Effect of suit therapy on back geometry in spastic diplegic cerebral palsied children

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Abstract: The purpose of this study was to examine the effect of suit therapy on back geometry in spastic diplegic cerebral palsied children. Subject: Thirty spastic diplegic children ranging in age from 7 to 9 years from both sexes. They were classified randomly into two groups of equal numbers group (A) and group (B). group A received designed exercise therapy program, while group B received the same exercise program while wearing the therasuit. Methods: The patients' posture was evaluated before and after the suggested treatment program by Formetric instrument system. The data were collected and analyzed using a paired and un-paired t-test to compare the difference between the results. Results: this study revealed that there were significant differences (p<0.05) of all of the measured variables (trunk imbalance, pelvic tilt, lateral rotation, surface rotation) between pre test and post test in the control and experimental groups. Conclusion: therasuit has got clear effect when added to treatment program in correcting the posture in spastic diplegic children.

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1. Introduction

Cerebral palsy(CP) is the most common cause of physical disability in childhood and may affect the child on several health dimensions; the motor signs include primary neuromuscular deficits, such as spasticity, muscle weakness and decreased selective motor control, and secondary musculoskeletal problems, such as bony malformations and contractures **(M. Siri et al, 2010).**

Cerebral palsy results from an injury to the developing center nervous system (CNS), which can occur in uterus during delivery or during the first two years of life. The clinical manifestations depend on the magnitude, extent and location of the insult that causes the irreversible damage to the brain, brain stem, or spinal cord. The severity ra8uy8gt6ytfvc6uygbn nges from subtle motor impairment to involvement of the whole body **(Koman et al., 2004).**

Cerebral palsy (CP) is the commonest cause of neuromuscular spinal deformity. The incidence of spinal deformity in patients with CP as a whole is estimated at about 25%. It must be realized that the incidence of spinal deformity depends not only on the severity of the neurological deficit, but also on the physiological category into which the patients falls. Spinal deformity is more common in spastic CP **(Williamson, 2003).**

Spastic diplegia is the most prevalent type of cerebral palsy. It is characterized by pyramidal motor syndrome predominating in the lower limbs commonly due to perinatal hypoxic – ischaemic insult causing lesion in the white matter adjacent to the lateral ventricles of the brain, or periventricular leukomalacia **(Mewansingh, 2002 and Dan et al., 2001).**

Lateral deviation of the spine is an attempt made by the spastic diplegic child to improve standing posture. Since pelvis is the link between lower limbs and spine, so the functional leg length discrepancy which is transmitted to the pelvic giving pelvic tilt is in turn transmitted to the spine using it's flexibility to give lateral deviation **(Chantraine et al.,1995).**

A variety of functional aids are available for therapy programs for cerebral palsy children like the prone or supine board, corner chair, feeding chair, other adaptive seating arrangements, sensory and motor stimulating toys, standing tables, etc. Use of brace together with a therapy program has both components and detractors. Therapy and bracing may be mutually supplemental in helping to achieve functional development. Use of braces should be task oriented like, in standing or weight bearing. As the child develops toward weight bearing and ambulation, appropriate use and progression to walker, crutches and canes must be considered **(Liptak, 2005)**

Suit therapy has been proposed as an alternative to conventional therapy to treat the impairments associated with cerebral palsy. Suit therapy also known as the Adeli suit, polish suit, therapy suit and penguin suit. It is a modification of a space suit. This therapy is based on a suit originally designed by the Russians for use by cosmonauts in space to minimize the effect of weightlessness. Although the cause of motor dysfunction between cerebral palsy patients and astronauts are different, results of a treatment trial with the Penguin suit to rehabilitate children with cerebral palsy appeared promising **(Alagesan et al, 2011).**

Therasuit is a soft dynamic proprioceptive orthotic device, which is classified as class I Limb Orthosis by the U.S. Food and Drug Administration. **(FDA, 2006)** It consists of a vest, shorts, headpiece and knee piece, and shoes with hooks. Suit therapy has been proposed as an alternative to conventional physiotherapy to treat the impairments associated with cerebral palsy providing an orthosis along with the conventional therapy improves the motor performance of the child. Hence (**Seifeldin et al, 2004).**

2. Material and Methods

1- Patients

Thirty spastic diplegic cerebral palsied children of both sex participated in this study. They were selected from the out patient clinic of Faculty of Physical Therapy 6 October University according to these criteria - Their ages ranged from 7to9years, They were able to stand alone, They had grade 1+ to 2 spasticity according to Modified Ashwarth Scale, They were able to walk with support with abnormal pattern of gait.

