LETTER TO THE EDITOR

Strengthening with Blood Flow Restriction: Can it be a Useful Option in the Rehabilitation of Patients with Coronavirus?

Dear Editor

The special issue published by Archives of Bone and Joint Surgery in April 2020 on "COVID-19" has managed to bring together in a single volume a great deal of knowledge that is very useful for the management of musculoskeletal problems of patients who have been infected by the COVID-19, including the rehabilitation of those patients who have been most severely affected, i.e. those admitted to the Intensive Care Unit (ICU) (1-4).

In this "Letter to the Editor" we want to add to that knowledge the possible usefulness of exercise and strengthening with blood flow restriction (BFR) as a means of treatment for the weakness acquired in the ICU.

Severe acute respiratory syndrome coronavirus-2, known as COVID-19, is a new coronavirus that was discovered in December 2019 in the Wuhan region of China (5). On March 11, 2020, the World Health Organization declared a global pandemic, and as of April 22, 2020, the virus is responsible for over 2.5 million infections and 170,000 deaths.

The majority of infected patients (approximately 80%) experience mild clinical manifestations, the most frequent being fever, cough and dyspnea (3, 6). However, a small percentage present a severe clinical picture, especially if they are older than 65 years or have comorbidities such as diabetes or hypertension (3, 7). Of these patients, who typically require hospitalization, a high proportion (20.3%) will require admission to an ICU, the most common reason being severe acute respiratory syndrome (SARS) (32.8%) (8).

Weakness acquired in the ICU is a frequent pathology (25%–100%) in patients who have experienced SARS (9). Polyneuropathy (25%–46%) and myopathy (48%–96%) are also common in critical patients (3, 10). These conditions result in a significant reduction in strength, with a significant worsening of functional independence and quality of life in the medium to long term. Rehabilitation of these patients, based primarily on therapeutic physical exercise, is the fundamental treatment for achieving functional recovery (1, 4).

On the other hand, given there is as yet no known effective treatment against the virus, one of the main measures adopted by various countries to stop its spread is home confinement of the population and massive limitation of movement. Due to the quarantine situation in many countries, levels of physical activity are decreasing in an alarming manner. This is particularly worrying for older people, given we know that muscle mass decreases with age at a rate of 3%–8% from the age of 30 onward (11).

When this loss of muscle mass is combined with a decrease in strength, it is called sarcopenia. Sarcopenia produces significant metabolic and functional impairments and is associated with increased mortality (12). The most effective strategy to combat this process is use of resistance exercise with progressive loading, with load-bearing exercise the most effective (13, 14). However, these programs are poorly tolerated by the elderly because of the mechanical stress involved.

Exercise and strengthening with BFR as a means of treatment has been employed since the second half of the 20th century. Today, exercise is an essential part of rehabilitation programs. Recently, BFR strengthening exercises have been incorporated into the techniques used for muscle training. They are based on the execution of exercises with small loads (20%–30% of a maximum repetition), using a tourniquet adjusted in the upper extremity area (thigh or arm). This tourniquet is typically a pneumatic cuff with an elastic band. The advantage of this technique is that it provides the benefits of strengthening with heavy weights [70%-85% of 1 maximum resistance (MR)], but with better tolerance, by using a smaller load (15, 16).

In many elderly patients, high-intensity strengthening exercises cannot be performed due to the presence of other pathologies, such as cardiovascular disease, diabetes, and musculoskeletal pathology (17). Currently, thousands of patients affected by COVID-19 present with severe respiratory pathology and are expected to have significant clinical and physical impairment.

The effectiveness of BFR strengthening has been

Corresponding Author: E. Carlos Rodriguez-Merchan, Department of Orthopedic Surgery, "La Paz" University Hospital-IdiPaz, Paseo de la Castellana, Madrid, Spain
Email: ecrmerchan@hotmail.com

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observed in studies of patients with osteoarthritis of the knee or who have undergone ligamentoplasty (18). It also appears to further improve pain in patellofemoral syndrome at 8 weeks compared with a conventional strengthening program (19). Shariyate and Kachooei have recently reported hip fractures in COVID-19 patients following falling due to weakness. They postulated that weakness as a symptom after COVID-19 infection leads to higher rate of falling and consequently higher rate of hip fractures and mortality (20). This means that we have to consider this symptomatic complication and take steps to manage and prevent the complications, probably by using FBR (20).

