The Effects of Dual Task Training Including Eye Movement on Visual Motor Function and Gross Motor Function in the Children with Spastic Cerebral Palsy with Ocular Anomalies : Pilot study

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Purpose The purpose of this study was to determine the effects of visual motor function and gross motor function, through to conduct dual task training include eye movement into children with spastic cerebral palsy with ocular anomalies. ***Methods*** The subjects of this study were 6 children with spastic cerebral palsy with ocular anomalies. The experimental group (n=3) received the dual task training include eye movement and control group (n=3) received the dual task training each for 30 minutes a day, twice a week for 8 weeks. Before and after the intervention were evaluated using VMI and GMFM. ***Results*** The results of this study were as follows; First, comparisons of group within VMI and GMFM values are as follows; The experimental group had no significant difference between the VMI and GMFM before intervention and after ($p > .05$). But, effect sizes had on effect on the GMFM-A (d = 0.6), GMFM-D (d = 0.7), GMFM total score (d = 0.5) The control group had no significant difference between the VMI and GMFM before intervention and after ($p > .05$). But, effect sizes had on effect on the GMFM total score (d = 0.6). Second, comparisons between groups after intervention of VMI and GMFM value were as follows; The comparison between groups had no significant difference after intervention of VMI and GMFM all ($p > .05$). But, effect sizes had an effect on the GMFM-C (d = 0.6). ***Conclusion*** As a result, the dual task including eye movement goes along for 8 weeks was no significant difference for improving the VMI and the GMFM in children with spastic cerebral palsy with ocular anomalies.
However, it gave show that this has been a partial effects. Therefore if the future progress in the study that complement the limitations of the study, it will be considered that there can be obtained a significant result.

Key words Dual task training, Ocular anomalies, Spastic cerebral palsy

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I. Introduction

The brain accepts a variety of information on the outside through the eyes. The information received in this way has a significant role in motor development and posture control at normal development process and involves in a feature of object, the discrimination between the object and the background, and spatial correlation.[1, 2] Vision is the most influential sense to human beings.[3, 4] According to most studies reported about visually impaired children's motor development, the order of visually impaired children's motor development was different from that of other normal children's at the same age, and their motor skill and physical ability were poor.[5, 6] Stimulation sent to brainstem through visual perception process is integrated with other sensors and sends the information leading the correct response to the eye unconsciously, then generates walking, various postures, visual motor control, visual focus, etc.[7] At the International Conference in 2004, new amendments and proposals on cerebral palsy were introduced. According to them, the motor disorders of cerebral palsy are often accompanied by disturbance of sensation, cognition, communication, perception and behavior by epilepsy, and by secondary musculoskeletal problems.[8] One of the most commonly associated disorders is the visual impairment which more than 40 percent of children with

cerebral palsy have. Especially Spastic cerebral palsy was often accompanied by strabismus, refractive error and visual field defect by lesions on cortex and pyramid track.[9] The ophthalmic disorder is the most frequently associated problem in cerebral palsy and may also influence the patient's developmental processs.[10] A recovery of the physical dysfunction occurred by cerebral impairment could be slowed by the visual motor dysfunction.[11] Also the children with cerebral palsy will obtain significantly lower score than normal children on a motor-free test of visual perception.[12] Han & Kong (2007) recommended that visual motor function is an important part to restore physical function to the children with cerebral palsy[11], and Hong & Han (2006) suggested that the study of visually impaired children's motor development should be approached through the correction of exercise goal, rule, and equipment of wear.[5] Task-oriented training that's based on motor learning was effective in functional performance of the children with cerebral palsy, and providing a interesting challenge prompted their motivation for easily functional movement.[13] Task-oriented approach regards the children as active participants and motivates them to have special position in given goal.[14] And because of learning by trying to solve the problem using the given functional tasks[15], repetitive training is an effective way for improving activities of daily living performance, balance function and communication ability.[16] Prior studies of the eye movement proceeded postural control, visual perception ability and eye movement function to children with cerebral palsy by using eye movement program. However, the study of children with spastic cerebral palsy with ocular anomalies are rare. Therefore this

