

Commentary on Clinical Feasibility of the Crossed-Education Using the Task-Oriented Approach on the Tilt Table in Stroke Patients

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Abstract

This commentary regards the inferences of the findings related to the effect of crossed-education using the progressive task-oriented approach on a tilt table in stroke patients. The findings from these studies recommend that crossed-education using the task-oriented training on the tilt table was very helpful for the function and rehabilitation of lower limb and clinical scores in acute and chronic hemiplegic stroke patients. Since these publications, a novel neuro-rehabilitation strategy using the crossed-education approach has been reported instead of rehabilitation treatment method concentrated on the affected-side. This has not been used in any study with acute and chronic stroke subjects. Furthermore, follow-up study also obtained that the use of crossed-education using task-oriented training on a tilt table has more aids on the betterment of maximal grip strength and arm function in a sub-acute stage of post-stroke hemiplegia subjects. Therefore, our proposed therapeutic approach could be a novel neuro-rehabilitation strategy for patients with various upper and lower limb severities.

Keywords: Crossed-education; Hemiplegia; Neuro-rehabilitation strategy; Task-oriented approach; Tilt table

Introduction

This commentary considers the implications of the findings related to the effect of crossed-education using the progressive task-oriented approach on a supplementary tilt table in stroke patients described by Kim et al. [1,2]. There were a single-blinded RCTs studies allowing for comparisons between intervention using the crossed-education, a bilateral adaptation after unilateral training, on a tilt table and control groups on lower extremity (LE) motor recovery and functional task improvements. Additionally, follow-up study which single-blinded RCTs not yet published also obtained that crossed-education using the task-oriented training on a tilt table has greater aids on the betterment of maximal grip strength and arm function in a sub-acute stage of post-stroke hemiplegia subjects.

These articles [1,2] has been referenced 13 times. Of the ten publications in English with stroke subjects, seven were review articles. There were not any articles describing an intervention aimed to identify the crossed-education using task-oriented training on the tilt table in the stroke population that referenced the Kim et al. [1,2] articles. Moreover, one of the seven review articles, Ehrensberger et al. [3] investigated the proof regarding the implication of crossed-education in the rehabilitation of the post-stroke hemiplegic subject and its share in motor function recovery, and study quality of our articles [1,2] involved a review article [3] was assessed using the Cochrane risk of bias assessment tool [4] and the PEDro scale [5]. They reported that our studies were considered to have a low-risk of bias according to the Cochrane risk of bias assessment tool and eight out of 11 items in the PEDro scale were satisfactory. Furthermore, results also suggest a possible transfert of strength gains toward motor recovery and functional task improvements.

Task-oriented training is one of the most effective approaches currently available to improve functional activities. The load and task required to arrange an effective training stimulus is changeable and dependent on the individual's physical ability [6]. In related to this, tilt table is a method that has been used for over 60 years by clinicians such as physiologists and physicians as well as physical therapists for many purposes. It has also become a useful device in the mobilization of traumatic brain injured and spinal cord injured patients, as well as in patients suffering from acute stroke, under the supervision of

physical therapists. However, a more standardized and effective method for applying the tilt table as a supplemental assistant device in stroke patients has not been presented. Furthermore, although the presence of contralateral strength transfer has been reported [3], a conclusion regarding the underlying mechanisms could not yet be presented.

Therefore, we have measured the parameters of the various aspects for improving the effectiveness using the crossed-education effect on the supplementary tilt table, and we have presented the above research findings [1,2] in the end. This paragraph explains an overview of crossed-education using task-oriented training in our study and presents credible hypotheses for its mechanisms. Two hypotheses are outlined that represent the most viable clarification for crossed-education using task-oriented training.

Hypothesis I: Modification of Contralateral Motor (Cortical Motor and Spinal) Pathways

The first hypothesis is based on witness that unilateral voluntary contractions can acutely alter the excitability of spinal [7,8] and cortical [7,9] motor pathways that project to the contralateral side. For example, the corticospinal fibers are divided by lateral corticospinal tract and medial corticospinal tract [10]. About 85% of corticospinal fibers cross over at the pyramidal decussation to from the lateral corticospinal tract, while the remaining fibers from the medial corticospinal tract. The direct connection from the cerebral cortex to the spinal cord, the medial corticospinal tract, descends from the cortex through the internal capsule and the anterior brainstem [10].

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Hypothesis II: Crossed-Education Using Task-Oriented Training and Motor Control and Learning

The second hypothesis is that task-oriented training induces adaptations in motor areas that are predominately responsible for the control and execution of movements of the trained limb. The opposite hemisphere may access these modified circuits during voluntary contraction of the opposite untrained limb to enhance force output [11,12]. For example, a motor program theory of motor control has considerable experimental support. Experiments in the early 1960s studied motor control in the grasshopper or locust and showed that the timing of the animal's wing beat in flight depended on a rhythmic pattern generator [10]. Previous experiments led to the motor program theory of motor control. The term motor program may be used to identify a central pattern generator (CPG), that is, a specific neural circuit like that for generating walking in the cat [10]. Thus spinal CPG activity elicits rhythmic, repetitive, alternating flexion and extension movements of the hips and knees. Each of the lower limbs has a dedicated CPG. The reciprocal movements of the lower limbs during walking are coordinated by signals conveyed in the anterior commissure of the spinal cord [6].

