

# RESEARCH ARTICLE

## COMPARISON THE EFFECT OF SIMULTANEOUS SENSORY STIMULATION AND CURRENT OCCUPATIONAL THERAPY APPROACHES ON MOTOR DEVELOPMENT OF THE INFANTS WITH DOWN SYNDROME

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Received: 11-Oct-2010

Last Revised: 20-Nov-2010

Accepted: 27-Nov-2010

### Abstract

#### Objective

Neuromuscular characteristics in Down syndrome result in generalized muscular hypotonia, developmental delays and sensory integration deficits. The aim of this study was to compare the effects of simultaneous sensory stimulations and current occupational therapy approaches on motor functions development of infants with Down syndrome.

#### Materials & Methods

Eighteen infants with Down syndrome, aged 6 -18 months, were evaluated in two groups: intervention group (simultaneous sensory stimulation and occupational therapy) and control group (occupational therapy alone). They attended the program 3 times a week for 6 months and each session lasted 45 minutes. Motor functions were assessed before, during, and after intervention in the two groups, using GMFM test.

#### Results

Mean motor function increased in both groups according to the GMFM test ( $P = 0.000$ ). Comparison of the changes showed that although the mean difference of this variable was higher in the intervention group, the difference was not statistically significant ( $P = 0.576$ ).

Mean motor deficit reduced in both groups during the period of the study, which was statistically significant ( $P < 0.05$ ). Comparison of the difference in mean motor deficit in the first and last evaluations showed that this difference was more in the intervention group but statistically insignificant ( $P = 0.617$ )

#### Conclusion

Early use of simultaneous sensory stimulations can improve the quality of motor skills in Down syndrome infants. It is suggested that it may be used as an early intervention in association with other methods in the rehabilitation of these patients. However, more studies in this regard are warranted.

**Keywords:** Down syndrome, Motor development, Occupational therapy, Sensory stimulation.

### Introduction

There are several neuromuscular and musculoskeletal characteristics in Down syndrome which can result in developmental delays(1,2). As a result, in neuropathology of Down syndrome, a smaller cerebellum and brain stem, generalized hypocellularity of the brain causing loss of neurons in many parts of the brain, decreased myelination of the brain hemispheres, basal ganglia, cerebellum and brain

stem in the first year of life(1,3), generalized hypotonia and laxity of the joints due to hypotonia are present. These factors may cause motor and postural delays, sensory processing and sensory integration deficits due to limitations in primary sensory experiments(1,2,3).

There are several experimental witnesses showing the relationship between the sensory experiments and neuronal inter-relation by making new synapses. New synapses are formed due to the dendritic growth and branching of the neurons by sensory experiments (4 - 7). On the other hand, using the afferent skin receptors to the brain cortex, we may change the cortical map(5). The recent studies suggest that the afferent data to the somatosensory neurons of the cortex is formed by the simultaneous firings. It means that when cells are simultaneously fired, their inter- relation will become more prominent. For example, increasing the selective use of the fingers increases their cortical presentation (5). Thus, using the sensory stimulations increases both the brain map in somatosensory part of the cortex and the receptive field of the organs(1,4,5).

Also, when the sensory and motor interventions are performed earlier, it is probably more effective on the improvement of generation of new synapses and prevention of decrease in synapses in the next years of the life of these children and more neuro-plasticity of the nervous system (1,4,9,10).

Since 1981, Bennet and Hines performed 20 studies on early interventional treatments in children and toddlers with Down syndrome (6). In this regard, although early rehabilitation interventions and their positive effects on motor, language and cognitive development have been proposed in children with Down syndrome, there are still some limitations in evaluation of the efficacy of different methods and finding an appropriate and advanced method to gain better results (1,6,8).

In this study, regarding the neuropathology of Down syndrome and neurophysiologic principles of the sensory receptors and the hypothesis that we can develop more knowledge of the cortex from the body and send more messages from the brain stem to the brain through simultaneous exteroceptive and proprioceptive stimulation and generation of over body images (4,5), we hoped that the exteroceptive receptors were better expressed in the brain cortex and more neurons were

impressed by inter-relationship of more receptors (4,5,9,10). It is probable that sensory integration and processing function be improved by this way and simultaneously (4,5,9), muscle tonicity and joint stability is improved (4,5,9) and finally, the quality of motor development in these children is enhanced (1,11). Therefore, the aim of this study was to compare the effects of simultaneous sensory stimulations in addition to current occupational therapy approaches on motor function development of the infants with Down syndrome.

### Materials & Methods

This study was an interventional, prospective, single blinded study with repeated measurements on Down syndrome infants in Asma, Saba and Zafar rehabilitation centers. First, the aim of the study was explained to each family and an informed written consent was obtained from the families of the participants. The inclusion criteria were as follows: Trisomy 21 by genetic karyotype, 6 to 18 months of age and consenting to participation. The exclusion criteria were severe orthopedic problems or malformations, seizures, uncontrolled thyroid disturbances, severe congenital heart problems (requiring surgery), perilabour asphyxia (Apgar of minutes 1 and 5 equal to or less than 7), severe visual or auditory disturbances, weight less than the 3<sup>rd</sup> percentile of Down syndrome, and history of the neonatal infections (meningitis, encephalitis). Those with a gestational age under 37 weeks (prematurity), use of rehabilitation services or physiotherapy in other centers, not attending 3 sessions or more, non participation in treatment sessions for at least 8 sessions in the total interventional course, and any acute or chronic disease that needed hospitalization or surgery during the intervention were also excluded. Also, if a child showed aversive reactions or irritability as a result of sticky pasty stimulation, he or she was excluded.

