

ANALYSIS OF CORTICOMUSCULAR COHERENCE BETWEEN CORTICAL AND LOWER LIMB MUSCLE ACTIVITIES

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ABSTRACT

Stroke is one of the most common neurological disorders where the evaluation of functional connection between the motor cortex and muscle is essential. This corticomuscular control is usually determined by measuring coherence in the simultaneously recorded electroencephalography (EEG) – electromyography (EMG) activities. In this work, an attempt has been made to estimate the EEG-EMG coherence using Magnitude Squared Coherence function. For this purpose, the simultaneous EEG-EMG activities of ten healthy subjects during standing, level walking, stair descending, stair descending, ramp descending, and ramp ascending are considered. The EEG signals associated with the motor cortex region and EMG signal of Tibialis Anterior (TA) are subjected to magnitude squared coherence function. In addition, the interaction of conventional frequency bands of EEG, namely, alpha (8-12 Hz) and beta (14-30 Hz) spectral components with EMG signals are also analysed. The results show that there exists notable coherence between the electrical activities of brain and muscular system during various activities. In addition, the frequency band interactions are also found to be distinct for different activities. Therefore, it seems that the analysis could be extended for the evolution of corticomuscular functions in patients with stroke.

Keywords. EEG, EMG, Corticomuscular Coherence, Magnitude Squared Coherence (MSC).

INTRODUCTION

The cortico-muscular coherence (CMC) is generally used toexamine functional connection between a human brain and muscles. It represents the relationship between the electroencephalogram (EEG), the recordof brain activity, and the electromyogram (EMG), the record of the activity of a muscle contraction [1]. It has been reported that the coherence analysis helps to understand the behaviours of cortical functions in patients with stroke [2]. In addition to this, the simultaneous EEG-EMG analysis plays a vital role in the diagnosis of neurological disorders such as dyskinesia [4] and to identify the root cause of central fatigue. It has also been used in the the neural machine interface [3] and functional rehabilitational research [5, 6].

In recent years, researchers have shown interest in developing neural machine interface (NMI) using multimodal signals such as EMG and EEG [7]. These simultaneously recorded EEG and EMG signals have been analyzedusing magnitude squaredcoherence (MSC). It measures the similarities associated with the frequency components of EEG and EMG signals [8]. Recently, wavelet coherence [9], and symbolic transfer entropy (STE) techniques have been utilized to assess the functional connection of brain and muscular system under varied movements [10]. There are only a very few studies have been reported that are based on the brain and low limb activities.