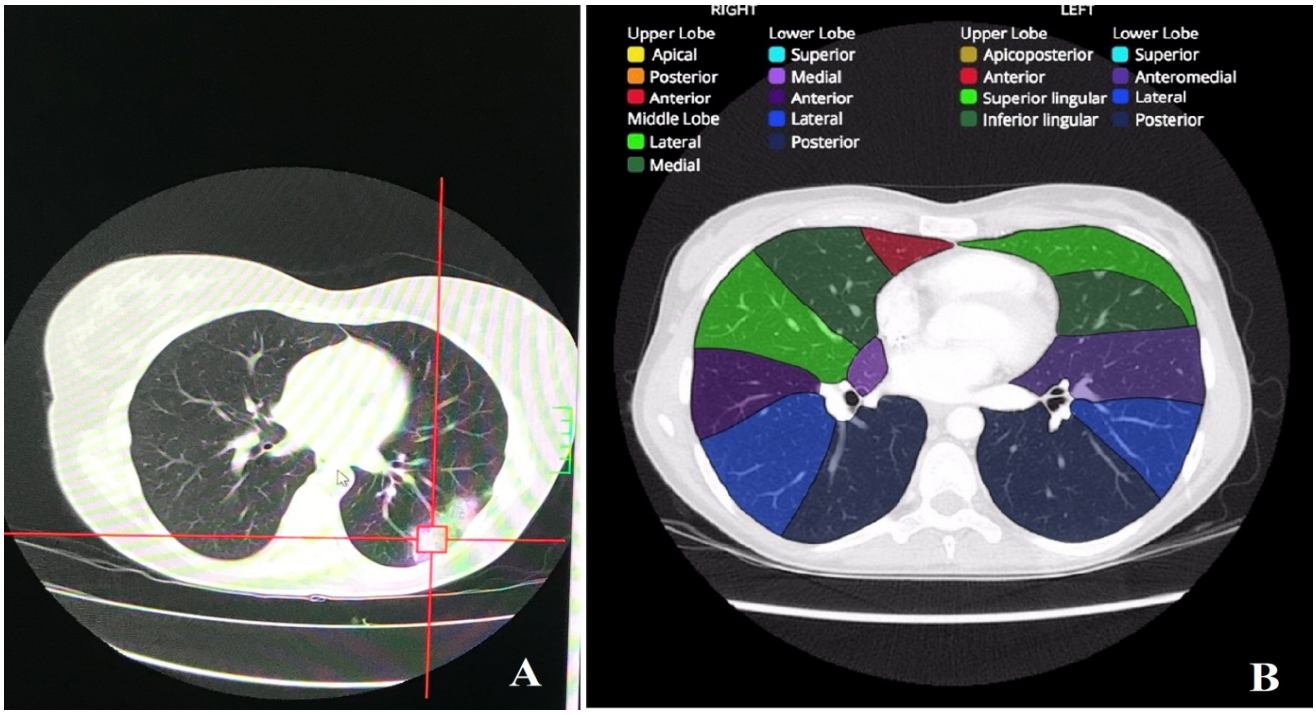

Figure 1. Determination of bronchopulmonary segment analysis via CT image (A) and the radiopeadia program image (B)

Statistical Analysis

Statistical analysis was performed through the SPSS v.22 package program (IBM SPSS Statistics, Chicago, IL, USA). The relationship between the age, gender and GGO was calculated through the "Pearson's correlation coefficient test." The intraclass correlation coefficient (ICC) test was used to analyze intraobserver reliability for repeated measurements with a 95% confidence interval. ICC was interpreted as follows: Below 0.50: Poor; between 0.50 and 0.75: Moderate; between 0.75 and 0.90: Good; and above 0.90: Excellent. A p=0.05 was considered statistically significant. Also, categorical variables were assessed as frequency and percent rates (%) with graphics.