Children were subsequently excluded for any of the following reasons: they were medically unstable as determined by, history, or medical records, they had epilepsy, visual or auditory problems.

Children were randomly assigned into two groups of equal number (A and B).Group A (control) received a designed exercise program for spastic diplegia with emphasis on posture correction, while group B (study) received conventional therapy while wearing Modified Suit consisting of a vest, shorts, knee pad and shoe attachments.

Back geometry for each child was evaluated before and after three months of treatment by using Formetric instrument system to assess lateral deviation, trunk imbalance, pelvic tilting and surface rotation of vertebra.

2- Instrumentation

2.1. For evaluation

Formetric instrument system

This system serves for the determination of the geometry of the spine of the human being based on non-contact three dimensional scan and spatial reconstruction of the spine derived from it by means of a specific mathematical model.

The Formetric instrument system contains the following major subassemblies

-The scan system: It is (optical column) with base plate contains a raster projector and a video camera mounted into a profile tube. A telescopic drive provides motorized vertical adjustment of the entire system.

-*The computer*: It is visual spine software which provides 3D-reconstruction of the spine based on measurement data of the system Formetric and allows individual image analysis of the carried out examinations.

-*The black background screen*: It is black to allow absorption of any light rays fall away of the patient body and prevents any reflection of the rays again to the recording camera to allow clear and accurate recording of the patient's back.

-*The laser printer*: Provides high-quality result presentation.

The results of shape analysis were plotted on the laser printer as graphic protocol. Each graphic protocol contains some anatomical parameters which are calculated from the anatomical landmarks. The anatomical landmarks are denoted as follows (Fig. 1):

VP: Vertebra prominence,

SP: Sacrum point,

DL: Left dimple,

DR: Right dimple, and

DM: Midpoint between both dimples, and, derived from it, a spatial reconstruction of the spine by means of a specific mathematical model

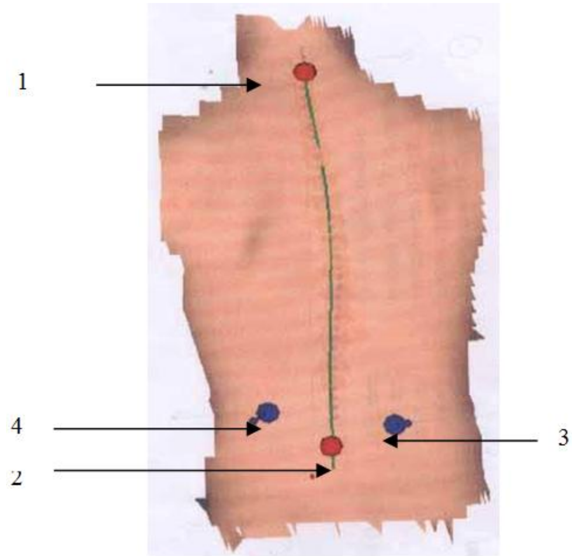

Fig 1 **-** (1) vertebral prominence (VP). **(2)** mid point between lumber dimples (DM). **(3)** right lumber dimple (DR). **(4)** left lumbar dimple (DL).

For treatment
Mats, Wedges, rolls of different size and Balance board

Fig. (2) Treatment equipment

Procedures

Evaluation by using Formetric instrumentation system:

The following steps were considered before starting the evaluation procedure

- The procedure was explained to the child and his/her family.
- The child was taught to take and hold deep breath and avoid forced breathing (this done by the therapist who perform the action several times in front of the child then, the child was asked to imitate the action several times until he do it correctly)
- One or two trials were run in order to make sure that the child understood the procedure.
- Any changes in the set up of procedure the recording was discarded and the procedure run start form the beginning.
- A free standing posture was preferable. A rigidly erect standing posture was avoided to avoid undetection of the axillary point.

The child was also asked to keep his/ her both upper extremities freely extended beside the body as much as possible. Height adjustment of the optical column was done before capturing to obtain the suitable image. When the camera was ready for image recording, a green horizontal line appeared on the computer screen and the projector lamp was automatically switched. During capture, the child was asked to hold on breath for a period of 40 ms. Full back shape three-dimensional analysis was recorded and printed out for each child **(Hierholzer 2001).**

Treatment procedures:

1- Treatment for control group:

Patients of the control group received a selected physical therapy program for one hour per session, three times per week for three successive months directed towards improving the physical condition of the child in a form of:

1) Back and abdominal exercises to prevent spinal deformities and improve trunk control

2) Facilitation of posture reaction including:

Stimulation of equilibrium reaction from sitting on ball.

