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Efficacy of Upsee Therapy Program with an Enriched Stimulating Active Environment on Improvement Gross, Fine Motor Abilities and Weight Bearing Distribution in Spastic Diplegic Cerebral Palsy Children

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Objectives: This work was carried out to investigate the efficacy of upsee therapy program with an enriched stimulating active environment on improvement gross, fine motor abilities and weight bearing distribution in spastic diplegic cerebral palsy children.
Method: Thirty children were enrolled in this study and randomly assigned into two groups; group A received (upsee therapy program plus specific physiotherapy training) and group B (specific physiotherapy training program only). Gross motor functional measure (**GMFCS**), pegboard test and weight bearing distribution stages evaluation were used to detect and follow gross, fine motor abilities and weight bearing distribution. This measurement was taken before initial treatment and after 12 weeks of treatment. The children parents in both groups A and B were instructed to

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complete 3 hours of the home routine program every day. Dependent t-test was used to compare pre to post treatment changes.
Results: Data analysis was available on the 30 spastic diplegic cerebral palsied children participated in the study. The difference between pre and post-treatment results was more significant in (**GMFCS**) upsee group than the control group. Weight-bearing distribution stages evaluation and pegboard test demonstrate representative improvement in the study groups (p=0.0001) while insignificant in the control groups.
Conclusion: The addition of upsee therapy program to specific physiotherapy training is recommended in improving gross, fine motor abilities and weight bearing. So this suggested approach may be used as a selective choice for improving walking, hand functions and weight bearing abilities in spastic diplegic cerebral palsy children.

Keywords: Upsee therapy; upright posture; cerebral palsy; walking performance.

1. INTRODUCTION

Cerebral palsy is considered the greatest cause of physical dysfunction in childhood [1]. The child becomes immobilized and non-weight bearing which lead to impaired bone mineral density plus reduced muscle mass which lead to improper muscle pumping and decreasing of bone blood supply leading to decrease bony mass [2,3]. There is a relationship between skeletal morphology and muscle function so to improve gross motor skills we should concentrate on activation of musculoskeletal system [4] so upsee therapy training could be used in the modulation of musculoskeletal system [5].

Non weight-bearing state of cerebral palsy children lead to valga thigh (neck-shaft angle of the femur exceeds than normal) with great spasticity of hip adductor and iliopsoas which direct femoral head against lateral rim of the acetabulum lead to delaying of hip joint development which leads to subluxation and dislocation of the hip-lead to pain, scoliosis and impaired upright posture [6,7].

Upsee therapy supplies the impaired mobility cerebral palsy children with an enriched stimulating active environment that form the foundations and the keys for acquisitions of new skills and reacquisition of lost skills [8]. Cerebral palsy is associated with impairment of perception-cognition complex which is the base of gross and fine motor skills acquisition [9]. Upright Posture control by upsee therapy keep the head, neck, trunk in a functional position to be able to connect with the environment leading to facilitate hand functions, ADL and walking abilities [10].

Changing of the child passive home environment to active one place the hand ready to perform all hand functions from upright posture leading to improvement of balance control, hand functions skills, walking abilities and provide CP children with the new sensory experience of movement and participation [11]. The dynamic compression forces of the upsee system during walking increase hip stability via increasing of acetabulum depth [12,13] through functional weight bearing which has more impaction on joint stability while the worst instability occurred by spasticity [14].

Upsee therapy can provide active standing which improves the bone mineral contents leading to increased bone density as increase femoral neck mineral density [15] and static standing increase lumbar bone mineral density [16] in addition the cognitive skills development need interplay between higher centers, posture alignment and right enriched environment which can be provided by upsee therapy program [17].

2. MATERIALS AND METHODS

2.1 Subjects

Thirty children from both sexes with spastic diplegic cerebral palsy children were enrolled for this study, aged 5 to 10 years at the time of enrollment due to the children in this age are able to participate in (GMFCS) levels. Children are not able to walk without assistance, Children who alternatively met the inclusion standard were rule out if they had severed tight muscles, epileptic fits, osteoporosis or brittle bone, Current fracture unless medical clearance has been given, post-operative weight-bearing restrictions, pain due to muscle strain or joint subluxation occurring during standing, previous BoNT-A injections in the LL. in the past year or previous lower limb surgery.