Results

In our study, we found that 57 of 93 COVID-19 patients had ground glass opacities (GGO). Of these 57 patients, 31 were male and 26 were female. The mean age of those with GGO was 47.05±16.35 (21-82) years, 45.77±16.15 for men and 48.58±16.76 for women. In addition, the mean age of 36 subjects without GGO (19 males and 17 females) was 44.28±17.53 years. We analyzed the correlation of age and gender with GGO and found a weak negative correlation between age and GGO (r=-0.081, p=0.440). We also found a weak positive correlation between gender and GGO (r=0.016, p=0.881). When the right and left lungs were compared, the presence of GGO was observed in 56.18% of the right lung and 43.82% of the left lung (Figure 2).

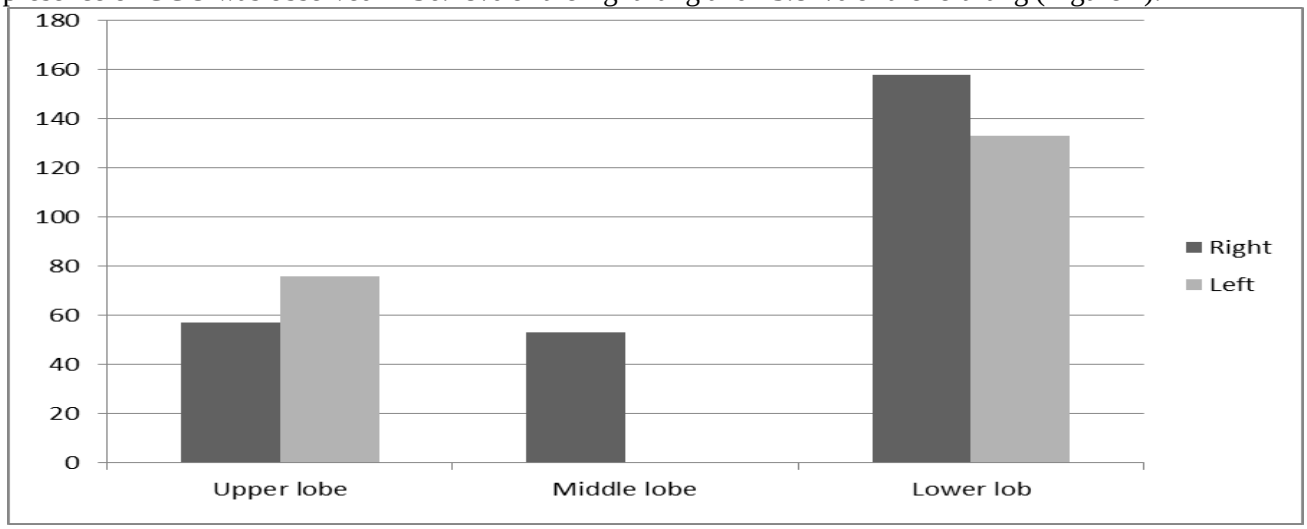

Figure 2. Distribution of ground glass opacities according to lobes in right and left lungs

The segmental distribution of GGO in the right lung was 21.27% in the upper lobe, 19.78% in the middle lobe and 58.95% in the lower lobe (Figure 3A). In addition, GGO density was observed in the posterior segment of the upper lobe (9.33%), lateral segment of the middle lobe (10.07%) and lateral (13.81%) and posterior (13.81%) segments of the lower lobe in the right lung (Figure 3A). In the left lung, the segmental distribution of GGO was 36.36% in the upper lobe and 63.64% in the lower lobe (Figure 3B). Furthermore, GGO density was observed in the superior lingular segment with a rate of 10.53% in the left lung upper lobe and in the posterior segment with a rate of 19.14% in the left lung lower lobe (Figure 3B).

