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ORIGINAL ARTICLE/ARTICLE ORIGINAL

Modulation of soleus H-reflex by presynaptic spinal mechanisms during varying surface and ankle brace conditions

Les variations de la surface d'appui et de contention élastique de la cheville modulent le réflexe de Hoffmann du muscle soléaire (réflexe H) par l'intermédiaire de mécanismes médullaires présynaptiques☆

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KEYWORDS
Paired reflex depression;
Presynaptic inhibition;
H-reflex;
Ankle injury;
Ankle instability

Abstract
Aims. — Reflex excitability is modulated in part by presynaptic spinal mechanisms. Presynaptic inhibition may prevent an over-response of the motoneuron pool to afferent information. A paired-reflex depression (PRD) conditioning protocol can be used to monitor reflex plasticity. Manipulation of stance, surface, and external bracing are common methods of rehabilitating and treating lower extremity musculoskeletal injuries. The intent of this study was to evaluate changes in PRD of the soleus H-reflex during single-leg stance under varying stability conditions.
Methods. — Seven trials were completed for each condition in ten healthy volunteers (age = 23 ± 1.8 yr, weight 65.0 ± 11.3 kg, height = 168.7 ± 28.0 cm). The conditioning stimuli were composed of soleus H-reflex pairs evoked 80 ms apart at an equal intensity. The mean percent decrease of the second H-reflex relative to the first represented PRD.

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***Results*. —** A 2×2 repeated measures ANOVA ($P < 0.05$) was used to evaluate influence of surface (foam, no foam) and support (semi-rigid ankle brace, no ankle brace) on PRD. Main effects testing revealed a significantly greater soleus PRD ($P = .034$) for the foam surface (62.5%) compared the flat surface (57.5%). Ankle brace application did not influence soleus PRD ($P = 0.63$).
***Conclusion*. —** The increase in soleus PRD during the foam condition suggests depression of the motoneuron pool. This may lessen postural over-corrections while maintaining upright stance during less stable conditions. No change in PRD during the ankle brace condition suggests that mechanical reinforcement provided an increase in ankle stability, decreasing the demand on the motoneuron pool.

MOTS CLÉS
Blessures de la cheville ;
Instabilité de la cheville ;
Réflexe couplé de dépression ;
Inhibition présynaptique

Résumé
***Objectifs*. —** L'excitabilité du réflexe myotatique est modulée en partie par des mécanismes médullaires d'inhibition présynaptique, permettant d'empêcher une stimulation excessive des neurones moteurs en réponse à l'information afférente. L'étude de la dépression du réflexe H en réponse à des doubles stimulations (DRHD) permet une bonne évaluation de sa plasticité. Les manipulations de la posture, de la surface d'appui ou des méthodes de contention sont des techniques communément utilisées pour la revalidation et le traitement des traumatismes musculo-squelettiques des membres inférieurs. Nous étudions l'influence des variations de la surface d'appui ou de contention de la cheville sur l'amplitude de la dépression du réflexe H du soléaire en station monopodale.
***Méthodes*. —** Dix sujets volontaires en bonne santé (âge = 23 ± 1,8 ans, poids = 65,0 ± 11,3 kg, taille = 168,7 ± 28,0 cm) ont réalisé sept essais pour chaque condition. Des stimulations du type de celles utilisées pour l'enregistrement du réflexe H sont appliquées par paires de deux stimuli d'intensité égale séparés de 80 ms. La diminution en pourcent de l'amplitude du second par rapport au premier réflexe H mesure la DRHD.
***Résultats*. —** L'influence de la surface d'appui (avec ou sans mousse) et d'une chevillière de contention (semi-rigide ou sans contention) sur la DRHD a été évaluée par une analyse de variance (ANOVA 2×2). L'analyse de l'effet principal indique que l'utilisation d'une surface d'appui mousse comparée à une surface plate a significativement augmenté la DRHD (62,5 % vs. 57,5 %, $P = 0,034$). L'utilisation d'une chevillière de contention n'a eu aucun effet sur le DRHD ($P = 0,63$).
***Conclusion*. —** L'accentuation de la DRHD du muscle soléaire sur une surface mousse indique une moindre excitabilité du pool motoneuronal. Ceci peut diminuer les hypercorrections posturales en position debout durant des états moins stables. Aucun changement du réflexe couplé de dépression n'a été observé avec l'utilisation d'une chevillière de contention, suggérant que le renfort mécanique augmente la stabilité de la cheville et diminue le recrutement des motoneurones.

Introduction

Reflex pathways and motor programs are mechanisms which enable the nervous system to produce an efficient efferent response to afferent information. Modulation of reflexes through descending commands, presynaptic (PI) and postsynaptic inhibition and facilitation provide the plasticity necessary for these motor control systems to adapt to a changing environment [4,38].

As PI plays such an imperative role in the control of movement, a great deal of research has been done in an effort to understand its mechanism of action. This action is thought to occur at two locations and through two different mechanisms, intrinsic and extrinsic PI [28]. Extrinsic PI is thought to occur through action at an axoaxonic synapse, although other mechanisms (paracrine effects and glomerular complexes) are being investigated. Intrinsic PI occurs when two action potentials travel down the axon with minimal separation [28]. Without adequate membrane recovery time, the amplitude of the second impulse is diminished by Ca^{++} and K^{+} changes resulting from the first action potential [18,28]. The frequency of reflex activation creates a modulation in the reflex amplitude resulting in an alteration of output of the motoneuron [25].

The Hoffmann reflex (H-reflex) is a common measure of motoneuron pool (MN) excitability. The H-reflex serves as a summative measure of excitability in the MN pool, reflecting influences of PI, postsynaptic inhibition, descending input and monoamines. By adding conditioning protocols to the H-reflex measure, specific sources of modulation of MN pool excitability can be studied. Changes in transmission due to the activation history (intrinsic PI) of the I_a afferents can be studied using the H-reflex through a paired reflex depression (PRD) conditioning protocol [34].

The H-reflex has been instrumental in research investigating nervous system plasticity. These studies have lead