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Immediate electromyographic changes of the upper limb muscles following cervical manipulation in a patient with essential tremor: a case report

Alterações eletromiográficas imediatas dos músculos dos membros superiores após manipulação cervical em uma paciente com tremor essencial: estudo de caso

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Abstract

Introduction and Objective: The purpose of this case report is to evaluate upper limb muscle electric behavior by surface electromyography before and after cervical manipulation in a patient with essential tremor. **Methods:** In 2009, essential tremor was diagnosed by a neurologist in a 25-year-old woman. Previous treatment included Paroxetine for a number of months, without alteration of her symptoms. The patient was assessed by surface electromyography of the upper limb muscles (flexor and extensor of the wrist, long heads of biceps and triceps) before and after being subjected to high-velocity, low-amplitude spinal manipulation to her mid cervical spine (C3-C4 level, 1 manipulation/side). **Results:** There was an increase of the median frequency rate and a decrease of the electrical activity of these muscles. **Conclusion:** This case study showed the cervical manipulation technique acutely modifying the electromyographic activity, increasing the median frequency, and decreasing the muscle recruitment of the upper limb. It suggests improved motor control during the tasks.

Key words Electromyography; Muscles; Spinal manipulation; Tremor.

Resumo

Introdução e Objetivo: O objetivo neste estudo de caso foi avaliar o comportamento elétrico dos músculos do membro superior, por eletromiografia, antes e após manipulação cervical em paciente com tremor essencial. **Métodos:** Uma mulher (25 anos) apresentou-se com tremor essencial, diagnosticado em 2009 por neurologista. Foi empregado tratamento prévio com Paroxetina por meses, sem diminuição dos sintomas. A paciente foi avaliada por eletromiografia dos músculos dos membros superiores (flexores e extensores do punho, cabeça longa do bíceps e do tríceps) antes e após manipulação de alta velocidade e baixa amplitude na cervical média (nível C3-C4, 1 manipulação para cada lado). **Resultados:** Observou-se aumento na frequência mediana e diminuição na atividade elétrica dos músculos avaliados. **Conclusão:** A técnica de manipulação cervical modificou de forma imediata a atividade eletromiográfica, aumentando a frequência mediana e diminuindo o recrutamento dos músculos do membro superior para a paciente estudada, sugerindo melhor controle motor durante a atividade proposta.

Descritores: Eletromiografia; Manipulação da coluna; Músculos; Tremor.

Introduction

Essential tremor (ET), the most prevalent idiopathic neurologic movement disorder, affects people throughout their life span[1]. ET is an involuntary, rhythmic oscillation of a body part. It results from contractions of agonist and antagonist muscles entrained by a signal pattern originating from an oscillator in the central nervous system (CNS)[2]. ET often has a familial history of similar tremors, and its prevalence rate is 3% to 6% in patients over 40 years. In addition, the upper limb is affected most often, with a prevalence of 90-95%[3]. There is no clear diagnostic test for ET, so it must be diagnosed in descriptive clinical terms[4]. Tremors are commonly suppressed with medication, which may provide partial relief, but this often causes undesirable side effects[5].

A biomechanical alteration between vertebral segments hypothetically produces a biomechanical change, which may alter the signaling properties of sensitive neurons in paraspinal tissues. These changes in sensory input seem to modify neural integration, directly affecting reflex activity as well as central neural integration within motor, nociceptive, and possibly autonomic neuronal pools. These changes in sensory input may elicit changes in efferent somatomotor and visceromotor activity[6]. Joint manipulation has been studied to stimulate the sensory receptors and to affect the CNS at the spinal segmental level and cortical level[7]. Studies demonstrate that spinal manipulation (SM) modifies the discharge of Group I and II afferents, the Golgi tendon organ, and muscle spindles[8,9]. The studies cited above make it reasonable to think that SM may add a novel sensory input or remove a source of aberrant input[6]. Furthermore, a recent study shows that manual therapies contribute to the management of nonspecific neck pain with a moderate level of evidence on the short-term effects[10].