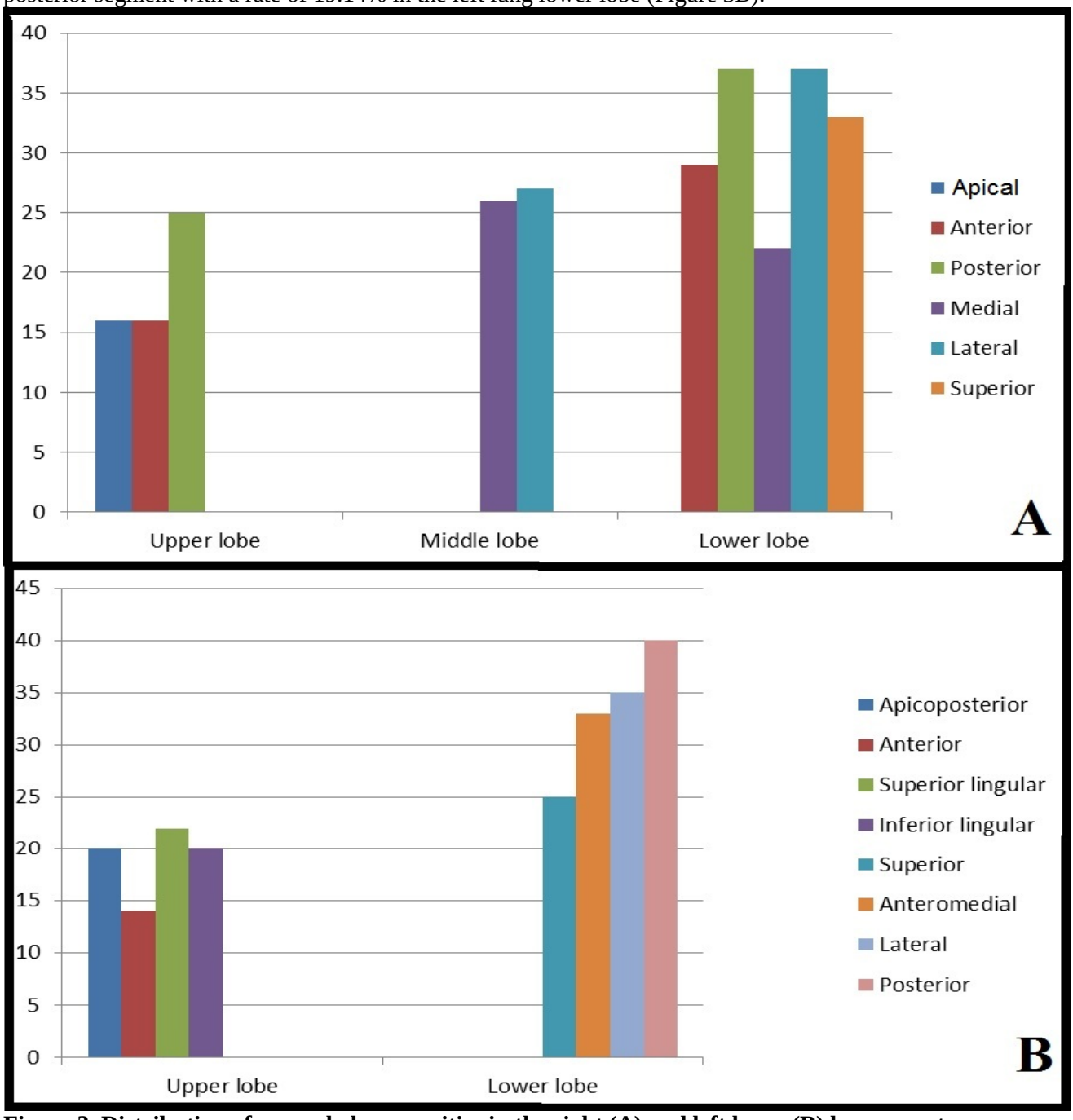

Figure 3. Distribution of ground glass opacities in the right (A) and left lungs (B) by segments

When the right and left lungs were compared by gender, GGO density was 50.17% in males and 49.83% in females in the right lung and 56.40% in males and 43.6% in females in the left lung (Figure 4).

