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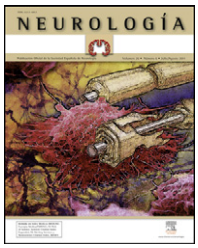

ORIGINAL ARTICLE

Movement analysis of upper extremity hemiparesis in patients with cerebrovascular disease: A pilot study☆

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KEYWORDS
Activities of daily living;
Cerebrovascular disease;
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Abstract
Introduction: As a result of neurophysiological injury, stroke patients have mobility limitations, mainly on the side of the body contralateral to the lesioned hemisphere. The purpose of this study is to quantify motor compensation strategies in stroke patients during the activity of drinking water from a glass.
Material and methods: Four male patient with cerebrovascular disease and four right-handed, healthy male control subjects. The motion analysis was conducted using the Vicon Motion System® and surface electromyography equipment ZeroWire Aurion®. We analysed elbow, shoulder and trunk joint movements and performed a qualitative analysis of the sequence of muscle activation.
Results: Trunk, shoulder and elbow movements measured in the stroke patient along the sagittal plane decreased during the drinking from a glass activity, whilst the movements in the shoulder in the coronal plane and trunk increased. As for the sequence of muscle activation, anterior, middle and posterior deltoid all contracted in the patient group during the task, whilst the upper trapezius activation remained throughout the activity.
Conclusions: Quantitative analysis of movement provides quantitative information on compensation strategies used by stroke patients, and is therefore, clinically relevant.

PALABRAS CLAVE
Actividades de la vida diaria;
Cinemática;
Control motor;

Análisis del movimiento de la extremidad superior hemiparética en pacientes con accidente cerebrovascular: estudio piloto

Resumen
Introducción: Consecuentemente a la lesión neurofisiológica, los pacientes con ictus presentan limitaciones motoras principalmente en el hemicuerpo contralateral al hemisferio lesionado.

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Electromiografía;
Enfermedad cerebrovascular;
Extremidad superior

El objetivo de este trabajo es cuantificar las estrategias motoras de compensación que ocurren en la extremidad superior afectada en pacientes con ictus durante la actividad de beber agua de un vaso.

Material y métodos: Cuatro pacientes con ictus y cuatro sujetos controles, sin patología y diestros. El análisis del movimiento se realizó usando el sistema VICONmotion System® y el equipo de electromiografía de superficie Aurion ZeroWire®. Se analizaron los movimientos articulares del codo, el hombro y el tórax. Se realizó un análisis cualitativo de la secuencia de activación muscular.

Resultados: Se observó una disminución de las amplitudes articulares en el plano sagital del codo y el hombro durante la actividad de beber en el grupo de casos; sin embargo, las amplitudes articulares del tronco y el hombro en el plano frontal fueron mayores con respecto a los sujetos controles. En cuanto a la secuencia de activación muscular, deltoides anterior, medio y posterior, se contrajeron en el grupo de pacientes conjuntamente durante la tarea, mientras que el trapecio superior mantuvo su activación durante toda la actividad.

Conclusiones: El análisis cuantitativo del movimiento ofrece información cuantitativa acerca de las estrategias de compensación que realizan los pacientes con ictus, y por tanto, su relevancia clínica es importante.

Introduction

Studying upper extremity range of motion using 3D kinematic analysis and surface electromyography (EMG) may come to be an important tool for clinical decision-making and measuring results in patients with cerebrovascular accidents (CVA).[1] Compared to gait analysis, 3D analysis of the upper extremities presents an array of difficulties. Firstly, the upper extremities do not engage in only one relevant functional activity. Secondly, the functional activities of upper extremities vary greatly within the general population, unlike gait, which follows a typical pattern. Third, the upper extremities, and the shoulder joint in particular, have a very wide range of motion compared to the lower extremities. All of these factors make movement analysis of the upper extremities very problematic. Upper extremity kinematics have been studied previously.[2] Until now, however, no studies have examined the function of the upper extremities using 3D systems. Previous studies have analysed daily life activities (DLA) in healthy subjects[3–6] and in patients with various neurological conditions.[7–10] Few studies of CVA patients evaluate kinematics in DLA,[11,12] and to our knowledge, none of those studies uses EMG activity in its analysis.

This cerebrovascular lesion affects brain areas and structures (the basal ganglia, for example) which are directly involved in performing DLA. Throughout the process of learning to creep, crawl and walk upright, these structures create priority pathways for extremity nerve roots. These pathways will constitute the easiest instructions for synchronising hand movements.[13,14] A hand movement to carry out a specific task originates in the cortex, but the position of the wrist, elbow and shoulder is adopted according to the basal ganglia's motor schemas. Additionally, the cerebellum, which is the motor coordination centre, is closely linked to these activities and facilitates cortical activity in distal movement. The motor system's continuous processing of afferent sensory signals prepares for motor actions and refines the performance of fine motor tasks. Through this continuous processing, the central nervous system (CNS) gathers information proceeding from a number of sensory channels, thereby enabling completion of specific tasks.[15]

Following the physiological brain lesion, CVA patients mainly present motor limitations on the side of the body contralateral to the damaged hemisphere. This means that changes occur in motor patterns for the upper extremity on the affected side, which is contralateral to the damaged brain hemisphere, as well as in the trunk and the upper extremity ipsilateral to the damaged brain hemisphere.[16] In any case, the body develops compensatory motor strategies, and repetitive use of these strategies may cause musculoskeletal disorders. Measuring existing motor limitations and compensatory motor strategies lets us target the motor disorder precisely,[11] and therefore decreases the need for developing compensatory motor strategies.

Objective

The purpose of this study is to analyse the kinematic and chronological differences in muscle activation that may be present in CVA patients and healthy subjects in the task of drinking water from a cup. Our study's hypothesis is that the upper extremity limitations in CVA patients will produce a compensatory motor strategy in patients when they drink water from a cup. This compensatory strategy will affect other muscles, mainly those in the trunk. Additionally, we believe that the muscle activation sequence will vary in order to compensate for the muscles specific to the motor pattern.

Material and methods

Subjects

Four male patients aged 42 ± 5.6 years with CVA in the territory of the middle cerebral artery and a predominance