According to the previous studies, the sample volume was determined to be 12 patients in both case and control groups. Sampling was performed through simple convenient method and infants were randomly assigned into 2 groups of intervention and control. Twenty-four infants with Down syndrome who were 6-18 months were primarily examined by a pediatrician and enrolled

in the study if they met the inclusion criteria. A total of 6 patients were excluded from the study because of their parents' unwillingness to cooperate and irregular attendance at the sessions, kidney problems and leukemia, and repeated common cold attacks and family problems (2 in each group). Finally, 9 infants remained in each group.

Data was collected by a questionnaire containing information on the medical and family history, results of examinations, and interview with the parents. The examiner evaluated the child's motor function and completed the GMFM88 questionnaire in 4 stages. This test was first introduced by Russell and colleagues in 1993 to evaluate the motor function of the children with Down syndrome or cerebral palsy. The intra group coefficient index was reported to be 0.99 and the sensitivity of this test for motor changes in a 6-month period has been validated for the children between 5 months and 16 years (12).

#### Method of the study

All the infants who entered the study were introduced to the occupational therapy ward. They all underwent GMFM88 test and evaluation of the level of motor deficit (scale of motor deficit in the GMFM88 manual) by an occupational therapist blind to the whole procedure. Then, they were assigned into either the intervention or control group and evaluated by the researcher regarding the sensory function, reflexes, muscle tonicity, joint range of motion and the level of motor control. They were treated by a determined protocol according to the assigned group. The intervention protocol of these patients was designed by the researcher and two other occupational therapists. The programs were evaluated by the researcher and in the case of progression in each course, the programs changed and the patient entered the next course.

The therapy sessions were held 3 times a week for 6 months and each session lasted for 45 minutes. Both groups were evaluated by the same occupational therapist who was blind to the whole procedure every 1.5 months using GMFM 88 and the results were recorded 4 times for each patient. At the end of 6 months, both groups were evaluated regarding the level of motor deficit using motor deficit score.

Data was analyzed with SPSS software version 11.5. Kolmogorov-Smirnov test was used to compare the distribution of the variables with a normal distribution. T test was used to evaluate the similarity of the variables in the groups and repeated measurements were used to evaluate the changes of the motor function during the study course in both intervention and control groups.

#### Intervention protocol

The infants were individually treated with current occupational therapy approaches by their occupational therapist and their mother (their mother's role was just to encourage the child). In the therapy room, there were some equipment such as therapy balls, rolls, wedges, protected swings oriented in different directions, ramps, steps, weight cuffs, etc.

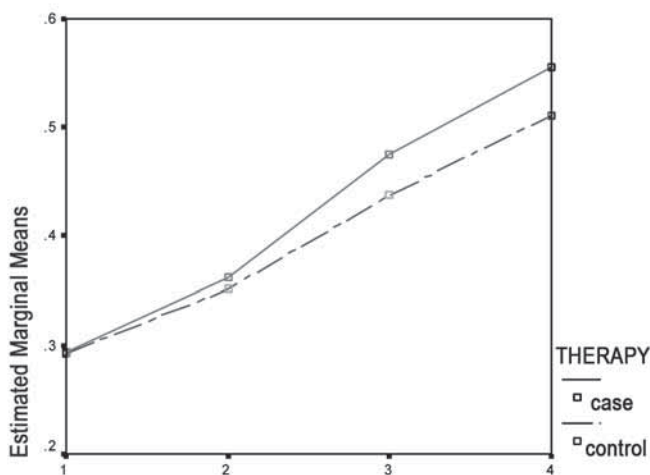
Intervention protocol of both groups included current occupational therapy approaches (Facilitatory techniques of neurodevelopmental therapy (NDT), Facilitatory techniques of Rood approaches and Rotatory vestibular stimulation. In the intervention group, in addition to current occupational therapy approaches, the therapist used herbal sticky pasty (a kind of mud which is traditionally used for hair washing (Gele Sarshur in Persian), white of the egg and one spoon of honey mixed together) on shoulder girdles, elbows, hip girdles and knees. Then, he bandaged these areas and practiced with the child, using current occupational therapy approaches, to stimulate both exteroceptive and proprioceptive receptors of the body simultaneously.

#### Results

Mean motor function in both groups increased according to the GMFM test ( $P = 0.000$ ). Comparison of the changes in the mean motor function scores using the GMFM test showed that although the mean difference of this variable was higher in the intervention group, it was not statistically significant ( $P = 0.576$ ) (table 1, figure 1).

