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Motor Irradiation According to the Concept of Proprioceptive Neuromuscular Facilitation: Measurement Tools and Future Prospects

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Abstract

The concept of Proprioceptive Neuromuscular Facilitation is widely used in the treatment of disorders of the musculoskeletal system. Among the basic principles, Motor Irradiation (MI) allows to activate weak muscles, by activating strong muscles. Despite being widely used, the neurophysiological basis that justify the Motor Irradiation and its measurement forms are not yet well understood, which motivated us to conduct a review of the databases of PubMed, Lilacs and Scielo, looking for articles that clarify the subject. The literature emphasizes three possible theories to justify MI, two neural and one biomechanical. There are several ways used to measure the MI, and the Electromyography, Functional magnetic resonance imaging and Load cell are the most cited in studies. Future studies could use the electroencephalography to measure the electrophysiological effects caused by strength irradiation in the Neuromuscular Facilitation Proprioceptive protocols.

Introduction

The concepts of Proprioceptive Neuromuscular Facilitation (PNF) are followed rigorously worldwide. Originally, PNF was used in the treatment of patients with poliomyelitis and with the progress of studies; it was shown that the PNF promotes effective results in diseases that compromise the musculoskeletal system [1]. The method combines concentric, eccentric and isometric contractions with the gradual application of a resistance and facilitatory procedures such as cutaneous, visual and auditory stimulus, which improve control and neuromuscular function [2,3].

Basic procedures of PNF were influenced by the works of Sir Charles Sherrington, a pioneer in research on spinal cord and motor control [4,5]. Among the basic procedures for facilitation, the Motor Irradiation (MI) allows that weak and impaired muscles are activated by strong muscles and preserved [6]. The spread of the motor response is proportional to the intensity, the duration of the stimulus and independent of sex, age or the presence of activity in untrained muscle or in the muscle group of application of PNF. Irradiation is governed by the principle of training specificity (isometric or dynamic), and eccentric contractions cause greater strength gains when compared to concentric contractions [7,8]. This strength gain can be propagated to the ipsilateral agonist muscle, to contralateral limb [9] or having origin in trunk and irradiate for the lower and / or upper limbs [10].

Studies support that motor irradiation is due to neuromuscular adaptations that reorganize the motor control in the contralateral limb through adaptive changes in neural circuits that involve planning and motor execution in the frontal cortex [8] and temporal lobe [11]. Possibly voluntary contraction produces activation in the cortex corresponding to executed movement and slight contralateral facilitation via the corpus callosum. The strong unilateral voluntary contractions may also affect the excitability of spinal motor pathways and the electrical impulses directed to the muscles that are receiving the PNF application are conducted to the muscles agonists or antagonists of the contralateral limb [12].

Biomechanical mechanisms may also be related to MI, since on unstable surfaces, irradiation is most notable [13]. Changes in limb positions cause modifications in muscle activation limit. This body rearrangement triggered by the Central Nervous System (CNS) possibly seeks to recover the information's from predetermined circuits for human development. In this way, the irradiation would act as a compensatory mechanism in order to ensure the best individual functional performance [12].

Several authors used electromyography (EMG) to evaluate the irradiation produced by PNF because is possible to record the activity of motor units that are recruited during muscle contractions [7,14,9]. The effects of PNF in the brain is evaluated using the Functional magnetic resonance imaging (fMRI), a tool also a lot highlighted in the studies of PNF [14].

The load cell is another instrument used to measure the motor irradiation for allow to assess strength and deformation of materials. In the case of muscular contractions, the load cell can be used to indicate the amount of force the limb is doing from the stress or strain generated by muscle activity that therefore, generates limb movements. The use of a load cell, showed to be an efficient quantifier of the motor irradiated during the application of manual resistance to flexion and extension of the trunk. The study demonstrated significant motor irradiation of trunk flexors to dorsiflexors and the extensors to plantar flexors [10].

Future studies may use the electroencephalogram (EEG) to better understand the neural mechanisms related to the principle of motor irradiation. With this tool it is possible to compare the electrical activity between two counterparts electrodes positioned on the scalp of the individual and assess the existence of a connection between two cortical areas and thus, point out which are involved with the task being performed [15]. Authors reported in their study the successful use of EEG to evaluate the bilateral cortical activity after the execution of liabilities, assets and imagined movements, whether unilateral or bilateral. They noted that the EEG is a promising resource in the seek to understand the irradiation principle observed in the PNF techniques [16].

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