At the time of writing this report, only three articles on SM and ET have been published. The purpose of the current study is to evaluate upper limb muscle electric behavior by sEMG before and after cervical SM in a patient with ET. The clinical relevance of this study is to provide an initial basis for better prescription of SM and its effects on upper limb movement control in patients with ET, assuming this procedure may benefit neuromuscular coordination.

Methods

Participant

A 25-year-old female patient, and coauthor of this report, presented herself for care. She had been previously diagnosed in 2009 with ET by her neurologist. The patient had undergone magnetic resonance imaging in the same year as well as neurological evaluation to rule out other disorders with similar symptoms. Previous treatment included Paroxetine for four months. She could not recall dosage amounts, but reported not having experienced a reduction in the frequency or duration of her tremor activity. The tremors were constant, bilateral in the upper extremities, and more severe in the left limb. She reported that the tremors increase with anxiety and physical activity. Physical examination showed normal function in orthopedic and neurologic tests. Cranial nerve tests were found to be normal. There was a decrease in the segmental passive range of motion from C1 through C3 bilaterally.

Data recording

A biological signal acquisition module with eight analog channels was used (Miotec™ Biomedical Equipments, Porto Alegre, RS, Brazil). The conversion of analog to digital signals was performed by an A/D board with a 14-bit resolution input range, sampling frequency of 2000 Hz, common rejection mode greater than 100 dB, signal/noise ratio of less than 03 µV RMS (root mean square), and impedance of 109 ohms. sEMG signals were recorded by RMS in µV and the average frequency in Hz with surface electrodes (20-mm diameter and a center-to-center distance of 20 mm). A reference electrode was placed on the left lateral epicondyle. Prior to the fixation of the electrodes, the skin was cleaned with 70% alcohol to eliminate residual oil, followed by exfoliation using a specific sandpaper for skin and a second cleaning with alcohol. The muscles analyzed by sEMG were as follows (both upper limbs): (1) radial flexor of the wrist (FW); (2) ulnar extensor of the wrist (EW); (3) long head of biceps (BB); and (4) long head of triceps (TB). Auto-adhesive surface electrodes (Meditrace™Ag/Ag Cl) were attached to the muscle bellies and positioned parallel to the muscle fibers using techniques described according to the sEMG for the Non-Invasive Assessment of Muscles (SENIAM) recommendations. sEMG signals were amplified and filtered (10–500 Hz).

Procedures

The patient performed maximum isometric voluntary contraction (MVIC) for the flexion and extension of the wrist (standing position with knee extended, shoulder flexed 90º with forearms extended – Figure 1), each lasting 12 seconds with a three-minute interval between contractions to allow for resting and metabolic recovery. The data were obtained from the average of two MVICs. Five minutes after this procedure, the patient performed another isometric voluntary contraction of upper limbs in the previously described position lasting three minutes. A high-velocity low-amplitude manipulative thrust was applied to the cervical spine (C3–C4 level, one manipulation in each side) with the contact hand on a specific area of the vertebra and the patient's head (Figure 2), and the evaluation procedures were repeated. sEMG data were not normalized, and mean muscle activity was calculated and compared at two moments: before (A1) and immediately after the cervical manipulation (A2). The values obtained in the median frequency (MF) analysis from A1 and A2 were used for comparisons. The delta percentage (Δ%=[A2-A1/A1]×100) was also analyzed, comparing the results between pre- (A1) and post-assessment (A2) to estimate variations in the intra- and inter-variables.