Children randomized to the experimental group (A) received upsee therapy program plus specific physiotherapy training. Children randomized to the control group (B) received specific physiotherapy training program only. The individual-based upsee therapy program treatment sessions of 60 minutes were conducted five times weekly for 12-weeks in a physiotherapy treatment room after the specific physiotherapy training for one hour. In addition, children in the two groups were exposed to home routine program 3 hours daily for the 12 week treatment period.

2.2 Outcome Measurements

1-Gross motor functional classification system (GMFCS)

It includes 5 levels for evaluation and follows up a gross motor abilities.

I and II Walk without support.

Ш Walk with a mobility device.

IV and V cannot sit or walk without support.

It has proven to give an accurate description method for evaluation of the gross motor abilities of children with CP. **GMFCS** reflect better indication toward spastic diplegic CP children more than other forms.

GMFCS levels:

Level I the children who walk without restriction.

Level II the children have restriction to walk elongated lengths and at equilibrium.

Level III the children walk using a hand-held mobility tool.

Level IV is carried by manual or mechanical wheelchair.

Level V there is loss of head and trunk control, requiring wide use of mechanical and physical aids [18].

2-Weight-bearing distribution stages evaluation

By using the weight scale we could locate the time of pressure that the child could perform on the scale to detect the level of weight bearing distribution

Stage 1: No weight bearing
Stage 2: Flickers of weight bearing
Stage 3: Weight-bearing extended for 5-30 seconds
Stage 4: Weight-bearing extended for more than 30 seconds however less than 2 minutes
Stage 5: Maintain symmetrical weight bearing through legs [19].

3 - Evaluation of hand functions:

Via 9 whole pegboard test by determining the level of hand function grading by locating the time needed to fit all materials on its position.

2.3 Intervention

The main goal of the upsee rehabilitation program is to gain utmost functional skills, upright postural control, and hand function skills with minimal external assistance [20].

Both groups (A and B) received a specific physiotherapy program, like the following: Facilitation of milestones, inhibition of released primitive reflexes , Balance training program, inhibition of spasticity, facilitation of hand function, correct deformity, gait training, proprioceptive training and using of orthoses.

The experimental group (group A) received upsee therapy program adding to specific physiotherapy program as following: Upsee therapy harness is an orthotic device. It was worn by the therapist, parents and child which was used for facilitation of standing, walking and hand functions skills [21] it is indicated in children with the severely impaired trunk and postural control [22] which is developed from cranium-caudal direction starting by head control then upper trunk control finally lower trunk control and pelvis control [23,24].

The upsee system consists of a waistcoat with the pelvic belt, groin support with adjustable straps to link the child from his shoulder to the adult pelvic belt and sandals shared from the child and therapist. The child put on his ankle-foot orthoses before wearing upsee system [8]. The degree of weight bearing can be controlled by the therapist via changing of the supporting straps via taking the weight through therapist legs [25].

The specific physiotherapy therapy session with upsee therapy system last for 2 hours 7 days/weeks for 3 months. Starting of weight bearing 15-20 minutes in standing and walking, increased by 5 minutes every few days until they reach 60 minutes of standing and walking [26]. The home routine program could be performed 3h/day.

2.4 Upsee Therapy Program

1- Upsee therapy from standing:

- At first, the therapist gives some support to the child's shoulder from the front to encourage the hand function activities.
- Start standing in front of a mirror then sway body to both sides.
- Allow the child to perform reaching in all directions.
- Shifting the weight slowly to less weight bearing side and encourage the reaching training on that side.
- Step forward by the more weight bearing leg to initiate the walking.
- Shifting weight from side to side.
- A pegboard table placed at the level of the child's elbow or slightly above containing different types of toys, puzzles, sands, water, paint, and different occupational material.
- Catching and throwing a ball, kick a balloon and ball.
- When the child weight bearing improved loosen the shoulder straps slightly to increase the trunk control.
- Put different magnet shapes on the door, draw, paint, and copy of a design.

2-Upsee therapy from walking

- Take slowly one step forward and backward then sideways and backward.
- locate one foot along with the other and by the therapist, leg induce rocking the child anterior and posterior.
- Start walking with short steps and a large base of support.
- Walk through obstacles, walking on different surfaces, walking downstairs then upstairs.
  Walking in different directions looking for toys.
- Encourage the child to locate the direction and initiate the step.
- Kicking ball and balloons during walking.
- Walking in the sand, garden of the low and high surface.
- Ask the child to point out to determine the direction by his head, hand then leg [19].