**Table 1:** Mean ± SD of the 4 stages of gross motor skills in the 2 groups

Groups	Mean score of gross motor stages	Mean	SD
Intervention	Stage 1	0.2933	0.06856
	Stage 2	0.3622	0.07870
	Stage 3	0.4744	0.08904
	Stage 4	0.5556	0.10382
Control	Stage 1	0.2922	0.06870
	Stage 2	0.3511	0.08313
	Stage 3	0.4378	0.09418
	Stage 4	0.5111	0.11005



**Fig 1.** Changes of Gross Motor Scores in 4 Stages of the Patient Assessment.

Mean scores were almost the same in the two groups of study. Over time, this measure increased in both groups, especially in the intervention group.

Mean motor deficit reduced in both groups during the period of the study which was statistically significant ( $P < 0.05$ ). Comparison of the difference in mean motor deficit in the first and last evaluations showed that although this difference was more noticeable in the intervention group, it was not statistically significant ( $P = 0.617$ ) (Table 2).

**Table 2:** Comparison of the Difference of the Mean Motor Deficit in the 2 Groups at the End of the Study.

Groups	Difference of the Mean Motor Deficit		T value	P value
	Mean	SD		
Intervention	1.00	0.70711	0.800	0.617
Control	0.78	0.44096		

**Discussion**

The result of this study showed that simultaneous exteroceptive and proprioceptive stimulations in addition to current occupational therapy approaches were more effective on the development of motor function of the infants with Down syndrome than using current occupational therapy approaches alone. In 1973, Sheifert performed a study on sensorimotor stimulations in children with motor problems. He stated that the body was an instrument for touch and kinesthetic triggers. This would give an opportunity to generate internal language, start of the body awareness, and a principle for the future cognition of the space principles (7).

In 1981, Harris modified the NDT method regarding the needs of the children with Down syndrome and continued this program 3 times a week for 9 weeks. No significant difference was noted between the NDT and the control group in the integration of the postural responses (13).

In 1990, Edwards and Yuen used Neurodevelopmental Therapy (NDT) techniques in addition to vestibular and tactile stimulations on twins with Down syndrome. The results showed that this intervention program decreased the rate of decline in the development of Down syndrome children (14).

Mahoney et al, in 2001, performed a study to evaluate the effect of early interventional techniques on children with cerebral palsy and Down syndrome. In this study, two different treatment methods, NDT and developmental skills, were evaluated on fifty 14-month-old infants (27 with Down syndrome and 23 with cerebral palsy) and the results were



compared after 1 year. The results showed progression of motor development with both techniques (NDT and developmental skills) (15).

In another study performed in 2003 by Uyanik et al, different treatment methods including sensory integration (SI), vestibular stimulation, and NDT were evaluated in children with Down syndrome. The results showed that all 3 approaches were effective in improving the capabilities of the children with Down syndrome and therefore, they all had to be used together to provide the needs of the Down syndrome children in different aspects (16).

In 2004, some researchers at Touch research institute evaluated the effect of massage on children with Down syndrome. Massage was performed 2 times a week for 2 months in 30-minute sessions. The results showed decreased hypotonia and improvement of the gross and fine motor functions in this group in comparison with the control group (17).

As it is obvious, in most of the performed studies as well as ours, the positive effects of NDT, SI and developmental skills (current occupational therapy approaches) on the improvement of gross and fine motor skills of the children with Down syndrome have been documented (13, 17-20).

In our study, although no statistically significant difference was seen in the improvement of the gross motor skills between the 2 groups, the improvement of the gross motor skills, muscular tonicity and decrease in the joint laxity was more noticeable in the intervention group in comparison with the control group (Table 1 and 2 and figure 1).

Due to our limited time and the small number of skilled therapists in this regard, the study was performed in a period of 6 months on a limited number of patients. Since we did not have access to other evaluating instruments such as Bayley test, we could not evaluate fine motor and cognitive skills. We could not evaluate the children who did not continue attending the clinics for different reasons or performed the therapy at home and therefore, we had to exclude them. Also, we could not perform paraclinic diagnostic tests such as FMRI, brain mapping, and PET that show the changes in relation to the flexibility of the central nervous system.

**In conclusion,** According to our results, it seems that

early simultaneous exteroceptive and proprioceptive sensory stimulations, in addition to current occupational therapy approaches, are more effective in the improvement of the quality of motor development in 6-to 18-month Down syndrome infants and therefore, are suggested to be performed early together with other methods in the rehabilitation programs of these children. However, since there are no similar researches, other in-depth studies are warranted in this regard.

Finally, it is suggested that the same study be performed on more patients and in other age groups. It is prudent to evaluate the effect of exteroceptive and proprioceptive sensory stimulations in conjunction with other current occupational therapy approaches on the development of the fine motor, cognitive, and perceptual motor skills in children with Down syndrome. Also, to obtain more valid results, it is suggested that other standard tests, including Bayley and Peabody tests, be used together with GMFM and paraclinic methods such as brain mapping, FMRI, and PET to evaluate the changes of CNS.

#### Acknowledgement

We would like to thank the parents of the Down syndrome infants who so willingly took part in the survey. The authors would also like to acknowledge the occupational therapists of the rehabilitation centers for their sincere cooperation in this survey.

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