Research Article

Differences in Clinical Features and Laboratory Results between Adults and Children with SARS-CoV-2 Infection

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1. Introduction

Coronavirus Disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is highly contagious and has spread widely around the world. As of June 8, 2020, SARS-CoV-2 has caused approximately 6.8 million infections and more than 380,000 deaths worldwide. However, the proportion of SARS-CoV-2 infection and death in children is relatively low. A survey of 45,000 COVID-19 patients in China showed that about 98% of the infected people were adults, and the remaining 2% were children of 1-19 years old [1]. Similarly, among the confirmed patients reported in the United States, the population under the age of 18 accounted for only 1.7% [2]. In addition to SARS-CoV-2, during 2002-2003 SARS-CoV and 2012 MERS (Middle East Respiratory Syndrome Coronavirus) epidemic,
children’s risk of coronavirus infection was also low (SARS was about 2%, while MERS was even lower) [3, 4]. Compared with adults, children usually have mild and asymptomatic SARS-CoV-2 infection, with lower viral load [5]. In addition, the symptoms of SARS-CoV-2 infection in children are different from those in adults, which are mostly characterized with fever, cough, or shortness of breath [6, 7].

The S protein of SARS-CoV-2 binds to the angiotensin-converting enzyme (ACE2) receptor on respiratory tract epithelial cells, and thus, the virus can enter the cells [8]. As the immune system gradually matures with age, the expression of ACE2 receptors also increases [9]. This could explain the lower number of SARS-CoV-2 infections in children. The ACE2 expression is higher in SARS-CoV-2-infected children as compared with noninfected children [10]. At present, there are few reports on the clinical characteristics and epidemiology of SARS-CoV-2 infection in children.

In this study, we retrospectively compared the differences between children and adult patients with COVID-19. Their clinical characteristics, number of SARS-CoV-2 positive days, laboratory results, and chest computed tomography (CT) performance were analyzed.

2. Materials and Methods

2.1. Study Design and Subjects. This retrospective study was approved by the Ethics Committee of Shenzhen Hospital of Southern Medical University, Shenzhen, China. The data were anonymous, and informed consent was therefore waived. We included 52 patients who were diagnosed with COVID-19 from February 1 to March 20, 2020, and were hospitalized in Shenzhen until 2 consecutive SARS-CoV-2 nucleic acid negative tests results were obtained. Patients were then transferred to Shenzhen Hospital of the Southern Medical University. Among them, 14 were children and 38 were adults. The COVID-19 was diagnosed based on “Diagnosis and Treatment of Pneumonia Caused by Novel Coronavirus (Trial Version 5)” and “Diagnosis, Treatment, and Prevention of 2019 Novel Coronavirus Infection in Children: Experts’ Consensus Statement” [11, 12]. The inclusion criteria were as follows: nasal/pharyngeal swab tested positive for SARS-CoV-2 nucleic acid, epidemiological and clinical history, and positive results for SARS-CoV-2-specific IgM and IgG antibodies. The exclusion criteria were as follows: negative SARS-CoV-2 nucleic acid test; patients with dysfunction of the heart, liver, kidney, or brain. For clinical classification, asymptomatic cases were individuals infected by SARS-CoV-2 who remain asymptomatic throughout the course of the infection with or without abnormal chest CT imaging findings. Mild COVID-19 was defined when there were mild clinical symptoms (such as slight fever and fatigue) and no features of pneumonia on imaging. Common COVID-19 was defined when there were symptoms of fever and respiratory symptoms (such as dry cough and running nose) and features of pneumonia on imaging.

2.2. Data Collection. The basic clinical information of patients were collected, including epidemiological history, clinical symptoms, number of SARS-CoV-2 nucleic acid-positive days, laboratory indicators including white blood cell count (WBC), neutrophil percentage (NEUT%), neutrophil absolute value (NEUT#), lymphocyte percentage (LYMPH%), lymphocyte absolute value (LYMPH#), platelet (PLT), alanine aminotransferase (ALT), aspartate aminotransferase (AST), AST/ALT, C-reactive protein (CRP), prothrombin time (PT), activation partial thrombin time (APTT), fibrinogen (FIB), D-dimers, and chest CT findings. All data were obtained from the Electronic Medical Record System of Shenzhen Hospital of Southern Medical University.