Stimulation of protective reaction from sitting on ball and standing on balance board by tilting the child in different directions forward, backward and side way

3) Exercises to maintain the optimum length of the muscle especially the tendoachilis, hamstrings, hip flexors and adductors in the lower limbs were done.

4) Strengthening exercise for antispastic muscles particularly, knee extensors, hip abductors and the ankle dorsi flexors muscles via graduated active exercise.

5) Facilitation of standing and weight shift:

6) Gait training exercises

7) Training for ascending and descending stairs

2- Treatment for study group:

In this group patients received the previous selected physical therapy program while wearing suit therapy for three successive months.

3. Data analysis

All statistics were calculated by using the statistical package of social sciences (SPSS) version 16. Descriptive statistics, (mean and standard

deviation) for each measuring variables of the two groups before and after three months of treatment.

3. Results

Descriptive data of both groups (A and B):

Table (1): Statistical analysis for age between group (A) and group (B) pre- and post-the program.

Items	Age(year)
Group A	8.10 ±0.78
Group B	8.11 ±0.67
t-value	0.36
P-value	>0.05
Significance (P<0.05)	NS

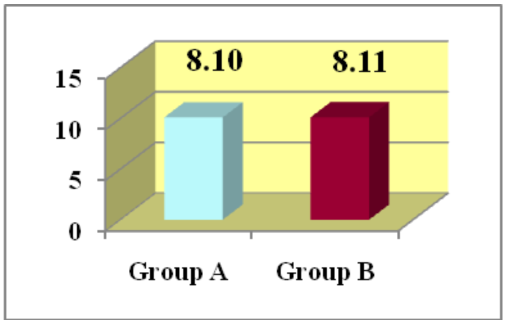

Figure (3): Mean age between group (A) and group (B)

The ages (mean ± standard deviation) of group A and group B were

8.10 ±0.78and 8.11 ±0.67years; respectively, which illustrate insignificant difference among both groups as shown in table 1.

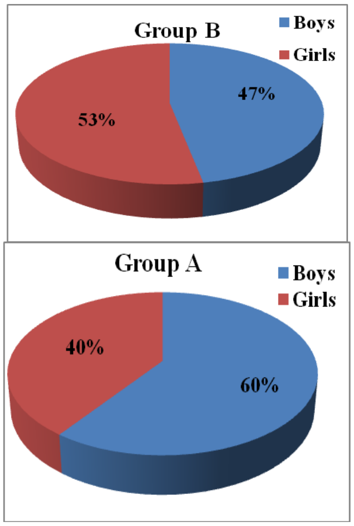

Figure (4): Sex distribution in groups A and B.

Table (2): The frequency distribution of sex in both groups (A and B)

Items	**Boys**	**Girls**	**Total**
Group A	**9 (60%)**	**6 (40%)**	**15 (100%)**
Group B	**7 (47%)**	**8 (53%)**	**15 (100%)**

The statistical analysis of the distribution of the children's sex for groups (A) and (B). The percentage of the females and males in group A was **(40%)** and **(60%)** respectively, while the percentage of the females and males in group B was **(53%)** and **(47%)** respectively as shown in table(2).

I - Trunk imbalance

There were significant differences of trunk imbalance score between pre and post test in control and experimental groups and there were significant differences of trunk imbalance between post test of both control and experimental groups as shown in table(3)and Fig (5).

Table (3): Statistical analysis for trunk imbalance between group (A) and group (B) pre- and post-the program

Items	Pre-	Post-	Improvement (%)	t-value	P-value	Sig.
Group A	13.80 ±7.42	8.27 ±6.87	40.07%	4.04	<0.05	S
Group B	16.13 ±8.31	4.00 ±2.54	75.20%	7.35	<0.001	S
t-value	0.81	2.26				
P-value	>0.05	<0.05				
Sig. (P<0.05)	NS	S				

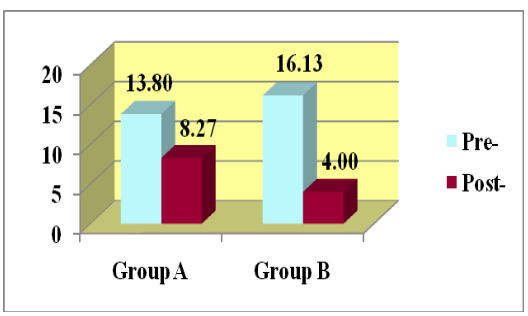

Figure (5): Showing pre- and post-treatment mean values of trunk imbalance in groups A and B.

