Simulation of virtual human hand evolution after stroke

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1. Introduction

Different types of neurological deficits and sequels in the upper extremities that affect the activities of daily living (ADL) in patients who have undergone stroke have been analyzed from a subjective clinical point of view (Kaldra et al. 2007; Valhlberg et al. 2008). Prognosis recovery after stroke depends on many factors, among which is included an individualized program of rehabilitation and cooperation of patients. Murphy et al. developed and tested a method of three-dimensional motion analysis for the activity “drinking from a glass” and described the drinking task kinematic variables in control subjects.

2. Practice innovation

Simulation in patients in the beginning of stroke. The aim of this work is to show a novel environment to simulate the initial improvement of the upper limb functions a few days after stroke and simulate the functional recovery of patients under a rehabilitation program.

3. Methods

Eighteen patients in the first seven days of stroke were selected. Inclusion criteria: over eighteen years old, collaborative patients, good cognitive level, and neurological deficits in upper limb poststroke. We measured the deficits of angles, lengths and range of motion for arm and hand affected; we also used four validated tests as clinical measures (NIH stroke scale (Goldstein, 1989), Fugl-Meyer arm subtest (Fugl-Meyer, 1975), Barthel’s Index (Mahoney, 1965), and Rankin test). After six months of rehabilitation program under supervision of a physician, we made a last evaluation of these deficits with the same measures and tests, and we included the Action Research Arm Test (ARAT) to assess the outcome of arm function. These measures were implemented in a virtual environment (Figure 1) with 29 DOF for each arm and hand (Peña-Pitarch, 2012).

Five men and thirteen women participated in the experiments. Out of the eighteen participants, sixteen had the right hand dominance and two the left hand dominance; eight suffered stroke in the right hemisphere and ten in the left hemisphere. After six months, six of them recovered all the functionality of the hand tested with the ARAT test and wearing a Ciberglobe system, five recovered part of the hand functionality, and seven did not show apparent recovery functionality of the hand.

4. Discussion

Virtual human simulation of arm and hand in patients affected by stroke gives an objective new tool for physicians that permits to simulate the evolution of deficits in some patients. Relevance of this work for patients affected by these deficits is that already in their first visit to a physician, it is possible to know through the simulation, the evolution of their functional recovery in time. Another relevance is that the model arm and hand is implemented with parametric lengths and we will extrapolate to another patients affected with the same deficits. Finally, we will give the ergonomist data of the hand movement and will help to design new products for the target people that have a partial improvement after rehabilitation program.
Figure 1.  Left ARAT environment with a patient. Right virtual simulation environment.

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References