

An integrated approach to movement function

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Theoretical background

A comprehensive model of a balancing human includes the inputs that influence the neuro-musculo-skeletal system (vision, proprioception and the vestibular system), the processes of the central and peripheral nerve system, and the outputs which are the three-dimensional movements of the body. The CAREN system (MOTEK, Amsterdam, The Netherlands) is the only super-system available commercially at present which combines various tools in an integrated environment in a way that gives control over the standing subject's proprioception, vision and vestibular system, and registers the person's responses by recording quantitative measures of movement. The equipment includes a software driven six degrees of freedom movable platform together with a virtual reality video screen and a complete clinical motion analysis system including a Vicon system, video, force platforms, analogue inputs, and electromyography.

Projects completed or ongoing in the laboratory

Kinematic response characteristics of the CAREN moving platform. The aim of this study was to determine the technical performance of the CAREN system by defining its kinematic response characteristics to two commonly used input functions (sine and ramp) for each of its six translational and rotational axes. The results suggest that the CAREN platform is a mid-range system with regard to single degree of freedom moving platform devices reported in the literature. The low level of maximal cross-talk in displacement (1.5%) and velocity (3.3%) together with the ability to faithfully follow ramp input functions make the CAREN system an appropriate device for postural and balance research with some unique features.

Manipulation of the axes of rotation of the CAREN platform. The purpose of this study was to locate the CAREN platform's default axes of rotation, implement an algorithm for relocating its axes of rotation, and evaluate the algorithm. The method developed allows rotating the supporting platform around specific joints which triggers proprioceptive receptors in the targeted joint only and so the method opens up the possibility of gaining a more detailed understanding of the roles of individual joints in balance corrections.

The effect of exercise on postural and movement function in older people. The aim of this ongoing study is to investigate the effects of a one-year aerobic exercise intervention for 60 year old individuals on the posture and balance of activities that relate to mobility and daily living. The expected improvements are measured during locomotor tasks (normal gait and walking across an obstacle), daily living activities (sit-to-stand, stepping up, lifting and turning), and balance tasks (Romberg test, dynamic balancing task and dynamic balancing on a moving surface).

The effect of balance training on postural control in children with CP. Recent studies suggest that short term intensive training in reactive balance control improves postural stability which manifests in faster muscle activation, emergence of a proximal to distal muscle sequence, and reduced co-contraction. The aim of this ongoing study is to devise optimal balance training protocols and to quantify the effects on standing balance and gait, followed by transferring the findings to hospital or community environments.

Biomechanical assessment of upper limb function following tendon transfers in tetraplegia. Following a tendon transfer, an identical activation pattern of the same muscle will lead to a different mechanical action coupled with changed proprioceptive and visual feedback about the task. The focus of this ongoing project is to explore the re-adaptation mechanisms of the neuro-musculo-skeletal system. The aims are to quantitatively assess the upper limb function of tetraplegic patients before and after deltoid-to-triceps tendon transfer surgery, and to develop a rehabilitation protocol based on bio-feedback to enhance functional recovery.