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A Patient with Acute Cervical Cord Injury and COVID-19:

A First Case Report

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Abstract

During the pandemic of Coronavirus disease 2019 (COVID-19), it is possible for rehabilitation physicians and personnel to take care of patients with concurrent spinal cord injury (SCI) and COVID-19. Here, we describe a case of acute cervical SCI resulting in complete tetraplegia C5 American Spinal Injury Association (ASIA) Impairment Scale (AIS) A with unrecognized, acute respiratory syndrome coronavirus 2 (SAR-CoV-2) infection. This resulted in large-scale quarantines of related surgical and rehabilitation staff, and the unexpected death of the patient despite receiving the treatments according to the standard guideline. Rehabilitation personnel who take care of acute SCI patients with COVID-19 should consider the effect of SCI on the course of COVID-19, the effect of COVID-19 and its treatments on the course of SCI, and risks of SAR-CoV2 transmission between patients and rehabilitation staff, to continue providing safe and effective rehabilitation programs.

Keywords: spinal cord injury, COVID-19, coronavirus, tetraplegia, rehabilitation, case report

Acute cervical spinal cord injury (SCI) is a severe, life-threatening condition causing functional impairments and affects multiple body systems including the respiratory system.[1] Coronavirus disease 2019 (COVID-19) resulting from severe acute respiratory syndrome coronavirus 2 (SAR-CoV-2) infection, which is currently pandemic, also causes severe respiratory problems[2]. In this case report, we present a patient who had these two devastating health conditions concurrently, resulting in catastrophic consequences to both the patient and related healthcare staff.

This study conforms to all CARE guidelines and reports the required information accordingly (see Supplemental Checklist, Supplemental Digital Content 1, http://links.lww.com/PHM/B18). A 28-year-old, previously healthy man was transferred to an emergency room of a provincial hospital due to a motorcycle accident. He presented with preserved consciousness, but weakness and numbness of upper and lower extremities bilaterally were observed. CT scan of the cervical spine revealed a burst fracture of the C5 and C6 vertebrae with retropulsion of fragments. Sensory examination showed absent pinprick and light touch sensations below the C5 dermatome bilaterally. Manual muscle testing revealed grade 5 of biceps brachialis and grade 0 of all muscles below the C5 myotome of both sides. Digital rectal examination revealed absent deep anal pressure and voluntary anal contraction; anal and bulbocavernosus reflexes were absent. The diagnosis of C5-6 burst fracture with SCI resulting in complete C5 tetraplegia American Spinal cord Injury Association (ASIA) impairment scale (AIS) A was made. No abnormal ECG finding was noted on admission. A local protocol for screening COVID-19 in all patients before admission to the hospital, which was a set of questions asking for a history of being in an epidemic area or contact with the confirmed COVID-19 case, as well

as a symptom screen for respiratory tract infection, was applied. A patient under investigation (PUI) would be indicated if the patient had both history of exposure and symptoms consistent with COVID-19. Since no information regarding exposure and no respiratory tract symptom was detected, the patient was not included in the PUI group on admission.

Ten hours after injury, anterior cervical discectomy, and fusion with plates and screws and iliac bone grafting were performed. An endotracheal tube was immediately removed after the operation, and no immediate post-operative respiratory complication was detected.

On day 2 of admission, he was transferred to an orthopedic ward and a rehabilitation physician was consulted to prevent complications and maximize his function. Daily subcutaneous injection of 0.6 ml (60 mg) of enoxaparin was initiated for venous thromboembolism (VTE) prophylaxis. No mechanical prophylaxis of VTE was applied. The rehabilitation program consisted of range of motion and isometric strengthening exercises of bilateral elbow flexors was provided at the bedside.

