MUSCULOSKELETAL PAIN
IASP Special Interest Group

FACT SHEET

Noninvasive Electric and Magnetic Stimulation of the Nervous System in Musculoskeletal Pain

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Musculoskeletal pain stands as a significant public health challenge, characterized by suffering, limitations in daily functioning, high medical expenses, and diminished quality of life. While abnormalities in the musculoskeletal system—such as joint and soft tissue degeneration, and biomechanical misalignments—are often associated with pain, the neurological aspects of musculoskeletal (MSK) conditions have received comparatively little attention. Nevertheless, individuals with MSK pain frequently display altered movement patterns, including claudication, restricted range of motion, grimacing during movement, diminished power, and more (Ervilha et al. 2023). Given that these alterations denote motor control disorders, recent years have seen increased scrutiny into the involvement of the nervous system in MSK pain.

Transcranial Magnetic Stimulation (TMS) serves as a valuable neuroscience tool for exploring central nervous system alterations in MSK pain. By administering magnetic pulses to the brain, specifically targeting the motor cortex, and observing the resultant responses in striate muscles with surface electromyography (TMS-EMG), researchers gain both qualitative and quantitative insights into muscle control. Quantitative parameters, such as response presence and magnitude, symmetry across brain hemispheres (Sato, Takanaka, and Izumi 2024), muscle representation in the motor cortex (Te et al. 2017), neurotransmission in the brain (Jodoin et al. 2020), and the degree of overlap between muscle representations (Chipchase et al. 2015)—can be assessed through TMS-EMG. This approach has shed light on changes in brain-muscle connectivity across conditions such as osteoarthritis, joint sprains, ligament lesions, and muscle pain. Such findings have challenged misconceptions surrounding the relationship between pain and movement, revealing that MSK pain involves alterations in multiple levels of nervous system activity, including brain motor map reorganization, reduced muscle activation capacity, and consequential changes in motor control. These alterations, often attributed to nonadaptive changes in the nervous system, are considered 'aberrant' by some authors (Thapa, Graven-Nielsen, and Schabrun 2021) and may represent a viable therapeutic target.

Noininvasive Electric and Magnetic Stimulation of the Nervous System in the Control of Musculoskeletal Pain

Given these insights, therapeutic strategies for managing MSK pain now aim to address abnormal brain activity. Initially, interventions focus on identifying clinical changes, employing techniques that are aimed to restore function, but that all have impact in central nervous system activity, such as exercises, manual therapy, cognitive training, and/or pharmacological treatments. By altering abnormal movement patterns and striving to restore function, clinicians aim to 'correct' brain activity and organization. However, in cases where voluntary movement control fails to reset abnormal brain activity, direct intervention may be necessary. Noninvasive Brain Stimulation (NIBS) techniques, encompassing various electric and magnetic tools, offer a means to modulate activity in specific brain areas, cerebellar cortices, the spinal cord, and peripheral nerves (for a general view of the techniques, see (Lopes et al. 2023)). Through targeted stimulation, it is possible to increase or decrease neuronal activity as needed. Repetitive TMS (rTMS) at frequencies above 1Hz and transcranial Direct Current Stimulation (tDCS) are the primary techniques investigated for treating MSK pain. Higher-frequency rTMS and anodal tDCS are utilized to enhance excitability and have shown promise in managing various MSK pain conditions, often yielding better outcomes when combined with exercises. Stimulation typically targets the primary motor cortex, owing to its direct role in movement control, and the dorsolateral prefrontal cortex, a crucial area for cognitive control (given the cognitive nature of motor control). Guidelines suggest moderate (around 30%) decreases in pain intensity, and increasing in quality of life (Baptista et al. 2019).

For instance, stimulating the motor cortex with 10Hz rTMS may prevent the transition from acute to sustained experimental MSK pain (Cavaleri et al. 2019), which is likely to be relevant for patients undergoing procedures like surgery, or those initiating therapeutic exercises while experiencing high levels of pain. However, interventions involving rTMS may not facilitate concurrent exercise due to the stationary nature of coil placement. In such cases, transcranial Direct Current Stimulation (tDCS) offers a viable alternative. This technique utilizes two sponge electrodes moistened with saline solution, positioned on specific scalp areas to modulate brain activity beneath the electrodes. By incorporating tDCS into exercises, such as a protocol involving treadmill walking or running for patients with fibromyalgia, superior pain control has been demonstrated compared to exercises alone (Mendonca et al. 2016).

Conclusion

In conclusion, brain stimulation techniques offer valuable insights into the dynamics of MSK pain and hold promise for enhancing the effectiveness of therapeutic interventions. Their use is increasingly recognized in meta-analyses and clinical guidelines as a viable option. However, further research is warranted to establish optimal protocols tailored to specific MSK pain conditions.

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