行政院國家科學委員會專題研究計畫 期中進度報告

肌肉震動對中風患者步行控制之效果

計畫類別：個別型計畫
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執行單位：國立成功大學物理治療學系

計畫主持人：林桑伊

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心得報告  林桑伊

第五屆世界生物力學大會

第五屆世界生物力學大會於 95 年 7 月 29 日至 8 月 10 日於德國慕尼黑舉行，於會議中報告已下論文

1. Effect of weight bearing on ankle joint position sense

**Background:** It is known that joint proprioceptive inputs play a major role in joint position sense (JPS). Muscle vibration that selectively activates primary muscle afferents has been found to lead to erroneous JPS in the upper extremity joints. The lower extremity joints frequently function while bearing the body weight. It is unclear if weight bearing (WB) would influence ankle JPS and if erroneous proprioceptive inputs induced by vibration would affect this process. The purpose of this study was to investigate the effect of WB and muscle vibration on ankle JPS. **Method:** Fifteen healthy young adults participated in this study. JPS was measured by joint repositioning test that required the subjects to perform ankle dorsiflexion (about 10°) from the resting position, stop motion, memorize the joint angle, return to the resting position, and then dorsiflex the same ankle again to the memorized angle. The test was conducted in seated position under 3 WB (0, 25%, 50% body weight) and 3 vibration (no, Achilles tendon, tibialis anterior) conditions. In non-weight bearing, both legs were suspended, while in other conditions WB percentage was manipulated by changing the chair height. Vicon 460 motion system was used to record the ankle joint angle. The angle difference (△angle) was defined as the absolute value of the difference between the final angles of the 2 ankle dorsiflexion movements. Repeated measure ANOVA was used to test vibration by position effect. **Result:** There was no significant vibration main effect or vibration x WB interaction. The △angle was significantly larger in non-WB (2.32±1.79°) than in 25% WB (1.58±1.38°) or 50% WB (1.73±1.52°). **Conclusion:** Somatosensory inputs from WB helped to increase the accuracy of ankle joint repositioning. What is more, this effect did not seem to be affected by erroneous proprioceptive inputs. Thus, somatosensory inputs from WB might have greater contribution than proprioceptive inputs in ankle position sense.

2. Effects of sensory deficits on limits of stability in patients with diabetic sensory neuropathy

**Background:** Somatosensory inputs from the sole of the foot are known to contribute to postural control. Research has shown impaired control in static standing and balance recovery after support surface perturbations in diabetic patients (DP) with sensory deficits at the foot. However, it is unknown if patient’s ability in moving the body’s center of mass (COM) toward the limits of stability would be associated with the extent of sensory impairment. **Purposes:** This study investigated the ability to move the COM forward in DP with sensory deficits, and to identify potential contributing factors. **Methods:** Ten DP participated in the study. Touch-pressure sensory threshold was tested by
Semmes-Weinstein monofilaments. Functional Reach Test that required the subject to reach forward as far as possible without losing balance or moving the feet, was used to measure the ability to control the COM forward. Body kinematics were recorded by VICON motion system. Timed Up-and-Go test was conducted to measure basic mobility. The plantarflexor strength was measured with standard Manual Muscle Testing. Spearman’s test and linear regression were used for correlation analysis and regression analysis to identify potential contributors (age, duration of diabetes, sensory threshold, strength, basic mobility) to COM displacement. **Results**: The range of COM forward displacement during the reach test was significantly correlated with the sensory threshold of the first metatarsal head (r=-0.721) and big toe (r=-0.699), and basic mobility (r=-0.796), but not other factors. Regression analysis identified sensory threshold of the big toe and basic mobility as significant contributors to COM forward displacement ($R^2$=0.834). **Conclusion**: The ability to move the COM forward toward the limits of stability was poorer in patients with greater sensory deficits and poorer basic mobility capacity. Clinically, special attention in fall prevention and balance training should be given to these patients.