On day 3 post-SCI, he complained of muscle pain in the neck and both shoulders and presented with low-grade fever, 37.8 °C. Acetaminophen was prescribed as a symptomatic treatment of fever. On day 4, it was the first time the possibility of COVID-19 was considered as his friend told that he stayed in an epidemic area of COVID-19 for two weeks before the accident. A nasal swab was done and the SAR-CoV2 RNA was identified with reverse transcriptase-polymerase chain reaction (RT-PCR) technique. The patient was then transferred to the COVID-19 cohort ward. Also, droplet precautions were applied. All related hospital staff

including rehabilitation personnel were investigated for SAR-CoV2 virus infection and the results were negative in all tested personnel. However, 104 hospital personnel had to be quarantined because of having close contact with the patient. Oral hydroxychloroquine and azithromycin were administrated according to the local COVID-19 treatment guideline.

On day 6, the patient developed high-grade fever, 39°C with mild dyspnea. The chest x-ray revealed mild thickening of left lower lung marking (Figure 1). The diagnosis of a mild degree of COVID-19 pneumonia was made. The oxygen saturation was 94% then non-invasive, 3 liters per minute, oxygen therapy was started, and it was effective to keep the patient's oxygen saturation more than 95%. A mechanical ventilator was not administrated since there was no characteristic of severe pneumonia. Oral lopinavir/ritonavir was added according to the local COVID-19 treatment guideline. On days 7-9, the patient was still febrile, but cooperative. No sign of progression of pneumonia was detected. The respiratory rate was 18-24 times/min and the oxygen saturation was 95-99% with non-invasive, 3 liters per minute, oxygen therapy. No extrapulmonary organ dysfunction was evident.

At 12.00 AM on day 10, his body temperature was 38°C, heart rate (HR) 72 /min, blood pressure 110/80 mmHg, respiratory rate 20/min, and oxygen saturation 95%. At 2.30 AM, the patient was found unconscious. His pulse was not detectable. An electrocardiogram showed asystole. Sudden cardiac arrest was diagnosed, and advanced cardiac life support was performed for an hour but failed. The patient was declared dead on day 10 of admission. Cervical spine injury leading to cervical cord injury was indicated as a cause of death in legal documentation, and the COVID-19 pneumonia was indicated as a comorbid condition. An autopsy was not

performed in this case due to safety and resource preservation issues during the COVID-19 epidemic period.

To our knowledge, this is the first case report describing COVID-19 in a patient with acute SCI. Although the exact cause of death in this patient has not been proven, which is the main limitation of this report, the differential diagnosis leading to death in this case is important to consider. The most common cause of death in patients with COVID-19 is reported to be acute respiratory distress syndrome (ARDS).[2,4]ARDS in COVID-19 is a result of severe COVID-19 pneumonia, indicated by definite pulmonary infiltration and severe hypoxemia. However, none of these findings were found in this patient. The characteristics of death in this patient were acute, unexpected cardiac arrest, or sudden death.[5] Sudden cardiac death is commonly due to ventricular arrhythmias.[5] The causes of ventricular arrhythmias in this patient could be divided into COVID-19 and non-COVID-19 related conditions. The COVID-19 related conditions are viral myocardial injury,[6,7] cardiac tamponade[8], and torsade de pointes from an underlying long QT syndrome superimposed by hydroxychloroquine and azithromycin use.[9,10] In this patient, myocarditis and cardiac tamponade are less likely since there were no symptom of severe dyspnea. Although torsade de pointes could not be ruled out since it could induce a sudden death without a prodromal symptom of dyspnea, it is less likely to be the cause of death since the ECG of the patient did not show a long QT interval.

A non-COVID-19 related cause of cardiac sudden death in this patient could be pulmonary embolism (PE),[5] which is commonly found in patients with acute SCI.[11,12] PE seems to be less likely as this patient had received the prophylactic dosage of enoxaparin when the

sudden death occurred. However, PE could still develop since this prophylactic dosage is lower than the treatment protocol for VTE.[11] Another possible cause of sudden death in cervical SCI patients is secretion obstruction from an inability to effectively produce cough.[13] However, this patient had never reported that he had sputum throughout the admission. Another possible non-COVID-19 cause of death in this patient is bradyarrhythmia, high degree atrioventricular (AV) block, or asystole. This condition is related to a disruption of the sympathetic pathway resulting from cervical SCI.[14] Cardiac dysrhythmias after SCI are primarily due to intact parasympathetic (vagal) control simultaneously with impaired supraspinal control of sympathetic system following cervical and high thoracic SCI. In this patient, the last record of HR before the cardiac arrest was 72 beats/min. Therefore, the cause of death might not be related to this issue.