<u>II – PELVIC TILT</u>

There were significant differences of pelvic tilt score between pre and post test in control and experimental groups and also there were significant differences of pelvic tilt between post test of both control and experimental groups as shown in table(4) and Fig (6).

Table (4): Statistical analysis for pelvic tilt between group (A) and group (B) pre- and post-the program

Items	Pre-	Post-	Improvement (%)	t-value	P-value	Sig.
Group A	11.20 ±4.33	7.60±3.87	32.14%	10.31	<0.05	**S**
Group B	12.47±7.73	4.47 ±3.18	64.15%	6.60	<0.05	**S**
t-value	0.55	4.75				
P-value	>0.05	<0.05				
Sig. (P<0.05)	**NS**	**S**				

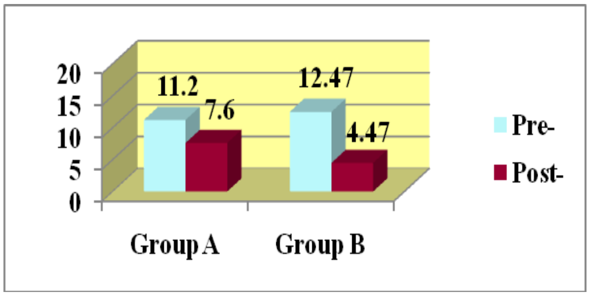

Figure (6): Showing pre- and post-treatment mean values of pelvic tilt in groups A and B

III – SURFACE ROTATION

There were significant differences of surface rotation score between pre and post test in control and experimental groups and also there were significant differences of surface rotation between post test of both control and experimental groups as shown in table(5) and Fig (7).

Table (5): Statistical analysis for surface rotation between group (A) and group (B) pre- and post-the program

Items	Pre-	Post-	Improvement (%)	t-value	P-value	Sig.
Group A	7.53±3.53	5.00 ±3.38	33.60%	4.92	<0.05	S
Group B	8.33±3.02	3.60±1.45	56.78%	7.53	<0.05	S
t-value	0.67	2.10				
P-value	>0.05	<0.05				
Sig. (P<0.05)	**NS**	**S**				

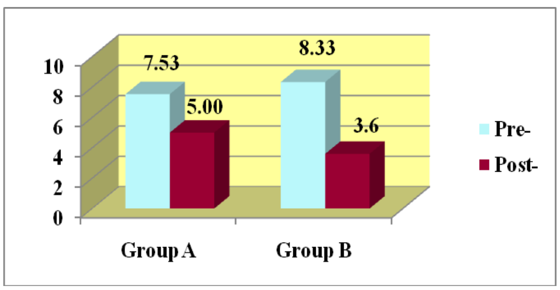

Figure (7): Showing pre- and post-treatment mean values of surface rotation in groups A and B.

IV – LATERAL DEVIATION

There were significant differences of lateral deviation score between pre and post test in control and experimental groups and there were significant differences of lateral deviation between post test of both control and experimental groups as shown in table(6) and Fig (8).

Table (6): Statistical analysis for lateral deviation between group (A) and group (B) pre- and post-the program

Items	Pre-	Post-	Improvement (%)	t-value	P-value	Sig.
Group A	9.80 ±4.72	6.67 ±3.92	31.94%	6.44	<0.05	S
Group B	12.87 ±6.22	4.13 ±2.59	67.83%	6.70	<0.05	S
t-value	1.52	2.09				
P-value	>0.05	<0.05				
Sig. (P<0.05)	**NS**	**S**				

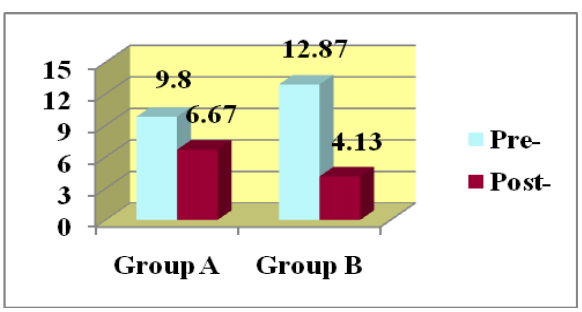

Figure (8): Showing pre- and post-treatment mean values of lateral deviation in groups A and B.