3. RESULTS

3.1 Patients' Characteristics

Table 1 display the demographic and analytic traits of all patients. There were 11 boys (36.67%) and 19 girls (63.33%) and in term of right-hand dominance reported in 22 patients (73.33%), and also eight patients (26.67%) were left-hand dominance. There was no representative change within both groups in relation to age (p=0.8038), toward sex (p=0.2712) and in term of hand dominance (p=0.1054).

3.2 Changes in GMFCS Level

Mean test scores and SD for both groups are demonstrated in Table 2. The mean record of **GMFCS** level in the two groups at (pretreatment level) was insignificant (p>0.05) while the two groups had an expressive enhancement in **GMFCS** at post-treatment level (p<.05). The average improvement of **GMFCS** level had a tendency to be highly representatives improvement in the experimental group (2.33 ± 0.49 versus 3.20 ± 0.41., p=0.0001) than in the control group (3.20 ± 0.77 versus 3.47 ± 0.52, p=0.0406). The percentage of improvement **GMFCS** level was (27.19%) in the study group compared to the (7.78%) in the control group.

Table 1. Patients characteristics

Variables	Study group N=15	Control groupN=15	P-value
Age	7.53±1. 64	7.40±1.24	0.8038
Sex N%			
Boys	4 (26.67%)	(46.67%)7	0.2712
Girls	11 (73.33%)	8 (53.33%)	
Hand dominance N%			
Right	9(60%)	13(86.67%)	0.1054
Left	6(40%)	2(13.33%)	

Table 2. The average test of GMFCS level in both groups

GMFCS levels	Study group Mean±SD	Control group Mean±SD	P-value (within groups)
Pre-treatment	3.20 ± 0.41.	3.47 ± 0.52	0.1299
Post-treatment	2.33 ± 0.49	3.20 ± 0.77	0.0010
Improvement%	27.19%	7.78%	0.0005
P-value (within groups)	0.0001	0.0406	

3.3 Changes in Weight-bearing Distribution

Mean test scores and SD for the two groups are demonstrated in Table 3. The mean record of weight bearing distribution level in the two groups at (pre-treatment) was insignificant (p>0.05) while the two groups had an expressive enhancement in weight bearing distribution at post-treatment level (p<.05). The average improvement of weight bearing distribution level had a tendency to be highly representatives improvement in the study group (2.47 ±0.52 versus1.53 ±0.52, p=0.0001) while in significant representatives in the control group (1.73 ±0.70 versus 1.53 ±0.52, p=0.0824). The percentage of improvement of weight bearing distribution level was (61.44%) in the study group compared to the (13.07%) in the control group.

3.4 Changes in Pegboard Test

Mean test scores and SD for both groups are displayed in Table 4. The mean record of pegboard score in both groups at pre-treatment was insignificant (p>0.05) while the two groups had a representatives enhancement in pegboard score post-treatment (p<.05). The average improvement of peg board score had a tendency to be highly representatives improvement in the study group (44.67 ± 4.42 versus 49.00 ± 5.41p=0.0001) while in significant representatives in the control group (48.67 ± 5.81 versus 48.00 ± 5.61, p=0.1643). The percentage of improvement of pegboard score was (8.8%) in the study group compared to the (1.4%) in the control group.

4. DISCUSSION

The results of the present study suggest that upsee therapy program with an enriched stimulating active environment might be useful to enhance independency in the GMFCS levels in addition to exceed the gradual weight bearing time during standing in upright posture also decreasing of the time required to perform hand functions skills. Both groups showed increases of the Independency in the GMFCS levels in favor of upsee training group (2.33 ± 0.49 versus 3.20 ± 0.41., p=0.0001) than in the control group (3.20 ± 0.77 versus 3.47 ± 0.52, p=0.0406) In addition to the upsee training groups showed increased of weight bearing distribution after training with upsee therapy program (2.47 ±0.52 versus 1.53 ±0.52,p=0.0001) while insignificant representatives in the control group (1.73 ±0.70 versus 1.53 ±0.52, p=0.0824) also In the upsee training groups showed a parallel improvement of the time required on the performing target confirms that the spastic diaplegic cerebral palsy children became better in performing of hand functions skills (group (44.67 ± 4.42 versus 49.00 ± 5.41p=0.0001) while insignificant representatives in the control group (48.67 ± 5.81 versus).

