THE INTERFACE BETWEEN BIOMECHANICS, NEUROSCIENCE AND REHABILITATION THERAPIES

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The goal of this presentation is to discuss research efforts by myself, my colleagues and other investigators over the last 15 years aimed at assessing and improving motor functioning in cerebral palsy (CP) as an example of using biomechanical techniques and principles to provide insights into neurological disorders. All motor deficits in a person with a central nervous system injury were long believed to be a direct consequence of the neural damage. The development and utilization of biomechanical measurement tools in neurorehabilitation have lead to challenging the primacy of the neurophysiological explanation. To illustrate this are two biomechanical observations that have had a major impact on treatment prescriptions in CP and other rehab populations: 1) that weakness in the lower extremities explains more of the variation in gait speed and function than spasticity, and 2) that not all resistance to passive movement is of neural orgin and may be due instead to structural changes in muscles. Another prevalent clinical myth was that spasticity underlies abnormal joint coupling. While it is likely that other neurophysiological mechanisms contribute to abnormal movement syneriges, biomechanical ‘coupling’ can also occur as a result of tightness, especially in two-joint muscles.

Although peripheral alterations can impair motor functioing, the hallmark of CP is motor incoordination, the origin of which is in the central nervous system. Quantifying coordination deficits using biomechanical tools is more challenging than quantifying strength, spasticity or stiffness. Improving coordination in a chronic neuromotor disorder was an elusive goal for decades. However, with the advent of more intense training paradigms, this now appears possible and biomechanical changes have been corroborated by changes in neural pathways. We will demonstrate some of our recent very preliminary investigations aiming to elucidate the neural mechanisms underlying coordination and coordination deficits in the lower extremities using motion analysis technologies, force plates and EMG systems. Our current interests are on investigating the sensory pathways in CP and using these to help drive adaptive changes in motor pathways and in undesrstanding abnormal sensorimotor disorders such as dyctonia. Quantifying motor coordination and altering the pathways in the spinal cord and brain that produce coordinated movements are the new frontier that is bringing biomechanics and neuroscience even closer together to fundamentally alter rehabilitation potential.