4. Discussions

The purpose of this study was to evaluate the effect of suit therapy on back geometry in spastic diplegic cerebral palsied children, which affect the quality of standing posture in those children by improving their posture, balance and facilitate the normal alignment between trunk, pelvis and lower limbs. Thirty spastic diplegic children were chosen from the outpatient clinic of the Faculty of Physical Therapy 6octber University. Both sexes were involved. Subjects were divided randomly into two groups of equal numbers, control group which received selected physical therapy program and study group which received the same treatment program while wearing therasuit for three successive months.

The pretreatment values of the formetric system obtained from both groups regarding the measured variables (trunk imbalance, pelvic tilt, surface rotation and lateral deviation) revealed non significant difference and abnormal values of these variables. This may attributed to neuromuscular impairments that interfere with proper postural control which agreed with **Cook and Wollacott (2001)** who found that, spastic diplegic patients are likely to have neuromuscular impairments which interfere with the development of proper postural control in addition to changes in the structure and function of the skeletal muscles particulary in the lower extremities.

The post treatment results of this study revealed an improvement in the mean values of the measured variables of the control group which received a selected physical therapy program which confirm the validity of the physical therapy techniques in treatment of diplegic CP patients.

The post treatment results of the study group revealed significant improvement in the mean values of the measured variables of the study group which received the selected physical therapy program while wearing therasuit.

Trunk imbalance and pelvic tilt may be improved due to the improvement of abdominal and back muscle strength. This was reflected on the ability of the child to elevate his upper trunk from prone or supine on wedge. A study by **(Datorre, 2005)** on intensive therapy combined with strengthening exercises using the Therasuit in a child with cerebral palsy concluded that the therasuit with intensive program includeing aquatherapy, hippotherapy helps to improve patient's functional abilities. **(Datorre, 2005)** stated that The therasuit provides external stabilization to the trunk and therefore allows more fluent and coordinated movement for both upper and lower extremities. The vestibular system, through the position of the body, records space and analyzes the muscle tone necessary to execute the movement. Patients with ataxia and athetosis benefit from the use of the therasuit through stabilization effect of the trunk.

Also this may be due to facilitation of postural reaction. This was supported by the opinion of **Wolacott et al., (2008)** who found that, spastic diplegic children have trunk imbalance which is due to poor postural reflexes..**(Koscielny, 2004)** stated that the theory behind the Suit therapy is that it induces a strong afferent proprioceptive input, which stimulates the formation of cerebral systems whose postnatal development has been delayed. the reduction of functional leg length discrepancy (LLD) in diplegic children (which is the main cause of pelvic tilt) this reduction in turn, may lead to improvement or reduce pelvic tilt. Such results add to the finding of **Gurney (2002)** who found that, functional LLD is a result of muscle (tightness/ weakness) or joint stiffness across any Joint in the lower extremity.

Benefits of Suit therapy includes external stabilization, normalizing muscle tone, aligns the body to as close to normal as possible, normalizing gait pattern **(Alagesan et al, 2011).**

The reduction of lateral deviation may be attributed to the reduction of trunk imbalance and pelvic tilt. Also this reduction may be due to the improvement of postural mechanisms, postural reactions and maintenance of proper body alignment. This comes in agreement with **Perrin (2009)** who found that, When modified suit is applied the child may improve his equilibrium reaction, as a result of improvement the efficiency of his trunk rotation, flexion and extension. providing tactile stimulation, influencing the vestibular system, improving balance, supports weak muscles, providing resistance to strong muscles to further enhance strength, helping to decrease contractures and improving coordination.

Very specific and precise placement of the elastic bands moves the entire body back on the heels and into, a more vertical position. Center of gravity moves back in between the feet. Very noticeable changes in muscle tone take place. A more relaxed and upright posture with corrected alignment of lower and upper extremities is noted immediately. This is how the orthosis normalizes muscle tone through the postural changes. This restoration of posture and proper function of postural muscles allows the child to learn (or relearn) proper patterns of movement. **(Bar-Haim ,2006)**

The effect of suit therapy which lead to improvement posture reactions, trunk muscles strength, trunk control and facilitate motor and sensory awareness may lead to the improvement of surface rotation.

Seifeldin et a, 2004 in a pilot study on the use of Suit Therapy in childhood cerebral palsy suggested that the combination of suit therapy with a short course of intensive physiotherapy may sufficiently reduce the functional limitation of children with cerebral palsy.

Conclusion

This study concludes that modified suit therapy along with conventional physiotherapy is effective in improving the back geometry in children with spastic diplegic cerebral palsy.

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