Table 3. The average test of weight bearing distribution level in both group

Weight-bearing distribution level	Study group Mean±SD	Control group Mean±SD	P-value (within groups)
Pre-treatment	1.53 ±0.52	1.53 ±0.52	1.0000
Post-treatment	2.47 ±0.52	1.73 ±0.70	0.0030
Improvement%	61.44%	13.07%	0.0052
P-value (within groups)	0.0001	0.0824	

Table 4. The average test of pegboard score in seconds in both groups

pegboard score level in seconds	Study group Mean±SD	Control group Mean±SD	P-value (within groups)
Pre-treatment	49.00 ± 5.41	48.00 ± 5.61	0.6230
Post-treatment	44.67 ± 4.42	48.67 ± 5.81	0.0429
Improvement%	8.8%	1.4%	0.0001
P-value (within groups)	0.0001	0.1643	

The spastic diplegic CP had more liability for walking mobility because the upper limbs were less affected than LL so they can participate better in activity [27]. The most important improvement time in the main motor developmental stages and muscle mass in cerebral palsy children is the first 10 years because in this period the body structure, function, participation, and mobility could be influenced better and the improvement in progress. Beyond this age, the secondary motor development either improved or be stable [28].

The upsee therapy supply the motor impairment children with an enriched stimulating environment(by putting the children in variant circumstances and difficult situations with massed physical practice) lead to enter the child in active participation which is the key of active motor learning and gaining of motor skills [29].

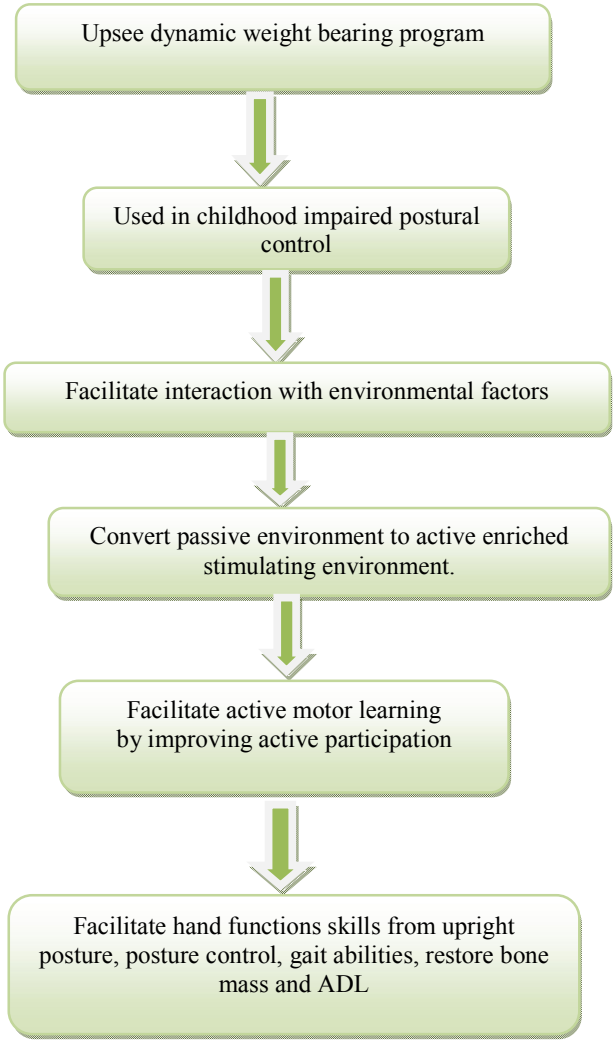

Fig. 1. Underlying mechanisms of upsee therapy [30]

The functional weight bearing with upsee system stimulate the reciprocal inhibition between spastic and anti-spastic muscles for improving selective motor control leading to a decrease of the degree of spasticity. A therapist could provide the lowest degree of support to the child allowing the child to increase his weight on his legs leading to sufficient inhibition of abnormal co-contraction leading to increase in the motor control of LL that improve walking abilities [31].

Unilateral weight bearing and weight shift training is a vital developmental skill required for lower limb motor control not only the start of upright mobility but also for balance control abilities [32]. The upper trunk with upper limbs should have a degree of freedom to be coordinated during reaching and ADL [33]. Posture stability at the pelvis and trunk is considered the biomechanical key for enhanced gross and fine motor abilities as upright postural control, eye-hand coordination, and hand functions skills [34].