2.3. Detection of SARS-CoV-2-Specific Antibodies. SARS-CoV-2-specific IgM/IgG antibodies were detected on Time-Resolved Immuno-fluorescence Analyzer by Fluorescence immunochromatographic assay method (Lot: 20200214, Beijing Diagreat Biotechnologies Co., Ltd., Beijing, China). The cut-off value of IgM and IgG was 0.88 and 1.02, respectively. The results were shown as fluorescence intensity (Flu).

2.4. Statistical Analysis. All data were analyzed with SPSS 16.0 statistical software. Measurement data were displayed as the mean ± standard deviation (SD) and compared with an independent sample t-test. The count data was analyzed using a chi-square test. The correlation was analyzed by Spearman. A P value < 0.05 was considered statistically significant.

3. Results

3.1. Baseline Clinical Characteristics of Patients. A total of 52 patients with COVID-19 were included in this study. There were 38 adults, including 22 males and 16 females, with a median age of 36 years (range 19–66 years) (Table 1). In addition, there were 14 children, including 6 males and 8 females, with a median age of 6.33 years (range 0–15 years). In the adult group, 27 (71.05%) cases had a history of epidemiological exposure, and 9 (23.68%) cases had infections related to family clustering. However, 12 (85.71%) cases in the children group had a history of epidemiological exposure, and 7 (50%) cases had infections of family clustering. There was no statistically significant difference between the two groups in epidemiological exposure history and family cluster infections (P = 0.470 and P = 0.068, Table 1).

3.2. Symptoms. The most common symptoms of the patients were fever and cough (Table 1). In the adult group, 16 (42.11%) patients had fever, 13 (34.21%) patients had cough, and 6 (15.79%) patients had throat discomfort, 4 (10.53%) patients each had fatigue and diarrhea, 3 (7.89%) cases each had headache and chest pain, and 1 (2.63%) case had runny nose and loss of taste (Table 1). Shortness of breath was not reported in the adult group. In the children group, there were 8 cases with fever (57.14%), 6 cases with cough (42.86%), 2 cases with expectoration (14.28), and 1 case each (7.14%) with fatigue, runny nose, shortness of breath, and diarrhea (Table 1). The children group had no symptoms such as headache, dizziness, and loss of taste. There was no statistically significant difference in symptoms between the adult and children groups. There were 5 cases (13.16%) of
asymptomatic infections in the adult group and 4 cases (28.57%) of asymptomatic infections in the children group (Table 1).

3.3. Clinical Classification and Chest CT Performance. In the adult group, there were 29 patients with common infection (76.32%) and 9 patients with mild infection (23.68%) (Table 2). In the children group, there were 9 patients (64.29%) with common infection and 5 patients (35.71%) with mild infection. The difference between the two groups was not statistically significant ($P = 0.390$). In the adult group, 17 patients had ground-glass opacity (44.74%), 4 patients had local patchy opacity (10.53%), and 8 patients had multiple patchy ground glass opacities in bilateral lungs (21.05%), and none of the patients had consolidation (0%). In the children group, 3 patients had ground-glass opacity (51.43%), 1 patient had local patchy opacity (7.14%), 4 patients had multiple patchy ground glass opacity in bilateral lungs (25.57%), and 1 patient consolidation (7.14%). There was no statistically significant difference in CT results between the two groups ($P = 0.812$). In the adult group, there were 9 cases (23.68%) with unilateral lung involvement and 19 cases (50%) with bilateral lung involvement. However, in the children group, 3 cases (21.43%) had unilateral lung involvement and 6 cases (42.86%) had bilateral lung involvement. The difference between the two groups was also not statistically significant. Among the asymptomatic infections, 5 cases were adults (13.16%). Among them, 4 cases had ground-glass opacity and 1 case had multiple patchy opacities. Among the 4 cases of children (28.57%) with asymptomatic infections, there was 1 case with ground-glass opacity, 1 case with limited patchy opacity, 1 case with normal CT imaging, and 1 case with right lung middle lobe consolidation (Table 2). This case with right lung middle lobe consolidation was a female whose parents were diagnosed with COVID-19. She underwent chest CT examination due to the close contact history and later tested positive for SARS-CoV-2 nucleic acid.

