ПРЕИМУЩЕСТВА ПЕРЕКРЕСТНОГО ОБУЧЕНИЯ У ПАЦИЕНТОВ С РЕПЕРФУЗИОННЫМ СИНДРОМОМ, ПРОХОДЯЩИХ РЕАБИЛИТАЦИЮ

BENEFITS OF CROSS TRAINING IN PATIENTS WITH REPERFUSION SYNDROME UNDERGOING REHABILITATION

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Резюме

В статье представлено описание посредством систематического обзора взаимозависимой роли сосудистой и неврологической систем в подходах к лечению реперфузионного синдрома. Предложена методика перекрестного обучения в качестве дополнительного метода к существующим подходам для случаев, когда пораженная конечность пациента временно иммобилизуется.

Ключевые слова: реабилитация, реперфузионный синдром, кросс-тренинг

Summary

To investigate and describe by a systematic review the interdependent role of the vascular and neurological systems in the treatment approaches for the reperfusion syndrome. To propose the cross-education methodology as a complementary method to the existing approaches, for cases in which the affected limb of the patient is temporarily immobilized.

Key words: rehabilitation, reperfusion syndrome, cross training

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Introduction. A plenty of traumas can involve different amounts of tissue layers and provoke vein disruptions, occlusions or microvascular dysfunctions, what depending upon the duration of oxygen and nutrients deprivation, may develop an imbalance between demand and supply in the injured tissue, result in physiological and immunologic response to that mechanical insult. In case of inappropriate response or inadequate resolution, this ischemic lesion will become an ischemia-reperfusion injury that eventually leads to oxidative stress and subsequently tissue death. The intensity of ischemia depends on the level of occlusion, status of collateral circulation and the degree of oxygen demand of the tissues involved, given that muscle tissue due to the large energy reserve in the form of creatine and the ability to maintain the basic cell functions by anaerobic glycolysis make them more resistant than nerves. Endothelial dysfunction can also enhance inflammatory responses to aggravate the damage of the autonomic nervous system. Oxidative stress, as a factor linked with both endothelial and autonomic nervous system function, causes sympathetic excitation via angiotensin II type 1 receptor (AT1R) in animal models [1] which can directly increase vascular resistance, because major arteries and precapillary arterioles are innervated by sympathetic nerves, but other vessels, such as venules, capillaries and collecting veins are rarely innervated [2]. To manage this situation were created several lines of treatment in different fields, surgical, pharmacological and therapeutic, however the goal of this article is to address the benefits of physical exercise, since it copes with oxidative stress, regulation of nervous system and vascular

peripheral resistance by means of mechanisms involved to reduce sympathetic outflow and restoration of endothelial function [3]. For patients recovering from ischemic trauma or reperfusion injury added to mobility limitations of the affected limbs, the cross-training methodology, which consists of unilateral strength training and neuromuscular maintenance of the contralateral limb, has strong indications of being a useful tool for completion of a therapeutic or physiotherapy treatment.

Materials and methods. Study design: Through a review of literature over the topics of reperfusion syndrome, skeletal muscle ischemia and changes in the nervous system, and Cross education as a rehabilitation method; conducted through Pubmed, Medline, Google Scholar, Scielo, medical reports from different countries and reports of the World Health Organization (WHO), all these obtained data are dated from articles since 2000 until 2021. Analysis of comparative study: These collected data were used to carry out a comparative analysis among physiotherapeutic principles and tactics for the rehabilitation of patients affected by ischemia and loss of skeletal muscle mobility and correlate with new approaches in the treatment of reperfusion syndrome.

Results and discussion: Reperfusion injury is the tissue damage cause by post-revascularization, there is a sudden increase in blood and oxygen flow that triggers the activation of the inflammatory process, release of cytokines and production of reactive oxygen species (ROS) and reduction of antioxidant reserves of the cells, often associated with microvascular dysfunction that is manifested as impaired endothelium-dependent dilation in arterioles, enhanced fluid filtration and leukocyte plugging in capillaries, and the trafficking of leukocytes and plasma protein extravasation in postcapillary venules. Those mediators do not affect only the circulatory system and vascular component, but also the autonomic nervous system. experimental studies indicates that the SNS is critically influence, at the central and additionally at the peripheral level, by the foremost relevant factors control vascular performance, such as nitric oxide (NO), reactive oxygen species (ROS), endothelin (ET), the renin-angiotensin system [3]. Sympathetic regulation plays a relevant role in vascular tone and blood pressure, because it innervates the major arteries and precapillary arterioles. The sympathetic hyperactivity induced by ROS and ET can be reversed with therapeutic approaches aimed at hemodynamic correction. Regardless of the methods used to achieve reperfusion, such as fibrinolysis, surgery, resuscitative therapy or the etiology of occlusion, there is a risk to develop complications that can be classified as systemic and local. In cases of local complications, highlighting the explosive swelling of the limb, compartment syndrome and rhabdomyolysis, physiotherapy plays a critical role in long term treatment as well as physical activity. Exercise training may ameliorate endothelial dysfunction in healthy subjects inducing sympathetic inhibition and restoration of vascular function, among many other advantages for patients in rehabilitation. Cross education is the strength gain or skill improvement transferred to the contralateral limb following unilateral training or practice [7] preventing the development of degenerative processes in the immobilized limb, bringing benefits to physiotherapeutic management.

Conclusion. The systemic review of the presenting study aimed to establish a theoretical ground for application of cross-education training as a physiotherapeutic tool in cases of ischemic or ischemia-reperfusion injury evoked by direct mechanical trauma in any limb. The benefits of periodic physical exercise are undeniable, since it works on several fronts such as homeostatic, neurologic, immunologic and endocrine systems. The apparent indications that resistance training induces changes in the hemostatic system, because according to its intensity, exercise can either accelerate clot formation or lead to fibrinolysis [4] and a few minutes when clot formation happens, the muscles retract, expelling the whey and uniting the sides of the injured vessel, causative to the ultimate stage of hemostasis [5]. The influence of resistive exercises and neural factors during a training program have verified that an increase in muscle strength does not affect an increase in the muscle cross-sectional area, however acts preventing atrophy, reinforcing the idea of cross training as a protective and healing stimulation of the collateral side [6]. In conclusion, cross-education looks to be helpful for preventing harmful effects of unilateral limb immobilization in healthy participants, however, additional analysis is required to further investigate the benefits in a clinical observation.

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