Table 1. dual task training including eye movement

dual task training		contents	Application time
eye movement	single task movement		
Warming-up		range of joint movement, lengthening exercise	5min.
vergence eye movements	holding on prone position	In the prone position on the floor, being able to see the card placed 5cm front. The extension slowly until the upper arm and the trunk 40 ~ 50cm. Put the items that match the card in the basket ahead. ※ Repeat the same movement with 10 cards for 5 minutes.	5min.
vestibulo - ocular movements or reflex	quadruped to standing	The children shakes their head once from side to side as fast as they can. Then, hold the ring in front of them and stand up completely, and put a ring on the bar above a bench in front of them. ※ When the children shake their head, they focus on the ring in front of them. Repeat the same movement with 10 rings for 5 minutes.	5min.
pursuit eye movements	weight shifting	Children sit on the bench, and the therapist sits behind the child. Placing it 30~50cm in front of children's eyes, their move with their head and weight to the direction of the slowly moving ring. ※ Encourage the children all the way to see the ring. Repeat the same movement with 10 rings in different directions (left·right·up·down, diago- nal, post) for 5 minutes.	5min.
saccadic eye movements	stand up and gait	Shows the children a picture card while they are sitting on a bench or chair. After making them sit down and stand up 5 times. Then make them walk 5m and find cards with the same picture among 20 cards on the table. ※ Repeat the same movement 2~4 times for 5 minutes.	5min.
Floor walk		range of joint movement, lengthening exercise	5min.

(Koo, 2002; Sieglinde, 2007; Stanger & Oresic, 2003)

study wanted to apply eye movement and task-oriented training to the children with cerebral palsy with ocular anomalies. The purpose of this study is to determine the effect of visual motor function and gross motor function, through conducting the dual task training, including eye movement, to children with spastic cerebral palsy with ocular anomalies.

II. Materials and Methods

This study selected patients who are 4 to 12 year old children, receiving physical therapy to A, S, K hospital at Seoul and Gyounggi province, in the following conditions; 1) who have been diagnosed Spastic cerebral palsy by doctor in rehabilitation medicine and the ocular anomalies by an eye specialist; 2) children with GMFCS level Ⅰ~Ⅱ; 3) children who understand and follow the instructions of the researchers; 4) children with no surgery or procedure record, that could affect the study, 3 months prior to the beginning of the study; 5) the parents of all participants provided written informed consent before participating the study. This study recruited 13 participants with parental consent. We researched their general characteristics and evaluated their Visual Motor Function and Gross Motor Function by VMI and GMFM as measurement tools. After assessment, the experimental group was implemented the dual task training including eye movement for 8 weeks; 30 minutes a day, 2 times a week; total 16 times. And the control group was implemented the same condition. The Dual task training including eye movement is changed and adapted the one of six eye movement program proposed by Koo (2002), Kim (1999) and Motor(or Posture) task training is changed and adapted the program of Sieglinde (2007), Stanger and Oresic (2003) to fit the participants.[1, 7-9] Dual task training projects, including eye movements applied to the study group are as follows.

1. Functional Evaluation

The Visual Motor Integration and the Gross Motor Function Measure were assessed for all participants. Visual Motor Integration is developed to aim at learning and prevention tool for children from 2 to 15 years old by appraising Visual perception and fine motor coordination ability, early screening and identification.[20] Gross Motor Function Measure is clinical tool aimed to appraise changes of gross motor function of the children with cerebral palsy.[21]

2. Data Analysis

Data of this study were analyzed using the SPSS Version 20.0. Analysis method was Shapiro-Wilk for executed normality test for the initial evaluation value to descriptive statistics. Comparisons of VMI and GMFM value before and after intervention within the group was analyzed by using Wilcoxon's signed-ranks test and significance tests for the difference in value between the groups after the intervention were carried out by ANCOVA. Statistical significance was determined at $p<.05$. In addition, all comparative values were calculated to Cohen's effect sizes. As Effect sizes is used most often when discussing the practical significance, when it is 0.2 degree, d is classified as small, 0.5 degree is medium, 0.8 degree is large and it was said that 0.8 or larger degree shows a high effect.[22-24]

III. Results

1. General characteristics of the subjects

All research participants were the outpatient of each hospital. Among them, experimental group consisted of 3 children, and control group 3 children. Total 6 children participated the study. General characteristics of the subjects are shown in the following table 2.

2. Comparisons of VMI, GMFM before and after intervention within the group

(1) Comparisons of VMI and GMFM before and after intervention within experimental group

There were no significant difference between the VMI and GMFM before and after intervention with experimental group ($p > .05$). but, Effect sizes had the effect on the GMFM-A (d = 0.6), GMFM-D (d = 0.7),

Table 2. General characteristics of the subjects

Group General Characterisitics		experimental group (n=3)		control group (n=3)	
		n(%)	M±SD	n(%)	M±SD
Gender	F	2(66.7)		1(33.3)	
	M	1(33.3)		2(66.7)	
Age			6.7±3.8		7.0±2.0
Diagnosis	spastic diplegia	3(100)		2(66.7)	
	Rt. hemiplegia			1(33.3)	
Ocular Anomalies types	stribismus	3(100)		1(33.3)	
	Anomalies of refraction			2(66.7)	
GMFCS	Ⅰ	1(33.3)		2(66.7)	
	Ⅱ	2(66.7)		1(33.3)	

