Effect of Visual Feedback on Motor Abilities in Children with Spastic Cerebral Palsy: Systematic Review

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Abstract

Background: Cerebral Palsy (CP) is a permanent non progressive disorder of movement and posture, associated with functional activity limitations, different sensory and cognitive problems.

Aim of the Study: We were designed to systematic review the effect of visual feedback on motor abilities in children with spastic cerebral palsy.

Methods: A search was made in databases pubmed, Cochrane and Pedro, for the period from August 2015 to December 2016. The inclusion criteria were: Published Randomized Controlled Trials (RCT), studies including children (2-18 years) with spastic cerebral palsy, studies which demonstrate the effect of visual feedback including mirror visual feedback and action observation therapy. The outcome measures were balance, gait and hand function. Two independent reviewers assessed the methodological quality and extracted data.

Results: A total number of 233 records, 94 of them were duplicated, 96 of them were excluded after screened the title and abstract, 43 were retrieved by the electronic searches, 38 of them were excluded after reading full article, only 5 articles were met the inclusion criteria. The existing data isn’t homogenous. The current studies were analyzed by using descriptive analysis.

Conclusion: The current level of evidence to support the effectiveness of visual feedback in children with spastic CP remains weak.


Introduction

CEREBRAL Palsy (CP) is the most frequent cause of disability in childhood. The clinical condition of these children is determined by motor, cognitive and perceptive disorders. Regarding energy requirements, cerebral palsy children have specific needs, due to clinical variability and therapy prerequisites [1]. It is caused by a group of developmental, infectious, metabolic, ischemic, genetic and other acquired etiologies that produce a common group of neurological symptoms. Initially cerebral palsy was considered as a disease which is static in nature, but some of the neurologic features of cerebral palsy, such as motor disorders and orthopedic complications as hip dislocation and scoliosis, can change or advance over time [2].

Cerebral palsy is classified according to topographical classification into tetraplegia, diplegia and hemiplegia. And also classified according to tone distribution into spastic cerebral palsy, athetoid (dyskinetic), ataxic cerebral palsy and mixed cerebral palsy [3].

The motor impairment in cerebral palsy may be accompanied by co-morbidities, including vision or hearing loss, disorders of communication, epilepsy, intellectual disability, behavioral difficulties, and secondary musculoskeletal problems. The most common motor disorder in cerebral palsy is spasticity, appearing in 86% of cases. Spasticity is a velocity-dependent increase in muscle tone with exaggerated tendon reflexes [4].

A systematic review attempts to collect all relevant evidence that fit the eligibility criteria to answer a certain research question. It uses specific systematic methods to minimize bias in the selection, identification, and summary of studies. When systematic review is done well, this give reliable findings from which conclusions and decisions can be made. It often includes a meta-analysis, but not always [5].

A randomized Controlled Trial (RCT) can be described as parallel group design, meaning there
are two treatments implemented: One the treatment group and one the control group. The participants are randomly assigned to either treatment or control group [6].

Meta-analysis is the use of statistical methods to collect and summarize the results of several studies. By collecting data from several studies, meta-analyses can provide more accurate estimates of the effects of health care than data that derived from the individual studies [7]. Meta-analysis should only be considered when a group of trials is sufficiently homogeneous in terms of participants, interventions and outcomes to provide a meaningful summary [8].

Descriptive analysis is used to describe the basic features of the data in a study. It provides simple summaries about the sample and the measures. It helps us to simplify large amounts of data in a sensible way [9].

Visual feedback provided during therapeutic training helps patients to be aware of how they move and correct any compensatory movements, which stimulates the motor learning process and leads to better functional outcomes [10]. It is effective when it enables processing of the visual and the kinesthetic information about the ongoing movement [11].

The evidence base of visual feedback therapy in rehabilitation of cerebral palsy children is not enough. Therefore, the optimal clinical decision making to improve motor abilities in cerebral palsy children needs to be systematically investigated and evidence based. Although the practical experience established that the visual feedback is an important or essential in motor learning. In this study we systematically review RCT’s to determine the effectiveness of visual feedback therapy on motor abilities (gait, balance and hand function) in spastic cerebral palsy children.

Material and Methods

Search strategy:

Electronic database search was done in databases PubMed, Cochrane and Pedro from August 2015 to December 2016. Using following keywords spastic cerebral palsy, visual feedback, mirror visual feedback, action observation therapy, motor abilities, balance, gait, bimanual hand function and randomized control trials.