### 3. Post-effects of vibration on Achilles tendon in different postures during walking

**Background and Purpose**: Integration of sensory inputs from different parts of the body for constructing proper sensory reference is crucial for locomotion control. It is unclear how interference induced by erroneous ankle proprioceptive inputs before locomotion would be affected by cutaneous inputs from the foot sole. The aim of this study was to investigate the effect of cutaneous input on pre-locomotion sensory integration of conflicting proprioceptive inputs. **Methods**: Fifteen healthy young adults participated in the study to walk on a pressure-sensor walkway (GAITRite) normally (CONTROL) and immediately after vibration for 1 min. To induce conflicting ankle proprioceptive inputs, mechanical vibration was applied to bilateral Achilles tendons of blindfolded subjects in 2 seated positions: feet placed on the ground (Sit-G), and feet suspended (Sit-S). These 2 conditions differed in the amount of cutaneous inputs from the foot sole. Each walking condition was repeated twice, and the standard deviations were used to represent performance variability. Multivariate repeated measures ANOVA was used to compare the means and variability of gait spatial (normalized to body height) and temporal characteristics. **Results**: Between CONTROL and the 2 vibration conditions, the mean step length (p= 0.001 for Sit-S, p=0.045 for Sit-G) and stride length (p=0.002 for Sit-S, p=0.050 for Sit-G) were greater in CONTROL, while the mean velocity was larger in CONTROL than in Sit-S (p=0.050). Greater variability in step length was found between Sit-G and Sit-S (p=0.003). Differences in base of support width and step time were not significant. **Conclusion**: Erroneous ankle proprioceptive inputs before locomotion were associated with poorer locomotion control. Furthermore, the addition of foot sole cutaneous inputs appeared to further deteriorate locomotion. It seemed that ankle proprioceptive inputs might play a greater role in constructing the sensory reference system for locomotion control than the foot sole cutaneous inputs.

### 4. Effect of different movement patterns on functional reach
**Background and Purpose.** Functional reach test (FRT) is frequently used to measure dynamic standing balance. It is not clear if reach strategy would affect the association between reach distance and dynamic balance ability. The purposes of this study were to investigate the extent to which reach distance reflected dynamic balance and the contribution of movement kinematics to reach performance.

**Methods.** Twenty-two young adults performed FRT involving standing with the feet shoulder width apart, raising one arm 90°, and then reaching forward as far as possible without moving the feet or losing balance. A 6-camera VICON motion system was used to record the body kinematics. A hip strategy (HIP-S) was defined as having the ankle move in the plantarflexing direction during reaching. An ankle strategy (ANKLE-S) was defined as beginning reaching with ankle dorsiflexion and with total hip flexion range smaller than 15°. The variables of interest were reach distance, range of center of mass (COM) forward displacement, range of trunk, hip, and ankle angular displacement, and hip-trunk ratio (ratio between trunk and hip flexion to represent contribution of hip flexion to trunk forward rotation). **Results.** Overall, reach distance was significantly correlated with the range of COM forward displacement (r=0.707). In HIP-S, reach distance and COM displacement significantly correlated with COM displacement (r=0.858) and trunk-hip ratio (r=0.660), respectively. In ANKLE-S, reach distance significantly correlated with COM (r=0.912) and trunk forward rotation (r=0.880). Overall, COM displacement and trunk rotation were significant predictors for reach distance (R²=0.878). Specifically, trunk-hip ratio (R²=0.435) and trunk forward rotation (R²=0.676) were significant predictors of COM displacement in HIP-S and ANKLE-S, respectively. **Conclusion.** FRT appeared to be a valid test of dynamic balance ability, regardless of reach strategies. However, the contribution of the body kinematics differed between the hip and ankle strategies.

生物力學是研究動作、平衡與步態控制不可或缺的工具，也需要不同研究領域間的整合與創新，才能拓展研究範疇，而生物力學國際研討會正是達成此目的的最佳途徑。此次會議主要進行研究海報報告，根據其他學者意見檢討研究優劣之處；此外個人也聆聽相關研究的口頭報告，閱讀研究海報，參觀展覽廠商所擺設之作新儀器，並與研究人員交換心得與意見。當然也有幸得到許多寶貴的建議與指教。另也參加專題演講，並與各國同儕討論與交換意見。