GMFCS : gross motor function classification system
M±SD : mean±standard deviation

Table 3. Comparison of VMI and GMFM between initial and follow-up tests in experimental group (n=3)

Experimental group	Initial	Follow-up	*Z*	*p*	*d*	PON
	M±SD	M±SD				
VMI	86.47±12.78	96.77±19.35	−1.604	.109	0.3	21.3%
GMFM-A	97.38±2.27	100±0	−1.414	.157	0.6[b]	38.2%
GMFM-B	99.44±0.96	100±0	−1.000	.317	0.4	27.4%
GMFM-C	89.68±6.87	94.44±4.96	−1.604	.109	0.4	27.4%
GMFM-D	77.42±7.64	87.18±2.56	−1.604	.109	0.7[b]	43.0%
GMFM-E	68.05±19.10	80.09±9.86	−1.342	.180	0.4	27.4%
GMFM TS	86.63±7.00	92.34±3.03	−1.604	.109	0.5[b]	33.0%

VMI : visual motor integration
GMFM-A : gross motor functional measures-lying & rolling
GMFM-B : gross motor functional measures-sitting
GMFM-C : gross motor functional measures-crawling & kneeling
GMFM-D : gross motor functional measures-standing
GMFM-E : gross motor functional measures-walking, running & jumping
GMFM-TS : gross motor functional measures-total score
Z : Wilcoxon's signed-ranks test
$p<.05$
d : Effect sizes
PON : percent of nonoverlap
b : Cohen's medium
M±SD : mean±standard deviation

and GMFM total score (d = 0.5).

(2) Comparisons of VMI and GMFM before and after intervention with control group

There was no significant difference between the VMI and GMFM before and after intervention with control group (p > .05). But, effect sizes had the effect on the GMFM total score (d = 0.6).

3. Comparisons of VMI, GMFM after intervention between the groups

(1) Comparisons of VMI after intervention between experimental groups and control group

There was no significant difference between the VMI

Table 4. Comparison of VMI and GMFM between initial and follow-up tests in control group (n=3)

control group	Initial	Follow-up	*Z*	*p*	*d*	PON
	M±SD	M±SD				
VMI	81.07±21.08	78.03±21.56	−0.535	.593	−0.1	−
GMFM-A	99.34±1.13	100±0	−1.000	.317	0.4	27.4%
GMFM-B	100±0	100±0	0.000	1.000	NaN	−
GMFM-C	100±0	100±0	0.000	1.000	NaN	−
GMFM-D	88.03±9.00	90.60±9.00	−1.633	.102	0.1	7.7%
GMFM-E	85.18±10.23	85.18±10.23	−1.342	.180	0	0%
GMFM-TS	87.03±8.13	95.89±3.48	−1.604	.109	0.6[b]	38.2%

VMI : visual motor integration
GMFM-A : gross motor functional measures-lying & rolling
GMFM-B : gross motor functional measures-sitting
GMFM-C : gross motor functional measures-crawling & kneeling
GMFM-D : gross motor functional measures-standing
GMFM-E : gross motor functional measures-walking, running & jumping
GMFM-TS : gross motor functional measures-total score
Z : Wilcoxon's signed-ranks test
p<.05
d : Effect size
PON : percent of Nonoverlap
b : Cohen's Medium
M±SD : mean±standard deviation

Table 5. Comparison of VMI after intervention with experimental group and control group (n=6)

Item	experimental group (n=3)	control group(n=3)	*F*	*p*	*d*	PON
	M±SD	M±SD				
VMI	96.76±19.35	78.30±21.56	1.236	.347	0.4	27.4%

VMI : visual motor integration
F : ANCOVA
p<.05
d : Effect size
PON : percent of nonoverlap
M±SD : mean±standard deviation

Table 6. Comparisons of GMFM after intervention between experimental groups and control group (n=6)

Item	experimental group (n=3)	control group (n=3)	*F*	*p*	*d*	PON
	M±SD	M±SD				
GMFM-A	100±0	100±0	−	−	NaN	−
GMFM-B	100±0	100±0	−	−	NaN	−
GMFM-C	94.44±4.96	100±0	1.639	.290	0.6[b]	38.2%
GMFM-D	87.18±2.56	90.60±9.00	1.000	.391	0.3	21.3%
GMFM-E	80.09±9.86	87.03±8.13	0.002	.970	0.4	27.4%
GMFM-TS	92.35±3.02	95.88±3.48	0.104	.768	0.5[b]	33.3%

VMI : visual motor integration
F : ANCOVA
p<.05
d : Effect size
PON : percent of nonoverlap
M±SD : mean±standard deviation

and GMFM after intervention with experimental group and control group (p > .05).

