Estimation of the upper arm motor deficit in stroke patients using EMG signals – a preliminary study

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Abstract
An ischemic or hemorrhagic stroke destroys the main control functions of human limbs generated in the brain, preserving the spine nerve pathway and the muscle-nerve complex of the limbs unaffected. The damage is primarily in the limb movement control. To restore the normal limb motions of these patients after the initial critical period, proper rehabilitation is of major importance. The estimation of the limb motor deficit and the effect of rehabilitation can be successfully performed using surface electromyographic signals (EMGs) recorded from corresponding muscles. Using this approach, the control signals from the nervous system and the muscle synergies can be estimated and followed during rehabilitation.

The EMGs were recorded by means of Telemyo 2400T G2 8 channel electromyography and kinematics measuring system (Noraxon USA, Inc.). The electrodes were placed over seven muscle spots of the upper limb: m.deltoides (pars clavicularis, pars acromialis and pars spinata), m.biceps brachii, m.triceps brachii (caput longum and caput laterale) and m.brachioradialis. Several postures and movements were investigated first on the unaffected upper limb (dominant for a control subject) and after that on the affected limb (non-dominant for a control subject). One stroke patient and one control subject were examined experimentally. The EMGs were stored on the hard disk and further processed by custom-made software. It includes power-frequency distribution analysis, filtration (low-pass and high-pass), rectification, smoothing and normalization.

The way of data processing and the experimental procedure (complex of appropriate motor tasks) were evaluated. The processed signals were compared between the left and the right hand and between a patient and a control subject. The differences in the synergistic and the antagonistic activity between the unaffected and the affected upper limb are discussed.

Keywords: Stroke, muscle, EMG signals, muscle coordination