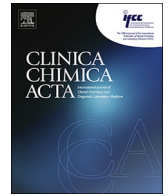




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## Relationship between ABO blood group distribution and clinical characteristics in patients with COVID-19



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### ABSTRACT

**Objective:** To explore ABO blood group distribution and clinical characteristics in patients with COVID-19.

**Methods:** The clinical data of 187 patients with COVID-19 seen between January 20, 2020 and March 5, 2020 at the First Hospital of Changsha were retrospectively analyzed. The differences in the ABO blood group distribution between COVID-19 patients and the control group (1991 cases) were analyzed. The relationship between blood type and clinical characteristics was analyzed.

**Results:** Of the 187 patients with COVID-19, 69 had type A (36.90%), 63 had type B (33.69%), 41 had type O (21.92%), and 14 had type AB blood (7.49%). The proportion of patients with type A blood in the COVID-19 group was significantly higher than that in the control group (36.90% vs. 27.47%,  $P = 0.006$ ), while the proportion of patients with type O blood in the COVID-19 group was significantly lower than that in the control group (21.92% vs. 30.19%,  $P = 0.018$ ). The risk of COVID-19 was higher for individuals with blood group A than for those with blood group O (OR = 1.849, 95% CI = 1.228–2.768,  $P = 0.003$ ). The risk of COVID-19 was higher for patients with blood group A than for those with a blood group other than A (OR = 1.544, 95% CI = 1.122–2.104,  $P = 0.006$ ). Patients with blood group O had a lower risk of COVID-19 than non-O blood group patients (OR = 0.649, 95% CI = 0.457–0.927,  $P = 0.018$ ). The ABO blood group distribution was related to COVID-19 status.

**Conclusions:** Patients with blood group A had an increased risk for infection with SARS-CoV-2, whereas blood group O was associated with a decreased risk, indicating that certain ABO blood groups were correlated with SARS-CoV-2 susceptibility. Blood type was related to some clinical characteristics of patients with COVID-19.

### 1. Introduction

Since December 2019, many cases of pneumonia caused by the novel coronavirus have been discovered in Wuhan, Hubei Province. The disease has been officially named coronavirus disease 2019 (COVID-19) by the WHO [1]. With the spread of the disease, many cases have been found in other parts of China and abroad [2]. The novel coronavirus is related to the viruses that cause the deadly diseases severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) [3]. Huang *et al.* [4] first reported 41 COVID-19 cases, most of which had been contracted at the Huanan Seafood Market. The clinical manifestations included fever, cough, dyspnea, myalgia, fatigue, a normal or decreased white blood cell count, and evidence of pneumonia on imaging. Scholars at home and abroad have conducted research on the association between blood groups and viruses and found that blood

groups show associations with certain viral infections. Scholars at home and abroad have reported the association of blood type with rotavirus, noroviruses (NoVs), dengue virus, Norwalk virus and hepatitis B virus [5–8]. The human blood type has been used as a genetic marker. By studying the relationship of human blood type with virus infection, it is possible to determine the susceptibility to the virus of people with different blood types. We collected samples from 187 COVID-19 patients at the First Hospital of Changsha for this article, analyzed the ABO blood group distribution, and compared the ABO blood group distribution of the patient group with that of the control group. Then, we explored the ABO blood group distribution and clinical characteristics of COVID-19 patients.

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## 2. Methods

### 2.1. Data sources

The medical records of patients were analyzed by the research team of the Third Xiangya Hospital of Central South University and the First Hospital of Changsha. Data on clinical characteristics were obtained with data collection forms from electronic medical records. The data were reviewed by a trained team of physicians.

### 2.2. Study design

This was a retrospective case-control study. The medical records of 187 patients with COVID-19 were divided into 4 groups, A, B, O, and AB, according to different ABO blood types. The ABO blood group distribution of the 187 patients was analyzed and compared with the ABO blood group distribution of the control group. The general conditions and clinical characteristics of 187 patients with COVID-19 were analyzed.