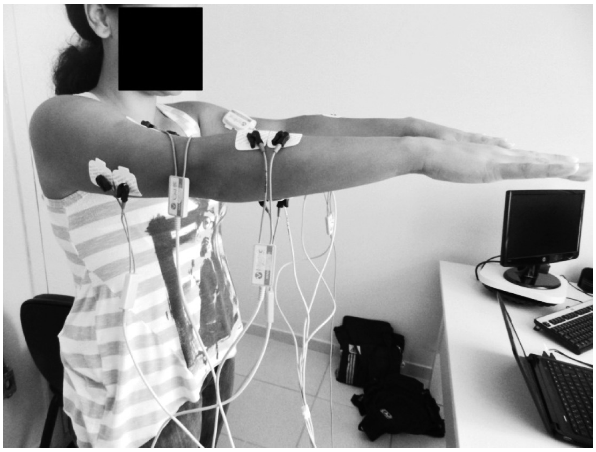

Figure 1: Standing position with knee extended, shoulder flexed 90º flexed with forearms extended

Figure 2: Cervical manipulation procedures

Results

Figure 3 shows the sEMG means during the wrist flexion MVIC and Figure 4 during the wrist extension MVIC. We noted a decrease in

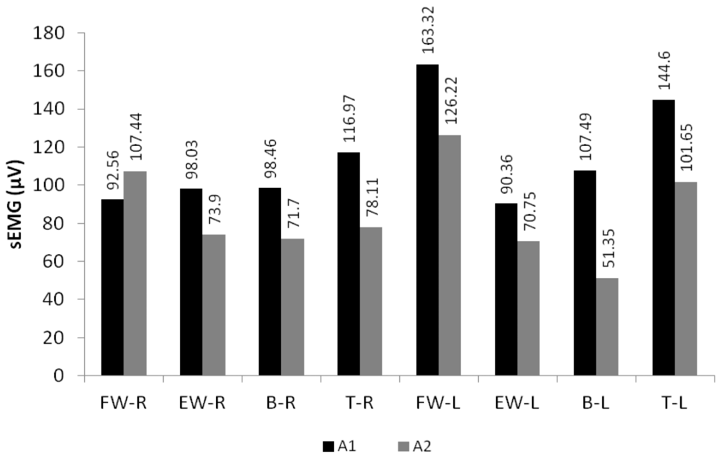

Figure 3: sEMG results (wrist flexion). A1: pre-assessment; A2: post-assessment; FW: radial flexor of the wrist; EW: ulnar extensor of the wrist; B: long head of biceps; T: long head of triceps; R: right upper limb; L: left upper limb

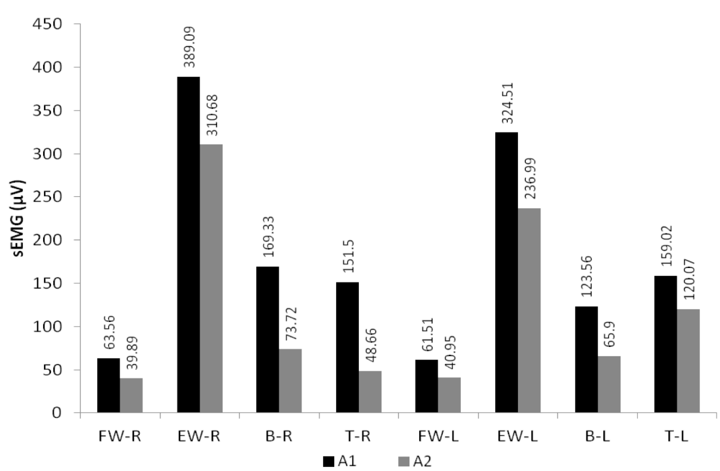

Figure 4: sEMG results (wrist extension). A1: pre-assessment; A2: post-assessment; FW: radial flexor of the wrist; EW: ulnar extensor of the wrist; B: long head of biceps; T: long head of triceps; R: right upper limb; L: left upper limb

all muscle activity after cervical manipulation, except FW-R during the flexion task.

Table 1 shows the median frequency results and their variation by Δ%. Despite the results being obtained from the sEMG means, all muscles showed an increase in Δ%, indicating an increase in motor unit (MU) recruitment.