(2) Comparisons of GMFM after intervention between experimental groups and control group

The value of GMFM after intervention between experimental group and control group was unable to be compared because both GMFM-A and GMFM-B had the same value before and after intervention, and other items had no significant difference statistically (p < .05). However, Effect sizes had the effect on GMFM-C total score(d = 0.6) and GMFM total score(d = 0.5).

VI. Discussion

Looking at the research trends of visually impaired children's motor development, even if they suffer any kind of visual damages, visually impaired children lack visual imitation, stimulation, coordination of ears and hands, the quality of position, preparation for the movement, perceptual basic concepts and early intervention program. Limit of the environment and social interaction experience, reduced opportunity and others are common factor for affecting the development exercise.[5] In addition, Visual perception disorder is the most problematic disorder in motor ability, cognitive impairment, rehabilitation to the children with cerebral palsy, and this acts as an inhibitory factor in the process of rehabilitation by disrupting independent performance and new motor ability learning.[25] Lew at al. (2015) who studied eye disorder associated with neurological disorder on 47 children with cerebral palsy reported that the damage to brain and motor development is negative influence on visual development.[10] During the important period of visual development, putting the visual stimulation is important for the ophthalmic development of the children with cerebral palsy. Zanandrea (1998) said that if visually impaired children are provided with a structured early education program, it could come positive effect for their development, growth and learning.[26] Among the researches applied the eye exercise program, one of them, studying 10 children with Spastic Cerebral Palsy as practice target, reported there were the meaningful difference at GMFM, PBS, PRT, and K-DTVP excluding visual integration sub-item. Another research, observing 24 children with cerebral palsy for 12 weeks, 3 times a week, reported the improvement of visual motor function when applied the program of attitude, the normalization of movement and eye movement. The other research studying 12 children with severe cerebral palsy applied an eye movement program and reported its affect on perceptual ability, motor development, and visual literacy on perceptual motor development.[27, 11, 28] One of the studies about the task-oriented training based on motor learning, Salem and Godwin (2009), who studied the task-oriented strengthening training to children with cerebral palsy, verified that the training had significant results in GMFM D, E and TUG in movement function.[29] Yang (2012) reported that the implemented the task-oriented program for 8 weeks, 3 times a week had increased isometric muscle of lower extrimity, and increased the rest of the muscles except extensor of the hip, Lt. intortor, ankle joint eversion, Rt. invertor, and had significant difference in GMFM and TUG.[30] Similarly, Shin and Song (2007), who applied the circulating task-oriented program to the children with spastic dipleagia, reported the significant difference with GMFM, walking speed and the range of sway.[31] In a study comparing two treatments, task-oriented training and neurodevelopmental treatment, Choi et al. (2011) had meaningful difference in EMG of erector spine muscle, but had no meaningful difference GMFM and EMG of rectus abdomens muscle between two groups.[32] Lee (2011) reported no significant correlation in visual perception development and motor development of the children with cerebral palsy.[25] The score of the GMPM did not correlate with the SE in the possible linkage between visual and motor development in children with cerebral palsy.[10] In the result of this study, experimental group who applied dual task training include eye movement had no significant difference statistically, but the value of each item had improved effect sizes slightly. It shows that, by making up for lack of the recipient, which limited the target of this study, and modifing the terms of programs

or number of the requirements that applied in the preceding studies, it could get the effect from this study method. The Limitation of this study was lack of the recipient, compared training result in short time of program test, and unable to control other variables during the research. Because involved recipients in this study were only outpatient children of the agencies, it was difficult to apply all types of children with cerebral palsy accompanied by ocular anomalies and spastic cerebral palsy.

V. Conclusion

This study conducted to see The Effects of Dual Task Training Including Eye Movement on Visual Motor Function and Gross Motor Function in Children with Spastic Cerebral Palsy with Ocular Anomalies. A summary of the findings are as follows; Comparisons of VMI and GMFM had no significant difference before and after intervention between the experimental group and the comparisons group ($p > .05$) and no difference after intervention between the experimental group and the comparisons group ($p > .05$). However, at the effect sizes figure, there's a partial impact; GMFM-A ($d = 0.6$), D ($d = 0.7$) before and after intervention in the experimental group, GMFM total ($d = 0.6$) before and after intervention in the comparisons group, and GMFM-C ($d = 0.6$), GMFM total ($d = 0.6$) after intervention compared GMFM in the experimental group and the comparisons group. Therefore, it is expected that, by making up for its limitations, the study will be able to obtain significant results.

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