The ABO type of each patient was retrieved from the ABO blood type database. Therefore, the case group consisted of Han Chinese individuals with known blood types who had received a diagnosis of COVID-19 and who were hospitalized in or discharged from The First Hospital of Changsha between January 20, 2020 and March 5, 2020. The control group consisted of all non-COVID-19 Han Chinese patients with determined blood types who were hospitalized between January 2019 and February 2020; for subjects with multiple admissions, only the first was considered.

The study was approved by the Ethical Committee of The First Hospital of Changsha. Due to the retrospective nature of the study and because no identifying information relating to participants was included, written informed consent was waived. All experimental protocols were conducted according to the Strengthening of the Reporting of Observational Studies in Epidemiology guidelines.

### 2.3. Statistical analysis

Statistical computations were performed using GraphPad Prism 7. Data were analyzed with the  $\chi^2$  test and Fisher's exact test. ORs with 95% CIs for specific blood types in COVID-19 patients were assessed with logistic regression models.  $P < 0.05$  was considered statistically significant.

## 3. Results

### 3.1. Comparison of the ABO blood group distribution of 187 patients with COVID-19 and the blood group distribution of the control group

The ABO blood group distribution of 187 patients with COVID-19 revealed that there were 69 patients with type A blood (36.90%), 63 patients with type B (33.69%), 41 patients with type O (21.92%), and 14 patients with type AB (7.49%). Among the blood types, type A was the most common, and type AB was the least common (Table 1). The COVID-19 patient group contained higher percentages of individuals with type A and B blood than the control group. The proportion of patients with COVID-19 with type A blood was significantly higher than the proportion of controls (36.90% vs. 27.47%,  $P = 0.006$ ), while the proportion of patients with COVID-19 with type O blood was significantly lower than the proportion of controls (21.92% vs. 30.19%,  $P = 0.018$ ). The risk of COVID-19 was higher in patients with blood group A than in those with blood group O (OR = 1.849, 95% CI = 1.228–2.768,  $P = 0.003$ ). The risk of COVID-19 was higher in patients with blood group A than in those with other blood groups (OR = 1.544, 95% CI = 1.122–2.104,  $P = 0.006$ ). Patients with blood group O had a lower risk of COVID-19 than patients with other blood group types (OR = 0.649, 95% CI = 0.457–0.927,  $P = 0.018$ )

**Table 1**

Comparison of the ABO blood group distribution between 187 patients with COVID-19 pneumonia and the control group.

	COVID-19	Control group	$\chi^2$	P
Subjects, n	187	1991		
Blood group, n				
A	69(36.90)	547(27.47)	7.486	0.006*
B	63(33.69)	644(32.35)	0.141	0.707
O	41(21.92)	601(30.19)	5.611	0.018*
AB	14(7.49)	199(9.99)	1.219	0.270
Blood group, OR (95% CI)				
A—B	1.289(0.904–1.848)	—	1.923	0.166
A—O	1.849(1.228–2.768)	—	9.134	0.003*
A—AB	1.793(0.992–3.308)	—	3.763	0.052
B—O	1.434(0.959–2.166)	—	3.014	0.083
B—AB	1.391(0.762–2.552)	—	1.167	0.280
O—AB	0.970(0.513–1.761)	—	0.009	0.923
A—Non-A	1.544(1.122–2.104)	—	7.486	0.006*
B—Non-B	1.063(0.773–1.457)	—	0.141	0.707
O—Non-O	0.649(0.457–0.927)	—	5.611	0.018*
AB—Non-AB	0.729(0.409–1.251)	—	1.219	0.270

Data are n (%) unless specified otherwise. COVID-19 = Coronavirus disease 2019.

\* Means the result have statistically significance.

(Table 1).