In addition, the presence of GGO in the right lung was 11.94% in the upper lobe, 10.82% in the middle lobe and 33.96% in the lower lobe in men, compared to 9.33% in the upper lobe, 8.95% in the middle lobe and 25% in the lower lobe in women (Figure 5C). Furthermore, the presence of GGO in the left lung was 20.40% in the upper lobe and 33.83% in the lower lobe in men, compared to 17.41% in the upper lobe and 28.36% in the lower lobe in women (Figure 5A). On the other hand, the segmental density distribution of GGO in the right lung was 9.87% in the upper lobe posterior segment, 10.53% in the middle lobe lateral segment and 15.79% in

the lower lobe posterior segment in men (Figure 5D), compared to 8.62% in the upper lobe posterior segment, 11.21% in the middle lobe medial segment and 14.66% in the lower lobe posterior segment in women (Figure 5D). Similarly, the segmental density distribution of GGO in the left lung was 6.47% in the upper lobe apicoposterior segment and 11.44% in the lower lobe posterior segment in men (Figure 5B) and 5.97% in the upper lobe superior lingular segment and 8.46% in the lower lobe posterior segment in women (Figure 5B).

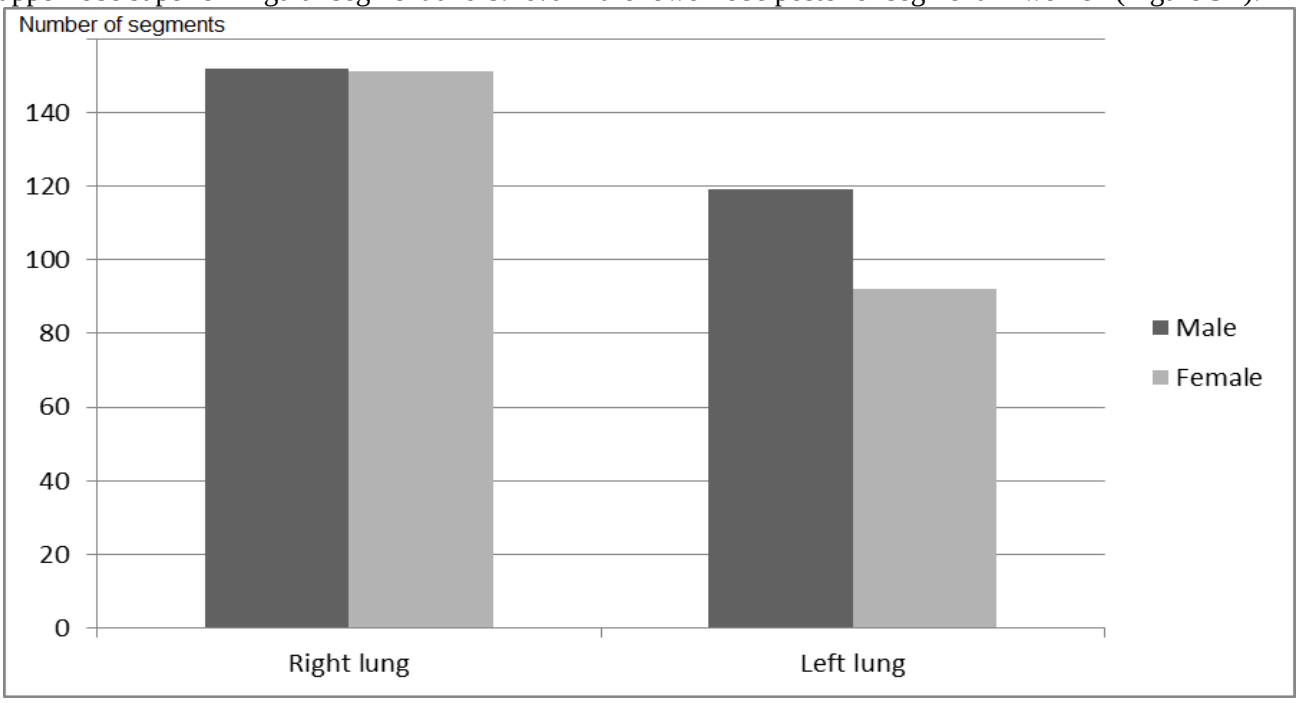

Figure 4. Distribution of ground glass opacities in the right and left lungs by gender

