Gross Pathology in COVID-19

Subjects: Pathology

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The global infectious disease COVID-19 is caused by SARS-CoV-2, a new member of the Coronaviridae family. Though presented as a novel disease that primarily affects the respiratory system, multi-organ involvement has been well-noticed and documented since the beginning of the pandemic. When performed properly with adequate safety measures, autopsy provides the most valuable information to decipher the pathogenesis of this novel disease, therefore providing a basis for clinical management. In addition to reviewing the macroscopic changes in organs and tissues involved in COVID-19, the relevant microscopic alterations and possible pathogenesis are also discussed.

COVID-19 SARS-CoV-2 gross pathology autopsy post-mortem

Coronavirus disease (COVID-19), a novel seventh coronavirus disease, initially broke out in Wuhan, China, in December 2019 [1]. It quickly spread worldwide and became a pandemic, as declared by the World Health Organization in March 2020 [2]. As of Friday, 22 July 2022, more than 567 million have been affected, with more than 6.38 million deaths all over the world [3]. The unprecedented public health threat and the gravity of the situation have inevitably overwhelmed the healthcare system of many countries and created much turmoil and emerging challenges in many aspects of human life [4]. Social distancing has been used worldwide to limit the spread of the virus [5]. COVID-19 and its causative agent, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), have been studied extensively.

The Coronaviridae family viruses are enveloped, positive-sense, single-stranded RNA viruses [6]. Previously, six coronaviruses have been identified to cause human diseases. Two of them, severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV), can cause severe respiratory illness with fatality rates of 10% and 40%, respectively. In contrast, the other four usually cause mild upper respiratory diseases similar to the common flu [7][8].

SARS-CoV-2 is transmitted via inhalation or direct contact of the virus with the mucous membrane [9]. Like SARS-CoV, SARS-CoV-2 also binds to the angiotensin-converting enzyme 2 (ACE2) receptor primarily present on the surface of the alveolar epithelial cells in the lung, resulting in respiratory symptoms [7]. ACE2 is also found in the small intestinal epithelium, endothelial cells of blood vessels, alveolar macrophage and monocyte, and epithelial cells of trachea and bronchi, which may explain the multiple organ involvement in COVID-19 [7]. The virus contains four structural proteins: spike (S), envelope (E), membrane glycoprotein (M), and nucleocapsid phosphoprotein (N). The virus enters the cell via the interaction between the viral spike (S) protein and the host cell proteases, TMPRSS2 [10].

Like other coronaviruses, SARS-CoV-2 continuously develops mutations. Since the global outbreak, five major variants of concern (VOC) with increased transmissibility, varied virulence, evasion from therapeutic drugs, or decreased effectiveness of vaccines have been reported after the ancestral one. Those VOCs are alpha (B.1.1.7), beta (B.1.351), gamma (P.1), delta (B.1.617.2), and omicron (B.1.1.529) [11]. Selective pressures such as the use of monoclonal antibodies further drive the evolution of SARS-CoV-2, especially in immunocompromised patients [12].

Though often present as a mild disease with typical flu-like symptoms such as fever, cough, myalgia, or fatigue [13], about 19%, however, develop severe to critical disease that may result in progressive respiratory failure, presumably due to massive alveolar damage [5]. Deceased patients present with severe pneumonitis and advance to acute respiratory distress syndrome, often accompanied by multi-organ failure [14], which may be contributed by severe endothelial damage, disseminated intravascular coagulation, and a cytokine storm [15][16]. The severity and prognosis of the disease seem to be associated with age; gender; blood group A; cigarette smoking; obesity; and a variety of comorbidities, including coronary artery disease, diabetes mellitus, chronic kidney disease, hypertension, congestive heart failure, and chronic obstructive pulmonary disease [14][17]. Most fatal cases have significant underlying diseases, with systemic hypertension and diabetes mellitus being the most common [18]. Besides the comorbidities listed above, HIV infection and tuberculosis are common among COVID-19 decedents in Africa [19].

The complexity of COVID-19 has been made well aware of since its outbreak. It is a multiorgan disease that presents with a broad spectrum of clinical manifestations and a wide range of degrees of severity [13][14][20]. For example, autopsies have revealed the systemic multiorgan involvement of vessels in the lungs, heart, kidney, liver, GI tract, kidney, brain, and skin [21]. Gross examination of involved organs obtained from autopsy provides valuable information, which is imperative for elucidating the pathogenesis of COVID-19 and laying out the basis for clinical management.

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