### 3.2. Relationship between the ABO blood group distribution and the clinical characteristics of patients with COVID-19

By analyzing 187 patients with COVID-19, we found a correlation between the ABO blood group distribution and fever. In terms of symptom distribution, fever was more common in patients with certain blood types [patients with fever had type A (85.51%), type B (76.19%), type O (53.66%), and type AB blood (57.14%),  $P = 0.002$ ]. The ABO blood group distribution was also related to cough. In terms of the symptom distribution, cough was associated with certain blood types [patients with cough had type A (71.01%), B (57.14%), O (43.90%), and AB blood (71.43%),  $P = 0.031$ ].

The ABO blood group distribution was significantly related to dyspnea. Patients with type A, B, and O blood were less likely to present with dyspnea [patients with dyspnea had type A (42.03%), type B (15.87%), type O (31.71%), and type AB blood (50.00%),  $P = 0.005$ ]. The ABO blood group distribution was also related to sore throat. Patients with all blood types were less likely to present with sore throat [patients with sore throat had type A (33.33%), type B (7.94%), type O (29.27%), and type AB blood (21.43%),  $P = 0.004$ ]. The ABO blood group distribution was significantly related to fatigue. Patients with type A and O blood were more likely to present with fatigue (patients with fatigue had type A (60.87%), type B (47.62%), type O (56.10%), and type AB blood (14.29%),  $P = 0.012$ ). There was no significant difference between the patients in different blood groups ( $P > 0.05$ ) (Table 2).

## 4. Discussion

The ABO blood group system mainly involves the A and B antigens and their corresponding antibodies. The antigen-encoding gene is located on chromosome 9q34.1–34.2. It consists of the A, B, and O alleles, and there are a total of 4 genetic phenotypes (A, B, O, and AB blood types) [9,10]. Differences in blood group antigen expression can increase or decrease host susceptibility to many infections. Blood group antigens can play a direct role in infection by serving as receptors and/or coreceptors for microorganisms, parasites, and viruses. In addition, many blood group antigens facilitate intracellular uptake, signal transduction, or cell adhesion through the organization of membrane microdomains. Blood group antigens can modify the innate immune

**Table 2**  
Relationship between the ABO blood group distribution and clinical characteristics in patients with COVID-19 pneumonia [n (%)].

Factor	ABO blood group				$\chi^2$	P
	A	B	O	AB		
<b>Age</b>						
< 40	22(31.88)	25(39.68)	14(34.15)	8(57.14)	3.553	0.314
≥ 40	47(68.12)	38(60.32)	27(65.85)	6(42.86)		
<b>Gender</b>						
Male	35(50.72)	33(52.38)	22(53.66)	7(50.00)	0.115	0.990
Female	34(49.28)	30(47.62)	19(46.34)	7(50.00)		
<b>Fever</b>						
Yes	59(85.51)	48(76.19)	22(53.66)	8(57.14)	15.460	0.002*
No	10(14.49)	15(23.81)	19(46.34)	6(28.56)		
<b>Cough</b>						
Yes	49(71.01)	36(57.14)	18(43.90)	10(71.43)	8.909	0.031*
No	20(28.99)	27(42.86)	23(56.10)	4(28.57)		
<b>Sputum production</b>						
Yes	17(24.64)	14(22.22)	17(41.46)	5(35.71)	5.478	0.140
No	52(75.36)	49(77.78)	24(58.54)	9(64.29)		
<b>Dyspnoea</b>						
Yes	29(42.03)	10(15.87)	13(31.71)	7(50.00)	12.890	0.005*
No	40(57.97)	53(84.13)	28(68.29)	7(50.00)		
<b>Myalgia or fatigue</b>						
Yes	14(20.29)	7(11.11)	3(7.32)	3(21.43)	4.714	0.194
No	55(79.71)	56(88.89)	38(92.68)	11(78.57)		
<b>Headache</b>						
Yes	13(18.84)	16(25.40)	4(9.75)	2(14.29)	4.193	0.241
No	56(81.16)	47(74.60)	37(90.24)	12(85.71)		
<b>Sore throat</b>						
Yes	23(33.33)	5(7.94)	12(29.27)	3(21.43)	13.160	0.004*
No	46(66.67)	58(92.06)	29(70.73)	11(78.57)		
<b>Chest pain or chest distress</b>						
Yes	11(15.94)	9(14.29)	3(7.32)	5(35.71)	6.693	0.082
No	58(84.06)	54(85.71)	38(92.68)	9(64.29)		
<b>Fatigue</b>						
Yes	42(60.87)	30(47.62)	23(56.10)	2(14.29)	10.910	0.012*
No	27(39.13)	33(52.38)	18(43.90)	12(85.71)		
<b>chronic underlying diseases</b>						
Yes	33(47.83)	22(34.92)	18(43.90)	5(35.71)	2.544	0.467
No	36(52.17)	41(65.08)	23(56.10)	9(64.29)		