Inclusion and exclusion criteria:

Studies were selected for inclusion according to the following criteria:
- Published randomized controlled studies.
- Studies including children (2-18 years) with spastic cerebral palsy.
- Studies which demonstrate the effect of visual feedback including mirror visual feedback, action observation therapy and video.
- Outcomes (motor abilities including: Gait, balance and hand function).

Exclusion criteria were:
- Unpublished studies.
- Study design other than randomized controlled trials.
- Studies that combined visual feedback with other types of modalities.

Article selection:

Two independent reviewers reviewed titles and abstracts. To ensure consistent interpretation of the inclusion and exclusion criteria.

Data extraction:

Data extraction and management: two independent reviewers extracted data from included studies in this systematic review using data extraction form developed by AACPDM [12].

Quality assessment:

The methodological quality of the included studies was evaluated independently by two reviewers using the Cochrane risk of bias tool, PEDro scale and American Academy for Cerebral Palsy and Developmental Medicine (AACPDM) quality assessment. Results were compared and any disagreement resolved by discussion.

Outcomes from selected studies are analyzed and categorized according to the components of the International Classification of Functioning, Disability and Health (ICF) [13].

Evidence assessment:

The hierarchy of “levels of evidence” is based on research design types. Level I: Evidence from a systematic review of all relevant Randomized Controlled Trials (RCT’s), or evidence-based clinical practice guidelines based on systematic reviews of RCT’s, Level II: Evidence obtained from at least one well-designed Randomized Controlled Trial (RCT), Level III: Evidence obtained from well-designed controlled trials without randomization,
quasi-experimental, Level IV: Evidence from well-designed case-control and cohort studies, Level V: Evidence from systematic reviews of descriptive and qualitative studies, Level VI: Evidence from a single descriptive or qualitative study and Level VII: Evidence from the opinion of authorities and/or reports of expert committees [12].

Results

The search results are presented in a PRISMA flow chart as shown in Fig. (1). Only five studies met the inclusion criteria.

According to AACPDM method of quality assessment from all studies included, three studies fulfill the criteria of high methodological quality which judged as strong ("yes" on 6 or 7 questions), one study fulfill the criteria of moderate methodological quality ("yes" on 4 questions) and one study fulfill the criteria of weak methodological quality ("yes" on 3 questions). According to the PEDro scale, three studies fulfill the criteria of high quality (score of 7 or higher), one study fulfill the criteria of moderate quality (score of 5 or 6), and one study fulfill the criteria of poor quality (score of 4 or less). According to Cochrane risk of bias summery is represented in Fig. (2).

After extracting data from each study included in this systematic review, data was compared and findings were represented. The variation among studies with regard to outcomes measures, interventions and methodological quality of the studies didn't allow us to perform a quantitative analysis (meta-analysis). The existing data isn't homogenous; thus the current studies were analyzed by using descriptive analysis. Included studies are summarized in (Table 1). The outcome measures of the selected five studies and the outcomes of interest are summarized in (Table 2).
Table (1): Summary of included studies.

<table>
<thead>
<tr>
<th>Studies</th>
<th>Research Level of design</th>
<th>Participant characteristics</th>
<th>No of participants</th>
<th>Age range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ledebt et al., [14]</td>
<td>RCT</td>
<td>Children with hemiplegic CP level I according to GMFM*.</td>
<td>5</td>
<td>5-11</td>
</tr>
<tr>
<td>Sgandurra et al., [15]</td>
<td>RCT</td>
<td>Children with hemiplegic CP selected according to age, grade 2 on the Modified Ashworth Scale and grade between 4 and 8 according to House Functional Classification System.</td>
<td>12</td>
<td>5-15</td>
</tr>
<tr>
<td>Sritipsukho et al., [16]</td>
<td>RCT</td>
<td>Children with spastic diplegia CP level I, II and III according to GMFM.</td>
<td>15</td>
<td>2-10</td>
</tr>
<tr>
<td>Sgandurra et al., [17]</td>
<td>RCT</td>
<td>Children with unilateral cerebral palsy selected according to age and grade 2 on the Modified Ashworth Scale.</td>
<td>12</td>
<td>5-15</td>
</tr>
<tr>
<td>Kirkpatric et al., [18]</td>
<td>RCT</td>
<td>Children with unilateral cerebral palsy.</td>
<td>35</td>
<td>3-10</td>
</tr>
</tbody>
</table>

(*) Gross Motor Function Measure.

Table (2): Summary of outcome measures of included studies.

