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ORIGINAL ARTICLE

Changes in muscle activity during karate guiaku-zuki-punch and kiza-mawashi-guiri-kick after specific training in elite athletes

Changements de l'activité musculaire lors des frappes guiaku-zuki et kiza-mawachi-guiri de karaté après entraînement spécifique chez des athlètes d'élite

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Electromyography;
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Guiaku-zuki;
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Summary
Objective. — Was to investigate the effect of 3-month karate training on electromyographic activity (EMG) of guiaku-zuki-punch and kiza-mawashi-guiri-kick in elite karatekas.
Material and methods. — Thirteen male elite karatekas have participated in this study. We have measured the EMG activity of the biceps and triceps brachii during guiaku-zuki and the biceps and rectus femoris during kiza-mawashi-guiri of the right side before (*T*0) and after 3-month intense karate training (*T*1).

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Results. — We found an increase in root mean square (RMS) values of the biceps and triceps brachii associated with increases in signal's amplitude and a significant decrease of the onset muscle activation time of the biceps brachii ($P < 0.0005$) after training. In addition, the EMG analysis of guiaku-zuki showed an activation of big size motor units regardless of the training, whereas medium and small size motor units appeared only after training (*T*1). We found significant decrease in activation time of the rectus femoris ($P < 0.05$) and a decrease in the onset muscle activation time of the biceps and rectus femoris ($P < 0.0005$) in *T*1.
Conclusion. — A 3-month karate training induced changes in neuromuscular activation strategy. The higher muscle activation during guiaku-zuki explains the enhancement of motor unit recruitment. The reduction in the onset of activation time after training indicates better coordination between agonist and antagonist muscles to stabilize and control the movement during punches and kicks in our athletes.
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MOTS CLÉS
Électromyographie ;
Art martial ;
Activité musculaire ;
Guiaku-zuki ;
Kiza-mawachi-guiri

Résumé
Objectifs. — Était d'étudier l'effet de l'entraînement spécifique de karaté sur l'activité électromyographique (EMG) des coups guiaku-zuki et kiza-mawachi-guiri chez des karatékas.
Matériels et méthodes. — Treize karatékas élites ont participé à l'étude. Nous avons mesuré l'activité EMG des muscles biceps et triceps brachial lors du mouvement guiaku-zuki et l'activité des muscles biceps et droit fémoral des côtés droits lors du mouvement kiza-mawachi-guiri, avant (*T*0) et après trois mois d'entraînement intense de karaté (*T*1).
Résultats. — Nous avons observé des changements au niveau du pattern de décharge des unités motrices et une amélioration très significative de l'amplitude du mouvement guiaku-zuki (*root mean square* ou RMS) associée à une diminution du temps de latence de l'activité musculaire (moment de démarrage des mouvements des muscles biceps et triceps) ($p < 0{,}0005$) après entraînement. À *T*0, seules les grandes unités motrices déchargent en bouffées distinctes lors de l'exécution du mouvement guiaku-zuki alors qu'à *T*1, nous avons enregistré l'apparition de petites unités motrices (nouvelles unités motrices de faible amplitude) qui déchargent spontanément. D'autre part, nous avons trouvé une diminution significative de la durée de décharge du muscle droit fémoral ($p < 0{,}05$) et de la mise en activité des muscles biceps et droit fémoral ($p < 0{,}0005$) à *T*1.
Conclusions. — Trois mois d'entraînement intense de karaté induisent des changements au niveau de l'activité neuromusculaire. La diminution de temps de mise en activité indique une meilleure coordination des muscles agonistes—antagonistes du bras droit (fléchisseurs et extenseurs), permettant une plus grande stabilité de l'articulation. Cette coordination implique des adaptations de la commande centrale qui agit via une meilleure co-activation alpha/gamma des motoneurones innervant les muscles sollicités.
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1. Introduction

Karate is one of the most popular martial arts in the world. This sport is characterized by different forms of punches and kicks in static and dynamic conditions [1,2]. In this context, several studies have suggested that ''guiaku-zuki'' as punch and ''kiza-mawashi-guiri'' as kick constitute the major skills to be used in the evaluation or in the training processes [3,4]. Indeed, some studies have realized kinematic and/or electromyographic analysis (EMG) of a karate punch [4], neuromuscular control adaptations during kicks [3], and have assessed some factors affecting punch efficacy [5]. Some authors have also examined the technical aspect of the competition [2], punch force, and speed among experts and non-karate subjects [6,7]. In addition, Vencesbrito et al. [4] have analyzed karate punches against a static target in experienced and non-experienced karatekas. The authors showed different kinematic and EMG patterns during the choku-zuk punch in the two groups. They also reported greater arm muscles activation than forearm.

To our knowledge, there are yet no studies assessing EMG patterns during karate randori (free sparring) as most studies assessed kinematics and EMG analysis of punches or kicks against a static target [3—5]. The arm internal rotation and forearm pronation constitute the final components during the punch movements [4]. However, in kumite, the controlled final component of the movement is based on the forearm flexion after the simulated touch [8]. In addition, there are few studies examining the EMG activity of kicks [3,9,10]. For instance, Sbriccoli et al. [3] assessed the neuromuscular control during kicks against a static target in top-level karatekas. The authors showed higher isokinetic knee flexion torque in elite karatekas compared to amateurs.

On the other hand, EMG is a good tool to evaluate muscle activation characteristics and muscle coordination patterns. These assessments are of interest, particularly, in elite

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