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Frequency of Congenital Aortic Arch Anomaly in COVID-19 Patients

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SUMMARY

OBJECTIVE: The aim of this study was to investigate the frequency of aortic arch anomaly in COVID-19 patients and to determine whether it will be included in the risk classification.

METHODS: The study was retrospectively conducted in a third-level hospital by scanning the contrast-enhanced thoracic computed tomography and thoracic computed tomography angiography examinations of patients who received PCR (+), hospitalization, and known COVID pneumonia between March 2020 and July 2021. The study consists of 88 cases and 88 control groups.

RESULTS: The study found that the frequency of aortic arch anomaly was higher in patients with COVID-19 pneumonia and in male patients with bovine-type anomaly.

CONCLUSIONS: The higher prevalence of bovine arch anomaly in COVID patients may be considered a risk factor for COVID-19 in individuals with this type of vascular anomaly.

KEYWORDS: COVID-19. CT angiography. Arch of the aorta.

INTRODUCTION

COVID-19 is a highly contagious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which is an infective strain. This virus is in the RNA genome structure, and it has been causing a pandemic all over the world since December 2019 and can cause a wide range of symptoms from mild to moderate signs such as dry cough, fever, and myalgia to severe clinical signs such as acute respiratory distress syndrome (ARDS)[1]. In addition, it is found that it also causes serious symptoms on the brain, heart, and liver[2]. As of November 2021, there have been 247 million cases and 5 million death reports worldwide (https://covid19.who.int/).

The following diseases are included in the content definition of chronic risk groups for COVID-19[3,4]:

- Advanced age (>65 years)
- Receiving immunosuppressive therapy (e.g., HIV, long-term steroid therapy)
- Metastatic cancer patients or receiving chemotherapy/radiotherapy
- Those with solid organ transplants, excluding cornea transplant
- Patients with bone marrow/stem cell transplantation
- Those with lung diseases such as chronic obstructive pulmonary disease (COPD), lung cancer, cystic fibrosis, pulmonary fibrosis, and moderate-to-severe asthma patients
- Insulin-dependent diabetes and its complications (i.e., cerebrovascular, coronary, renal, and polyneuropathy)
- Patients with non-insulin-dependent diabetes mellitus
- Patients with complicated hypertension (i.e., cerebrovascular, renal, and congestive heart failure)
- Cardiac patients with cardiomyopathy, pulmonary hypertension, congenital heart diseases, heart failure, and coronary artery disease
- Patients with chronic liver disease or chronic renal failure
- Patients with cerebrovascular disease (e.g., stroke and bleeding)
- Patients with blood cell disease (e.g., sickle cell anemia and thalassemia patients)
- Down's syndrome

Thoracic vascular anomalies

Congenital thoracic vascular anomalies consist of a large group, which includes the thoracic aorta and its branches, pulmonary arteries, thoracic systemic veins, and pulmonary veins[5]. These anomalies can be either accompanied by congenital heart diseases or seen alone. These anomalies can be completely asymptomatic or they can create esophageal, take

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pressure effect, and create clinics that may be related to cardiovascular, respiratory, and nutrition[6].

No identification of the COVID-19 disease risk group has been made for congenital vascular anomalies and variations. In our study, the types and frequency of vascular anomalies of the arcus aorta in COVID-19 patients were investigated and predictions were made for the risk group.

Anomaly of the aortic arch and its variants

This group includes the left aortic arch, the right aortic arch, the double aortic arch, and the large vessel branching patterns[7]. The left aortic arch continues as the descending aorta, which crosses the left main bronchus at the level of the T5 vertebral corpus and descends to the left of the midline. Its incidence is found to be between 70 and 80%[7]. Among the large vessel anomalies branching from the left aortic arch, the most common is the bovine type of arcus anomaly. The frequency of bovine-type arch anomalies in the general population varies between 9 and 13%. An anomaly of the left vertebral artery of the aortic arch origin is observed in 5–6% of the population. Another frequent anomaly is the aberrant right subclavian artery anomaly with the left aortic arch, which is observed in 0.5–2% of the population[7].

Imaging methods have a very important place in the detection of these anomalies and in the preoperative evaluation[8]. Due to the advancement of technology, contrast-enhanced computed tomography (CT)/CT angiography and non-contrast-enhanced magnetic resonance imaging (MRI) examinations are now primarily selected from noninvasive methods. With these examinations, more detailed and three-dimensional images can be obtained[8].

Limitations

The study group may not fully reflect the general population due to the fact that there are inpatients diagnosed with COVID-19 and the contrast-enhanced thoracic CT and thoracic CT angiography examinations performed as an examination.

METHODS

This study was conducted in a third-line hospital, retrospectively, between March 2020 and July 2021, among 88 patients aged 18–90 years, who received PCR (+), inpatient treatment, and with known COVID pneumonia, and randomly selected 88 patients without a diagnosis of COVID-19 as control group. Ethics committee approval of the study was obtained with protocol number GOKA/2021/11/8. In the study, contrast-enhanced thoracic CT and thoracic CT angiography examinations were examined in both the patient and control groups. After contrast-enhanced thoracic CT examinations, contrast media, 5 mm thick sections were taken, and after 2.5 mm reconstructions, images were obtained in the lung parenchyma and mediastinal Windows. Thoracic CT angiography examinations were taken for thoracic structures after injection of contrast medium together with the test bolus, and images were obtained with 5 mm thick sections and 1 mm reconstructions.