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Control intervention</th>
<th>Outcome of interest</th>
<th>Measures</th>
<th>ICF</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ledebt et al., [14]</td>
<td>• Didn't received training.</td>
<td>• Balance in quiet stance.</td>
<td>• Cop displacement.</td>
<td>• Body Functions and Structures.</td>
</tr>
<tr>
<td></td>
<td>• Showing computer games with no biological movement following by verbal instruction to carry out same exercise in experimental group 60min/day for 15 sessions.</td>
<td>• Balance in dynamic stance.</td>
<td>• Voluntary displacement of COP.</td>
<td>• Activities and participation.</td>
</tr>
<tr>
<td></td>
<td>• Observation of 3min video sequences followed by execution of the observed actions for 3min, total time 60min/day for 15 sessions.</td>
<td>• Balance in gait.</td>
<td>• Step length.</td>
<td>• ABILHAND-Kids(***)</td>
</tr>
<tr>
<td>• Sgandurra et al., [15]</td>
<td>• Watch the video sequence then same objects shown in video placed on the table and the child was requested to perform the same action 60 min/day for 15 sessions.</td>
<td>• Bobath concept, stretching exercise and functional training for 30-45min 1 session/week.</td>
<td>• AHA(*)</td>
<td>• Activities and participation.</td>
</tr>
<tr>
<td>• Sritipsukho et al., [16]</td>
<td>• Video CD program 3 time/day for 2 months.</td>
<td>Motor skills.</td>
<td>• MUUL(**).</td>
<td>• ABILHAND-Kids(***)</td>
</tr>
<tr>
<td>• Sgandurra et al., [17]</td>
<td>• Action observation + repeated practice 15min session, 5 sessions/week, 3 months.</td>
<td>• Watch computer games and then verbally instructed to perform the same action as the experimental group.</td>
<td>• AHA.</td>
<td>• Activities and participation.</td>
</tr>
<tr>
<td></td>
<td>• Repeated practice 15min session, 5 sessions/week, 3 months.</td>
<td>• Spontaneous use of the assisting hand.</td>
<td>• MUUL.</td>
<td>• ABILHAND-Kids.</td>
</tr>
<tr>
<td></td>
<td>• Observation of 3min video sequences followed by execution of the observed actions for 3min, total time 60min/day for 15 sessions.</td>
<td>• Unilateral upper limb function.</td>
<td>• AHA.</td>
<td>• Activities and participation.</td>
</tr>
<tr>
<td></td>
<td>• Action observation + repeated practice 15min session, 5 sessions/week, 3 months.</td>
<td>• Bimanual home and community activities.</td>
<td>• MA2(****).</td>
<td>• ABILHAND-Kids.</td>
</tr>
<tr>
<td>• Kirkpatric et al., [18]</td>
<td>• Repeated practice 15min session, 5 sessions/week, 3 months.</td>
<td>• Spontaneous use of the affected hand.</td>
<td>• ABILHAND-Kids.</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

The purpose of this systematic review was to evaluate the effect of visual feedback on motor abilities in children with spastic cerebral palsy. The articles included in this review are characterized by providing immediate and follow-up results and this helps in determining the effect of visual feedback both immediately and also postpone effect. The total number of participants in all studies was 158 ranging in age from 2 to 15 years.

Visual feedback is a non-invasive method in dealing with spastic cerebral palsy children. Two studies reported that no adverse effects were detected following this intervention, while the other three didn't mention it.

The assessment of the quality of controlled trials is essential because variations in the quality of trials can affect the conclusions about the existing evidence [19].

All outcomes of the studies represent the ICF component of activities and participation except one study by Ledebt et al., [14] which included outcomes representing the ICF component of Body Functions and Structures, the remaining ICF component of contextual/environmental factors were not mentioned in any study.

Children are not born with all the immediate visual abilities they need in life, such as focusing and moving their eyes accurately and using them together as a team. These skills are learned over a period of time as they develop. From birth, they explore with their eyes the amazing world around them, even before their motor skills begin to develop. Their eyes provide information and stimulation important for their development [19].

When children reach the age of two years, their hand-eye coordination and depth perception are usually well developed. At this age they take great interest in exploring their environment and can intently look and listen. Familiar objects, such as pictures or books, are recognizable [19]. So this systematic review included children from 2 years.

The study by Ledebt et al., [14] showed that balance training with visual feedback is useful to decrease the amplitude of postural sway during quiet standing, increase the amplitude of the voluntary weight shifts during standing and decrease of the asymmetry in step length during walking.