Data are n (%) unless specified otherwise. COVID-19 = Coronavirus disease 2019.

\* Means the result have statistically significance.

response to infection [11]. In this study, we demonstrated that patients with blood group A were at increased risk of SARS-CoV-2 infection, whereas patients with blood group O had a lower risk, indicating that the ABO blood group was correlated with SARS-CoV-2 susceptibility. The ABO blood group distribution also contributed to significant differences for other viral infections in previous studies. Zhanna Kaidarova and other researchers found that genetic susceptibility places individuals with blood groups A and D at increased risk for the development of severe disease outcomes after West Nile virus infection [12]. Genetic susceptibility to norovirus is largely dependent on the presence of histo-blood group antigens (HBGA), specifically those corresponding to the ABO, secretor, and Lewis phenotypes [13]. Children with blood group A and AB were significantly more prone to rotavirus gastroenteritis than those with blood group O. The results confirm that an HBGA genetic background is linked to rotavirus susceptibility [14]. Cheng *et al.* reported that patients with blood group O had decreased SARS-CoV infection susceptibility [15]. Patrice *et al.* indicated that natural human anti-A antibodies might block the interaction between SARS-CoV and its receptor, thereby providing protection, which could explain why individuals with blood group A were more susceptible to SARS-CoV infection, while individuals with blood group O were not [16]. It can be speculated that the decreased susceptibility of individuals with blood group O and the increased susceptibility of individuals with blood group A to COVID-19 could be linked to the presence of natural anti-blood group antibodies, particularly anti-A

antibody, in the blood. However, there might be other mechanisms that require further study.

In this study, we found that the ABO blood group distribution was related to fever, cough, dyspnea, sore throat, chest pain/distress and fatigue. There were no significant differences between the other blood group patient groups ( $P > 0.05$ ). This indicated that blood type might have some influence on the clinical characteristics of patients with COVID-19. The clinical manifestations of people with different blood types after infection with COVID-19 were different.

This study had some limitations. First, the vast majority of patients diagnosed with COVID-19 were not tested to determine their blood group. We retested the patients who were not previously tested. Only 187 patients with COVID-19 were included in this study, which might lead to a certain bias in the results. Second, patients with undiagnosed COVID-19 could have been enrolled in the control group, and the study lacked a normal population group as a control. In summary, the blood group of individuals might not be one of the risk factors for COVID-19, but it was related to the clinical characteristics of patients with COVID-19.

#### Informed consent

Written informed consent was obtained from all subjects (patients) in this study.

#### Ethical approval

Institutional Review Board approval was obtained.

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#### CRediT authorship contribution statement

**Yuqin Wu:** Data curation, Writing - original draft. **Zhicai Feng:** Writing - review & editing. **Peng Li:** Investigation. **Qizhi Yu:** Conceptualization, Methodology.

#### Declaration of Competing Interest

The authors declare that there is no conflict of interest or financial disclosure related to this publication.

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