This case raises four important issues that healthcare providers who take care of people with SCI need to consider. The first issue is about the effect of COVID-19 on the clinical course of SCI. Patients with acute SCI have a very high risk of venous thromboembolism (VTE).[11] Additionally, it was previously reported that COVID-19 could induce disseminated intravascular coagulopathy[15,16], as indicated by increased intravascular clotting markers (d-dimer).[15,16] Therefore, patients with acute SCI and concomitant disease of COVID-19 might be in the highest risk of developing VTE, including PE, which could be one of the suspected causes of sudden death in this patient, despite routine prophylaxis as PE should be a differential diagnosis in all acute SCI patients who abruptly develop dyspnea or in a severe case with a sudden loss of consciousness, regardless of COVID-19.

The second issue to consider is the effect of SCI on the clinical course of COVID-19. Cervical cord injury results in weakness or paralysis of extremities and trunk muscles, including respiratory muscles such as intercostal, pectoral, abdominal, or even diaphragmatic muscles. This respiratory muscle function impairment change reduces the vital capacity of the patient's lungs and decreases the ability to cough effectively.[13] Therefore, having COVID-19, patients with cervical cord injury might develop the symptoms of dyspnea and respiratory failure earlier than those without SCI. In this case, although the patient had a complete C5 tetraplegic condition when COVID-19 symptoms developed, the course of COVID-19 disease seemed not significantly different from those without SCI. This might be because he was young and had no underlying disease.

The third issue is about how to prevent SAR-CoV2 transmission between patients and health personnel including rehabilitation staff. In almost all rehabilitation services, rehabilitation physicians, nurses, and therapists are usually in close contact with the patients and they are at a very high-risk of droplet transmission, for example during swallowing evaluation and training, speech therapy, and chest physical therapy.[17] Since our screening method using the screening by self-report of the patient totally failed to detect the patient's true risk of COVID-19, we suggest that in this COVID-19 pandemic period, all SCI patients, either old or new, who are candidates for surgical and rehabilitation therapy should be intensively screened for SAR-CoV2 infection. Direct and indirect questions, regarding the symptoms and/or signs of COVID-19, as well as a history of living in the epidemic area or close contact with confirmed or suspected COVID-19 patients, should be asked. When indicated, a definite test should be done. All rehabilitation personnel should use personal protective equipment (PPE), according to the risk of the related

procedures and the recommendation of each hospital, to prevent an event of large-scale quarantine of medical providers, which aggravates the overwork of the healthcare system during this COVID-19 period.[17,18] Many patients who need rehabilitation services are elderly with multiple comorbidities, and at the highest risk of developing severe COVID-19.[17] To protect this group of patients, rehabilitation personnel should carefully protect themselves from SAR-CoV2 infection. In addition to the strict use of PPE, one should follow hospital recommendations, avoid traveling to epidemic areas, and frequently self-monitor for symptoms of COVID-19.

The last issue is regarding rehabilitation management in an epidemic area. Splitting the team and restricting movements between each other, as well as physical distancing policies, should be implemented to prevent contracting and spreading of infection to all staff.[17] Whenever possible, hospital-based rehabilitation services should be replaced with other alternatives such as home-based rehabilitation and telerehabilitation, based on safety, appropriateness, availability, and cost-effectiveness.[17,18]

In conclusion, during this COVID-19 epidemic period, acute SCI patients could have concurrent COVID-19. Therefore, rehabilitation personnel who take care of acute SCI patients with COVID-19 should always consider the effect of SCI on the course of COVID-19, the effect of COVID-19 and its treatment on the course of SCI, and risks of SAR-CoV2 transmission between patients and rehabilitation staffs, to continue providing safe and effective rehabilitation programs.

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Figure legends

Figure 1 Portable chest x-ray on the third day of COVID-19 symptoms (day 6 after SCI), revealed mild thickening of left lower lung markers.

Figure 1