The training group showed increases of the voluntary weight shifts in the forward and backward directions and toward the non-paretic leg. Postural sway during quiet stance appeared to be more stable after the training as indexed by smaller amplitude of the maximum sway in the forward and backward directions. The parallel increase of time on the target confirms that the children became better in quiet standing with visual feedback.

Balance training in gait with visual feedback results in an increase in step length when the paretic leg was supporting (thus non-paretic leg was swinging forward). Step length asymmetry was previously observed in hemiparetic children as the result of weakened relevant muscles (e.g., ankle plantar flexors and hip flexors and extensors) of the affected leg. Ledebt et al., [14] proved that the weight shifts included in the training might have helped to exercise these relevant ankle muscles.

The study by Sgandurra et al., [15] presents the background and the design for a matched pairs randomized trial for evaluating the efficacy of action-observation therapy in improving UL activity in children with hemiplegic cerebral palsy. But the results aren't mentioned.

The study by Sritipsukho et al., [16] showed that the mirror neurons stimulation based on video compact disc VCD program on motor skill rehabilitation result in larger mean changes of GMFM scores in the experimental group at the second month compared to those in the control group in many dimensions after adjusted for the baseline level. However, significant improvement of the mean GMFM scores was found in both groups after the first and the second month periods. In addition, the good compliance in watching reflected good performance of VCD presentation. Sritipsukho et al., [16] suggest that the mirror neurons stimulation based VCD program is an alternative treatment for children with cerebral palsy who lack the opportunities to access conventional physical therapy in medical center. The study confirmed that the mirror neurons stimulation based VCD program could improve motor function, at least, as much as the conventional physical therapy.

The study by Sgandurra et al., [17] showed that intensive UL action observation training in children with hemiplegia is effective in improving UL activity performance in daily activities and that these effects tend to persist over time. Changes were statistically significant at AHA, the primary outcome measure. Moreover, within-group analysis indicates a significant improvement of the experimental group that continued in the follow-up assessments, whereas the control group remained unchanged. At ABILHAND-Kids no between group
differences were found. MUUL scores did not statistically change between-groups analysis. The results obtained, as assessed with the AHA, showed a change in the use of UL in daily activity but not in action kinematics.

The study by Kirkpatric et al., [18] showed that there is no significant improvement in hand function with action observation and repeated practice compared with repeated practice alone in children age 3 to 10 years with UCP.

Clinical evaluation of the effects of visual feedback is also needed because existing research evidence is not adequate to support or deny the effectiveness of visual feedback in spastic cerebral palsy. Pediatric physical therapists have an essential role to play in this area of evaluation.

Conclusion:

This systematic review is a trial to fill the gap of knowledge between research and clinical practice in using visual feedback in children with spastic cerebral palsy. There is a clear need for more high quality trials focusing on this issue to establish strong evidence.

The current level of evidence to support the effectiveness of visual feedback in children with spastic cerebral palsy remains weak. The main limitations were that the meta-analysis not allowed because of different outcome of interest, so descriptive analysis was used. There are few conclusions that can be drawn from the existing evidence as follows: (1) There is some evidence favoring visual feedback in improving balance in quiet stance, dynamic stance and gait (2) There is some evidence favoring action observation and execution in improving unimanual capacity, bimanual daily activities and spontaneous use of the assisting hand (3) There is some evidence to indicate that mirror neurons stimulation is preferable to motor skills.

At last we can conclude that it is evident that there is a significant gap between clinical rationale for visual feedback and research evidence.

References
12- DARRAH J., HICKMAN R., O’DONNELL M., VOGTLE L. and WIART L.: AACPDM methodology to develop systematic reviews of treatment interventions (Revision 1.2), Milwaukee, WI, USA: American Academy for Cerebral Palsy and Developmental Medicine, 2008.
16- SRITIPSUKHO P. and HANSAKUNACHAI T.: Effects of Mirror Neurons Stimulation on Motor Skill Rehabili-
TAIYER AL-TAQWI 

The objective of this study was to evaluate the effectiveness of visual feedback in unilateral cerebral palsy and its effects on the movement capabilities of the affected children.

Methodology: This study included a total of 64 children with unilateral cerebral palsy, aged between 2 to 6 years old. They were randomly assigned to two groups: a control group and an intervention group. The intervention group received visual feedback training. The control group received conventional therapy.

Results: The intervention group showed significant improvements in movement capabilities compared to the control group. The differences were statistically significant.

Conclusion: Visual feedback training is an effective intervention for improving movement capabilities in children with unilateral cerebral palsy. Further research is needed to explore the long-term effects and to determine the optimal training protocols.