ANALYSIS OF HAND BIOMECHANICS USING A SENSORISED GLOVE

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INTRODUCTION

The co-ordination among hand joints has been widely accepted as a strategy implemented by the Central Nervous System (CNS) to reduce the computational load of the natural control of highly redundant movements (Bernstein, 1967) as the ones involved in manipulation. The aim of this paper was to verify whether a sensorised glove can be used as a tool for the analysis of hand synergies in different experimental conditions.

METHODS

The posture of the hand of the subjects was recorded by using the 20 Hall-effect sensors embedded in a commercial glove (Humanware srl, Pisa, Italy). The sensors can provide information concerning the abduction/adduction of the fingers and the flexion/extension of the joints of the fingers.

A. Protocol of the experiments on rizarthrosis

Three able-bodied subjects (with no known hand diseases, aged 27-35) and five subjects affected by rizarthrosis with trapezio-metacarpal sub-luxation (aged 66-78) participated in this study after providing informed consent. Starting from a rest position (defined as the condition of electromyographic silence), different grasping tasks were carried out by the subjects.

B. Protocol of the experiments in weightlessness

The experiments were performed in the framework of the “ESA Parabolic Flight Campaign”. Two right-handed subjects (age 21-23 yrs) with no known neurological disorders and no previous experience participated in this study after giving informed consent. After donning the glove, the subjects had to catch a ball launched by another subject located in front of them. The subjects were in a seated position, with their back against the wall, their feet leaning against a footrest, and their pelvis secured by a belt. The experiments were carried out on earth and in weightlessness.

C. Data analysis

The data were processed by using the Principal Component Analysis (PCA) technique transforming a set of initial variables into another reduced-dimension set of uncorrelated variables, the PCs (Cohen, 1996).

RESULTS AND DISCUSSION

In Figure 1, the projection on the first two PCs of the different subjects is shown for the experiments on rizarthrosis assessment. The PCs proved to be able to discriminate not only between able-bodied and disabled persons but also between persons who received a surgical intervention and persons who are still waiting for it.

In Figure 2 the ratio $\kappa$ between the first and second PCs is given for one subject during microgravity. The results showed that $\kappa$ was quite small during the trial at 1g while becoming significantly greater than 1 during the first parabolas. Then, the value $k$ decreased to the values at 1g after some parabolas. These results suggest a possible adaptation process of the manipulation abilities during the permanence at 0g conditions.

SUMMARY

The aim of this paper was to analyse the feasibility of using a sensorised glove as a tool for the assessment of hand function in able-bodied and disabled persons. The glove was used to assess the performance of the hand in two different experimental conditions. The data were processed by using the PCA technique. The preliminary results of these experiments showed that this approach can provide important information on hand biomechanics. Further experiments will be carried out in the future in order to confirm these preliminary results.

REFERENCES


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