Statistical analysis

SPSS version 21.0 package program was used for statistical analysis. Descriptive statistics are expressed as mean±standard deviation for continuous data and number and percentage distributions (%) for frequency data. The Shapiro-Wilk test was used to evaluate whether the data met the parametric conditions. Chi-square test was used in the comparison of categorical variables. Student's t-test for pairwise comparisons of independent groups and one-way analysis of variance (ANOVA) for comparisons of more than two groups were used to determine the difference between groups. In the evaluations, $p<0.05$ was accepted as the statistical significance level for all tests.

RESULTS

The study consists of a total of 176 patients, including 88 cases and 88 control groups. The mean age of the case group was 61, the mean age of the control group was 59, and the demographic (e.g., age and gender) data of the study are given in Table 1.

The frequency of vascular anomalies was found to be 34% (30) in the case group. Of these, 27 (31%) bovine arcus aortic anomalies and 3 (3%) other classified as vascular anomalies (2 left vertebral artery anomalies of aortic origin, 1 right aberrant subclavian artery anomaly) were detected. In the case group, 58 (66%) patients without vascular anomalies were found (Table 2).

The frequency of vascular anomalies in the control group was 21% (19). Of these, 17 (19%) bovine-type aortic arch anomalies and 2 (2%) classified as other types (2 left vertebral artery anomalies originating from the aorta) were found (Table 2). Although the frequency of vascular anomalies was higher in the case group, no statistically significant difference was observed ($p>0.05$).

Table 1. Demographic data.

	Case group		Control group	
	Average age	Count	Average age	Count
Male	60±14	60	58±13	52
Female	65±15	28	60±12	36
Total		88		88

Table 2. Vascular anomaly frequency distribution.

	Case group	Control group
Normal	58	61
Bovine-type archus anomaly	27	17
Anomaly of the left vertebral artery of aortic origin	2	2
Anomaly of the right aberrant subclavian artery	1	0

Table 3. Frequency distribution of vascular anomalies by gender.

	Case group		Control group	
	Male	Female	Male	Female
Bovine-type archus anomaly	22	19	10	7
Anomaly of the left vertebral artery of aortic origin	2	0	0	2
Anomaly of the right aberrant subclavian artery	1	0	0	0

When the vascular anomaly types and gender were compared in the case group, the incidence of bovine-type anomalies was found to be 81% (22) in men and 19% (5) in women, showing male dominance to be statistically significant (p=0.02). In the classification as other type, all three cases were found to be male gender (Table 3).

When the vascular anomaly types and gender were compared in the control group, the frequency of bovine-type anomaly was 60% (10) in men and 40% (7) in women. In the classification made as other type, all two cases were found to be female and no statistically significant difference was observed between the genders (p>0.05) (Table 3).

In the case group, the average age of those with vascular anomalies was 64±14, and in control group it was 60±15, which is more advanced, but not statistically significant (p>0.05).

DISCUSSION

It is known that since the COVID-19 disease has been identified, patients with various risk factors are more likely to develop this disease and have a predisposing effect for COVID-19 pneumonia[3,4].

According to the VASCERN (European reference network for rare vascular diseases) vascular anomaly study group, there is no consensus on the risk of COVID-19 disease for people with vascular abnormalities; however, it has been stated that vascular anomalies that cause the heart, lungs, kidney, and liver to be affected may pose a high risk. For this reason, the occurrence of severe and severe effects of COVID-19 in people with complicated vascular anomalies caused by cardiac and lung diseases has been considered a high risk[9]. Microdeletions were found in *22q11.2* gene in thoracic midline anomalies, such as thymic hypoplasia, DiGeorge syndrome, conotruncal anomalies, truncus arteriosus, and tetralogy of Fallot. About 25–35% of thoracic arch anomalies have been found to have microdeletions in *22q11.2* gene, even without congenital cardiac defect[5,7]. This shows that there are some genetic defects in isolated arch anomalies. Likewise, the genetic basis of which has not yet been clarified, but also in COVID-19 patients, some mutations are also a factor in catching the disease and having a severe disease, which makes us think that it is effective in its reflection in the clinic.

In our study, the incidence of thoracic arch vascular anomalies is more common in COVID-19 patients, and the incidence of bovine type of arcus aortic anomaly is also higher in them (31%). According to Hanneman et al. and Priya et al., the normal prevalence of the bovine-type arch anomaly varies between 9 and 20%[7,8,10]. The higher prevalence of bovine-type arch anomaly in COVID patients can be considered a risk factor for COVID-19 disease in individuals with this type of vascular anomaly.

The frequency of bovine-type arch anomaly was higher in male gender COVID-19 patients. According to Jeffrey et al., more arc anomalies were detected in the male sex and are compatible with our study[5].

In our study, the prevalence and gender distribution of vascular arch anomalies, which were classified into "other" and seen less frequently, were similar to the general population[7,8].

CONCLUSION

As a result, it can be said that the incidence of thoracic arch anomalies is higher in COVID-19 patients. The fact that the population can be made with new studies to include larger patient groups and that additional imaging tests that do not cause radiation exposure, such as echocardiography, can be added to provide more objective data.

ETHICS APPROVAL

The study was obtained with protocol number GOKA/2021/11/8.

AUTHORS' CONTRIBUTIONS

MMA: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Writing – original draft. **MY:** Data curation, Investigation, Supervision, Validation, Resources.

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