Summary

Introduction

Gait and posture disturbances are one of the most common problems in children with CP. The clinical studies presented in this thesis, broaden the current knowledge on movement abnormalities in children with CP and allow us to better understand and describe the pathophysiological mechanisms of these disorders.

Aims

Study 1 – To prove the hypothesis that early knee recurvation is caused by a dynamic equinus deformity and late knee recurvation is linked to the fixed equinus deformity. Second aim was to analyze the role of hamstrings in the pathobiomechanics of the knee recurvatum.

Study 2 - To evaluate the function of the triceps surae during walking when either dynamic triceps surae tightness or a fixed equinus contracture is present in children with CP.

Study 3 - To perform a comprehensive analysis of the short-term effects of a standardized dose of Botulinum toxin A (BTX-A) and serial casting on spastic equinus.

Study 4 - To compare nondimensional normalization of energy cost of walking in children with CP to clinically used body mass normalization scheme.

Study 5 - To evaluate the evolution of different gait parameters over a period of nine months following corrective soft tissue surgery in children with CP.

Methods

Computerized kinematic and kinetic three-dimensional gait analysis together with musculoskeletal modeling, dynamic electromyography and evaluation of energy expenditure while walking were used to answer the hypotheses.

Subjects

The presented studies were performed in different groups of children with spastic cerebral palsy. They were at level I-III according to the Gross Motor Function Classification Scale.

Results

Study 1 - Early knee recurvation is caused by a dynamic equinus deformity and the late knee recurvation is linked to the fixed equinus deformity. Hamstrings are abnormally long at initial contact and operate over a wider range of muscle-tendon lengths. Abnormally long hamstrings together with equinus at initial contact are the main causes of genu recurvatum.

Study 2 - The rate of change of muscle-tendon length was newly defined as a promising parameter to distinguish between fixed and dynamic equinus gait in children with CP.

Study 3 - The study demonstrated beneficial functional changes in ankle kinematics and kinetics after the application of BTX-A when combined with serial casting. There was no increase in peak triceps surae length. The application of BTX-A might have a more significant influence on muscle spasticity than on muscle growth.

Study 4 - The net nondimensional VO_2 was able to detect the postoperative improvement of gait efficiency with smaller variability compared to standard mass relative normalization.

Study 5 - Some important gait parameters (push-off range of motion at ankle joint) did not recover to preoperative level until nine months postoperatively. There is an obvious period of gait deterioration after a corrective surgery in CP patients.

Conclusions

Studies presented in this thesis enhance the up-to-date knowledge in the field of pathophysiology of movement disorders in children with CP. Based on the literature review, our team was the first one to introduce the three-dimensional gait analysis in children with CP in the Czech Republic. In cooperatin with the Medical University of Graz and University Duisburg-Essen, Institute of Mechatronics and System Dynamics new technique of the dynamic muscle length modeling was introduced. Outcomes of our clinical studies have a direct implication in the treatment strategy of children with cerebral palsy.