Hypothesis III: Influence of Contralateral Muscular Afferents on Ipsilateral Reciprocal Inhibition

The third hypothesis is that there exists preliminary evidence to suggest that artificial activation of the contralateral Ia afferents and movements of the contralateral limb can acutely alter ipsilateral spinal circuits (e.g. reciprocal inhibition). Adaptations in these spinal circuits could potentially affect the ability to generate force. For example, in a pair of strictly antagonistic muscles, the agonist may be able to exert more force if it can inhibit its antagonist more effectively during contraction. Inhibition of Renshaw cells could also increase force-generating capacity because Renshaw cells are known to inhibit motoneurons (via the recurrent pathway) and Ia inhibitory interneurons projecting to the antagonistic motoneurons [6]. Therefore, attenuation of Renshaw cells may indirectly facilitate more efficient reciprocal Ia inhibition.

Major Limitation Applying for the Crossed-Education Effect on the Tilt Table in this Study

It is possible that the crossed-education effect using task-oriented training with less-affected side on the tilt table could be explained through three kinds of possible mechanisms mentioned above. Furthermore, training methods on the tilt table presented in our study can be easily applied to patients with stroke in clinical settings. However, although the favorable outcomes of crossed-education using the task-oriented training with less-affected side on the tilt table were demonstrated by the between-group and within-group comparisons, there is a major limitation to our study that can be corrected by further research. Crossed-education describes the increase in voluntary force-generating capacity of the opposite untrained limb that occurs as a result of unilateral resistance training [13]. Regard to this point, subjects performed task-oriented training with the less-affected limb while they were strapped by safety thoracic, pelvic and affected side knee belts in our experimental design.

As subject's weight was loaded on the affected side fastened by the strap belts of tilt table, then it might be given the stability to the affected side. That is, it could not have complete control over the affected side in our study and our results cannot be recognized as the crossed-education effect using task-oriented training with less-affected side on

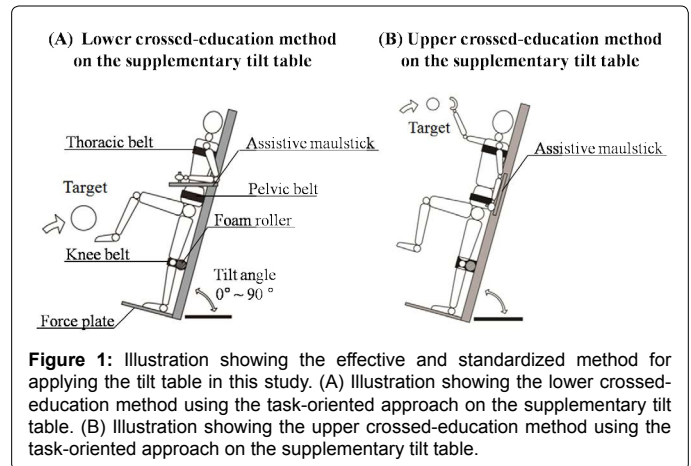


Figure 1: Illustration showing the effective and standardized method for applying the tilt table in this study. (A) Illustration showing the lower crossed-education method using the task-oriented approach on the supplementary tilt table. (B) Illustration showing the upper crossed-education method using the task-oriented approach on the supplementary tilt table.

the tilt table. Therefore, future studies would provide direct qualitative parameters during fully-supported trajectory tracking with controlling the affected side, measuring the biomechanical measurements such as force plate and electromyography recordings from the upper and LE muscles.

Conclusion

Overall recommendations and perspectives applying for the crossed-education on the tilt table in stroke patients

By demonstrating several significant findings in our studies [1,2], we showed that the crossed-education using the task-oriented approach on a tilt table facilitates a smooth transition to walking in the vertical position and thus, increases the effectiveness of rehabilitation and functional abilities of the patients. In conclusion, the present results indicated that crossed-education using task-oriented approach on a tilt table may also have a favorable effect on improving the walking function and LE muscle strength in acute and chronic stage of stroke patients. Furthermore, results of our follow-up study showed that there was a significantly greater increase in the Fugl-Meyer scale, maximal grip strength of the affected hand, and grip strength normalized to the less-affected hand in subjects who underwent crossed-education using task-oriented training on a tilt table compared with the control group post-test. Therefore, our proposed therapeutic approach (Figure 1) could be a novel neuro-rehabilitation strategy for neurological patients with upper and lower extremity severities.

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