3.4. Laboratory Findings. All 38 adults were positive for SARS-CoV-2 nucleic acid in nasal/pharyngeal swabs. However, 2/14 children cases were negative for SARS-CoV-2 nucleic acid in nasal/pharyngeal swabs, but tested positive for SARS-CoV-2-specific IgM and IgG. There were no statistically significant differences between the adult group and the children group in WBC, NEUT#, ALT, CRP, PT, APTT, FIB, D-dimer, and number of SARS-CoV-2-positive days (Table 3). However, the NEUT% of adults ($57.98 \pm 9.56$) was significantly higher than that of children ($38.36 \pm 14.92$) ($P < 0.001$). In addition, LYMPH%, LYMPH#, and PLT in adults were significantly lower than those of children, respectively ($30.81 \pm 9.06$ vs. $50.84 \pm 14.90$, $1.71 \pm 0.73$ vs. $3.94 \pm 2.12$, and $214 \pm 82.15$ vs. $317 \pm 115.17$, respectively) ($P < 0.001$, $P = 0.011$, and $P = 0.001$, respectively). The normal range of ALT and AST is 0-45 U/L. In the adult group, patients with elevated ALT accounted for 15.79% (6/38), and patients with elevated AST accounted for 5.26% (2/38). However, in the children group, patients with elevated ALT accounted for 7.14% (1/14), and patients with

| Symptom                          | Total Adults | Children | $P$ value |
|----------------------------------|--------------|----------|-----------|
| Fever                            | 24           | 16 (64.29%) | 8 (57.14%) | 0.335      |
| Cough                            | 18           | 13 (34.21%) | 6 (42.86%) | 0.524      |
| Expectoration                    | 2            | 0 (0%)    | 2 (14.28) | 0.288      |
| Dizziness                        | 1            | 1 (2.63%)  | 0 (0%)    | 0.426      |
| Headache                         | 3            | 3 (7.89%)  | 0 (0%)    | 1.000      |
| Fatigue                          | 5            | 4 (10.53%) | 1 (7.14%)  | 0.706      |
| Throat discomfort                | 6            | 6 (15.79%) | 0 (0%)    | 0.174      |
| Runny nose                       | 2            | 1 (2.63%)  | 1 (7.14%)  | 0.470      |
| Loss of taste                    | 1            | 1 (2.63%)  | 0 (0%)    | 0.426      |
| Shortness of breath              | 1            | 0 (0%)    | 1 (7.14%)  | 0.269      |
| Diarrhea                         | 5            | 4 (10.53%) | 1 (7.14%)  | 1.000      |
| Chest pain                       | 3            | 3 (7.89%)  | 0 (0%)    | 0.555      |
| Asymptomatic infection           | 9            | 5 (13.16%) | 4 (28.57%) | 0.373      |

3Table 1: Patient characteristics, exposure status, and clinical symptoms.