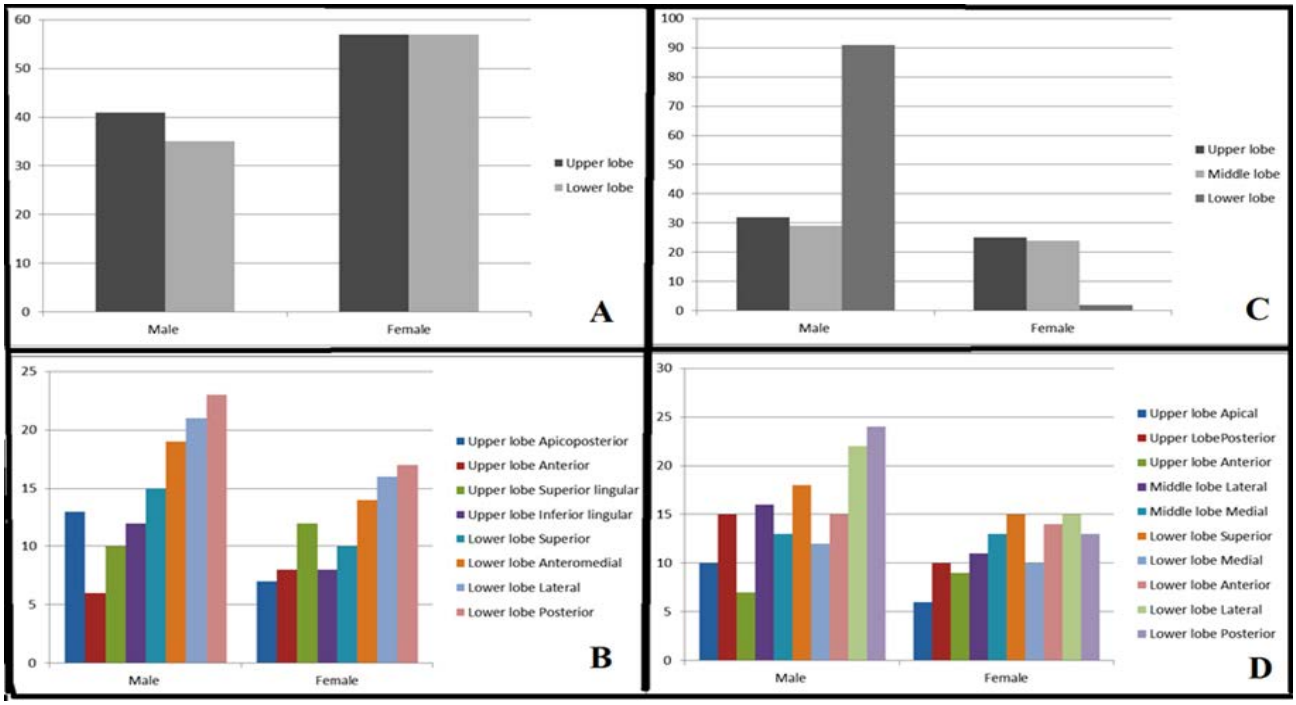

Figure 5. Distribution of ground glass opacities according to segments in the right (C and D) and left (A and B) lungs by gender

