EFFECTS OF CONTINUOUS PASSIVE MOTION ON LOWER EXTREMITY HYPERTONIA IN CHILDREN WITH CEREBRAL PALSY

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INTRODUCTION
Statistics showed that 70 to 80 percent of patients with cerebral palsy have spastic clinical feature, and the affected limbs often demonstrated muscular hypertonia and abnormal gait [1]. To avoid musculoskeletal deformities and improve gait characteristics in children with cerebral palsy, managing muscular hyperactivity is an important treatment goal. Recently researchers have found decrement of muscle hypertonia after continuous passive motion (CPM) treatment in patient with stroke and spinal cord injuries [2, 3]. Similar to stroke and spinal cord injury, cerebral palsy was also characterized with upper motor neuron lesion. However to date, no such application has been applied to children with cerebral palsy. The purpose of this study was to investigate the effects of CPM on lower extremity hyperonia in children with cerebral palsy. We hypothesized a decrease in muscle hypertonia and an improvement in ambulatory function could be found following CPM intervention.

METHODS
This study implemented a quasi-experimental design. A total of 10 children with spastic cerebral palsy with six-minute walking ability with or without assistive devices between ages 6-12 were included. All the subjects had hypertonia confirmed by Modified Ashworth Scale (MAS) scores at knee extensors greater than 1. Subjects were recruited from local hospitals and the informed consent was in accordance with institutional review board procedures at Chang-Gung Memorial Hospital. Subjects with the following conditions were excluded: 1) received lower extremity operation within 6 months; 2) received lower extremity Botox injection within 6 months; 3) knee joint contracture over 10 degree. Those who were taking oral anti-hypertonia medication such as baclofen were asked not to take any within 24 hours before the experiment.

All subject received CPM to the knee joints with angular velocity of 15 and 0 degree per second for 20 minutes, with a one-week interval between the two CPM interventions. Angular velocity of 15°/s was the experimental condition. The cyclic knee excursion was set between flexion 20° to 100°. For the control condition, subjects sat on the CPM device with both knees rested at 60° flexion for 20 minutes. The orders of the tests were counter-balanced. The control group could help distinguish a real tone-reducing effect caused by CPM movement from an effect caused by merely a 20-minute muscle relaxation. Variables measured included the Relaxation Index (RI) of the pendulum test of knee joints, the MAS scores, passive range of motion (PROM) of the knee joints, plus the timed up-and-go (TUG) and the 6-minute walking test (6MWT) for lower extremity functional evaluation. Electromyography (EMG) of the leg muscles were monitor during the intervention to ensure no active muscle involvement. The knee joint angle was monitored by electrogoniometer (SG65, Biometrics Ltd. USA) and collected via Biopac system with further analysis with Acqknowledge software (Biopac system, Inc., Santa Barbara, CA, USA).

Each of these variables was measured before and after each CPM intervention.

All data were analyzed using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA) statistical software. Descriptive statistics were used to calculate the means and standard deviations of the subject’s demographics. Friedman two-way analysis of variance (ANOVA) by ranks was used to analyze if the MAS scores have changed. All other measurements were analyzed with two-way ANOVAs with repeated measures on velocity (15°/s and 0°/s) and timing (pretest and posttest). The level of significance was set at p < 0.05.
RESULTS AND DISCUSSION
Five girls and five boys participated this study, with an average age of 8.28±2.42 years, height 135.62±10.23 cm. As expected, the EMG of leg muscles revealed that the muscles did not participate actively during the intervention. The Friedman ANOVA by ranks showed a statistically significant decrease of MAS scores ($\chi^2=9.25$, p<0.05). The MAS score after CPM at 15°/s was 1.08±0.51. The minimum significant difference for all pairwise contrasts indicated that differences existed between the MAS score measured after CPM at 15°/s and the MAS scores measured at three other timings.

Statistical significances were also found for RI values (Fig. 1). Post-hoc Tukey test revealed that the differences existed between the RI measured after CPM at 15°/s and three other RIs. No significant difference was found among PROM measurements. As for the ambulation tests, both TUG (Fig. 2) and 6MWT (Fig. 3) demonstrated statistically significant improvements (p<0.05). Post-hoc Tukey also revealed that the differences were found between the values measured after CPM at 15°/s and three values measured at other timings.

The MAS evaluates overall hypertonia and is commonly used for testing the efficiency of treatment in clinics. Our results demonstrated that CPM on the knee joint reduced the MAS score in the children with cerebral palsy. In stroke patients, it was also demonstrated that repeated passive movement induced a decrease in spastic hypertonia through a combination of reflexive and mechanical factors [4]. Since a good correlation was found between the severity of spasticity measured by the MAS and the RI measured with pendulum test [5], the significantly improved RI scores found in this study, like the results for MAS scores, supported that CPM could be effective in managing hypertonia.

No difference was found for PROM in the current study. The authors intended to avoid CPM excursion to the end range of knee joint to avoid the involvement of stretch effects. Therefore the results of PROM indicated that CPM at 15°/s did not contribute to muscle lengthening.

The authors included the TUG and 6MWT for the purpose of evaluating the immediate effect of CPM intervention on subject’s ambulation. Since existing hypertonia of the lower extremity in children with cerebral palsy often disturbed their gait characteristics and performance, it was expected that decreased hypertonia would improve ambulatory function. The results of TUG and 6MWT provided a direct evidence of the contribution of hypertonia and its influence on ambulation.

CONCLUSIONS
The current study demonstrated that CPM to the knee joint at an angular velocity of 15°/s for 20 minutes decreased muscular hypertonia and improved ambulatory function in children with cerebral palsy. Whether the effects would last for a longer period of time and demonstrate clinical significance need further investigation.

REFERENCES