|                           | Total | Adults | Children | $P$ value |
|---------------------------|-------|--------|----------|-----------|
| Total                     | 52    | 38 (73.08%) | 14 (26.92%) | <0.001     |
| Age (median) (years)      |       | 36     | 6.33     |           |
| Gender                    |       |        |          |           |
| Male                      | 28    | 22 (57.89%) | 6 (42.85%) | 0.344      |
| Female                    | 24    | 16 (42.11%) | 8 (57.13%) |           |
| Epidemiological exposure history | 39    | 27 (71.05%) | 12 (85.71%) | 0.470      |
| Family clustering infection | 16    | 9 (23.68%)  | 7 (50%)   | 0.068      |
| Symptoms                  |       |        |          |           |
| Fever                     | 24    | 16 (42.11%) | 8 (57.14%) | 0.335      |
| Cough                     | 18    | 13 (34.21%) | 6 (42.86%) | 0.524      |
| Expectoration             | 2     | 0 (0%)   | 2 (14.28) | 0.288      |
| Dizziness                 | 1     | 1 (2.63%)  | 0 (0%)    | 0.426      |
| Headache                  | 3     | 3 (7.89%)  | 0 (0%)    | 1.000      |
| Fatigue                   | 5     | 4 (10.53%) | 1 (7.14%)  | 0.706      |
| Throat discomfort          | 6     | 6 (15.79%) | 0 (0%)    | 0.174      |
| Runny nose                | 2     | 1 (2.63%)  | 1 (7.14%)  | 0.470      |
| Loss of taste             | 1     | 1 (2.63%)  | 0 (0%)    | 0.426      |
| Shortness of breath       | 1     | 0 (0%)   | 1 (7.14%)  | 0.269      |
| Diarrhea                  | 5     | 4 (10.53%) | 1 (7.14%)  | 1.000      |
| Chest pain                | 3     | 3 (7.89%)  | 0 (0%)    | 0.555      |
| Asymptomatic infection    | 9     | 5 (13.16%) | 4 (28.57%) | 0.373      |
elevated AST accounted for 28.57% (4/14). The AST and AST/ALT in the children group were higher than those in the adult group, which were 39.37 ± 18.04 vs. 26.52 ± 12.95 and 2.37 ± 1.16 vs. 1.16 ± 0.56, respectively. These differences between the two groups were statistically significant (P = 0.006 and P < 0.001, respectively) (Table 3).

3.5. Correlation Analysis. In addition, correlation analysis showed that there was no correlation of mild or common clinical classifications with LYMPH%, LYMPH#, NEUT%, PLT, AST, and AST/ALT (Table 4).

4. Discussion

The World Health Organization reports that an average of 20%-30% of toddlers and school-age children are affected by seasonal influenza outbreaks every year [13]. Unlike the common viral respiratory infections in children such as respiratory syncytial virus, adenovirus, rhinovirus, and influenza virus, the proportion of children infected with SARS-CoV-2 is not high [1, 2, 14]. A study involving 1099 patients with COVID-19 [14] found that there were only 9 children aged 0-14 years old, accounting for 0.9%, including 8 mild patients and 1 severe patient. A
prospective multicenter observational cohort study in the United Kingdom recruited 651 children and young people (<19 years old) with SARS-CoV-2 [15]. The results showed that the all cause in-hospital case fatality rate was low at 1%, compared with 27% in the whole cohort of all ages (0-106 years) over the same time period. Another study from South Korea showed that 22% of 91 of all ages (0-106 years) over the same time period. showed that the all cause in-hospital case fatality rate (United Kingdom recruited 651 children and young people [30]. In this study, we found that PLTs in children were significantly higher than those in adults. Therefore, in children, the PLT damage caused by the virus is less than that in the adult group. These results were consistent with the clinical classifications and lymphocyte levels of the two groups.

