Chapter 40
Introductory Analysis of Human Upper Extremity After Stroke

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ABSTRACT

The most reliable prognostic factors associated with upper extremity (UE) recovery are localized motor impairments, especially in the musculature of the hand and abduction of the shoulder in the first days after a stroke. An evaluation of the biomechanics of the hand allows an accurate identification of the motion arcs of the digital joints. This article includes an assess the prognostic value of the range of motion of the finger joints using an instrumental glove (CyberGlove II®) for the time one week after stroke for UE functional recovery. A prospective, longitudinal, observational study is made with follow-ups at 3-4 days, 1 week, 3 and 6 months of the patients with UE motor impairment. Variables collected included: demographic data, level of stroke severity (NIHSS), deep sensitivity, sphincter incontinence, Fugl Meyer assessment of UE (FM-UE), muscle balance with the Medical Research Council (MRC), muscle tone (Modified Ashworth Scale) and pre- and post-stroke functional ability (Barthel Index and Modified Rankin Scale).

INTRODUCTION

Stroke is one of the leading causes of death in industrialized countries as well as of disability and economic cost in adults. Stroke is associated with a connotation of poor prognosis and difficult recovery. It has an impact at personal, family, social and work level, in addition to producing a high expenditure for all health and social services.

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Therapeutic advances of the last years, both in prevention and in diagnostic and therapeutic complexity, have determined a change in stroke management towards the multidisciplinary approach and the creation of specific units that has led to a significant decrease in mortality and its sequels.

Most studies on the evolution and functional prognosis of patients with acute stroke are focused on the assessment of gait recovery and the performance of daily life activities. Predictors of survival, hospital discharge, hospital stay, and overall motor recovery have also been described. Studies on the prediction of recovery of specific neurological deficits, such as upper extremity (UE) function, have been increasing in recent years. In this sense, in the last years there are more studies on the specific evaluation of the functional recovery of the UE after having suffered a stroke. This increase in the prevalence of this type of clinical research could also be due to the recent development of validated predictive measures of motor function of UE useful also to establish appropriate therapeutic programs (Chen and Winstein, 2009).

Approximately 70-80% of patients with stroke have deficits in UE in the acute phase and 40% in the chronic phase (Nakayama et al., 1994, Broeks et al., 1999). These deficits limit voluntary movement, coordination, sensitivity, level of physical activity, as well as the realization of activities of daily living (Feys et al., 1998). This aspect implies a limitation and difficulty in their reintegration in their socio-labor environment (Nakayama et al., 1994) and it affects their quality of life (Nichols-Larsen et al., 2005).

Carrying out studies on prognostic factors of the functionality of UE paresis in people who have suffered a stroke is important because of its incidence, its prevalence, its sequels and disability, and its difficulty to predict recovery and functional prognosis of UE.

In another line, several authors are working in design and built an exoskeleton to help rehabilitate UE after stroke. In this sense, (Durairajak et al., 2018), work in a low-cost hand exoskeleton that is design and developed for rehabilitation while the safety rules and regulation kept in mind. Xiao et al. (2018), proposes seven degrees of freedom cable-driven upper limb exoskeleton (CABXLexo-7), which is compact, lightweight, and comfortable for post-stroke patients. For wrist rehabilitation (Saadatgi et al., 2018) presented an experimental implementation and comparative accuracy evaluation of five methods for estimation of human-robot interaction torques are. For rehabilitation of post-stroke patients (Plitea et al., 2017) presents the kinematics of an exoskeleton-based robot for elbow and wrist. There are representative works in rehabilitation after stroke, however, we propose a study that obtains data that can help to build and design these exoskeletons.

Therefore, the involvement of UE and specifically the hand in diseases such as stroke implies in these patients a significant alteration in the performance of many activities of daily living, as well as motor, sensory and body expression limitations that can seriously affect the relationship of these people with their environment.

Alt Murphy et al. (2018) work in kinematic analysis method for objective assessment of upper extremity movements in a three-dimensional (3D) space. In Department of Clinical Neuroscience at Institute of Neuroscience and Physiology at University of Gothenburg an active group are doing research in stroke based in kinematic analysis (Alt Murphy et al., 2017; Olsson et al., 2017).

The aim of the present study is the simulation in patients at the beginning and at the end of six months of suffering from a stroke. The intention of this work is to show a novel virtual environment to simulate the improvement of the functions of the upper extremity a few days after having suffered a stroke and to simulate its recovery under a rehabilitation program.

This document continues with a section of materials and methods. Next section is dedicated to the results, the next section is the discussion and it ends with the conclusions.