Discussion

The most common finding in the lungs during COVID-19 diagnosis is ground-glass opacities (GGO) (8). Therefore, we examined the pulmonary segmental distribution of GGO in our study. In this way, the presence of GGO in the right and left lungs was mostly seen in the lower lobe. In addition, more GGO was detected in the right lung than in the left lung. In the right lung, most glass opacities were observed in the lower lobe

posterior and lateral segments. In addition, the right lung upper lobe posterior segment and the middle lobe lateral segment had the most GGO appearance. On the other hand, the highest GGO in the left lung upper lobe was observed in the superior lingular segment. Similar to our study, it has been reported in the literature that the characteristic findings of COVID19 pneumonia are predominantly localized in the lower lobes (9). In addition, Salehi et al. (10) revealed that the posterior regions of the lungs were affected by COVID-19 with a rate of 80%. Similarly, Özmen's study showed that COVID-19 pneumonia is characterized by bilateral, peripheral, round GGO predominantly located in the posterior lower lobes (11). In another study, Litmanovich et al. (12) reported that GGO was commonly located in the lower lobe of the lung in their Chest Radiography Findings. These results were also consistent with our study. The predominant distribution of GGO in the lower lung can also be interpreted as findings specific to COVID-19 pneumonia, but may overlap with other infections, drug reactions, and other causes of acute lung injury. Conversely, the atypical appearance of the GGO image may indicate that COVID-19 may also affect other lung segments. Moreover, in our study, the condition of 36 COVID-19 patients without GGO may show that there is no sign of pneumonia. However, chest CT findings may also show that COVID-19 pneumonia may have disappeared in the early period.

Furthermore, when we evaluated by gender, GGO was most common in males. In addition, the right lung was most commonly involved in both sexes. In the right lung, men were mostly affected in the upper lobe posterior segment, middle lobe lateral segment and lower lobe posterior segment, whereas women were mostly affected in the upper lobe posterior segment, middle lobe medial segment and lower lobe lateral and superior segments. We also found that the apicoposterior segment of the upper lobe and the posterior segment of the lower lobe of the left lung were most affected in men, whereas the superior lingular segment of the upper lobe and the posterior segment of the lower lobe were most affected in women. However, we found that although the appearance of GGO was more common in men, the upper lobe of the right lung was more affected in women. Karacan et al. and Gu et al. examined the variability of chest CT findings of COVID-19 according to age and gender and found that older and male patients were more affected (13,14). In our study, similar to the literature, GGO was found more frequently in men. In addition, Xudong et al. similarly found that the distribution of lesions in the right lobe was higher in men in an artificial intelligence study conducted in young and middle age group (15). In conclusion, the results of our study before vaccination and the results of the studies in the literature after vaccination were found to be similar.

Study Limitations

The limitations of this study are that it was a single-center study, which limits its generalizability. The study was conducted before vaccines against COVID-19 became available, so the clinical situation and management of patients with severe COVID-19 may have changed, as fewer patients now progress to acute respiratory failure. Therefore, a limitation of our study is the absence of findings from the pre-vaccination period as well as post-vaccination period. Furthermore, the main limitation of this study is the inclusion of a small population. We recommend studies with a larger number of patients, using different methods and influencing factors (chronic disease, smoking, inflammation markers, etc.) to determine the severity of pulmonary involvement in the pre-vaccination period and post-vaccination period.

Conclusion

We found that the lower lobe of the right lung with the densest GGO image and the most affected right lung was found in COVID-19 patients. In addition, the lower lobe posterior segment was mostly affected in men, while the lower lobe superior and lateral segments were affected in women. Although many discoveries have been made regarding the pathogenesis and treatment of COVID-19, we believe that this study will be a source of data on the course of the disease in the medium and long term. We also believe that our study analyses will contribute to the rapid triage and evaluation of acute patients suspected of having COVID-19, as studies in the literature have done.

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Ethical Approval: *The study protocol was approved by the Cukurova University, Faculty of Medicine, Non-invasive clinical research Ethic Board (Date 07/04/2023, Meeting Number: 132/30).*

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