The systemic response syndrome caused by COVID-19 is closely related to the activation of natural immunity and cellular immunity triggered by SARS-CoV-2 infection [31]. Most SARS-CoV-2-infected pediatric cases are mild or asymptomatic, and only a small portion of pediatric cases will develop a multisystem inflammatory syndrome several weeks after SARS-CoV-2 infection or exposure, with severe cardiac complications, including shock, hypotension, and acute heart failure [32, 33]. Understanding postinfectious immune responses in pediatric SARS-CoV-2 infection is critical for treatment and prevention, especially with

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**Table 4: Correlation analysis.**

| COVID-19 clinical classification | LYMPH% | LYMPH# | NEUT% | PLT | AST | AST/ALT |
|---------------------------------|--------|--------|-------|-----|-----|---------|
|                                 | $r = 0.020$ | $r = -0.221$ | $r = -0.066$ | $r = -0.147$ | $r = 0.125$ | $r = 0.062$ |
|                                 | $P = 0.889$ | $P = 0.116$ | $P = 0.640$ | $P = 0.298$ | $P = 0.379$ | $P = 0.661$ |

LYMPH%: lymphocyte percentage; LYMPH#: lymphocyte absolute value; NEUT%: neutrophil percentage; PLT: platelet; ALT: alanine aminotransferase; AST: aspartate aminotransferase.
multisystem inflammatory syndrome in children. Here, we describe the impact of SARS-CoV-2 infection on children and adults, specifically the impact of viral infection on lymphocytes, platelet, and organ dysfunction. The virus can directly induce a variety of proinflammatory signals through toll-like receptors and promote the activation of T lymphocytes. Activated T lymphocytes attack infected cells, leading to apoptosis and necrosis. When T lymphocytes cannot completely eliminate the virus, they activate a variety of inflammatory signaling pathways, leading to macrophage activation and secondary inflammation. When more inflammatory cytokines are released, it eventually causes more cell damage and necrosis. This vicious circle causes damage not only to the lungs but also to multiple organs of the liver, heart, and kidneys [34]. Recent studies on COVID-19 have shown [13, 14] that mild-to-moderate aminotransferase elevations are very common in patients with COVID-19, although there have been no reports of acute liver failure. The proportion of liver injury in severe COVID-19 patients is significantly higher than that in mild COVID-19 patients [13, 35]. A study of 138 inpatients in Wuhan [22] showed that the ALT and AST levels of COVID-19 patients in ICU were higher than those not admitted to ICU. In addition, ALT levels greater than 40 IU/L are associated with patient mortality [36]. Furthermore, elevated AST and bilirubin levels may be associated with an increased risk of progression to respiratory failure and death. Although the available data is not clear whether an elevated liver enzyme level is an independent predictor of poor prognosis for COVID-19, elevated aminotransferases are common in patients of ICU and patients with mechanical ventilation, meaning that increased aminotransferases are more common in severely ill patients. Therefore, elevated aminotransferase is associated with the severity of the disease. Our study found no significant differences in ALT levels between the adult and children groups. However, the AST and AST/ALT ratios of children were higher than those of adults. About 28.57% children had higher AST than the normal limit of 45 U/L, while the proportion in adults was 5.26%. The tests on ALT and AST were all performed before the application of antiviral therapy. Thus, the increase in AST is not likely to be induced by the drug. This may, to some extent, indicate that children with SARS-CoV-2 infection are more prone to liver cell damage. However, due to the small sample size of this study and the lack of literature reports on liver function impairments in children and adults, we cannot yet make a definite conclusion.

This study has some limitations. First, the number of included children was relatively small. Second, anal swab results were not analyzed. Therefore, whether there is the possibility of fecal mouth transmission in the family is unclear. Third, more cases are needed to confirm whether there is liver injury after SARS-CoV-2 infection in children.

In summary, SARS-CoV-2 infections in children are mostly family clustering infections and are mostly mild and asymptomatic infections. Thus, timely isolation of family members with a history of epidemiological exposure is important for protecting children from SARS-CoV-2 infection. In addition, even asymptomatic children should undergo SARS-CoV-2 nucleic acid testing and chest CT to further determine whether they are infected. Lymphocyte reduction is common in adults, but not in children, which may relate to the physiological characteristics of children and may explain why children are less likely to be infected with SARS-CoV-2 than adults. Moreover, attention should be paid to SARS-CoV-2 infected children with elevated transaminases.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Authors’ Contributions

Xiaoli Li and Yan Rong contributed equally to this work.

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