CLINICAL EVALUATION OF THE UPPER EXTREMITY MOTION IN SUBJECTS WITH NEUROLOGICAL DISORDERS

Joan Lobo-Prat (1), Josep M. Font-Llagunes (2), Josep Medina-Casanovas (1), Rosa M. Angulo-Barroso (3)

1. Institut Guttmann, Spain; 2. Universitat Politècnica de Catalunya, Spain; 3. INEFC, Universitat de Barcelona, Spain

Introduction

Cervical spinal cord injury and acquired brain injury commonly imply a reduction of the upper extremity (UE) function which complicates, or even constrains, the performance of basic activities of daily living (ADL). Neurological rehabilitation in specialized hospitals is a common treatment for patients with neurological disorders. Patients' progress through a complex rehabilitation process has to be systematically evaluated. Unfortunately, clinical assessment of upper extremity functional capacity is less advanced than that of the lower extremity. Furthermore, it is currently too dependent on subjective, qualitative observational motion analysis, which is highly based on intuitive understanding of human motion [Williams *et al.*, 2006]. Basing the physician's experience on an objective quantification of the rehabilitation progress is necessary to improve clinical treatment methods and rehabilitation strategies, and to prevent further injuries [Slavens and Harris, 2008]. This work presents a practical methodology for the objective and quantitative evaluation of the UE motion during an ADL in subjects with neurological disorders.

Methods

We defined a biomechanical (BM) model to carry out a kinematic and dynamic analysis of the UE motion during a reaching task through data acquired by an optoelectronic system BTS SMART-D with 6 cameras and a sampling frequency of 140 Hz. The BM model used (Fig. 1) consisted of 10 rigid segments and had 20 DoF. The reaching task was repeated for nine target positions (combination of 3 widths and 3 heights) at the maximum distance that can be reached by the subject. In addition to the model, we described a new processing and analysis methodology designed to present relevant summaries of BM information to rehabilitation specialists. The method was tested on a total of 6 subjects: 3 healthy and 3 pathological. The analysis was implemented using the software Kwon3D XP and customized programs using the statistics software R.

Results

An interactive clinical report was created to present an objective and quantitative summary of relevant biomechanics of the subject's UE motion.

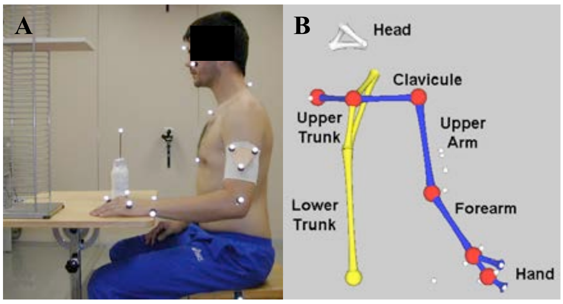

Figure 1: A) Set-up for the acquisition of motion data of the upper extremity. B) Schematic representation of the biomechanical model.

The clinical report includes 4 main sections: (i) Kinematics, (ii) Kinetics, (iii) Trajectories and (iv) Motor Coordination. Section (i) presented the angles for each DoF of the 3 main arm joints (shoulder, elbow and wrist) and the grasp motion. The Kinetics section provided joint moments and muscular power at the 3 arm joints. The Trajectories section includes 3D and 2D views of the BM model. Finally, the Motor Coordination section made possible the analysis of the joint motor coordination, motion patterns and control of the elbow and shoulder flexion-extension by means of the Phase Portrait and Phase Angle methods [Angulo-Barroso *et al.*, 2010, Angulo-Barroso *et al.*, 2011]. The clinician could select the variables to display.

Discussion

In contrast to previous UE models, the present model includes the analysis of the grasp motion, a motion considered as crucial by clinicians. The resulting set of biomechanical measurements, which are reported according to clinical standards, provides valuable information for clinicians to achieve a thorough understanding of the UE motion during an ADL in patients with neurological disorders.

References

Williams *et al.*, J Biomech, 39: 2419-2429, 2006.

Slavens & Harris, Crit Rev Biomed Eng, 36:93-125, 2008.

Angulo-Barroso *et al.* Apunts Educació Física i Sport, 102, 49-61, 2010.

Angulo-Barroso *et al*, Apunts Educació Física i Sport,103, 38-47, 2011.