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REVIEW/MISE AU POINT

Effects of repetitive peripheral magnetic stimulation on normal or impaired motor control. A review

Influence des stimulations magnétiques périphériques répétitives sur le contrôle moteur normal ou déficient. Revue de littérature

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KEYWORDS
Repetitive peripheral magnetic stimulation;
Motor impairment;
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Plasticity;
Sensory afferents

Summary
Introduction. — Repetitive magnetic stimulation at the periphery (rPMS), i.e. over spinal roots, nerves or muscles, represents a new painless and noninvasive approach that can contribute to motor recovery. This method is based on the assumption that, under rPMS, neural networks involved in motor control would be regulated by the large recruitment of proprioceptive afferents, with little activation of cutaneous receptors.
Study aim. — This literature review dealing with rPMS after-effects on motor control aimed at better understanding the outcome measures and further discussing some possible involved mechanisms.
Results. — Our literature search resulted in 13 studies that used different types of outcomes (neurophysiological, biomechanical, clinical) to test the influence of rPMS over spinal roots or muscles in healthy individuals and in persons with stroke or spinal disorders. Dynamic changes were reported post-rPMS, such as spasticity reduction and improvements of movement dynamics. Studies also brought about some interesting insights on the cortical plasticity associated with rPMS effects, such as the activation of fronto-parietal loops that may explain the post-rPMS improvement of motor planning.
Conclusions. — Due to the heterogeneous and scant literature on the topic, no conclusion can be drawn to date. However, the results encourage the concurrent testing of clinical, neurophysiological and biomechanical outcomes to investigate more precisely the relevance of rPMS in neurological rehabilitation.

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MOTS CLÉS
Stimulation magnétique périphérique répétitive ;
Désordres moteurs ;
Revue ;
Réadaptation ;
Plasticité ;
Afférences sensorielles

Résumé
Introduction. — La stimulation magnétique répétitive périphérique (rPMS) (c'est-à-dire appliquée sur des racines nerveuses, des nerfs ou des muscles), représente une méthode indolore et non invasive pouvant contribuer à la récupération motrice. Le principe à la base de cette méthode est que la rPMS permettrait le recrutement d'afférences proprioceptives, avec peu d'activation des récepteurs cutanés, ce recrutement étant à la base d'une régulation des réseaux neuronaux du contrôle moteur.
But de l'article. — Améliorer la compréhension de la manière de mesurer les changements induits par la rPMS et discuter des mécanismes sous-jacents à ceux-ci.
Résultats. — Nous reprenons les résultats de 13 études qui ont utilisé différents types de mesures (neurophysiologiques, biomécaniques, cliniques) pour tester l'influence de la rPMS appliquée sur des racines nerveuses ou des muscles chez des personnes neurologiquement normales ou ayant présenté un accident vasculaire cérébral ou des pathologies médullaires. Ces études font état de changements dynamiques survenant après rPMS, comme une diminution de la spasticité ou l'amélioration de certaines composantes dynamiques du mouvement. Les études ont aussi proposé certaines pistes de réflexion intéressantes sur la plasticité corticale associée aux effets rPMS, telle que l'activation de circuits fronto-pariétaux qui pourrait expliquer les améliorations de planification motrice.
Conclusions. — Vu l'hétérogénéité et la quantité limitée d'études sur le sujet, aucune conclusion ne peut être tirée à l'heure actuelle. Les résultats constituent cependant un encouragement à l'utilisation conjointe d'outils cliniques, neurophysiologiques et biomécaniques pour investiguer plus précisément la pertinence de la rPMS en réadaptation neurologique.

Introduction

Repetitive magnetic stimulation at the periphery (rPMS), i.e. over spinal roots, nerves or muscles is gaining popularity in clinical neurological research as a new painless and noninvasive approach to activate proprioceptive afferents with little activation of cutaneous receptors [24,45]. rPMS has been used for almost two decades in humans in order to understand the changes of motor function under peripheral stimulation and question the underlying mechanisms of action that may contribute to motor control improvement in physiopathology. It is mainly proposed that peripheral recruitment of sensory afferents generates cortical somesthetic reactivation that may improve sensorimotor integration in persons with stroke [42,44], or down-regulate the hyperactive spinal excitability in persons with spinal cord disorders [19,33]. However, the functional impact of rPMS remains difficult to overview because good quality evidence remains scarce, each rPMS study having focused on a different neurological population and testing different outcomes under different parameters of stimulation. Thus, there is a gap between the insufficient understanding of rPMS influence on motor control (e.g., which components of movement are improved) and the dire need in clinical research of protocols testing rPMS in larger samples. Therefore, the aim of the present work was to review all studies dealing with rPMS influence on motor control and document the different outcome measures tested in healthy humans and persons with motor impairment caused by central nervous system (CNS) lesion or disease. RPMS influence on normal and impaired motor control is discussed in both terms of clinical relevance and potential mechanisms of action.

Methods

Our literature search on rPMS papers used the terms (repetitive peripheral magnetic stimulation) OR (repetitive spinal magnetic stimulation) with no imposed time restriction and the EBSCOhost website hosted the selection of MEDLINE, CINAHL and SPORTDiscus databases and automatically removed duplicates. Additional relevant studies were also hand-searched in the references list of the papers selected for the review. The inclusion criteria were full-text original papers written in English and about repetitive magnetic stimulation applied to nerves, muscles or spinal roots, both in healthy individuals and in persons with motor impairments caused by CNS lesion or disease. The exclusion criteria were any study with other devices than focal magnetic stimulators (e.g., pulsed magnetic fields), with single peripheral magnetic stimulation (i.e. not a repetitive pattern), repetitive magnetic stimulation to scalp, and studies that did not focus on motor control. Inclusion and exclusion criteria were applied using title and abstract, and if necessary, full text.

The literature search was ended in September 2012 and had resulted in 244 papers. Two hundred and thirty-three papers were excluded for methods other than rPMS ($n = 202$), not full-text original papers written in English ($n = 17$) and not papers focusing on motor control ($n = 14$). One paper that applied rPMS to persons with chronic pain syndrome [20] was not excluded for the relevant data obtained in a group of healthy participants. The remaining 11 papers were included in the review and two supplementary papers were found in the references list. Thirteen rPMS papers were thus reviewed for the present work.