Discussion

It has been well established that the voluntary motor system possesses the capacity to control the direction, distance, speed and accuracy of movement[11,12]. A theory of motor control, based on optimal feedback control, posits that voluntary motor behavior involves the manipulation of sensory feedback[13,14], emphasizing the importance of using and manipulating this sensory feedback to guide voluntary motor behavior. The implication is that the two systems (feedback mechanisms and voluntary motor behavior) are inherently linked as part of the same control process[15].

Neurophysiological stimuli, including SM, deform articular structures rich in sensory inputs, leading to changes in the axoplasmic afferent inflow. These changes might bring awareness to the CNS, modifying motor patterns and suggesting that the CNS is able to contribute to reducing the clinical symptoms and patterns of MU recruitment[16]. The expected result is a link between sensory feedback signals and motor outputs that changes as a function of the task being performed[12].

In the current study, after cervical SM had proceeded, the upper limb muscles decreased their activity and the median frequency increased. Another study showed that manipulations applied peripherally to the cervical spine can cause changes in cortical plasticity, altering somatosensory processing and sensorimotor integration and leading to pain reduction and functional restructuring by manipulative treatment[17]. Some hypotheses have been formulated to explain the mechanisms behind the effectiveness of SM techniques. Most of these are based on neurophysiological reflexes triggered by sensory receptors mechanically stimulated by

Table 1: Median frequency (Hz) and Delta percentage (Δ%) results between A1: pre-assessment and A2: post-assessment; FW: radial flexor of the wrist; EW: ulnar extensor of the wrist; B: long head of biceps; T: long head of triceps; R: right upper limb; L: left upper limb

Movement	Muscle	A1 (Hz)	A2 (Hz)	Δ%
Flexion	FW-R	141.36	156.13	10.45
	EW-R	147.89	149.41	1.03
	B-R	85.51	87.22	2.00
	T-R	138.67	139.83	0.84
	FW-L	139.28	161.01	15.60
	EW-L	126.34	140.14	10.92
	B-L	64.94	93.26	43.61
	T-L	145.14	156.98	8.16
Extension	FW-R	133.24	152.71	14.61
	EW-R	135.07	148.99	10.31
	B-R	91.06	92.77	1.88
	T-R	103.52	130.62	26.18
	FW-L	147.03	161.99	10.17
	EW-L	133.73	145.81	9.03
	B-L	91.92	106.02	15.34
	T-L	157.35	160.16	1.79

SM[18,19]. Experimental studies in humans and animals have supported these ideas[9,20-26] and, recently, a study highlighted that control group sEMG values did not change after manipulation and muscle activity, whereas those obtained from the experimental group, submitted to SM, decreased significantly after the manipulation, which supports the idea that observed changes are related to the manipulation procedure[27]. A recent review concluded that SM appears to be associated with short-term changes in the amplitude of the sEMG signal and that extremity muscles at a distance from the targeted spinal level of the manipulation respond with changes in their myoelectric amplitude after SM, most of all with a decrease in activity[28]. The response of the upper limb muscles to SM in a patient with ET suggests the possibility of including the procedure to facilitate the management of the tremor once the magnitude of recruitment increases. This may lead to the better control of the movement and, based on the current hypothesis of motor control, may generate changes in sensorial feedback by the peripheral modulation of the mechanoreceptors. Obviously, this procedure would be able to change the sEMG pattern only in our patient, leading to the need for more extensive studies to confirm this process and to prescribe SM to other ET patients.

Additionally, it has been suggested that the spectral characteristics of sEMG are the result of the altered recruitment patterns between different MUs[15,29] and that differential patterns of recruitment between faster and slower MUs can be detected from their spectral patterns in sEMG[29,30]. The MF analysis might thus be useful for detecting changes in MU recruitment. This case report showed a positive variation and considered the increased MF after SM, which suggests possible changes in MU recruitment without increasing the total magnitude of the contraction in the patient studied. Despite the difficulties finding patients with an ET diagnosis, more studies must confirm these results by using a larger sample.

Conclusion

The results reported allow us to conclude that, for the patient studied, a high-velocity SM technique modifies the sEMG activity, increasing the median frequency rate and decreasing the activity in her upper limb muscles.

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