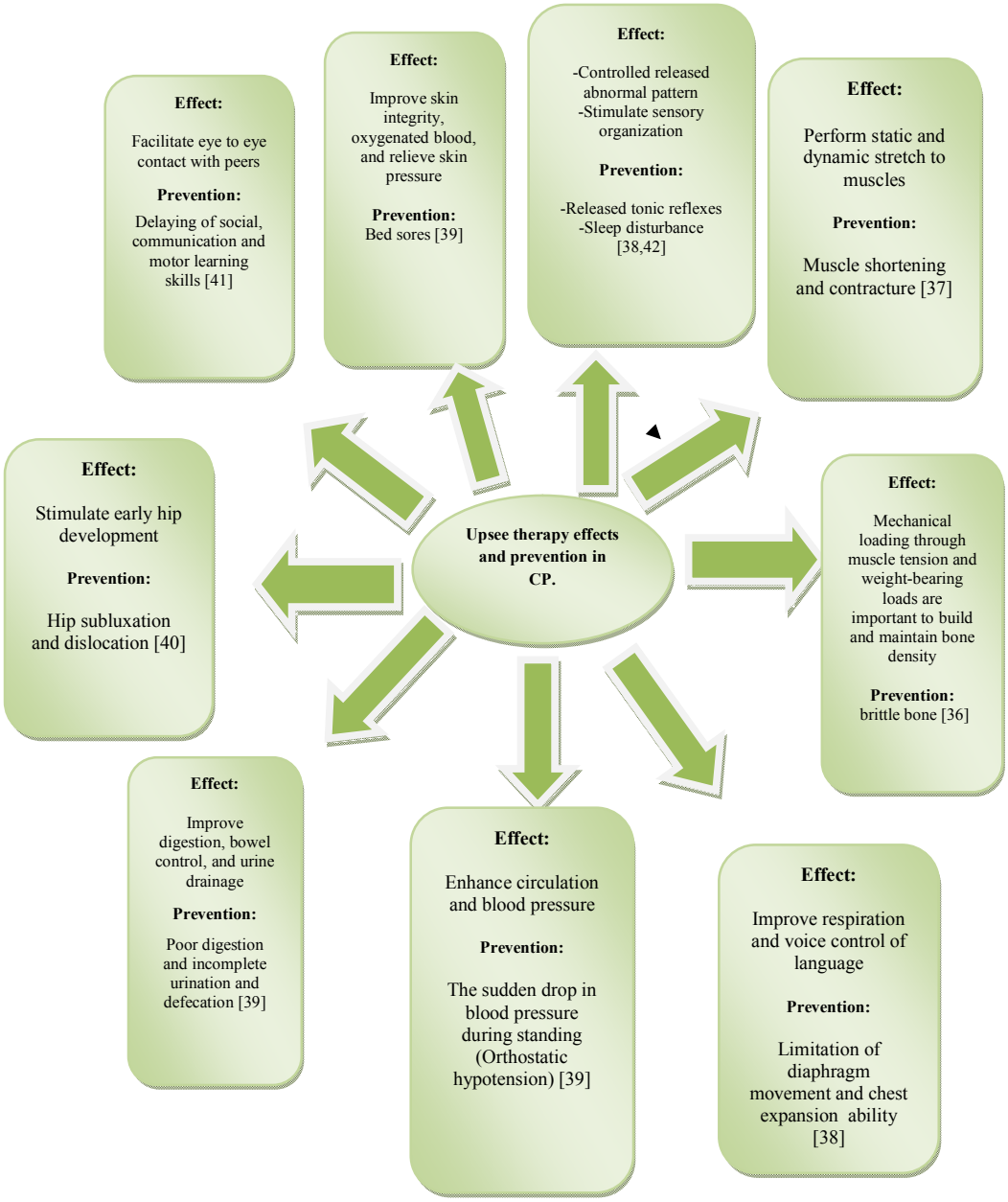

Fig. 2. Upsee therapy effects and preventions in cerebral palsy

The requirements of posture control include the presence of postural reactions (righting-equilibrium and protective reactions), controlling on primitive and tonic reflexes, reciprocal inhibition mechanism, motor development and normal intention movement and normal muscle tone plus the normal posture curves after labor thoracic and sacral curves and with four-foot kneeling cervical curve was formed and with sitting and standing lumbar curve was formed [35].

5. CONCLUSION

The addition of upsee therapy program to specific physiotherapy training is recommended in improving gross, fine motor abilities and weight bearing. So this suggested approach may be used as a selective choice for improving walking, hand functions and weight bearing abilities in spastic diplegic CP children.

CONSENT

As per international standard written participant consent from the concerned parents has been collected and preserved by the authors.

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COMPETING INTERESTS

The author has declared that no competing interests exist.

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