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SIMULATION OF KINEMATIC OF UPPER LIMB OF DUCHENNE MUSCULAR DYSTROPHY PATIENTS FOR PERFORMING CUSTOM-MADE EXOSKELETON

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INTRODUCTION

Duchenne muscular dystrophy (DMD) is a genetically conditioned, progressive disorder. At present, it is not possible to cure this disease, the modern treatment used only delays its inevitable progress. The effect of disease progression is the gradual loss of walking and standing in the second decade of life (teenage age). In subsequent years, patients move on electric wheelchairs gradually losing the function of upper limbs, i.e. the possibility of being independent in self-service e.g. eating, washing, dressing and undressing due to gradual weakening of the shoulder girdle muscles, and further on the arms and forearms. As the last one, the independent hand function is maintained, enabling the use of a mobile phone, laptop, trolley driver or electric bed located at the patient's waist level.

The aim of the study was testing upper limb performance of Duchenne muscular dystrophy (DMD) patients and control group (healthy young) by using principles of the PUL and DMDSAT test [1,2]. These kinematic patterns will be performed by using custom-made upper limb exoskeleton.

METHODS

Tests were performed by using the dominant upper limb: abduction-adduction motion in the frontal plane; lifting a 50/200/500/1000 g weight from the waist height to the shoulder height; lifting a 50/200/500/1000 g weight from the waist height above the head; moving 100/200/500/1000 g weight on the table (on the waist height); raising an arm with a 50/200 g weight from the waist height; moving, lifting and stacking light/heavy cans on the waist height; tracing a path on the waist height; supination; picking up coins; performing a giving grip; transferring a given weight from the initial position to the given position; raising the arm to the eyes height and tip of the head; bringing food/cup to the mouth; placing fingers on the diagram and pressing the electronic device. The control group results will be used to create individual kinematic patterns for the chosen DMD patient.

RESULTS AND DISCUSSION

The solution for supporting the patient's movement functions with DMD performs the guidance (guidance mode) and assistant (assist mode) functions based on the patient's current condition (e.g., Fig. 1), the type of movement intended to be performed (e.g. raising a hand to the mouth or lifting a given weight to a given height) and external interactions (e.g., gravity field). It is also necessary to protect the possibility of frequent calibration of individual modes of operation of the proposed solution based on periodic checking of the patient's DMD movement functions, which deteriorate over time due to the inevitable progression of the disease. The setting of specific work modes should be based on the patient's functional assessment using specialized tests. The use of ICT technology will allow the processing of personalized data collected from sensors (including surface electromyography [3] and grip sensor), the collection of these data and their application to control the work of the executive components of the proposed solution.

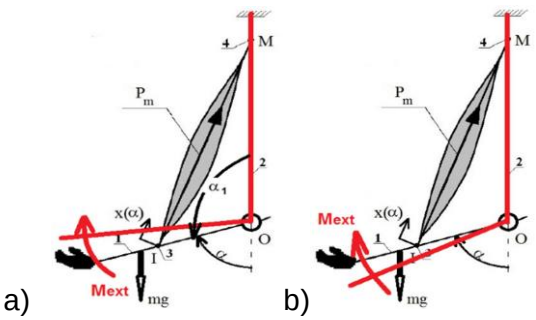

Fig 1: Guidance mode (a) and assist mode (b) functions [4]

CONCLUSIONS

The proposed solution implements two operating modes (guidance mode and assistance mode). Calibration of each operating mode will be performed after performing functional tests and obtaining kinematic patterns and providing guidelines from the rehabilitation team.

Ensuring implementation by solving the possibility of adapting the work based on data from two diagnostic systems, i.e. surface electromyography and a grip sensor.

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The 'e-Pionier - using tertiary education institutions' potential to boost ICT solutions in the public sector, WG-POPC.03.03.00-00-0008/16-00, Custom-made device to assist the motor functions of the upper limb with muscular dystrophy.