Skeletal Muscle Damage in COVID-19

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Muscle dystrophy in COVID-19 entails loss of muscle mass and muscle strength, as well as suboptimal physical performance same as in cachexia and sarcopenia, albeit the loss in COVID is exaggerated. It is most evident in hospitalized patients during the acute phase by myalgia/muscle pain and fatigue, and it is associated with poor prognosis. It manifests in remitting COVID-19 patients by poor physical performance, slowness, fatigue and dyspnea while performing activities of daily living.

Keywords: coronavirus disease 2019 ; COVID-19 ; cytokine storm ; intensive care unit-acquired weakness ; older adults ; aging ; skeletal muscle ; musculoskeletal ; myoglobin ; rhabdomyolysis ; malnutrition ; severity

1. Possible mechanism of muscle damage in COVID-19

Older adults and people with chronic condition demonstrate Pre-COVID-19 frailty due to inflamaging, metabolic dysregulation, chronic subclinical inflammation, and decreased physical activity due to the lockdown measures associated with the COVID-19 outbreak. Given their high vulnerability, these individuals are highly likely to contract COVID-19, and they often express a severe course of the disease. The cytokine storms associated immune dysregulation in COVID-19 are accompanied by excessive release of reactive oxygen species (ROS). Both proinflammatory cytokines and ROS trigger generalized hypoproteinemia due to excessive protein degradation in major body stores of protein such as skeletal muscle. They also directly activate signaling responsible for skeletal muscle remodeling and atrophy such as myostatin.

Deficient diet along with gastrointestinal symptoms (e.g., vomiting and diarrhea) increase nutrient loss, which further aggravates muscular proteolysis to support body energy supply. Immobility, intubation, mechanical ventilation, and improper dietary formula associated with intensive care unit (ICU) stay along with certain drugs administered to severe patients in the ICU such as dexamethasone promote skeletal fiber remodeling resulting in a condition known as ICU-acquired weakness [1][2][3][4].

2. Evaluating/assessing skeletal muscle damage in COVID-19 patients

Severe patients with hypoproteinemia, hypercytokinemia, gastrointestinal symptoms, prolonged ICU stay, mechanical ventilation, remarkable weight loss, comorbidities, advanced age, receiving dexamethasone need regular evaluation of skeletal muscle condition [5][6][7].

Alterations in muscular biomarkers such as creatine kinase (CK), lactate dehydrogenase (LDH), and myoglobin—a heme-containing globular protein abundant in myocytes [8] signifiy further evaluation of muscle injury.

During the acute phase, skeletal muscle insult can be simultaneously depicted by evaluating Pectoralis muscle mass during routine examination for lung fibrosis by computed tomography. Pectoralis muscle index (cross-sectional areas of the pectoralis muscle/patient's height square (m^2)) is a valid frailty index that can predict pulmonary functioning, length of hospital stay and survival [9]. Magnetic resonance imaging (MRI) has been used to identify myositis in a case of in a case of COVID-19-related rhabdomyolysis [10].

Frequent measures of muscle loss in old age (sarcopenia) or diseased conditions (cachexia) such as dual-energy X-ray absorptiometry, total and partial body potassium, and bio-electrical impedance analysis may not reflect muscle loss in severe cases since they are confounded by body hydration and fat mass—obesity and edema are common in COVID-19 patients [5][11]. Spirometry, grip strength, six-minute walk test, physical performance (one-min sit-to-stand and short physical performance battery tests), and cardiopulmonary exercise test can reflect muscle insult in recovering patients [12][13].

3. Options for minimizing, preventing, and treating muscle damage in COVID-19 patients

High protein supplementation may prevent skeletal muscle protein degradation [14][15], which occurs in malnutrition as a source of energy [16]. Milk proteins in particular can enhance anabolism and muscular performance [17]. Phenols from bioactive compounds such as propolis may improve the delivery of proteins and amino acid to skeletal muscle [18]. Bioactive compounds with reported effect on gut microbiome dysfunction, neuronal and vascular integrity, as well as characteristics of skeletal muscle fiber such as bee products (e.g., honey, propolis, and royal jelly) may counteract oxidative stress and inflammation [18][19][20]. Neuromuscular electrical stimulation—inducing muscle contraction by applying small electrical impulses—is suggested to be used to maintain muscular blood flow, reduce muscle atrophy, and improve muscle strength in ICU-admitted COVID-19 patients [21].

4. Conclusion

Aging and chronic diseases are associated with malnutrition, oxidative stress, and inflammation, which facilitate muscle degradation. Muscle damage may be detected by CT regularly performed to screen for pulmonary injury in COVID-19. Nutritional interventions involving high protein diet and bioactive compounds may revert pathologies that contribute to muscle damage.

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