BFR strengthening appears to be equally as effective as high-load training at the level of muscle mass gain, although it is somewhat less effective at the level of strength gain. This benefit is probably due to an increase in metabolic stress due to ischemia in the muscle (21). One study found an increase in lactate concentration after a BFR program and low resistance comparable to a high resistance program (22). In addition, muscle ischemia can facilitate the recruitment of motor units during training. The compression cuff causes a reduction in the availability of oxygen to the muscle and an accumulation of metabolites, which can lead to increased recruitment of fast muscle fibers (23). Low-intensity training without BFR can produce these adaptations when performed to the point of exhaustion (24). However, in elderly or functionally compromised patients such as those discharged from the ICU, this option is less well tolerated and could lead to injuries that prevent further training. In these cases, low intensity and BFR might be a better option.

Various mechanisms have been proposed to explain the muscular hypertrophy that occurs during exercise under ischemic conditions. Mechanisms of mechanotransduction, growth hormones, acute production of reactive oxygen species and inflammation of muscle cells have been proposed (25- 28).

It has also been found that exercises with low BFR load can act on bone metabolism; thus, they could have an effect on the control of osteoporosis (29). In addition, plethysmography has shown that a 6-week BFR walking program can improve limb venous compliance (30).

With regard to the safety of BFR, although it appears to be a safe treatment modality for muscle strengthening, prescribing a low BFR load program should be performed with caution. Possible comorbidities (especially cardiovascular pathology) need to be assessed, given many risk factors in elderly patients and in those affected by COVID-19 have not yet been fully investigated (3, 15).

A full clinical assessment, examination, and history evaluation should be performed to safely prescribe a low-burden training program and BFR (1-4, 31). This approach is especially relevant in patients with COVID-19 involvement, given the manifestations and complications are diverse.

When prescribing exercise, the patient should be provided with the most accurate and complete information possible. The resistance exercise that the patient must perform with each contraction should be personalized, as should be the number of repetitions and the series in which the exercises should be performed. The patient's strength must be evaluated for this purpose. Typically, you can determine the MR a patient can achieve in 1 contraction (1MR) or in 10 contractions (10MR) and prescribe the load accordingly. There appears to be no difference in outcome when prescribing exercise based on the 1MR or 10MR value (14). The exercise should always be progressive.

Patients affected by coronavirus have been shown to have an increased incidence of thrombotic events, such as deep vein thrombosis, with a particularly high incidence (31%) in ICU patients (32, 33). The mechanisms by which this occurs are not yet fully understood. However, this possible association between thrombotic events and COVID-19 requires particular caution when indicating a strengthening program with BFR.

In conclusion, it is necessary to have a greater understanding of COVID-19, and studies with an adequate design must be performed to be able to make treatment and rehabilitation recommendations with a sufficient degree of evidence. However, for patients discharged from the hospital who have been cured of the infection and who have significant functional impairment, BFR strengthening might be an effective option to aid the strengthening and functional recovery process.

Juan M. Roman-Belmonte[1]
Hortensia De la Corte-Rodriguez[2]
E. Carlos Rodriguez-Merchan[3]
Elena Muñoz-De la Torre[1]
Aranzazu Vazquez-Sasot[1]
1 Department of Physical Medicine and Rehabilitation, "Cruz Roja San José y Santa Adela" Hospital, Madrid, Spain
2 Department of Physical Medicine and Rehabilitation, "La Paz" University Hospital-IdiPaz, Madrid, Spain
3 Department of Orthopedic Surgery, "La Paz" University Hospital-IdiPaz, Madrid, Spain

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